Ski transportation

A lead user study and product concept development for alpine ski equipment

transportation outside a car

Johan Axelson
Linus Svensson
2013

Master of Science in Engineering Technology
Industrial Design Engineering

Luleå University of Technology
SKI TRANSPORTATION

- A lead user study and conceptual product development for alpine ski equipment transportation outside a car

Johan Axelson
Linus Svensson
2013

Master of Science in Industrial Design Engineering
Department of Business Administration, Technology and Social Sciences
Luleå University of Technology
PREFACE

As dedicated skiers we believe that transporting the skis to the slopes should be an easy task. It is important that the transporting procedure is not associated with problems and hassles since most of the skiers want to spend their valuable spare time in the slopes. It is essential that the transport solution works proper to retain the good mood that usually arises when skiers go skiing.

In this project, we have used our own experiences according to ski transport. We have during the last couple of years spent around 30 days per season in various ski resorts. This has involved a lot of travel and transportation. Besides this aspect we have been collecting information from other skiers worldwide regarding ski transportation.

We want to thank everyone involved in this project. Anders Nilvius, Henrik Eriksson and Kalle Magnusson at Thule gave us the opportunity to carry out this project and their guidance and supervision through this project have been outstanding. We also like to thank Niklas Kronborg at Thule for great support regarding patent questions.

Daniel Höglund and Fredrik Eriksson at the design consultancy Veryday have given great support and supervision regarding methodology, project plan, and workshop.

Henrik Kax at Fearless design helped us with his expertise in textile products, for which we are very thankful.

Anders Häkanson at the division Innovation and Design, Luleå University of Technology has contributed with his valuable experience relevant to master thesis work.

Not least we would to thank all those who contributed their experience in internet forums, in our blog and in our workshop.

Luleå 5th of June 2013

..............................................
Johan Axelson

..............................................
Linus Svensson
ABSTRACT

This report is the result of a Thesis project at the Master Programme in Industrial Design Engineering at Luleå University of Technology. The project took place between January and June 2013 and the goal was to implement a lead user study and develop a concept for alpine ski transportation outside a car. The client was Thule which is a company developing products for transport solutions aimed at users who want to bring their equipment in a safe, simple and elegant way. Example of products are ski, bike and water sport carriers, roof racks, roof boxes, trailers, snow chains and bags.

The methodology used in the project have been inspired by the Lead user method originally developed by Eric Von Hippel in 1986. We have used internet forums, communities and a blog to collect opinions, and identify concerns from skiers around the world. A blog was created to be able to show off ideas and concepts in terms of sketches to users. This to get an indication of what ideas the users liked or how the ideas could be improved.

After the initial phase of getting feedback from users it was concluded that a large number of the users thought aerodynamics were most important for a good ski transport. It was also important to protect the skis from water and dirt. Based on these conclusions a concept of an expandable roof box was chosen to further develop.

To verify the expandable concept we built a variety of different mockups to investigate function, shape, volume and even perceived wind noise when mounted on a roof car.

The final concept is presented as CAD renderings and illustrates a new innovative product to be used for transport alpine skis and snowboards. It is a roof box, where the volume can be customised and adapted to the amount of cargo. The cross sectional area of the box will be minimised which is positive for the aerodynamic properties when the box is used on the roof of the car, but is also an advantage when storing the box when not in use since it will take up less space than an ordinary box. An flexible front, works as a hinge but also contributes to create a drop shaped and aerodynamic profile in all position, independent if the box is fully loaded or fully compressed. An empty box will cause less drag compared to a fully loaded. Skis and snowboards can be transported in safe manner without getting wet or dirty.
<table>
<thead>
<tr>
<th>INDEX</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>1.1 Background</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Objective and goal</td>
<td>3</td>
</tr>
<tr>
<td>1.3 Scope and boundaries</td>
<td>3</td>
</tr>
<tr>
<td>1.4 Thesis outline</td>
<td>3</td>
</tr>
<tr>
<td>2. SITUATION ANALYSIS</td>
<td>4</td>
</tr>
<tr>
<td>2.1 Thule - the client company</td>
<td>4</td>
</tr>
<tr>
<td>2.2 Thule Product Design</td>
<td>5</td>
</tr>
<tr>
<td>2.3 Safety</td>
<td>5</td>
</tr>
<tr>
<td>2.4 Alpine ski equipment</td>
<td>6</td>
</tr>
<tr>
<td>3. THEORY</td>
<td>7</td>
</tr>
<tr>
<td>3.1 Aerodynamics</td>
<td>7</td>
</tr>
<tr>
<td>3.2 Roof mounted accessories</td>
<td>11</td>
</tr>
<tr>
<td>3.3 Materials/Manufacturing</td>
<td>12</td>
</tr>
<tr>
<td>3.4 Colours</td>
<td>13</td>
</tr>
<tr>
<td>3.5 Patent</td>
<td>14</td>
</tr>
<tr>
<td>4. METHOD</td>
<td>16</td>
</tr>
<tr>
<td>4.2 Implementation of the Lead User Method</td>
<td>18</td>
</tr>
<tr>
<td>4.3 Organisation and planning</td>
<td>18</td>
</tr>
<tr>
<td>4.4 Iterative and incremental development</td>
<td>20</td>
</tr>
<tr>
<td>4.5 Using Internet forums</td>
<td>22</td>
</tr>
<tr>
<td>4.6 Using a blog as a communication platform</td>
<td>24</td>
</tr>
<tr>
<td>4.7 Benchmarking/Competitive testing</td>
<td>25</td>
</tr>
<tr>
<td>4.8 Related technology</td>
<td>26</td>
</tr>
<tr>
<td>4.9 Trend observations</td>
<td>26</td>
</tr>
<tr>
<td>4.10 Design workshop</td>
<td>27</td>
</tr>
<tr>
<td>4.11 Evaluation methods</td>
<td>29</td>
</tr>
</tbody>
</table>
4.12 Patent
4.13 Voting
4.14 Eliminating Matrix
4.15 Establish requirement specification
4.16 Concept refining and development
4.17 Prototyping and testing
4.18 CAD

5. RESULTS

5.1 Current market/Benchmarking results
5.2 Trend observations
5.3 Forum results
5.4 Identifying lead users
5.5 Concept generation and blog comments
5.6 Blog statistics
5.7 Evaluation results
5.8 Related technology
5.9 Workshop results
5.10 Patent results
5.11 Requirement specification
5.12 Concept development - Refining and improvements
5.13 Prototyping/Mockup results
5.14 Final concept
5.15 Material selection proposal

6. DISCUSSION

7. RECOMMENDATIONS

8. REFERENCES
9. APPENDIX INDEX

<table>
<thead>
<tr>
<th>Section</th>
<th>Number of pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ski dimensions</td>
<td>1</td>
</tr>
<tr>
<td>Preliminary time plan</td>
<td>1</td>
</tr>
<tr>
<td>Web communities and forums</td>
<td>2</td>
</tr>
<tr>
<td>Statistics of forum replies and unique users</td>
<td>1</td>
</tr>
<tr>
<td>Visitor statistics - Blog</td>
<td>1</td>
</tr>
<tr>
<td>Comment statistics - Blog</td>
<td>1</td>
</tr>
<tr>
<td>Workshop script</td>
<td>2</td>
</tr>
<tr>
<td>Pictures from workshop</td>
<td>1</td>
</tr>
<tr>
<td>Exploded view and material proposal</td>
<td>2</td>
</tr>
<tr>
<td>Computer renderings and visualizations</td>
<td>4</td>
</tr>
</tbody>
</table>
1. INTRODUCTION

This report is the result of a Master thesis project at the Master Programme in Industrial Design Engineering at Luleå University of Technology. The project took place between January and June 2013. The client in this project was Thule. Veryday have also been involved as supervisors, mainly regarding the methodology. In a later stage of the project Fearless Design was also involved for guidance and expertise within the specific area of textiles. The goal was to implement a lead user study and develop a concept for alpine ski transportation outside a car. The focus in this report is to describe the process and methods used during the project as well as the results.

1.1 Background

Thule Sweden AB is a company developing products for transport solutions aimed at users who want to bring their equipment in a safe, simple and elegant way. Example of their products are ski, bike and water sport carriers, roof racks, roof boxes, trailers, snow chains and bags. Thule was established in Sweden in 1942 and is today a global company and the largest brand in the Thule Group with the motto "Active life, simplified".

Thule sees a need to update their product range of existing ski carrier solutions, since the solutions have been very similar the last 20 years. Thule want to have a product range that is up to date and that appeal to a wider range of users as well as offer products that will help build up the Thule brand and give it a clear connection to an active lifestyle. With our skiing background and long experience of transporting ski equipment we wanted to investigate how the next generation of ski transportation solution could look like. What are the latest trends within ski transportation and what are user needs, both today and tomorrow, that the product needs to satisfy?

Below are example of traditional ski carriers that Thule offers today, figure 1-5.

Figure 1. Thule Xtender.
http://www.thule.com/sv-se/se/products/snowsports/skicarriers/thule-xtender-739-_-739?view=technical

Figure 2. Thule Deluxe.
Both Thule Deluxe (figure 2) and Snowpro (figure 3) have been on the market for around 17 respectively 15 years. Other Thule products used for ski equipment transportation are:
1.2 Objective and goal
The objective of this master thesis is to perform a lead user study and analyse the customer’s preferences, concerns and needs for transportation of alpine skis and equipment. The result of this study will be the basis to develop a concept for transportation of alpine ski equipment outside a car. The goal is to develop a new concept that have a clear connection to the Thule brand language and their motto "Bring your life". The product will be developed on a conceptual level and will be delivered as visualisations and include mockups. The product should have a clear relation with the activity, in this case skiing. The product must be safe, yet simple and elegant and satisfy the market needs.

1.3 Scope and boundaries
The timeframe for the project equals 30 hp (20 weeks full time work), involving two students. The project will be executed from 28 January to 7 June 2013.

The project will not include; strength of material and solid mechanics calculations, cost calculations, drawings, tooling or documentation for manufacturing, due restricted time frame.

1.4 Thesis outline
In the beginning of this report you can find relevant theories regarding product development, Thule’s core values, aerodynamics and ski transportation. Following is an in depth explanation of methods used in this project and how they were implemented. The work process of this project has consisted of several stages corresponding to the method. The result of each stage are presented in the result chapter. In the last part of the result chapter you can read about the final concept and how it works. Finally there is discussion and recommendation in which we critically review the final results and communicates what to be done if Thule want to continue to work with the final concept or to use the method.
2. SITUATION ANALYSIS

2.1 Thule - the client company

Thule Group believes their brands are the most valuable assets the company have, and Thule is the largest brand in the group. Thule Group is also convinced that one of the essential parts to continue to be one of the market leaders and to continue to grow, is that their staff continuously strive to be ambassadors for their products and brands. Thule Group wants that all their staff should understand the fundamentals of the products, what the brand stands for and their three guiding principles. The three guiding principles are Smart Solutions, Shared Passions and Active life. In aspect to smart solutions Thule Group wants their products to be innovative, user-friendly, safe, stylish and made of highest quality material. Considering shared passions Thule Group want to have their consumers around them and understand user needs, also by being consumers themselves. They want to listen to their users and develop trust through products and their services. By sharing the passion of an active lifestyle with their customers Thule wants to create products that makes the active life easier. (Thule Group, 2013)

The Thule brand was established in Sweden in 1942 and is today a premium brand used globally for a wide assortment of products with a focus on products related to transporting equipment when using a car. Other product areas Thule are involved in are for example accessories for recreational vehicles, trailers for horses, boats etc., snow chains and luggage.

Today Thule delivers 500 000 roof boxes to customers worldwide a year. They have four different manufacturing sites that are producing roof boxes. The biggest one is situated in Germany and the others are in England, Brazil and the United states. One reasons why they have several factories is for logistical reasons and that the boxes are bulky to ship. Talking to Michael Mitschke, international Product Manager Thule Cargo, the factory in Germany has a capacity of producing 1600 boxes daily and 16 fully loaded trucks can leave the factory each day to deliver boxes to costumers. It is important to have a flexible production line since the boxes are bulky and storage costs and logistics gets very expensive. The resellers often has limited storage as well. With a flexible production line Thule are able to adjust the production rate to fulfil the market needs momentarily. Usually the market need is fairly constant, but there are peaks, especially in connection with the winter/summer holidays and easter. Normally the boxes are delivered to customers within 24-48 hours after order. This enables retailers to offer the entire product range of Thule. The biggest market is the United States and Canada. The second largest market is Europe with Germany in the lead, followed by England, Italy and France. The nordic market is small but if the number of sold boxes is compared to the number of inhabitants the market is very valuable.
2.2 Thule Product Design
Thule is a premium brand that values a dynamic design approach that at the same time should add to a consistent design identity that communicates and strengthens the Thule brand. The Thule brand have a design philosophy that rests on three pillars (Thule, 2013):

• Fit for purpose - Designed on insight for a specific use.
• Genuine - Genuine materials and designs.
• Inspires Passion - Helps me express my lifestyle.

To define the desired user experience, how the products should be used and handled, four main functional benefits are used to outline the design philosophy in more detail:

• High Quality - User needs and design in balance.
• Safe - Reliable and trustworthy.
• Easy to Use - Intuitive, inviting and comfortable.
• Contemporary - Appealing and modern design that lasts.

To define the visual appearance of their products Thule have five main design values:

• Tension - Arches, tensioned surfaces and curves.
• Accentuated edges - Articulated shapes.
• Clean - Let form follow function.
• Contrast - A bold separation of parts and materials.
• Integrated - One main character.

2.3 Safety
When driving on roads and transporting goods, it is important to consider safety and security. The driving characteristics of a car can easily change when loaded with goods. Depending on how the car is loaded, it can be dangerous for drivers, passengers and other road users. For instance the car can easily become wobbly if you place heavy load on the roof of the car. With a heavily loaded roof box the centre of gravity is offset from the cars normal centre of gravity and this impairs driving properties (Trafikverket, 2013).

Thule test
Thule test all their products to be able to guarantee that the products can be used safe. They have a testing laboratory where they can simulate and test the products in various extreme situations. One of the tests is called city crash test, it is a standardised testing procedure that the International Organisation for Standardisation have developed. It means that the product is tested to investigate their performance in a frontal crash at 16-30 km/h, (ISO 11154, 2006). The products are subjected to other types of tests, such as vibration and fatigue tests, durability, UV-light, temperature and weather tests. All Thule products must pass the tests before they continue to manufacturing and be introduced to the market.
**Legal requirements**

In a global perspective there are different rules of what kinds of goods and what weight you are allowed to transport with cars. In general the car manufacturers specify the maximum load in four categories, maximum load for roof, maximum towing weight, maximum load on towball, and maximum load trunk/inside including passengers. It is against the law in most countries to exceed these limits. It is the driver of the vehicle who is responsible for the cargo, and that it does not exceed the maximum weight. The cargo must also be secured in such a way that it can not be a hazard. In Sweden drivers can be prosecuted for reckless driving it the cargo seems to be transported in unsafe manner (Transportstyrelsen, 2013). Transportstyrelsen recommends that all cargo in roof boxes should be secure inside the box to prevent movement.

This is an example of accepted loads, Volvo V70, D5, 2012 (Volvo Cars, 2013):

- Maximum load for roof: 100 kg
- Maximum towing weight: 2000 kg
- Maximum load on tow ball: 75 kg
- Maximum load inside: 450 kg

### 2.4 Alpine ski equipment

The alpine ski equipment means a greater variety of gadgets. Different skiers have different types of equipment, it may depend on ski conditions, skiing style, season, the users economy etc. Naturally, the skis/snowboard, boots and the poles are the most specific equipment for the alpine skiing activity. Skis and snowboards are the most critical equipment in a transportation perspective since the dimensions often results in that specially designed transport accessories are required. It is essential to know the dimensions of the equipment that skiers use to ensure that the equipment fits in a transportation product. This section shows dimensions of skis and snowboards. More ski dimensions can be found in appendix 1

![Figure 6 - Definition of ski dimensions.](http://skiingbusiness.com/files/2011/01/dynastarskis.gif)

**Dimensions skis:**
- Length: 70-205 cm
- Waist width: 60-150 mm
- Maximum width: 70-165 mm

**Dimensions snowboard:**
- Length: 110-180 cm
- Width: 20-32 cm
3. THEORY

In this section of the report we intend to provide relevant theories to the subject product development and ski transportation.

3.1 Aerodynamics

It is generally known that external accessories for cars are affecting the car’s aerodynamic properties. By definition aerodynamics is the branch of the science which is concerned with the study of the interaction between a body and the atmosphere through which it moves (Scibor-Rylski, 1975). Cars are playing an important part of today’s society and a lot of people use cars for daily basis.

Today it is a controversial topic and the uses of cars affect the global environment through emissions. Most car manufacturers are currently working to reduce emissions and make cars more efficient. To make their cars more environmentally friendly the manufacturers strive to reduce loss of energy. This means that it is not only sports car manufacturers that are investing for good aerodynamics. The accessory manufacturers should also put effort to make their products as efficient as possible to reduce the environmental impact.

Because it is a controversial subject, it is also something that customers are aware of. Today there are many companies that market their products as green, and that their products affect the environment less than their competitors. In many countries, there are reduced costs for environmentally friendly products. It is not only the environment that benefits from good aerodynamics, but it also saves money through reduced fuel consumption.

In this project it is important to be aware of all the basic aerodynamic principles involved, to avoid making a fundamental error. It is a logical connection that the shape of an external accessory for a car will affect the car’s aerodynamic characteristic. For instance, the cross sectional area have a big impact on the aerodynamics. The bigger cross sectional area, the greater the resistance will appear.
**Axisymmetric bodies**

Some shapes are approved to be more aerodynamic than others. A shape which has good aerodynamic properties is the axisymmetric droplet shape, figure 7A. This shape handle the air separation in the end of the body smooth and does not generate greater turbulence. The droplet shape can also be modified and still keep its aerodynamic properties. According to Scibor-Rylski this is called bobtailing. When Bobtailing the back of the droplet shape is cut off, figure 7B.

![Figure 7A - axisymmetric droplet shape, Figure 7B Bobtailed droplet (Scibor-Rylski, 1975).](image)

**Minimum drag - The ideal three dimensional shape**

All three-dimensional objects can have different shapes, and the shape will affect the drag when moving through air. The object can have an optimal shape to reduce the drag to a minimum. Cars and other shapes are often compared with drag coefficients \(C_v\) of different cars and shapes corresponding to typical length-to-height ratio. Scibor-Rylski claims that both experiments and theory show that the aerodynamic drag of a shape is relatively high when an object is short, and that it falls to a minimum drag coefficient of 0.04 when the length-to-height ratio is around 2.4 and then it increases again as the length increases, figure 8.

![Figure 8 - Effect of dimensions ratio of the axisymmetric body to drag coefficient, Cdf. (Scibor-Rylski, 1975).](image)
The minimum drag coefficient occurs when the relation between the normal pressure distribution from the drag and that due to the surface friction is optimum. The longer the object is the bigger resistance will be caused by surface friction. Scibor-Rylski also mentions that the axisymmetric body shape is not the most ideal shape when it moves closely along the ground. The axisymmetric body is only the ideal shape when flying free. He considers that objects moving through air along other surfaces are very complex and difficult to create an ideal shape of.

Scibor-Rylski have shown that a good approximation for an ideal shape that are going to travel along another surface is an “whale-shaped” body. This three dimensional shape looks like a drop, figure 9, but the lower half of the drop has a smaller radius than the upper part.

In order to prevent dirt and water accumulating at a surface that is moving through a dirty environment it is important that it is does not exist grooves and ridges. If it exists these will create turbulence and it will accumulate dirt in this areas. It is especially important that there are no grooves or ribs perpendicular to the driving direction. Since cavities or ribs contributes to turbulence and they also affect wind noise. A smooth surface is the best for both wind noise and dirt accumulation.

\[ A) \quad B) \]

*Figure 9A - Body of ideal shape, 9B - Picture of ideal shaped body (Scibor-Rylski, 1975).*

**Smooth surfaces**

In order to prevent dirt and water accumulating at a surface that is moving through a dirty environment it is important that it is does not exist grooves and ridges. If it exists these will create turbulence and it will accumulate dirt in this areas. It is especially important that there are no grooves or ribs perpendicular to the driving direction. Since cavities or ribs contributes to turbulence and they also affect wind noise. A smooth surface is the best for both wind noise and dirt accumulation.
Streamlined back
Scibor-Rylski mentions that in order to reduce the turbulence and the size of the wake behind the vehicle it is better to style the rear surface so that it slopes gently backwards to avoid premature flow separation. This shape is often adapted to sports cars and they often have style of what is called “fastback”, figure 10. This shape contributes to better aerodynamics and less drag.

Figure 10A - Fastback shape creating less turbulence, 10B, no fastback creating more turbulence. (Scibor-Rylski, 1975)

Effect of aerodynamic drag on fuel consumption
The aerodynamic drag of the car and its accessories has to be overcome by the force created by the engine. The bigger the drag is the more force has to be generated by the car and this affects the fuel consumption. The fuel consumption, at any speed, is directly proportional to the power required (Scibor-rylski, 1975). This obviously means that the greater the drag is at a given speed the more fuel is consumed. The drag is as mentioned before affected by shape and cross sectional area.
3.2 Roof mounted accessories

There is no absolute standard for roof rack systems. Automobiles have different shapes and sizes and are adapted for different types of loads. This means that a manufacturer like Thule strives for universal designs that can be used on as many cars as possible. To attach a roof rack on a car’s roof there are some basic principles. These principles are affecting the design of the roof racks feet which is connected to the car, figure 11-15.

**Figure 11 - Standard feet. Used for cars with no rails or fixed points.**
www.thule.com/sv-se/se/products/base-racks/feet/thule-rapid-system-754-754#

**Figure 12 - Feets for flush railings and fixpoints.**
http://www.thule.com/sv-se/se/products/base-racks/feet/thule-rapid-system-751-751#

**Figure 13 - Feets for rails. Used for cars with pre mounted rails.**
http://www.thule.com/sv-se/se/products/base-racks/feet/thule-rapid-system-753-753?view=technical
Apart from these attachment methods, there are other methods that are not dependent to any roof rack. Some manufacturers are producing products using magnets instead, figure 14, and these are usually equipped with a safety strap to be attached to the car's door.

Figure 14 - Feets with magnets, Deluxe magnetic.
http://images.esellerpro.com/2145/I/124/335/medscaleVIKING%20coppia%20copia.jpg

There are also products that use straps and no roof racks. For example, there are products designed for skis where they are placed on the roof and fastened with straps either through the vehicle or to the door hinges, figure 15.

Figure 15 - Skiboardbag, using only straps
http://www.boot-bag.com/skiboardbag.htm

3.3 Materials/Manufacturing

All roof boxes that Thule are producing today are made of a vacuum formed thermoplastic. There are a few manufacturers that choose to manufacture roof boxes in other materials, such as Skigard and Pacline that make their roof boxes out of fiberglass. Thule values the use of thermoplastic although the equipment for vacuum forming is much more advanced and more expensive compared to the equipment required to manufacture fiberglass. The vacuum forming does not require the same handicraft techniques which makes it easier to ensure the quality. The working environment is also cleaner when using thermoplastics, no dust from fibers, no resins, no hardener or volatile gases are involved in the process. A thermoplastic can also be recycled compared to a resin reinforced with fiberglass.

Thule use a ABS plastic for their vacuum formed roof boxes. The top part and base can differ in quality since the top part needs better resistance against sunlight. Polyamide reinforced with glass fibre, PA6 with 30% and 15% glass, are used in a wide range of their products because of its high quality and durability properties.
3.4 Colours

It is important that the product colour reflects what Thule is known for. It should be a link between the colour choices and Thule’s other products.

Thule colours

Thule’s four standard colours, black, dark graphite, white and silver, are used on all main parts within all product business areas (Thule, 2013).

![Thule colours, Black, Dark Graphite, Silver, White (Thule, 2013)](image)

The most common colour combination is black and silver, which is characteristic for Thule and creates great contrast that Thule strive for. Silver usually refers to satin silver aluminium which is the most important silver finish in the Thule product collection as a lot of their products include aluminium details. To highlight elements and points of interaction that need to be distinguishable from black and white, Thule use light grey for high contrast and dark grey primarily for exterior touch points. These colours can be applied on details such as grips, turning knobs or handles. Points of interaction can also be combined with a surface texture or pattern to clarify the interaction and create more contrast. For car related products Thule use a greyscale colour scheme, other accent colours such as blue are mainly used in non car related products and soft products. When using other colours in car related products it is to communicate if something is locked, closed, secured or warnings. The colours green, red and yellow can be used to indicate this and give feedback to the user.

Colour choices are important since they affect people’s emotions. Following are examples of general thoughts and emotions that people experience of colour (Löfgren, 2002):

- **Red** - Dynamic, activating, eye catching, intense, heat, love, revolution
- **White** - Virgin, capitulation
- **Black** - Force, strength, toughness, death
3.5 Patent

*It is a natural part of Thule product development to study patents and to seek patents for their own solutions. Therefore, they wanted us to study how it works to broaden our area of expertise in patents. In this section we present the theories about how patents can be applied.*

Patents protect technical solutions and inventions. The idea of the patent system is that it should stimulate technological development. The patent system is used to protect and promote innovation as well as sharing knowledge to facilitate the learning from each other. Patents are only valid in the countries in which you have applied and got the patent approved.

The number of searched patent applications worldwide have increased from 600 000 in 1980 to 1 000 000 in 2005 (Löfgren, 2005). The patent system plays an important role in today’s business, especially for companies striving to be market leading and working with cutting edge technology. With a patent, you get the exclusive right to use the invention commercially, for example, with sales and manufacturing (Löfgren, 2005). The patent owner is responsible for ensuring that no one is infringing on the patent. A patent normally last for a maximum of 20 years, but you have to pay a fee for every year and every country you want the patent to be active in.

The time for the application to be processed and approved are 18-24 months (normally up to 24 months to get approved by the Patent- och Registeringsverket, PRV, (Kaniuk, 2008). When applying for patent you also accept the fact that your invention will be published officially. The basic conditions for a patent to be approved are that the invention must be new, inventive and industrially applicable (PRV, 2013).

The rules for patents varies in different parts of the world. In USA the patent belongs to the first person to invent, where in Europe and most other countries the patent belongs to the first person to file an application. Confidentiality in development projects plays an important role since you can not apply for a patent once an invention is official. Therefore it is very important to keep an invention with patent potential secret until the patent has been filed (EPO, 2013).

There are different databases where you can search for patents. Espacenet, a patent search service provided by the European Patent Office, is a big commonly used database. To easier search for patents a classification system called IPC, International Patent Classification, is used. IPC classes that are relevant for this project are particularly within the classification B60R 9/00 that stands for supplementary fittings on vehicle exterior for carrying loads, e.g. luggage, sports gear or the like. Within this category there are several sub categories. Relevant examples for this project are B60R 9/04 - Carriers associated with vehicle roof, B60R 9/042 - Carriers characterised by means to facilitate loading or unloading of the load, e.g. rollers, tracks, or the like, and B60R 9/12 - for skis (Espacenet, 2013).
Why apply for a patent?
There are many reasons why a patent can be profitable. Today many patents are used to support market strategies by protecting inventions in the countries where they are manufactured or sold. The fact that you have exclusive rights to a product is good to prevent competitors to plagiarise the product and you should have the opportunity to recoup the investments you have made. Another advantage is that the competitors must develop their own inventions and it gives you time to be on the leading edge of the market (Löfgren, 2005). Likewise it is possible to sell at a higher price if there are no equivalent products on the market.

According to Niklas Kronborg, Patent Manager at Thule, it is very useful to have knowledge about the patent system when working with innovation and product development. It is of course valuable to to find out if your ideas are unique or not, but it can also be used to find inspiration on how to solve problems.

Usually it is a good idea to talk with someone that are skilled in patent applications and have insight in the relevant technologies connected to the product. People working for patent agencies can help you find technologies related to your idea in the patent database (Löfgren, 2005).

What is the price of a patent?
When talking to Niklas Kronborg, he mentioned that it is important to keep in mind that a patent only is valid in the country where it has been approved. You can apply for multi country patents within countries that have patent collaborations, but you always have to pay an amount to each country to where you want your patent to be approved. It is always an annual fee for the patient and the charges depend on patents scope and how long it has been valid. In general the annual fees will increase gradually.

The first thing you do in a patent application process is that you order a search from the Patent Office, to investigate if there is potential for a new patent. Then you write a proposal of patent and tying to include as much information as possible. Often a discussion arises about what the patent can contain between the patent applier and the patent office, and it is a good sign. If a patent is accepted without discussion it can mean that you did not cover as wide area as you potentially could. When discussions arises you know you are on the edge of what can be accepted so you can get get the most out of your invention or product. The total cost for the patent application are usually around 200 000 SEK.
4. METHOD

This chapter describes methods used in the project and how they have been applied in the development process. Some methods have been used as they are, while others have been developed or combined to better suit the project. As we used an iterative approach for this project some methods are used several times in the process.

4.1 Lead User Method

The Lead user method was originally developed by Eric Von Hippel in 1986, and later refined together with Mary Sonnack and Joan Churchill. Von Hippel is a well known professor from Massachusetts Institute of Technology, MIT, and one of the leading experts and researchers on user innovation in the world (Vinnova, 2013). The method have been developed based on his research and is a market research tool that focus on persons, so called lead users.

Lead users have two main characteristics; Firstly they are users of a product or service and experience needs that is still unknown to the majority of the market. Lead users are not to be confused with early adopters, i.e. users who are among the first to buy new products or services. What lead users need and want in the present might not yet exist, and is what the market as a whole want in the future. Secondly lead users often innovate, as they will benefit greatly if they obtain a solution to their needs (Von Hippel, 2009). Figure 17 illustrate the market trend and that the lead users are ahead of the mainstream market and the big mass of consumers.

![Figure 17 - Lead user diagram](Von Hippel, 2009)
According to Von Hippel, are normal users not supposed to innovate, they are supposed to consume (Vinnova, 2013). From national representative surveys Von Hippel have found that approximately six percent of the population actually innovates, users that have developed or improved a product for themselves to make it work better. He believes that this innovation is ignored by a lot of manufacturers, instead they go to the center of the market, since that is where the majority of users are found, and ask what they need, what they can provide for them. They find out about user needs and innovate themselves to try solve the needs for the users. But when you strive for being at the leading edge of the market, that are small and uncertain, there is no known market for the product and most companies are not willing to spend money on those projects. That is a reason why user innovation in this segment is very important. A common scenario can be that a lead user innovate something that other users find useful and start copying and use themselves. After a while when a lot of people gets involved, companies can see that there is starting to become a market, and by this time the technique is usually developed so it is easy for companies to start investing in this.

Von Hippel suggest two ways to identify lead users. One is to observe the crowd, too see what tends to build and identify a trend in your field that people are trying to do something about. Search for activity, there might be existing activity and small groups of people that are passionate about something. By observing the crowd activity you can see what people think is interesting and how many people are beginning to adopt, whether it might be a potential market.

The other way is to identify a trend and think of who is most extreme within this trend. Users that have extreme needs, doing an activity in an more extreme way can usually give more concentrated and qualitative information than a normal user. If someone developed a product in more extreme situations than you, the solution will be more robust.

Finding users that are facing the same kind of issue in a more extreme situation compared to you is also good even if that might be within another market. The most obvious type of lead users are the ones within the target application and market, but useful lead users can also be found in other applications and markets that are similar or where the user face problems that have something in common with the problems faced by users in the target market.

Common lead users do not only invent for themselves but also founding companies for themselves because the crowd tells them that they like what they are doing. There might not always be a trend, but a demand from people around that see the product and want one themselves. That is a sign that can mean that an invention have great potential.

An advantage with finding a lead user that have invented something themselves, is that they have already shown that their innovation works within the use context. This is very valuable since it often results in products that works very well in reality. Von Hippel believes this is a much more effective approach than identifying user needs, innovate something that they think is responsive and let the user test it. If you find things that user have already developed you can directly see what works in the user context. He also think the method is a great opportunity for companies since the ratio of user innovators and people working with R&D at companies are very big, there are a lot more user innovators out there.
Finding lead users can be a big challenge. Users innovates where it is functionally novel. For example skiing or sports where people are pushing on new things to do you will find lead users. If there are something ahead of the crowd, if things are changing, there are also lead users. The commodity market is an example where it can be harder to find lead users. One approach to find the right people is to first search for those who care a lot about what you are interested in. Then ask them who knows more than themselves. Contact that person, learn from them and then ask the same question; who knows more than you? When continuing with this approach you will most likely find very extreme users that can have very valuable input for you.

In summary, when working with lead user innovation, the first step is to prepare and organise the project and select project focus and scope. The second step includes an in depth investigation of trends and emerging market needs. In step three information of needs and solutions from lead users are collected. In this phase initial concept generation starts. Interviews with lead users are done to gain deeper insights to emerging needs and to acquire new product ideas. In the end of this phase the goal is to have several preliminary concepts. The concept development continues in phase four together with lead users, including intensive workshops with experts and lead users.

4.2 Implementation of the Lead User Method

In consultation with Veryday a method inspired by the lead user method was developed and chosen as an appropriate method based on the circumstances. To adapt it to this project and to take advantage of internet as a communication platform some modifications were done. One parameter that also affected the use of this method is the fact that the project members, Johan Axelson and Linus Svensson, themselves are considered as lead users within the focus area. Johan and Linus are dedicated skiers who have a long experience of transporting ski equipment in various ways to the slope. This resulted in a method where the project members own experiences and needs was considered and emphasised during the project, which is also consistent with the Thule Groups guiding principles, shared passions (section 2.1).

4.3 Organisation and planning

Similar to the original Lead user method, this project started with organisation and planning to select project focus and scope. This phase resulted in a project plan that described the project and goals as well as a preliminary time plan, appendix 2.

To get a clear view of the project and make sure everybody is striving in the same direction it is important to state expected results and deliveries as well as the project definition in the project plan. The definition of the task is crucial for the development of the project as it will set both boundaries and possibilities for the project. The project plan was written in agreement with both Thule and supervisor Anders Håkansson at Luleå University of Technology.

The initial time plan was created using the Gantt chart method. A Gantt chart is a method to quickly create a schedule to illustrate the time frame of the project and break it down to different tasks and activities. Using a chart with all activities on the y axis and having the x axis representing time, you can visualise the time frame of the whole project and the different tasks involved as well as how different activities are related to each other or performed simultaneously (Johannesson, 2009). The Gantt chart of this project can be found in appendix 2.
A project time plan is constantly changing due to different circumstances. To always have the work process under control and better organise the project a physical timeline was created on two cardboard sheets. By using post it notes that could be moved around we created a dynamic visualisation of the time plan and workflow that gave us a better understanding and reminder of where in the project time frame we were at the moment. A post it representing today, meetings, deadlines and other events was put up on the timeline. This was an important and valuable method for us as we could set up smaller deadlines and goals on the way to the final deadline to be able to focus and work more efficiently.

The cardboards were also used as an organisation board and to do list. By using post it notes in different colours, general thoughts or anything that that come up in mind regarding the project could be organised and moved around on the board. To have information and things to do written down and organised in one place helped us seeing small details in a context and gave a better overview over the project as a whole. Having a physical organisation board also helped facilitate discussions and contributed to a more creative work environment as well as being able to quickly reorganise things to do as the project continued.

Figure 18 - Time axis with organisation board and to do list.
4.4 Iterative and incremental development

The part of the development process that involved external lead users consisted of iterative loops, figure 19. In each loop input from lead users was an important source of information used in the ideation process.

During the first stage, figure 20, different internet forums and communities connected to skiing were observed to find out about “hot” topics. “Hot” topics could for example be discussions about ski gear, transportation solutions and how the community members are approaching issues today. Questions was formulated and posted on forums with the intention to start discussions that can give valuable information regarding users needs and concerns as well as identifying potential lead users. This methodology relied on the assumption that community members had useful experience and ideas that they were willing to share with other community members. Benchmarking and research, consisting of both literature study and physical tests of products as well as communicating and gather information from Thule, was also a part of the first loop.

In the second stage a blog was created to communicate and discuss ideas and concepts with invited lead users. Ideas and concepts based on lead user input as well as our own research and experience from ski transportation were visualised in sketches and posted on the blog together with a describing text. The goal was to address specific problems and start discussions that were digging deeper into details.
A workshop together with lead users was organised to take advantage of their knowledge and input in a later phase of the project. The development process benefits from involving lead users as much as possible during the whole process and having them inventing themselves. The workshop was seen as the last part of the project that would involve input from external lead users. It would take place after all initial concepts had been discussed and evaluated on the blog and a final concept direction had been chosen. The idea with the workshop was to collect even more valuable information and generate ideas on how to develop the chosen concept further. A big challenge was to find appropriate people that could and were willing to meet and spend time on a workshop without any compensation and finding a free day in everyone’s calendar.

In summary, external lead users were involved in two iterative loops, using internet as a communication platform and a physical workshop, figure 22.
4.5 Using Internet forums
The main modification of the lead user method for this project was the use of internet forums. Instead of collecting data using telephone interviews a more modern approach was used where internet communities and forums were used as main data input source. Relevant forums such as popular ski sites was used as the primary place to find lead users. A list with short descriptions of relevant internet websites and communities that have been used in this project can be found in Appendix 3.

The idea was to take advantage of the fact that ski equipment is a topic that engage a lot of people and are discussed a lot all over the world. A lot of forums and communities have members that are spending a lot of time reading and writing about their personal interest, in this case skiing and products related to the sport. They are also willing to share their own experience and opinions.

The first thing to do was to search for forum threads with relevant subjects that already existed. Posting a new thread with a subject that have already been discussed previously is not popular and do not get much response. Those threads are usually not following the forum rules and can be deleted by the moderator. By spending time reading different threads on forums we could find out what kind of topics that are popular and identify common concerns, trends, opinions and interests, but also learn from other peoples mistakes.

Normally there are rules of what you can write and not, for example most forums do not permit commercial threads or direct advertising. You have to respect this and be transparent in what you are trying to achieve in order to gain trust and not cause any hard feelings that can do more harm than it would help you. As we used this method we discovered that transparency is the key to success on the forums.

When asking community members about how they were handling issues one big challenge was to formulate topics that were engaging and could start a discussion. It was important that the topic discussed was not perceived as an advertisement, since we observed from old threads at the forums that it many times make people in the forum angry and irritated.

When first posting new threads on the communities we tried two different approaches, one with the approach as a private person with a personal interest in the topic. Following is the the text tested on a Swedish ski forum using this approach:


Translated to English
"What are the best way to transport skis and snowboards? I often travel by car and are interested in solutions suited for cars, like roof boxes, ski carriers, magnetic holders, tow bar and hitch carriers. Pros and cons? Is there any other solutions that are better? Is there anyone who have made there own solution? All comments are very welcome."
The other approach we tested was more transparent and made it clear that we were students working with a project in the topic discussed. Here is the text using the more transparent approach:

“We are two students who love skiing. At the moment we are doing a project regarding transportation of ski equipment outside a car. We would love to hear from all you skiing enthusiasts out there what you wish for in the ultimate ski transport solution! What are your needs? Something that is missing, annoying or that you appreciate with today's products?

All opinions and thoughts are welcome!”

It turned out that the more transparent approach worked best. Some users got suspicious when the less transparent method was used and asked about the purpose of discussing the topic and what we intended to use the information for. Therefore, we continued using the more transparent approach on all other forums where we made it clear that it was a student project and what our intention was.

Using this methodology, there was a risk of people involved in discussions wanting a compensation for sharing their ideas or inventions. Because there was no budget in this project for compensating lead users it was important to emphasise that it was a student project. It was also important to find concerns that evoke peoples emotions, since those concerns were more likely discussed just as a private interest. Posting pictures of existing solution was also a way to trigger and enrich the discussions.

To keep the thread alive and on top of the list to get even more readers and response it is important that it is a constant flow of comments in the thread. When a new comment is posted in the thread the thread pops up on top of active topics. If you can keep your thread on top of the list over active and well responded threads you will increase the number of readers dramatically and most likely get even more response. One way to handle this is to be active yourself and post comments in your own thread. This also shows that you are interested and appreciate the response from other people.

Another advantage with using forums in the research process is that it can be used as a crowdsourcing method. Crowdsourcing occurs when a crowd responds to an open question or call and perform tasks or small projects voluntarily (Hanington, 2012). Since research can be very time consuming this is a very valuable method to use. Taking advantage of the fact that skiing and ski equipment is a popular subject for discussions and engage people on forums all over the world, you can get a large quantity of research data in less time as people voluntarily gather and share information on the forum. The compensation or payback participants get is usually some kind of reputation points, as forum is social platform.
4.6 Using a blog as a communication platform

The reason of inviting a few selected people instead of selecting random users that you hope to get something out of, is that you want to get more concentrated and qualitative information. Therefore people that was considered more active within the identified trends were chosen. By setting up a blog we could communicate with potential lead users all over the world using different media such as sketches, pictures and text.

Persons involved in the discussions on the forum threads had different characters and personalities, with an interest in skiing related products in common. The different characters were analysed and potential lead users were identified and contacted personally to see whether they had a personal interest in continuing discussions on the blog and if they wanted to take part in a student research and product development project where their input was valuable. The purpose of selecting a smaller group of lead users and invite them to the blog was to make them feel ‘special and chosen’ and therefore more motivated to participate. It was also a way to get more high quality feedback and to not spread concept and ideas to a lot of people in order to maintain confidentiality at some extent. Except from using forums as a platform in the searching of lead users, personal contacts or people known by the project members were considered. Thule athletics or other professional athletics were also considered as relevant users.

One goal with the lead user discussions was to identify concerns that evoked emotions, both bad and good, as a new product addressing these concern areas have an opportunity to stand out from competitors. The intention with visualising ideas using pictures and sketches, was to make concepts more tangible and easier for people to have opinions on as well as more engaging than just plain text. In an attempt to maintain continuity and peoples interest in the blog without overloading them with information, one concept or idea was posted each day during a twelve day period. The input from the lead users could be used both to evaluate ideas but also to trigger new ones. In this phase we were as transparent as possible without conflicting with the confidentiality issue. All the sketches, images and text of concepts and ideas were shown to Thule for approval before posted on the blog.
4.7 Benchmarking/Competitive testing

Benchmarking, or competitive testing, is a method used to evaluate the usability and learnability of competitors’ products (Hanington, 2012). By comparing products, services and practices against the toughest competitors or those companies recognized as industry leaders, you get a better understanding of what is already available on the market and what possibilities a new product could have in the product segment. This can be done by taking the competitors’ products apart and browse the internet, determining why the products were designed the way they were and finding a better way to perform the same function or fulfilling the same need.

To complement the information from the internet forums and communities we wanted to broaden our own knowledge about different existing products. We tried products from the current market of transport solutions related to skies, both Thule products and competitor products. We analysed how well the products met the criteria of mounting them on a car, loading/unloading ski equipment as well as general use. It gave us valuable insights and a sense of what we liked and did not like with today’s solution.

The tests included two of Thule’s current ski carriers, Xtender 739 and Snowpro 748, figure 1 and figure 3, visiting car dealers offering cargo boxes. We also had access to Thule’s big collection of competitor products in their facilities in Hillerstorp. During the early stage of the project time was spent in the Thule testing facilities where a selection of products found interesting were tested and evaluated. The result of the test can be found in the result section 5.1.

The benchmarking also included browsing internet, reading tests, watching videos etc. of related products. Talking to employees at Alpingaraget, a ski equipment store in Stockholm, we learned about what type of skis and other ski-related equipment they are selling most. If we can understand what products common users are buying we can better decide dimensions and features needed to customize the concept to the users’ needs.

Figure 23 - Testing the Thule Snowpro ski carrier.
4.8 Related technology

Related technology is a methodology similar to benchmarking but where you instead of looking at the competitors within your product segment, search for inspiration and learn from other domains. By stepping outside the current industry branch you can learn how other industries and branches address similar problems. This could for example be looking into the space industry to find a new composite material that would also be useful in for example sports equipment development.

In this project the method was used mainly in a stage when a final concept direction had been chosen. The concept involved implementation of fabric and therefore Henrik Kax\(^1\) was contacted. He is owner/head of design and development at Fearless Design and specialised in textile products. Thule has engaged him in other projects regarding textile products to get advices. Discussing our concepts and looking into how fabric is used in other contexts gave us both inspiration and insights of difficulties and important things to consider when working with fabric.

Other technology areas of interest was the flying industry and aerodynamic products. Products considered and used for inspiration also included bags and backpacks, boat equipment such as cam cleats, products with different expandable properties such as umbrella, camera tripod, scissor lifts, folded fabrics, waterproof fabrics.

4.9 Trend observations

Also related to benchmarking, observing trends regarding ski equipment was an important part of the methodology. To be able to develop a product for transporting ski equipment that will satisfy and meet users needs both today and tomorrow it is important to understand what gear people use today and what the trends will possibly look like for the future.

One method used to identify trends in the skiing industry was to analyse the 2013 ISPO show. ISPO is an international multi-segment trade show for sports business. It is an event where companies can discover new segments and trends and get an overview of the latest products. This year, 2013, the show took place in Munich and had more than 2400 exhibitors from the outdoor, ski, action and performance industry that presented the latest trends to 81 000 visitors from 109 countries (ISPO, 2013). We did not have the opportunity to visit the trade show in person, but watched videos posted on internet from the show as well as reading articles.

A document provided by Thule involving trend observation in areas such as form, colour, graphic, materials, textures, fashion, architecture, culture, economics, packaging, media, marketing and technology, was used as inspiration.

---

\(^1\) Meeting, 25/3 2013
4.10 Design workshop

In a design workshop, several participants work with creative co-design methods, usually organised in different sessions. Design workshops should be compelling and fun for the participants to be efficient and is most common in generative research and in participatory sessions focused on co-design exercises such as flexible modelling, contributing to ideation, verifying design direction (Hanington, 2012).

A script was created for the workshop in this project, appendix 7. The workshop included three different main activities: An individual association exercise, ideation and sketching in two groups and in the end building quick prototypes and mock ups in the same two groups.

The workshop in numbers:
Total time: 2h
Participants: 8
Girls: 4
Boys: 4
Age: 20 - 30 years old

One of the reasons why we wanted to organise a workshop was to broaden our own design perspective as well as to implement user innovation in the project. Thus, the main part of the workshop was to let the participants innovate and build prototypes themselves. We had during the initial sketching and blogging phase reached a decision point and narrowed the project down to one final concept direction. The final concept direction were focusing on expandability and aerodynamics and therefore we wanted to collect more information about the those two themes.

For the workshop we wanted to involve boys and girls with lead user qualities, but most importantly, people that have a skiing background and great experience of transporting ski equipment to and from the slope. We believe that diversity can enrich a workshop, and we wanted them to think, discuss and create simple mock-ups of their own expandable ski transportation solution. With the help of the workshop method, we wanted to identify what the participants thought was important and what functions a ski transportation product for the car should have and how to implement expandability.

To recruit people, we used our social network at Luleå University of Technology. A challenge when having a workshop is to find appropriate people and to find a time in the schedule that works for everyone, especially when people are working and you do not have any resources to compensate their time. The participants were students, including one PhD student with expertise in aerodynamics and flow analysis. All participants are dedicated skiers and all of them had great experience of transporting alpine ski equipment.
Fredrik Ericsson from Veryday was involved in planning the workshop to help us get the most out of it. Fredrik is a researcher of human factors and have a long experience in managing and leading creative workshops for product development at Veryday. Some of the lessons learned from discussing the workshop with Fredrik was how the number of participants is crucial for group dynamics, where five to nine participants is preferable as it will create a homogenous group. Thus we used eight participants in our workshop. He also advised us to be aware of that people tends to “fall in love” with their ideas and that it is important to keep the focus on the theme. It is importance of explaining your intention with the workshop for the participants and have a clear goal with what you want to get out from it. Thus we decided to introduce the workshop with a short presentation about the project and some background information as well as explaining the agenda, what we wanted to focus on, our intentions and general rules about brainstorming. The attitude through the workshop should be that all ideas are good ideas. You should avoid giving a lot of new instructions, instead try to build on each others ideas. Build on ideas as far as you can until you hit a dead end, and in this way creating threads of ideas.

After the presentation the first task was to do an association exercise. The participants wrote down as many associations of three different words as they could on post it notes during one and a half minute for each word. The words used were Aerodynamics, expandability/compressibility and open/close. After each word all the post it notes were put up and arranged on a wall. In this way we wanted the participants to start focus on the workshop theme and open their minds as well as getting inspiration from what other people associate.

The workshop continued with dividing the participants into two groups. In the groups of four people they were now assigned to perform a ideation and sketching session. Provided with pen and papers they discussed ideas and did some simple sketches explaining their thoughts.

An important part of the workshop was to present ideas for each other. The two groups presented their ideas and concepts after the sketching session where they had to explain their ideas, motivate decisions and choices made as well as reflect on benefits and challenges with the concepts. The participants also had to evaluate and vote on each other ideas by putting three stickers on the three concepts and ideas they liked the most. This is both too see what is popular and to help the participants think of what they like before start building prototypes, which was the next exercise in the workshop.

The prototyping exercise were performed within the two same groups. A creative toolkit was used to facilitate the prototyping. Creative toolkits are collections of physical objects used for participatory modelling, visualisation or creative play. Engaging people in creative exercises were they build a physical prototype can help articulate thoughts, feelings, desires and emotions that would be hard to find out about using traditional research methods. Creative toolkit can benefit innovation through creativity. What to include in the creative toolkit depends on what activities you want them to encourage (Hanington 2012).
In this case, the intention was to build an expandable ski box and the toolkit was chosen according to that. The toolkit consisted of materials such as different fabrics, wood sticks, cardboard, paper, foams, cellular plastic, a curtain, an umbrella, a tripod, magnets, a wine stand etc. that the participants could tear apart and use as they wanted. Tools like hot glue gun, duct tape, clothespins, stapler, gem, knives, scissors were available to easy combine and put materials together and build the mock ups.

Other tools and materials prepared for the workshop included post it notes in different colours, and colour pencils. Fredrik recommended providing the participants with big pens when writing on post it notes to be able to read notes from distance and to avoid people writing too small and too much on each note. For inspirational input through the whole workshop a lot of different solutions and inspirational images regarding expandability, aerodynamics and ski transportation was printed and put up on a wall in the room. Participants were provided with drink and snacks to keep the energy and mood up through the whole workshop. Another trick used to keep up the energy was to let the participants perform exercises standing up, that is more energetic than sitting down.

The workshop ended with the two groups presenting their prototypes for each other. Both the prototype and sketching presentations were filmed to document the results. The presentation were followed up by discussions and questions.

4.11 Evaluation methods

All concepts generated during the ideation phase are evaluated and analysed in order to chose the a final direction with the greatest potential. The concepts properties and performance are predicted. When evaluating concepts both ‘hard’ and ‘soft’ values have to be considered. We believe as the project goes from abstract to concrete the most efficient evaluation method to use will differ. In an early stage of a project soft values are more important to consider, as concepts are usually too fuzzy to be able to measure concrete values. As the project continues and concepts are more refined, the evaluation methods need to be more concrete as well, using and measuring more hard values. The value of the concept is affected by many different aspects, which can have different significance depending on who you ask.

One critical aspect in this project was the conflict between the transparent lead user methodology and confidentiality interests. Concepts classified as confidential was chosen to not develop further since the lead user method could not be fully utilised in that case. It was in Thules interest to both keep interesting concepts confidential as well as trying and evaluate the lead user study method.

The input from forum and blogs were taking into account when evaluating concepts. Comments were analysed to see what problems that was important for the product to solve and the significance of different criterias. Comments from the blog also directly showed what concepts users saw as potential and what seemed to engage people more.
4.12 Patent
Browsing the Espacenet, a patent search service provided by the European Patent Office, for patents was also part of the evaluation method. In this way we could see if something similar had been done before or if there was a risk of the concept conflicting with already existing patents.

Niklas Kronoborg, patent manager at Thule, was involved in the patent search and helped and guided us in our search for relevant patents. He advised us to combine an IPC, International Patent Classification, with different search terms. For example you can use IPC B60R9/04, that is the classification for carriers associated with vehicle roof, or B60R9/12, for skis, and combine it with the title/abstract: box. Searching for patents can be very time consuming, especially if you do not have a professional searching software. People working with patent usually invest in a software with better search options and where images can be listed directly in the search results, instead of you having to open the original document. As the patent holder do not have any interest in having a patent that is easy to find, you have to try different search methods and experiment with wildcards and search operators.

In this project we choose to not do any searches for patents in the initial concept generation phase. In the early phase of this project we wanted to be open minded and not limited in any direction.

4.13 Voting
Voting is a simple evaluation method where the idea or ideas with the most votes being taken forward for implementation or further development. The voting assumes that people have equal authority and capability in applying votes. In this project voting was used as an evaluation method in the blog. The three concepts considered to have the best potential was listed in the last post on the blog. The lead users were then invited to give their votes on which one they liked the best.

4.14 Eliminating Matrix
An eliminating matrix after Pahl and Beitz was used to quickly evaluate the concepts against different criterias (Johannesson, 2004). A criteria considered to be fulfilled by the concept is marked with a “+”. If the concept is considered to not meet the criteria it is marked with a “-”. If more information is needed the criteria is marked with “?”. In this way concepts can be compared against each other and the ones with the most plus signs advance to the next evaluation phase.

4.15 Establish requirement specification
In the requirement specification should focus be on the functional requirements, what the product should accomplish. The specification is developed and get more details during the product development process as the knowledge around the product increases. The information in the requirement specification can be used as basis when later searching for solutions and it should contain clearly defined and measurable goals that can be used as a reference when comparing and evaluating results (Johannesson, 2004). The requirement specification was discussed and developed in cooperation with Thule. The input from the lead user study, including the forum, blog and workshop phase, were considered when setting up requirements for the final concept direction.
4.16 Concept refining and development
The concept refining phase started by initiating a second loop research phase. The research focused on details in how to make the concept work and give it the best looks possible.

4.17 Prototyping and testing
Building physical prototypes as a part of the product development process can provide invaluable information about form and function. If a picture is worth 1000 words, then a prototype is worth 1000 pictures (Kelley, 2001).

Building quick prototypes was an important part of the process in this project to better communicate and gain feedback from lead users as well as stakeholders. The advantage of a physical prototype compared to a sketch is that it is much more concrete and tangible. It is therefore a very effective way to visualise an idea or a concept and communicate with others. Persons who are not themselves designers and used to interpret sketches and drawings can usually understand a prototype much better.

In the early stage of the project it is important to not make too advanced and time consuming prototypes, but adjust the realism to the stage that the idea is in. According to Kelley (2001) you should not be afraid of showing rough prototypes since the purpose is just to make ideas more tangible, in order to quickly evaluate and detect problem areas. Prototypes are used for examining design problems and evaluating solutions. Prototypes invites to conversations, arguments, consultations and collaborations. These kinds of interactions are very valuable for the product development process and can both validate ideas as well as generate new ones.

Distinction is often made in a number of different prototype categories and when they should be used depending on what stage the project is in. Example of basic prototype categories used in a product development process are (Johannesson, 2004):

- Mock-ups or sketch prototypes. Simple and quick prototypes made of materials such as cardboard, designed to convey the shape and proportions.
- Functional prototype. A function prototype is used for evaluation of parameters such as ergonomics, interaction, function and verify technical solutions
- Visual prototype. Used to validate a design, describe the colour, shape and size, as well as any surface properties. The model can be used in marketing purpose but may not include any functionality.

In this project focus was on creating quick mock ups and function prototypes. At the early stage prototypes were built in scale 1:4 or 1:5, but a full scale mock up was also made to evaluate form, function, size, feasibility and detect design problems. The full scale prototype was mounted on roof racks on a car and tested up to 90 km/h to roughly evaluate aerodynamics, wind noise and turbulence. Materials used when building prototypes included different types of cardboard, foam, rope, aluminium profiles, wood sticks, clamps, tarpaulin. The full scale prototype were built and tested in Thules facilities in Hillerstorp. In this way we had access to a lot of useful tools and could have daily contact and discussions with the supervisors.
4.18 CAD

Computer Aided Design, CAD is a computer-based design tool in which 2-dimensional or 3-dimensional models can be created. This is often used in an early stage of projects in order to quickly get an idea of how the product or concept would look like. The use of CAD software is a cost effective way to verify functionality, and interaction between different parts of the product before it is sent to manufacturing. From a CAD model, you can create manufacturing drawings, simulations, animations and renderings (Johannesson, 2004).

In this project we used the CAD software Siemens NX 8.5. CAD was used after the full scale prototype was made, since at that time we had verified the function and had a sense of shape, size and volume. By creating a CAD model it was possible test and evaluate different shapes and mechanisms. Finally we created renderings to visualise the final result using a software called Keyshot 4. The rendered images images would provide an understanding of appearance and function of the final concept.
5. RESULTS

Each topic in this chapter is corresponding to the outcome from the method used. The results are presented in the chronological order in which they were discovered during the project. In the last part of the result chapter you can read about the final concept and how it works.

5.1 Current market/Benchmarking results

In this section the current market of transport solutions related to skies is described, including both Thule products and competitor products.

Ski carriers, general info

Ski carriers consists of a mechanism which clamps skis on the roof rack. On the market, there are various models in different sizes and shapes. We like that this kind of product is strongly related to the skiing activity. We think the major drawback is that skis are carried without protection and easily gets dirty. The equipage is not as streamlined as a roof box or as versatile.

![Figure 24 - Thule Snowpro.](http://www.thule.com/sv-se/se/products/snowsports/skicarriers/thule-snowpro-745_-745#)

**Thule Snowpro, figure 24**

According to the product specification the ski carrier is designed for up to 4 pairs of skis or 2 snowboards and one pair of skis. We think it is too optimistic for an 40 cm wide ski carrier and a sign that the product has been on the market for many years. Commonly used skis are wider than 100mm. Thule Snowpro is made of a plastic wrapped steel, which was seen as an advantage during testing as the plastic was not nearly as cold to handle as Thule Xtender which had an uncovered aluminium surface. We also noted that the design is not suitable for telemark skis because the bindings needs to be secured to not scratch the roof of the car.

Measurements: 400 mm as loading surface

Colours: Black

Price: 1139 SEK (Mekonomen)

+ Big bottom, easy to use with gloves.
+ Covered with plastic and rubber, good for handling when cold compared to metal.
- Not easy to mount, mainly because of small washers.
- Do not protect skis and bindings from the surrounding environment.
Thule Xtender, figure 25

The design is built to facilitate loading. When the clamp is open, the carrier can slide sideways to make it easier for the users to load their skis without hanging over the car. It reduces the risk of clothes to become dirty or the car to get scratched. It is mainly made of aluminium combined with a rubber strip.

Measurements: 672 mm as loading surface
Colours: Black and Aluminium
Price: 2259 SEK (Mekonomen)

Reflections:
+ Great loading procedure, because of the sliding mechanism.
+ Big bottom, easy to use with gloves.
- Not easy to mount, mainly because of small washers.
- Do not protect skis and bindings from the surrounding environment.
- A lot of metal/aluminium surfaces makes it cold to handle without gloves.
Saris 931 Ski Carrier, figure 26
This ski carrier is like the Thule ski carrier made of a plastic covered steel. The top part can be folded when not in use, making this ski carrier one of the most slim constructions. This gives an aerodynamically good impression.

Measurements: Unknown
Colours: Black
Price: Not sold anymore

Reflections:
+ Nice aerodynamic appearance when folded backwards.
+ Covered with plastic and rubber, good for handling when cold compared to metal.
- Not sold anymore.
- Small screws makes it hard to mount.
- Do not protect skis and bindings from the surrounding environment.
Terzo ski rack, figure 27

Terzo ski rack had greater distance to the roof of the car and it was angled compared to the other models. That made it possible to fit snowboards and skis with big bindings without getting close to the roof. We experienced the distance between the bindings and roof was excessively long. It was an advantage that it was equipped with large knobs instead nuts, it was easy to mount, even with gloves.

Measurements: Unknown
Colours: Black/Grey
Price: Not sold anymore

Reflections:
+ No problems to fits skis and snowboards with bigger bindings because of great distance between roof and loading surface.
+ Big bottom for easy opening even with gloves.
- Not easy to mount due small screws.
- Do not protect skis and bindings from the surrounding environment.
Roof boxes
There is a wide range of different roof box models on today's market. The boxes vary in size and shape and can be adapted for different car models. Generally, they are made of some type of thermoplastic or fiberglass.

Figure 28 - Thule Excellence.

Thule Excellence, figure 28
A top of the line roof box from Thule. The box features a lowered base as well as longitudinal air channels and a spoiler on the box base for, according to Thule, improved aerodynamic properties. A Power-Click quick mounting system is integrated in the box that use grip claws that are self-centering as they are closed. The mounting system includes a torque indicator for easier fixation of the box. Thule Excellence can be opened from both sides for easier loading/unloading and mounting of the box. The locking system is constructed to work as a hinge on the side that is not unlocked. Inside the box is a non-slip base mat to better holding the load in place.

Measurements: 218x94x40 cm
Volume: 470 litres
Weight: 26 kg
Colours: Black/Grey
Price: 11499.00 SEK (Mekonomen, 2013)

Reflections:
+ Easy to mount.
+ Able to open from both sides.
+ Net inside for easy securing the load.
- The lock feels weak.
- The pointy shaped front only allow long objects to be placed in the middle of the box.
Figure 29 - Packline FX series.

Packline FX series, figure 29, and figure 30 mounted on Audi Q7
The box is made of metal reinforced fibreglass. The unique feature of this box is that the roof racks not are attached to the bottom of the box. Instead the box has pipes through the box where the racks can be inserted. According to Packline this improves aerodynamics and the box are getting closer to the cars roof. Most likely this will affect the mounting of the box as well as the roof racks have to be mounted on the box before put on the roof. This box opens from the rear with help from a gas struts mechanism. Packline FX series was also evaluated on a Audi Q7. Even if the box have a lower profile it was still difficult to reach up to the box for a 180 cm long person. The lower profile also made it necessary to create a custom made hole for the shark fin antenna, figure 30.

Figure 30a - Packline FX series evaluated on a Audi Q7.

Measurements: 210x90x28 cm
Volume: 410 litre
Weight: 31 kg
Colours: Black and black
Price: 8495 SEK (Carparts, 2013)

Reflections:
+ Good quality appearance.
+ Stiff and stable.
+ Integrated look.
- Gas struts, needs to be replaced after some years because of loss of power.
**Skiguard 860 touring**

Skiguard is a norwegian roof box manufacturer and their boxes are similar to the Packline, made of reinforced fiberglass. The box opens from rear and have a opening mechanism including gas struts.

- **Measurements:** 226x90x32 cm
- **Volume:** 500 litre
- **Weight:** about 30 kg
- **Price:** 9500 NOK (Skiguard, 2013)

**Reflections:**

+ Good quality appearance.
+ Stiff and stable.
+ Easy to open.
- Gas struts, needs to be replaced after some years because of loss of power.

**Figure 31 - Mont Blanc vista 540.**

http://www.motorserv.com/media/catalog/product/cache/1/image/9df78eab33525d08d6e5fb88d27136e95/r/o/roof-box-classic-vista540-main-download.jpg

**Mont Blanc vista 540, figure 31**

A roof box made of a thermoplastic that you open from the side. You can adjust the hinges depending on from what side you want to open the box. The impression we got when looking at the box at a car dealer, Bilia in Gothenburg was that the box feels weak and unstable compared to more exclusive boxes.

- **Measurements:** 200x95x42 cm
- **Volume:** 540 litre
- **Weight:** 17 kg
- **Price:** 3295 SEK (Bilia, 2013)

**Reflections:**

+ Cheap.
+ Large volume.
+ Lightweight makes it easy to handle.
- Low quality appearance.
- Feels week and unstable.
Volvo V70 roof box, Figure 32

This box is designed by Volvo Cars and is custom made for the V70 (model 00-08). It is no longer produced because the car that it fits is no longer produced. When the box was made the customers had the opportunity to customise the product to match the colour of the car.

Measurements: unknown
Volume: unknown
Weight: unknown
Price: Was 17000 SEK (it is no longer sold)

Reflections:
+ Integrated to the car.
+ Good aerodynamic appearance.
- Expensive.
- Does only fit one specific car, limited second hand market.
Ranger 500, Figure 33

This is Thule’s foldable roof box, designed to facilitating storage while not in use. The box can not be used unloaded. It is made of tarpaulin with fibre reinforcement, a plastic frame and a zipper as opening. The zipper is not waterproof, but there is an overlap of tarpaulin that cover the zipper. Thule are outsourcing the production to a company in China.

Weight: 10 kg  
Dimensions: 190x50x30 cm  
Volume: 260 litres  
Price: 4399 SEK

Reflections:  
+ An advantage is that the box can easily be mounted on a car roof by a single person.  
+ Easy to store.  
- The box can not be attached on a Thule SlideBar since the SlideBar is too thick.  
- The user has poor insight into the box when installing and loading. A possible improvement would be if it the mounting system was moved to be outside the box.  
- A disadvantage with the product is that it have a baggy look and feel. According to Thule it is no bestseller, about 500 units per year worldwide.
Autoforum AB have designed this roof box and markets the product as the easy way to give your small car a bigger cargo space (Autoform, 2013). It is an expandable roof box that is constructed of two shells made of ABS plastic and a fabric with stretch. The plastic shells are held together with a folding steel mechanism and a fabric with stretch. To open the box it is equipped with a zipper.

Weight: 15 kg  
Dimensions: 1408x889x260(515) mm  
Volume: 500 litres  
Price: 6999 SEK

Reflections:
+ Lightweight, one person is able to carry it.  
+ The access from side without any sidewalls makes it easier to see and reach the fixture bolts and the content.  
+ Can accommodate relatively high products, such as a folded baby stroller  
+ Easy to understand the user manual on the inside of the fabric. It made it easier to mount the box. Both figures and english text.  
+ No tools needed for assembly/mounting.  
- Although the box was brand new it had a rip in the fabric.  
- The bottom of the box felt weak and flabby. No reinforcing ribs.  
- In the raised position, it seem to have very poor aerodynamic properties.  
- Speed Limit 110 Km/h.  
- Hard to open and close the zipper when the box was in compressed mode.  
- When the cargo i loaded it was tricky to secure it.  
- You are not allowed to load the box when in compressed mode.
Douchebag, figure 35
This ski bag is mainly made of cloth, but it is also equipped with a pair of wheels so the bag can be rolled. The bag can also be connected to an backpack that is called the hugger, which enables the bag to be pulled without the use of hands. The bag is designed to facilitate the gear transportation for the traveling skier. It can accommodate one pair of skis and some other equipment such as a pair of boots. The bag length can be varied depending on the length of the skis or snowboard to be carried in the bag. It also has a number of battens like those that occur in sails for sailboats, in order to contribute to rigidity without reducing the ability to roll the bag. One of the people behind the development of this bag is named Jon Olsson. He is an icon among skiers and has competed at the elite level and in the winter X Games.

Weight: 3.4kg
Width: 38cm
Height: 18.5cm
Max ski length: 210cm
Price: 2000 SEK

Reflections:
+ It can be adjusted to the length of content.
+ I can be rolled without using hands.
+ Can be very small when it is empty. Good for storage.
+ Possible to fit snowboard/skis and some other gear.
- One small and vital strap must be removed from the bag when adjusting the length. Probably, it is easy to lose the strap.
- The name of the bag gives bad associations for a lot of people. Especially for people with English as their mother tongue.
- The bag is unstable when stored vertically against a wall.
Sportube, Figure 36

This bag is made of a thermoplastic and is probably produced by vacuum forming process. The Sportube consists of two parts, one slightly smaller so that it can be inserted in the second part. This also serves to regulate the length of the bag. Sportube produces three bags for skis and they differ in size (the series 1 fits one pair of alpine skis, the series 2 fits 2 pairs of alpine skis, and the Series 3 fits 3 pairs of alpine skis). All the bags are provided with wheels to facilitate easy movement when walking.

Dimensions (Series 2): 168mm x 140mm
Adjustable length: 122cm to 212cm
Weight: 3.62kg
Price: 182 USD

Reflections:
+ Can be attached to a roof rack.
+ Easy and stable to roll.
+ Big handle.
- Does not have any ribs for securing the straps when mounted on a roof rack.
- It was hard and time consuming to fit two skis in the bag.
- Many small parts, such as straps and a cotter. Probably, easy to lose and then it will be impossible to use the bag.
- It required several different types of straps to pack the skis in the bag. To be able to fit the skis in the box the snow stoppers has to be secured with rubber bands.
- Can not be used for skis with bindings mounted in the middle of the ski.
- The bag is unstable when stored vertically against a wall.
- The handle is bulky and makes it difficult to store the bag under a bed when not in use. It also reduces aerodynamic properties when mounted on a car. Would also be nice to have a handle in the front of the bag.
Dakine fall line double, figure 37

Dakine produces a few different bags for skis. We have tried the Fall line model and it is a padded bag equipped with wheels. There is space for one pair of skis, poles, boots and clothing/accessories including avalanche gear. We like the wheels because it makes it easier to carry the bag. We have experienced this bag as good for flying, because you can fit all the ski gear in the bag and check it in as skiing equipment.

Dimensions: 30x 16x203 cm
Weight: 3.6kg
Price: 100 €, (Dakine, 2013)

Reflections
+ Transport all gear in one bag.
+ Wheels makes it easier to carry.
- Hard to fit in smaller cars.

Ski equipment:

From talking to employees at Alpingaraget\(^2\) we learned that the most common dimension of skis people are buying have around 100-120 mm in waist. More users want to have a ski they can use both in the piste and off piste, where 100-120 in waist is usually optimal for European skiing conditions. People who are skiing deep powder snow in for example Japan or Canada normally choose a wider ski. People only skiing in the piste usually choose a smaller ski. The length of the skis are typically not longer than 190-195 cm. There are only a very limited number of people buying skis over 195 cm. One of the employees had a pair of 203 cm long skis but told us he had only sold this size to one or two customers during this season.

A lot of todays skis have a short turning radius even if they are long since the widest part of the ski have been moved back from the ends towards the middle of the ski. The contact area with hard snow will be much smaller than in soft snow. This is a reason why wider and longer skis have become more popular, since they work well both off and in piste.

Very few skis have full rocker according to salesman at Alpingaraget, as few manufacturers are able to produce high performance skis with a full rocker shape. The company considered best in producing full rocker at the moment are Völkl that also produce piste and racing skis with this shape. However, a lot of skis produced today features small to medium rocker. The rocker shape, especially full rocker affects the transport solution as the skis will take up more space than a flat ski profile.

\(^2\) Meeting, 10/3 2013
Alpingaraget are selling ski bags and we discussed a new bag called Douchebag. The bag offers interesting functions such as compressibility/expandability, wheels and a backpack carrying system for easier transportation when walking with the bag. The main issue with the product are the name Douchbag that are bothering a lot of people. The salesman at alpingaraget estimated that they had sold around 40-50 Douchebags since it arrived to the store.

5.2 Trend observations
We have identified from the ISPO show that a lot of manufacturers put effort to develop lighter products. Both skis, bindings, boots, backpacks etc are getting lighter and lighter, especially products used for hiking. Several ski and snowboard manufacturers also show products with features that facilitate hiking. A commonly used selling point is the use of carbon fibre.

According to the ISPO show there is a lot of attention to wide skis. Even skis made to work well in the piste are wider than before to gain better properties when skiing outside the piste. Most manufacturers have really wide alternatives, waist around 150mm, but put most effort on marketing skis with waist around 100 to 115 mm. The skis with a waist around 100-115 mm are marketed as all mountain skis and this means they are developed to be used both in the piste and off-piste. Elan, are showing a pair of skis which are asymmetric, and it means that the skis have different shape on the inner edge compared to the outer, figure 38.

Figure 38 - Elan Amphibio asymmetric skis.

The common shape on skis called Rocker, figure 39B, is a trend that lives on. A ski with rocker shape usually take up more space.

Figure 39A - A camber shaped ski to the left, a rocker shaped ski to the right.

We have identified from the ISPO show that it is popular among the manufacturers to produce more multifunctional products. Two examples is K2 ice axe combined with shovel and Poc Spine Snow Pack, a backpack with integrated spine protection. The 2014 Swix Sonic R1 Ski Touring Poles, is also a good example with its integrated locking mechanism, new functional strap, changed basket system, a hook to lock up bindings and a ice scraper on the handle.
An other trend is the companies are having a more environmental focus and environmental thinking, mostly clothing that is recyclable, but also skis and other equipment. Using alternative materials such as linen and oil-free epoxy. Environmental excellence awards, a ski with a core made of recycled wood, outside made of oak instead of plastic, reinforced with flax, linen fibre instead of glass fibre, bio resin instead of regular epoxy resin. Another common selling point is that products are developed together with professional athletics that also put their name on the product.

Skiers are constantly pushing the limits and safety is more important topic than ever before. Several manufacturers have extended their product range with so called ABS backpacks with built in airbags to enhance flotation in the snow if the skiers would get caught in an avalanche, figure 40. These are relatively expensive accessories, about 600-1000 Euro, but since they are becoming more and more popular we assume that a lot of skiers today are aware of the risks and are willing to pay for safety.

We also believe that the current fashion affects skiwear and accessories. There are a few manufacturers that showcases clothing and accessories with a vintage style at ISPO fair. One example is the Peak Performance Progressive Backpack, figure 40.

![Peak progressive pack and Northface ABS backpack](http://www.freeride.se/prylar/ryggsackar/2013/peak-performance/progressive-backpack.html)

The increased use of action cameras and other technical devices have affected the design of ski accessories at the show. As an example Giro showed a helmet with integrated mounting for GoPro cameras, figure 41

![Giro edit, helmet with integrated fastener for action camera](http://gearjunkie.com/ski-helmet-with-gopro-camera-mount)
5.3 Forum results

Between the 7/2-13 and 26/2-13 we started 11 forum threads at internet communities around the globe. During this 11 day period our posts were read/viewed 5321 times and we got a total of 171 replies regarding ski transportation.

![Pie Chart of Total views/readers and number of replies.](image)

The number of people involved in the discussions varied at different forums. The proportion of returning visitors were also unique for each forum and we considered it to be valuable with users who were actively interested in the subject ski transportation. To get an overview of each community we mapped the number of replies written and compared it to number of unique users that were participating in the thread, appendix 4. We were also able to use this data when we were about to identify lead users.

To clarify what the users were discussing the most regarding ski transportation we mapped all the threads. We counted the frequency of discussed subjects and based on the data we were able to compile a table with identified subjects and how many times they were mentioned in the forums. The list is represented as a thermometer in fig 43, the more red, the more frequent the subject was discussed. We base our notion that the subjects frequently discussed have a connection with what concerns that triggers the most emotions.
Aerodynamics (fuel consumption)
Safe against theft
Easy to load
Cheaper system
Hitch system
Protect skis from dust/mud
To transport inside car (safely)
Avoid wet skis (rust)
Get warm boots
Rattling noise
Waterproof locks (no ice in locks)
Not able to see what’s inside
Not sport specific (can be used for many activities)
Suction cups mount
Easy to secure the content
Something to stand on
Magnetic attachment
System for air traveling and cars
Nothing to remove on non skiing days
To be able to get in garages (low profile)
Good looking
If transport inside not scratch interior
Wind noise
Easy to close
Be able to use car washer
Not scratching roof
Truly portable
Long but narrow (over 200cm)
Secure the skis in the truck bed
Easy to mount the system
Rear visibility

Fig 43 - Identified subjects thermometer, the number correspond to number of times mentioned.
Identified concerns
Based on the discussions at forums we were able to identify concerns that users mentioned:

- Roof boxes cause drag and higher fuel consumption.
- Roof boxes are non attractive.
- Ski bindings get dirty from road salt and grime when using ski carriers on winter roads.
- Afraid of skis moving and breaking the box when break heavy.
- Wind noise and rattling noise.
- Loading and unloading cargo box.
- Edges getting rusty.
- Cold ski boots.
- Protect equipment from theft.
- Storage of ski box when not in use.

We asked the users about what kind of transport solution they use/prefer today. The result is presented in table 1.

Table 1 - What kind of transport the users prefer today.

<table>
<thead>
<tr>
<th>Preferred solution</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof box</td>
<td>22</td>
</tr>
<tr>
<td>Inside car</td>
<td>9</td>
</tr>
<tr>
<td>Pick up</td>
<td>8</td>
</tr>
<tr>
<td>Strap ski bags on roof</td>
<td>3</td>
</tr>
<tr>
<td>Ski carrier (if close to slope)</td>
<td>2</td>
</tr>
<tr>
<td>Ski carrier (less drag)</td>
<td>1</td>
</tr>
<tr>
<td>Ski carrier (road dirt no problem where the user lives)</td>
<td>1</td>
</tr>
<tr>
<td>Ski carrier</td>
<td>1</td>
</tr>
<tr>
<td>Skis stuck in middle rear seat inside car</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>48</strong></td>
</tr>
</tbody>
</table>
5.4 Identifying lead users
A number of persons were visiting our forum threads more frequently than others and gave constant feedback. Some users were very interested of sharing their ideas and how they are transporting skis today. A few users sent us pictures of their own configurations to show off how they have solved their own concerns, figure 44. We classified these individuals as lead users of ski transportation. In total we identified 24 potential lead users in the forum threads. All these users were later invited to our blog to be able to give feedback on our ideas.

![Figure 44 - Picture sent from lead user who have solved ski transportation in a unique way (photo Anders Odegarn).](image)

We perceived that there is a culture in the forums and a social aspect involved. Users who writes a lot about their experiences and give other advices gain a respected status in the community. The members at the sites who write are not paid in any way, it is by their own initiative and interest that they share information. This is an important thing to consider, even if forum members do not get paid, they want to feel they get something in return and not only giving away information that someone use for their own gain.
5.5 Concept generation and blog comments

In this section, we show the initial concepts. All of these concepts, except two, were presented to invited users at our blog. Two concepts were not shown with respect to confidentiality on Thule’s ongoing projects. After each concept there is also a summary of comments and thoughts from the blog.

Figure 45 - Concept 1, Alternative opening.

Concept 1, Alternative opening, Figure 45
This idea is about an alternative opening mechanism on a roof/ski box. The concept is based on the concern of not being able to reach or see into the box when loading/unloading. The idea is that the box will have a sliding mechanism, so the user would first slide the box to the side and then open it as seen in the sketch.

Blog comments about concept 1 [number of comments: 8 ]
The followers seem to like the idea to have a sliding mechanism to have a better access of the box inside. They all agree that it will be easier to load and unload the box but most of them also become worried about the tilting part. The gravity can be a problem when you tilt the box and the skis might slide out and hit you or scratch the car. An interesting observation was that one user mentioned that he miss a feature of todays roof boxes. His concern it that it is hard to know when the box i completely full, he says that it is more like an trial and error process. He would like some kind of feature in the roof boxes that can give him a hint of how high he can stack inside the box.

Discovered emotions:
- Users are worried to scratch their cars.
- Safety, to prevent to get hurt.
**Concept 2, Slide and tilt, Figure 46**

This concept is similar to concept 1, it is about easier loading/unloading. On the market today you can find load bars with a sliding functionality such as the Slidebar from Thule. In this concept the slide idea is combined with a tilt functionality in order to get a better view over what is inside the box and better reach the content.

**Blog comments about concept 2** [number of comments: 7]

Compared to the first concept the followers prefer concept 2 because it is a construction that have a more robust look. All the comments agree and think it is an interesting concept to make it easier to reach and see the content of the box. Most of them are also concerned about the gear falling out when tilting. One user said that hooks or elastic cargo nets can be used to secure the items when tilting. It is also mentioned that the drawer style opening might be a problem during wintertime usage and can be jamming with the gear.

Discovered emotions:

- Worried that things can fall out and hit yourself or the car.
- Worried that it would not work during winter, because of ice and snow.
Concept 3, Rotate and tilt ski carrier, Figure 47

In this concept we have thought about what could be done with a ski carrier. The idea with this concept is that you would not need to lean over the car and get a dirty jacket when try to reach skis in the middle of the roof. Instead you tilt the carrier to the side of the car as seen in the sketch.

For telemark skiers traditional ski carriers can be a problem since the loose heel binding can hit the roof. A way to solve this problem is to tilt and lock the carrier in a vertical position. This can also be a way to transport a lot of skis if needed by attaching several carriers vertically on load bars. Another idea is to integrate the carrier with a foot to be able to mount it directly on the vehicle roof or onto siderails, tracks or fixpoints without needing any load bar.

When it comes to aerodynamics an idea is to rotate and tilt the carrier along the side of the car as seen in the sketch in order to get minimal air resistance. One issue with ski carriers is that the skis are not protected from dirt that can be a problem depending on road conditions. On the other hand, ski carriers are much smaller and easier to store when not in use for people with limited storage space.

Blog comments about concept 3 [number of comments 7]
This concept attracted attention to its innovative level. Two users sees the opportunities when it is used on taller vehicles like SUV since the loading will occur in lower level. It is also mentioned as a benefit that the skis can be stored in a way that will not involve the risk of the bindings hitting the roof. It is mentioned that the rotation mechanism must be able to secure in different angles to be sure that the skis does not crash down to the top of the car.
**Concept 4, Integrated lights, Figure 48**

This concept is simply about integrating headlights into a cargo box. The idea is to take advantage of the box being the highest point of the car by placing headlights on the box that will have a better angle than normal headlights. This would improve the visibility when driving on dark roads, especially on roads with snow drifts.

**Blog comments about concept 4** [number of comments 6]

There are different opinions about this concept. Most of the comments criticise the idea of integrated headlights in the roof box. It is mentioned that the light can be reflected in the hood of the car and distract the driver, and it can blend other drivers, how to get electricity to the roof. One follower suspects that it may be illegal to use the overhead lights in the United States. We noted a possible misunderstanding when presenting concept. It was just meant that the lights would be extra light and complement the existing high beams and not be turned on all the time.

Discovered emotions:

- Users want to be sure that they follow the legal requirements.
A lot of big cars today are over 2 meter wide and most skis are less than 2 meter long. Hence most skis are less than 2 meters long this concept transporting the skis horizontally in the back of the car. Would probably cause less wind drag than a box on the roof. There are hitch ski carriers on the market today but a disadvantage can be dirt flying up on the skis. By having a box skis would be protected from dirt and you could also load other gear in the box as well.

And for skiers that preferring taking a sport car to the mountain, it might be a good idea to integrate the ski box to the spoiler, figure 49 B.

There are mixed opinions about this concept. A person like the idea and think it has the potential to facilitate easy loading. The other person does not like the idea of having anything attached to the cars hitch. He thinks it is a problem when you want to access the trunk. An interesting observation was that one user believes that the "ball" system used by 1UP USA's bike racks is much easier to put on and take off any trailer hitch than solutions that Thule or Yakima currently offer.
Concept 6, Ski step, Figure 50
This concept would be for people having a vehicle with high ground clearance such as a truck. What if you put a ski box just under the doors at the car that at the same time could be used as a step, making it easier getting into the car and also better reach stuff on the roof.

Blog comments about concept 6 [number of comments 4]
3 persons like this idea and one of them says that it would be a great solution for the huge american SUV cars with step rails. They also says the market will be limited since most of the the truck owners just throw their stuff in the trunk.

Discovered emotions:
• Afraid that the box will be dirty.
Concept 7, Ski straps/fast securing, Figure 51
The idea behind this concept is that it should be easy to reach straps and fast to secure the load. The concept consists of two straps. One that can secure the load and one that is attached to the roof and used for lifting the other strap. The intention is that you should be able to load and secure the box from one side without having to walk from one side to the other side of the car.

Blog comments about concept 7 [number of comments 2]
The comments about this concept is about their use of straps today. One say that he only use the straps when traveling long distances and that he usually do not care about the straps. The other user says that he usually pack his roof box full so the gear can not move anyway. It seems that users are not very aware of what will happen if you crash without having the cargo fastened.

Discovered emotions:
- Time consuming to use straps.
Concept 8, Expandable box, Figure 52a-52b
The idea with an expandable box is that you can adjust the volume depending on the load. When not in use the box would be as small as possible, to cause as little drag as possible and be more aerodynamic, saving fuel consumption. This functionality might also make it less important to mount down the box when not in use. However, when taken down from the vehicle it would also be an advantage when storing the box, as it would take up less space.

In these two concepts the side of the box would be in a weather resistant fabric. In one concept the fabric is folded when compressing the volume, figure 52b. The other concept tighten the box using a lacing method similar to a backpack or shoes, figure 52a.
Blog comments about concept 8 [number of comments 2]
This concept triggered ideas of how an expandable box could be made. They obviously liked the idea of a changing volume. Both persons contributes with ideas of how it could be designed.

“why not have a stiff base and then a hinges frame along the edge of the base. The frame have an elastic sheet that covers the skis and gear. to get skis inside the thing the frame is opened from the side and when the frame is closed the ski gear is pressed down by the sheet in the frame” - Telefred

“as an alternative, you may consider a fiberglass or carbon accordian-type mechanism for the base with a neoprene top. The base then can protect the roof of the car from sharper objects.” - quant2325

Concept 9, Expandable box 2, Figure 53
Compared the Concept 8 you are able to compress the width instead of the hight.

Blog comments about concept 9 [number of comments 1]
The only comment about this concept was a concern about if an expandable box is what the customer are looking for. He himself owns two narrow boxes today and he like that he can mount them at the side of the cars roof. He can not see the advantage of an expandable box and does not see the problem with traveling around with a box only partly full. He also mentioned that the box will be more expensive than standard boxes and difficult to save money on the investment.
Concept 10, Stool support, figure 54
This two concept allowing you to get closer to the box without standing on the the bumpers or in the doorway. One concept is an accessory that can be attached to a tow ball. When not in use it can be folded upwards.
Second concept is a box with a removable end part that can be used as a stool. The cargo box could be opened in two different ways - as a classic cargo box or by removing the stool in order to get access from the rear. Or you could use both alternatives at the same time.

Blog comments about Concept 10 [number of comments 0]
Concept 11, Door opening, figure 55
An idea of having a ski box together with a supporting arm structure that you can slide back. With help of the supporting arm you would then tilt down the box behind the car in a vertical position. The box would then be opened like a normal door. Inside the box a ski rack would hold the equipment in place.

Blog comments about concept 11 [number of comments 1]
One person liked this concept and he thought it would be a fantastic box for transporting skis and snowboards but less suited for bags and accessories.

Discovered emotions:
• Versatility is seen as an advantage.
Concept 12, Expandable 3, figure 56
A third concept based on expandability. The base and top would basically be two sheets of a stiffer material and connected with a medium stiff material (maybe something similar to rubber) that can easily be bent in order to have a curved and aerodynamic profile in both compressed and expanded position. On the sides a folded fabric structure could be used to maintain the expandability. The box could be accessed from all sides with help of a zipper that goes around the box. To hold up the fabric when loading the box magnets could be attached to the edge of the top and on the fabric just above the zipper. Velcro straps could also be an alternative. By opening the box from the sides you will have a better view over the content and easier access when on the roof.

Blog comments about concept 12 [number of comments 6]
6 persons comment that they like this concept. Two of them believe it will consume less fuel compared to other boxes, but they are also concerned about if the fabric will cause fluttering noise.

Discovered emotions:
- To save money and the environment through less fuel consumption.
- Suspicious of wind and fluttering noise.
**Concept 13, Ski click, Figure 57**

This concept allowing you to fasten your skis to the roof of the car with a click mechanism. One part will be attached to the skis and a holder with a quick release will be attached to a roof rack or the rails of the cars. Then it would be possible to fasten your skis quick and easy. An advantage of this is that it is a very small piece of equipment that can be sold in sport shops. It could easily be used by professional athletes and shown off at competitions. The click system can be combined and used in other applications as well such as fasten the skis on your backpack.

**Blog comments about concept 13**

With respect to one of Thule's ongoing product development projects this concept were not displayed at the blog.
Figure 58 - Concept 14, Multi use bag.

**Concept 14, Multi use bag, Figure 58**

Skiers often use different transportation methods to get to the mountains and ski resorts. It can also be a combination of different transportation solutions during the same journey. This concept is made to facilitate all the commonly used transportation alternatives, it could be used when traveling by train, aeroplane or busses and features a fastening system to be able to secure it on top of a car. It is a bag where you are able to carry your skis and other equipment such as boots, protection gear and clothing. The bag is equipped with wheels and straps in order to roll the bag without hands similar to a backpack. The bag can feature an attachment point for boot bags or similar close to the wheels to unburden the load for the user. It is water resistant, made of a stiff to semi stiff material to add stability and allow storage in an upright position as well as maintain an aerodynamic shape when used on a car roof.

**Blog comments about concept 14**

With respect to one of Thule’s ongoing product development projects this concept were not displayed at the blog.
5.6 Blog statistics

Statistics from the blog, appendix 5 and 6, shows that the number of visitors as well as the comment ratio decreased for every day. The statistics went up a little bit in day six as a reminder was sent out to the users. The activity and response on the blog was not nearly as good as on the forums. Possible reasons for this behaviour is discussed in chapter 5. Discussions.
5.7 Evaluation results

The eliminating matrix, table 2, resulted in two main concepts that were considered to have best potential; Tilt and rotate ski carrier and Expandable ski box.

Table 2 - Eliminating matrix.

<table>
<thead>
<tr>
<th>Concept</th>
<th>Innovation</th>
<th>Safety</th>
<th>Protect skis</th>
<th>Protection against theft</th>
<th>Aerodynamic</th>
<th>Easy loading</th>
<th>Easy mounting</th>
<th>Tall vehicles/small persons</th>
<th>Patent</th>
<th>Usability for other applications</th>
<th>Aesthetics</th>
<th>Storage when not in use</th>
<th>Life style related</th>
<th>Environmental</th>
<th>Costs</th>
<th>Feasibility</th>
<th>Marketability</th>
<th>Positive Lead user feedback</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>?</td>
<td>+</td>
<td>?</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>?</td>
<td>+</td>
<td>?</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>?</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>?</td>
<td>+</td>
<td>?</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>+</td>
<td>?</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>?</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>?</td>
<td>+</td>
<td>?</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>?</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>+</td>
<td>?</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>+</td>
<td>?</td>
<td>+</td>
<td>?</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>-</td>
<td>?</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>?</td>
<td>?</td>
<td>+</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Tilt and rotate ski carrier was considered a unique concept with no equivalent product on the market today, but what talked against the ski carrier concept was the forum statistics. The statistics, table 1 in the forum results section, shows that the majority of users preferred ski box as transport solution for skis. During the forum discussions it was also identified as a significant concern users wanted to be able keep their skis protected from water and dirt. The comments and voting at the blog also showed that a expandable box was something users liked and believed had a potential of being a good product. Considering this and also discussing concepts with both Thule and Veryday the concept of an expandable ski box was chosen for further development. The decision was based mainly on input from the Lead user study on forums and the blog, as well as feasibility and the concept being a unique and interesting approach with no equivalent products on the market today.
5.8 Related technology

Because the expandable concept may include textile we were introduced to Henrik Kax, fearless design through Thule as they have engaged him in other projects regarding textile products to get advices. Henrik Kax have long experience and knowledge from textile and bag product development. We wanted to get more knowledge about what to consider when using textile products, included pros and cons with using zippers.

This is the outcome from the meeting with Henrik; Zippers are very fragile and do not withstand traction force very well. Once a zipper break at one point, the whole zipper will easily split and become useless. An advice from Henrik is to avoid using zippers if possible, especially in corners, as they are very exposed and usually breaks first. Waterproof zippers are very expensive. Using an overlapping fabric layer over the zipper improves water resistance. Wireframes can be implemented in fabrics for improved durability, security and protection against theft. The behaviour of fabric and textiles as a material can be difficult to predict. A common method used for imitating the properties of fabric when building quick prototypes is using waxed paper. As fabrics do not have any structure on its own, it needs to be combined with something else. Giving structure to a textile product can be made for example by glueing the textile on other materials, upholstering, using filling/stuffing/padding, sewing or integrate other more stiff materials. The main challenge according to Henrik would most likely be to make it look nice, not baggy or sloppy.
5.9 Workshop results

In this section we are presenting the outcome of the workshop. You can find a schedule of the workshop in the appendix 7.

In the introductory phase of the workshop we had a association game when the participants were writing down on post-its as many words as they could associated to some specific themes. Each set/theme were 1 minutes and 30 seconds. After each set all post-its were put up and summarised on a whiteboard.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Association</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open/close</td>
<td>Door, Handle, buttons, Zipper, box, door, twist, fly, jar, buttons, box, lock, secrets, mouth, lock, push, angle, restriction, velcro, door, variable, lock, door, jar, velcro, key, lock, padlock, zipper, hinge, bag, box, door, zipper, buckles, velcro, lock, strings, screw, hatch.</td>
</tr>
<tr>
<td>Aerodynamic</td>
<td>Formula 1, particles, air resistance, shape drag, friction, soft lines, golfball, fast, shape, shape, Bernoulli, round, current, speed of air resistance, speed, water, boat, aeroplane, CFD, wings, streamlined, wind, air, air, air, wind, air, turbulence, brakes, speed, rearview mirror, speed, air resistance, swirls, aeroplane, downforce, car, car, car, drop, cars, flying, aeroplane, art of engineering, grip, drop, drop, bumblebee, wing, lifting force, lifting force, wing, streamline, fast, arrow, turbulence, drag, jaguar e-type, physics.</td>
</tr>
<tr>
<td>Compressible/expandable</td>
<td>Hot air balloon, accordion, light, gas, moveable, camping table, foldable, camping chair, balloon, balloon, tent, air mattress, hot, air mattress, tire, elasticity, volume, air, compressed air, rubber band, foam, compressed air, lego, accordion, balloon, vacuum, pressure, flexible, gas, balloon, lungs, success, winter sledge, inflatable, balloon, compressible, tracks, dry bag, pressure, swivel, difficult.</td>
</tr>
</tbody>
</table>

Workshop sketching phase

During this phase there was an intense discussions about what kind of functions/features they wanted for a roof box. Their discussions and reflections will be summarised in this section.

- The load/unload process is frequently discussed. One person says that he prefers loading from the back of the car.
- Aerodynamics is considered to be vital and it is important that it does not affects the fuel consumption a lot.
- The box should fit both snowboards and skis.
- Possibilities to move the box to the side for easier loading would be a valuable function.
- It is important that there is enough space for bindings.
- For the expendable parts a elastic fabric could be used - But they are concerned about the durability and safety.
• It is important that it does not look clumsy.
• It would have been amazing if it was slim when not in use.
• May also be nice if you could expand the box sideways and take advantage of the width of the car.
• It would be nice if it was possible to mount the box without any roof racks, directly on the roof. No space between the roof and the box. It would look good and give less drag.
• To be able to store the box under the bed is a desired feature.
• To load the skies from side or from the very back of the car.

Selling points
We asked the group "what if you were about to sell an expandable roof box, what would be your selling point?"

• You will always have your extra cargo space with you.
• Flexible.
• Aerodynamic.
• Less fuel consumption compared to standard cargo boxes.
• Better interaction with the car.
• Easy to organise the load.
• Easy storage when not in use (at home).
• Could be used for other gear than just alpine skies and snowboard.

Other possible uses
We asked the group “what about if you would combine the roof box function with something else, what would it be?”

• Ski storage.
• Wardrobe.
• Storage gadgets.
• Could be used as a mattress, bed or as a tent (sleep inside).
• Use it as a sledge.
• Use it as a stretcher.
• As a backpack.
• Sledge for a snowmobile (rubber mat without skids works fine for transportation in winter landscape).

Presenting sketches and ideas
When the two groups presented their concepts and ideas to each other, the fist concepts was a box with a stiff base and top and fabric on the sides to allow expandability, addressing the issue of having enough room for the ski bindings. Securing the load could be done using the top part. An idea was to use a padded bottom to place the box directly on the roof to improve aerodynamics and lower the box for easier access. The concept would be easier to load unload skies since you get rid of the side walls. It would be able to take with you and use as a tent. It would provide better storage possibilities.
Other ideas included integrating a box to the roof, similar to in old Volkswagen busses, so the box will be flat when not in use and not take up any space at all. The concept would better follow the form/curvature of the car. Would be great if you can reduce fuel consumption. There where thoughts about lower the box closer to the roof and focus on making the box wider and not as high since it is easier to load and have a structure when loading skis next to each other instead of on top of each other. An idea was also to be able to slide back the box and open it as a wardrobe. Secondary use of a box could be as a sled. Maybe integrate a solution for hanging the box on a wall or roof when storing the box. Use as a ski closet in the house.

**Evaluating the concepts and ideas during the workshop**

To help the participants to evaluate and realise what they liked about their ideas we gave the task to explain their concept to each other and then vote. We gave them three post it notes each and told them to place them next to the concepts as they liked the most, figure 59.

![Fig 59. Votes on concepts from the sketching phase.](image)

The voting helped the participants reflect on what they liked the most and get inspired by other ideas. There were a common belief that there was potential in an expandable box and many liked the design with a softer side where the roof could be adjusted for more space.

**Workshop prototyping phase**

The results from the prototyping phase were four different models. One of the groups decided to make one prototype together, figure 60. where the other group worked more individually and created three different prototypes.

![Fig 60. Teamwork.](image)
The concept to the left, figure 61, the black prototype, is a box that can expand in two directions. It have fabric on the sides and stiff to semi stiff materials on top for a rigid construction that is still flexible. A trail or channel in front and back is used to allow expansion to the side using a two layered base and top part. Using a buckle or similar fastening mechanism in back to tighten the back and maintain the drop shaped and aerodynamic profile in all positions. Would be opened using a zipper in the fabric or a similar solution as a dry bag by folding the fabric. Put it upside down to use it as a sledge. Padding on inside to protect content and provide comfortable bed when used as a tent. Idea of using a handle similar to many travel bags that can be pulled out from the sides and used to lift up and down the box and the roof easier. Problems and difficulties with the solution is to solve the implementation of the fabric. The function of expanding the box to the sides involves a lot of new challenges. Having the box sliding without any friction or resistance is one issue.

The white prototype in the middle is made of all stiff material. Expands mainly to the sides but also allow you to angle the sides allowing some expandability of the height as well, mainly in the middle. The idea is that the box should be able to slide back on the roof and tilted down and the opened as a closet. Press down the middle to compress the box.

The blue prototype to the right folds inwards when not in use. Facilitate drop shape when expanded for better aerodynamics, folded fabric on sides allowing you to expand the height. Could also be used as a tent. Difficulties was seen in adapting and folding fabric in a good way.
5.10 Patent results
We did not find any patents obviously conflicting with the final concept direction in our patent search.

5.11 Requirement specification
Following is a list of requirements a final product should meet before introduced to the market:

Volume, size and weight:
- The height of the box shall be expandable/compressible.
- The box shall fit 4 pair of 195 long skis with bindings in expanded position.
- The box shall allow storage under 2 dm when compressed (for instance under a bed)
- Facilitate easy handling and mounting on car roof by one person.

Other:
- The box shall have good aerodynamic properties, low drag and wind noise.
- The box shall protect the load from water and dirt.
- The box shall be mounted on roof racks.
- The box shall allow loading from the side.
- The design must not conflict with any current patent.
- The box shall have a locking mechanism.
- The user shall be able to secure/fasten the load.
- Manufacturing costs shall not exceed x SEK (will be defined by Thule).
- The box shall fulfil the demands of city safety ISO 111 54, be UV resistant and fire safety.
- The product should be adapted for alpine skis and snowboards (Not including cross country skis).
5.12 Concept development - Refining and improvements

In this section we are presenting how we applied our theoretical ideas from initial ideation to mock up models. We did this to investigate if our ideas would have potential to work in reality and detect design problems and challenges. We built scale models to examine the shape and function, but we also built a model in full scale.

5.13 Prototyping/Mockup results

It is important that the roof box can protect the skis from water and dirt. We have tested several different methods to make it possible to open/close, seal and have access to the skis. Our idea was depending on implementing a semi soft material like rubber in the front part to be able to have aerodynamic shape in both expanded and compressed mode, figure 63. The front would be attached to a top and bottom made of a stiffer material. To seal these three main elements, the top, the semisoft front and the bottom, we wanted to use a weather resistant fabric that would allow expandability.

![Mockup made to test the combination of a semisoft material in front and stiff bottom and top.](image)

**Fabric**

To be able to change the volume several experiments and quick prototypes was made and resulted in different kinds of designs of textile sides for the box. We tried different kinds of folding and lacing techniques. Lessons learned was that a lacing method could be combined with a closing mechanism, figure 64. But it seems hard to get a aesthetically and aerodynamic pleasing look because of wrinkles easily was formed to the fabric.

![Mockup with lacing.](image)

A better technique was to fold the fabric into a more strict structure. When the fabric was folded the edges were sewed together to keep a permanent structure to the fabric. This avoided the fabric to fold randomly and instead fold in the same way time after time. Additional structure was generated when the fabric was folded in two directions, creating a corner, figure 65.
We experimented with different numbers of folds to see how the fabric stability and willingness to fold were affected. The conclusion from these tests was that a few folds gave clear indication of how is supposed to be folded, but the fewer folds the more space are occupied by the fabric inside the box when folded together, figure 66.

From our experiments we found that a total of 3 folds would work well for our concept in terms of expansion length, stability and ease of use, figure 67.
Opening
One idea was to use zippers in the fabric to open the box. According to discussions with Henrik Kax at Fearless design it is very important to consider if zippers really are necessary with respect to durability. Thus we continued searching for a solution without including a zipper.

Another idea tested was about using a similar technique as used in window blinds where you could pull a string to open one of the sides. This idea was evaluated with a simple mockup and the Urban loader, figure 68. We realised that it would be a complex solution and difficult to seal. We chose to not further develop this idea.

![Figure 68 - testing drop down opening with Urban Loader.](image)

To get into the box we had an idea of lifting the fabric upwards to the roof of the box. We added a frame to the lower part of the fabric in a mock up model. We realised that the frame would make it possible to lift the fabric and get into the box. But the idea had to be complemented with a mechanism that could raise the roof of the box. If the roof were raised the opening were able to be significantly larger. The semisoft front will act as a hinge. We used two sheets of foam a camping mattress, 10mm thick to test if something similar could be used as the a semisoft material. To add stiffness to the material it was reinforced with two strips of flexible plastic and ridges of plastic foam, figure 69. It worked and we believe it would be possible to produce the part using rubber instead. It would withstand different weather conditions and be able to act like a hinge because of the flexible properties.

![Figure 69 - flexible front made of camping mattress.](image)
We created some sketches and models of possible mechanisms that would be able to raise the roof of the box, figure 70.

*Figure 70 - Sketches and models of different mechanisms for rear end of box.*
To evaluate which had the most potential we tested two concepts on a full scale mock up. One idea was to install two powerful springs in the very front of the box, that always had an aspiration to open the box and then use a strap to force the roof downwards when compressing the box. To try if it had potential to work we bought a pair of Cocraft spring clamps, figure 71 and installed in our full scale mock up.

![Cocraft spring clamp](image)

**Figure 71 - Cocraft spring clamp.**

Although the spring was powerful, and the mock up relatively light, the spring was not able to open the box in the way we hoped for. The gravity and lever arm of the two meter long roof was too heavy for the spring. We also realised that the top was unstable because of the lack of support from the flexible front, and decided that the box needed some kind of stabilisation and support in the back. The top would especially be exposed if the box would be exposed to wind when opened, figure 72, or if the top would be closed on an unevenly divided load.

![Box in loading mode](image)

**Figure 72 - The box in loading mode.**

A mechanism similar to the ones used to secure the engine hood was also tested. It was a strut which could be raised and thus keep the roof in an open position. It was a good solution, given its simplicity, but the structure was too unstable given only a single point of support. By providing the box with two supporting struts it became more stable, but there arose new questions. How could both be raised simultaneously? Where could the struts be stored? It is a mechanism that works, but we wanted to develop the mechanism further. The conclusion of the struts test was that we wanted to create a supporting mechanism with two
supporting points in the very back of the box. As we also tested to load the box, we could determine that placing an opening mechanism in the back would not block and prevent loading of the skis.

We were also interested in testing a scissor inspired mechanism, figure 73. We made a decision to test scissor design using CAD software.

Figure 73 - Sketch of scissor mechanism.

Sealing and lock mechanism
The frame attached to the fabric needed to be secured to the bottom plate and able to open. We sought a design that would allow easy opening, resist water and dirt and secure the load to the inside of the box.

We designed a concept that enabled several locking points. It could hold onto a frame shaped like a L and with only one pull in one point 8 latches moved and were able to hold the frame, figure 74. The design worked but the L-shaped profile needed to be placed in a groove to work. We found that the frame required a design that could guide the frame in the right place when closing the box. We experimented with using magnets to solve this, but the fact that the solution would require a lot of space and be complex and difficult to seal against water, made us choose to not implement it in the concept. Instead we searched for solutions requiring less locking points.

Figure 74 - Test of locking mechanism with 8 latches that moves when pulling.
A second idea was tested, based on a L-profile resting on the outside of the bottom part. Together with a ridge on the inside of the L-profile the box could be sealed, figure 75. The ridge on the inside ensured the frame could not be moved when placed in the lower position and created a water resistant construction. The ridge also helped secure the cargo from not falling out from the sides when the box was opened. This design was applied to the final result.

![Figure 75 - Cross section view of L-profile and ridge as sealing.](image)

The fabric need to be fastened and sealed to the top of the box. To secure the fabric on the inside of the top shell a circular groove can be used. The fabric can be folded around and fastened around a thin rope and then threaded through the groove. Our idea is that it could be made like in figure 76.

![Figure 76 - Idea of how to fasten the fabric to the roof.](image)

**Volume and aerodynamics**
Creating a full scale prototype, we were able to evaluate size/volume of the box, figure. We realised it was hard to fit more than two pair of skis lying with sides downwards (width of loading surface: 45 cm), without stacking the skis on top of each other. When two pairs of skis were stacked on top of each other and there was a total of four pairs of skis in the box it felt unsafe. Since the rib at the bottom was only two cm high it was an obvious risk that the stacked skis could fall out. With only two pairs of skis in the box it was possible to have a very slim shape of the box and it was very easy to get a visual overview of the content in the box.
By sewing the fabric in a folded and adept it to the full scale prototype we were not only able to evaluate its appearance. The model was perceived very stable and we wanted to examine how the fabric would behave if it were exposed to wind speed. The prototype box was secured to a roof rack mounted on a car and we were able to test the box various speeds. When mounting the box on top of the car we realised it would be necessary to have a u-bolt system with turning knobs. It is a simple, cheap solution and it does not require the same space as the Thule quick grip. We were worried that the fabric would flutter in the wind and cause noise. By driving carefully separated from other traffic the mock up of box was tested in 20, 50, 70 and 90 km/h. The prototype was only tested in compressed mode as the prototype lacked mechanism for other positions. The conclusion was that the fabric did not cause any flutter and the perceived wind noise were lower compared to Urban Loader, the only collapsible box at the market today.
5.14 Final concept

The following chapter shows the final result of the project. The final result is a concept consisting of a CAD model and computer renderings, showing how the concept can look like in reality. Design details and functions are described to give a picture of how the product is supposed to be used. The final result is still on a concept level, even though a lot of effort have been spent on the feasibility of the product.

The final concept, that we chose to call Thule Snowdrift, is a new innovative product to be used for transporting alpine skis and snowboards. It is a roof box, where the volume can be customised and adapted to the size of the cargo. It is one of a kind roof box with great aerodynamic properties. An empty box will cause less aerodynamic drag compared to a fully loaded. Skis and snowboards can be transported in safe manner without getting wet or dirty. There is room for four pairs of skis with a width of 155mm and length of 1.97 m or 4 pairs of snowboards.

Figure 79 - Visualisation of the final concept, compressed mode.

Figure 80 - The shape of the box in compressed mode compared to shape of an optimal aerodynamic body.

The aerodynamic properties will reduce fuel consumption, that was one of the biggest and most common concerns found among users in the research phase. An aerodynamic box will help the user save both gas
money and the environment, as well as reducing irritating wind noise. The fact that the box can be compressed is also an advantage when storing the box when not in use. Another benefit is the logistical perspective as Thule ships their products world wide. The number of trucks needed to transport the boxes will be reduced, saving both money and the environment.

![Side view of a opened, a fully loaded and a fully compressed box.](83)

The box dimensions are customised for alpine skis. When the box is opened skis can easily be loaded from the rear part of both sides. The box has a lower edge than a traditional roof box which make it possible to easily look into the box and grab the gear. In fully loaded mode the box will fit four pair of 155 mm wide skis with bindings, alternatively four snowboards or two snowboards and two pair of skis, figure 82.

![Box loaded with two pair of 155 mm wide skis and two 310 mm wide snowboards.](83)
Ski carriers, figure 83, are included that divides the pressure more evenly on the skis when strapped down in horizontal position. The bindings normally takes up the most space, therefore the ski carrier was developed to allow loading the skis in both horizontal and vertical position. By simply turning the carrier upside down a rack structure allows the box to now fit three pair of skis in vertical position, figure 84. The rack structure prevent skis from falling down on the car roof, makes it easier to arrange the skis and also secures the skis sideways as well as front-ways as the pins prevents the bindings from moving forward. A security net in the front also contributes to the safety. Loading skis in vertical position allows the box to be more compressed, but do not fit as many skis.

Figure 83 - Ski carrier.

Figure 84 - Three pair of skis placed in vertical position.
The box consists of two hard shells, a top and a bottom, which are connected by a semi-soft material in the front. The flexible front part will be made in rubber or other semi-soft material with similar properties and will act as a hinge and make it possible to change the volume of the box. By using a semi soft material the front will have a rounded shape in all positions to retain the aerodynamic properties. The base and top part will be vacuum moulded in ABS plastic to take advantage of Thule’s manufacturing facilities and techniques used today. Both top and base have a grooved structure for increased stability and stiffness, figure 85.

![Figure 85 - Implementing grooves in the vacuum moulded details increase stability and stiffness.](image)

To mount the box on roof racks U-bolts equipped with twist knobs are used. The low sides of the base part allow better access to the twist knobs, making the mounting on roof racks easier. To open the box the strap is released and a scissor lift equipped with a compressing spring will automatically open the box with the fabric and frame following upwards. The scissor lift mechanism is designed to have a wide fixation point both to the bottom and the top. This is necessary when a flexible front part is used, to stabilise the top part in all positions and prevent it from twisting, for example when closed down on an unevenly divided load.

![Figure 86 - Overview of the inside of the box. The scissor lift is equipped with a spring in the rear part of the box. The mechanism will force the roof to lift and at the same time keep it stable in all positions.](image)
The box is closed by simply pulling the strap. The strap buckle allow the strap to run freely when pulling the top down, but locks the strap in the opposite direction as long as the buckle is not released. The buckle can be used to tighten the top against the load and works similar to how for example snowboard bindings are tightened. In this way you prevent the load from moving around and you get the lowest profile possible. The strap goes from the buckle into a hole in the back and then runs under the scissor lift and into a channel protecting the strap from get stuck in the load, figure 87. In this way the strap is integrated in the box and always hided in all positions.

Figure 87 - The ridge and L-shaped frame profile prevents water from reaching the inside of the box.

A weather resistant fabric, tarpaulin or equivalent material, is used on the sides of the box. The fabric have a folded structure to allow expandability. The folds are reinforced with plastic ribs, giving the fabric a stronger structure and stability. The fabric is attached to the top, the flexible front part and to a frame. The frame is attached to the bottom with a hinge in the front to be able to open the box. A ridge mounted on the vacuum moulded base part together with the L-profile shaped frame creates a waterproof sealing, figure 88, while still maintaining a low profile for easier access and visual overview of the content. This profile also facilitates easy handling of the box, since it is easy to grip around when lifting and moving the box. The hole in the ridge profile will be used when connecting the flexible front to the base part.

Figure 88 - The ridge and L-shaped frame profile prevents water from reaching the inside of the box.
To protect the load from theft a locking mechanism is implemented that allows the frame to be locked to the base from both sides, figure 89. The locking mechanism is hooked onto a bow eye in steel connected to the frame that fits into a hole in the base.

![Locking mechanism](image)

**Figure 89 - Locking mechanism.**

The lock and strap are strategically placed in the back to have all functions within reach from one place. It is possible to open/close, load/unload and lock/unlock the box easy and fast without the having to walk around the car.

![Box with strap and buckle](image)

**Figure 90 - The strap, buckle and locking mechanism placed within reach from one place. The box can be locked from both sides.**
The concept Thule Snowdrift is a new aerodynamic way of transporting the ski equipment outside the car. The concept is designed in accordance with Thule’s motto “Bring your life” as well as their design values; tension, clean, accentuated edges, contrast and integrated.

![Figure 91 - Thule snowdrift mounted on a Audi A6 Allroad.](image)

The curved shape of the top creates tension, and is highlighted using the white colour. Using a white colour combined with the darker black colours in the bottom helps give the box a low profile appearance and creates great contrast.

![Figure 92 - The box in opened position. The low sides make it easy the get an visual overview and reach the content.](image)

When designing the product, focus have been on letting form, function experience be in balance, which in the end have led to an clean and modern design that gives an aerodynamic and appealing appearance. The concept is intuitive and easy to use, as it is based on deep insight in the specific task of transporting alpine ski equipment. Thule Snowdrift is designed to fit for that purpose. The concept will benefit both the user, as fuel
consumption and storage space is reduced, Thule themselves, as they will save money in logistics and transportation of the box, but also the society as a whole, as the concept is an environmentally friendly option both when used on the car and when it comes to logistics.

5.15 Material selection proposal
A proposal of what materials to use in the product was made for Thule so they could roughly estimate costs, weight, load capacity, manufacturing methods. When choosing appropriate materials we considered Thule’s current manufacturing methods and materials used in their boxes today. The material selection proposal was also based on discussions with supervisor Anders Nilvius, where factors as costs, weight, durability and appearance was considered. It is important that an exterior accessory for a car can withstand the load of the cargo, be safe and it needs to be suited for many different environments. The product must withstand sunlight and various weather conditions. An exploded view and a material selection proposal can be found in appendix 9.
6. DISCUSSION

Method
Using the lead user method have been a great experience for us. With no experience in this approach beforehand we learned a lot. It is not an easy method to use, since it relies a lot on that you can find the right people with desired characteristics. One thing that made this project special was the fact that we could be seen as lead users ourselves. We are experts and have long experience in the activity skiing and can experience needs that is still unknown to the majority of the market. We also innovate and would benefit ourselves if we could find a solution that satisfy our needs. You could say Thule used the a lead user innovation approach just by having us doing a master thesis project for them regarding our special interest in skiing. Instead of just asking us what our needs are they let us invent ourselves and be a part of the development process. We then took it one step further by trying to find even more lead users to involve in the process.

Compared to other projects we noticed that we could directly come up with a lot of interesting concepts in a short period of time. Since we already had been thinking of problems unconsciously when skiing and experienced problems ourselves, we had a lot of ideas already from the start. We did not have to spend a lot of time to familiarise ourselves with the activity and problems associated with it. Working with a product related to our passion in skiing in our master thesis project was very motivating and fun.

We believe that the lead user method is a good method for this kind of project where the product developed is connected to an activity that a lot of people are passionate about and where the technique is constantly evolving.

Thule did not show us any of their conceptual ideas at the first stage of the project. They wanted us to generate concept from our own perspective and other lead users concerns and needs. It was a decision that we made together because we wanted to stay open-minded and keep thoughts like "they have already thought of this" away.

Before the second stage of the project, just before we were about to publish our concepts at the blog to get feedback from the lead users, we had a meeting with our supervisors at the client company Thule. During this meeting we presented all our initial ideas and sketches to Thule. Two of our ideas/concepts was basically spot on on what Thule themselves were working with at the moment. With this reason these two concept became sensitive in a confidential way. With respect to this, it was decided that none of these ideas would be showed at the blog. This was a critical moment in the project as it affected the choice of concept to be developed further. Even though the concepts were very interesting and considered to have great potential they were not chosen for further development. One option could have been to continue the development of Thule’s concepts or developing a new alternative version of it, but since the methodology was an important part of the project that required transparency to work properly, we chose to continue with the other concepts not conflicting with confidentiality in the same way.

We could have used more lead users in the development process within other markets than skiing. For example users with extreme need of aerodynamic solutions.
Understanding the definition of a lead user can be difficult and deciding if a user really have the lead user characteristics. One way you can approach this is to have a user oriented development process where all user input can be valuable and where the more lead user characteristics the users have, the better.

A difficulty with the method is that companies typically do not want users to invent the things they produce, they want to invent it themselves. If you give a firm a free choice, the majority would most likely move away from trying to find user innovations to finding user needs.

**Organisation**

A challenge when working at home and not in an office is to separate spare time with work time. The organisation and working environment is important and therefore dedicating an area in the home as a creative working space was important for us.

When working with innovation and creativity it can be a challenge to decide when to end the ideation phase of a project, choose a direction and move forward. You can generate new ideas forever, but in reality you have to say, this is good enough, and move on at some point. Therefore it is very good to create shorter deadlines and decision points within the project. There is a balance of having a detailed and structured working process and at the same time working with an open and iterative process that facilitate creativity. We believe we managed well in finding this balance in the project.

**Forum**

An advantage for us when using forums might be that we were students. People usually have a different attitude to students in general, where they are more helpful and open minded, compared to professionals working for companies.

We discovered that posting threads on forum gave the project a motivational boost. To see that other people were interested in our topic and motivated us to work even harder. When getting responses from people it was both great for validating our own ideas but it also triggered new ones and helped us open up our minds and see problems from different angles.

In opposite to just hand out a survey to people you can ask follow up questions and keep a discussion going when using forums. In this way you get both quantitative data that is an advantage of handing out surveys to a lot of people, but also more qualitative and deeper understanding similar to an interview.

Gathering information from a global community can have both benefits and drawbacks. On one hand you get a lot of information from a more varied and diverse population. On the other hand people on internet are usually very anonymous and there is a lack of demographic information and other unknowns regarding their expertise or intentions. Therefore it can be a good idea to combine multiple methods on the same research question to confirm the input from several different angles. To increase the confidence of research outcomes as well as get depth in the information we did not only trust the input from forum threads but compared this with input from both the blog and the workshop. When having discussions on internet with anonymous users, it is also expected with some unserious user feedback. This can be a problem but was luckily not a big issue for us.
Forums and communities are good places to verify data and the significance in input gathered from other places. To see if people are passionate about something special, if there are any trends and how many people are adopting to this. Forums and communities are also great places to find out more about the characteristics of your target user group and what concerns they have and what triggers their emotions. It is more difficult to find innovation on the forums. You will find discussions where users ask for help on how to solve problems and other users giving their input and sharing their experiences trying to help each other. Finding innovative people is also possible that are willing to share their solutions. A big challenge can be to involve people on a deeper level and involve them in your development process. People are usually anonymous on internet and can be living on the other side of the world. Having them participate in a workshop for example can be very difficult.

When dealing with confidential information you want to work with people close to you that you can trust and sign confidentiality agreements. Continue a cooperation with lead users over the internet is not a good solution in this sense. In general we believe the approach that works best on internet is to be transparent.

**Blog**

When posting sketches and ideas on the blog was good for practising on communicating ideas to people in an understandable way.

The input from the blog was a little disappointing. We had expected more feedback from the invited users.

One reason for this is that people not used to read and interpret sketches could have a hard time understanding the ideas. From statistics we could see that we had a lot of visitors on the blog that did not leave a comment.

The statistics also showed that the blog had a lot of visitors in the beginning shortly after we invited everyone, than the number of visitor decreased gradually for every day that passed. We believe people forgot about visiting the blog or that they felt it was a too big effort to spend time formulating comments and give feedback. A way to prevent this is to create a more win win situation, where users feel they get something back in return for their time spent giving feedback. A difference from the blog is that the social aspect is not as big trigger for people anymore, since the blog was only a temporary communication platform. It could be a good idea to keep using the forums as a communication platform since a lot of users there gain a higher social status in the community by writing more comments. A drawback of staying in the forum is that your project will be very public and you do not have the same control over who is reading and commenting.

We also got feedback from some of the invited lead users that they had tried to comment but it would not work for them.

**Workshop**

From the workshop we learned a lot of the importance of group dynamics and that the type of workshop we arranged benefit a lot from having groups of people that know each other beforehand and are comfortable with each other. One of the two groups in the workshop knew each other better from before than the other group, which also reflected in the result of the discussions and ideas developed during the exercises. We also
saw the benefit of being well prepared with backup questions to trigger the creativity in case a group gets stuck.

We noticed that having people that have a good understanding and already experts within the area the product is targeted for will give you a lot of qualitative feedback. When having this people inventing themselves you get even more valuable information. Overall we were very satisfied with how the workshop was executed and the outcome from it.

**Prototyping**

Spending one and a half week in Thule’s facilities in Hillerstorp building prototypes was very valuable. We could use their facilities and equipment and get fast feedback from our supervisor Anders Nilvius.

**Patent**

It was interesting involving patent and confidentiality questions in the project since we did not have much knowledge of this beforehand. Using the lead user method that benefits from being transparent and at the same time consider a company's confidentiality interests, meant that we had some restrictions and had to compromise in some situations.

**The Result**

We are very satisfied with the results of the final concept, but also believes that many of the concepts that was not chosen for further development had great potential. The concept Thule Snowdrift is a new and aerodynamic way of transporting alpine ski equipment outside the car. We believe the concept satisfies the identified problems and concerns discovered during the project as well as the goal of creating a product that have a clear connection to the Thule brand language and their motto "Bring your life".

The result in this project is based on the MIT professor Eric Von Hippel’s research and lead user methodology. Lead user innovation have been proven to be very successful with several success stories from the past. Thus we believe that the scientific relevance is also high in this project as well as the result.

A challenge when implementing fabric to the product is to maintain a high quality impression, to not have the product looking baggy. We believe that the folded structure of the fabric is a good way to prevent this and that it also is a form that clearly follows function. One of Thule’s current products, Ranger 500, that is a foldable ski box made in fabric gives a baggy impression that we think a lot of people do not want to associate with their car.

Other big challenges were to figure out a proper opening and locking mechanism. Finding a mechanism that would stabilise the top in all positions, yet simple and easy to use as well as not take up too much space and be in the way when loading/unloading, was not an easy task. We believe the solution in the final concept will meet those requirements, but needs to be tested in reality to validate this.

Rubber has properties suitable for the flexible front part but is a material with high density and will be very heavy if the the thickness of the detail required in a durability, safety and quality perspective results in a high volume.
Skiing is an activity very dependent on the environment. Global warming affect everyone who enjoys snow in
the winter and skiing. Today a lot of companies have a clear environmental focus and approach, both in the
skiing industry and the car industry, and therefore we believe it is relevant for Thule to put effort and focus in
this area as well. Offering solutions that are superior other products in an environmental perspective will
benefit in a marketing perspective. The final concept address this problem with a focus on being
aerodynamic and taking up as little space as possible. This is an advantage both when it comes to fuel
consumption and gas emissions when using the box, but also in logistics as it will not take up as much space
as traditional boxes. Less trucks needed for transporting the product means less environmental impact and
saving more money.
The following section provides recommendations of what Thule needs to do if they want to take the final concept to the market. We also give our recommendation on what to consider when using the lead user method in a future product development project.

The final concept
We believe that the final concept have a potential market and that the product meet the needs of todays and tomorrows skiers. Until now it is a conceptual idea which have been evaluated and tested with a full scale mock up and CAD. The products current design requires that a number of factors are investigated further to get the product ready for the market.

A critical part of the overall functionality is the semisoft part and material in the front of the box, which will act as hinge and make it possible to change the volume of the box. Thule needs to find a suitable material and manufacturing technique for this detail to be able to produce the box. Our recommendation is to investigate if rubber could be the proper material to use.

If Thule find a suitable material to produce the front, we recommend continuing with creating prototypes made of materials as the box is intended to be made of. It is also important to find a method and a suitable tarpaulin/fabric to produce the folded fabric for the sides. It is important to make sure that the fabric feels like a robust and high quality detail and well integrated in order for the product to fit into the premium segment Thule is aiming for. The product have to feel genuine in both materials and design.

Features like locking mechanism, opening mechanism and straps are details where different solutions already exists and that would most likely only need smaller modifications to be customised for the product. Dimensions and suitable materials needs to be specified in more detail.

The prototypes needs to be evaluated and tested to verify that the product design and materials will satisfy all the requirements Thule has regarding safety, ease of use, durability and quality. Calculating manufacturing costs and pricing the product is also necessary to evaluate profitability.
The method

If continuing hire people that are pioneers within the activity the product is aimed for, we believe Thule will get great results. Thule should also consider involving experts within other markets that are facing similar problems. For example, talking to aerodynamic experts, facing aerodynamic problems in more extreme situations than in car transportation, can be very helpful and valuable. Or involve people with knowledge in wind noise in more extreme situations. Find situations where wind noise is absolutely critical for the product and talk to those people facing and working with this problem.

Identify persons who is in great need to solve a problem that have something in common with problems Thule are facing and users inventing solutions for problems that they would benefit themselves from solving. Finding people like us, with a genuine interest in the activity related to the product and that at the same time can spend a lot of time in a product development project innovating can be a challenge, but well worth the effort.

We think Thule can ask themselves if they think this master thesis worked well, then using lead user innovation is a great approach for them to use in their product development process.
8. REFERENCES

Litterature


Thule. (2013). Thule product design manual. PDF. Confidential

Websites


**Videos**


**Picture references**


Figure 7. Axisymmetric droplet shape. (Scibor-Rylski, 1975) page 26

Figure 8. Effect of dimensions ratio. (Scibor-Rylski, 1975) page 106

Figure 9. Body of ideal shape. (Scibor-Rylski, 1975) page 108

Figure 10. Fastback shape. (Scibor-Rylski, 1975) page 113


Figure 16. Colours. Thule. (2013). Thule product design manual. PDF. Confidential

Figure 17. Lead user diagram (Von Hippel, 2009). Page 7

Figure 24. Same as figure 3

Figure 25. Same as figure 1


Figure 31. Picture of Mont Blanc vista 540, 4/3 2013, Retrieved from http://www.motorserv.com/media/catalog/product/cache/1/image/9df78eab33525d08d6e5fb8d27136e95/r/o/roof-box-classic-vista540-main-download.jpg (2012-3-13)


Figure 44. Photo, Anders Odegarn. Retrieved from (2012-3-15).


People
Henrik Eriksson, Thule, 2013-01-20 - 2013-03-30
Anders Nilvius, Thule. 2013 -01-20 - 2013-06-05
Niklas Kronborg, Thule, 2013-04-19
Michael Mitschke, Thule, 2013-04-18
Fredrik Ericsson, Veryday, 2013 -01-20 - 2013-06-05
Daniel Höglund, Veryday, 2013 -01-20 - 2013-06-05
Henrik Kax, Fearless Design, 2013-03-25
Ski dimensions
A few different examples of models and dimensions of common and extreme skis:

Common dimensions piste ski:
Brand, model: Nordica, Dobermann Spitfire PRO
Length: 177cm
Tip/waist/tail: 122mm/70mm/105mm

Common dimensions freeride skis:
Brand, model: Völkl Gotama 2013
Length: 194
Tip/waist/tail: 139/107/123

Extreme dimensions freeride skis:
Brand, model: Black Diamond, Gigawatt 2013
Length: 195
Tip/waist/tail: 163/135/141

Common dimensions freeride skis (ladies):
Brand, model: 4front, athera
Length: 168 cm
Tip/waist/tail: 124mm/100mm/116mm

Snowboard dimensions:
Brand, model: Burton, Custom
Length: 160 cm
Tip/waist/tail: 299mm/255mm/299mm
### GANTT CHART MASTER THESIS 2013

<table>
<thead>
<tr>
<th>Task</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>Maj</th>
<th>Jun</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisation &amp; planning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research &amp; analysing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Method selection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial concept &amp; ideaation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concept presentation &amp; feedback</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concept development &amp; possibly prototyping</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concept presentation &amp; feedback</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detail design &amp; possibly prototyping of final concept</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concept presentation &amp; feedback</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presentation &amp; documentation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand in report for feedback from opponent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final presentation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Documentation/report writing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand in final report</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Web communities and forums

Below is a list with short descriptions of relevant internet websites and communities that have been used in this project.

http://www.freeride.se/forum/
Freeride was established in 1998 and is today Sweden’s most popular skiing website with around 250 000 visitors each month during the skiing season. It is a big meeting place for skiers and in the forum discussions about skiing and related topics take place. The community has about 90 000 registered members.

http://www.freeride.co.uk
This is the same site and community as www.freeride.se but it is made for english speaking users. Same kind of features but less members compared to the swedish version.

www.epicskies.com
EpicSkis.com, they describe their site as the online home for dedicated skiers, and that it is the leading internet resource for ski information and community discussions. The community members can post questions, answers, thoughts, comments, suggestions, and so forth, on a galaxy of ski-related topics. The site has about 40 000 members, 110 000 threads and about 1,5 million posts.

http://www.utsidan.se/forum/forumdisplay.php?f=90
Popular Swedish outdoor and adventure site with a forum.

http://freeskier.com/forums
Freeskier was established in 1998, originally as a magazine company. Today Freeskier is a multi-platform, multi-channel connection between ski industry and skiers. Their distribution channels are through print, podcast, website, social media and more. The publisher Storm Mountain Publishing also publish a snowboard magazine and website, snowboardmag.com. The print magazines, Freeskier and Snowboard, distribute 840 000 copies annually to 2.5 million readers. The websites reach over 2 million unique visitors every year.

http://www.newschoolers.com/ns/forums/forums
Website dedicated for snowboarders and skiers with emphasis on photo and video. Big and active forum called gear talk.

Ski.com.au has been publishing since early 1995 and has since remained the number one destination on-line for the Australian snow sport audience. There is an estimated 1.4 million skiers and boarders in Australia and each year Ski.com.au reaches over 85% of this market.
Web communities and forums

http://www.wildsnow.com
Popular backcountry skiing blog site in US with lots of equipment tests. Probably a good place to find lead users, personal contact with one of writers.

Teton Gravity Research, famous as TGR is a company and brand, producing action sport films and selling clothing. It was founded in 1996 and have expanded since and are nowadays producing films together with the worlds top snowboarding, skiing and surfing athletes. Their website has a forum with different categories of everything from fishing, kayaking to skiing and snowboarding. The ski/snowboard category has about 60 000 threads and 1,4 million posts.

http://backcountryskiingcanada.com/forums/view
A site visited by backcountry enthusiasts who have needs for the gear and services to get them out on their next self-propelled, snowy adventure.

http://www.j2ski.com/ski-chat-forum/recentTopics/list.page
Community on, according to themselves, the second most popular UK Ski Site.

According to TheSkiDiva.com, it is the leading community for women skiers.

http://www.carving-ski.de
German ski site and forum.

German ski forum.

http://www.skitalk-24.de/
German ski forum.

http://snowheads.com/ski-forum/
A popular UK ski community and forum.

http://www.garaget.org
A swedish community dedicated for people that love cars. A lot of the members are modifying their own cars and showcase their own cars and the modifying process.

http://www.powdermag.com
No forum but lots of news and inspiration.

http://skiingbusiness.com
No forum but a good site for researching trends and get inspiration.
Statistics of forum replies and unique users

- epicski.com
- snowheads.com
- tetongravity.com
- ulsdan.se
- newschoolers.com
- freeride.se
- ski.com.au
- freeskier.com
- backcountryskingcanada.com
- garage.org
- j2ski.com
- freeskier.com

Y-axis: Replies & Unique users
X-axis: Websites

50 replies
20 unique users

Visitor statistics - Blog

Översikt över målgrupp

<table>
<thead>
<tr>
<th>% av besök: 100,00 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Översikt</td>
</tr>
</tbody>
</table>

Besök

![Graph showing visitor statistics from 5 mar 2013 to 23 mar 2013.](image)

109 personer besökte denna webbplats

<table>
<thead>
<tr>
<th>Besök</th>
<th>Unika besökare</th>
</tr>
</thead>
<tbody>
<tr>
<td>343</td>
<td>109</td>
</tr>
</tbody>
</table>

Sidvisningar

<table>
<thead>
<tr>
<th>Sidorbesök</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 210</td>
</tr>
</tbody>
</table>

Gen. längd på besöken

<table>
<thead>
<tr>
<th>Avg. avläningsfrekvens</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:02:48</td>
</tr>
</tbody>
</table>

% nya besök

<table>
<thead>
<tr>
<th>% nya besök</th>
</tr>
</thead>
<tbody>
<tr>
<td>31,78 %</td>
</tr>
</tbody>
</table>

Språk Besök % Besök

<table>
<thead>
<tr>
<th>Språk</th>
<th>Besök</th>
<th>% Besök</th>
</tr>
</thead>
<tbody>
<tr>
<td>sv-se</td>
<td>196</td>
<td>57,14 %</td>
</tr>
<tr>
<td>sv</td>
<td>80</td>
<td>23,32 %</td>
</tr>
<tr>
<td>en-us</td>
<td>60</td>
<td>17,49 %</td>
</tr>
<tr>
<td>en-gb</td>
<td>3</td>
<td>0,87 %</td>
</tr>
<tr>
<td>en</td>
<td>2</td>
<td>0,58 %</td>
</tr>
<tr>
<td>no</td>
<td>2</td>
<td>0,58 %</td>
</tr>
</tbody>
</table>
Workshop script

Introduction.
We want to gather ski enthusiasts who can help us with various experiences and ideas related to an expandable roof box. The workshop will consist of three phases and we are going to provide smaller groups with material to create sketches and crap-ups of roof boxes with expandable design. In the first phase the members will interact with each other and carry out an association exercise, in the second phase they will be sketching ideas, and in the final phase they will build prototypes. The idea of the workshop is to take notes of what the groups are discussing and what kind of concerns they want to solve. The main purpose is not to evaluate the quality of the final prototype and sketch. It is all about to listen to the discussions, arguments, and visions the exercises rise. We want to figure out what people think is important features for an expandable roof box.

Goals & Objectives.
To identify desirable features related to an expandable roof box, and possible difficulties. The collected information will be the basis for the further development of the expandable roof box concept.

Duration
2 hours

Date:
3rd of April

Organisers:
Linus & Johan

Participants:
4-9 people. In first instance "lead users" in skiing, but also ordinary skiers can be invited. No more than 9 persons. 5-9 becomes a group that is not too big for everyone to be able to listen to everyone’s ideas.

Procedure:
1. Presentation - short introduction of our project, what we do and the idea with the workshop. Divide the group into two teams, preferable into teams where they feel comfortable. They can divide the teams themselves. It could be good if they know each other since before, because then they will likely act and speak more open minded.

2. Association exercise
Participants write their associations on each word for 1.5 minute, then summarized on the whiteboard. Word: open/close, Aerodynamics, Expandable. This exercise is to trig the creative thoughts and on focus quantity.
3. **Sketch phase**, the participants will be discussing and try to sketch what they want for an expandable roof box. The intentions is to focus on valuable functions and how they want to solve their concerns. The suggestions/ideas will be drawn in a very basic level of sketching. We will observe what kind of things they want to solve. It is not the quality of the sketches that will be analysed, it is what is discussed that is interesting. In the end of this session the teams will prepare a short presentation for the other team to share their ideas. They will also have the possibility to ask questions to understand the concepts. We will record presentation to be able to analyze it later. After the presentation the participants will be able to vote for the ideas they like. We will hand out green post-it notes and they will place these notes on the ideas they like.

4. **Prototyping phase**, the two teams will start to build prototypes using the tool and materials that we are providing. We will listen what they are discussing when building and take notes. After this phase they will present their ideas to each other. And summary will be done to clarify what they like about the ideas and prototypes.

**Schedule**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>16:00</td>
<td>Introduction - Presentation and dividing participants into groups.</td>
</tr>
<tr>
<td></td>
<td>We will also provide refreshments.</td>
</tr>
<tr>
<td>16.10</td>
<td>Association exercise</td>
</tr>
<tr>
<td>16.20</td>
<td>Summary of association exercise</td>
</tr>
<tr>
<td>16.30</td>
<td>Introduce sketch phase</td>
</tr>
<tr>
<td>16.38</td>
<td>(if needed, enrich the discussions with (what else can a roofbox be used for?)</td>
</tr>
<tr>
<td>16.44</td>
<td>(if needed, enrich the discussions. If you were a salesman trying to sell an expandable box, what would be your selling points)</td>
</tr>
<tr>
<td>16.50</td>
<td>Let the groups present their Ideas to each others</td>
</tr>
<tr>
<td>17.00</td>
<td>Hand out post-it notes and let them vote for the things likes</td>
</tr>
<tr>
<td>17.10</td>
<td>Start prototyping phase and introduce the available material</td>
</tr>
<tr>
<td>17.40</td>
<td>Tell them to prepare a short presentation for the other teams.</td>
</tr>
<tr>
<td>17.45</td>
<td>The teams will present their ideas. Record</td>
</tr>
<tr>
<td>17.55</td>
<td>We will summarise the workshop and thank the participants for their input</td>
</tr>
</tbody>
</table>

**Materials**

Cardboard, fabric, wax paper, plastic tape, magnets, flower sticks in various sizes, string, laces, sponges, toothpicks, glue, different kinds of tape, scissors, glue gun, umbrella, tarpaulin, sleeping mats, camera tripod, insulation materials, bubble wrap, paper clips, staples, pens, paper, post-it notes, inspirational images (pictures that might trig ideas)
Pictures from workshop

[Series of images from a workshop setting showing participants engaging in creative activities.]
Exploded view and material proposal
## Exploded view and material proposal

<table>
<thead>
<tr>
<th>No.</th>
<th>PART NAME</th>
<th>Quantity</th>
<th>DIMENSIONS [mm]</th>
<th>VOLUME [mm^3]</th>
<th>MATERIAL PROPOSAL/COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Top</td>
<td>1</td>
<td>2000x670x3</td>
<td>~ 4 360 000</td>
<td>Vacuum formed plastic, UV-resistant</td>
</tr>
<tr>
<td>2</td>
<td>Hinge (scissor)</td>
<td>2</td>
<td>48x24x2</td>
<td>-</td>
<td>Steel</td>
</tr>
<tr>
<td>3</td>
<td>Scissor lift mechanism</td>
<td>1</td>
<td>-</td>
<td>~ 329 000</td>
<td>Aluminium</td>
</tr>
<tr>
<td>4</td>
<td>Frame</td>
<td>1</td>
<td>Total profile: 4600x20x3</td>
<td>-</td>
<td>Aluminium, L-profile</td>
</tr>
<tr>
<td>5</td>
<td>Ski carrier</td>
<td>2</td>
<td>620x40X120</td>
<td>~ 262 000</td>
<td>Steel + coating to protect skis</td>
</tr>
<tr>
<td>6</td>
<td>Base</td>
<td>1</td>
<td>1980x670x3</td>
<td>~ 5 400 000</td>
<td>Vacuum formed plastic + extruded plastic</td>
</tr>
<tr>
<td>7</td>
<td>Flexible Front</td>
<td>1</td>
<td>-</td>
<td>~ 2 850 000</td>
<td>Rubber</td>
</tr>
<tr>
<td>8</td>
<td>Hinge (frame)</td>
<td>2</td>
<td>70x16x2</td>
<td>-</td>
<td>Steel</td>
</tr>
<tr>
<td>9</td>
<td>Fabric</td>
<td>1</td>
<td>4815x350</td>
<td>-</td>
<td>Water resistant fabric as Tarpaulin/TPE</td>
</tr>
<tr>
<td>10</td>
<td>Mounting kit</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>To attach box to roof bars</td>
</tr>
<tr>
<td>11</td>
<td>Lock</td>
<td>1</td>
<td></td>
<td></td>
<td>Lock mechanism</td>
</tr>
<tr>
<td>12</td>
<td>Strap and buckle</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>To close the box</td>
</tr>
<tr>
<td>13</td>
<td>Clip ski carrier</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>Steel</td>
</tr>
<tr>
<td>14</td>
<td>Straps</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>To secure skis</td>
</tr>
</tbody>
</table>
Computer renderings and visualisations


Computer renderings and visualisations

Concept mounted to BMW X1. Original image: http://4.bp.blogspot.com/-oVSKqADu80o/UGmZo-2dFzI/AAAAAAAYoo/gC5M9F8o6mE/s1600/BMW-X1-Edition-Powder-Ride-2012-2.jpg


Appendix 10, page 4

Computer renderings and visualisations
