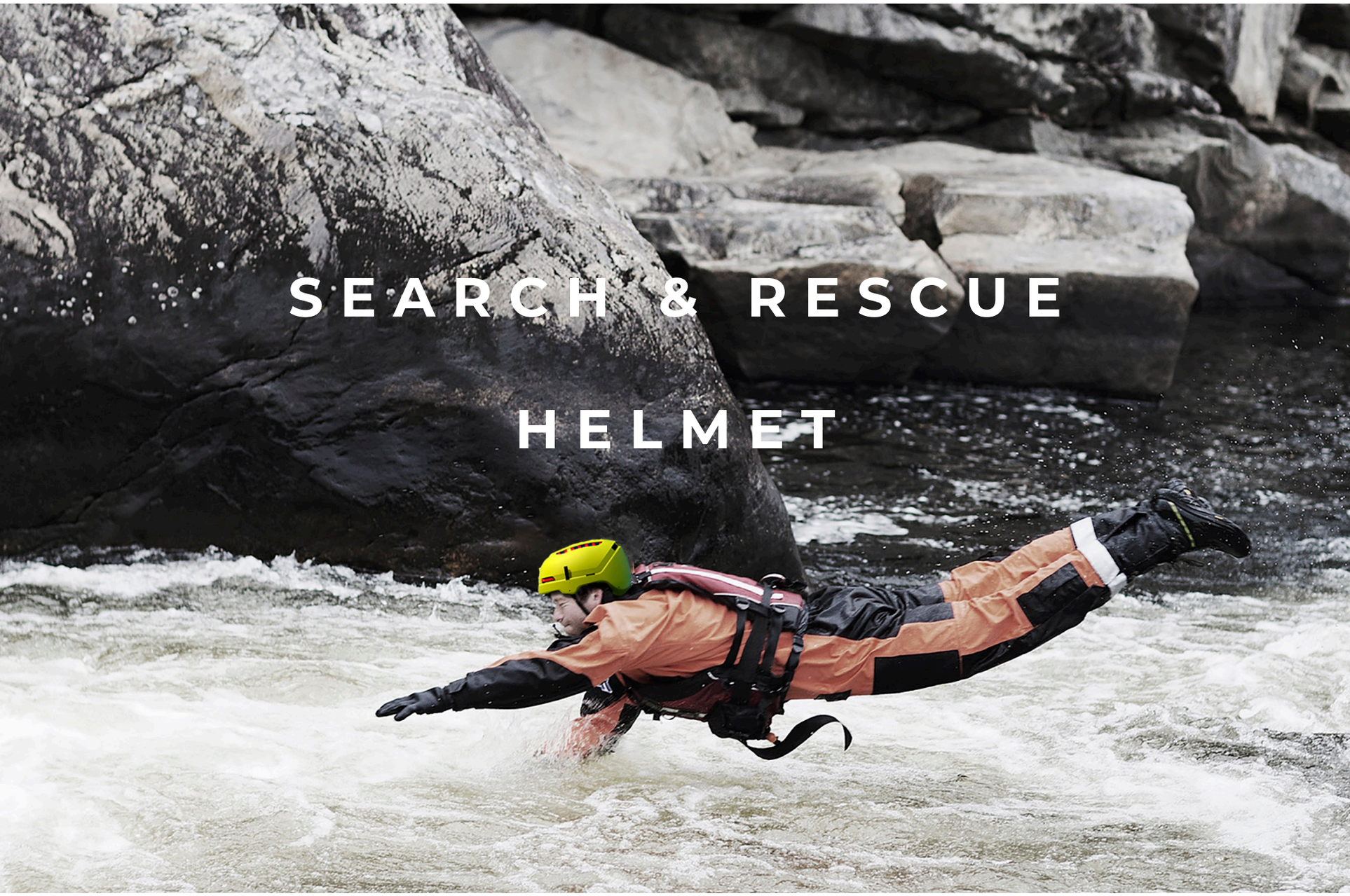


by

Jørgen S. E. Frederiksen

Photo: Stiftelsen Norsk Luftambulanse AS

DIPLOMA SPRING 2019

Title: Search & Rescue Helmet

Diploma kandidate: Jørgen Sebastian Ebbel Frederiksen

Institute: Design

Field: Industrial Design

Supervisors: Stein Rokseth, Steinar Killi

External supervisors: Thomas N. Dahle, Even Wøllo

Collaborative project with

Stiftelsen
Norsk Luftambulanse

Arkitektur- og designhøgskolen i Oslo
The Oslo School of Architecture and Design

FOREWORD

Through my project, I have participated in drills and rescue operations to experience how the skilled crew of the Norwegian Air Ambulance operates, and it has been eye opening.

Learning medical treatments, rescue tactics and how it is to be a patient, has given me a unique insight into the work of the Norwegian Air Ambulances.

I hope this report gives a good insight into my work and my experiences during the project.

Jørgen S. E. frederiksen

ABSTRACT

Today, the workers of the Norwegian Air Ambulance service are using a safety helmet for certain rescue operations. Unfortunately, the helmet does not meet the requirements that the service has today.

Thomas N. Dahle, a rescuer in the service, has been aware of the potential for a dedicated search and rescue helmet, and together with the Air Ambulance Foundation, they wanted to explore the potential of developing a better and dedicated rescue helmet.

This diploma is the first step in that direction. My focus in this investigation has therefore been to identify the issues that they are currently having with their existing equipment, explore potential options, and hopefully, solve some of the problems.

Photo: Stiftelsen Norsk Luftambulanse AS

CONTENT

SAR HELMET

PROCESS

INTRODUCTION

The Norwegian Air Ambulance is one of the leading operators in helicopter emergency services. From twelve base stations in Norway, they provide a national coverage. Every year, they have over seven thousand rescue missions, and they face difficult and challenging environments. Shifting weather means that the crew operates in foul weather and storm, amongst steep mountains and in freezing conditions.

That the rescuers equipment and gear functions well are, are critical to their work. Both gear and crew will need to withstand extreme situations during the whole year, and the crew are highly dependent on their equipment to work properly, and safety are of the uppermost importance.

So my chosen design challenge was: Could the current Search & Rescue helmet (SAR) be improved? How could a new design of the helmet improve the safety and the daily working experience?

Photo: Marius Wigen Andersen

SAR HELMET

This Search & Rescue helmet is a concept designed to improve the working environment of the workers in NLA.

Through extensive field research with user interviews and hands on experience with helmets, I have tried to solve some of the many issues with the current solution.

With a five year development phase, this project is looking at what is viable within that time. The choices made for this concept represents what I believe is a possible solution within this timeframe.

My approach has been user oriented, and focusing on practical and functional solutions.

In this diploma, my solution is shown and described, based on the project research.

Abbreviations:

NLA - The Norwegian Air Ambulanse
SNLA - The Norwegian Air Ambulance Foundation
SAR - Search & Rescue
HEMS - Helicopter Emergency Service

 Photo: Lasse R. Thomasgård

Photo: Stiftelsen Norsk Luftambulanse AS

COMFORT

VENTILATION

When operating as an emergency service in Norway, you are operating in one of the most varied natural environments in the world. From the deep valleys on the west coast to the high mountains in the North, the crew has to adapt as best as they can with their equipment.

A Norwegian summers day can be extremely cold when you're up in the mountains, hanging from underneath a helicpoter, while a mid winters day can be warm because of the level of activity in the rescue mission.

When taking this into consideration, there is a clear issue with how the helmet can adapt to the shifting temperature and weather that the rescuers encounter on a daily basis.

If you're going skiing, rafting or sailing, there are dedicated helmets that suits the needs for the users. However, the rescuers can't bring 3-4 different helmets on each mission in case they encounter snowy conditions, rivers or cliffs. An alpine helmet would be terrible to use during a hot summers day, and a bike helmet would be extremely cold during an avalanche rescue.

Can one helmet adapt to the shifting temperature and weather that the rescuers encounter?

Proper ventilation has the possibility to affects these scenarios in a big way.

If the ventilation can be regulated according to climate and temperature, it can increase the comfort of wearing the helmet, and improving the safety of the crew.

By adding adjustable ventilation in the helmet, they have the possibility to adjust the ventilation as they go.

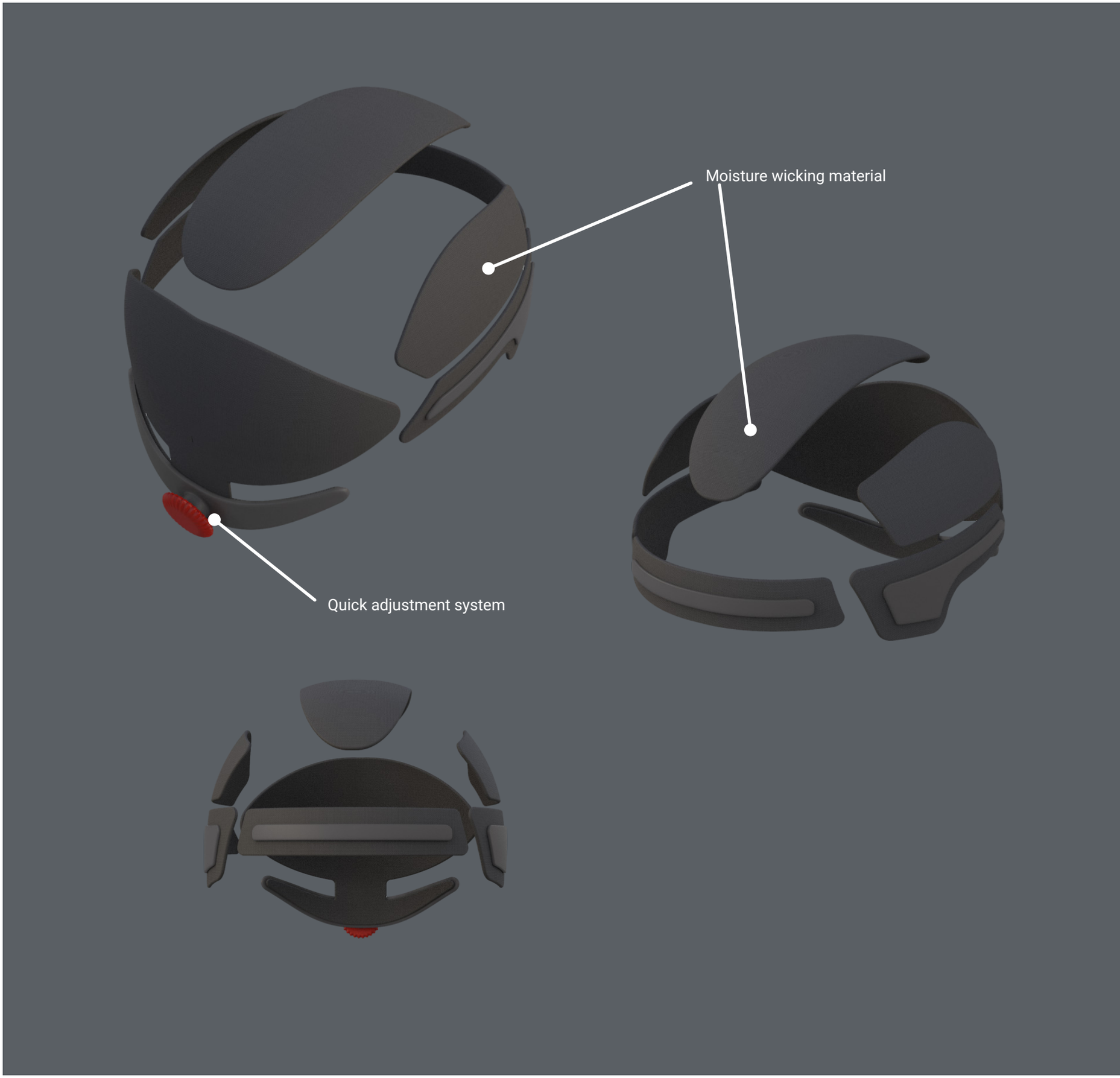
During a rescue mission in wintertime, the ability to close the ventilation also prevents snow from entering and transfering cold to the head of the rescuer.

To avoid the goggles from foggin up, there is also two openings on each front ventilation that allows air down to the goggles when used.

Adjustable ventilation up top gives the rescuer the ability to adjust the temperature considerably.
Spending a considerable amount of time underhung the helicopter, the adjustable ventilation also provides the option to close the ventilation to stop the winds created by the helicopter above.

Two adjustable vents in front of the helmet.

Adjustable ventilation at the back


Moisture wicking material
Quick adjustment system

INNER LINING

As the rescuers are highly active, both on land and in waters, the inner lining will absorb sweat, seawater, freshwater and dirt from the operations.

To deal with these conditions, the inner lining of the helmet is equipped with a moisture wicking material that absorbs and disperse the moisture away from the skin.

The material allows for the body to disperse heat and moisture through absorption while still maintaining its breathability, increasing the comfort and longevity of wear. The fabric is therefore antibacterial and preventing reproduction of bacteria.

The inner lining is easily replaceable and removable with the use of plastic hook velcro, making it easy to wash and maintain.

SIZE ADJUSTMENT

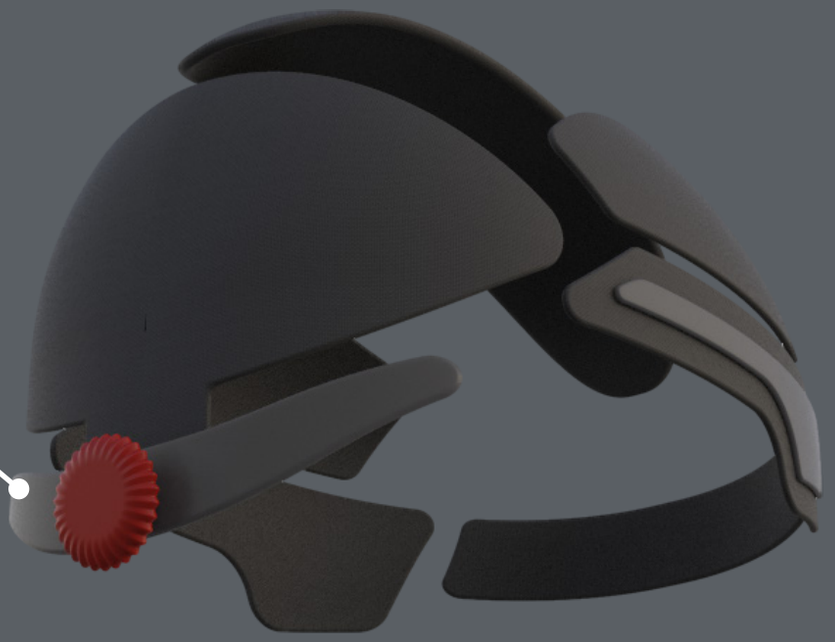
In Norway there are times where it is necessary to use a warmer hat inside the helmet. During a river or ocean rescue, the helmet is also used in combination with a neoprene hood.

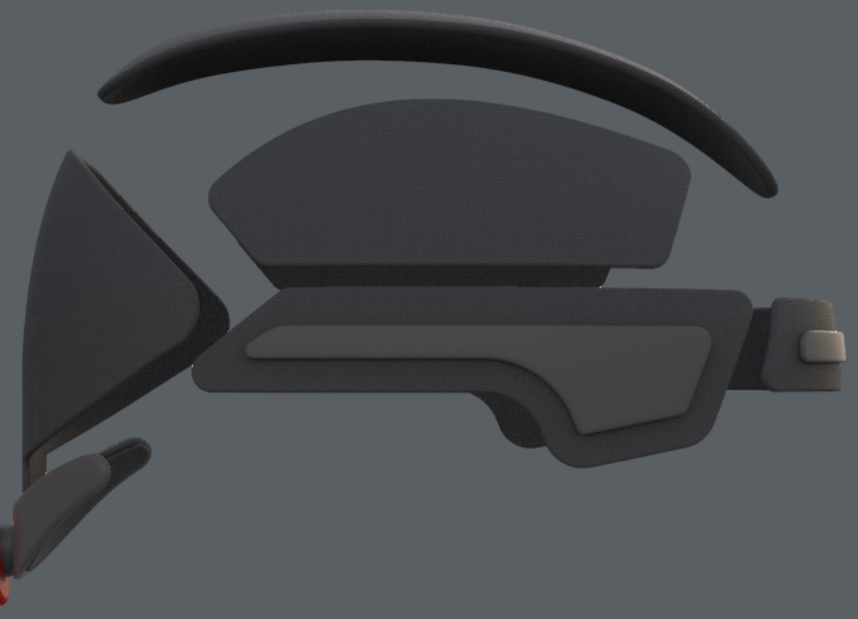
To provide a lightweight and efficient adjustment system, the helmet is equipped with BOA adjustment system. This system is easily adjustable with the twist of a button.

The adjustment system is used in a wide array of sports, from biking, alpine and climbing helmets, and the user can adapt the helmet with the padding that they want to achieve a higher level of comfort.

To increase the ease of use, the adjustment wheel size has a jagged edge to provide easy adjustment while wearing gloves.

Similar adjustment system
as BOA Fit.





Increased adjustment wheel for
easy use with gloves.

STRAP SYSTEM

A majority of the rescue operations are from underneath a helicopter where the helmet is mandatory, and has to meet requirements given for airborne activities.

To keep the weight low, the strap system is similar to that of a climbers' helmet. And this provides a light and easy strap system.
This also meets the requirements for helmets used for abseiling and in airborne operations.

In a variety of rescue operations, the crew has to land at the nearest safe location to change into the proper gear for the rescue.

The strap is fitted with a magnetic buckle that can be released with the use of one hand. This also makes it easier to release while wearing gloves

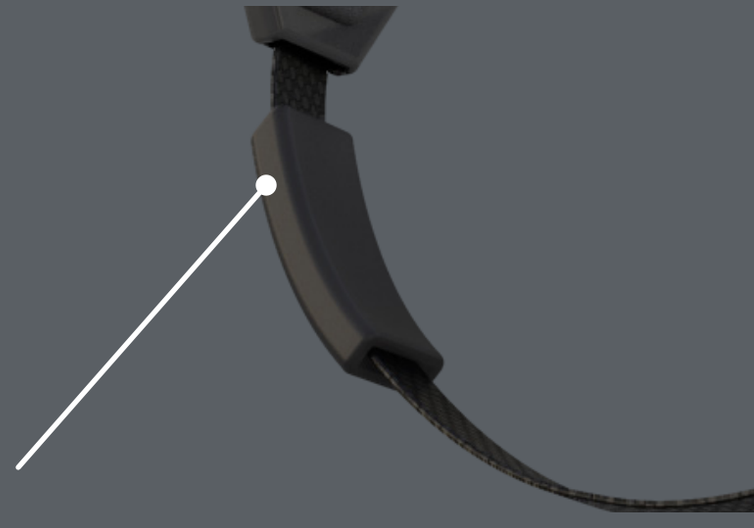


Photo: Stiftelsen Norsk Luftambulanse AS

TECHNOLOGY

LIGHT

Being operational all year around means that the crew often work during the nighttime. While the helicopter provides a great light source, it does not work while being up close with a patient.

Climbing into car wrecks, homes and rescuing people stuck in hard to reach places, having a light source is often important. Today the rescuers use several lights, such as penlight, headlamps and flashlights depending on the mission.

Today they use several lights, such as penlight, headlamps and flashlights depending on the mission.

An integrated light source would not only provide a great light source, but it would also relieve the rescuers hands from holding a flashlight.

The integration of the light source also minimizes the number of added equipment on the helmet, avoiding gear to interfer with each other.

Integrating a light source completely into the helmet would result in a helmet that could be expensive to produce and maintain. In addition, considering the extreme use this helmet is made for, it is the possibility that the light can be damaged. That is why I have chosen å light module that can easily be replaced.

When considering the varying daylight throughout the year, the light source might have a greater value for some rescuers than others. During the winter time, the workers, stationed up north might need a stronger light source than the rescuers in the south, due to the polar night.

The solution to this is having a semi-integrated light into the helmet through the use of an integrated NVG mount in the helmet. Having the light semi-integrated in this fashion allows for a clean surface without obstructing any additional equipment that might be attached via rubber straps.

NVG is a universal mount that allows for additional equipment to be attached to the helmet, such as light, cameras etc. This solution allows for personal modification for the rescuers.

To avoid blinding of a patient, the headlamp is equipped with a light sensor that reacts when light is bouncing back from objects near the user. During a rescue mission, the crew go from long distances to close ups with patients. It is therefore important that the patients are not blinded by a strong light beam. As this functionality is automated, it also frees up the user's hands from adjusting the light, giving the crew more time to focus on the treatment and rescue.

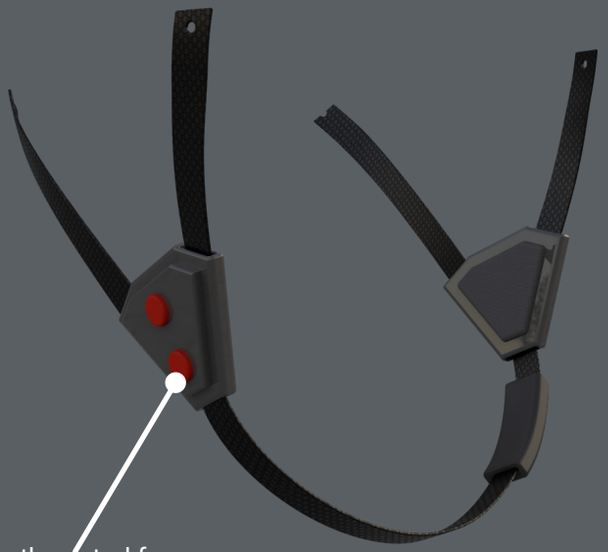
Several rescuers had experience with this type of reactive lighting, and confirmed its functionality in the field.

The light module showed here is built after the dimensions of the interior parts of a headlamp that offers responsive lighting.

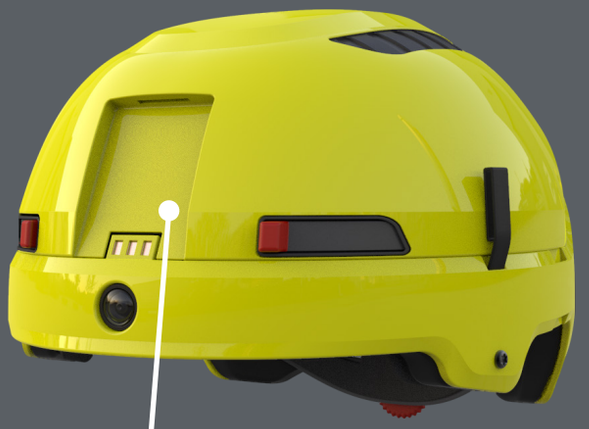
To avoid any moving parts, the light is controlled from a bluetooth switch, located at the strap. This gives the user quick access to the functionalities, without having to fiddle with small buttons on top of the helmet.

To maintain a good weight balance, the battery is placed at the back of the helmet. The light and camera is powered from the same source which is a 2000mah lithium-ion battery.
This should provide operational time for abouth 2-5 hours, depending on the usage, which is more than enough power for most of the rescue operations.

To charge the battery and connect to the camera, there is a USB-C charging port at the back side of the helmet. The battery should also be easily replaceable and it is therefore a standalone unit that can easily be replaced with a fully charged battery.

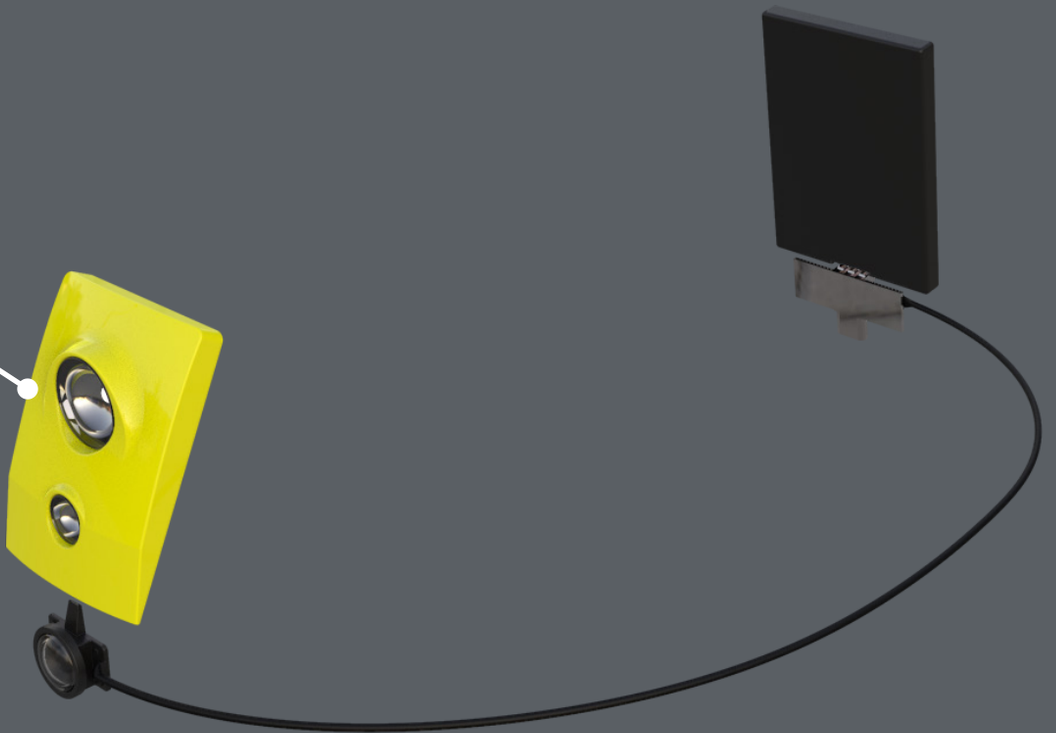


Bluetooth control for
the light and camera.



NVG Mount for the light.

Light module



CAMERA

There is an ongoing research project amongst ambulance workers in Norway to test out the integration of a camera and live stream during an emergency response. Instead of explaining the situation and symptoms via telephone, the doctor can get an overview through both video and audio on the conditions of the patient and can provide detailed information of what kind of treatment he or she needs. [Reference]

This was an element that the Norwegian Air Ambulance wanted for their a new rescue helmet.

The integration of a camera and live video transfer is something that is explored in several areas of the emergency service in Norway. in Norway and this was an element that the Norwegian Air Ambulance wished for in a new rescue helmet.

Providing live stream from the rescuer to the doctor in the helicopter can enhance the efficiency of diagnosis, treatment and equipment preparation as the doctor will be able to both see and hear the patient and the rescuers assessments.

Capturing the interaction between the crew, the patient and the given treatment can also be a great learning resource, both for the mission debrief and for other rescuers and future workers of the service.

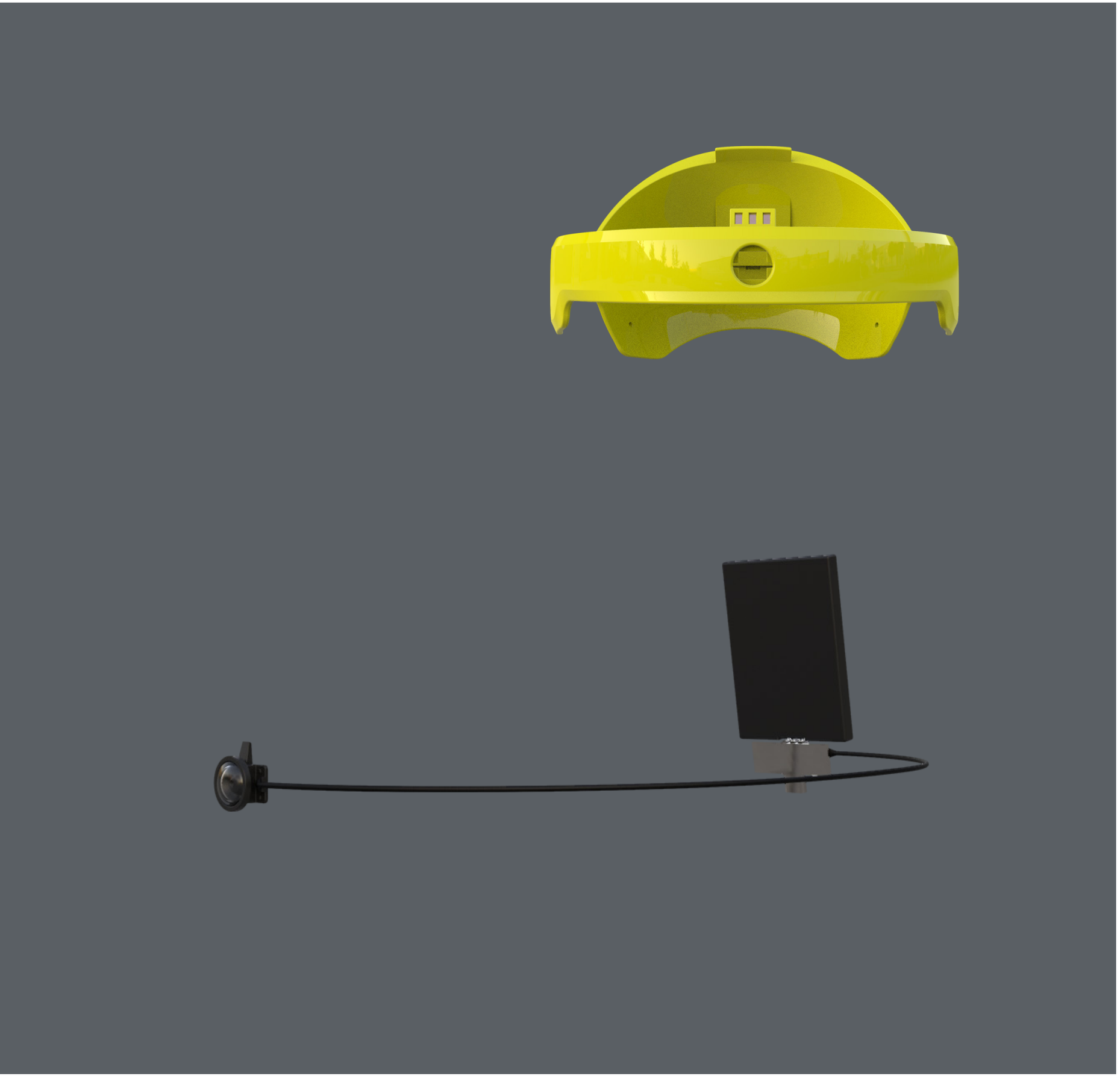
To enable the live stream from the rescuer, the easiest way would be to use wifi or similar. The helicopter is already equipped with this technology.

To capture the best POV from the helmet, the camera has to be located as close to the eyes of the rescuer as possible. Combined with a wide angle lens, this makes it possible to capture the close interactions with the patient.

With the active role that the rescuer has during a operation, the end footage could end up extremely shaky. To compensate for this, the camera is equipped with an Electronic Image Stabilization chip.

This chip croppes the image slightly to produce a steady and smooth video. Similar technology can be found in most action cameras.

The camera is operated from the same bluetooth control as the light is, avoiding movable buttons on the helmet construction.



CONSTRUCTION

MAIN BODY

The integration of the technical components into the helmet offers challenges concerning production and construction. In addition to this, the helmet has to be modular to fit the need of other rescuers that might operate under different conditions.

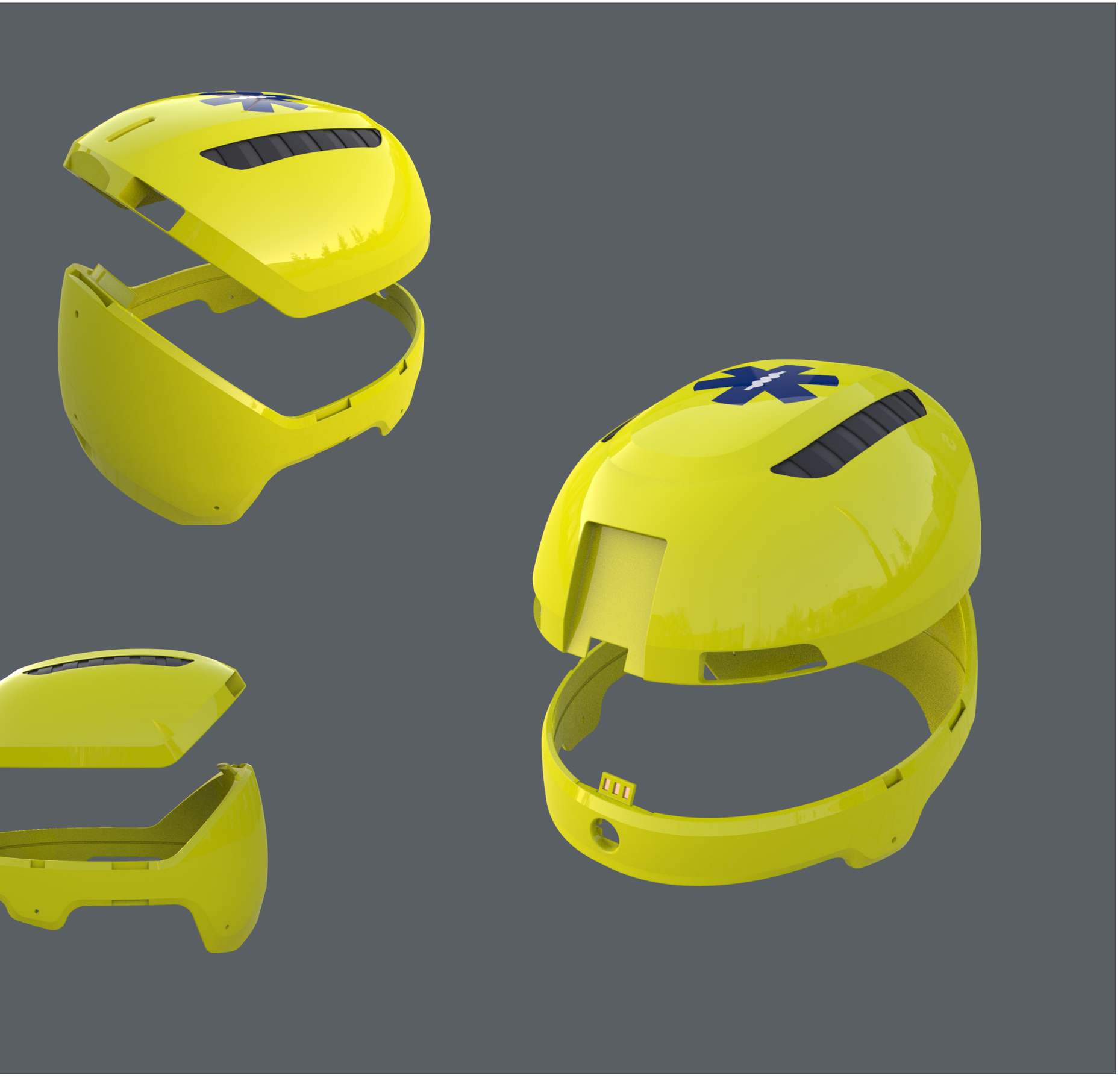
The helmet should also be adaptable for other rescue services that might operate under different conditions

Through prototyping with both 3D software and physical models, it occurred that the helmet could be separated into two parts.

With the technical demands the camera, light and battery offers, it became clear that the bottom half had to contain the electrical equipment. By having the electronics in one smaller unit it allows an easier production and assembly as they do not have to work with the entire helmet.

The top part contains the adjustable ventilation system. It interlocks with the bottom part in the front, sides and back to provide a secure fit, while the EPS inner layer also connects the two parts, creating a solid construction.

As with the bottom part, having the top part separated with only the adjustable ventilation, makes it an easier assembly.



MODULARITY

In addition to simplifying the production and assembly of the helmet, the two main bodies offer a modular system that does not require the design of an entirely new helmet to fit the need of the users.

By offering different specifications to the top and bottom part, the user can customize each main part to fit their needs. In this way the producer doesn't have to construct entire new helmets.

If one rescue unit does not have the need for the electrical components, but wants the adjustable ventilation, they can choose a combination of a stripped down bottom part with a ventilation top.

In certain scenarios, there is a need for additional protection below the ears. As the bottom part is separated from the top, it is possible to create a bottom part that offers the needed protection, without changing the top ventilation part.

It also offers a level of modularity regarding the electrical components as it is easier to replace and fix a small part of the helmet compared to an entire unit.

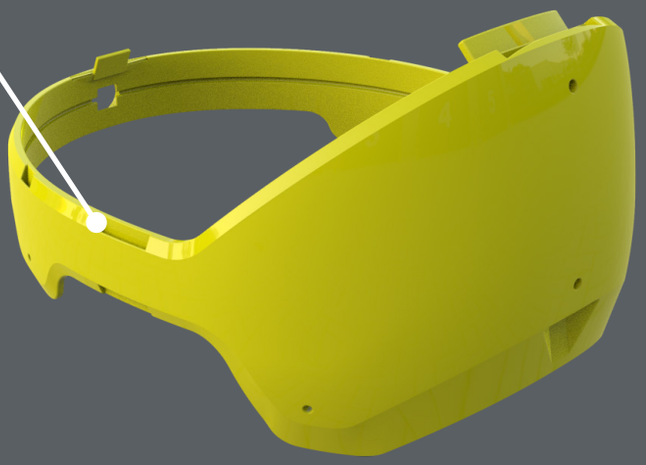
The bottom part also offers attachment points for the equipment needed in addition, to their helmet.

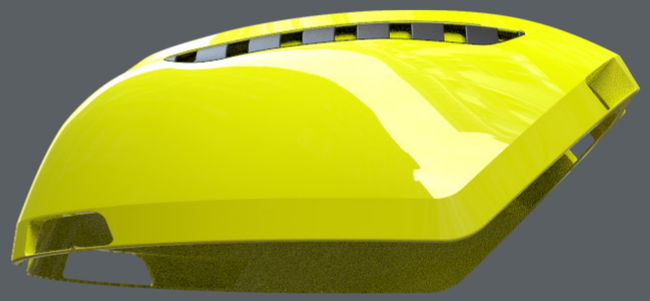
In wet and snowy conditions, the rescuers use goggles to protect against the whirled up snow and water from the helicopter. This can be fixed in place by using the back strap of the helmet, and the integrated locks along the side of the bottom part.

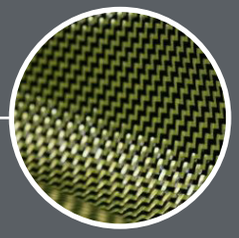
In most rescue operations, they use a headset to maintain communications within the crew. In the bottom part, a traditional headset mount is integrated along the side, avoiding the use of additional attachment rails to mount the headsets to the helmet.

Goggle strap attachment points.

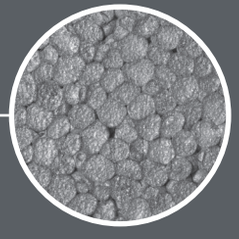
Integrated helmet headset mounts.



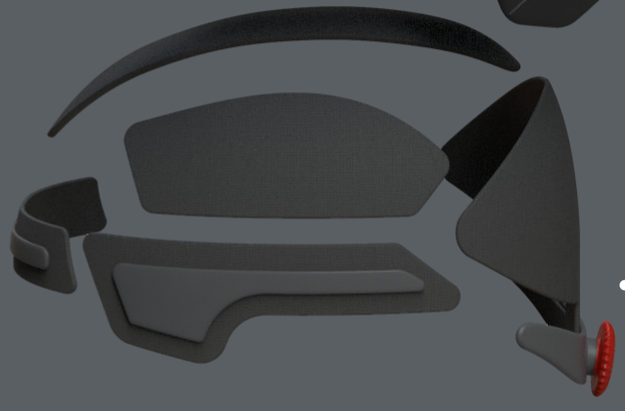


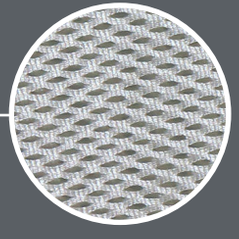


Kevlar/Carbon



EPS impact liner





Moisture wicking material

MATERIAL

The choice of material for this helmet has to satisfy several requirements both regarding impacts and environmental demands. The material has to withstand the deterioration that these elements give, without loosing its strength, and maintain the safety standards.

Industry helmets made of ABS plastic have a limited time of wear, due to the deterioration that wear and tear, as well as rays have on the plastic.

With these high requirements, the material has to be strong, light and durable.

From exploring different material composites, as well as other rescue helmets on the market today, it became clear that a combination of Kevlar and carbon fiber would be ideal for this helmet.

Carbon fiber provides the helmet with a great strength to weight ratio, while the Kevlar provides great tensile strength to weight as well as being abrasive resistant.

Although salt water, sunlight and changing temperatures will affect this combination as well, it offers superior strength and weight compared to ABS plastics, making it a more durable product for the user.

The impact linen is a standard EPS protection layer, similar to a lot of existing helmets. This is a recyclable product that offers great impact dispersion compared to weight.

ABS plastic or reinforced plastic, such as polycarbonate, offers an efficient, and cost effective, production method through injection moulding.

While the Kevlar/carbon fiber-production for a long time has been quite expensive, the recent years has seen an increase in carbon fiber and Kevlar reinforced helmets produced.

This is partly because of the successful integration of the material into the atomised production cycles.

Helmets, ranging from heavy duty military helmets, to recreational alpine helmets and bicycle helmets are now available in carbon fiber, at a fair price.

The production is considered to be fairly reasonable, considering the area of use and the end customers.


N-OON
EC135
NORSK LUFTAMBULANSE
LEGE
NORSK LUFTAMBULANSE

CERTIFICATIONS

The ultimate search and rescue helmet has to be certified for all its intended purposes. A helmet that is certified across multiple disciplines and jobs such as medical, firearms and police works, would increase the opportunity to become a functional and successful product.

The helmet has to be certified for water rescue operations, urban search and rescue (USAR), vehicle extrication, specialist operations, climbing and abseil work and more.

The current rescue helmet used today, approved for white water sports and canoeing. This definitely does not represent the actual need of use for the helmet.

These Standards have a big impact on how the helmet is constructed and designed, and complicates the production and construction.

In addition to the helmet requirements, the technical equipment such as the headset, light and camera, has to be certified with an IPX7 rating. This is obtainable considering the amount of waterproof action cameras and headlamps that exist in the market today.

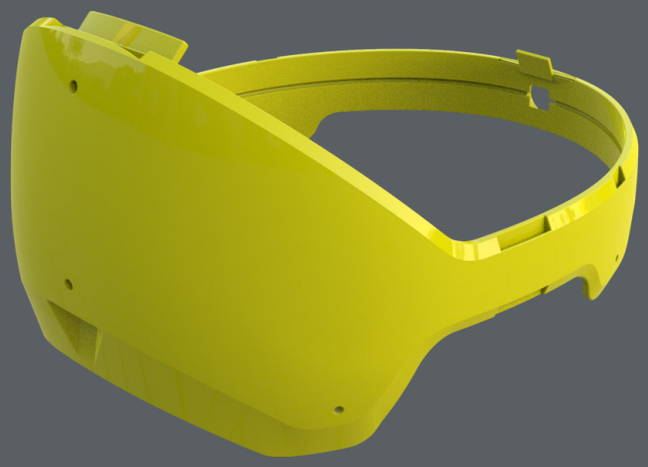
In this project, the standards have been used as inspiration, rather than guidelines, as it would complicate the process.

STANDARD	APPLIES FOR
EN397:1995	Industrial safety helmets
EN 16473:2014	Technical rescue Vehicle Extrication Animal Rescue Confined space work
EN 12492:2012	Working at Height Safety at Height Aerial platforms Abseiling
PAS 028	Water and Flood rescue
EN 352-3	Ear-muffs attached to an industrial safety helmet
IPX7	Immersion, up to 1m depth

SAFETY

A helmet is primarily designed to protect your head against injury. A common misconception is that the helmet is absorbing the energy, while it in fact is design to dissipate energy in the events of a crash. The fact is that a helmet is managing the energy during a collision.

From the first law of thermodynamics, energy can neither be created nor destroyed; energy can only be transferred or changed, from one form to another.
This is obvious when a helmet has been exposed to a crash. The helmet and interior might crack, and it is possible to feel the heat of the impact in the absorbing material afterwards.

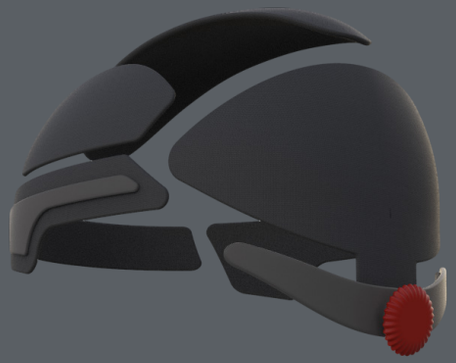


To provide a safe protection, there are a several components that work together to dissipate the energy during a crash.
The outer shell is preventing the minor impacts and objects penetrating, while the inner layer is the main energy disperser component.

The impact tests are usually tested with vertical and lateral impacts on a helmet. This does not always represent how we crash, as it is impossible to predict. There are an infinite number of ways to crash, with various elements involved.

Helmets are usually worn in combination with activities where the risk of injury can come from every angle. When crashing with a bike, the impact is usually never straight from the side or top, but rather at different sides and angles.

Even if the helmet absorbs the impact, our brain is floating around in cerebrospinal fluid which does not stop the brain movement from crashing into our cranium.



In recent years, there has been a focus on developing protection against angled impacts. A friction layer allows the helmet to move relative to the head, protecting against the rotational motion of angled impacts.

Several companies are offering solutions to this issue, with MIPS being one of the most common.
The rotational motion is a combination of rotational energy (angular velocity) and rotational forces (from angular acceleration) that both affects the brain and increases the risk for minor and severe brain injuries.
By implementing a frictional layer, separating the shell and the liner, it can absorb and redirect rotational energies and forces transferred to the brain.

In 2018, MIPS and BOA collaborated on creating a combined solution of adjustment system and rotational protection. This combination would suit the lightweight demands and safety regards that the crew value.

The model is created after measurements of an existing EPS shell. To avoid any sharp objects from protruding the EPS shell and possibly create a weak spot in the helmet, the wall thickness has been changed to minimum to allow for the technical elements to be integrated.

AESTHETICS

The phrase “form follows function” is apparent in the final concept design, and it has been a conscious choice. The aesthetic lines of the helmet design are a result of the choices made when integrating the electronics and ventilation into the helmet.

From the construction evaluation, the separation of the two parts resulted in the base design of the helmet.

The design of helmets in sports today has changed towards the sleeker and neutral design that is less likely to stand out.

Several rescuers mentioned that they wanted a sleek and clean design, without too much going on.

Most SAR-helmets today are of tactical designs, with vast amounts of attachments and mounts for different equipment. Although some consider this a cool and tactical look, the feedback from the users where different.

From user research and interviews, it appears that aesthetics actually means a lot to the crew.

They have their NLA suit with patches describing name and profession. The suit represents their identity when working. However very few rescuers had any attachment to their rescue helmet.

Giving the helmet a design that reflects shapes and colours of the equipment in their service can create a connection between the user and the product

The attachment of name tags could further improve the identification of the helmet to the user.

With the added technology and functionality of the camera, light and ventilation system, the helmet becomes in many regards a tool.

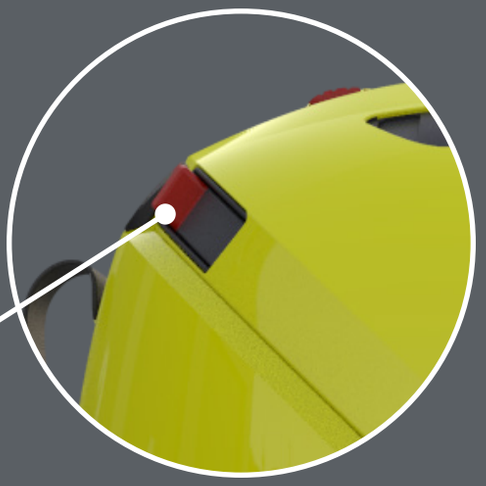
To provide easy recognition of buttons and movable elements, they are colored with a strong color, separating them from the other components.

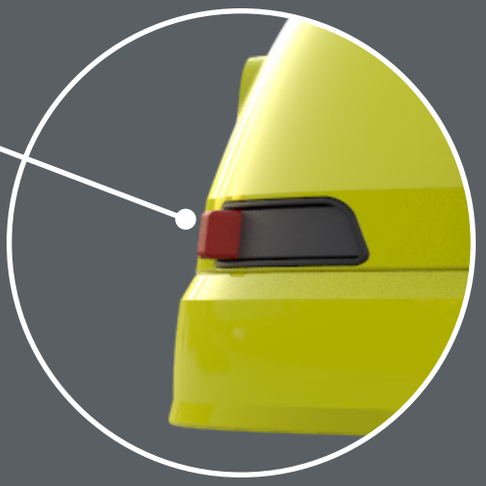
The enhancment on top strengthens the structure to increase the impact strength from above

The lower edge, naturally transfers into a lip, providing an edge for water to drip off.

The curvature allows for a natural entrance for the USB port.

The edge along the seam allows for easy integration of adjustable ventilation, both back and front of the top part.





MARKET

The Norwegian Air Ambulance is not the only unit in need of a rescue helmet when operating outside of the helicopter. The 330 Squadron, a helicopter unit of the Royal Norwegian Air Force, is Norway's military search and rescue service. They operate ten Westland Sea King helicopters on six airbases along the coast, and they do search and rescue missions in highly demanding environments, similar to the Norwegian Air Ambulance. They are also dependent on the equipment to be on point.

With the Air Ambulance rescue service being highly regarded in Europe, it could provide a platform for other air ambulance services to change to the potential rescue helmet, for example the regarded Swiss air ambulance, Rega. With NLA operating in cold, wet, and hot conditions, the helmet could be easily adaptable to other countries demands.

In addition to air rescue services, there is a huge market for safety helmets to be used by additional rescue services, such as lightweight firefighters, ambulance workers, police etc.

For this to be achieved, the helmet has to meet the certifications of global standards. As the helmet is an element of high safety, a standardised way of testing provides equal results across companies, avoiding potential false advertising.

With all of these elements being implemented into one helmet, an analysis of the market potential and the needed solution could give a boost to the project and the collaborators, or it could show that certain elements would be too cost inefficient to implement.

CONCEPT REFLECTION

Initially, the scope of this project was to try and integrate a camera and a light into a rescue helmet. Through research, testing and exploration, it became obvious that there were a lot more that could be improved from the existing solution.

With this being the first step towards a rescue helmet, I considered it to be of a bigger value for the initiators if I could identify and challenge more of their issues.

Through the field research and interviews, it was clear that they wanted a lightweight helmet with as many functionalities as possible.
Creating a lightweight helmet with integrated equipment that meets the certifications is going to be very hard to achieve.

The amount of ventilation needed to make a helmet comfortable both during a highly active day in the summer and a stationary position during the winter requires in-depth testing and evaluation.

The next step for this project would be to bring the prototype to a potential helmet producer to get feedback as to what is possible. Sweet Protection is a highly potential collaborator as they are located in Norway and are producing helmets within the fields of watersports, alpine, and bicycle activities.

FEEDBACK

To confirm that my final proposal is on the right track, it was important to get feedback from the rescuers themselves. The final feedback on this project was given by two rescuers, where one of them were the project initiator, Thomas N. Dahle.

They both thought that the concept looked good, and solved several of the issues. Some questions regarding the hearing and eye protection were raised as these elements have not been my focus area.

“It looks good! I would love to have that helmet tomorrow.“

“The ventilation was a nice feature, but I wonder if its enough?”

“If its possible to shut everything down, while the inner lining isolates enough so that you don’t have to wear a hat, that would be nice.”

“A great pluss with the light, as long as it’s easy to use.”

With this feedback, I believe that the concept can be a great stepping stone towards the continued development of a dedicated search and rescue helmet.

PROCESS

With such a specific equipment and usergroup, it was clear that I had to truly understand their job if I were to be able to solve some of their issues with their helmet.

My process has therefore been higly user oriented with extensive field research and hands-on experience of different helmets from different categories.

Photo: Marius Wigen Andersen

USER ANALYSIS

THE CREW

To design a product for such a specific user as the workers of the NLA, understanding the user and the user needs is highly relevant.
The first step of my process was to understand how they operate.

The Norwegian Air Ambulance operates with a crew of three people on each team, consisting of a pilot, doctor and a rescuer. Because of their job operations, they rely heavily on teamwork.

In practice, it means that all three are leaders in their area.
The pilot is the commander during flight, the doctor is boss of the medical and the rescuer is the leader of the rescue operations.
At the same time, they are all assistants to each other. In flight, the rescuer assist the pilot with the navigation, during the rescue operation, the doctor and pilot assists with equipment and navigation towards the patient, while the pilot and rescuer assist with the medical treatment when on safe grounds.

By assisting eachother through each step of a rescue operation, they increase their efficiency and thereby the effect of the treatment given to the patient.

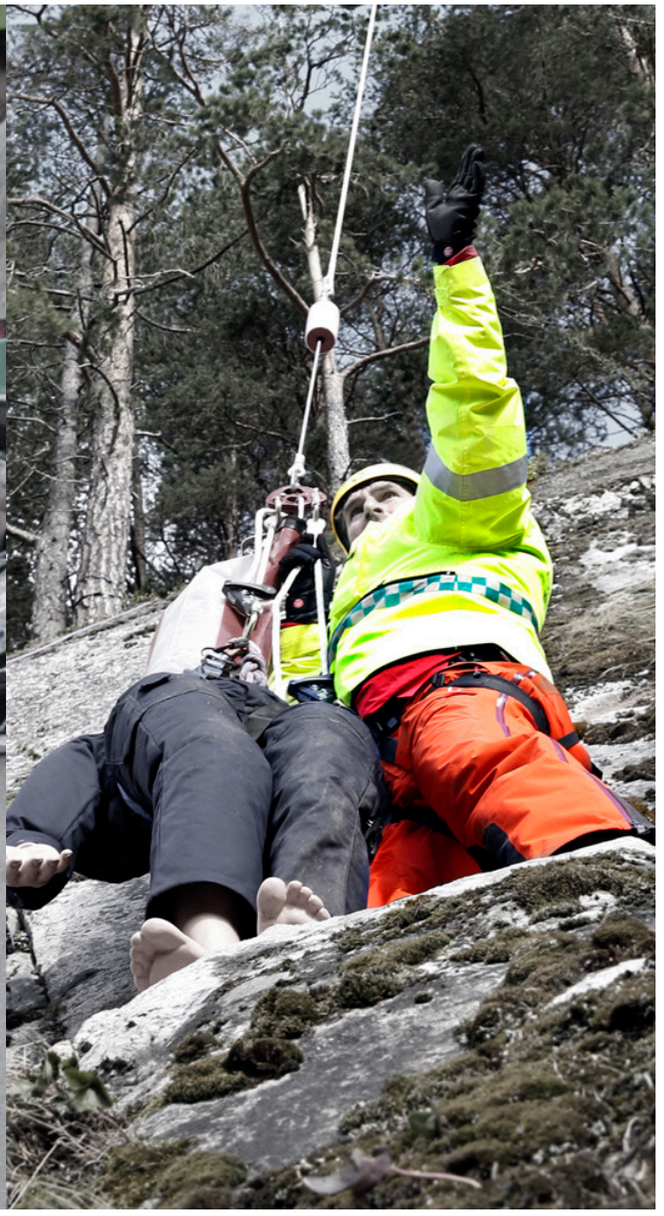
Both the pilot and the doctor may use the safety helmet, but the main user is the rescuer.

The rescuer has to have a substantial resumé to be able to work in NLA. Their base education is paramedic with a minimum of two years of experience.

In addition to the medical education, the have to have certificate of flight theory, sportsdiving, and general knowledge of abseiling and rescuing.

Together with the pilot and the doctor, the three people makes a highly skilled and trained crew that are at the top of advanced emergency rescue chain.

With the rescuer being the responsible for performing the rescue, they have first hand experience with a lot of rescue equipment. They are experts at this area.



PILOT

The pilot is the leader during flight and will determine the safety of flight for rescue.

He will assist the rescuer with equipment and the doctor with medical treatment

DOCTOR

The doctor is the leader during medical treatment.

He assist the rescuer during equipment change and preparations as well as navigation during underhung operations.

RESCUER

The rescuer leads the rescue operations and decides how they should be executed.

He will assist the pilot with navigation during flight and the doctor with medical treatment on ground.

Photos: Stiftelsen Norsk Luftambulanse AS

OPEN WATER

The following scenarios represent the different areas where rescuers have to wear a helmet during the operations. In open waters, this is usually in combination with a neoprene suit, and additional swimming gear.

RIVER

In a river rescue, the danger is often hidden rocks and dangerous currents. As with the open water rescue, the use of a neoprene hood is common to protect against the cold waters.

ROUGH TERRAIN

With the attractive nature that Norway offers, hikers often take to big of a risk and end up in places that can be hard to reach. During climbing operations and in rough terrain, the rescuers have to wear a helmet.

UNDERHUNG

When the rescuer is underhung the helicopter, he always has to use a helmet for protection. Underhung rescue operations is their main use for the helmet.

CAR ACCIDENT

Car accidents can be brutal. Because of the extreme nature of a car crash, there are often sharp objects, broken glass and bent metal that can create serious injury to the rescuers if they're not paying attention.
In some operations, they have to use the helmet to avoid injury.

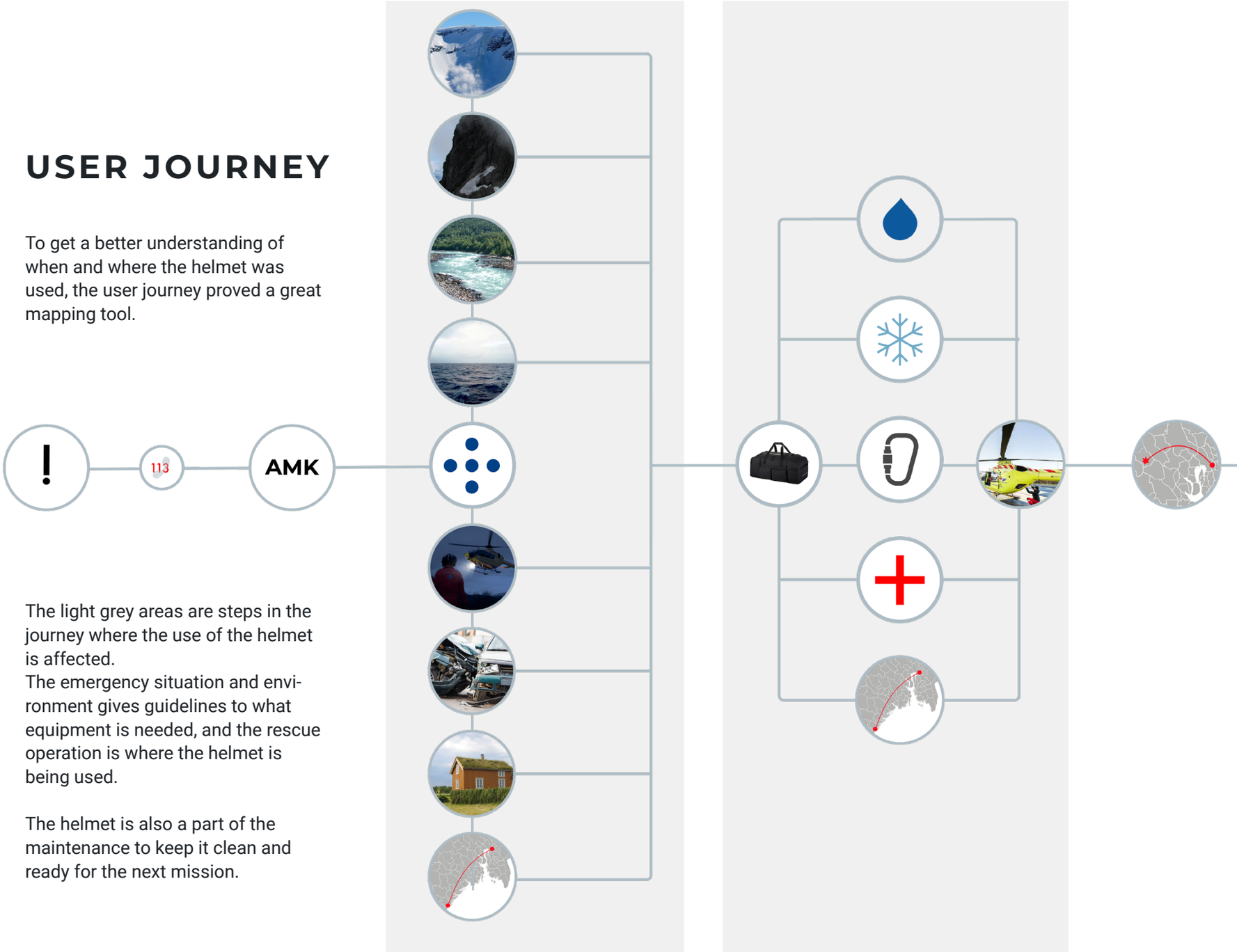
GLACIERS

Rescue operations in glaciers, also require the use of a safety helmet. Together with climbing equipment

Photos: Stiftelsen Norsk Luftambulanse AS

USER JOURNEY

To get a better understanding of when and where the helmet was used, the user journey proved a great mapping tool.



The light grey areas are steps in the journey where the use of the helmet is affected.
The emergency situation and environment gives guidelines to what equipment is needed, and the rescue operation is where the helmet is being used.

The helmet is also a part of the maintenance to keep it clean and ready for the next mission.

EMERGENCY

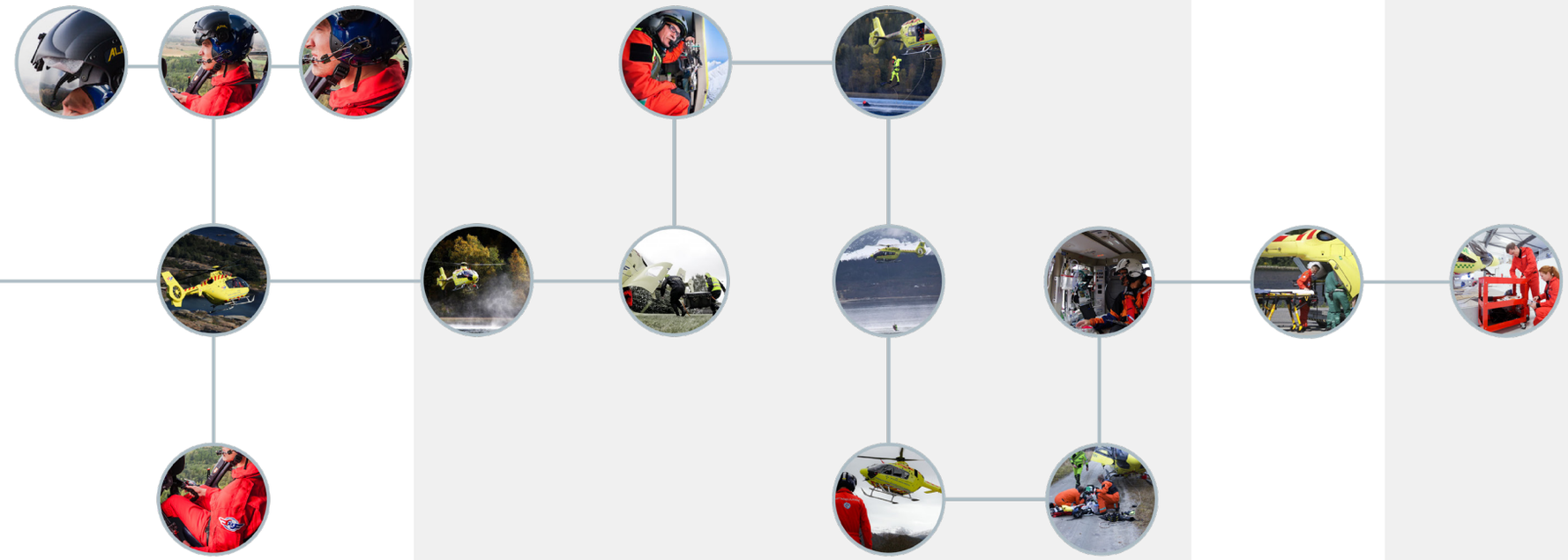
It all starts with a phonecall. They are directed to the lokal emergency medical communication center, AMK. Based on the information provided about the accident, AMK will decide if it is neccessary to call for an emergency helicopter.

SCENARIOS

When the Norwegian Air Ambulance recieves the call from AMK, they are brief about the accident; type of injury, where they are located, what kind of environment and situation they will encounter.

EQUIPMENT

Based on the information given from AMK, they will equip the helicopter with the necessary gear for the rescue operation.Because of space and wheight limitations, the quipment is stored in pre-packed bags according to different scenarios: water, snow, illness and hospital transportation. This increases the efficiency of preparing the crew and helicopter.



IN-FLIGHT

In flight, the crew are usually wearing a pilots helmet and flight suits.The practicality and comfort of the pilots helmet is a lot better than the rescue helmet as visors and communication is integrated into the helmet.

RESCUE

When arriving at the patients location, the crew assess the situation and lands in the nearest location to change equipment. When arriving at the patient, the crew will give the neccessary immediate treatment before extracting to a safe location. The doctor will take over the main treatment of the patient, while the rescuer and pilot assists.

TREATMENT

The treatment will keep on in flight on treating the patient while the pilot navigates to the nearest hospital. When arriving with the patient, a crew from the hospital will meet them and they will continue the treatment along side the doctor until they are ready to take over.

RETURN/DEBRIEF

After the hospital has taken over the medical treatment, the crew will pack up and travel back to base to debrief and perform neccessary maintenance.

EQUIPMENT ANALYSIS

INTRODUCTION

In the beginning of the project, Thomas Dahle, the project initiator invited me to the Lørenskog base station to give me and introduction to the equipment that they use in todays operations.

The flight helmet is used onboard the helicopter to- and from the accident location. This helmet has integrated visors and noice cancelling headphones. Because of the comfort it provides, it is the preferred helmet to use during the flight.

The rescue helmet, originally from the ground forces of the military. It is used in most rescue operations outside of the helicopter, unless the pilots helmet can be used.

The goggles are used during undehung operations to protect against wind, water and especially snow.

The neoprene hood is used during wet and cold operations. This is used underneath the headset and helmet.

The Polycon is the communications unit that connects

1. Neoprene hood

2. Headset

3. The helmet

4. Goggles.

5. Optional equipment

PRODUCT ANALYSIS

From the intial introduction and analysis of their current equipment, I began the tedious process of exploring products in each category. Because the helmet is being used all year round, in all conditions, it was important to see what exists in those categories.

All types of helmet categories offers something else to the table. From moisture wicking material from sports helmets, to the airflow systems of a bicycle helmet.

By exploring a wide range of categories, I developed a great understanding of the helmet construction, innovations and solutions that could be implemented into a future rescue helmet.

Elements such as the BOA fit, MIPS, antibacterial fabric and moisture wicking material comes from this research.

PRODUCT RESEARCH

HANDS-ON EXPERIENCE

Working with something as relatable as a helmet, you quickly start seeing helmets everywhere you go.

The first thing I did was to gather helmets to keep around me at all times. From my fathers old kayak helmets from the 70's to the modern, lightweight climbing helmets, they all inspired me in some whay or form.

When you're deeply involved with the development of a new helmet, you tend to spot helmets everywhere. I took every oportunity that I had to test out the helmets that I found.


PETZL
PETZL
PETZL 2 B K... EN166


VERTEX ST
PETZL


AMBULANSE


PROTEC


GRIVEL


MSA

FIELD RESEARCH

Every year, SNLA arranges a training camp where the pilots, doctors and rescuers as well as other emergency rescue services, are invited to work on their skills and experience scenarios that represents their daily job.

They focus on specific scenarios with various elements to push the participants into uncomfortable situations, and the the main scenarios for this years training camp was avalanche, overweight stroke patient, and car accident patient with hypothermia.

I was fortunate to be able to join the camp for three weeks, participating as a marker in all the three scenarios.

Photo: Lasse R. Tomasgård

FIELD RESEARCH

AVALANCHE

The avalanche scenario was the main event for this years training camp. Considering the amount of avalance accidents that has been registered in Norway the past years, this was a highly relevant scenario. During the three weeks that I participated in the camp, ten avalanches where registered with five fatalities.

Up high in the Ål mountain area, they had created a an avalanche, about 200 meters wide and 60 meters long. In this scenario, three people had been taken by an avalanche, two buried deep while one was at the surface.

The learning goal for the rescuers was to practice efficient surface search and perform the proper treatment on people that had been withouth oxygen for a set amount of time.

My role was to be the survior at the surface. As I was concious and only suffered from a minor back fracture, the other two dolls that where buried deep where the focus point for the crew.

Photo: Lasse R. Thomasgård

AVALANCHE

The Norwegian Air Ambulance is usually the first emergency unit at an avalanche site. The first person out is the rescuer who takes charge in the rescue operation.

A systematical aproach to an avalanche search is important to avoid searching in the same areas again. As the facilitators pointed out, about 75% of all survivors from an avalanche are are discovered on the surface. A thorough surface search is therefore the first step increase the possibility of finding survivors and to get a good overview of the accident site.

When an avalanche occurs, huge masses of snow has been released and pummels down until it comes to a stop. If caught and buried in an avlanche, the rate of survival when the avalanche stops is about 2/10. After 30 minutes, the rate of survival is 1/10.

Observing the crew running around after equipment while trying to discover where the patients where located made it clear just how active and stressful their job really is.

Even if they are not obligated to use a helmet during an avalanche rescue, they do happen in dangerous mountains and terrains, and in certain situations, they would consider using the helmet.

With every crew, we had a debrief where the scenario was discussed in detail. Taking part in these debriefs was an incredible experience as you realize that amount of variables they have to consider.

One element that was reoccurring was their thoughts of their own safety. Did they bring the proper equipment? Warm enough cloting? What about the weather?

Observing and listening to their debrief was one of the most interesting aspect of this project as you learn a lot, just from their evaluations and observations.

Photos: Lasse R. Thomasgård / Marius Wigen Andersen

FIELD RESEARCH

CAR ACCIDENT

As the camp was arranged during the winter, cold and snow was a natural element to the scenarios.

In the car accident, I was assigned the role as a 70-year old man who had driven off the road in harsh conditions with -8C and 12ms winds up in the Hemsedal Mountains.
Suffering from substantial injuries to the thorax and pelvis, as well as a hematoma on the left thigh as a result of a broken femur, my conditions where poor. My left ankle was broken and stuck in the wreckage. On top of this, I was wearing a thin shirt and jeans, gradually suffering from hypothermia.

The goal for the crew was to properly treat hypothermia in addition to the implications that internal bleedings and injuries give.

Photos: Lasse R. Thomasgård

Photos: Lasse R. Thomasgård

CAR ACCIDENT

In contrast to the avalanche scenario, I was now the main patient. Being the «center of attention» during a rescue mission gives you a completely different perspective of how they operate, and what they prioritize. The feeling of being taken care of by professionals in a situation that would surely be terrible, was in many ways a comforting experience.

Again in the debrief, they discussed their choice regarding their own safety. If the crew allows for risky maneuvers, they can risk loosing more than one life.

Eventhough the helmet is not an obligated equipment to wear during a car crash rescue, there were several rescuers that used it. A car crash usually involves a lot of broken glass and sharp metal, and the helmet becomes a great safety for the rescuer as he takes charge to go inside the wreck.

FIELD RESEARCH

STROKE PATIENT

What do you do when you're supposed to rescue someone that might not fit the helicopter? In this scenario, I was a 45 year old overweight (170kg) man who had suffered a stroke in the bathroom. I would be partly unconscious with puke around my mouth while snoring with involitary movements.

A lot of the rescuers that came through the bathroom door where quite surprised when they saw me at the bathroom floor. The complications that overweight have on medical prosedures is huge.

Even in this scenario, the crew discussed their safety before entering the appartment. Did they consider that the next of kin could be the one responsible for the injury?

FIELD RESEARCH

WORKSHOP 1.0

The training camp offered a great oportunity to talk to several doctors, rescuers and pilots whom all had their opinions for a new rescue helmet. During my second week, I was fortunate to get some of the most experienced rescuer onboard for a workshop.
In this workshop I brought the existing helmet and the equipment that they use in the service today as I wanted to get their opinion and ideas down on paper.

They are the experts. Its therefore likely that they have already thought about the issues and possible solutions.

In this room, there where more than 80 years of experience within emergency service in Norway.

To gather as much of that knowledge from this as possible, I had created a map with all of the equipment that they used, together with the physical equipment.

Photos: Lasse R. Thomasgård

FINDINGS

Since this camp took place in march, I had already made certain predictions and choices based on my research. By keeping the workshop closer to a regular conversation, the group began discussing the equipment right away.

This workshop proved extremely useful as I discovered several new issues and solutions that I would never consider. This was also a great way to both confirm and destroy several ideas and solutions that I had previously considered.

We also discussed a lot of reasons to why they don't wear the helmet and how stupid it is. They are the highest skilled rescuers that know how important it is with safety, yet the current helmet solution is inadequate

The findings that this workshop provided gave me helped me move further with the choice of solutions.

- Todays pilothelmet is not certified for underhung operations. Neither is their current rescue helmet (whitewater sports and canoeing)

- It would be a great improvement to be able to close the ventilation during underhung operations, especially during the winter. Snow gets into the helmet through the airholes, melts and runs down the back of your neck. This can create unwanted cooling and moisture.

- Great with a spotlight that lights up where you're working. Petzl was reccommended because of the automated light adjustment.

- The light unit has to be replaceable to minimize the cost in case the units break.

- It has to be light as possible, price is not an obstacle.

Photo: Lasse R. Thomasgård

Photo: Lasse R. Thomasgård

FIELD RESEARCH

WORKSHOP 2.0

For the second workshop, I gathered different helmets from different sports and professions to discuss the benefits and downsides of certain designs and solutions.

I had also made a quick prototype that they could test to see if one of my communications solutions would be viable.

The findings from this workshop was just as interesting as the first one. As one of the rescuers put it, If you ask fifty different rescuers, you'll get a hundred different answers.

FINDINGS

- Everybody talks and loves working with a flight helmet, but if you're going to work with the patient, you'll get sweaty, and you won't hear anything, and you end up removing it.

- They want something that is super comfortable in flight, light and easy to use on the ground, certified for everything.

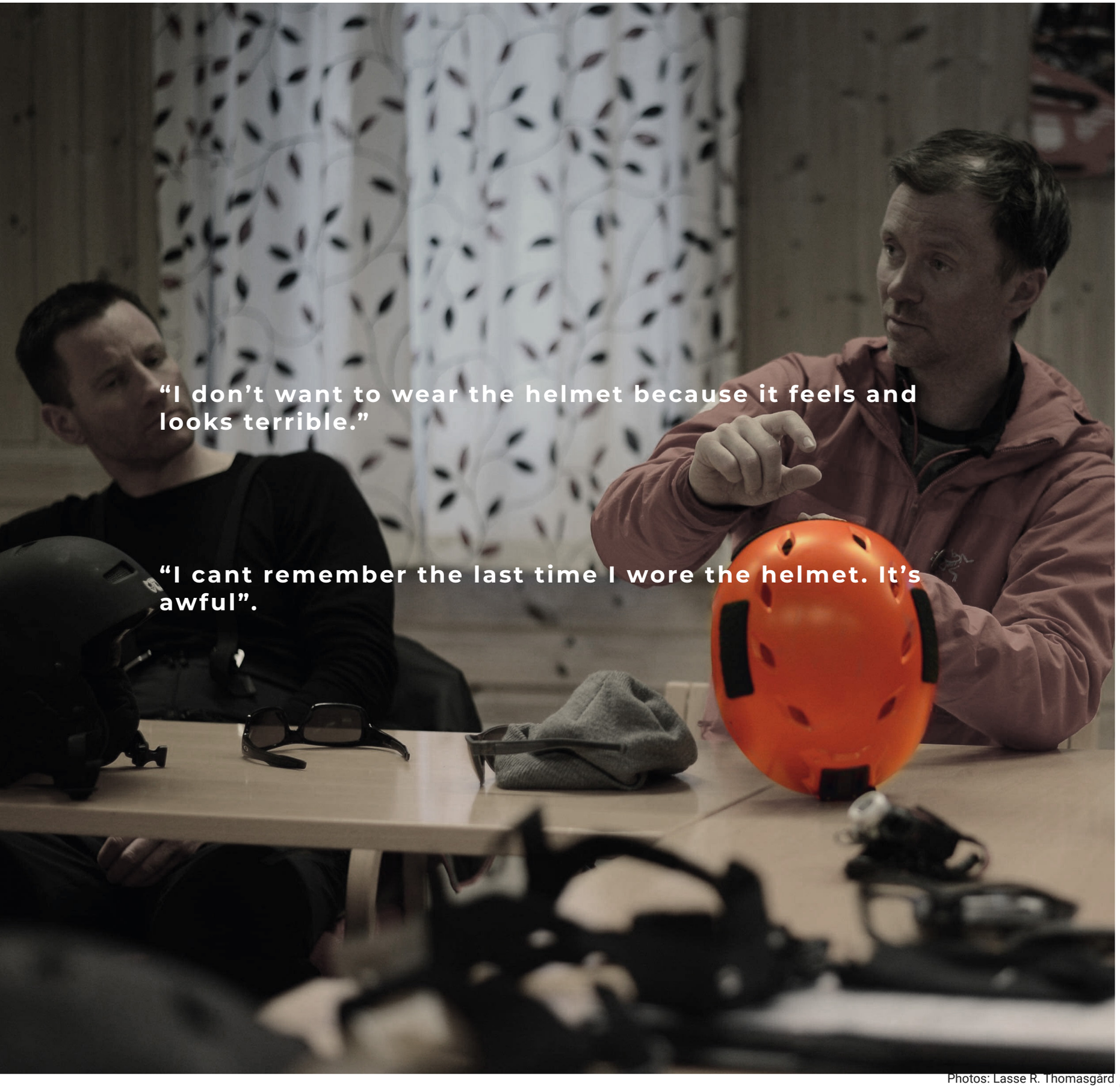
- I tore out everything, found an old bicycle helmet and took the interior lining from this helmet and put it into the rescue helmet.

- Better comfort, more people are willing to use it.

- If you're going to work for a while, you're removing the helmet anyways

- Plug and play solution

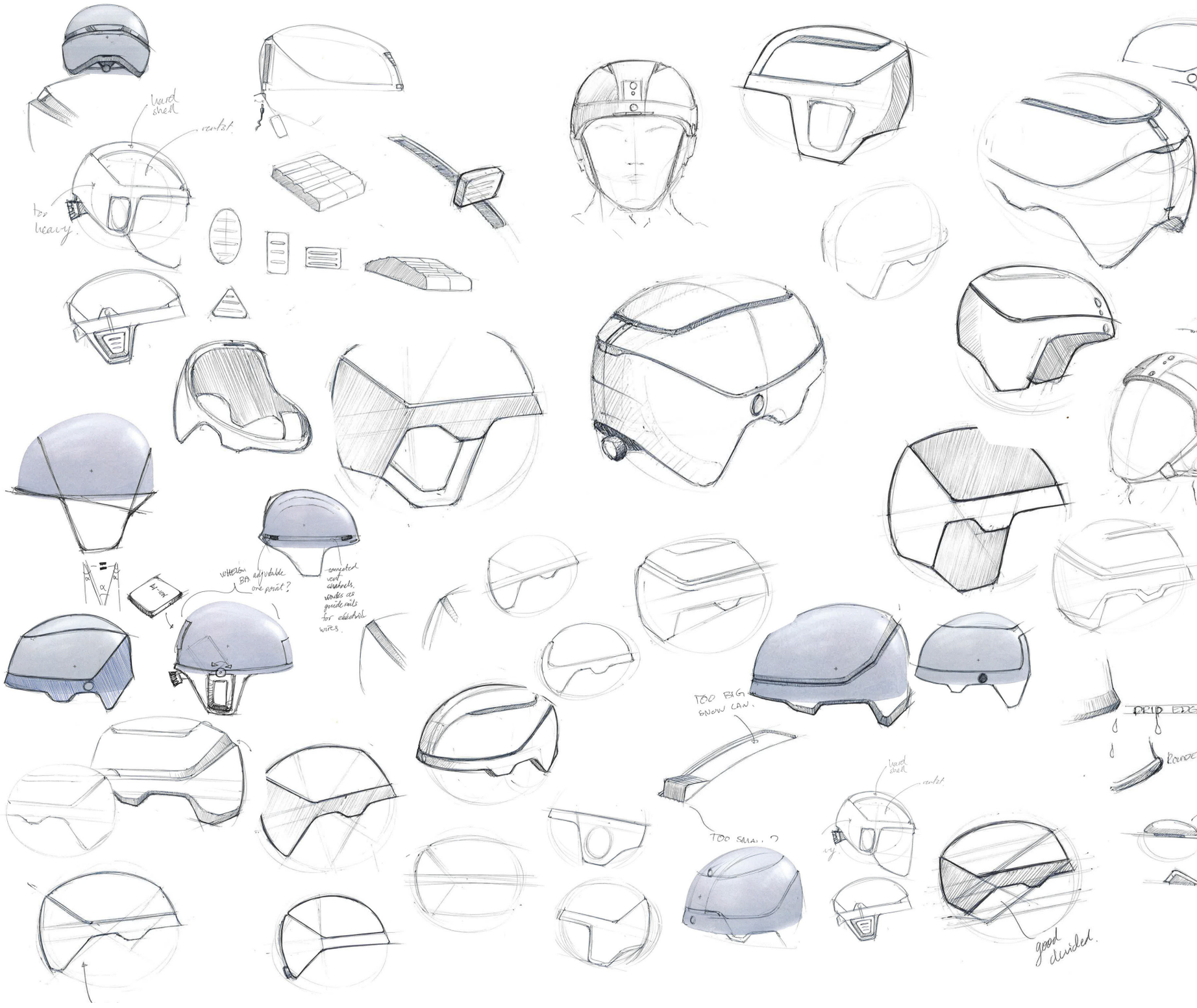
- Few people dare to say it, but it actually means a lot. It has to look good.

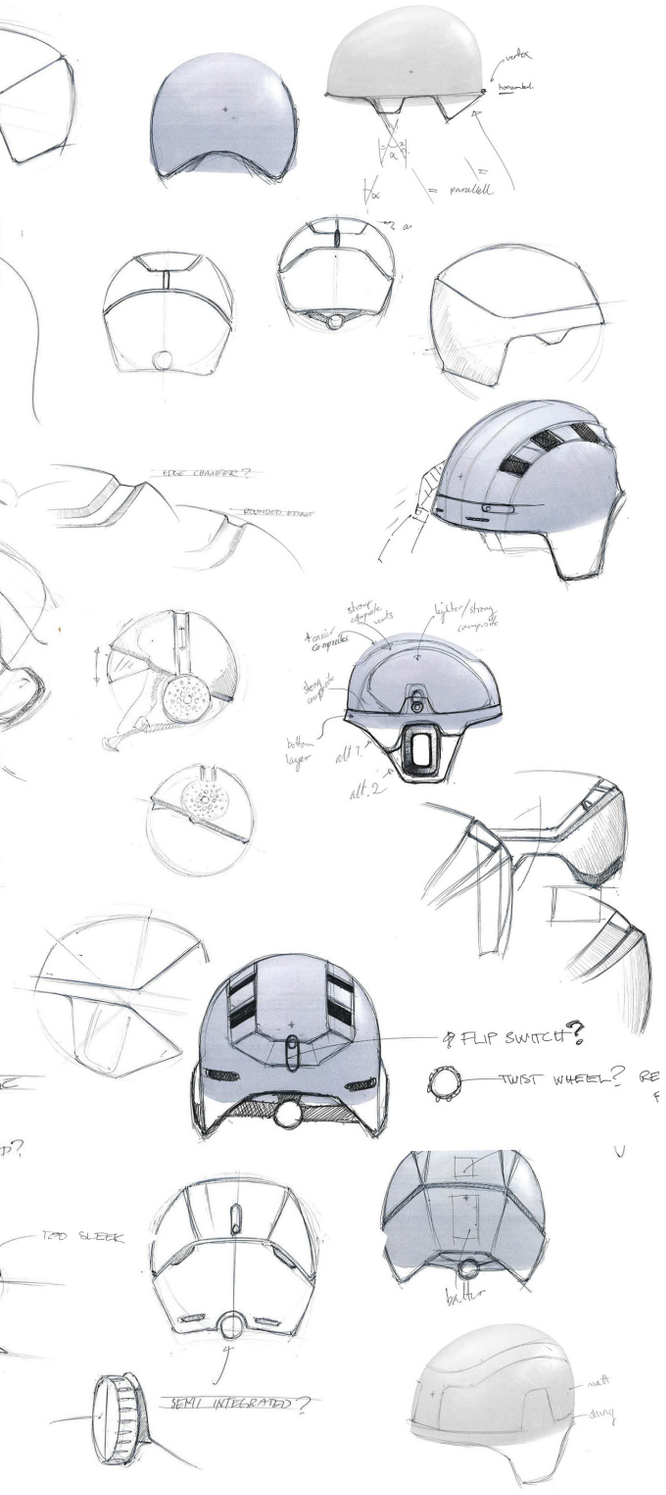


Photos: Lasse R. Thomasgård

DESIGN PROCESS

In combination with the hands-on experience, I have worked with several of the traditional design methods to arrive at the final concept. Through sketching, working with clay and prototyping, I was able to combine the different elements in a logical way.


inward shell
too heavy.
connected vent channels, works as guide rails for electrical wires.
TOO BIG SNOW CAN.
TOO SMALL ?
DRIP EDGE
good divided.



SKETCHING

With the amount of functionality and elements that the helmet should provide, it became an increasingly complex product. During the entire process of the project, sketching has been used as a tool to map out the functionalities.

PROTOTYPING

I went through several types of prototyping to figure out what the best way would be to test out my ideas and principles. Working with clay proved to be very helpful in regards to the volume and shaping of the helmet, while hacking existing products made it possible to test out the adjustable ventilation system.

3D-MODELING

3D modeling has been used actively as a tool to control the volume and size of the different elements that were to be integrated into the helmet.

Through the process, I was able to discover several issues with ideas and solutions as well as discovering new possibilities. To be able to keep the volume down as much as possible, 3D-modeling was a great tool to use to control the helmet design.

As I wanted to use the final 3D-model as a base for the physical model, It had to fit the measurements of a helmet.

Beginning with the interior and working outwards, it was a great test of the placement of the different elements to control where the dividing line of the model would be, and where the design could be altered and modified.

With over a thousand sketches, this model became a lot more complex than what I originally intended, but it is the representation of my final idea and solutions.

FINAL PROTOTYPE

From the beginning of this project, my goal was to end up with a physical model that you could test out and get a feel for how it could work. The final prototype is a 3D-printed model of the helmet that is going to be fitted with an EPS liner, and BOA-fit adjustment system so that will be possible to test the model out.

Unfortunately, I was not able to finish this model before this report, but I'm looking forwards to making it look as good as possible.

REFLECTION

The combination equipment, environment and requirements, the project proved to be a challenging and fun project.

I did not imagine myself to be acting as a 170kg overweight person with a stroke in a small bathroom. Through the field research and interviews with the users, I have gained new experiences and knowledge that

One of the most challenging parts of this project was the 3D-modeling phase. Eventhough I have experience with 3D-modeling in Solidworks, a helmet is a complicated shape to get right. With my end goal being a model that you could wear and test out, the 3D-model had to be accurate. As I used the 3D-modeling as a tool to check volumes and tewchnical elements, I became too detail oriented.

Regardless, I do think the end results is a fair representation of my choices and solutions. In the end, I hope that the SNLA and NLA find value in this project and that they continue on with the development.


N-OUH
AIRBUS
LEGE
TAMBULANS
TJENESTEN

THANK YOU

I would like to give a huge thank you to everybody that has participated and helped me with my project in one way or the other.

Supervisors: Stein Rokseth, Steinar Killi

External supervisors: Even Wøllo, Thomas N. Dahle

The crew at Camp Torpomoen

A special thanks to Lasse Thomasgård from SNLA for providing support and photos throughout this project.

REFERENCES

SNLA STORES

The crew	https://norskluftambulanse.no/superlaget/
Life as a Pilot	https://norskluftambulanse.no/slik-er-livet-som-pilot-i-luftambulansen/ https://norskluftambulanse.no/pa-lag-for-a-hjelpe-piloten/
Life as a Doctor	https://norskluftambulanse.no/slik-er-livet-som-lege-i-luftambulansen/ https://norskluftambulanse.no/pa-lag-for-a-hjelpe-legen/
Life as a Rescuer	https://norskluftambulanse.no/slik-er-livet-som-redningsmann-i-luftambulansen/ https://norskluftambulanse.no/pa-lag-for-a-hjelpe-redningsmannen/
Facts of SNLA	https://norskluftambulanse.no/organisering-av-luftambulansetjenesten-i-norge
Ambulanse camera	NRK artikkel: https:v//www.nrk.no/ho/hodekamera-med-lege-pa-direktelin-je-skal-hjelpe-ambulansearbeidere-1.14435584


LN-OON
EC135
LEGE
NORSK LUFTAMBULANSE

Photo: Stiftelsen Norsk Luftambulanse