ARC
Rescue
Beacon

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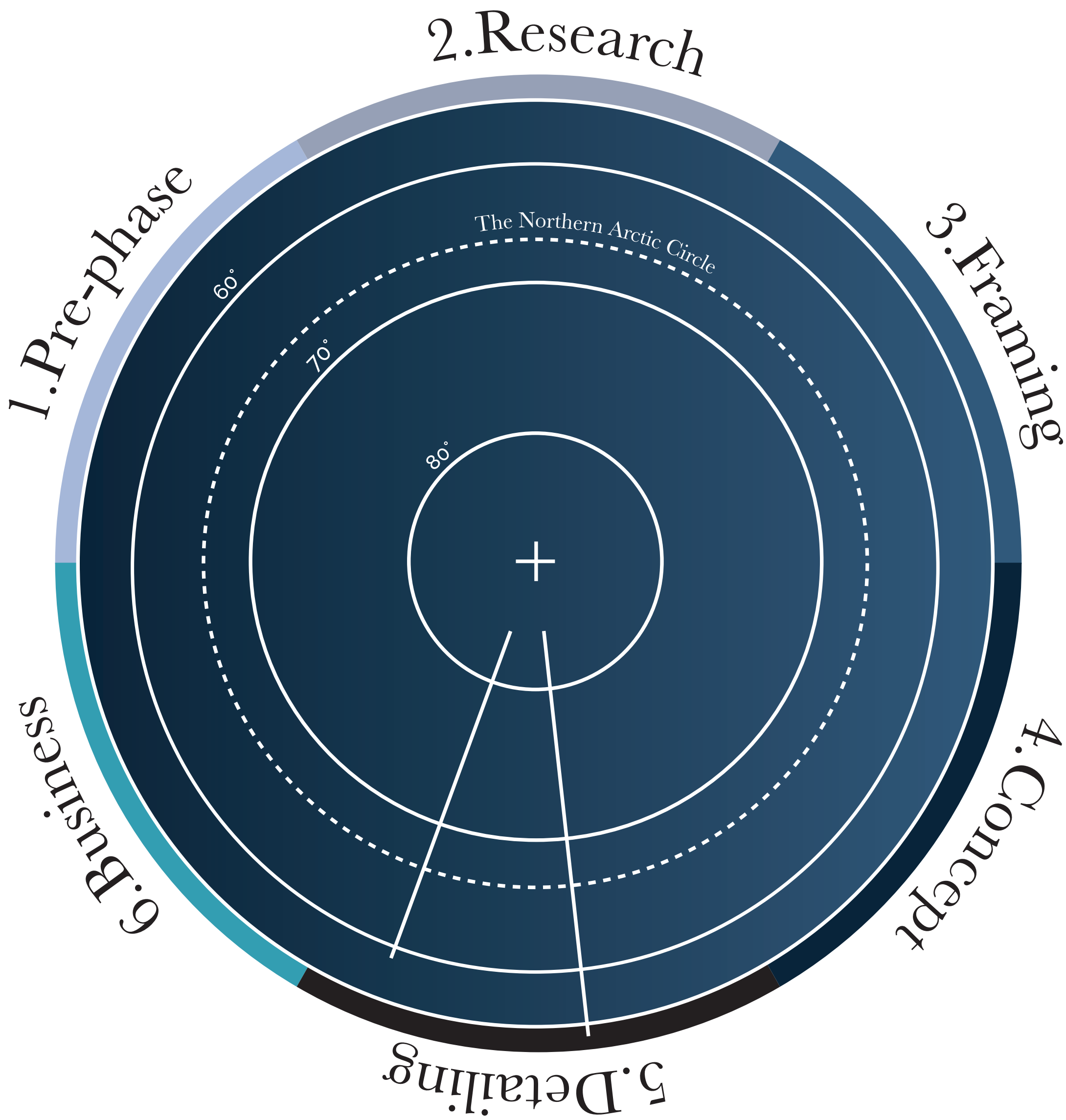
Abstract

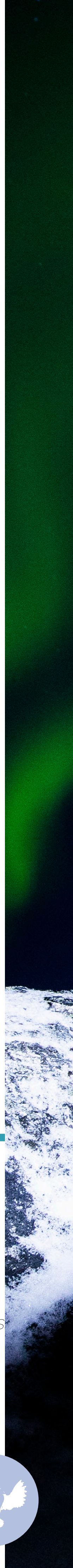
This master thesis, developed by Industrial Design engineer students at Aalborg University in collaboration with Joint Arctic Command, presents the development process behind a design proposal for aiding sailors in emergency situations in Arctic areas. The product aims to deliver a more meaningful help for the distressed, tailor-made for their situation without limiting the user's mobility or function level when not in an emergency. As time is the most critical factor for survival when in distress in the extreme environment, the main purpose is the ability to signal help with the assistance of an inflatable beacon, that can be dropped from the boat, but also to ease the difficulty in finding the distressed in the Search and Rescue (SAR) operations. The design aims to minimize the time before aid arrives, therefore also greatly improving the chance of survival for the distressed.

The design is based on a situated ethnological study of the sailors in Greenland, leading to a user centred design approach in the design phase. The solution and the sub-principles presented is validated through small-scale tests and user-/stakeholder-based interviews, and shows significant improvement to the current situation observed. The project resulted in an integrated design proposal which is specified in regard to construction, design, interaction and business case.


Ill. 01

Table of Contents





Pre-phase

This report is developed by group MSc4ID6 from Aalborg University in spring 2019. The full project is presented through a product- and a project-report, as well as technical documentation under the common name: ARC Rescue Beacon as a master thesis in MSc. Industrial Design.
The project is developed in collaboration with multiple collaborative- and knowledge partners and locals, that all have shared indispensable information on the topic.

Collaboration & knowledge partners:

As well as:
InFront Carwrap - photographer Stian Klo and the collection "A Bittersweet Story" - Polar Seafood - Polog - KNAPK - Naalakkersuisut - Defend Arctic at Aalborg University - The locals in Nuuk - DMI - Geodatastyrelsen - Louise Møller Haase - Jørgen Asbøll Kepler

Reading Guide

It is recommended to read the ***process report*** *before reading the* ***product report*** *to achieve best understanding of the project.*
It is also highly recommended that you use the ***design brief****, that is folded and included in the process report, as a "goal check" to more easily understand what the goal and result of each ideation, test and investigation leads to.*

It is also recommended to skim or read the ***worksheets*** *and* ***appendix*** *referred to in the report as soon as the reference is noted to gain insight into the underlying elaborated decision making process, basis for the research and general progression of the research.*

Worksheets are shown by "W.xxx", throughout the report referring to the worksheet number.
The same goes with appendixes, "A.xx" referring to the appendix number.
Finally refereeing to specific pages in the process report is shown by "P.xxx".

*Any word marked with the symbol * in the report is explained in the glossary in the back of the report.*

⭘ *These marks indicate that a new user need have been identified.*

Insights

Throughout the report is "Insights" boxes. These boxes explain additional insights throughout the process, as well as how they were acquired.

So Far...

The report consists of chapters. To develop a better understanding of how the process have developed throughout the project, we included a "So far..." at the end of each chapter.

It creates an overview of the critical findings (ill-defined user needs) that evidently is being translated into measurable product specifications. This means that after each chapter the "So Far..." will be updated with new findings.

"So Far..." allows for a deeper elaboration of where the team finds product specifications and the source of this information.

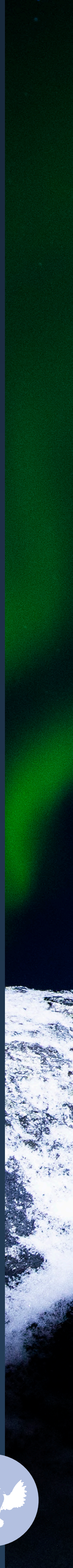
The final product specification can be found on page 74 and 75, and for the reader's convenience a combined user needs and product specification can be found in attached drawing folder, to get the full overview.

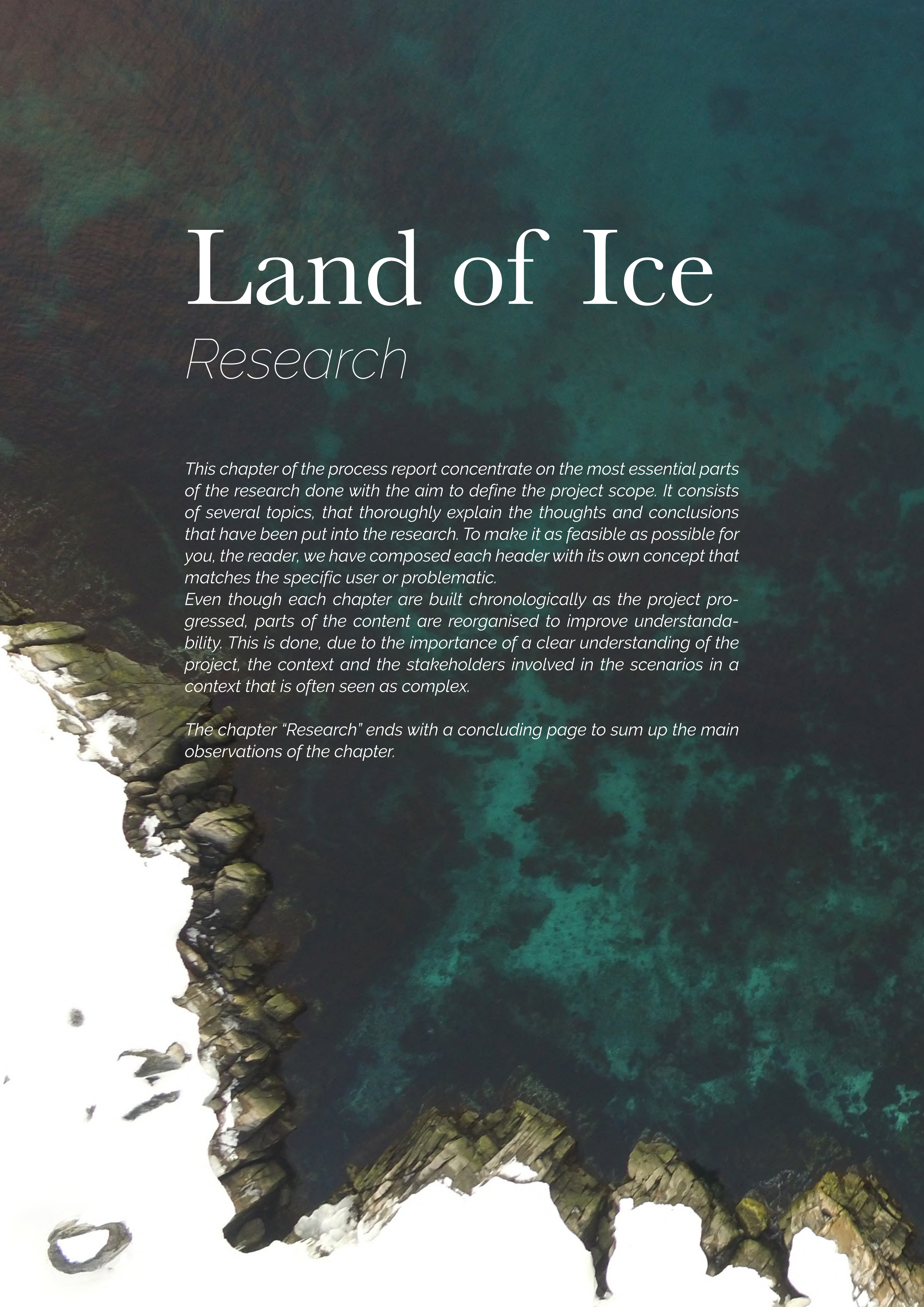
An example of the ill-defined user needs:

- The test showed that the user will try to climb onto the product, so the product must support this action (W.000; P.000).

- W.000 is the referred worksheet number.
- P000 is the referred page in the process report to the discovery of the user need.

This way the discovered user need has both worksheet and process report page reference.





Land of Ice

Research

This chapter of the process report concentrate on the most essential parts of the research done with the aim to define the project scope. It consists of several topics, that thoroughly explain the thoughts and conclusions that have been put into the research. To make it as feasible as possible for you, the reader, we have composed each header with its own concept that matches the specific user or problematic.
Even though each chapter are built chronologically as the project progressed, parts of the content are reorganised to improve understandability. This is done, due to the importance of a clear understanding of the project, the context and the stakeholders involved in the scenarios in a context that is often seen as complex.

The chapter "Research" ends with a concluding page to sum up the main observations of the chapter.

Context

Greenland is the largest island in the world. It's a part of 'Rigsfællesskabet'* with a population of just 56,000 people living in settlements spread across 2,200,000 km² make the population density extremely low (Skibsfartens og Luftfartens Redningsråd, 2016). Greenland consists of a few major cities: Ilulissat, Sisimiut, Qaqortoqand and the capital Nuuk. (Grønlands Rejsebureau, 2019; W.007)

The rest is small settlements ranging from just a few people up to a few hundred. These are scattered all over the coastline, creating a naval highway of transportation on the 44,000 km coast line (Skibsfartens og Luftfartens Redningsråd, 2016).

Being in the Arctic region, the climate is represented with a harsh winter with temperatures down to -40°C, strong costal winds, but also mild summers with temperatures of +20°C in the south (Kleemann, 2018). Due to the geography of the fjords with mountains, local weather phenomenons with rapid changes in both temperature and visibility due to haze is common (DMI, 2019; Oltsmanns, 2019; W.007).

The result is a country with limited land-based infrastructure. The few options to transport people from settlement to settlement is either by helicopter, dog-sledge or by boat (W.007).

The problem is, that in this tough climate, that if you end in an emergency at sea, it is often an extremely critical situation.

Indication of product service temperatures

Storyboard of Current Situation

Sailors

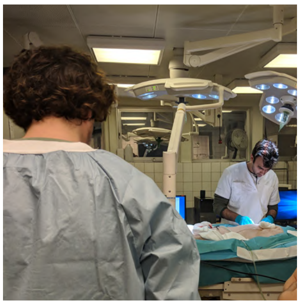
The sailors in Greenland are extremely skilled and experienced. They make sure to pack all the gear to go sailing for days, but when it comes to rescue equipment, they often only have a life-jacket.

When leaving port, the first thing they do, is preparing the boat, the fishing gear and the rifle. Then they attach the safety line, so that if they fall overboard, the boat doesn't sail away. Finally, they are ready to sail out to fish, hunt or regular transportation.

In Greenland underneath the waves lurks many dangers. One of the most common accidents is hitting a skerry or ice, resulting in a broken propeller leaving the sailor incapacitated. Some don't even have a radio and must wait until family gets worried and alarm the SAR units.

SAR

Paramedics



SAR is the Search and Rescue unit in Greenland and consists of the Danish military, Air Greenland and locals. When a distress call is received, they try to find the distressed on distances as far as 200 km away.

These missions can take up to five days - the longer, the more critical. As days' progress, more units, such as planes and helicopters are called in to help the search missions.

If the distressed are found, they are brought to the paramedics. The paramedics often must deal with strong symptoms of confusion, panic, heart-failure, hypothermia, exhaustion and it does sadly often results in death.

Key Actors
Sailors

Sailing is part of the culture in Greenland. Most people sail from a very young age. Most commonly used boats are small, open dinghy boats with high powered outboard motors. Most families in Greenland own one of these boats (Polar Fish, 2018; W.017) and many sail alone.

Sailing has multiple purposes for individuals in Greenland: (W.41)

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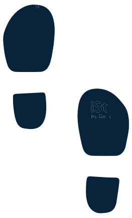
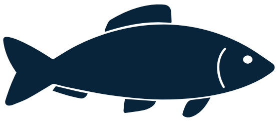


It is the main means of transport between cities and settlements as they have no road infrastructure between them.



Boats are used for fishing trips. Fishing is both used as a way of personal income and to collect food for the families.

Boats are used for hunting. Hunting is done either directly from the boat itself or by sailing into the fjords to hunt at land. This is done in any weather condition, clear, foggy, rain or snow (W.008; W.016; W.020)

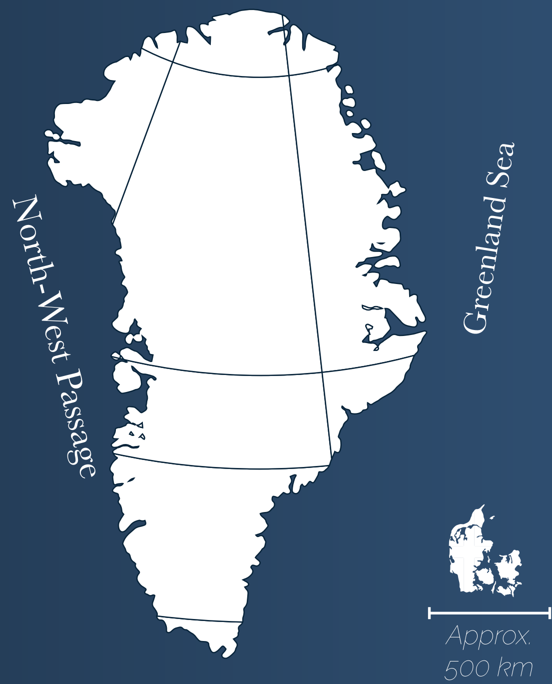
- *Must withstand to be submerged*
- *Usability with big gloves*

Long distance travel

Travel distances are quite long. Many travel up to 200 km in a single trip over a few days in the small boats (W.020).

The long-distance travel is needed to go to a hospital, visiting families or even just to attend a party (W.017).

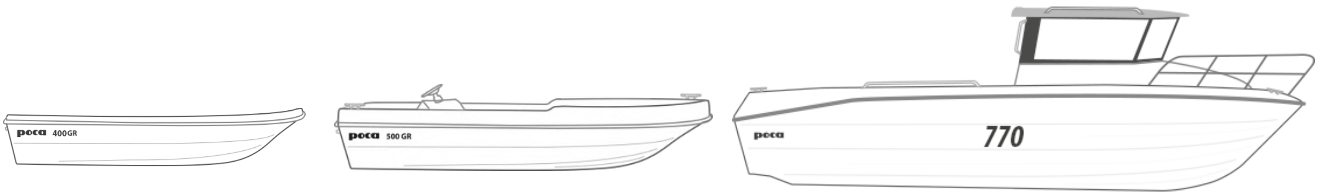
Even though most sailors are highly experienced in sailing in the Arctic waters, accidents still happen as it only takes one tiny mistake for everything to go wrong. And in these situations, it's even more critical that a very large part of the Greenlandic population can't swim. (W.008; W.016; W.020; W.021)



Target Group

"There are way too many accidents at sea in Greenland, especially from smaller vessels. Many of these accidents could have been avoided with better knowledge in the field and a will to prevent accident at sea." - Thomas Bruun de Neergaard.

This is the head of the Training Department at Greenland Maritime Centre, Thomas Bruun De Neergaard. This project therefore focuses on solving the problem for the smaller open boats. Small boats in this project will be defined as any open or partially open boat from 4 meters to about 8 meters and for sailors sailing alone..



Mentality towards safety equipment

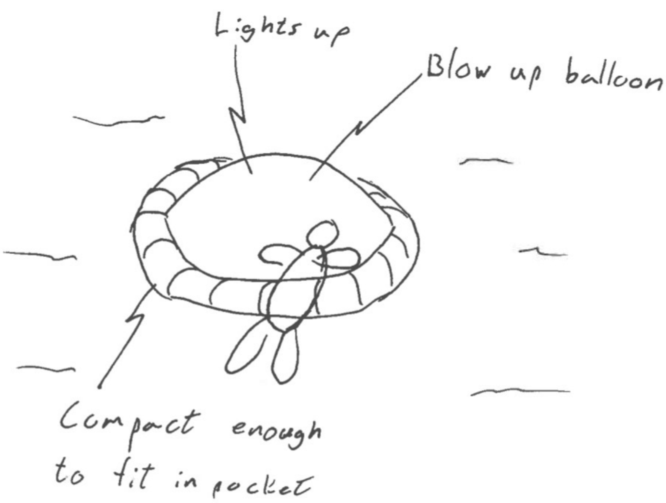
The sailors generally don't wear life jackets, survival suits, or any safety equipment at all. Most of this equipment is restricting their movement making it hard to fish, hold a rifle or move around. These types of equipment are generally thought to be less important as the sailors doubt the benefit of use. It's the simple belief, that it will just drag out their deaths, in the case of an accident. Radios, on the other hand, have slowly become more common but mainly for the convenience of talking to other sailors nearby. (W.017; W.020; W.021)

- *Must accommodate users daily work.*
- *Must have manual inflation.*

Concept 1: Flotation device

The team saw that the sailors main interest is staying alive in an emergency. As many of them are bad at swimming, the main focus here is to stay afloat.
The flotation concept is a large inflatable surface that expands under the user allowing him to stay afloat and keeping him partially out of the water.

See W.005, W.006 and W.014 for more sketches.



Key Actors
Search and Rescue

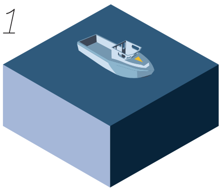
SAR stands for Search and Rescue and is the common name for all rescue units in the Arctic. SAR include the Royal Danish Army support ships, helicopters and aircraft. The Greenlandic police-boats, sledges and local actors such as Air Greenland and NaviAir are also among the SAR resources. Just last year, SAR had more than 74 logged missions in Greenland (A.01).

It's either the Joint Arctic Command or the police who are the first responders to an emergency. To do this, they must first know in which area to search. The more concrete information they get, the better the chances of locating the distressed. Because Greenland is so large, it is often a big search area which often results in search missions that can take days. *The information SAR gets, is often limited to a time and location of departure*, and an assumed destination, up to 100 km away. The search-team therefore rely on clear weather, the chance of radio communication with the distressed or in few cases, a GPS signal that can help locating them. (Skibsfartens og Luftfartens Redningsråd, 2016; W.017)

Reaction procedure for SAR Greenland

Police

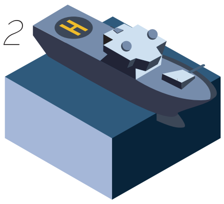
1



- *Binoculars*
- *Radio*

Joint Arctic Command

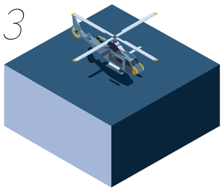
2



- *Binoculars*
- *Radio*
- *Radar*
- *Thermal Camera*
- *Camera*

Helicopter

3

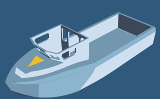


- *Binoculars*
- *Radio*
- *Camera*

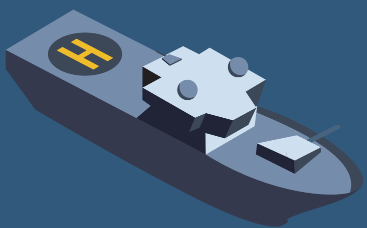
Surveillance plane

4

- *Radio*
- *Radar*
- *Thermal Camera*
- *Camera*



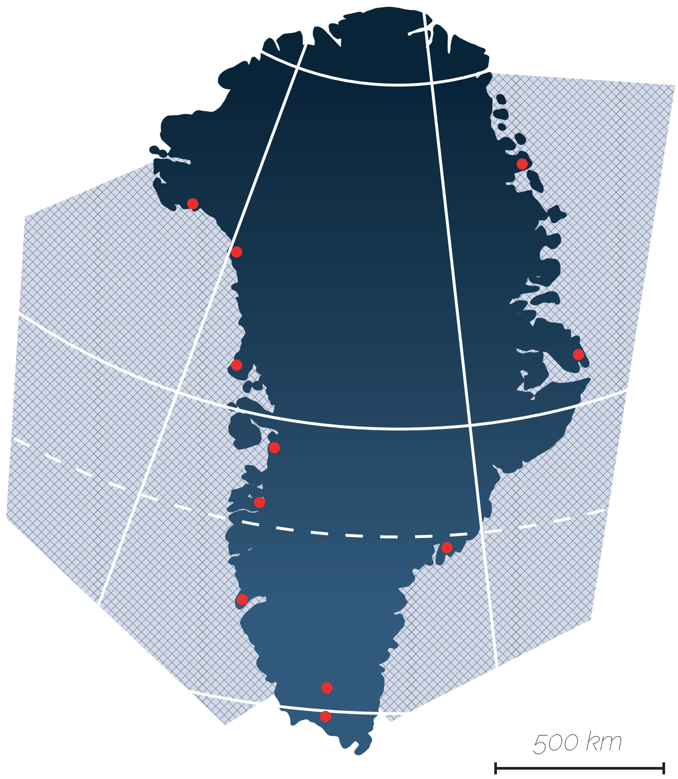
Most missions within a three nautical mile radius from shoreline (W.009) is handled by the police. This is the most common and starts by an investigation in collaboration with Joint Arctic Command support ships and sometimes locals. If the situation is not resolved, helicopters and/or military planes with thermal and radar technologies are called in to search expanding the area of operation.



This map indicates where SAR personnel is stationed. The huge distances mean that response time from the distress call is made until help arrives can be between 12 and 36 hours, depending on the type of vessel of transport (A.11), whether the exact location is known alongside active communication with the distressed.

The problem becomes apparent if the location is unknown. The interview with the Joint Arctic Command also revealed that several missions have extended up to and beyond 5 days, because of the issue of locating the distressed.

Searching for a distressed with a thermal camera is described as "looking through a soda straw" and that most vessels easily could be confused with an iceberg (W.038). There is therefore defiantly a need for making the distressed sailors more visible. Being able to locate them quickly could be the difference between life and death (W.018).



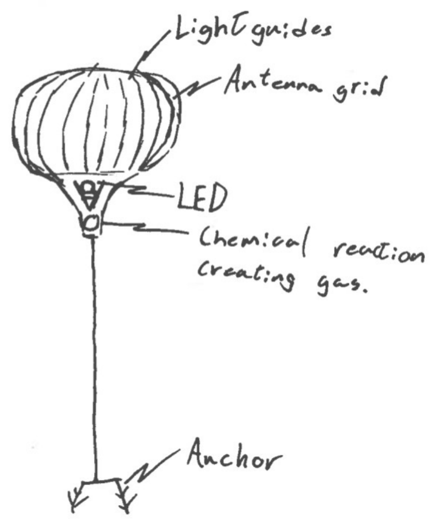
Indication that product should work for minimum 5 days operation time.

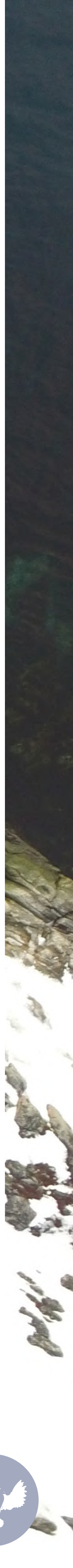
Concept 2: Location device

With the knowledge of the SAR missions in Greenland it was clear that the distressed had to become more visible for the SAR personal to locate the sailor faster and thereby increasing the chances of survival.

The location concept does this by inflating an airborne balloon. When flying at a high altitude it will be more visible.

See W.005, W.006 and W.014 for more sketches.





Joint Arctic Command

Movement, colour, illumination and size. Those are the key elements to be discovered. Joint Arctic Command represents one side of the rescue mission, with the sailors on the other. Data and knowledge from interviews have delivered better insight into the context as well as mindset of the stakeholders. (W.018; W.020)

Key Actors
Paramedics

Most of the paramedic work in Greenland is carried out by SAR personnel.
Some of the most frequently observed conditions include disillusion, panic, dehydration and most importantly, hypothermia.
Treatment by the paramedics mostly include wrapping the person in heat-blankets, but in some severe cases, this is simply not enough.

Danish doctor and expert in the field, Benedict Kjærgaard, Aalborg University Hospital has developed tools for reheating and oxygenating the blood in the body in an external device, that is able to increase the chances of survival for victims of extreme hypothermia (W.015). This page is dedicated to explaining the condition that some sailors experience, when in distress in the extreme cold.

Staying in cold water can have fatal consequences since the human body is cooled around 24 times quicker in water than in air (Young, 1992). This can trigger "cold-shock response", that is one of the most frequent reasons for drowning. (The Science of Sport, 2008). Falling in cold water can provoke a stage of chock that can in worst case trigger a cardiac arrest.

Surviving in the cold water is extremely difficult, and even with the proper equipment the time is sparse. Even with survival suites, the amount of time an untrained person can survive is very limited (Lyngse, 2019).

Sometimes it's minutes before the distressed either passes out or drowns because of cold-shock response.

There are several ways that might help you in surviving a little longer. Three of the most common tips for doing this are shown below (Boating Tips from the Canadian Safe Boating Council, 2016; W.004).

Indication that the product should allow the user to hold on to - maybe climb on to.

Keeping body extremities close to the core. Protecting groin and armpit areas as these have large blood vessels close to the surface skin. Individuals needs a life vest to do this.

Sharing heat, lowering heat loss and have a large positive mental effect on individuals.

Get as much of the body out of the water as possible. Even getting partially out the water will dramatically decrease loss of heat.

The stages of hypothermia

Cooling begins

37˚C
As soon as there is made contact with water and the distressed, the cooling process begins.

Conscious, shivering

35-32˚C Mild hypothermia
The distressed emerges from the water in confusion. Shivering from the cold and in panic.

Loss of fine motor-function

32-28˚C Moderate hypothermia
The cooling begins to affect the distressed and fine motor-function such as fingers stop functioning.

Impaired, not shivering

Cramps and loss of control of all limps starts and impairs the distressed.

Unconscious

28-20˚C Severe hypothermia
The impaired becomes unconscious from the hypothermia and starts a hibernation.

Clinical dead

<20˚C Clinical death
The distressed is clinical dead, meaning that no vital signs are visible. Breathing and pulse has stopped and normal CPR is no longer alone effective.
The cells of the body enter a "hibernating state" because of the cold and are preserved for hours.
Revival from hypothermia is now able by reheating and oxygenating the blood. Reviving a person, with examples of core temperatures of just 15˚C and after more than 5 hours of clinical death have been executed with success.

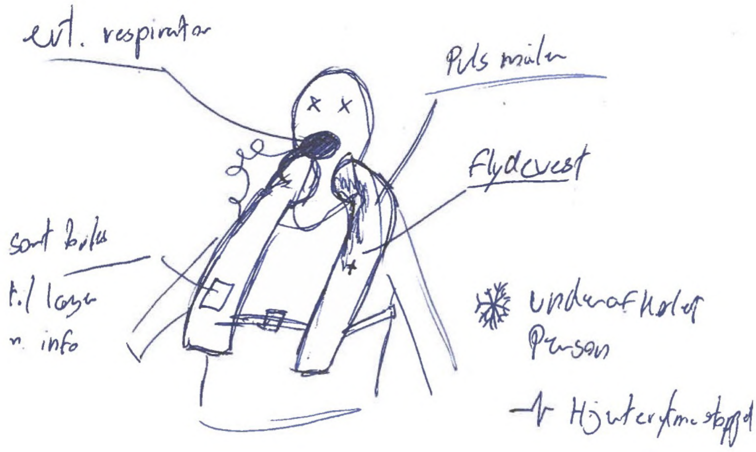
Death

Source: W.011; W.015; Illustreret Videnskab, 2019

Concept 3: Revival device

After learning the extreme cold means that an individual could be revived many hours after cardiac arrest. The team created a concept that tried to accommodate the paramedics in their revival work.

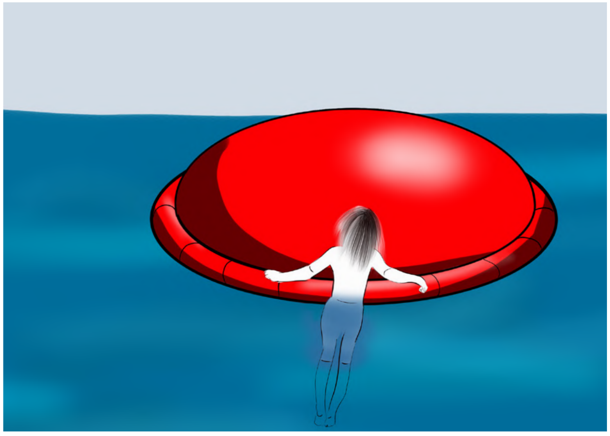
The distressed would wear a device that measures heart rate and vital signs that the paramedics could use in the revival process. It could also keep the user afloat until help arrives after cardiac arrest.



See W.005, W.006 and W.014 for more sketches.

Elaboration of concepts

The three concepts handle different aspects of the same problem: Too many people lose their lives when in distress at sea. Each of the concepts opens up to solution spaces, that tries to tackle the problem; prolonging the time the distressed can survive, shortening the time before help arrives and increasing the chance of resurrection, if the distressed is perished.

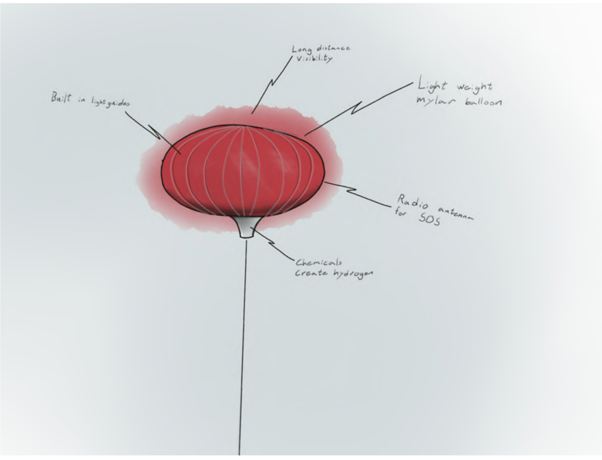


Concept 1: Flotation device

The floatation device provides flotation and shelter from the cold water and harsh weather conditions. The team found existing life rafts for bigger boats and ferries, but discovered no single-person life raft.

The concept was intended to be a wearable device, that would inflate autocratically when in contact with water.

Initial thoughts consisted of an inflatable ring, that the user could climb onto - even with limited mobility. From there he wouldn't be as exposed to the water and therefore not cooled down as fast, ensuring a prolonged survival time. If the user had additional energy, it's possible to enclose a wind resistant shelter around him.



Concept 2: Location device

The location concept was a device that helps the search teams - both SAR personnel and civilians, locate the distressed. When in distress, the user could deploy a balloon, that broadcasts an emergency signal.

Because of the altitude, it gains better signal strength and is more visible for the search teams.

To further improve visibility, the device is equipped with lights and radar reflecting surface.

It was, in an early stage, discussed to include a heat element, so that it was visible from thermal cameras as well.

Concept 3: Revival device

The initial thoughts for the revival device, was an assistant for the SAR personal when the distressed had been found dead. A product placed on the person that delivered information such as name, contact person, allergies and maybe even a personal message for the family.

In addition, the team had ideas, that the product could put the distressed in an induced coma, to improve chances of revival after cardiac arrest, but later dismissed because of problems with saleability and scenario understanding.

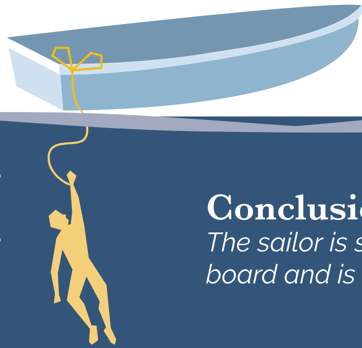
Possibility of different scenarios

In interviews with Joint Arctic Command in Nuuk, the team became aware of the limited or withheld statistical information:

- The percentage of successful operations where the distress was found alive.
- The percentage of operations where incident had any health effects to distressed.
- The percentage of the operations where the distressed were still in the boat or were found in the water.

The Joint Arctic Command revealed that the likely-hood of being saved alive greatly depended on the time before they were found, the clothes they whore and if they were in contact with the water.

These statements lead to the assumption, that out of the distressed, most of these are still in their boat simply hoping for help to come to the rescue or another sailor to hopefully notice them. (W.018)



"We have seen incidents, where the distressed have tied themselves to the side to be able to be found". - Klaus

Conclusion

The sailor is still in the boat and if not, he has fallen overboard and is often found close by, failed to re-enter.

Concept Evaluation

The three concept directions each had their values for the different key actors and how they would benefit from them.

Concept 1, flotation device, had the main focus on the distressed person, getting him out of the water was the first priority.

Concept 2, was framed more towards the SAR personnel, to aid in the search process of locating the distressed. The value of this product was to let the distressed know, that help is on its way.

Concept 3, revival device was very fuzzy in its stage of development. The team had little knowledge about the possibilities and how the concept would benefit both the distressed and the SAR personnel.

The team didn't want to eliminate the concept, and had intentions of bringing strong value to the distressed, in letting him know, that his options for being rescued were good, and even more: the options for surviving the situation were improved. Later in the process a mail with Benedict Kjærgaard revealed, that the team's visions for the concept, would have little impact in helping the SAR personnel in doing their job. For this reason, the concept was terminated, and from this point on, only the flotation and location device had focus. (W.024; A.06)

"What the SAR personnel knows in advance, doesn't really matter. It doesn't change anything really. Still you can't be to thorough in the procedures, and everyone will get the same treatment at the hospital" - Benedict Kjærgaard

Ill. 03

Rescue Equipment

Framing

In this chapter, the framework for the ideation process is presented. It makes up for the limitations and values that throughout the process helped shaping the product. By creating this framework, the team managed to build a set of verbal tools to not only present the project and its uniqueness more sharply, but also to form a common language, that was extremely valuable when taking decisions within the process itself. The framework therefore became the cornerstone in all future decisions and almost all discussions ended out in the question: "Does this live up to the framework of the project?". That being said, like the project is a constant iterative process that constantly change and is evaluated, so does the frame. You will notice throughout the process report, that the argumentation becomes increasingly more specific, as knowledge is accumulated, processed and quantified, one page at a time.

Greenland Expedition

The team needed a deeper understanding of the Arctic climate, culture and the SAR operations. For this reason, a expedition trip to Greenland was arranged to get insights in real scenarios and meeting the potential users several interviews with the different knowledge partners were conducted.

Day 1 and 2: Interviews with the police and equipment supplier, revealed that the fishermen often don't use survival and flotation suites because of discomfort.

The Greenlandic police also noted that the majority of sailors is equipped with VHF-radios, even though the signal is considered "bad", and that the lack of focus on safety is a huge problem.

Feedback on the concept also indicated an interest in the location and flotation device as a new alternative.
Addressed as the main reason for becoming distressed is because of hitting a skerry (W.017).

Day 3: Visiting Joint Arctic Command and NaviAir was critical for the team with insights into real SAR cases and feedback on initial concepts. They revealed that the biggest problem is finding the distressed in time. A shared potential was seen in both ***flotation*** and ***location*** devices with relation to real cases (W.018).

Visiting a Polar Seafood Trawler provided insights into the professional fishing industry. The team learned much about the culture of living in Greenland, and that the boat basically is their bike, car or train (W.020).

Day 4: Visiting the Government of Greenland provided further insights into the culture of sailors. The department of Maritime Affairs have a yearly budget of 250,000 DKK for campaigns and media coverage for maritime safety. Oversized motors on the small Poca boats is a major issue, which is among the reasons they hit the stone reefs with high speed. (W.021)

An interview with a local sailor provided critical insights into the culture and feedback on concepts.
In both interviews the ***location*** and ***flotation*** device was of high interest.
Again because of the concepts relation to real life cases and experiences (W.020).

Day 5: A second interview with a sailor was conducted. A typical fishing trip lasts several days, traveling 80 to 200 km each day.
The problem with VHF radio signal, blind spots and the bad geographical mapping of the seas was also addressed. This highlights the two main reasons why sailors hit skerries and black ice; high speed and incorrect depth mapping in GPS' (W.020). Another interesting observation is that all sailors agree that many other sailors have been in distress, but deny that it would happen for themselves (W.017; W.020).

Conclusion: The Greenlanders are considered among the world best sailors - yet accidents still happen. Many sailors don't wear or own safety equipment, but do have access to VHF radios, GPS and emergency flares, which they use in case of a distressed situation. Still the problem for SAR personnel is to locate them due to the vast geographical environment. The team became aware that fishermen are not the only users, but sailors in general. The problem is apparent among all types of sailors, simply because sailing is the only extended infrastructure in Greenland (W.022). The interview with KNAPK (W.017) also indicated that the appreciate tools and equipment, that do not need service.

- *Extend product service life as much as possible*

Full overview of actors

Throughout the project the team have had communication with a series of partners in all sectors throughout the rescue operations. Each have helped with insights, feedback and cases in the development of the project scope and helped to shape the project, to acknowledge the most active actors as possible.
Below is a representation of the actors in a SAR missions, how it is organised and who the team talked with.

JRCC Greenland*

*Joint Arctic Command**
Klaus D. Iversen - Duty Joint Officer
Rasmus Kimer - Planning Manager

*NaviAir**

Royal Danish Airforce
Lars Bonderup - Production developer
"DES" - Rescue helicopter pilot

Air Greenland
Jens Ploug Larsen - Pilot

With much interest in the project, the Arctic Command, the police and NaviAir have been helping with information and crucial insights into the capabilities and limitations of SAR operations in the Arctic.

Police

Regional Police
Carl Sværd - Police Commissioner

Police Boats and sailors

PROFESSIONAL COLLABORATORS

Government
Gorm Nørgaard - Maritime Affairs

*DMI**

*KNAPK**
Niels Boassen - Office manager

Medical personal
Benedikt Kærgaard - Aalborg University Hospital - Hypothermia expert

Locals

Nabo RCC - Voluntary rescue organisation

Ships and sailors
Martin K. Hjort - Professional fisherman
Ivik Jensen - Leisure fisherman
Polar Seafood - sailors and workers

Local guides
Malene Nielsen - Illulisat
Janette AC - Nuuk

LOCALS
Gaining knowledge about the users with crucial insight in culture, usage, storage and working principals, two local fishermen have helped the team with feedback for concepts ideas and the project scope. Polar Seafood provided insights into the professional industry of fishing and hunting.

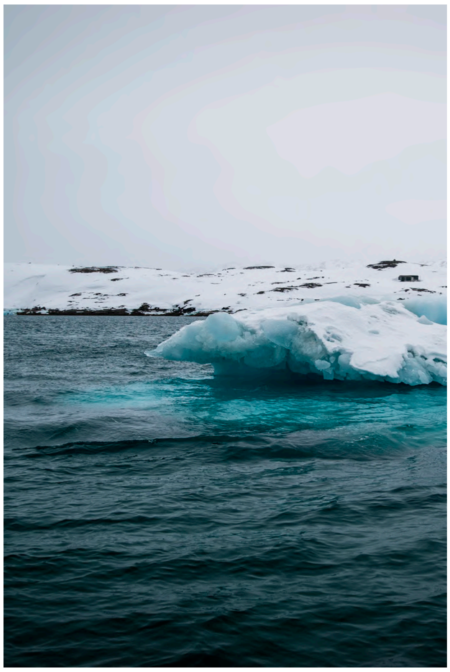
Several partners have provided insights as 'expert knowledge' on the topic of maritime safety and surviving in the cold harsh climate. Benedict Kjærgaard is the 'go-to' person in Europe when it comes to hypothermia and providing medical care.

The Greenland Regional Government and the interest organisation of fishermen and hunters in Greenland have helped with further understanding of the culture and feedback on the concept development.

A B C

1

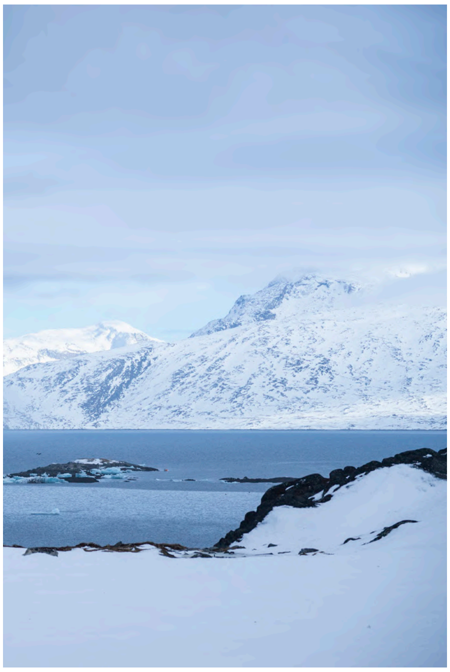
2

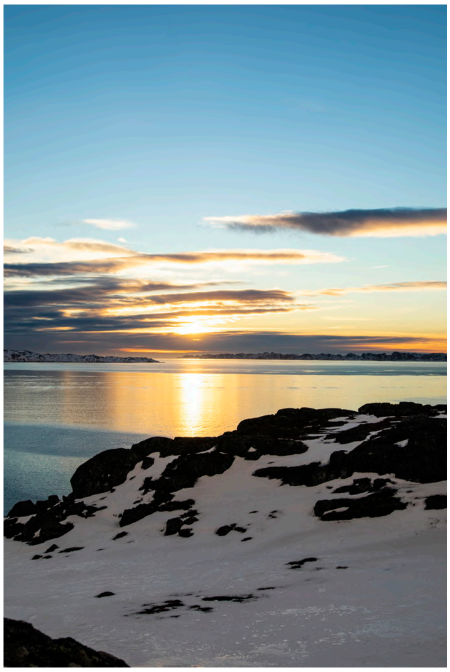


3

This page is dedicated for the reader to dive into a few of the scenes the team have seen while visiting Greenland. Even though Denmark and Greenland politically have many things in common, the countries are very different in most other aspects. Culture, nature, people, climate and living is remarkably different from what we are used to in Denmark.

Use a few minutes to watch the pictures to better understand the Greenlandic context and the people who live there.





D

E

A1.
Typical living arrangement in Nuuk, the capital of Greenland with the ice-cap in the background. Urban and nature meet site by site.

A2.
B1 & B2. All settlements and cities in Greenland are placed next to the ocean or fjords Life on the sea is part of the everyday.

C1.
Even though the temperatures are far beneath zero degrees, life flourish even under sea-level. A Greenlander called it "The living pantry".

C2.
Just as life flourish under sea-level, so does the danger. As vaguely indicated, only the top of the iceberg is visible.

D1.
Joint Arctic Command's headquarters in Nuuk overlook the harbour. In the centre of the picture is also the giant radar station that helps with communication as well as surveillance.

D3.
All over Nuuk harbour are placed plastic buckets filled with fishing-line. These buckets are used by local fishermen to fish all kinds of fish and sell to the large organisations such as Royal Greenland or Arctic Seafood.

Mentality of the Sailors

During the trip to Greenland, the team tried to gain a better understanding of what values the sailors in Greenland appreciate.
Interviews with both fishermen and local resellers (W.016) of equipment for sailors revealed that independence is an important value for them. To be able to take care of yourself as a proud sailor is one of the most important factors for these people.
This is shown on two different levels: Freedom while sailing, and independence from the Joint Arctic Command.

> *If I fall into the water I die.*
> *If I have a life-jacket on, I die slowly.*
> *- Local fisherman*

Independent while sailing

In an interview a local reseller of sailor equipment said that the Greenlandic culture is very apparent. They want to live in close relation to the nature around them. This freedom to just sail out manifest into elaboration on the statement, that the sailors generally aren't interested in additional things that they need to remember when they leave their house to go to the boat. It complicates their freedom. The same goes for equipment, that they must wear while sailing. Flotation-vests and other equipment complicates their work and is of annoyance to them, and they therefore rather not use it at all. (W.016)

Ill. 04

Independency from Joint Arctic Command

The picture to the right, and the story behind displays well a tendency, that only in the out most critical situations, do the locals want help from the SAR units. Six sailors in three boats had been stuck in the ice for 14 days without asking for help. The Joint Arctic Command had offered to extract them, but they declined the help. To make sure the sailors situation didn't get more critical, a Challenger aircraft dropped petroleum to the sailors to start a fire. (Joint Arctic Command, 2019)

Ill. 05. Picture taken from Challenger plane of distressed sailors with boats frozen into the ice, waiting for the ice to break. (Joint Arctic Command, 2019)

Existing solutions

The team learned that sailors tend to not bring or wear emergency equipment while sailing. The team realised a need for understanding, what actually are wrong with the existing emergency equipment. Below are the most common pieces of emergency equipment. Positives and negatives have been written for each product. See worksheet 012 for further existing products.

Ill. 06

Life jacket
+ Keeps you afloat
- Still going to hypothermia in minutes
- Doesn't call for help
- Doesn't make you more visible
- Limited mobility
(Mustan Survival, 2019)

Ill. 07

Survival suit
+ Effective at keeping user alive and warm for longer
- Extremely limited mobility
- Hard to get on if you are already in the water
(Ocean Medix, 2019)

Ill. 08

Life Raft
+ Keeps user dry
+ Keeps user afloat
- Takes up to much space in small boats
- Only exists in 6 person version or bigger
(Favim, 2019)

Ill. 09

VHF Radio
+ Can call for help
- Often bad signal
- Doesn't make you more visible
- Doesn't keep you alive
(Amazon, 2019; Bauhaus, 2019)

Ill. 10

Personal Location Beacon (PLB)
+ Calls for help via satellite
+ Gives approximate location
- Doesn't make you more visible
- Doesn't keep you alive
- Not very common among Greenlandic sailors
(Favim, 2019)

Conclusion:
This research is based the team's own perspective with support from the statements from the interviews. The problem with most existing equipment is a combination of limiting the user's mobility or comfort when not in an emergency and the ineffectiveness in the extreme environment of the Arctic. Most of the equipment on the market only solves a small part of the overall problem in an emergency. For any of this equipment to truly be effective the users need to use many different pieces of equipment.

- *Utilizing strong colours on the concept.*
- *Must have a manual inflation option.*

Regulations and Limitations

Regulations

By looking at the existing equipment the team learned that there are exists a set of regulations for safety equipment, mostly dictated by two major players: SoLaS, by the United Nations and the local Danish legislation.

*SoLaS**

The United Nations have made a set of regulations, that dictate many rules for naval safety equipment. One of the most essential requirements is that all life rafts must be able to carry at least six people. Simply, by this regulation, a single man life raft is not feasible, or otherwise must be defined as something else than a "life raft". (W.023)

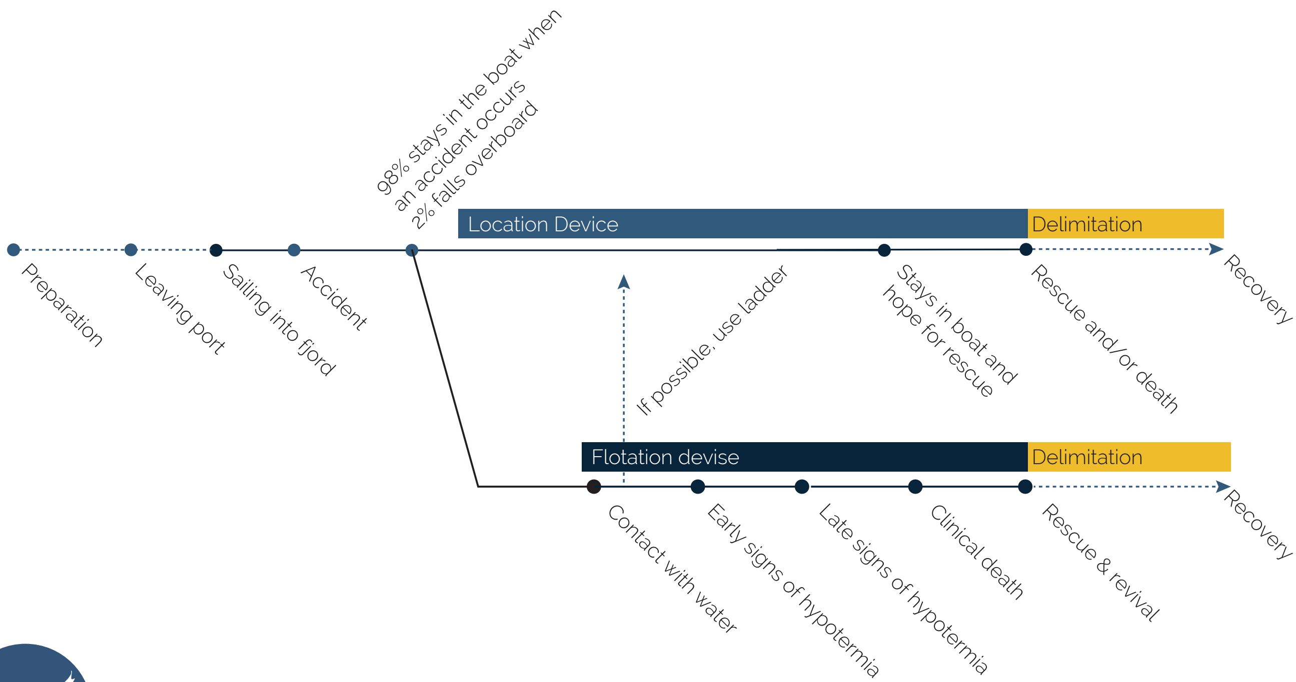
Danish Legislation

Because Greenland is part of Rigsfælleskabet*, they are under Danish legislation. This also applies to the naval laws. The Danish legislation dictates, that everyone sailing must have a life-vest for every passenger aboard, but not that they should be wearing them. Many of these laws do not applicable in Greenland or don't relate to the much harsher climate. (W.010)

Delimitation

Working with a complex problem as this, with many different sub-problems, the team had to develop delimitations for the case. To do this, a timeline was developed. This timeline displays the scenarios at play when an accident occurs. When the accident occurs, one of two things may happen. Either the person falls overboard or the person doesn't.

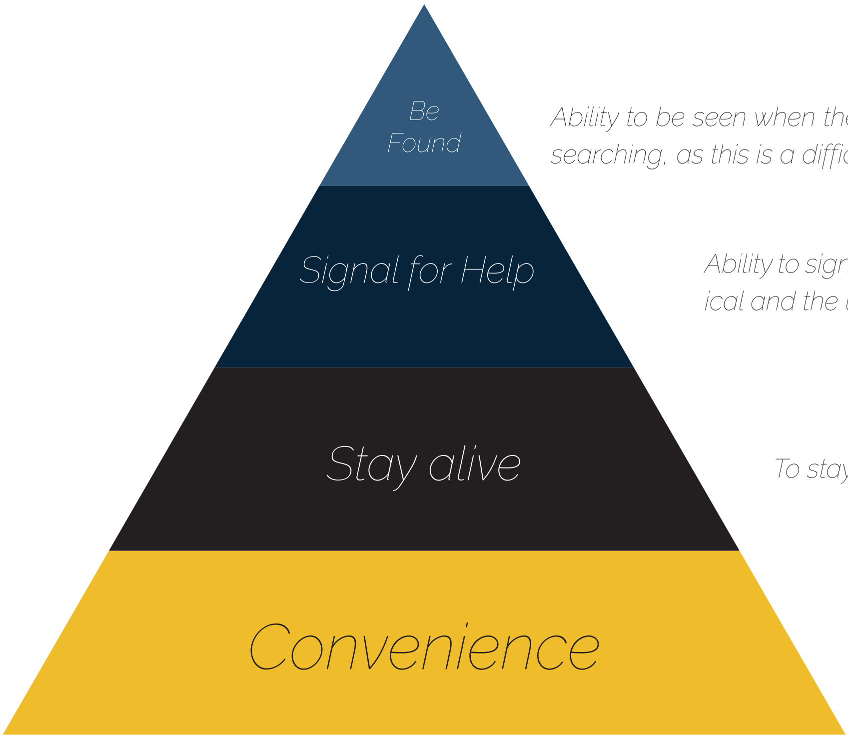
In 98% of the cases, the person is still in the boat and able to stay there, whereas the other 2% end in the water (A.012). If the distressed ends in the water, it can be difficult to get up without a ladder on the boat. In an interview, Gorm Nørgaard, head of safety at the local government of Greenland (W.021) said, that it's strongly discussed to make it mandatory to have a ladder mounted on the smaller boats. Therefore, this isn't the main function of this product.



Problem Interpretation

Through a user centred approach the team aims to deliver the best experience for the user. This is done through an analysis of an interpretation of the problem, with the user in focus.
As learned preciously, many sailors are fully aware, that it's dangerous to sail in the Greenlandic waters and that safety equipment could possibly save their lives. Yet the team learned, that very few sailors actively use and own safety equipment due to it being inconvenient and in the way when working on the boat.
For this reason, ***convenience*** as the most important aspect of the product. ***The best location device or survival suit is irrelevant, if the user doesn't find it convenient and relevant. (W.026)***

The triangle below describes the priority of the product as seen from the team's perspective with the base being the most important while the top is the least important. If the product is not convenient, the sailors will not use it. If they don't use it, they often die. Then they can't signal for help, they therefore can't be found.



Ability to be seen when the Search and Rescue personnel are searching, as this is a difficult task.

Ability to signal for help, only if the situation is critical and the user is aware that it's.

To stay alive.

Convenience, defined as something that you don't notice or is in the way while doing all other assignments on the boat (W.013).

Value Vision

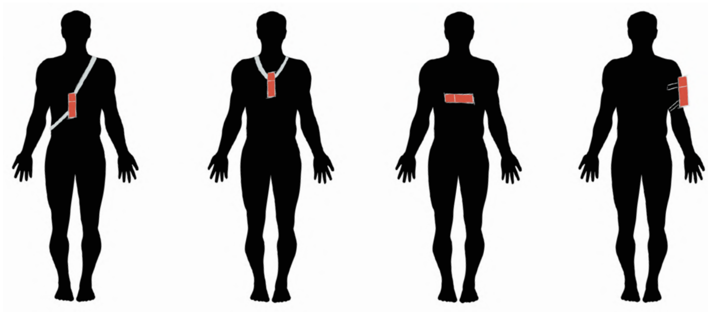
To help define the problems, initial parts of a 'Value Vision' workshop was conducted. This helped define the mindset of the sailor as well as align the team on the problematic at stake. The 'Value Vision' was later reinterpreted to the result presented above (W.013).

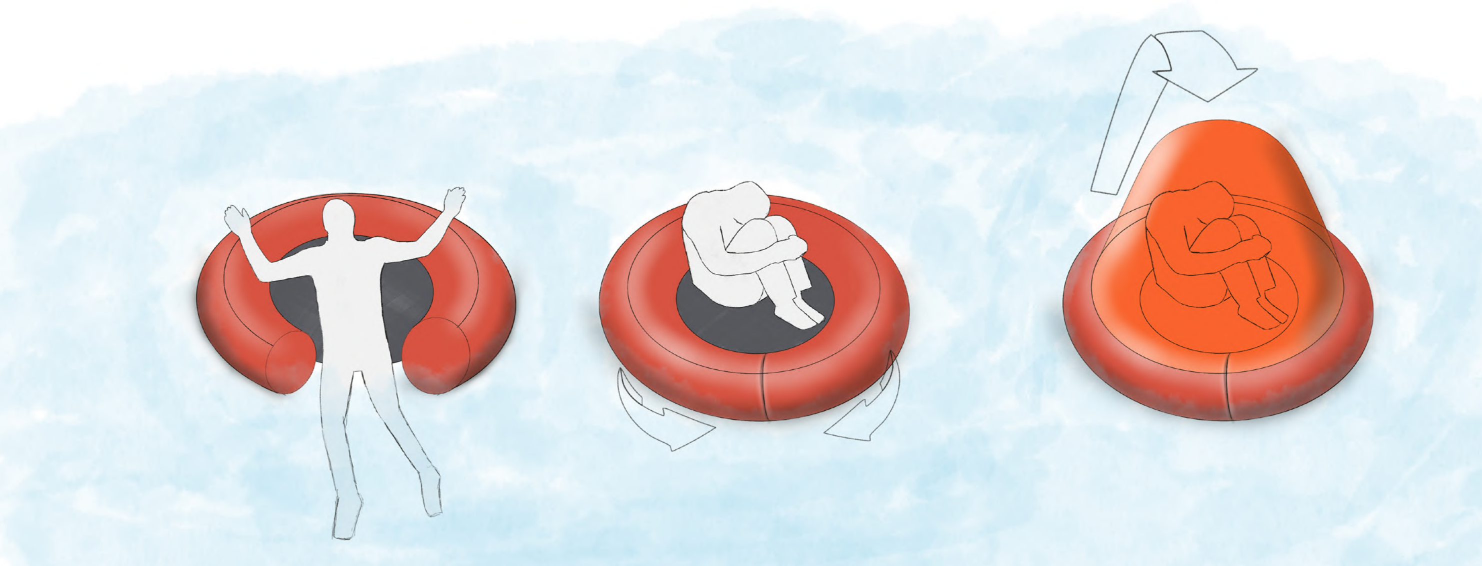
Evaluation of concepts

The two concepts were further developed to better evaluate them. Here they were slightly more detailed with their functionalities and highlighting the value they created in an emergency. The team also presented all three concepts to sailors, the police and the Joint Arctic commando in Greenland to get their views and feedback on the concepts.

Concept 1: Flotation device

A small wearable package that inflates upon impact with water.





When encountering water, it inflates under the body of the user keeping him partially over the water.

If the user has enough energy he can crawl onto the flotation device and close it.

To protect against the wind the user can then pull a top roof.

+

Small neat package
Get out of the water
Shelter for the wind

–

Can be difficult to enter
Must withstand waves and wind
Fragile to ice
Questionable stability

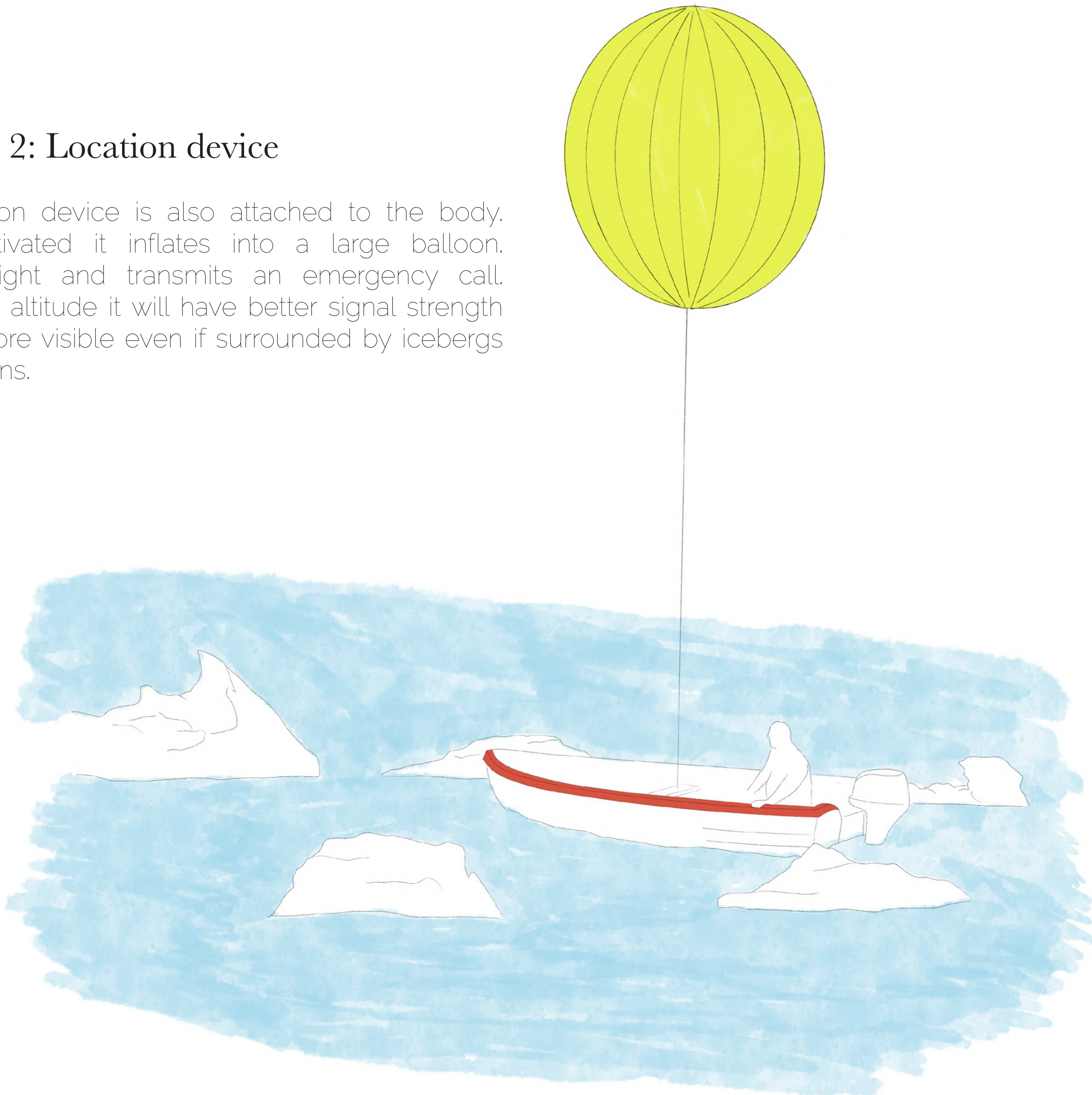
Sources: W.017; W.018; W.020; W.021

Evaluation

The limitations set by the SoLaS regulative mentioned on the previous pages. Therefore, the product has to be defined as a "buoy" or a "life-vest" in order to work within the regulative. Creating a life-raft is also in direct competition with the company Viking, which is specialised in this exact field and well respected around the world.

Concept 2: Location device

The location device is also attached to the body. When activated it inflates into a large balloon. It emits light and transmits an emergency call. By gaining altitude it will have better signal strength and be more visible even if surrounded by icebergs or mountains.



+

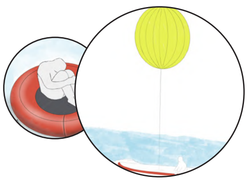
Altitude strengthen the signal
High altitude is not required
Easy to recognise and use
Could be a good radar reflector

−

Drag from the balloon influence the boat
The wind will have a big impact on the performance
Sources: W.017; W.018; W.020; W.021

Evaluation

The location had a strong and positive value for the problem. Differentiation from current existing products was high, as a more specialised device for this extreme environment (W.012).
The interest from both the SAR personnel and the sailors was high. Especially the SAR personnel could see the potential for this concept to have a large impact on the rescue missions in easing the location ability.



Conclusion

Evaluating the concepts lead to a realisation, that concept 2: Location device, was the most ideal concept for further development. The core functionalities of aiding the distressed user to call for help and to be spotted was supported by all key actors; sailors, police and the Joint Arctic Command. The concept was chosen to be the working concept for future development.

Rescue Beacon

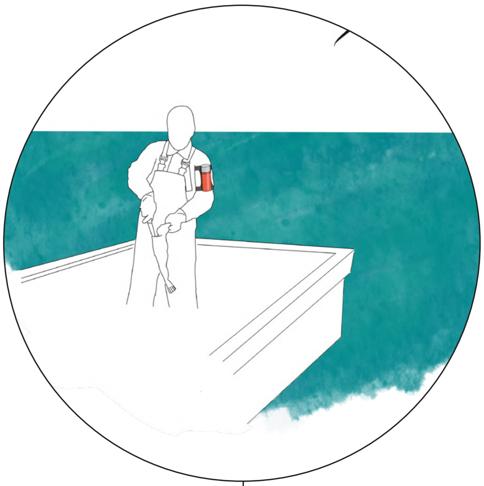
Conceptualisation

This chapter centres around the conceptualisation of the product. Emerging from the findings observed in the framing chapter, the product takes shape all while constantly being evaluated on the parameters set by the framework of the project. In the centre of the design is the problem interpretation described in the previous chapter, that also helped structure the design process and break down the working principle of the final product.

The chapter is divided based on the problem interpretation. Each level contributes to different parts of the product and each deal with their part of the problem interpretation, resulting in a specification of the major component in the product, that is further explored and elaborated upon in the detailing chapter.

Initial Concept Storyboard

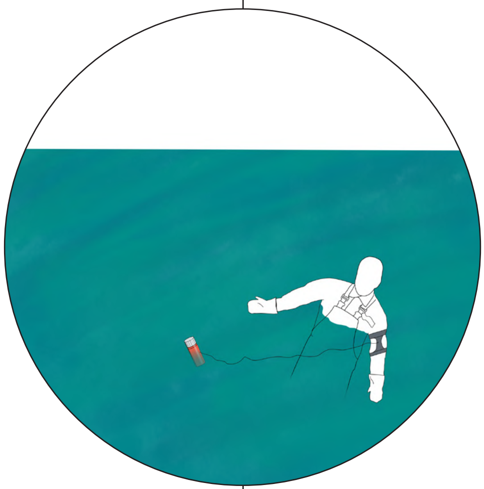
To define the current an initial storyboard introduces some of the products features and interactions before attending the concept development.



Inactive concept

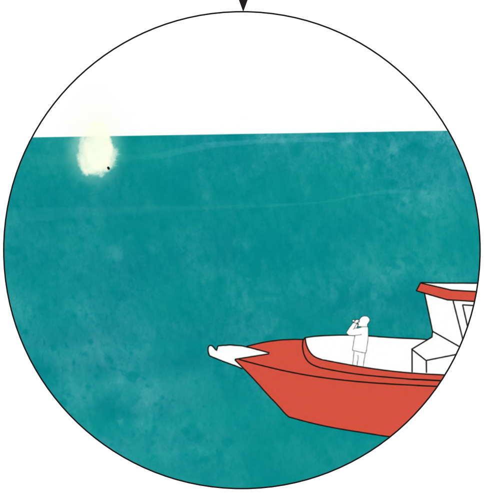
When the product is inactive, it's a small compact sized product close to the body. It's placed on upper arm for minimal annoyance for the sailor, but still being so close, that it is ready to use at any time.

- *Activation using one hand.*



Activation

When the sailor is in distress, quickly rip of the device from the shoulder and throw it in the water, while still being attached to the person with a line. As the product detects contact with the water, it starts inflation.
If the person has fallen overboard, the device automatically inflates.



Waiting

As inflation starts, so does the electronic communication module. This module broadcast an emergency signal to nearby sailors. When the product is fully inflated, the balloon will hover over the distressed. It signals 'help' through its strong orange colour, flashing light and radio signals. Thereby it helps the SAR personnel to more easily locate the distressed.

Sailors as first response

Sailing is the number one choice of transport in Greenland. Therefore, travelling long distances by boat is not uncommon. The difference, however, is that the distance between each city is huge.

This map shows the Disco Bay on the west coast of Greenland. This is not a particular remote place but quite inhabited compared to most of Greenland (W.009). The distance between the two closest villages here is more than 300 km through multiple waterways and skerries. This makes it extremely hard to locate where the distressed are. Especially if the distressed can't call for help or give his location.

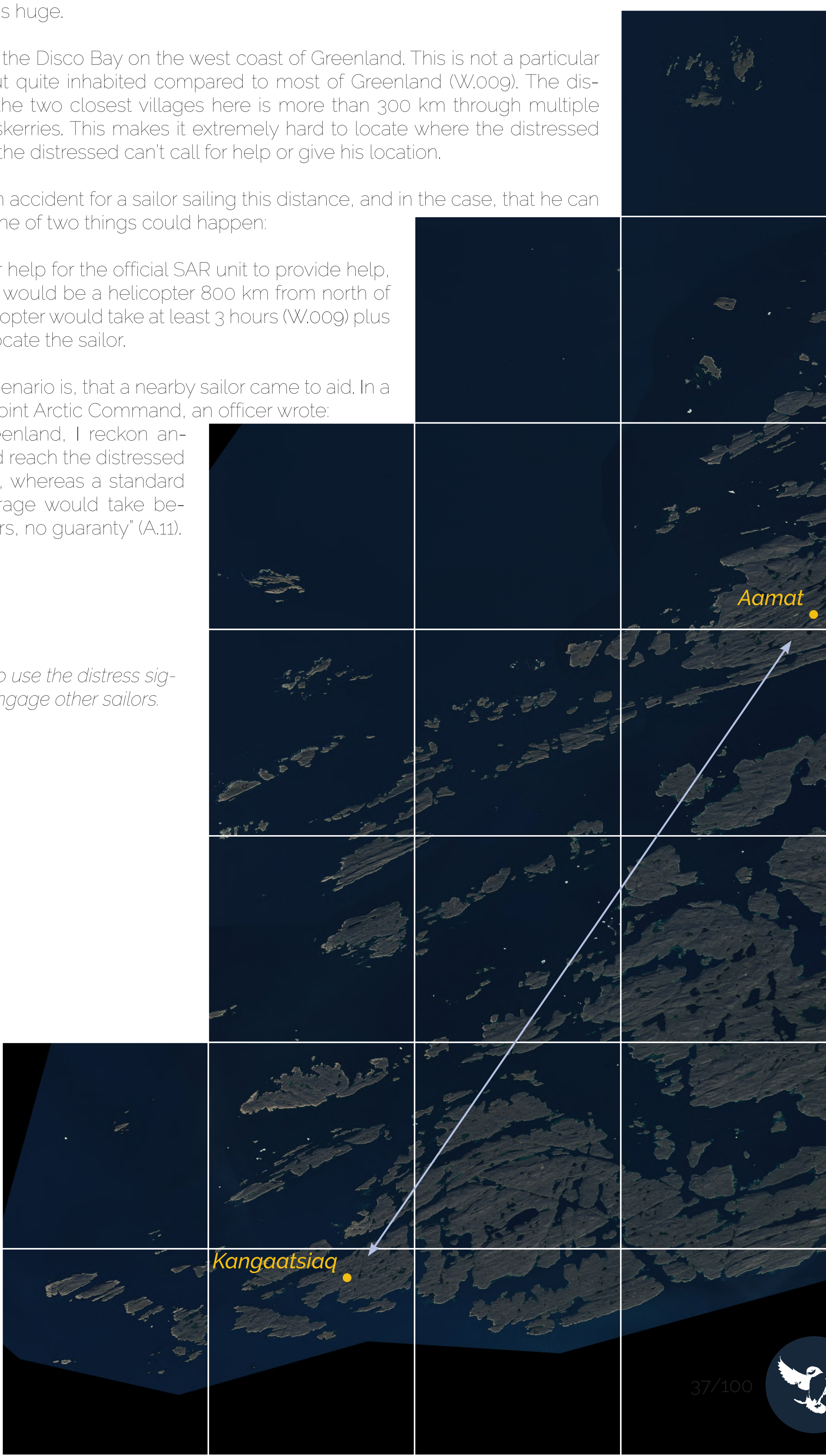
In the event of an accident for a sailor sailing this distance, and in the case, that he can signal for help, one of two things could happen:

1. If he signals for help for the official SAR unit to provide help, the nearest help would be a helicopter 800 km from north of Aamat. This helicopter would take at least 3 hours (W.009) plus search-time to locate the sailor.

2. The second scenario is, that a nearby sailor came to aid. In a e-mail with the Joint Arctic Command, an officer wrote: "Internally in Greenland, I reckon another sailor could reach the distressed within 3-6 hours, whereas a standard SAR unit in average would take between 12-36 hours, no guaranty" (A.11).

Must focus to use the distress signal to also engage other sailors.

Additional 500 km is Egedesminde. The closest city with a helicopter



100 km

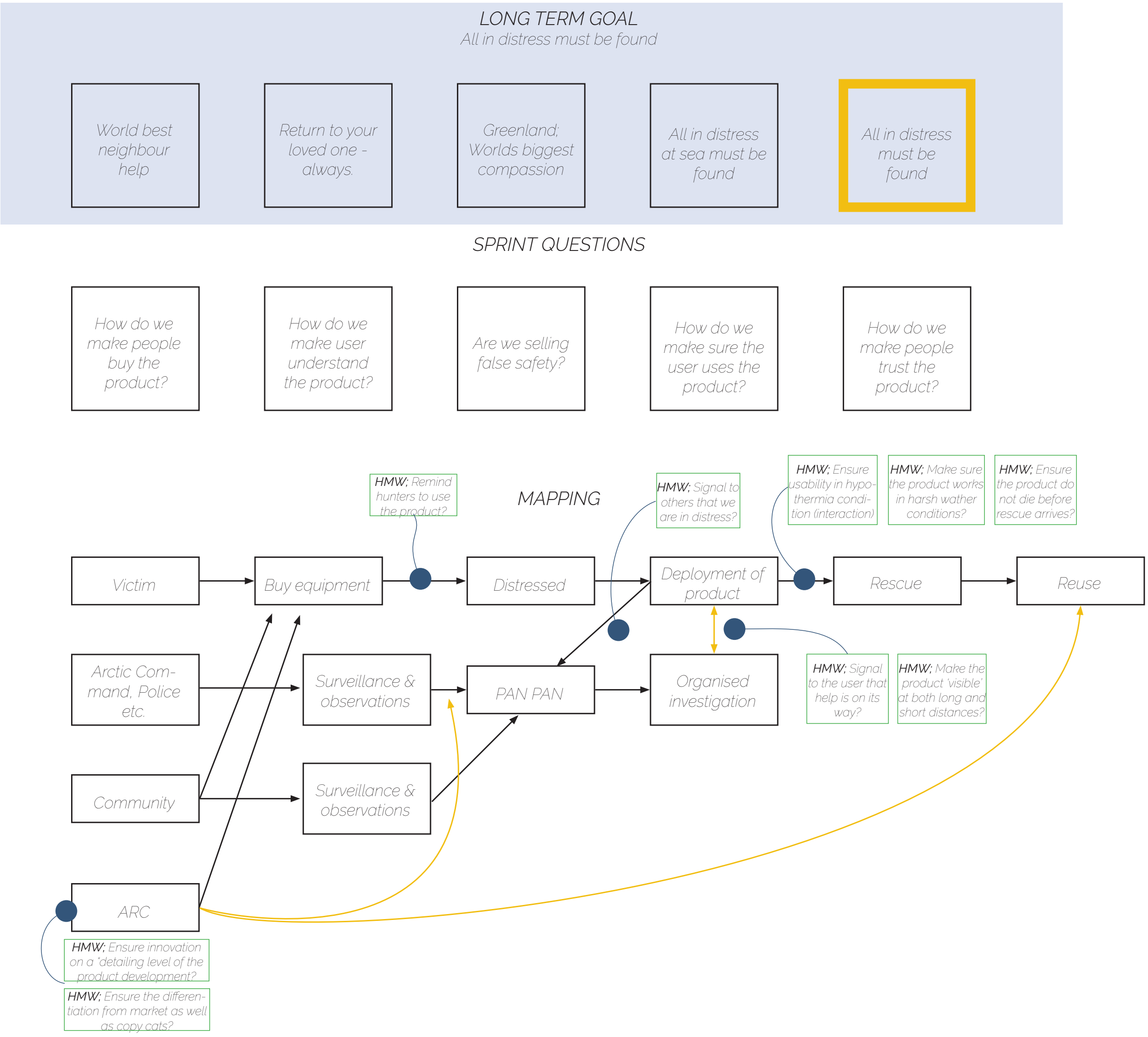
Village

Ill. 11

Sketching process

The conceptualisation phase was kicked off by a "Design Sprint". The sprint was guided through the principles of Jake Knapp (Knapp, 2016) and divided the process into in five days' activities, each with their own focus. This sprint lead to a deeper understanding of the problem and helped the team to synthesize the information gathered until this point. This concluded in the airborne concept turning into a concept that floats on water instead.

Scenario Mapping



To start the sketching process, the group aligned their understanding of the scenario. This was firstly done by setting a long-term goal for the project. "All in distress must be found" was chosen as the long-term goal, referring to, that no matter the condition of the distressed, dead or alive, must at least be found. Even though this is morbid, many sailors in distress are never found, which is not only a tragedy for the family, but also brings no closure.

To further align the team, 'worries' were formulated into 'Sprint Questions', that were discussed until agreed upon being valid.
A scenario described by Joint Arctic Command (W.018) was drawn up and used actively to define HMW (How Might We) questions, that challenged what the product features must solve. As seen in the mapping, the team discussed challenges in many aspects of the situation, but also in opportunities, to improve on existing products in this category. (W.025)

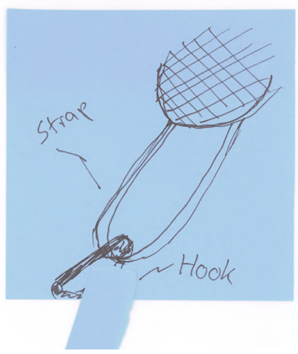
Napkin Sketching

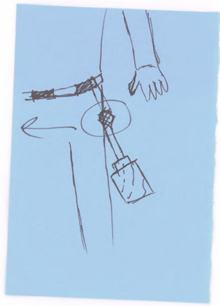
Based on the 'Scenario Mapping', 5 minutes sketching sessions created many ideas.

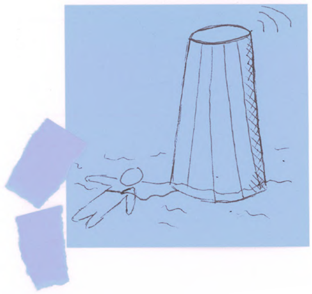
This was done in rounds based on different topics;
- Concentrating on technology
- Concentrating on user interaction

All ideas had to focus on the values uncovered in the previous chapter. The diversion in the sketching sessions opened up for new project possibilities; creating uplift for the product, by shaping it like a kite. Inspiration from Chinese rise-lamps, to create uplift through heat-exchange. An interesting idea was a solution that accepted that the product couldn't keep uplift forever. This concept would over time land on the water and still function as a beacon on the surface of the water to identify the distressed.

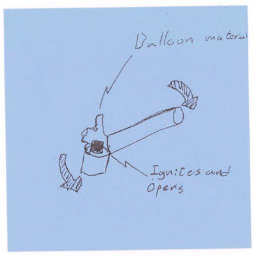
All ideas were evaluated through discussions with pinpoints to the most promising ideas rated subjectively by the team members. These ideas where carried to the next phase in the process, to strengthen the fidelity level and start converging the solution space. (W.025)

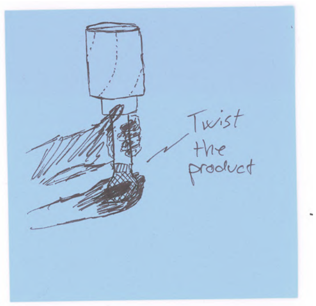


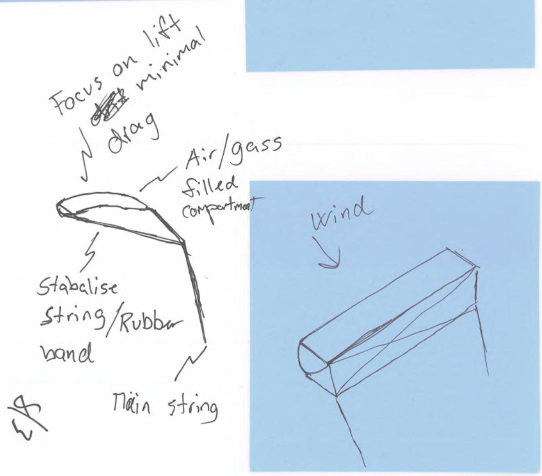




Interaction principles, inspired by German WW2 hand grenade with a large top and a slender handle to get best throw distance. The device was then supposed to be an inflatable kite, that catches the wind to aain altitude.

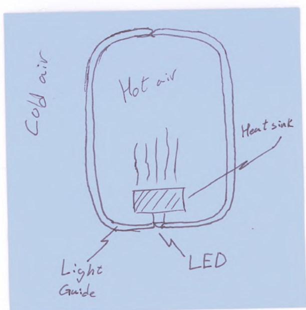


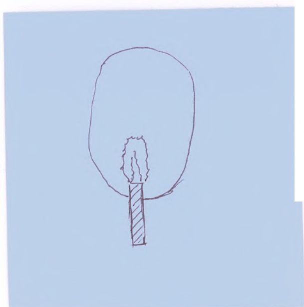




Technical principles

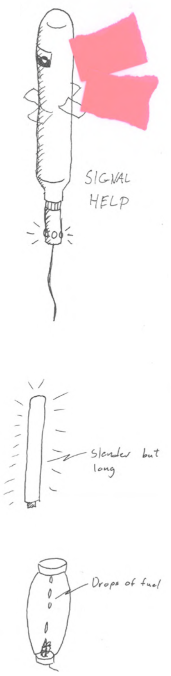
Technical principles of how the lifting was created in the product: in part of the process had many ideas focused on the hot air-balloon principle. Heating up air inside the balloon created uplift, but how the air was heated, went through further ideation. Some ideas included liquid fuel-burning, gas burning, electrical heater or chemical heating.



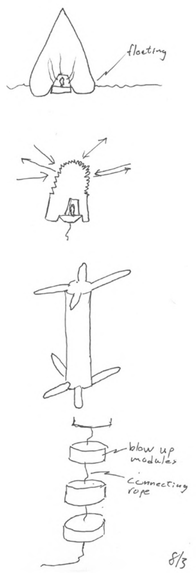


Sketching Session

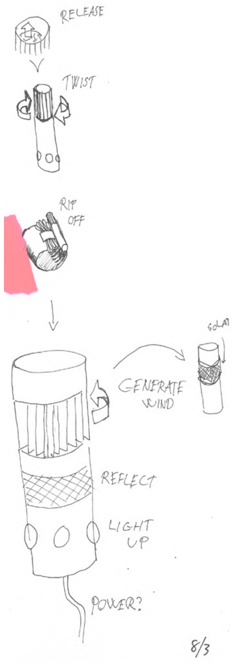
The team chose the most promising concepts and strengthened their fidelity. This also sprouting a few new ideas: *What if the balloon was not in the air at all?* This idea became a standalone concept, that was developed alongside the other concepts ensuring, that when evaluating, they would be evaluated on the same fidelity level.



Slender long balloon concepts.
In these concepts, heat created the lift to get the balloon airborne.



Floating concepts.
Different concept on a floating product, that stayed on the water and how they could be visible.



Electronic concepts.
More electronic concepts, that included many moving parts and an electrical heater to create uplift.

Prototype Testing

The Slender long balloon concept and the Floating concept were then 'moved' into a prototyping session. The team soon realized that achieving lift was a major challenge by experimenting with different simple approaches. Using the 'Bird in the hand' principal the team asked a chemist, Nils Johannes Kritmøller, for different ideas (A.08) to come up with the best solutions for this. The tested methods were **heat** (from a flame) or **pressurized gas** (helium).


Heat as uplift


Compressed helium

The testing concluded, that the uncertainties for the flame heated concept was too great for survival equipment and a difficult challenge for the team to account for.

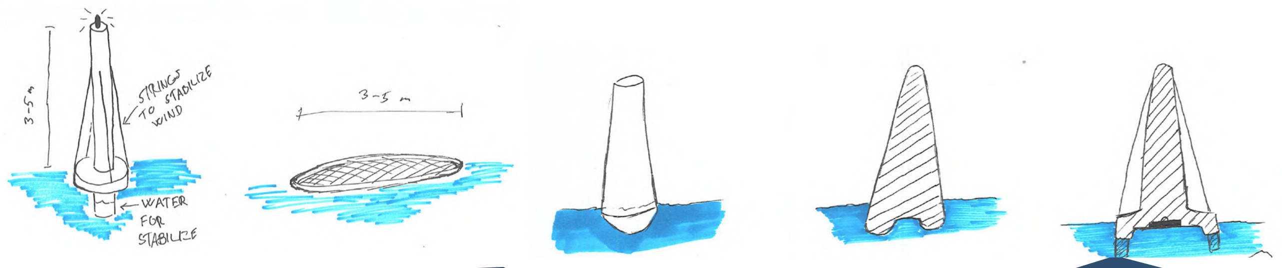
Additional tests with helium was conducted supported with calculations to specify lift and weight (W.033). The team realised, that the helium prototype balloon couldn't create enough uplift for the balloon, but only very limited additional weight.

Size and visibility

By calculating the amount of helium needed for balloon to carry any significant weigh, 100 L of helium = 100 g uplift. A balloon prototype in a large size, which was estimated to be large enough to lift itself and the estimated weight of the electronics. By the assumption, that a slender high balloon would be less effected by wind, this would result in a balloon at the height of 3 meters. Hanging it 14 meters above the ground to simulate it airborne was quickly realized unrealistic. This simple test of visibility did not deliver a realistic representation as too many factors; buildings and trees, impacted the test. (W.033)

The uncertainties combined with the low expectations towards a design with enough helium to create lift, eliminated the aerial concept. From this point, the floating beacon was the main focus of the project, as it was seen as a more feasible task.

Floating Beacon

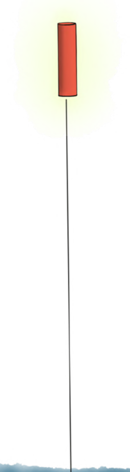


The initial floating beacon was, like the airborne beacon, a high slender shape, that balanced on water and stayed upright using contra weights. The concepts shown above was some of the early ideation on how to achieve the highest height with the lowest consumption of gas - while remaining stable. Sketches, from left to right, included a concept with wires attached to stabilize, a total flat base on the water, that would improve visibility for a helicopter significantly, a conic figure inspired by the 'roly-poly' toy that always stands up right. The last two is section cuts of a slightly more triangular inflatable shape.

Common for all concepts was that they had a wide base and a conic shape which was assumed the most stable shape for a structure in sea. (W.025)

Aerial or floating beacon

From the design sprint, the team became aware of the difficulties in lifting an object. To determine the next move, the team researched the technical properties of what was needed to make the concept fly or not. This was done with weight calculations with an analysis of 'pros' and 'cons' of the two directions (W.033).

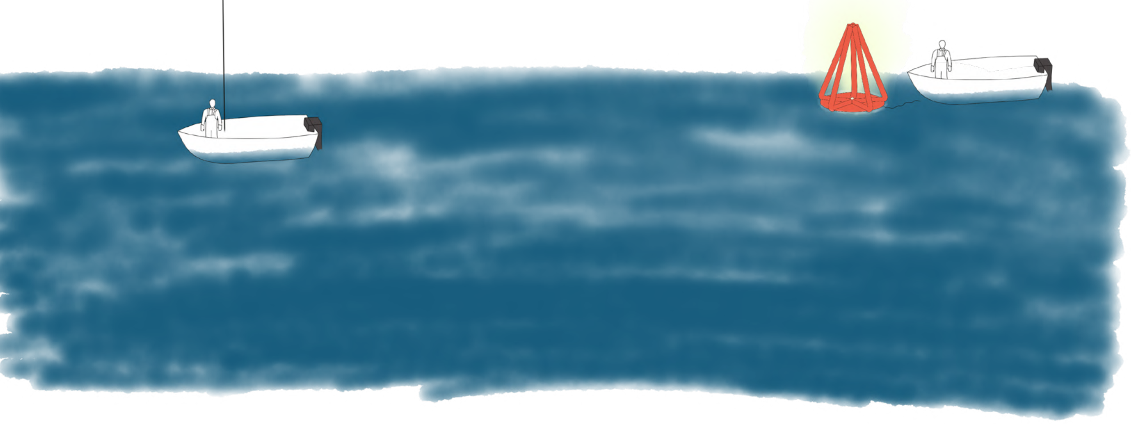


The calculations showed that even a small airborne product quickly ended up weighing a lot therefore require more gas to lift the object. Helium is very expensive because of its limited ability for manufacturing in labs (J, 2017). Hydrogen is cheaper, but requires more safety when handling the gas. A second issue with the two gasses is the problem of diffusion, simply where the gas will escape both the balloon and the canister over time creating an expiration date for the canisters usage (Helmenstine, 2018; OpenStax, 2016).

If the product stays on the surface, it can be filled with compressed air or CO_2. Both gasses are very cheap. They both occurs in nature, and CO_2 can be manufactured very easily. It has a wide range of uses in many industries, which further lowers the price of both the gas and pressurized canisters. CO_2 benefits air because of the safety in transportation and storage, yet has a problem. The fact that CO_2 does not follow the rules of an 'ideal gas', makes it difficult to use in extreme temperatures. (A.08; Dietrich, 2019; Health and Safety Executive, 1998; Linde AG, 2019).

If using dry air, the need for servicing the canister is also very limited, and the user can have the canister installed for up to 10 years before maintenance (Force Technology, 2019).

● *Need for maintenance after 10 years*



CO_2

- \+ *Very cheap*
- \+ *Not critical cargo*
- \+ *Very accessible*
- \+ *No gas diffusion*
- ÷ *Temperature limitation*

Dry air

- \+ *Very cheap*
- ÷ *Critical cargo*
- \+ *Very accessible*
- \+ *Limited gas diffusion*
- \+ *No temperature limitation*

He

- \+ *Create lift*
- ÷ *Expensive*
- ÷ *Flammable*
- ÷ *Gas diffusion*
- ÷ *Critical cargo*
- ÷ *Hard to produce*

H

- \+ *Create lift*
- \+ *Less expensive*
- ÷ *Flammable*
- ÷ *Gas diffusion*
- ÷ *Critical cargo*
- \+ *Easy to produce*

Conclusion

From the current observations, knowledge and testing, the team concluded that having an object in the air is not a feasible solution. The main reasons are the sheer weight of the concept that would make it impossible for a wearable device. Second the gasses only provide technical issues with the diffusion as the main concern.

Placing the product on the surface with dry air, is a much more feasible design task. An option for pure nitrogen was also discussed but provided little beneficial effect at a higher cost.

More information see worksheet 034.

● *Indication of using dry air for inflation*

Sources: (Alibaba, 2019; Health and Safety Executive, 1998; Helmenstine, 2018; J, 2017; JJ, 2015; OpenStax, 2016; PennState, 2019; The Engineering ToolBox, 2003c, 2003b, 2003a; The Naked Scientists, 2007)

Evolving Concept

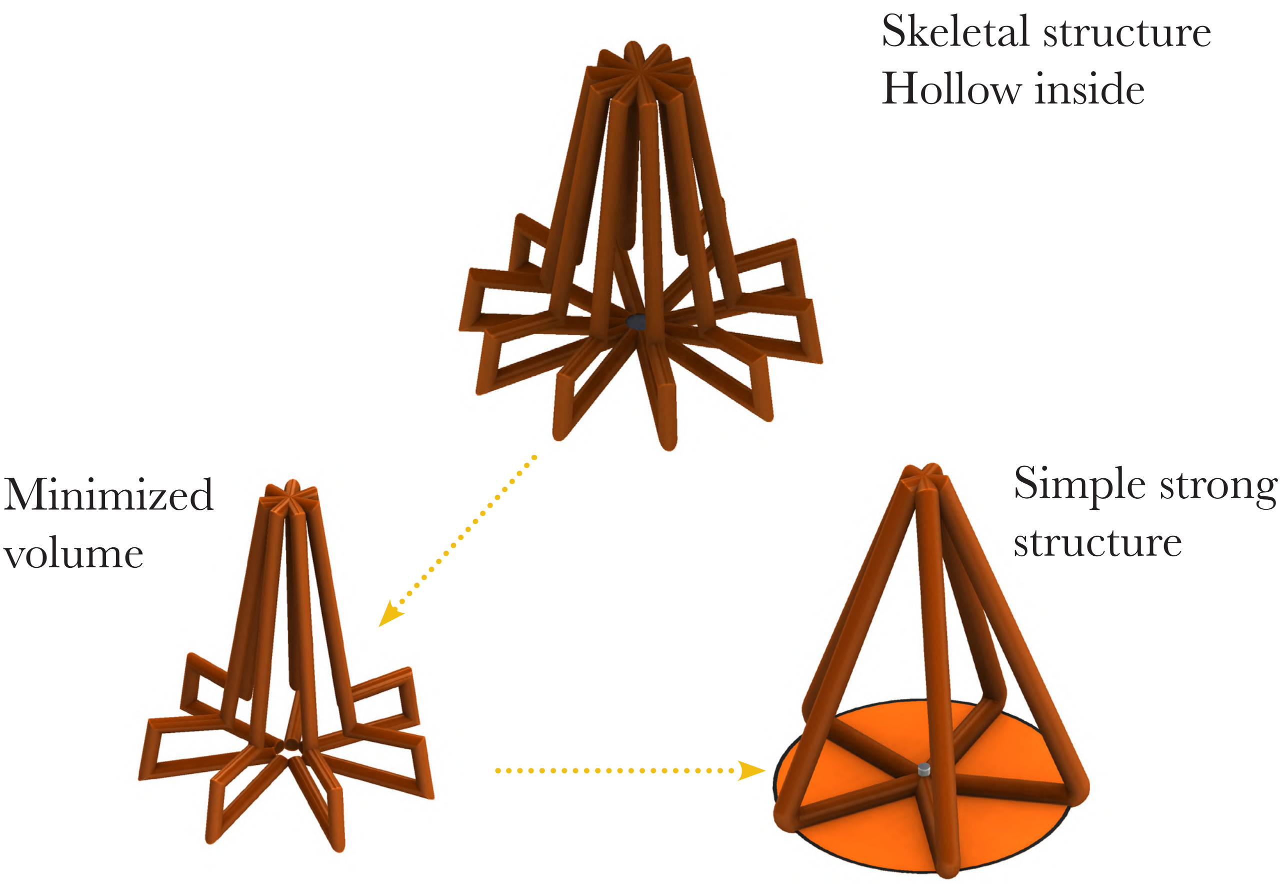
Rethinking the product

As it became clear that it might be unrealistic to store large amounts of gas to fill the balloon structure the team chose to pursue the floating concept. Here the most interesting solution was using compressed dry air or CO_2 for inflation. This solution would still contain the wanted features, from the airborne location balloon concept. The downside of not being airborne would be a lowered visibility and potentially lower signal strength.

The shape of the floating beacon was through ideation morphed into a skeletal structure, that visually seemed like a large object, that could be seen from far away, but used minimal amount of gas compared to the earlier 'solid' shapes.

For more information see worksheet 025 and 028.

Biggest size with lowest volume



Conclusion
The pursue of the final shape lead to a design challenge that focused on minimizing gas consumption while sustaining large surface area for visibility. One of the most obvious pitfalls in the designs presented was stability, which had to be tested.

User interaction in the water

After deciding that the concept needs to be on water, a full-size mock-up model was created. For testing it was brought to the ocean to conduct an immersion test and to evaluate size and visibility. The test showed that the wind affected and deformed the construction. Therefore, defining a new potential problem.
Users who have fallen into the water might very well try to hold onto the object or even crawl onto it if they are not able to get back into the boat. With the simple mock-up, this wasn't possible and the model simply didn't have enough buoyancy to support the weight of the user resulting in the collapsing (W.032). The test therefore proved new needs:

- *Must support the weight of a user without collapsing.*
- *Must be possible for user to fully or partially crawl unto.*
- *Must have a safety line between user and product.*

Buoyancy

To accommodate these new needs the team calculated the necessary buoyancy needed to hold the weight of a grown man in wet clothing (for full calculation see W.048).

Buoyancy to support a grown man:
1471 N

With large safety factor:
2943 N

This calculation doesn't consider the weight of the product itself. The team also don't want the total product to be submerged by the weight of the product. The bottom part of the beacon should therefore have at least this amount of buoyancy. The large safety factor of 2, is to accommodate several unknown factors in this calculation such as weight of the product and the actual weight of wet clothe etc.

Size and gas use

The buoyancy calculation was used to calculate the amount of compressed air needed to create the necessary uplift.

Amount of gas needed to create 2943 N buoyancy
Approx. 0,3 m³ or 300 litres

A range of different canisters could supply this. It became clear that the size of a single or a bundle of canisters to supply this amount of gas was physically larger than expected (W.033). The team began to question the idea of having the product as a wearable device, simply because of the demand for compressed air and the size of a canister (W.037).

Scenario

Through further interviews with members of the Joint Arctic Command the team was reminded that by far most incidents at sea ends with the distressed stranded in the boat. Rarely the distressed ends in the water (A.12). Therefore, it's important for the concept to be focussing on the main objectives, 'calling for help' and 'being spotted' leaving the function of keeping the distressed out of the water to a secondary function. To fully understand the two different scenarios, the team created a 'before an accident' and an 'after an accident' scenario to see the difference and present the ideas to the local sailors.

Before an accident

User walks to the boat.

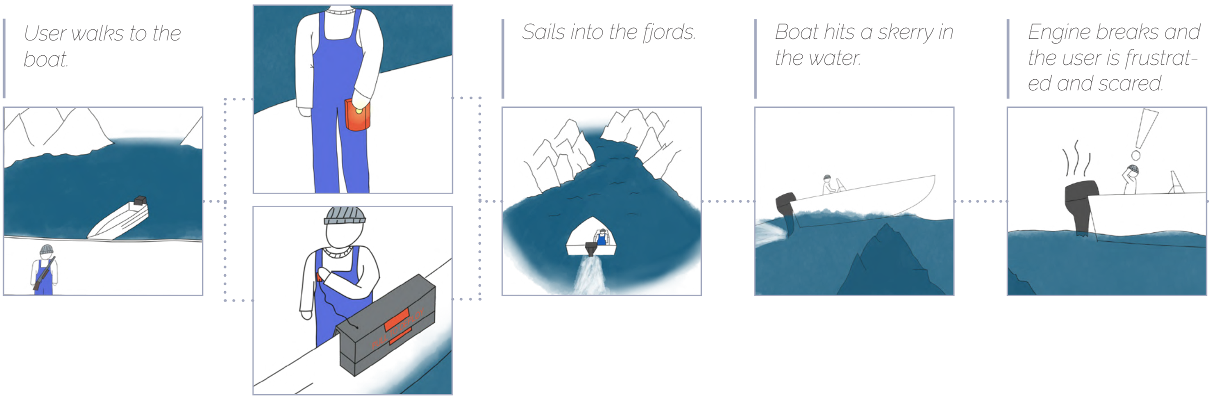
Activates the product.

Activates the product and mounts cable release.

Sails into the fjords.

Boat hits a skerry in the water.

Engine breaks and the user is frustrated and scared.



After an accident

Pulls release to activate the product.

*Pulls cable release to activate. *If the user falls overboard the cable will activate product.*

Throws it into the water when it starts inflating.

The product is automatically dropped into the water and starts inflating.

Product starts broadcasting emergency signals and lights up.

Help will arrive and be able to spot the user at a large distance.

"Only 1/50 ends in the water"
- Michael Hjort (A.12)

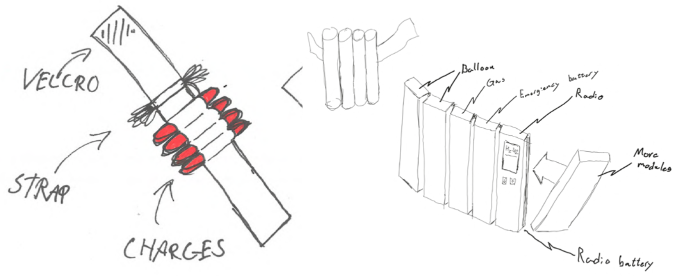
Conclusion

Creating a wearable product creates to high of a risk of user finding it annoying. If this is the case they might not bring the product with them or never buy the product. During the iteration of the storyboard, the team became aware of the many similarities of the two scenarios. The team had to present the two concept ideas to the fellow sailors to get feedback on the size, placement and interaction.

Concept ideation

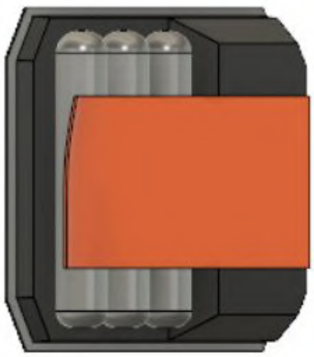
The team knew they had two very different concept directions, for this reason the team split up and in turn worked on both concepts trying to challenge the fidelity and evidently present them both to the sailors for final feedback and concept direction selection.

Wearable

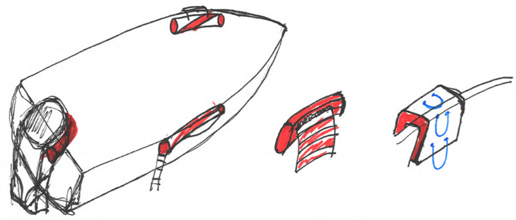


One of the most explored ideas was a belt with compartments attached, that was close to the body (W.030).

From the initial ideas, the team became aware of an ever-growing size of the wearable device (W.037). A weight estimation and a mock-up with the weight of 2.5 kg was tested (W.40). From this, it became clear that the wearable lacked feasibility due to the initial size of the deployed beacon. The weight alone was too inconvenient to carry and the unknown size of the folded beacon became a rising fear when iterating on the wearable device. (".040)



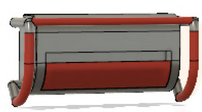
On the boat



Several mock-ups testing concept placement was concluded with the result that a user interview was needed. (W.031; W.035).

Test of ideas for concept activation (W.039). Smart remote technology was also considered but was disqualified due to price and complexity (W.036).

With several iterations on the installed concept, the team became more aware of the benefits of having the concept installed on the boat. The scenario showed that most scenarios, it would simply not make sense to wear the device, compared to it being installed on the boat (W.035).



Feedback from users

The different ideas were presented to the users to get feedback on the ideas regarding product size and placement. The general feedback was that they saw the benefit of having it on the body, but couldn't help noticing the size and weight of the concept and that it might simply be too intrusive, with the conclusion that many sailors might find it annoying (A.03; A.04).

The team agreed on the feedback. For this reason, the team disqualified the wearable device and moved on with the concept installed in the boat (W.43).

- *Product placement on the boat*

Placement of product

To determine the placement of the box the team visited a Danish sailor, Jan Næser. Jan lives a fairly similar lifestyle to the Greenlandic sailors. A strong community base around sailing and providing for the family is in his blood. He was also the first Danish sailor to hear about the project. The boat trip was used to eliminate wonders and to test different ideas (W.054).

Placement considerations

In the interview with Jan he stated that ideally the product would not be placed at the sides of the boat as these are heavily used for pulling in catch. Here lines and nets would risk getting stuck in the product. From the concept presentation to sailors, the same thing was addressed. Also, the sides of the boat were very likely to hit other boats when mooring in the harbour (A.03; A.04).

All interviews concluded that the rear end of the boat as the optimal placement as this location generally gets sprayed with less water and therefore less ice as well as being less in the way. With this information, the team chose to place the product at the rear end of the boat next to the engine.

- *Must withstand water splashes*
- *Need for the product to withstand icy conditions*
- *Product must always within reach*

This position allows for the user to activate the beacon both from inside the boat and from within the water. The rear end allows for mechanical fasting, because of the structure of the boat build to attach features, making it easier to attach a new object to this location (W.054). Measuring several boats helped the team to find the maximum allowable size. (W.43)

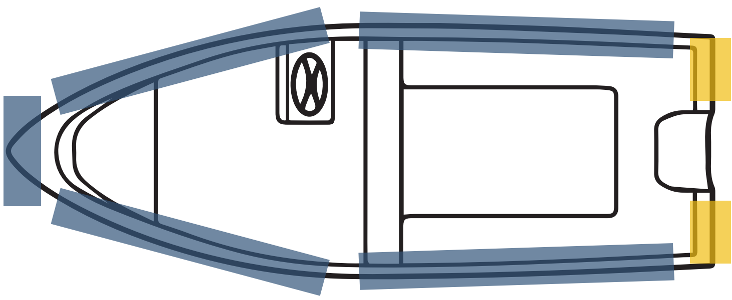
Inside of the boats most of the space is kept for the catch, fishing-lines and nets. If they bring safety equipment it is mostly thrown into a closed compartment in the boat.

How much space can we use?

By measuring the rear end of a range of boats the maximum measurements could be determined to fit a wide arrange of boat sizes:

Height > 400mm
Wight > 600mm

- *Maximum sizes for the box*



Communication Technology

To make sure the concepts' functionalities enables the distressed sailor to get help, the team explored all possible options for calling for help.

Establishing two groups of stakeholders (Joint Arctic Command and Fellow Sailors), created an overview of ways of 'calling for help'.
"Worst case scenario" made the team aware that redundancy is key. If plan A didn't work, then go to plan B and C. From the trip to Greenland, the team became aware of the great value of having a community based rescue possibility (W.16; W.20).

The team also learned that several sailors uses regular phones as the main source of contact - even though the reception signal is very limited in Greenland (W.020; W.027). The sailors expressed the lack of options to help each other, and this was acknowledged by the police (W.017). Research on means of communication and location was initiated, to find good options for the concepts functionalities (W.027; W.036).

The two groups are presented as the fellow sailors and the combination of the Joint Arctic Command and the police.

Utilize the functionalities of GPS location to help SAR personnel.

Means of communication and location

Fellow sailors

*VHF Radio and DSC**

Maritime GPS

Reduced distance to each other

GSM Mobile Phone

Eyes

Binoculars

Joint Arctic Command and Greenland Police

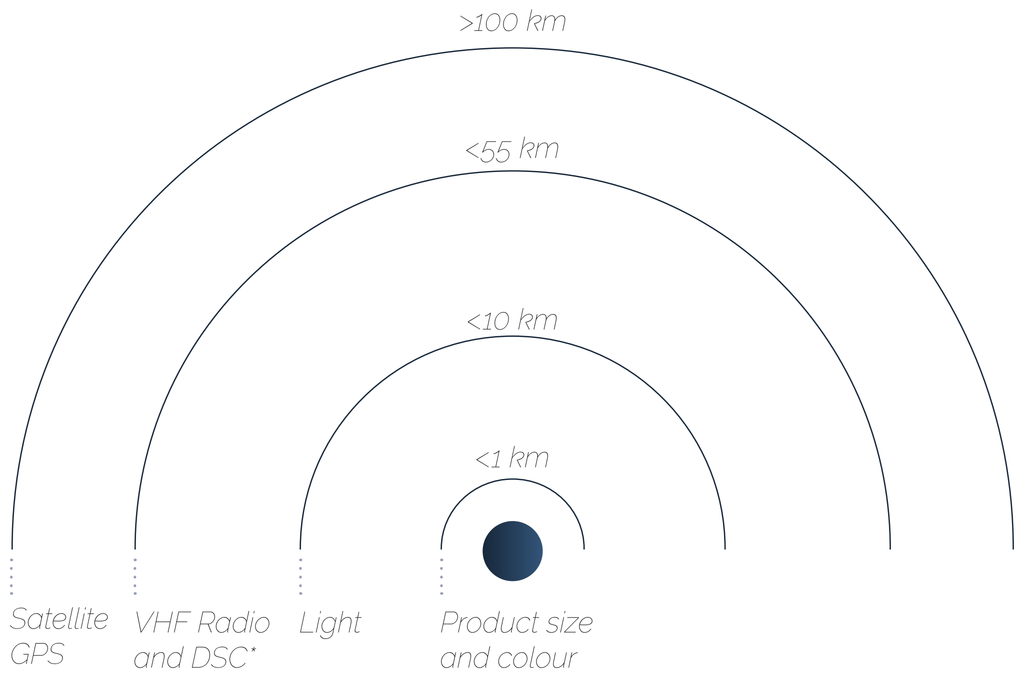
Radar detection

Thermal imagery

Satellite GPS

Eyes

Binoculars

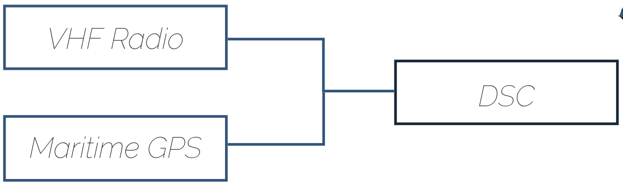


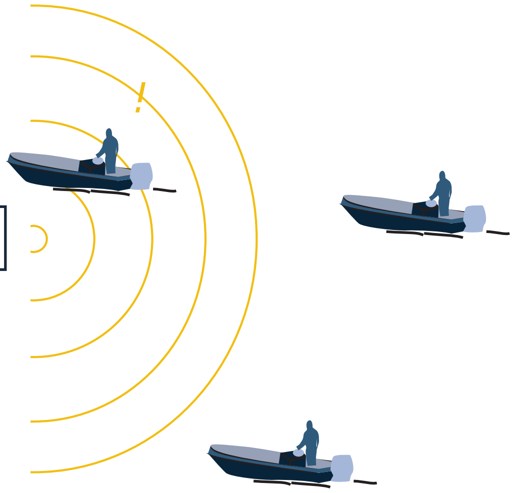
*Digital Selective Call**

Call for help!

The value of having a fellow sailor help another requires that the distressed can call for help. A bright flashing distress light is placed on top of the concept with a visibility of up to 18 km (Weems & Plath, 2019). But size, light, and colour does not solve the problem entirely.

By using the existing VHF radios that the sailors use, the team can utilize the emergency 'Digital Selective Calling' (DSC) (W.017; W.020). The system is well known in the maritime field, and requires a simple modern VHF radio to function. The system takes advantage of the units GPS location and broadcasts it to any nearby vessel that are within range of the unit. Because it's digital it enables the distressed to get feedback that someone has heard and acted upon the distress signal. This provides great value for the distressed in the stressful situation (Søsportens Sikkerhedsråd, 2014).



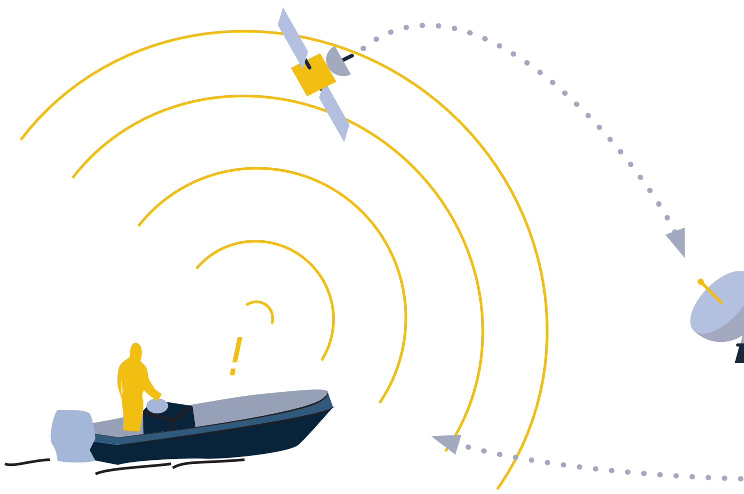


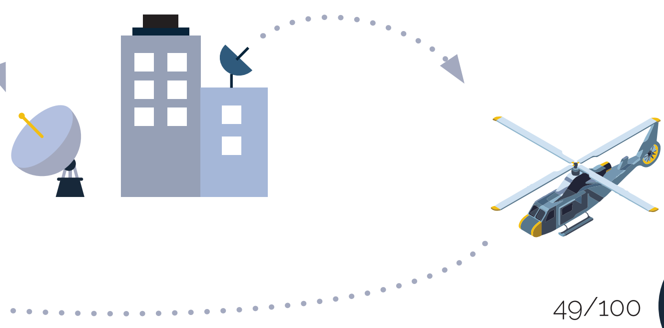
DSC system broadcasts the concepts GPS position, personal ID (name, age etc.) up to 55 km away from its location.

Satellite based communication

DSC is problematic if you are alone, with no fellow sailor anywhere near, the limitations becomes clear. A VHF radio can only broadcast up to 55 km (Søsportens Sikkerhedsråd, 2014), through the interviews it was discovered, that the geography can disrupt the signal of land based communication technologies (A.10; W.017). For this reason and to further include the Joint Arctic Command, implementing satellite communication ensures full functionality of the concept.

Cospas-Sarsat is the largest collaboration of satellite systems that work together to cover the whole world. The system uses the technology of PLB's (Personal Locater Beacon). It's free of charge to be used anywhere in the Danish kingdom. Cospas-Sarsat's call-centres picks up a distress signal from a PLB and relay the distress call to the nearest SAR station (Cospas-Sarsat, 2019). The accuracy of satellite based GPS is always hard to specify, but Galileo systems estimates an accuracy of 2,5 km in radius. These distances are to be considered the "best possible option", meaning that in reality clouds, rain and mountains can disrupt the signal and by that decrease the accuracy of the position (Galileo, 2019). Galileo also presents a unique feature, like the DSC, to get feedback of acquired signal for SAR units. (W.046)





Improvement of Visibility
For the Search Units

From the research of the first prototype the team learned that the product size was something to be considered. When approaching the Joint Arctic Command with questions of size, the answer was simple. The bigger the better (A.12).

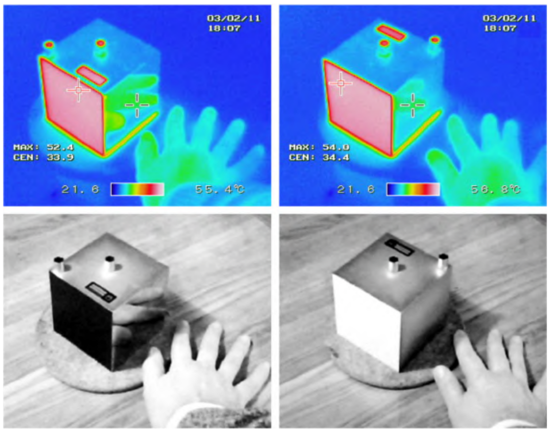
From this the team began digging into how get a clearer answer from the experts. The team wanted to have the concept take advantage of both thermal imagery and radar detection, and started researching on how to accomplish this in theory.

Thermal Imagery

Initially it was thought that it would require heat to be detected on a thermal camera, until the topic of 'emissivity' was discovered. Every material surface emits thermal energy differently, and the efficiency in how the surface does this is measured as its emissivity (ThermoWorks, 2019; Young, 1992).

What this means is that a polished metal surface, will be highly visible on a thermal camera even though it's the same temperature as its surroundings (W.036).

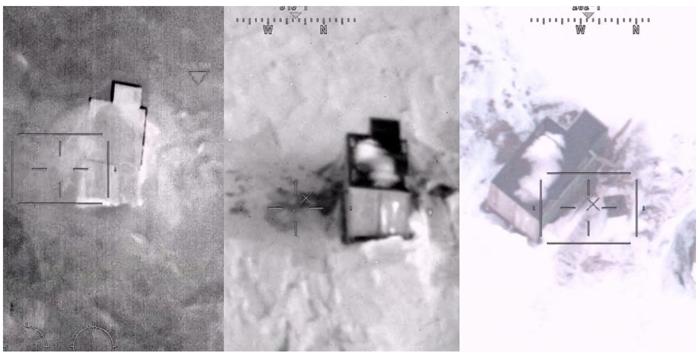
- *Utilize the features of thermal imagery into the concept*



Ill. 12. The surface becomes totally black on the polished surface, and stands out quite drastically.

The Rabbit Hole

The thermal camera gives the SAR personnel great options for searching, but it has its limitations addressed by the rescuer FIR: "It's very difficult to use the thermal camera. We use it a lot but you can compare it with searching for someone and looking through a straw" - FIR (Lyngse, 2019).

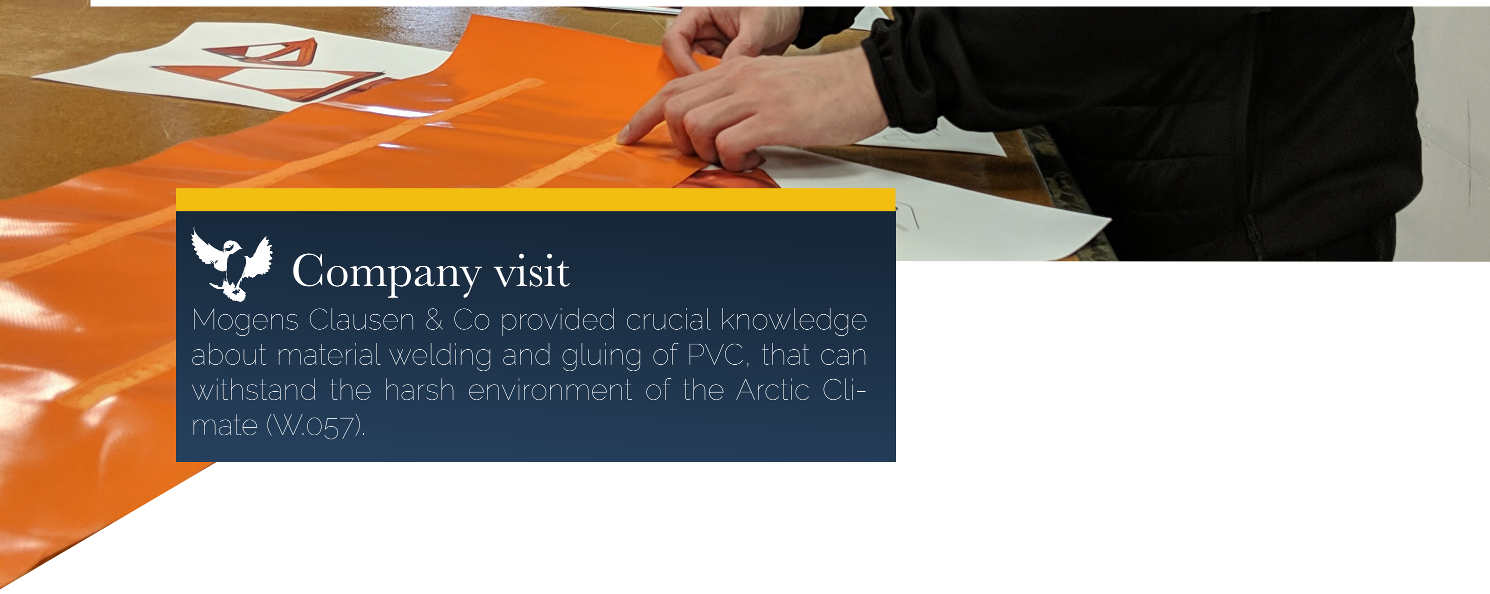


Ill. 13

Colour and Size

The product would need to have a size and colour that is visible from a distance. A visibility test concluded that in foggy weather a road worker is clearly visible up to 450 meters, and in clear weather the working prototype was visible at the same distance (W.029; W.032). For the construction, the concept needs to be constructed in a foldable, durable and airtight material. The Arctic climate possess a number of challenges for the concept. Extreme low temperature down to -51°C added with icy salty seawater.

The team visited the company "Mogens Clausen & Co" that specialises in building and repairing life rafts and inflatable boats. It was quickly realised that the concept should be made of either welded or glued pieces of rubberised canvas of PVC (W.044; W.057). Orange rubberised canvas was considered ideal for the construction of the concept. It's durable, airtight and reasonable in prince for production (Seattle Fabrics Inc., 2019; Viking Life-Saving Equipment, 2017).



Company visit

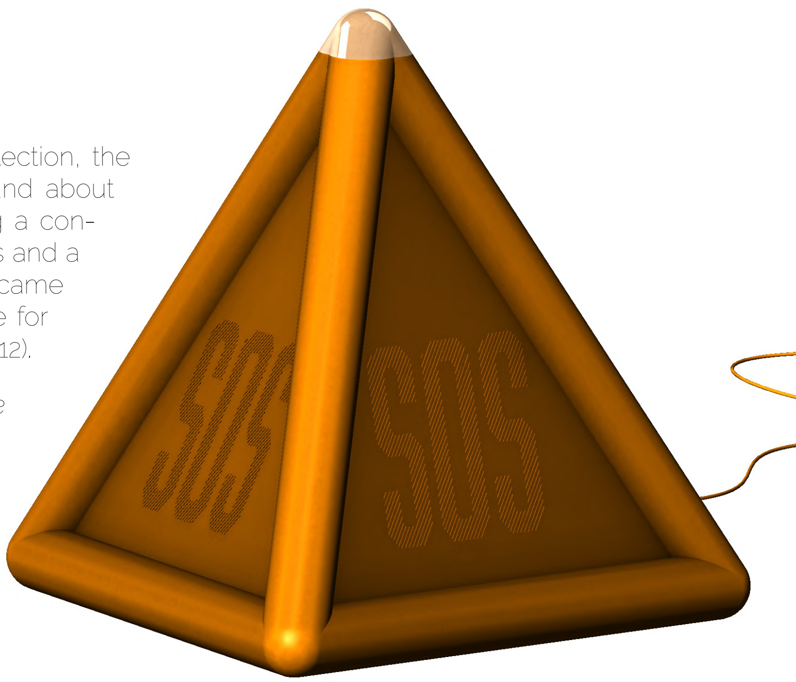
Mogens Clausen & Co provided crucial knowledge about material welding and gluing of PVC, that can withstand the harsh environment of the Arctic Climate (W.057).

Additional Visibility

Radar Signature

Finally, to take advantage of the radar detection, the team kept asking the Joint Arctic Command about the necessary height, and after presenting a concept idea that had a height of 1.5 - 2 meters and a footprint of 1.5 x 1.5 meters, the response became much more clear. The size was reasonable for the SAR personnel as a starting point (A.11; A.12).

- *Indication of the minimal size need for the concept*



Size and Radar

The radar signature is calculated of the size of the product, its shape and the material properties that the object is made of. For the concept, it's ideal to utilize the same hard metal that is used for the thermal imagery (Diaz, 2019; Janjua & Kayani, 2003; W.036).

- *Utilize the features of radar reflection into the concept*

Visual Reconstruction of Scenario

You have most likely already spotted the buoy in the water on page 53 but did you notice the distressed person on this page?

"Background, movement, illumination and vegetation. The four B's are the most important factors to consider no matter if you want to be spotted or stay hidden"
- Joint Arctic Command

Visibility Test

W.029 was a test of how visible different colours was on a very foggy day in Aalborg. The test showed that orange and bright yellow is by far the most visible colours.

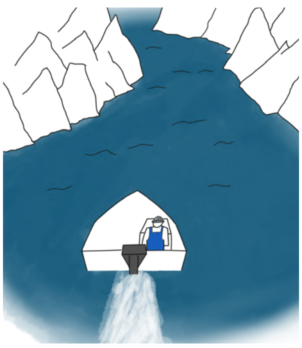
Product Evaluation

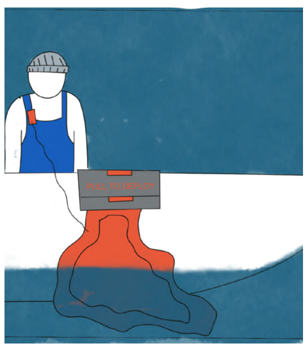
General Product Scenario

1. The sailor have mounted the safety device securely on the back of his boat before leaving port. This is only done once, as the product is permanently installed on the boat. He straps in his safety wire and is ready to sail out.

2. The sailor sails out to hunt, fish or transport. While doing so or engaging in other activities, the product is practically invisible for the user as it is inactive until the accident occurs.

3. If the sailor is in an accident, he can pull the wire that activates the product. When the wire is pulled, inflation begins and the broadcasting of signals starts.

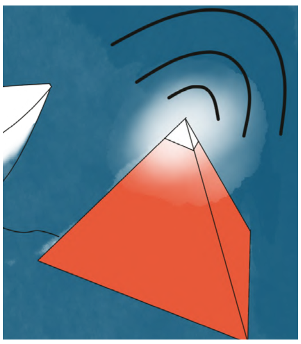


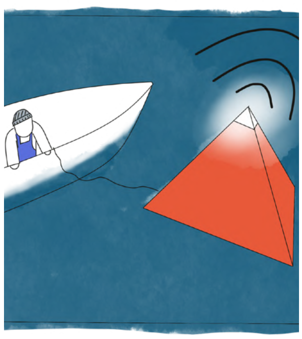


4. The emergency broadcast module broadcasts a DSC signal for other sailors to notify the location of the distressed. It also sends out a PLB signal to alarm the official SAR, that most likely have a longer response time.

5. When the signal is received by another sailor, he knows that a fellow sailor is in distress and the approximate location of himself.

6. With the device inflated, the sailor is much more visible with both bright colours and flashing lights. If the SAR unit is searching, the beacon is also radar and thermal reflective.





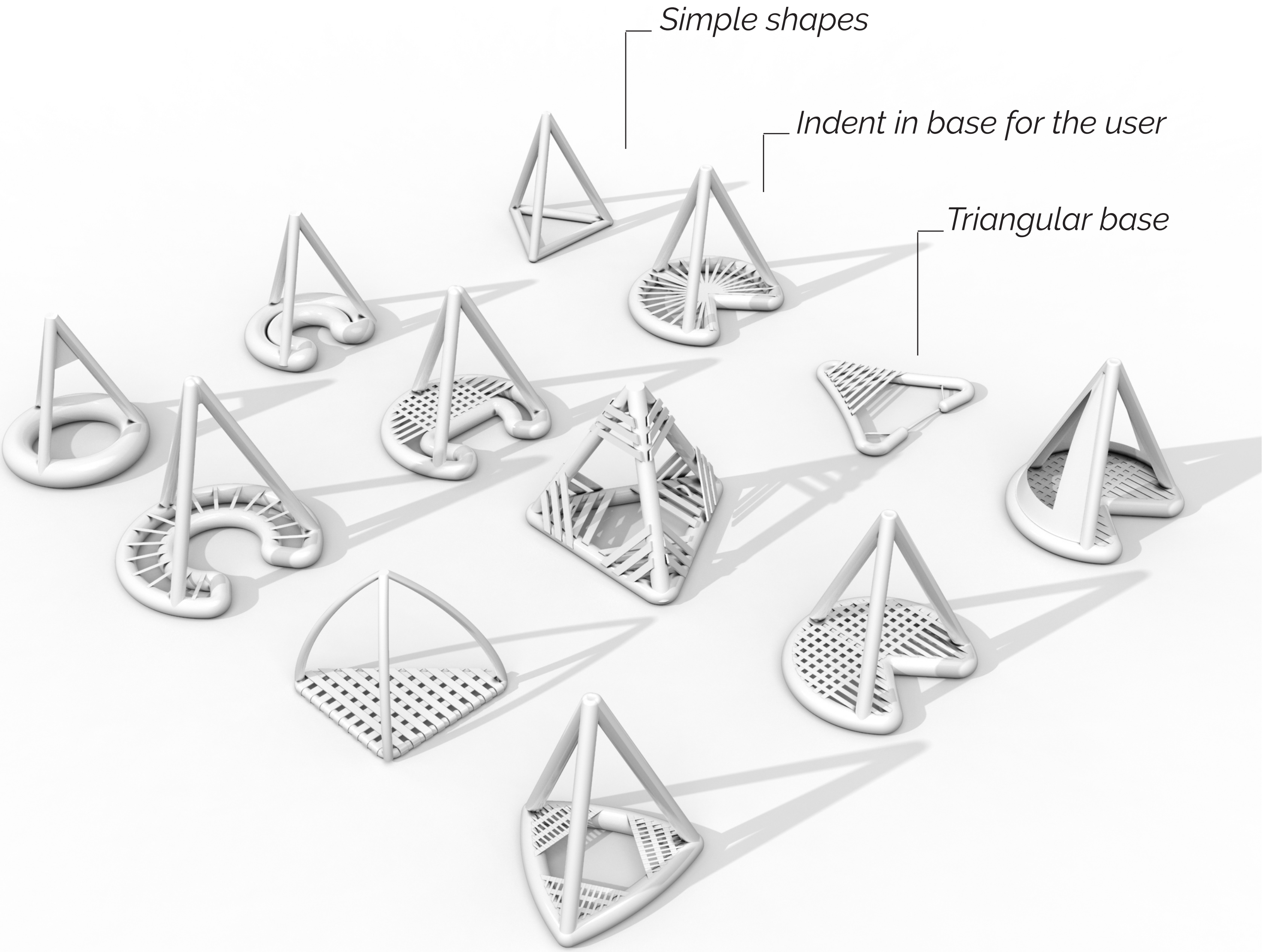
ARC Rescue Beacon

Concept detailing

In this chapter, the progression of the concept detailing is presented. The collected data from ideation sessions, mock-up testing and feedback from local sailors presented an opportunity to move into the detailing phase of the working concept. The 'user needs' were discussed and integrated into the concept with the wish of creating meaningful lifesaving equipment. The process of 'detailing' centred around the need to determine the necessary measurements and making critical decisions, to find the final design considerations. User tests and mock-up testing also contributed to create structural design decisions.

Chapter Introduction

This chapter is divided into four sections splitting the beacon into *top*, *pillars*, *base* and including the specifications on the *box container* that stores the beacon. The paragraph about the top include a specification of the technology as well as radar/thermal reflective surfaces and light emission. The pillars paragraph specifies the stability test of the construction, shelter for the user and production methods.
The first paragraph; the base, introduces the decision process behind the shaping of the product as well as tests, specifications of features and materials.
Last, the specifications of the product container are detailed in regard to interaction, aesthetics and materials.

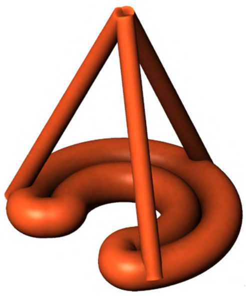


Base

In the process of developing the right shape for the beacon, considerations went into three major factors; stability, usability (ability to get aboard if in water) and aesthetics (subjective opinion). These three factors were evaluated for each concept against each other to determine the best concept choice. The factors had the following priority:

To test out the concept, quick mock up models where created in a 1:1 scale and brought to the local outdoor swimming pool. Fully clothed, windy and with water-temperatures around 5 degrees, the team tested each concept for usability and stability. (W.032; W.049; W.055)

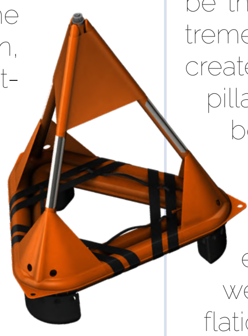
The test showed, that especially concepts with a solid button catches wind and tipped over as well as the general need of drift anchors. The test also proved, that the concepts with a tall base where extremely difficult to climb onto, while models with a flatter base structure where easier.



Early ideation of the concept included this rounded two-layered construction. It was the first model to introduce an entry into the middle section, where the user would be sealed from wind, even if in contact with water. Later improvements, that included separating the two champers completely gave the concept a chance for later ideation (W.047). The open shape in this concept proved to be unstable as the air inside the construction pushed the opening of the product apart, weakening the entire structure.

Later ideation of the concept included this concept with straps stabilizing the construction functioning as handles or maybe even isolate the user from the water. Here again, the construction proved to be too unstable due to the cut-in in the circle structure.

The last concept before deciding a direction to peruse was a tetrahedral shape: the three-sided pyramid. This concept proved very stable, while creating a large shape, compared to the consumption of air inflated. This became the shape, ideations were based on, combined with the two compartment tubes from concept 1.



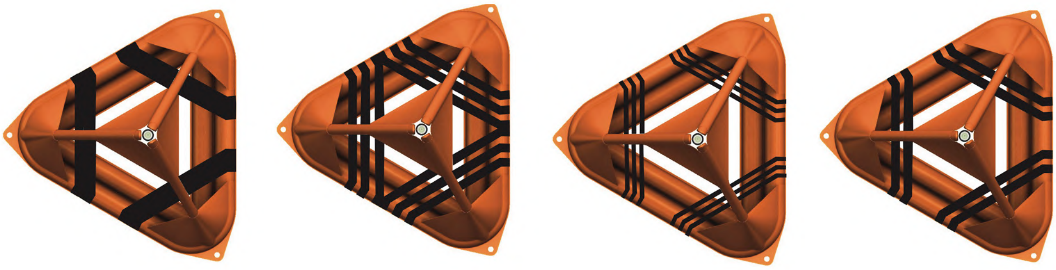
Conclusion

The final design fell on the structural tetrahedron shape with the argumentation, that the stability in the triangular shape would be the most reliable in the extreme weather conditions and create the best support for the pillars. The base should also be divided into two separate compartments connected through a check valve. This improves the ease of getting aboard as well as lower chance of deflation.

Straps and handles

The straps were a way of creating affordance for the users, creating an intuitive way of holding onto the beacon if in the water. Guiding the user towards the best places to hold onto the product and keeping them from pulling the pillars or the side coves. Different iterations of the strap-handles were created with inspiration from earlier mesh- and strap-designs as seen on the previous pages.

Two large nylon straps around each corner



The final strap design was a simplified version of this with strung straps allowing the user to hold on to the product multiple places.

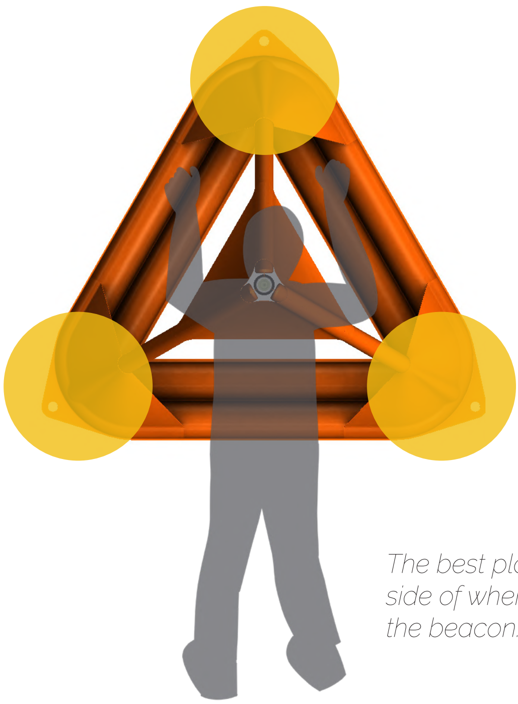
Between each large strap a thinner nylon handle is place

Anchor

A 1:1 scale test (W.049) made it clear that strong waves, wind or user pulling on the product could possibly result in the product to flip over. To combat this risk the team looked at existing emergency rafts on the market. Many of these use drift anchors under the raft preventing it from drifting away or lifting (Viking Life-Saving Equipment, 2019). Essentially, they are bags filling up with water and functioning as a parachute in the water. This same design was added to the beacon design.

Ill. 14

Drift anchors

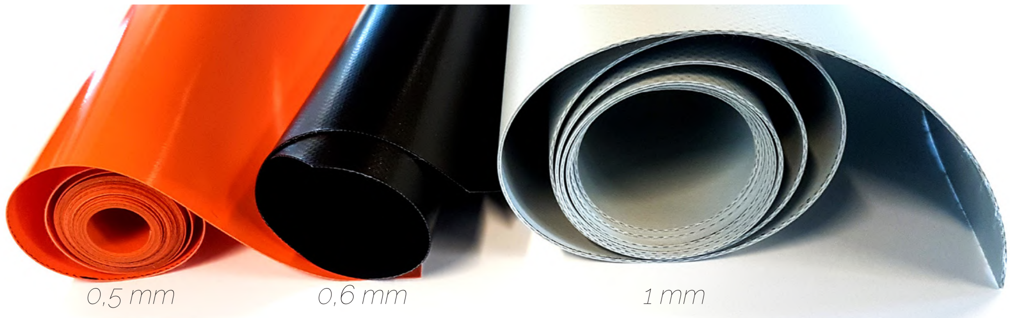


The best placement was the opposite side of where the user would crawl on to the beacon.

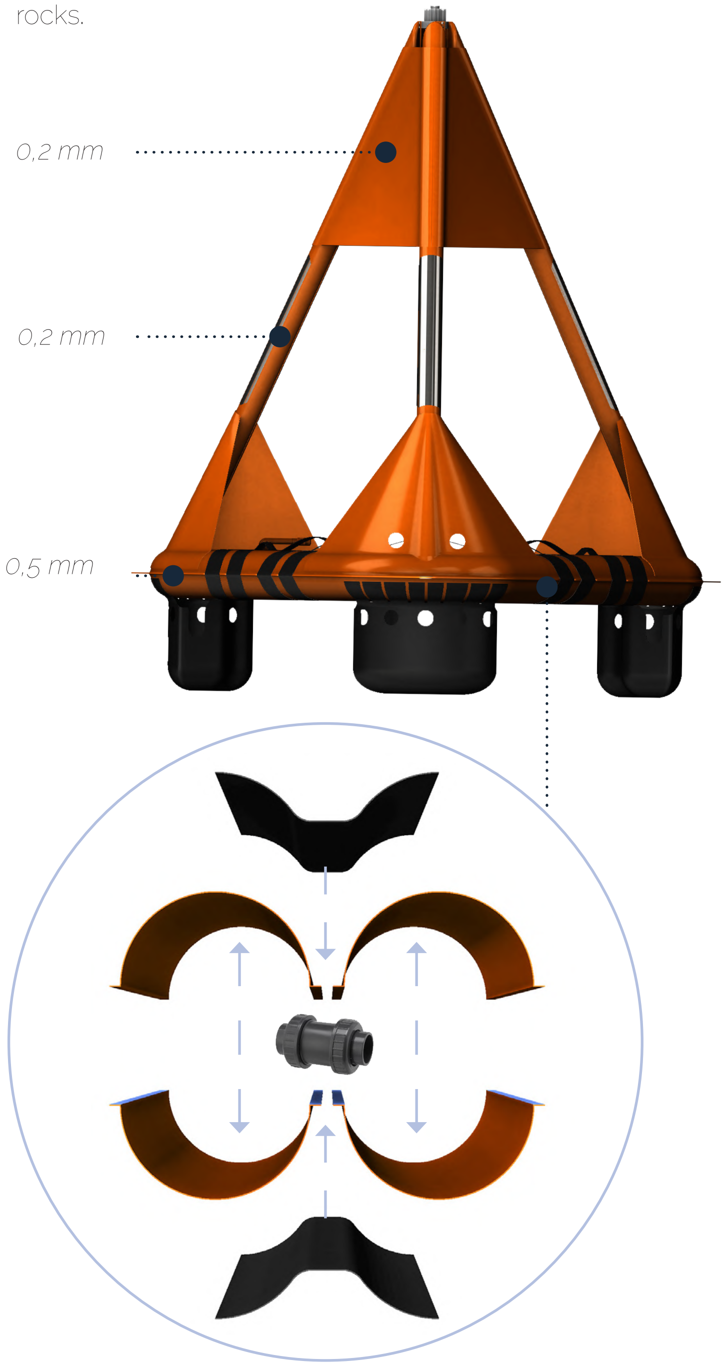
Materials

Throughout the process, the materials were constantly revisited. At this point the team started considering which specific material would be best suited. In the beginning, rubber materials were the most attractive as these were often found in the construction of both life-rafts and even cheap inflatable pool toys for children. It was found that most life-rafts tend to use a fibre reinforced rubber material as this makes it less prone to ripping or puncturing (Seattle Fabrics Inc., 2019). Mogens Clausen & Co confirmed this in interviews (W.057) but that a simple PVC infused fabric (tarpaulin) would be an effective and fairly inexpensive material to use.

Different material thicknesses were tested to find the most fitting yet flexible one.



The most effective choice landed on using two different thickness for the product.0,5 mm for the base and 0,2 mm for the pillars and side covers as these are less exposed to sharp objects such as ice and rocks.



Manufacturing

When manufacturing the base in PVC material the base should most effectively be cut out in two layers. The layers should be plastic welded together along the edges (W.060).

To evaluate that this approach was realistic simple drawings were brought to the production company Mogens Clausen & Co. Here they verified that it could easily be produced and helped optimize the drawings to fit realism. But they recommended building the base as two separate tubes that should be glued together afterwards. This would allow the two to be separated for safety as well as implementing a check valve to separate the champers. This would allow for a more reliable construction in the event of deflation of the outer chamber, as the product would still stay afloat even if the outer chamber is punctured.

Pillars

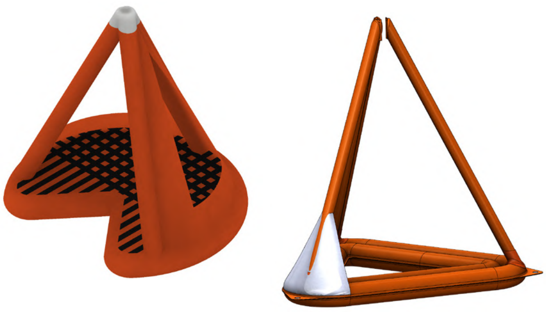
A core part of the pillars ability to raise the product, from the ground (W.031). The geometric shape came from the idea of a simple triangle skeleton structure, with low mass to reduce the risk of tipping over as well as the best stability. By using this simple shape, it would be easier to fold, cheaper to manufacture, require less storage space and reduce the volume to inflate the structure (W.033). During the development, several wind tests were executed, to determine the necessary size of the tubes to withstand strong winds. To create a mechanical meaningful transition between the base and the pillars with evaluation on both the wind test and the necessary volume to be filled with air, a diameter of 80 mm was chosen (W.056). Lastly, an elaborate exploration of manufacturing processes needed for the beacon was uncovered in collaboration with external partners to optimize the inflatable beacon.

Side covers

In the 1:1 mock-up test the team had learned that the wind had large effect on the speed the body cools down.

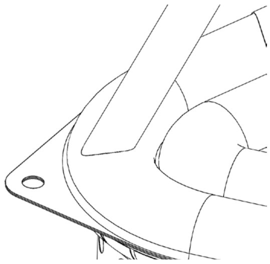
The team also knew that the downside of a skeletal structure is a lowered visibility as visible surfaces are smaller.
These two aspects were worked into the product by creating side covers. The covers were made large enough to create a level of wind protection while not becoming too much of a sail or obstructing the user from crawling onto the beacon.

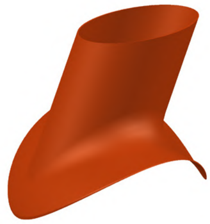
The final side covers were designed so be glued on the beacon which gave the added benefit of extra rigidity in the structure.



Manufacturing

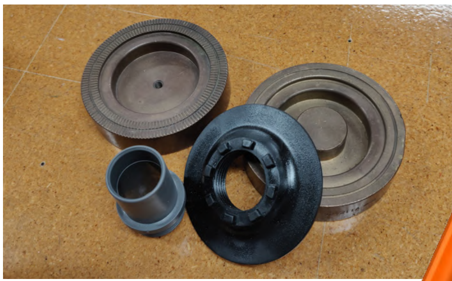
Became aware of a technical issue with the manufacturing of the pillars from the visit at Mogens Clausen meant optimizing the design. An older iteration had a special 'transition-piece' between the base and the pillars that required a substantial technique to create - shown below.



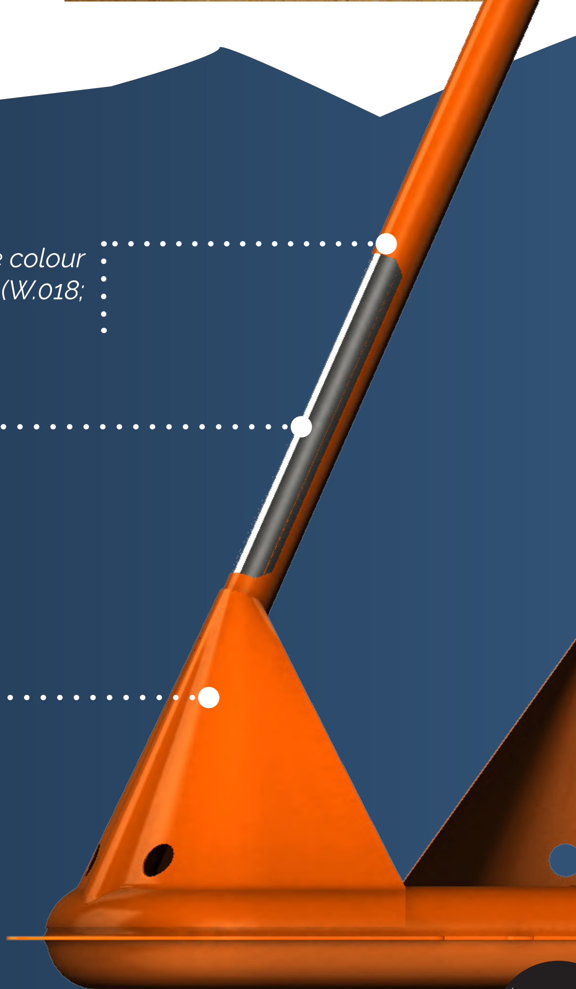


The first intended production method was a blow moulded piece, that is welded onto the base. Then a pillar is inserted and welded creating the transition between the base and the pillars. Through the interview, the idea was discussed and evaluated that it was too complicated and other solutions was better suited (W.057).

The correct method of combining the two elements was the use of flanges. Flanges are plastic fittings that allows for numerous options for mounting and combining air compartments together. They are welded into the main body, using the same production method to produce the base and pillars. The fittings have either threaded or snapping features to attach the two objects together. The flanges themselves are very commonly used as a standard unit, lowering the price of the individual units (W.060).



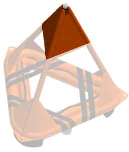
Construction elements



Pillars gives the product a height of 1750mm. The bright orange colour makes the product more visible, and helps locating the beacon (W.018; A.09; A.11; A.12).

The SoLaS reflective tape is attached to the pillars facing out to act as light reflectors so that even at night it's visibility for several hundred meters (W.060; SoLaS Tapes, 2019). This also accommodate the SoLaS regulation for SAR equipment (SoLaS, 1996).

With a height of 520 mm and width of 600 mm the desired shelter allows for cover from cold winds. The construction also contributes to a more stiff and stable construction (W.058).

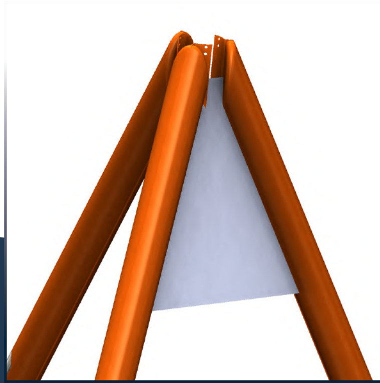


Top

This section is dedicated to the detailing of the top part of the beacon. The top consists of the top cover(s) and the electrical components.
The electronic components were detailed regarding system and power consumption to ensure, that the product was able to run until the help arrived.

Top Covers

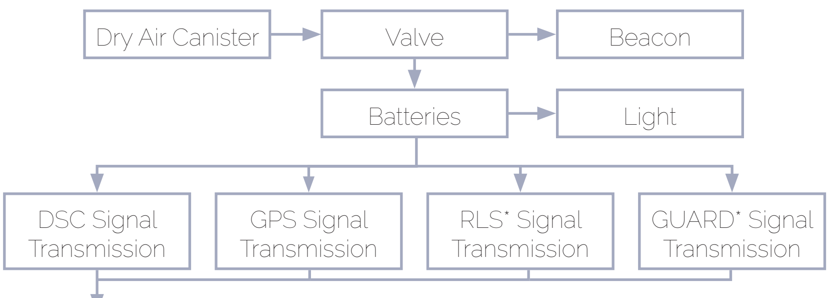
Like the side covers the top covers creates a larger visible surface. An effort was put into making these function as the main radar reflective surface. Several designs were 3D sketched. The objective was to find the perfect spot between size and limited wind affect.



Several ideas were iterated on, regarding positioning and fastening of the top covers. It was desired to have the cover wrapped around the three pillars to support the construction and to use adhesive for bonding the elements together (W.058). The team was aware of the limited options for testing the scenario with the design of the top covers without the real model (scale, material and production). This was something that would require a lot of resources and time to conduct through experimentation.

Beacon System

The team had researched all the necessary technologies that make the concept function as intended (W.027; W.036). To strengthen the feasibility of the functionalities, two outside experts were consulted, Jes Lundberg, electrical engineer at Asetek, Aalborg and Henning Christensen, electrical engineer at LiftUp, Støvring, to better understand what was required of the system. The team presented the idea and through elaboration, a system-tree was established creating an overview of functions to determine the needed electrical parts (W.060; Tjalve, 1989).



RLS: Galileo Return Link Service (P.047)
GUARD: The aviation distress call (W.036)

With the initial system-tree, it was a better understanding of needed components was acquired, and begin structuring the PCB layout. The team pursued a minimal form factor, trying to reduce the size of the PCB in the end. Four types of signal had to be transmitted and two had to be received.

Components

To determine the initial components, Jes Lundberg guided the team to understand what was possible and what was required of both the user and the PCB. The team wanted to have the electrical activation of the system by a simple pressure valve. It would detect the pressure from the activated air canister after pulling the split, and then activate the whole electrical system (W.060; A.23).

DSC transponder	GPS transmitter	RLS receiver	GUARD transmitter
A PLB-like transmitter that transmits on 406 Mhz (Galileo, 2019)	*Component that both transmits and receives data on 156.525 Mhz (DK Scan, 2019)*	*A radio receiver on 1575.42 Mhz for Return Link Service (P.047) (Maufroid, 2014)*	*Follow Cospas-Sarsat regulation on PLB. A transmitter on 121.5 Mhz for the aircraft emergency channel. (Cospas-Sarsat, 2019)*

Power consumption

From the interviews with the Joint Arctic Command, the awareness of long SAR operations demanded a long battery life. With several cases where operations had durations of up to five days, the demand for battery capacity was critical and high (W.018). Yet another important factor was the temperature in which the beacon could operate.

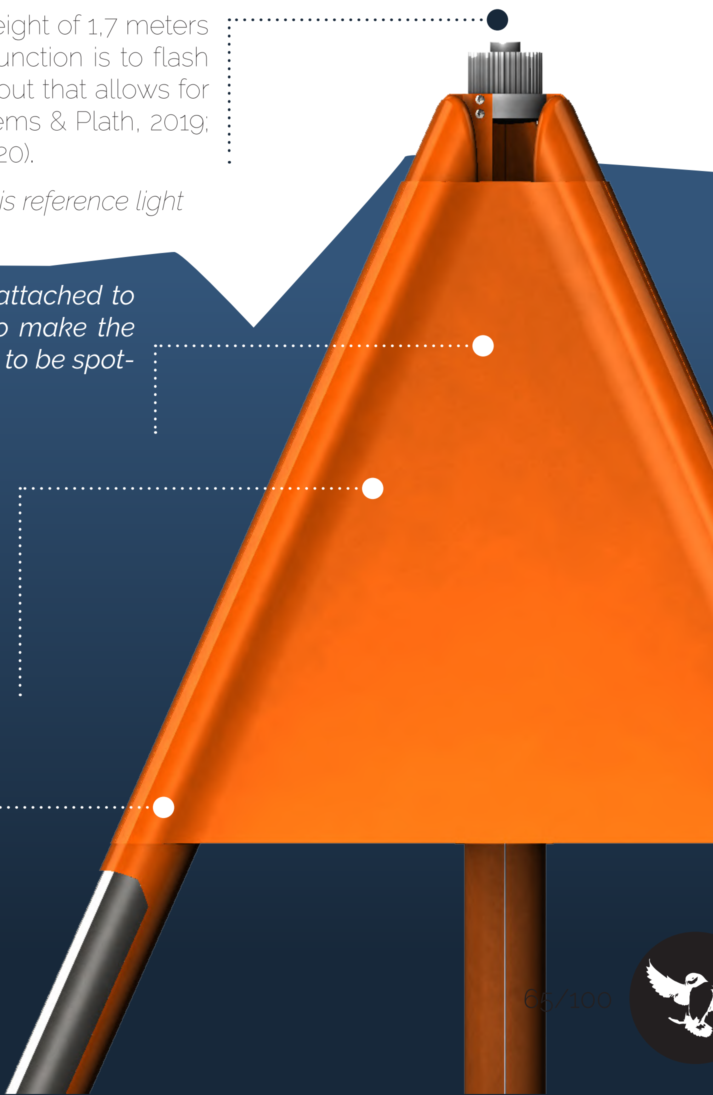
With temperatures of up down -51°C, most "normally accessible batteries" had no luck operating in these extreme environments (A.013; W.007). Through research the best suited battery were Lithium-Sulfur Dioxide (Li-SO_2) batteries and calculated power consumption resulted in the need of four batteries in the cell size "D" (W.060; A.16).

- *Indication of maximum battery life*

Construction elements

The distress light is at the top of the beacon. At a height of 1,7 meters this connects the three pillars. The lights primary function is to flash a bright white strobe every second, with a high output that allows for detection of up to 18 km. (Bhattacharjee, 2019; Weems & Plath, 2019; W.023). Local sailors also highlighted this need (W.020).

- *User need of getting spotted*
- *Implement this reference light*



Right below the light are the top covers. They are attached to the pillars by adhesive. Their primary function is to make the product more visual to increase the products ability to be spotted. (W.007; W.017; W.018; W.044; W.056).

Attached to the Top Covers are sheets of orange covered Mylar foil. This glossy surface both acts as a radar reflector, but also has a distinctive thermal emission, that allows for great visual signature on thermal cameras, to increase the beacons efficiency in being spotted by SAR personnel. (W.036; Janjua & Kayani, 2003; ThermoWorks, 2019; Young, 1992)

At the bottom of the beacon, below the base are the rest of the products technology. It's located in a IP68 rated waterproof box under water. Powering the light a Coax cable is attached to the inside of one of the pillars to the technology box. The cable act both as antenna and power (A.010; W.060).

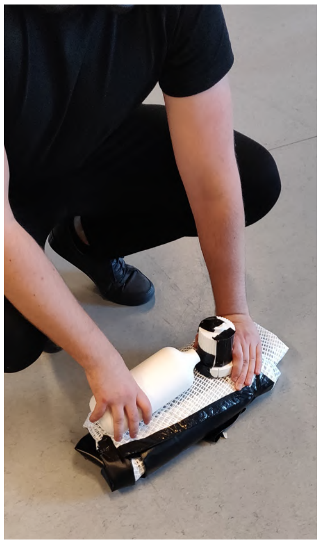
- *Need for a strong antenna*

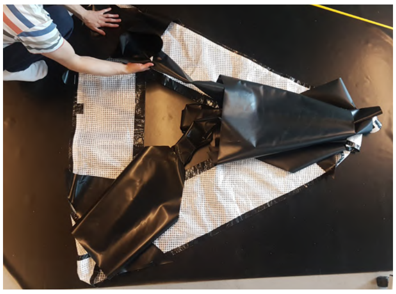
Storage Unit

The detailing of the storage unit was conducted through an analysis of the product structure using quantitative structure and systematic sketching structure by Tjalve (Tjalve, 1989). An epiphany emerged regarding the use of materials, as well as an exclusion of a ladder, that lead to a rethinking of the storage unit in its current stage in this process.
The result became a concept, that in material and aesthetics relates to the beacon. It clearly signals interaction points and is optimized for the production cost.

Size

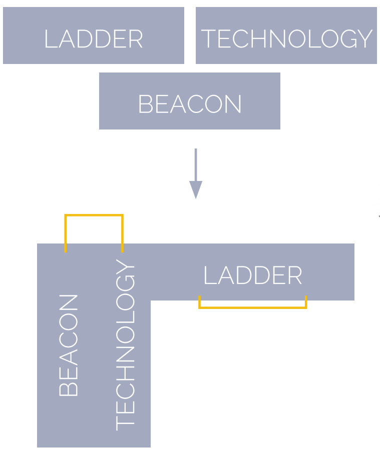
To estimate the size of the beacon when folded, a 1:1 mock-up of the concept was made. Different folding techniques was tested to find a simple and straight forward technique, that allows for the minimal size of the folded product while being easy to inflate.
Finding the minimal size would allow for the best options for fitting on the largest range of boat sizes. With a combination of folding and rolling, it was possible to pack it to the size; 80 x 400 x 200 millimetres.

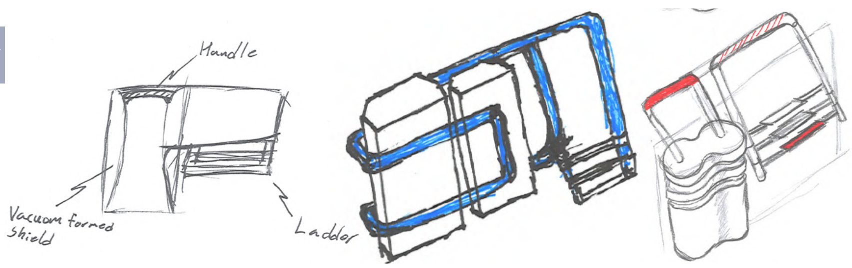




Clarification of functionalities

To fully understand what was needed of the storage box, the team created a product structure to get an overview of all the need functions and what was required of the box. From this, a wonder began on the idea that the concept would include a ladder in conjunction with the box (W.042). Having several steps for activating the product, this meant that an understanding of the interaction points was critical for the design.
The box was a product that the user would interact with in case of an emergency. This meant that the design must be easy to decode in an emergency. A revisit of the analysis of the three main elements (a ladder, the beacon and the box with technology and canister), it was discovered the best arrangement and position of interaction points. This created the arrangement as shown below, concluding in a sketching session to explore design solutions for a complete unit (W.059; W.043).





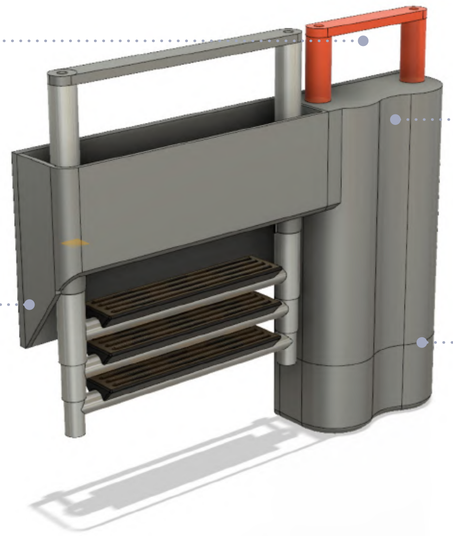
Explored designs

Initial sketches were created with different aesthetically expressions, trying to find an entry for an integrated solution. The team quickly turned to 3D modelling to work on details for the chosen design (W.059).

Concept evaluation

Handle for ejection and activation of the product. When pulled, the project ejects from the boat, inflation of the beacon starts and the emergency signal is being broadcast.

The separate ladder is mounted beside the product. If the person in an emergency falls into the water, the user can get into the boat before hypothermia stages starts and prolong survival time.

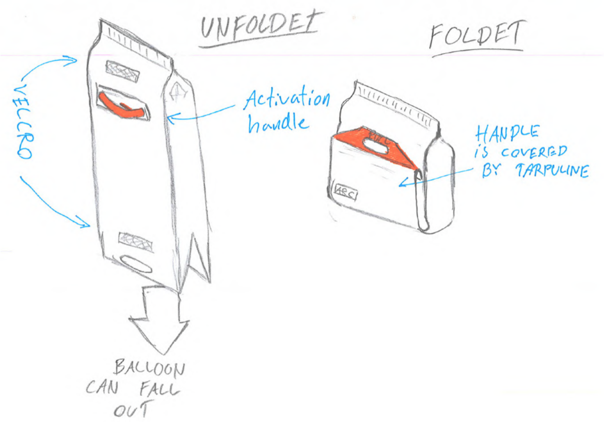


In a separate part of the plastic container, is the electrical components for the emergency broadcast together with the pressure tank and the packed beacon itself, protected from shocks and water.

Criteria evaluation showed a dilemma regarding integration of the ladder in the design.
Technical disadvantages and value considerations regarding lack of focus on the core project framing, lead to the disqualification of the ladder as a part of the concept (W.061). Additionally, as mentioned earlier the government of Greenland is currently proposing mandatory installation on boats in Greenland, no matter the size of the vessel (W.021).

Detailing the box

Now that the ladder had been disqualified, an exploration of material was conducted. To challenge the current ideas of a hard-box, the idea to utilize the same material as the beacon for the box was ideates on. During this process, the team realized that the material had beneficial properties as the surface is slippery and can reduce the amount of icing to the overall construction. Creating a soft-box evolves an interesting look to the final solution on the boat, instead of hiding the product as first thought (W.063).



A simple unit with clear interaction points, using bright colours on black to highlight this. To make sure the beacon was not activated by accident, a two-step activation was implemented into the working design.

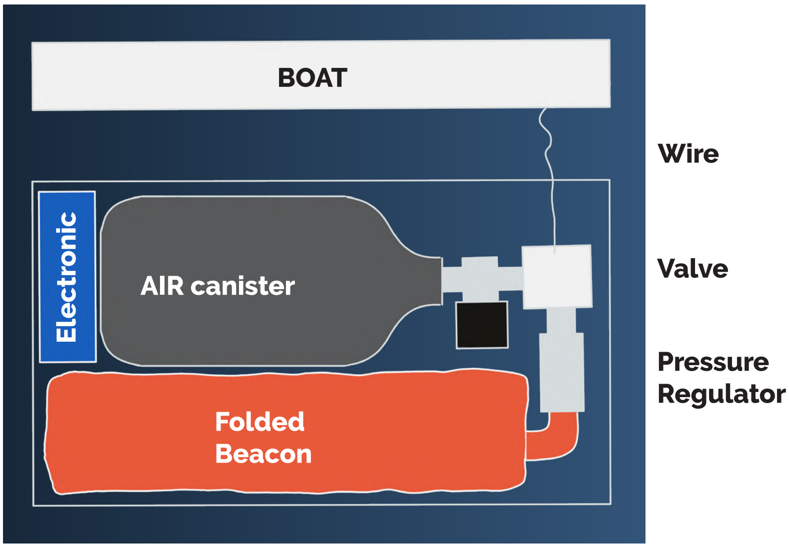
Using the folded device, the team began to work with 1:1 scale model of the box to quickly make adjustments before detailing the model in 3D (W.063).

Must require two-step activation

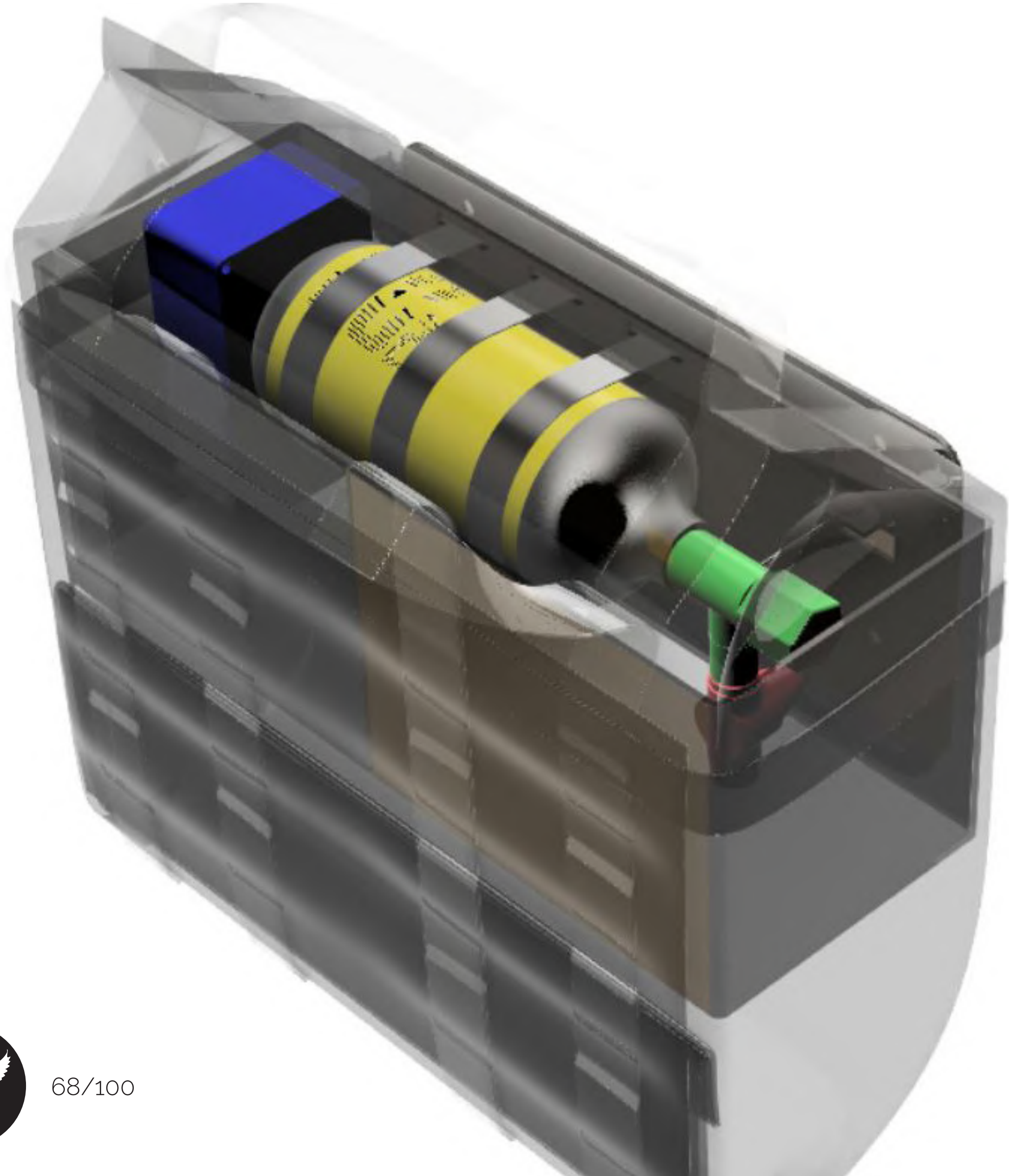
Inflation activation

To activate the inflation mechanism, a well-known solution that is used in many exiting life jackets was chosen. A split arms a valve, that when detached will allow flow of air into the beacon. This meant that the mechanical design had to activate a movement to remove the split. A research and sketching sessions explored different ideas based around a handle with a mechanical switch to release the valve.

Considerations about the handle icing up in the harsh environment invited a simple solution: Attaching the wire that pulls the split to the boat. So, when the box is pulled of the boat the split is pulled. (W.063)

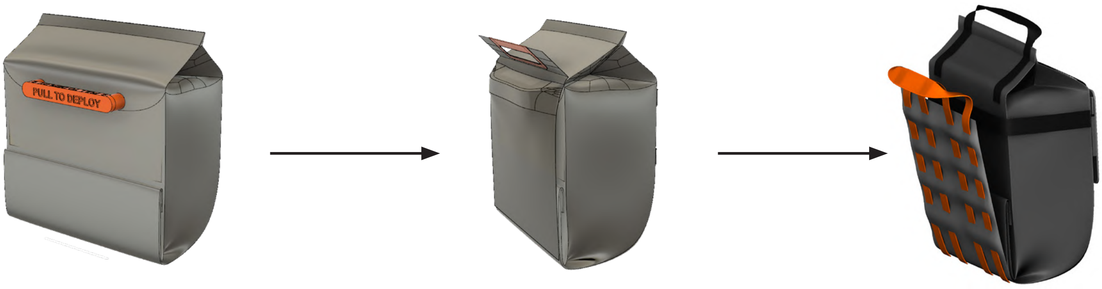


Must be serviced by a professional service provider



Affordance and interaction

Several ideas for creating a clear affordance for the user when interacting with the unit. After installing the box on the back of the boat, the next time the user will interact with the product is in an emergency. For this reason, the interaction has to be clear and easily understandable.



Detailing in 3D and physical models, lead to simple experiments and test options of folding the material to the desired shape. The result was a design with understandable affordance integrated into the box. Using aesthetically references from backpacks and military clothing, the design resembles a more professional piece of equipment. The team realised that the user needed to be involved in this process and through video calls they were asked for input along the way to make sure they understand the interaction.

"My first thought is it to pull the handle, but maybe add a sign that says "pull"!"
- Greenlandic fisherman

Conclusion

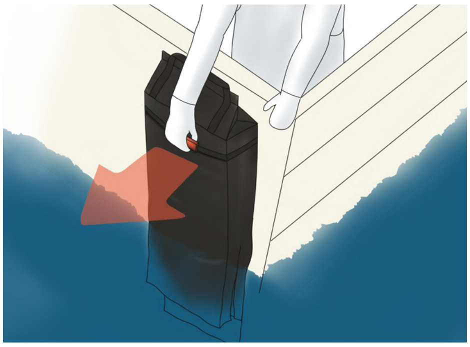
The box would have a two-step interaction before activation. The first would be to remove the front cover of the box and create clearance for the beacon to exit the box. Secondly the user would grab a stiff plastic handle attached to the unit. When pulling firmly to the handle, the whole box will detach from the boat and activate the inflation of the beacon. Now the user can let go of the box (W.061).


SUZUKI
140
FOURSTROKE
LEAN BURN
↓PULL↓
Royal OC
↓PULL↓

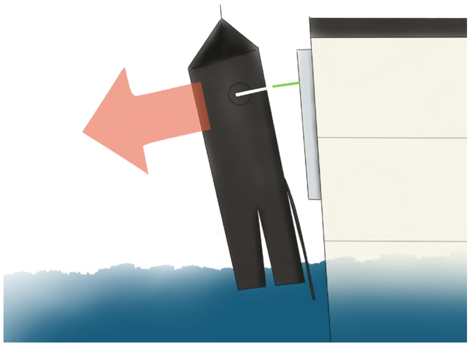
Product function scenario

This scenario sums up the features and interactions of the product in a final product scenario.
This shows both intended activation of the product and the full deployment process.

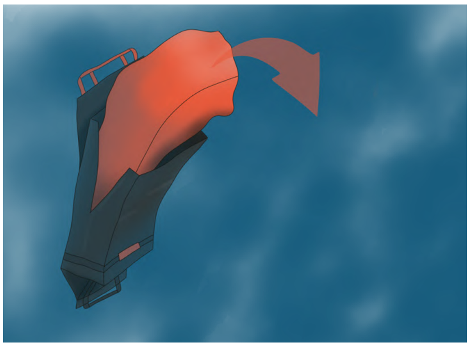
1: The front handle is pulled open revealing another handle protected underneath.



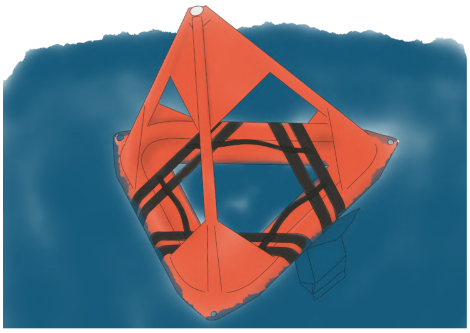
2: The second handle is pulled clicking the package of the boat mount and letting it fall into the water.



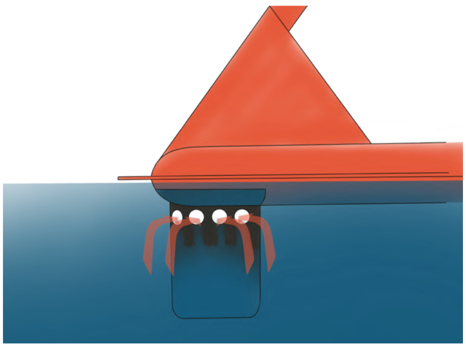
3: As product is pulled from the mount a split is pulled from gas valve starting the inflation and activating electronics.



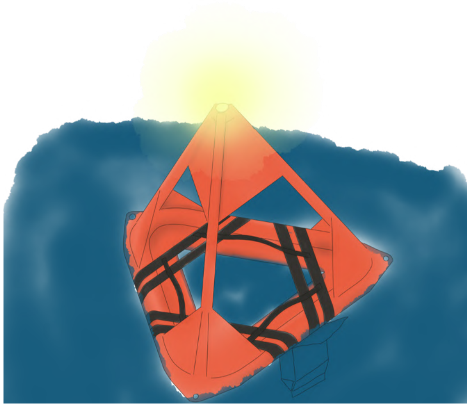
4: The beacon starts inflating and comes out of the box.



5: Beacon fully inflates and emerges from the water.



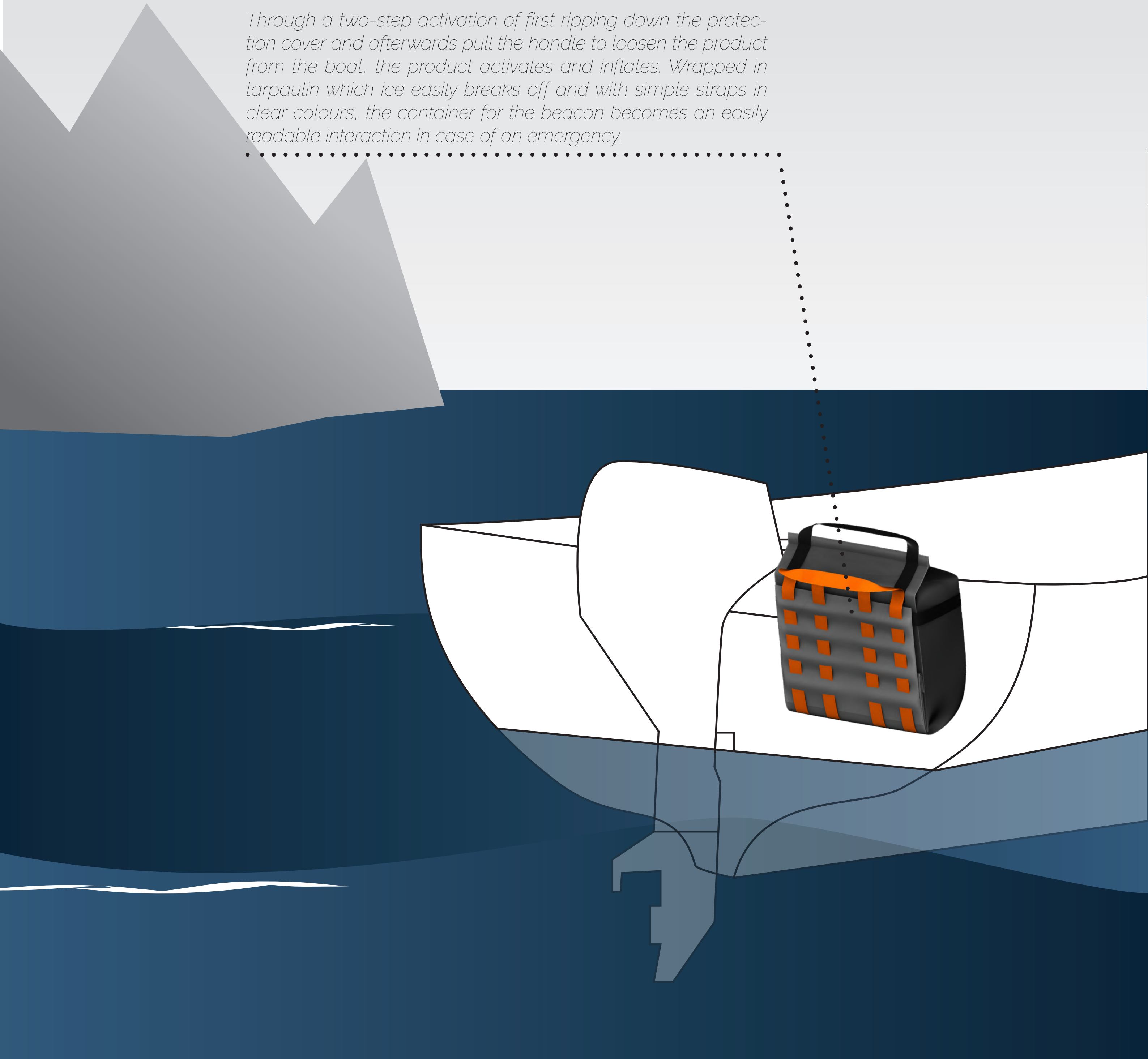
6: Anchors fill with water and keeps the product stable.



7: All this time the broadcasting has been initiated and will continue for up to 5 days.

Final Evaluation

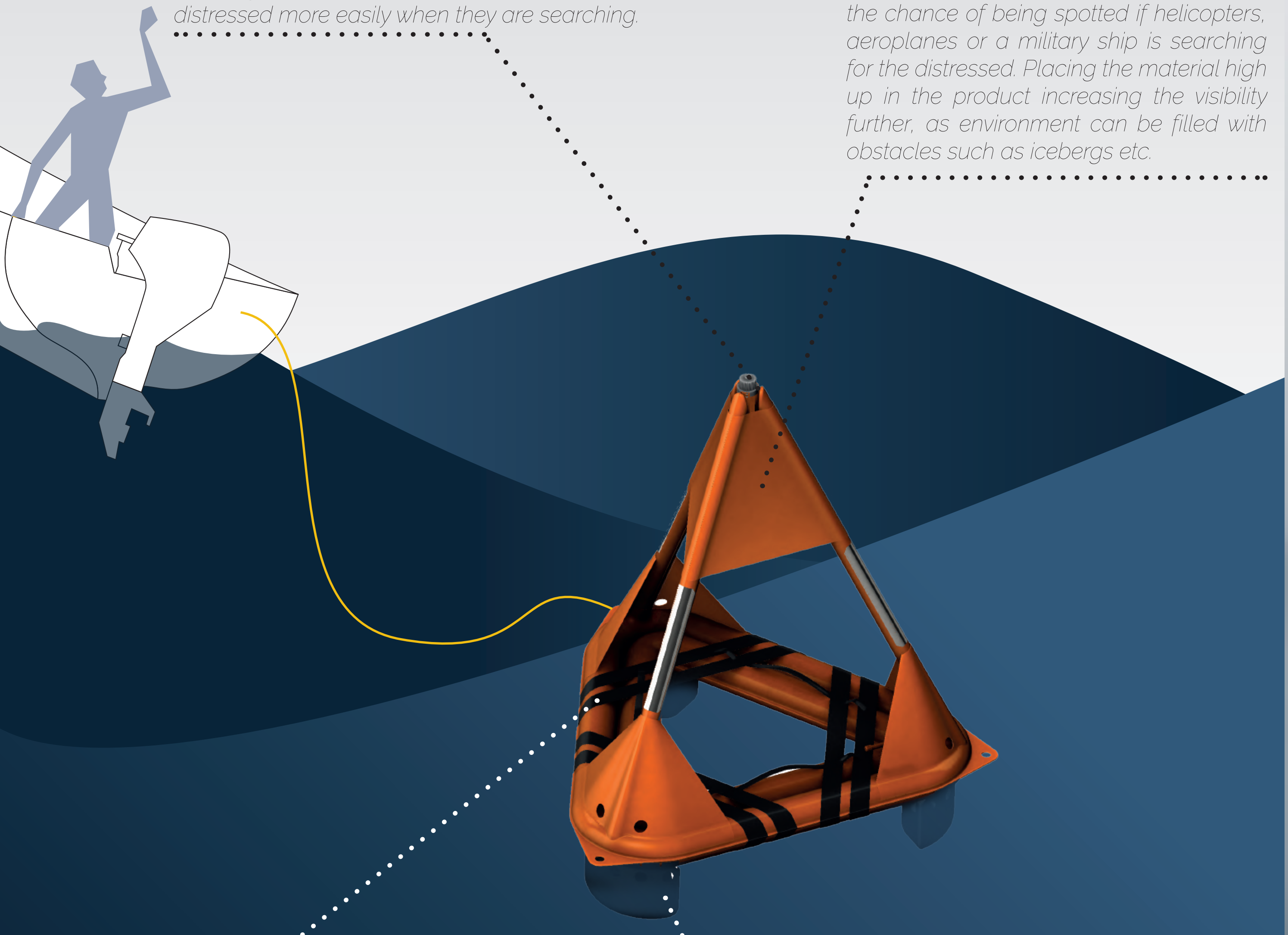
This chapter concludes with an evaluation of the last implementations of features into the product. A large re-evaluation of the container of the beacon as well as major detailing on the beacon leads to a final product, that lives up to the standard set by current emergency products for this context. A product that delivers a simple and intuitive interaction for the user, while offering one of the best chances of being found in an environment, where nature is so rough, that every minute counts.



Through a two-step activation of first ripping down the protection cover and afterwards pull the handle to loosen the product from the boat, the product activates and inflates. Wrapped in tarpaulin which ice easily breaks off and with simple straps in clear colours, the container for the beacon becomes an easily readable interaction in case of an emergency.

Broadcasting DSC and GPS signal so other sailors and the SAR personnel is informed, that a sailor is in distress. Flashing lights and bright colours help the search and rescue team find the distressed more easily when they are searching.

By implementing radar and thermal reflecting material in the beacon increases the chance of being spotted if helicopters, aeroplanes or a military ship is searching for the distressed. Placing the material high up in the product increasing the visibility further, as environment can be filled with obstacles such as icebergs etc.



A two-compartment base make access onto the beacon easier if a person is in distress as well as decrease the chance of deflation as the two compartment is separated by a check valve. The triangular structure is strengthened by straps that also function as handles to grab onto if the distressed needs to get onto the beacon.

To stabilize the structure, sea anchors are placed underneath. These are filled with water and make sure that the beacon won't tip over in rough sea or heavy wind.

Product Specification

Issue	Requirements for the Rescue Beacon	Unit	Marginal Value	Ideal value	References
01	*Minimum storage temperature* *Maximum storage temperature*	*Degrees Celsius*	*- 35* *+ 60*	*- 60* *+ 70*	*W.013; P.012; S.01*
02	*Minimum operational temperature* *Maximum operational temperature*	*Degrees Celsius*	*- 35* *+ 40*	*- 55* *+ 55*	*W.007; P.012; S.01*
03	*Electrical component enclosure in a IP68 Standard* container*	*Binary*	*Pass*	*Pass*	*W.020; P.015; S.01*
04	*Battery capacity in operation*	*Hours*	*48*	*120*	*W.018; P.016; S.01*
05	*Duration of active inflation*	*Hours*	*120*	*200*	*W.018; P.016*
06	*Required buoyancy of the inflatable beacon*	*Newton*	*2500*	*3000*	*W.004; P.018*
07	*Battery capacity in standby time*	*Years*	*8*	*10*	*W.019; P.025; S.01*
08	*Make use of bright colour for improved product visibility*	*Binary*	*Pass*	*Pass*	*W.012; P.029*
09	*Allow for manual inflation*	*Binary*	*Pass*	*Pass*	*W.012; P.029*
10	*Broadcast distress signal on the maritime Digital Selective Calling band*	*Frequency*	*156.525 Mhz*	*156.525 Mhz*	*A.11; P.037*
11	*Gas to be used for inflation*	*Gas*	*Dry air*	*Nitrogen*	*A.08; P.043*
12	*Service life for inflatable beacon*	*Years*	*5*	*10*	*W.033; P.043; S.02*
13	*Attach safety line between boat and beacon*	*Binary*	*Pass*	*Pass*	*W.035; P.044*
14	*Container enclosure must be designed to withstand icy conditions*	*Binary*	*Pass*	*Pass*	*A.04; P.047*
15	*Broadcast distress signal on GPS based distress band*	*Frequency*	*406 Mhz*	*406 Mhz*	*A.20; P.049*
16	*Minimum height of the inflatable beacon* *Minimum width of the inflatable beacon* *Minimum footprint of the inflatable beacon*	*Meters* *Meters* *Cubic meters*	*1.5* *1.5* *2.5*	*>1.5* *>1.5* *>2.5*	*A.09; P.051*
17	*Service life for battery capacity*	*Years*	*5*	*10*	*A.16; P.065*
18	*Antenna length*	*Millimetres*	*300*	*600*	*A.10; P.065*
19	*Equip a light on top of the product*	*Binary*	*Pass*	*Pass*	*W.020; P.065*
20	*Light flashing intervals*	*Watt*	*0.5*	*1*	*W.050; P.065; S.03*
21	*Watt usage of the light*	*Hertz*	*F = 1.0*	*F = 1.0*	*W.023; P.065*
22	*Use the colour white for lights*	*Binary*	*Pass*	*Pass*	*W.023; P.065*
23	*Broadcast GUARD* distress call*	*Frequency*	*121.5 Mhz*	*121.5 Mhz*	*W.046; A.15; S.04*
24	*Receive Galileo's smart RLS*, to get feedback on help*	*Frequency*	*1575.42 Mhz*	*1575.42 Mhz*	*W.046; A.15; S.05*

Issue	Wishes for the Rescue Beacon	Unit	Marginal Value	Ideal value	References
25	*Visible on thermal camera*	*Binary*	*Pass*	*Pass*	*W.002; P.050*
26	*Use radar reflective materials*	*Binary*	*Pass*	*Pass*	*W.018; P.051*

Issue	Requirements for the storage container	Unit	Marginal Value	Ideal value	References
27	Product is possible to activate manually by the user	Binary	Pass	Pass	W.020; P.015; S.01
28	Product is non-intrusive while operating the boat, hunting or fishing	Subjective			W.020; P.015
29	Extensive use of bright colours to indicate interaction points	Subjective			W.012; P.029; S.01
30	Single handed operation	Binary	Pass	Pass	W.030; P.036
31	The Product should be able to be installed on the outside of the boat	Binary	Pass	Pass	A.04; P.046
32	Product container must withstand water splashes	IP Standard*	IP 11	IP 44	A.54; P.047; S.01
33	Container enclosure must be designed to withstand icy conditions	Binary	Pass	Pass	A.04; P.047
34	Maximum height of the container Maximum width of the container Maximum depth of the container	Millimetres	H:450 W: 650 T: 400	H: <400 W: <400 T: <300	W.052; P.047
35	Activation by two independent actions	Binary	Pass	Pass	W.063; P.067; S.01
Issue	**Wishes for the storage container**	**Unit**	**Marginal Value**	**Ideal value**	**References**
36	Interaction handle size	Subjective			W.020; P.014
37	The product is easily accessible	Subjective			A.03; P.046
38	Product should be able to be rearmed by a professional service provider	Binary	Pass	Pass	W.061; P.068

Supported sources:

S.01 Cospas-Sarsat. (2019). Handbook of Beacon Regulations (1st ed., Vol. 1)

S.02 Force Technology. (2019, May 27). Trykprøvning af flasker [Information]

S.03 Weems & Plath. (2019, April 26). SOS Distress Light C-1001 [Product]

S.04 Cospas-Sarsat. (2019). Cospas-Sarsat Handbook of Beacon Regulations - Denmark

S.05 Galileo. (2019, April 9). Galileo SAR Service [Information]

Word catalogue:

Guard — The aircraft emergency frequency band

IP Standard — A standard definition on enclosures ability to keep out dust and moisture

RLS — The Return Link Service, is a unique feature of Galileo satellites, that allows the user to get feedback of acknowledgement of signal. This could be a spoken message, a sound or a light (led colour on/off or colour change)

Arctic Rescue Crew

Business

The business case has been progressively developed throughout the process, but to fully grasp the task, the business chapter is presented separately. Framing the business case requires a fairly tame product scope, to determine budget decisions, market placement and product scalability.

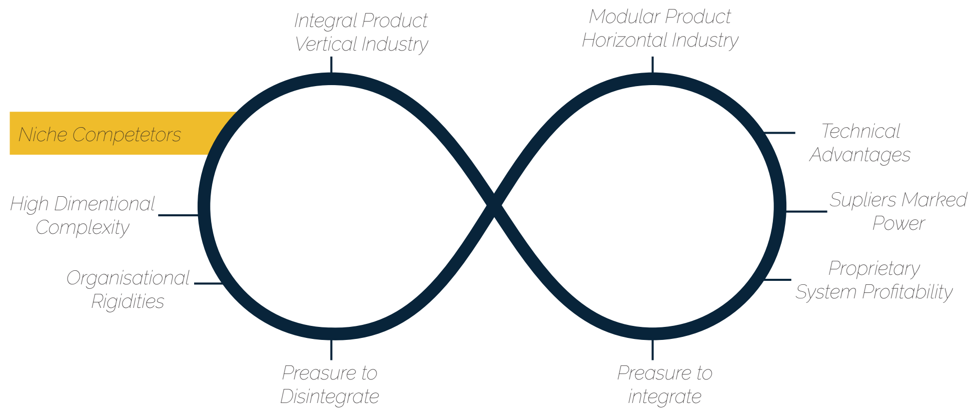
This chapter integrates the considerations of the product (ARC Rescue Beacon) estimations in regard to production cost and mark-up value. The business strategy is explored with sales channels and potential market expansion.

Finally, the chapter concludes the overall project with the teams process and concept proposal with a reflection on the outcome. The process report ends with an overview of all the used methods and a detailed process tracking walk through.

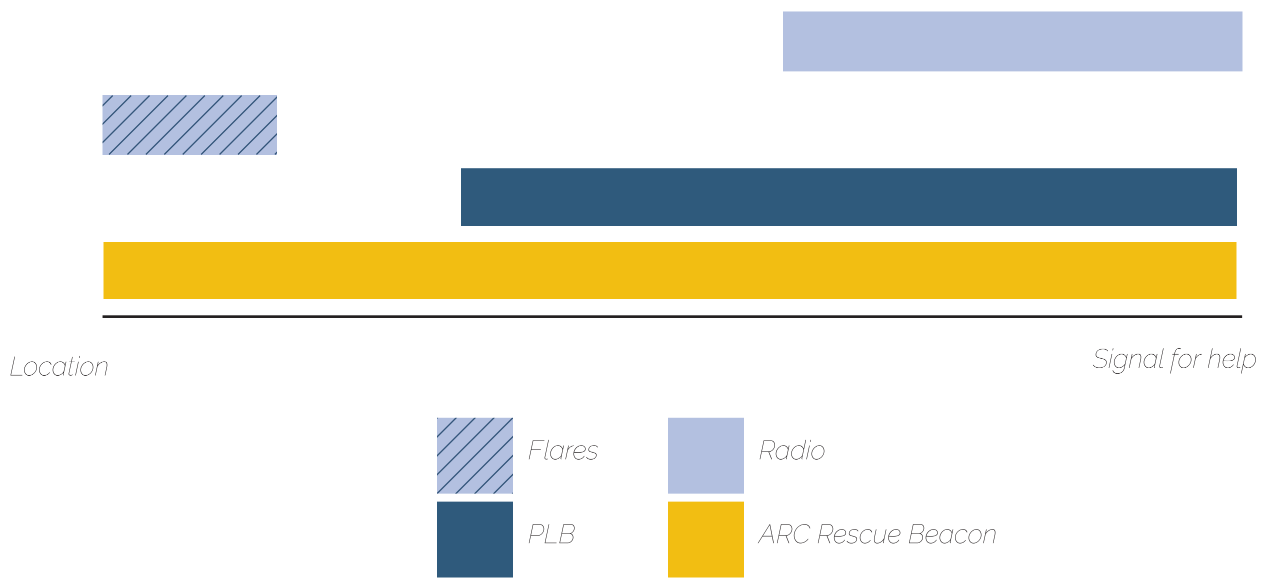
Market positioning

One of the world leading companies producing equipment for emergencies at sea and life prolonging safety equipment at sea, is the Danish founded company Viking. With almost 3,000 employees in more than 30 countries, this is a dominating player in the field (Viking-Life, 2019).
For ARC Rescue Beacon to be relevant on the marked, one of three scenarios are possible:
1. ARC Rescue Beacon is being developed by Viking, who implements it into their existing product portfolio
2. ARC Rescue Beacon is being developed as an independent start-up that challenge the marked and thereby also Viking
3. ARC Rescue Beacon is being developed fully and patent or idea is being sold to Viking later.

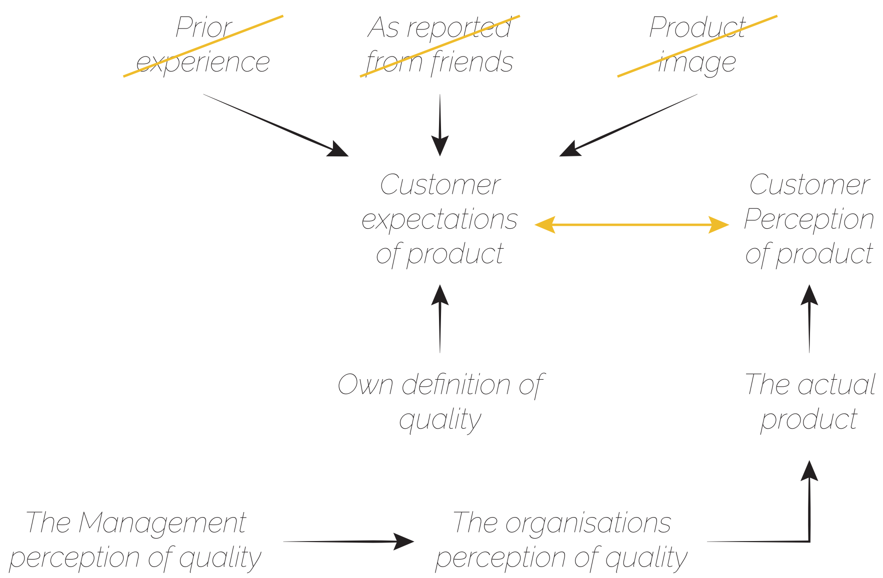
As described by the Clockspeed Double Helix model (Fine, 1998), Viking is such a large company, organizational rigidity, organizational complexity and niche competitors can develop. This is where ARC sees an opportunity in the marked.



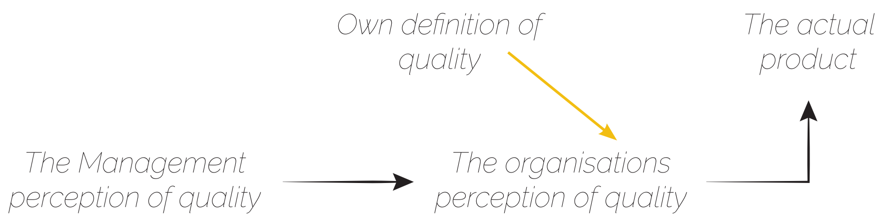
Looking at the existing product portfolio only few products deliver a solution, that solves the entire complexity of the problem presented for the Greenlandic sailors: signalling for help, and drastically improving the chances of being found. By doing so, ARC Rescue Beacon is setting a new standard for what to expect from emergency equipment for smaller vessels, while catering a marked, that Viking is currently neglecting in their portfolio. This analysis was conducted by the team creating a biased analysis - still it proves the values of ARC Rescue Beacon.



ARC Rescue Beacon is through its development and values build as an integrated product, delivering a complete solution to the problems presented. That being said, the product itself is, due to the focus on each individual feature, constructed fairly modular, with few limitations to product customization.
To deliver a product, that can challenge the current marked, as well as satisfy customers, this aspect is critical. The customers don't have a preconceived idea of ARC as a company as well as no prior experience with products from ARC. As it's a new company in the field, and it therefore needs to establish the brand solely through the perception of the products and services delivered by ARC. Being a modular product is therefore fairly simple to modify, if new needs, user perception or difficulties emerges when launched into marked. (Slack et al., 2007)



By doing so, ARC expects to meet the expectations of the customers by using, just like in the conceptualization-, product development- and detailing phase, input from them to improve on the product to form a common perception of quality in the product category.



Competitive products

Researching on other products, the general cost for a product, that potentially could deliver the same service as ARC Rescue Beacon is around 15,000 - 20,000 DKK (W.045)

Cost Estimation

To create a business on the ARC Beacon a strategy is needed. Throughout the process the team have been integrating the production aspects and pricing aspects into the concept. In the final concept the team calculated a full price estimation of the product and optimized it for production.

PRICE CALCULATION OF PRODUCT

Balloon	
PVC Fabric	500 DKK
Manufacturing	700 DKK
Top Light	
CNC turning	50 DKK
O-ring	0.2 DKK
LED PCB	20 DKK
Box Production	
PVC tarpaulin	100 DKK
Metal construction	100 DKK
Pressure tank	134 DKK
DIN valve	220 DkK
Tech components	
VHF	10 DKK
GPS	100 DKK
Satellite beacon	4.7 DKK
System chip	20 DKK
LED	40 DKK
Battery	241.1 DKK
IP67 box	21 DKK
Activation switch	5.3 DKK
Total per unit	*2,266.3 DKK*

A.014

Because of the fairly low number of units that the company can expect to sell in the relative small marked in Greenland, the production has been optimized. Lowering the number of different production methods and choosing methods with low start-up cost rather than low unit cost reduces the unit price. Methods like injection moulding were set aside in favour of CNC turned components, before marked expansion.

In the future, if product proves successful, it would be preferable to change some production methods for again to accommodate for the lower unit cost. This would require an investment, that possibly could be financed by the profit made in the Greenlandic marked.

In A.14 you will find the prices of different production methods considered and more.

The estimated production cost per unit is therefore approx. 2,300 DKK. As most parts are produced and sub assembled by suppliers the costs for employees are extremely low. Only expenses for marketing, storage, salaries and customer support, and certifications must be included when calculating the final estimations.

Looking at other products in this category and the features they provide, a selling price of approx. 10,000 DKK is not unreasonable leaving the product with a selling mark-up of approx. 3.3.

Business Strategy

As mentioned previously the potential user group is quite hesitating towards safety equipment. This could mean that customers would need an explanation of the benefit of the product as well as experience the benefits. Considerations of collaborating with the organizations or companies that the sailor community in Greenland know and trust is made. Here both the KNAPK (interest organization for sailors in Greenland) and Danish boat producer Poca came up.

KNAPK often helps local sailors with buying and financing boats. KNAPK has a large interest in safety for their members and using safety equipment, to live up to the international standards. The idea is, that the ARC Rescue Beacon provides a solution much more acceptable to the sailors and would therefore be easier for KNAPK to convince the sailors to invest in it or help fund it.

As Poca is one of the biggest producers of small boats exported to Greenland, it could make sense to sell the product through them. This would benefit them as their boats would have a larger advantage over competing boat producers. ARC would than feed of the brand-loyalty and gain sales through the sales of Poca boats as an extra-equipment to opt into.

Military Subsidies

Thirdly the team saw that the Royal Danish military who oversees the SAR missions would indirectly benefit hugely from the ARC Rescue Beacon being placed at as many boats as possible (W.053). SAR missions are very expensive. For them this would mean that locating the distressed would be much quicker which simply means less flight time for their helicopters and aircrafts.
By calculating the costs of these missions the team found that it could be such a large cost saving for the state that they might very well be open to giving subsidies to sailors buying the product. Contacting the Joint Arctic Command revealed, that they could neither confirm nor deny the results.

Average salary for a helicopter pilot (Forsvaret, 2019) — *43,600 DKK*

Salary for 5 person SAR helicopters yearly — *57,552,000 DKK*

Rough number of small fishing vessels (Polar Fish, 2018) — *55,000*

Cost for installing on all vessels — *55,000,000 DKK*

Potential savings from lowered number of helicopter missions.

25% less	*16,608,000 DKK*
50% less	*33,216,000 DKK*
75% less	*49,824,000 DKK*

The Joint Arctic Command is currently in the process of moving most of the helicopter based SAR work over to the private sector (Forsvaret, 2018). Therefore, they have a large economic incentive to lower the time spend on locating distressed sailors. The large savings found through these calculations simply gives a larger incentive for the state to give some form of subsidies to the sailors buying the product.

Final Business Strategy

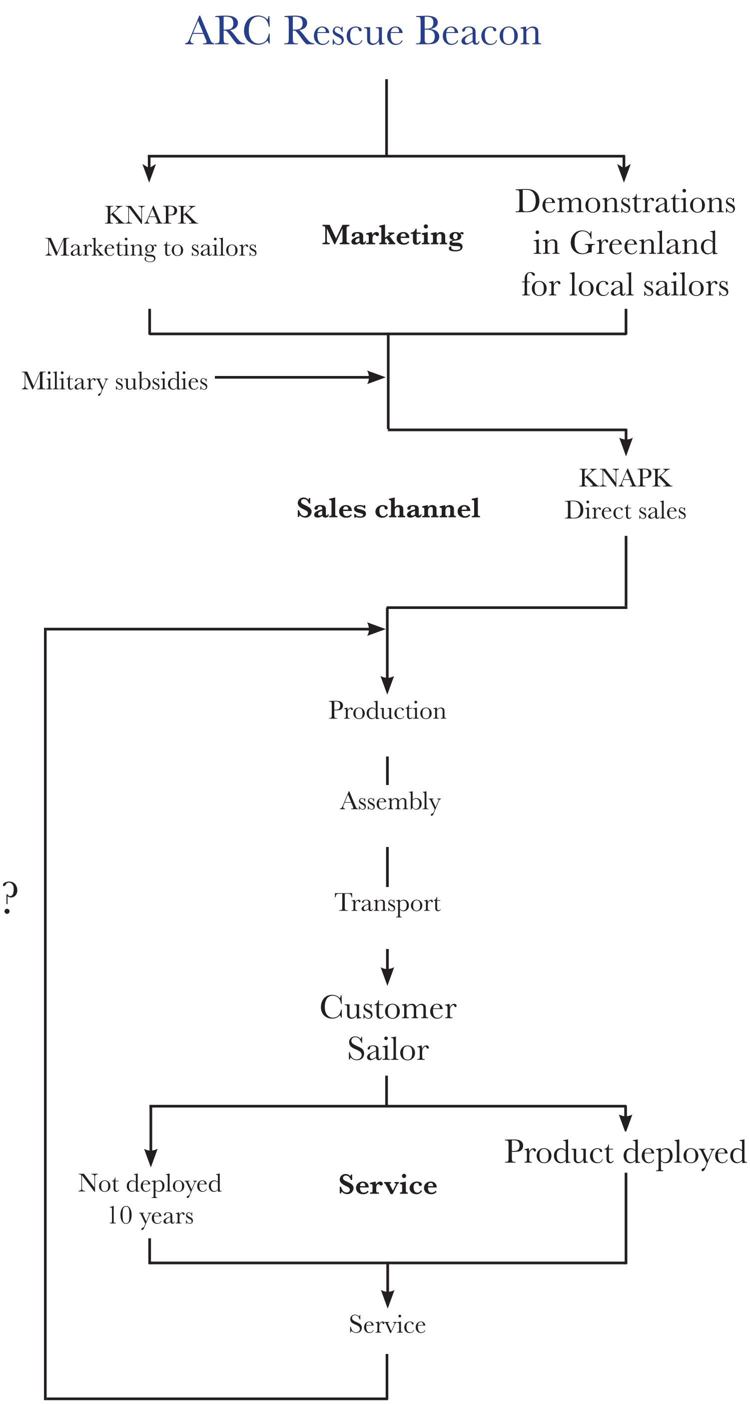
A full overview of the final business model is seen in the figure to the right. This figure explains the strategy in steps from production to customer and beyond.

The team will use KNAPK to reach the sailors as well as use KNAPK as a sales channel, to bypass resellers.

Live demonstrations in Greenland might be necessary to make the sailors aware of the new product and create interest.

Through the lifetime, the product will need service as batteries must be changed and gas canister needs pressure testing.

A service system is there for created. This service setup benefits the user as he will not need to buy a whole new product every 10 years. Instead the user can just have the beacon serviced. The product could also be serviced after being deployed. In terms of the business it might be more financially effective to simply sell a new product each time but this might also scare off some users from buying the product.



What would a service include?

The most time sensitive parts of the product is the pressure tank and the batteries. The pressure tank normally needs to be serviced every 10 years (Force Technology, 2019). The batteries are calculated to last at least 10 year in this climate as well (A.16). This means that these would need to be changed every service.

If the product has been deployed the inflatable part of the beacon would also need to be inspected for leaks and folded up correct again.

Break Even Analyses

Investment	
Development of product	750,000 DKK
Certification	250,000 DKK
Branding and marketing	25,000 DKK
Overhead and storage cost	20,000 DKK
Total	1,045,000 DKK

Potential Marked	
Potential Marked	5,000 Customers
Marked saturation	20%
Estimated marked	1,000 Customers

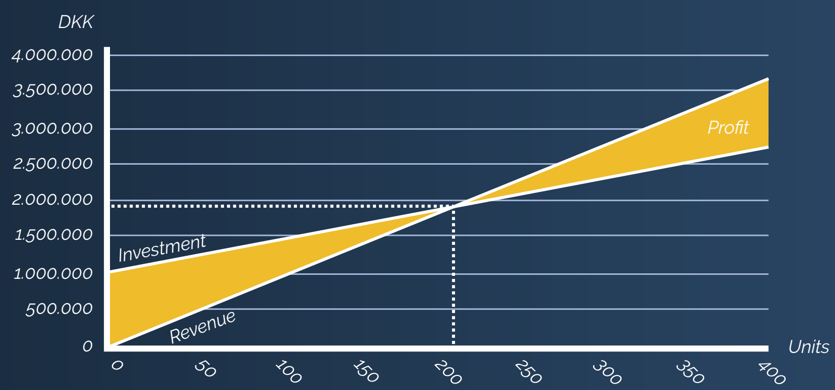
Production cost per unit (1,000 units)	
Production cost 1,000 units	2,266,300 DKK
Production cost per unit (1,000)	2,266 DKK
Retail Price (x4 mark-up)	**9,065 DKK**

Sales price per unit (1,000)	
Investment cost per unit (1,000)	1,045 DKK
Production cost per unit	2,266 DKK
Total Production cost	3,311 DKK

Cost of sale per unit	
Assembly	100 DKK
Consultancy (8% of retail price)	725 DKK
Transport	59 DKK
Total	884 DKK
Variable Cost per unit (1000)	**4,195 DKK**
Profit per Sale	**4,869 DKK**

Budget of sale	**Year 1**	**Year 2**	**Year 3**
Units sold	200	300	500
Turnover	1,813,040	2,719,560	4,532,600
Variable cost	839,183	1,258,774	2,097,958
Contribution Margin	**973,856**	**1,460,785**	**2,434,642**

Break Even Analysis	**Year 1**	**Year 2**	**Year 3**
Investment Balance	-1,045,000	2,018,856	3,479,642
Yearly Contribution	973,856	1,460,785	2,434,642
Total Profit	**-71,143**	**3,479,642**	**5,914,284**



The graph show the break-even point estimated to be at 215 units when reaching 1,940,000 DKK. Many uncertainties can influence the result, and this graph is only used as a "guestimate". Expenses may depend on sales, labour, transport and logistics. W.064 show full calculations.

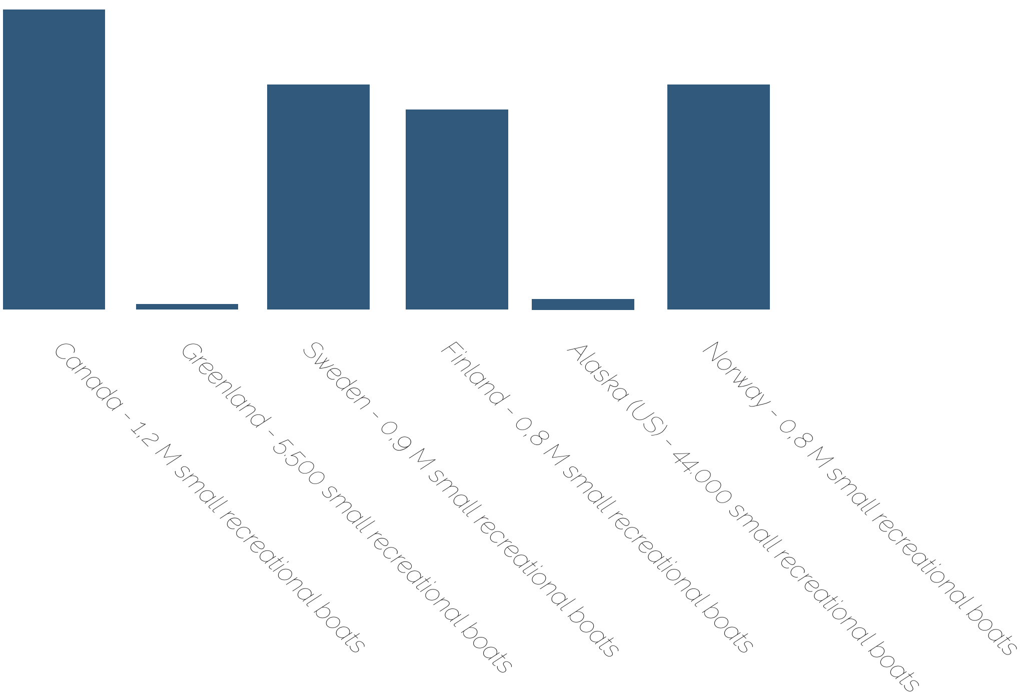
One of the market expansion possibilities include larger fishing vessels, that also currently is hesitant to invest in safety equipment such as rafts or flotation device.

Potential Marked Expansion

Polar and sub-polar climate zones

Greenland is the test marked and used as a case study of the problems presented with sailing generally in arctic waters. With only about 5,500 smaller recreational boats (Polar Fish, 2018) they only make up for a small percentage of the recreational boat fleet in the Arctic waters. If the product proves successful in Greenland, enough capital could be raised to expand into other and bigger markets. The most promising markets are identified as Canada, Sweden, Finland and Norway, all with close to one million potential customers in the small recreational boat sector. These countries all have areas that share comparable climate, water temperatures and weather, with Greenland and it is therefore plausible, that the current product suggestion is directly transferable to these areas. Greenland (under Danish supremacy), Sweden, Finland, Norway, Canada and the United States are all part of UN and therefore share same rules for regulations under UN SOLAS regulation (described earlier in the report).

Also, Russia is considered as a large potential marked, but statistics on how many small recreational boats that exist in Russia has not been possible to find. Furthermore, other regulations apply in Russia that needs to be certified to the product.

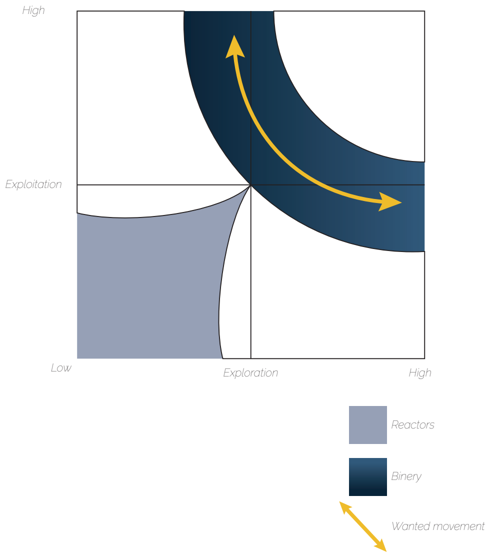


Sources: (ECSIP, 2015; U.S. Commercial Service, 2018; U.S Department of Homeland Security, 2016)

Potential Marked Expansion

Exploration and exploitation

Looking at Greenland as a test marked for the ARC Rescue Beacon, the team have made considerations regarding the potential marked expansion. As of the current business model suggested, expansion towards other Arctic regions are possible with the current product, but developing new products in the product family is also possible. In the pipeline for the ARC Rescue Equipment-family is two suggestions. (Meyer, 1997)

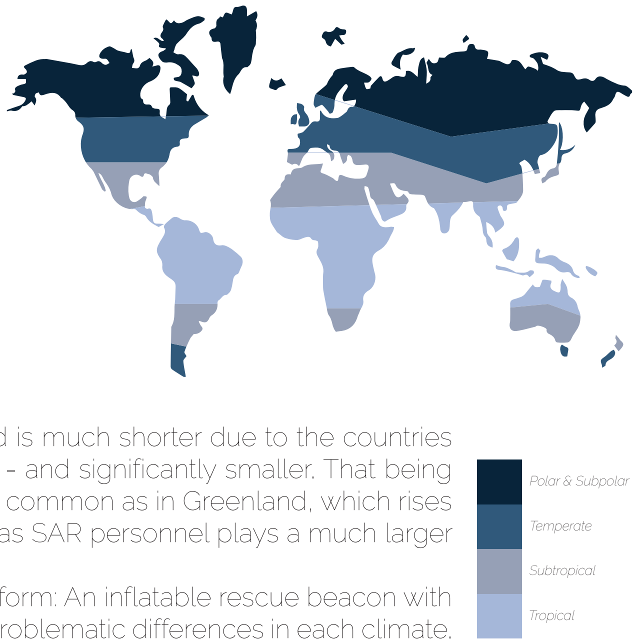


1. *An exploitation of the current product to fit into the context of new markets with minor changes to the product.*

2. *An exploratory approach towards the product category, to uncover possibilities for new product categories within the field of safety equipment at sea.*

1. Marked Exploitation

The architecture of the ARC Rescue Beacon allows for both this exploration and exploitation of marked expansion. The team sees a possibility for hitting other markets worldwide. These markets are based on the climate zones. Here the current presented ARC Rescue Beacon is addressing the polar and sub polar zones (Greenland, Canada, Alaska, Russia, Finland, North Norway and North Sweden).



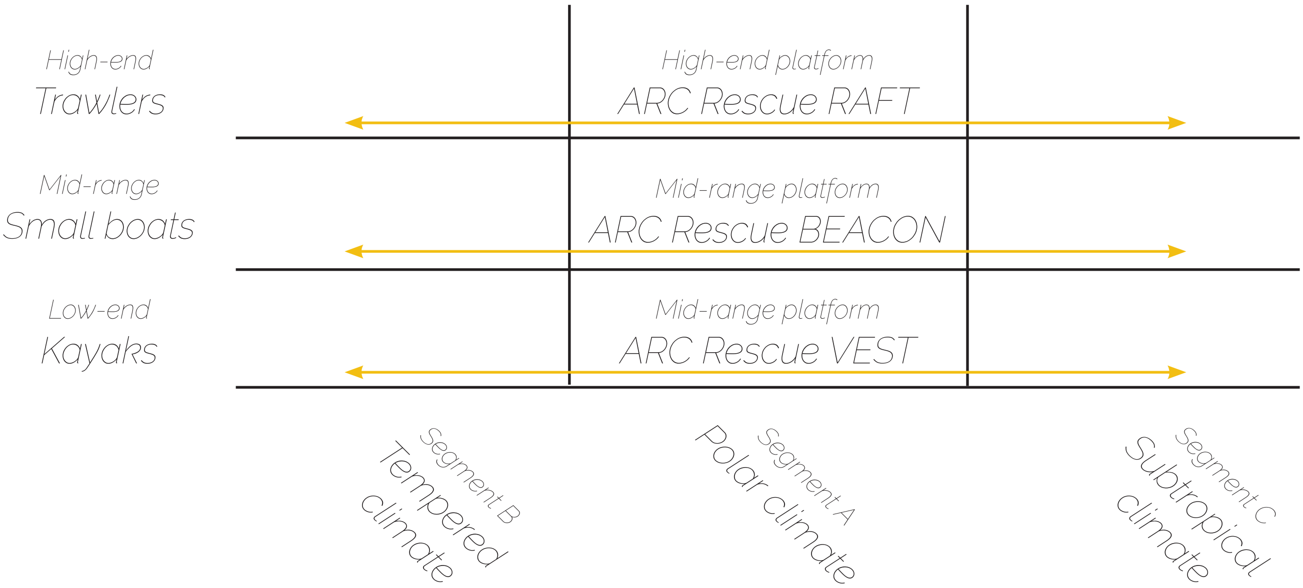
The first expansion should be into the temperate climate zone, as climate conditions are comparable to the arctic climate, especially in the winter periods. In interviews with SAR personnel (W.062) from Denmark (a country in the temperate climate zone) they tell, that the time before being saved is much shorter due to the countries being more populated and better covered by SAR stations - and significantly smaller. That being said, sailing in the Nordic countries in small vessels is not as common as in Greenland, which rises a need for more focus on PLB, Thermal imagery and radar as SAR personnel plays a much larger role in the search and rescue operations here.

Therefore, the product range should build on the same platform: An inflatable rescue beacon with the existing build in features, but modified to suit the minor problematic differences in each climate.

Mid-range Small boats	ARC Rescue Beacon Model 2	ARC Rescue Beacon Model 1	ARC Rescue Beacon Model 3
	Inflatable beacon platform More focus on PLB More focus on raft-aspects	Inflatable beacon platform PLB + VHF Lights + Colors Possible to climb onto	Inflatable beacon platform More focus on VHF Less focus on PLB Sun protection
	Segment B Tempered climate	Segment A Polar climate	Segment C Subtropical climate

2. Marked Exploration

The other possibility for marked expansion is a new platform for safety equipment at sea in the ARC family. The potential for a new platform is seen in other types of vessels than the open boats, that the current device addresses. New platforms can differentiate from the original in two directions: a high-end platform with more and improved features, better safety and space for additional distressed etc. for bigger fishing vessels as trawlers, small ferries or large fishing boats. The other possibility is a lower end platform, with a less space consuming packaging, less features, cheaper and aimed towards rowboats, small sailboats or sea canoes or kayaks.



Looking at platform leveraging strategies (Meyer, 1997), this strategy suits the horizontal leveraging. Developing a common platform for different markets, while operating different platforms for alternative segments. This minimizes the cost of the development process, as the common platform can be reused as a modular module in other markets, like much of the car industry today. (Autocar, 2019)

A low-end platform could be a personal flotation device, that helps users operating kayaks, divers or canoes in case of emergency. The suggestion include device, placed on the person, that inflates into a "ring" optimized for flotation, a small manual release activated gas canister, that inflates when the user pulls a string. The ring could be equipped with reflexes as well as a whistle to more easily signal that the person is in distress. With aesthetically familiarity to the ARC Rescue Beacon, such as shape and colour, but at a much lower price and limited features, this would be suitable for sailors of kayaks or divers in warmer waters.

A high-end platform could be an actual raft suited for 6-12 persons, moving into a direct competition with Viking. The raft would, like the ARC Rescue Beacon be equipped with different forms of distress signals, that could also manually be operated from the inside of the raft. A fully inflated base would separate the user from the water. The raft could also be equipped with blankets, food rations, water, flares and lights, as well as being completely sealed off, to isolate the users from wind and waves.

Conclusion

This master thesis project sought to create a more fitting piece of safety equipment for small boat sailors in Greenland. Sailors don't wear safety equipment when sailing because they find it annoying, in the way for their work and ineffective. A great insight into the mentality, the scenario and understanding of the people and their relation to equipment was gained by travelling to Greenland.
Through the interviews with the Joint Arctic Command and the police in Greenland the team learned that the main problems for the SAR units are:

1. The sailors can't call for help resulting in late response from the SAR units.

2. The rescuers must search over enormous areas as they rarely have an approximate location of the distressed.

3. The sailors in distress are extremely difficult to spot at distance.

The team could frame these problems together with the insights from the sailors to form a prioritized model with the convenience for the user is the main focus. If it didn't live up to the user needs for convenience it wouldn't be used at all.

Through continuous sparing with a user-group of sailors and the Joint Arctic Command, the team was able to conceptualize the values into ARC Rescue Beacon which is able to call for help to both SAR units and to nearby sailors. This was all done by implementing existing technologies into a highly visible and inflatable object. All of this was integrated into a product that met the users' high expectations towards the inactive product by placing it on the rear outside of the boat.

A business plan was created around the product showing that the product could in fact become profitable within a timespan of two years by collaborating with KNAPK (sailors interest organisation in Greenland) and tapping into the existing relationship between sailors and KNAPK distributing the products through their organisation.

Reflection

Looking back at the project, the team chose to develop a concept for a very complex and important problem. Naval life saving equipment is a conservative field regarding 'problem solving', meaning that a radical new perspective on the problem was needed. Throughout the project the team has tried to establish a series of boundaries, first to understand the scenario and second to create a concept for solving the problem in the scenario.

The ever evolving scenario
Throughout the project, the team's effort to establish the boundaries for the concept, have been a "roller-coaster ride" of constant converging and diverging workflow and project focus. Early on, the team realized that the scenario of becoming distressed at sea, had several outcomes. Trying to structure a more linear scenario was difficult and it ended up with ideas that moved in many directions in the later part of the project. The product would have to solve 'problem A', but soon it would also have to solve problem B, C, D, and this complicated the concept development - and the understanding of the core problem. Through interviews in the detailing phase the team became much aware of this. By taking a step back, and looking at the project from a different perspective, as outsiders, the team realized what the core case was; sailors in distress at sea are still in the boat. This realization helped the team in structuring a linear scenario and created defined boundaries for the concept functionalities and features.

Detachment system
The detachment system has room for improvement to cater for activation of the product and detachment as soon as the product is submerged. Currently it's only activated by pulling a string. This would solve the uncommon, but existing problem involved with the boat sinking in the event of an accident. This could be done by making an electrical lock alongside a build-in pressure sensor. The sensor detects the pressure of the product being submerged, to automatically detach the product from the boat, starts inflating the beacon and activates the distress signals. Tests of the durability of the detachment system should be conducted by simulating the movement and force of the boat, as well as the weight of the product.

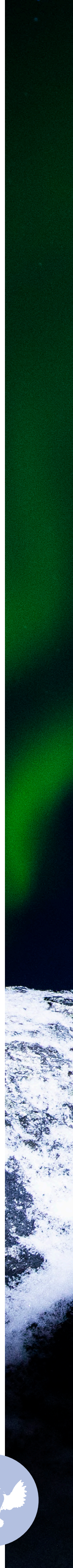
Additional testing
Additional testing is required regarding multiple parameters. Wind testing, Time for inflation and durability is some of the most urgent tests required. These should be conducted with an alpha model and in environment that is comparable to a real life scenario. Limitations for inflations centres around the limitations for the valve installed in the tank. Durability can be improved by reinforcing the most vulnerable areas of the product.

Broadcast Signals
The broadcast of the different signals should be tested, to better estimate actual coverage. Mountains, weather and other objects may interfere with signal strength and therefore can decrease reception range - also noted by Henning Christensen (A.10).

Indication of errors/malfunction
The product must have the option for feature testing and indicate product failure and status (hardware or software etc.). An indication should show that the product malfunctions. This could be an LED and a push button, that the user can click to check for errors.

The cut/glue/weld drawings
The technical appendix should be revised in collaboration with an authorised producent of liferafts (ex. Mogens Clausen or Viking) to ensure optimization, limiting the cost, production time, reducing the use of material and ensuring that no deflation would happen.

Product as a bag for hunters, snowmobiles, sledges etc.
An increasing interest from users is seen in other fields than safety at sea. The features and problematic presented in the project share many similarities to the situation for hunters, users of snowmobiles and users of sledges when travelling into nature. Future exploration for implementation into these user groups would be interesting.



Methods

Throughout this project the team have been used several methods to gather knowledge, frame the project, ideate on basic ideas, test concepts and evaluate the project through the principals of problem based learnings This overview is structured by topics, with an explanation of the method used and the effect for the team.

Participatory Design

Purpose:	*- Ideate and evolve the conceptualization in collaboration with the users feedback.*
Output:	*- Establish a solid connection with the user and the product functionalities.*
Usage: A.01; A.02; A.09; A.11; A.12	*- The team have had mail-interviews with all knowledge partners all throughout the project ever since the trip to Greenland.*

Napkin sketches/brain-pool

Purpose:	*- Ideation method with low fidelity to create many quick ideas.*
Output:	*- Extended amount of generated ideas using limited time to find new opportunities.*
Usage: P.051 W.001; W.005; W.0014; W.037	*- A tool used in exploration of every new concept topic (location, flotation, revival, beacon, box).*

Design Sprint

Purpose:	*- Within 5 days find, develop, test and evaluate a concept.*
Output:	*- Can be a useful tool to make quick progression during long development phases.*
Usage: P.038 W.025; W.031; W.037	*- The team did one full sprint during the project, which had major impact on the project. The team was able to 'close doors' and progress the project by testing and eliminating ideas for feasibility.*

Mock-up and testing

Purpose:	*- Build simple models for scale understanding and testing.*
Output:	*- Explore concept issues, limitations or develop new ideas.*
Usage: P.044 W.028	*- The team have used mock-ups extensively throughout the project, to explore sizes, interaction principals, and stability tests. This have revealed concept limitations and issues that later have been addressed and fixed because of knowledge from the tests.*

Body-storming

Purpose:	*- Interacting with physical models during testing in the real context.*
Output:	*- Unique insight into concept limitations and find new concept opportunities.*
Usage: P.044; P.059 W.032; W.049	*- The team have been using this method extensively throughout the project to understand the properties of the different concepts in relation to the context.*

Immersion

Purpose:	*- Explore a specific situation or climate.*
Output:	*- Get an unique understanding of the context.*
Usage: P.025 W.022	*- The team went to Greenland to experience the Arctic climate. This provided much understanding about the grand scale of the island, the way of life and the sailors mentality.*

Situated interviews

Purpose:	*- Interviews that is executed in the context in which the topic is relevant to the interview.*
Output:	*- Doing interviews in the context can reveal new problems/insights that might not be revealed in a telephone or mail interview.*
Usage: P.025 W.015 - 021 W.057	*- During the trip to Greenland the team have been using this method in every interview.*

Qualitative Interview

Purpose:	*- Gathering data via interviews.*
Output:	*- Get specific insights in relation to feelings and opinions.*
Usage: P.014 W.008 A.02; A.07; A.08; A10	*- Qualitative interviews have been used extensively throughout this project. From the very beginning the team visited Danish Royal Air Force, to discuss the first hypothesis the team had with the project. Secondly the team have interviewed numerous people in many fields of the problem, and have been in touch throughout the project with crucial feedback during concept development.*

Bird in the hand

Purpose:	*- A Lean technique using the network of people to access information or experts.*
Output:	*- Easy access to quick or advanced resources or knowledge.*
Usage:	*- The team used the method during gathering knowledge preparing the trip to Greenland and through the detailing phase to gather knowledge from 'experts' in technical fields.*

Act it out

Purpose:	*- Act scenarios from the users perspective.*
Output:	*- Explore the users situations to find new ideas or confirm hypothesis.*
Usage: P.059 W.049	*- The team have done act it out scenarios the extend to understand the distressed situations in the relation to the users needs, physical and mental conditions. This have helped during concept development to understand the usability of different concepts.*

Show me how

Purpose: - Tool where the observer is guided through a task with or without speech.
Output: - Observer will establish an understanding of the scenario and learn about the physical and mental aspect of the task.
Usage: - The team primary used this method during the company visit to get an understanding of the production method when working with welding sheets of PVC.
P.051
W.057

Observation/Shadowing

Purpose: - Watch people during a task or daily life.
Output: - Ability to spot issues or findings that people might not reveal through interviews.
Usage: - While in Greenland, several observations on sailors to understand how they worked onshore and see the usage of lifesaving and other equipment was made.
P.025
W.018; W.020

Storyboard

Purpose: - Establish a story about a situation through drawings.
Output: - Get additional and unexpected insights because of the thorough work.
Usage: - The team have used storyboard throughout the project to understand the many situations in relation to the different outcomes of the emergency. Also used for understand important interaction aspects for the concept development.
P.036; P.045
W.025; W.042

Value Vision

Purpose: - Ideate and establish values for the project, the users and the concept.
Output: - Structure a hypothesis about the users needs and wishes on a value-based level.
Usage: - The team used the method in the early part of the project, to establish core values for the users potential needs and the concepts values for the user. The 'Seatbelt' was a strong value used by the team throughout the project, as a 'non-invasive' safety object.
P.31
W.013

Combinatorics

Purpose: - Sketching method of combining features or functionalities into future sketches.
Output: - Explore design opportunities to discover new ideas.
Usage: - The team have used the tool during the early phases of concept ideation, it was used to develop several ideas, remarkably the flotation design.
P.032
W.001; W.005

Quantitative Structures

Purpose: - A sketching method by Tjalve, by exploring component structuring and positioning.
Output: - Exploring many combinations to find new opportunities for concept ideas.
Usage: - The tool was used during the development of the box, to quickly determine the structure of the unit.
P.066
W.059

3D modelling

Purpose: - Design tool for detailing purposes.
Output: - Explore design details and structural elements for strengthen concept feasibility.
Usage: - The team have moved back and forth between sketching and 3D modelling, for quick ideation and detailed understanding of complex shapes or detailing elements.
P.058
W.047

Product Specification

Purpose: - A tool for well defined products for knowledge sharing and technical decision making.
Output: - Used for structuring frames for products in relation to all aspects of the products structure, features and functionalities.
Usage: - The team have had emphasis on working with a wicked problem definitional and project, resulting in a late implementation of the product specification.
P.072
A.21

Worksheets

Purpose: - A predefined structure for documentation of tasks.
Output: - An framework that allows for an agile and wicked work with the project for easy documentation.
Usage: - The team have been using worksheets throughout the whole project. The function of the tool have allowed the team to document, evaluate and reflect on every task done within the projects fuzzy front end all throughout the detailing phases. The worksheets have allowed to revisit work through a reflective process.

Kanban

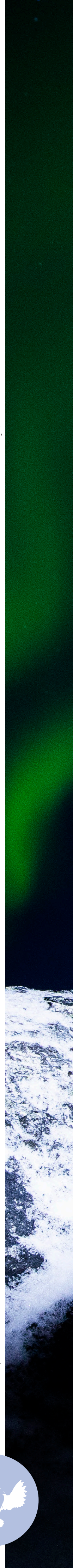
Purpose: - Structuring the projects tasks and assignments.
Output: - Creating an overview of crucial tasks and their status.
Usage: - Throughout the project, the team have used an online software; Kanbanchi, to structure project tasks and prioritize task.

Gantt

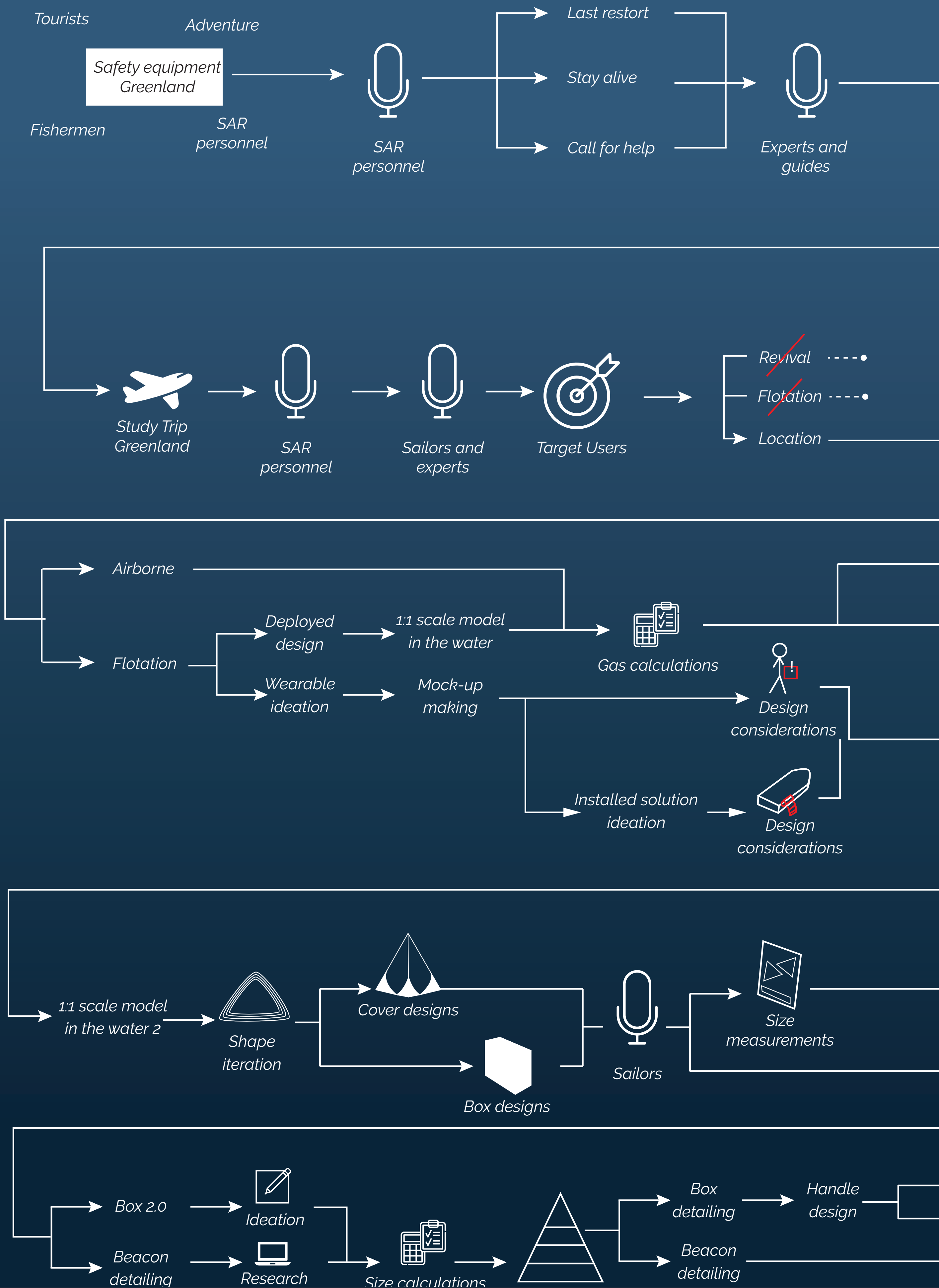
Purpose: - A tool for process tracking and planning.
Output: - Create an overview on how time is spent and create milestones or gates for the future process.
Usage: - The team have tried to plan ahead, but mainly used the tool for process tracking.

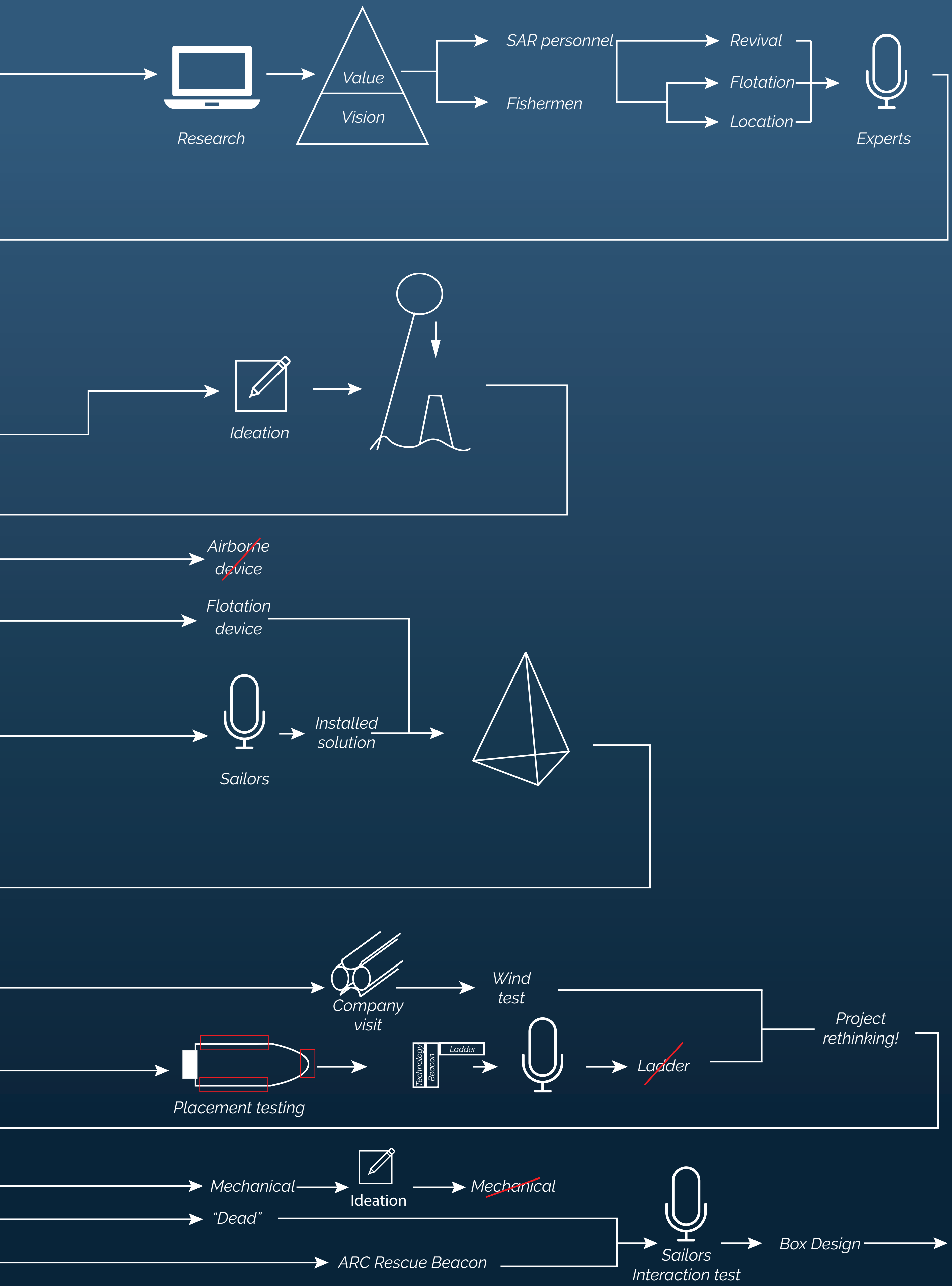
SCRUM meetings

Purpose: - Small pitch-like meetings with reduced time consumption.
Output: - Quickly get essential knowledge about subjects, problems or task progression.
Usage: - The team have used the daily SCRUM meetings to quickly address task obstetrical and in general to get task progression for all team members, when sharing knowledge.



Process Tracking




Research
Value
Vision
SAR personnel
Fishermen
Revival
Flotation
Location
Experts
Ideation
Airborne device
Flotation device
Sailors
Installed solution
Company visit
Wind test
Project rethinking!
Technology Beacon
Ladder
Ladder
Placement testing
Mechanical
Ideation
Mechanical
"Dead"
ARC Rescue Beacon
Sailors Interaction test
Box Design

Glossary

You can find explanation of shortenings and foreign words in the list below.

SAR	*Search and Rescue operations*
Arktisk Kommando / Joint Arctic Command	*The Danish/Greenlandic/Faroe Island enforcement of sovereignty through military presence*
Qilanngaq	*Greenlandic for the puffin; the unofficial national bird of Greenland*
JRCC	*Joint Rescue Coordination Centre*
NaviAir	*Private air-control company that surveillance the Greenlandic aerospace for crashes.*
DMI	*The Danish meteorological institute*
Nabo RCC	*Voluntary rescue organisation*
KNAPK	*The Greenlandic fishermen's union*
SOLAS	*International Convention for the Safety of Life at Sea (UN)*
Rigsfælleskabet	*The commonwealth uniting Denmark, Greenland and the Faroe Island*
PLB	*Personal Locater Beacon*
PCB	*Printed Circuit Board*
DSC	*Digital Selective Calling (maritime emergency broadcast technology)*
RLS	*Return Link Service (Galileo's smart satellite SAR signal which is returned to the users PLB)*
GUARD	*Aerospace's emergency radio channel*
PAN-PAN	*Authorities informs civilians to look out for suspicious actions or events. Highly used before initiating the actual SAR operation*
VHF	*"Very High Frequency" (standard description for maritime radios)*
Skerry	*A stone reef that often is hidden just underneath the waves.*

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Illustrations that haven't been marked are self made or own photographs.

Cases from sailors

Flares
Arctic Command reported a story of the ineffectively use of flares in Greenland. In bright daylight, the flares are nearly impossible to see. On a helicopter mission, where the distressed location was known, within a 5 km radius, the pilot was still unable to spot the injured. Only on the fourth flare and last flare was he spotted, saving his life. (W.018)

The Disappearing Family
Just a few weeks ago, a family of two adults and two infants disappeared in their boat from a small village in the Disco Bay. Even though start and end position, as well as eyewitnesses was known, after two weeks of searching with ships, civil, helicopters and planes they were not found. Two hunters have recently found the family dead on land, with evidence that all four have been alive and able to see the search planes, but incapable of signalling for help. (W.018)

Man Overboard!
The police of Nuuk told several stories of fishermen falling overboard for several seasons. Due to the temperatures and the wet heavy clothe is re-interring the boat impossible. Knowing that they soon faint by the cold, the fishermen tie their wrist to the boat, so that when the boat is found at least their corpse can be reunited with their family. (W.017)

Sinking Ship
Sailing in Greenland is part of the DNA and it is not uncommon to see small open boats with very strong motors attached. This proves one of the biggest dangers with the transom braking off, exposing the inside of the boat to water and sinking. Locals told us, that everyone know someone who is taken in by nature, never to be found again, which strengthen the respect to nature and the ocean. (W.016, W.017, W.019, W.020)

Product Brief

This page will briefly explain the endresult of this master thesis.

The ARC Rescue Beacon is highly visible beacon calling for help in an emergiency.

Packed in an convinient package placed on the rear outside of the boat where it is never in the way of the sailors work.

Technologies in the product

Following are the main technologies implemented in the final product concept.

DSC

Utilizing the VHF radio bandwidth with the 'Digital Selective Calling' which is used for maritime emergency distress calls with ranges up to 55 km away from the unit.

PLB

ARC Rescue Beacon will also broadcast a satellite based signal, which will be picked up by the nearest professional emergency service, to initiate a Search and Rescue operation. Your position can be located with a precision up to a 5 km perimeter.

Lights

Bright directional light signals for help for other sailors looking for you.

Radar/Thermal reflection

Reflecting surfaces heighten the chances for SAR to spot and find you with their equipment.

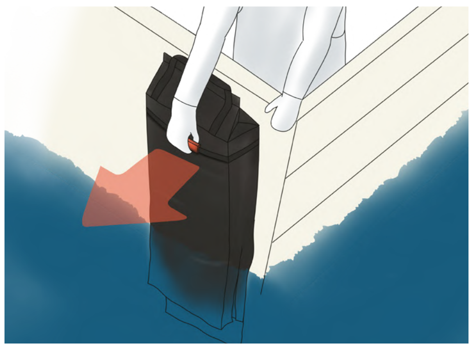
ARC Rescue Beacon

A single sailor emergency beacon for distressed at sea!

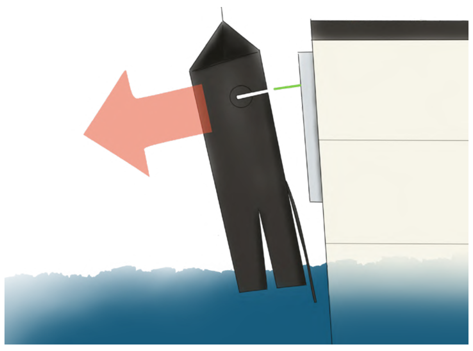
Product function scenario

This scenario sums up the features and interactions of the product in a final product scenario.
This shows both intended activation of the product and the full deployment process.

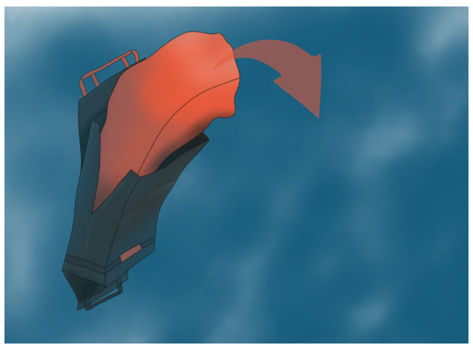
1: The front handle is pulled open revealing another handle protected underneath.



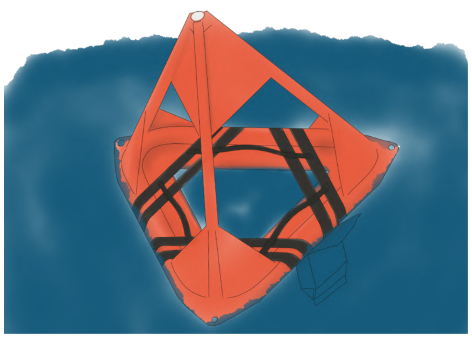
2: The second handle is pulled clicking the package of the boat mount and letting it fall into the water.



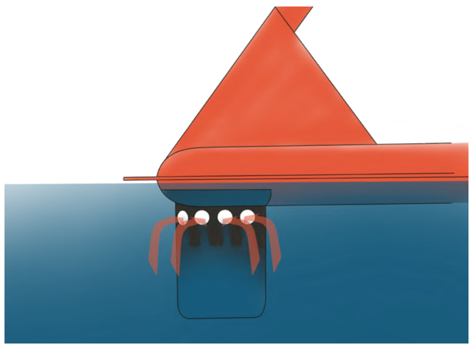
3: As product is pulled from the mount a split is pulled from gas valve starting the inflation and activating electronics.



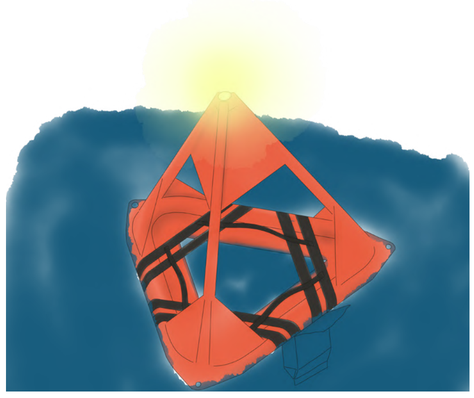
4: The beacon starts inflating and comes out of the package.



5: Beacon fully inflates and emerges from the water.



6: Anchors fill with water and keeps the product stable.



7: All this time the broadcasting has been initiated and will continue for up to 5 days.

See Technical folder for full product specification including elaborations!

ARC

Rescue beacon

Product report

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Sebastian Hougaard Andersen
Martin Lundberg

Group nr. MSc.4-ID06
Industrial Design
AAU
June 2019

Title page

Project title: *Rescue Beacon*

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Authors: *Peter Byrial Jensen, Sebastian Hougaard Andersen, Martin Lundberg*

Abstract

This master thesis, developed by Industrial Design engineer student at Aalborg University in collaboration with Arktisk Kommando, presents the development process behind a design proposal for aiding sailors in emergency situations in Arctic areas of the world. The product aims to deliver a more meaningful help for the distressed tailor-made for their situation without limiting the users mobility or function level when not in an emergency. As time is the most critical factor for survival when in distress in the extreme environment, the main purpose is the ability to signal help with the assistance of an inflatable beacon, that can be dropped from the boat, but also to ease the difficulty in finding the distressed in the Search and Rescue operations. The design aims to minimize the time before aid arrives, therefore also greatly improving the chance of survival for the distressed.

The design is based on a situated ethnological study of the sailors in Greenland, leading to a user centred design approach in the design phase. The solution and the sub principles presented is validated through small-scale tests and user-/stakeholder-based interviews and shows significant improvement to the current situation observed. The project resulted in an integrated design proposal which is specified in regards to construction, design, interaction and business case.

What you get in the package

A simple and practical solution fitting all smaller boats.

The box

A compact package with the inflatable Rescue Beacon with powerful PLB functionalities.

The mount

Easy to install and fits most boats. If it doesn't mount directly to you boat a simple adaptor can be bought separately.

Mount it and go on with your life.

The package is protected against the elements of the Arctic climate up to 10 years before service is needed. This means you don't have to worry about batteries or changing anything in-between trips.

ARC

Rescue beacon

How can a beacon device improve the chances of survival for distressed Greenlanders at sea, without being inconvenient when inactive?

Sailing in Greenland can be dangerous. Huge distances, lack of safety equipment, extreme weather and a small population makes search and rescue operations difficult. The sailors don't trust the current equipment and it's annoying to wear. The search and rescue personnel therefore have little chance of knowing that the sailor is in distress and struggles to know where he and his boat is.

The Annoyance Paradox

Travelling long distances by boat in Greenland is not uncommon. Trips to visit family, going to a social event, visiting cities with better shops or other similar things we know from our everyday life can be a journey for days by boat, in waters filled with skerries and temperatures far below 0° C. Therefore, if an emergency situation emerges, urgent response from others is critical.

Sailors don't trust the equipment

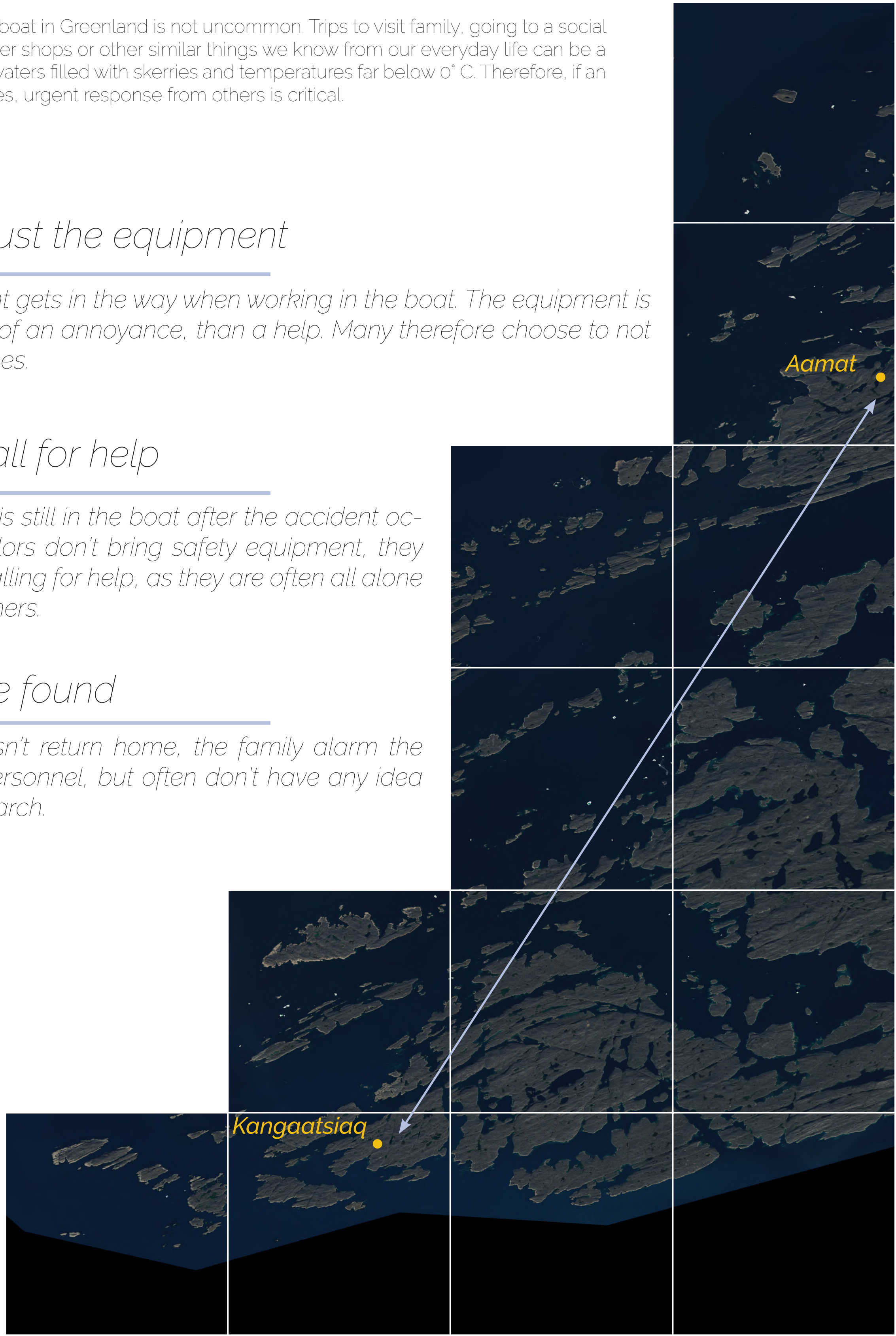
Most safety equipment gets in the way when working in the boat. The equipment is therefore much more of an annoyance, than a help. Many therefore choose to not bring it, on their voyages.

Sailors can't call for help

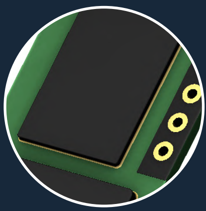
Most often, the sailor is still in the boat after the accident occur. But when the sailors don't bring safety equipment, they have no chance for calling for help, as they are often all alone and far away from others.

Sailors can't be found

When the sailor doesn't return home, the family alarm the search and rescue personnel, but often don't have any idea where to begin the search.



Safety, only when you need it!



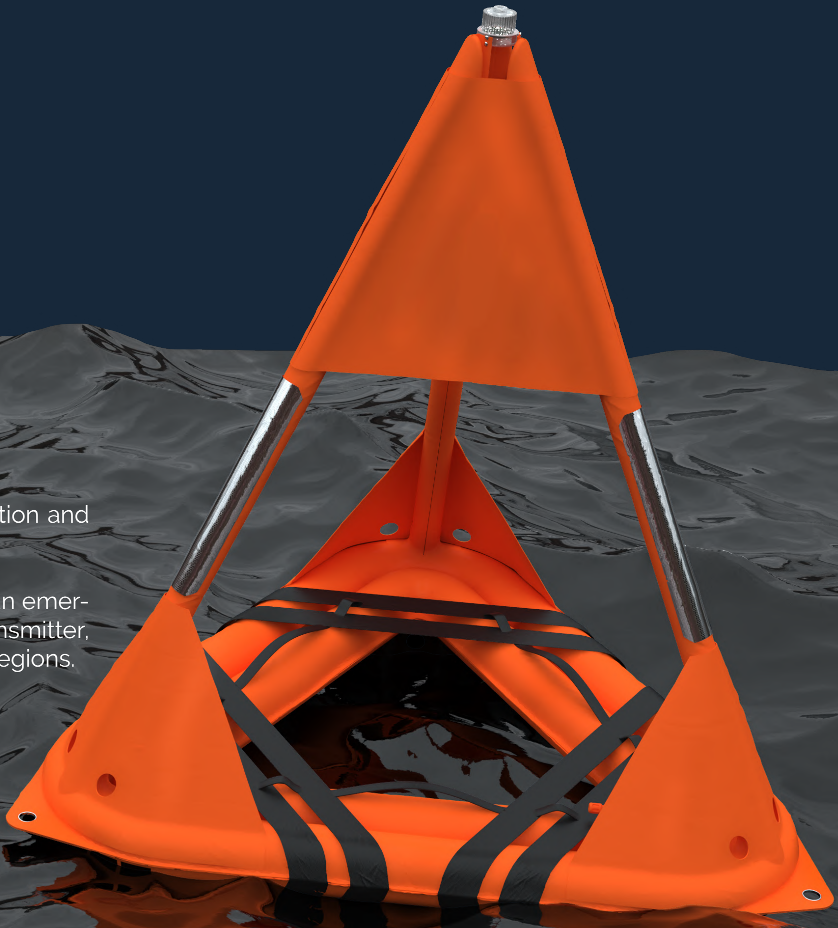
Call other sailors for help through modern emergency channels (DSC)

Call for help and give your location directly to authorities

Create the best chances to be found

Almost unnoticeable until you need it

Up to 5 days of active use



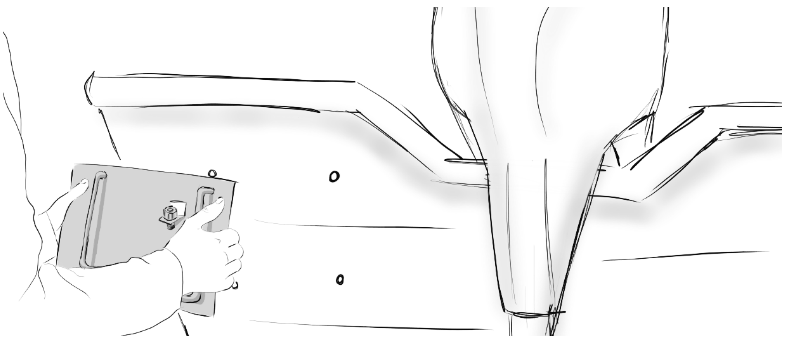
The Rescue Beacon is the first integrated communication and location tool designed for the Arctic climate.

Rescue Beacon gives the control back to the sailor in an emergency. The Rescue Beacon is a mobile distress call transmitter, that allows for class leading coverage even in remote regions.

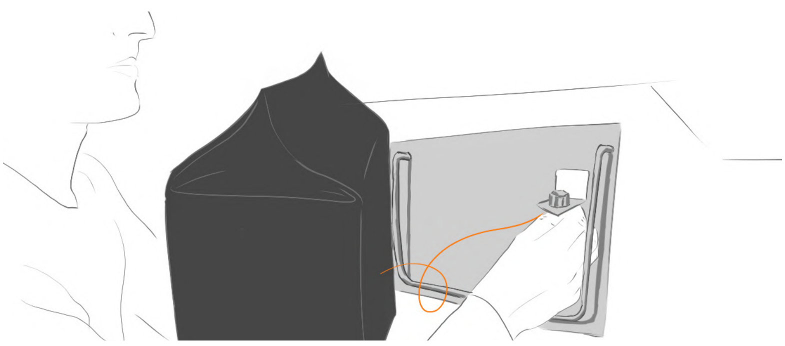
Product installation

The product comes pre-packed into a soft-box storage container, that the user can install on the back of the boat. The container is built from the ground up to withstand the harsh environment and cold climate for up to 10 year without service. Easy installation in minutes that doesn't affect your boats performance in any way. The mount also allows for quick detachment when the product needs service after the 10 year period.

Product Installation



Install the boat-mount to the boat - either side is accepted.



Attach the split wire to the boat mount.

Snap the box onto the boat-mount.

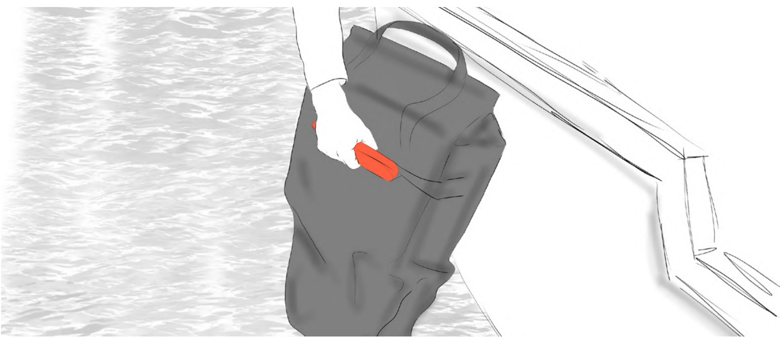

We **listen**
to your wishes
Zero annoyance, 100% safety
SUZUKI
60
PULL

Product Activation

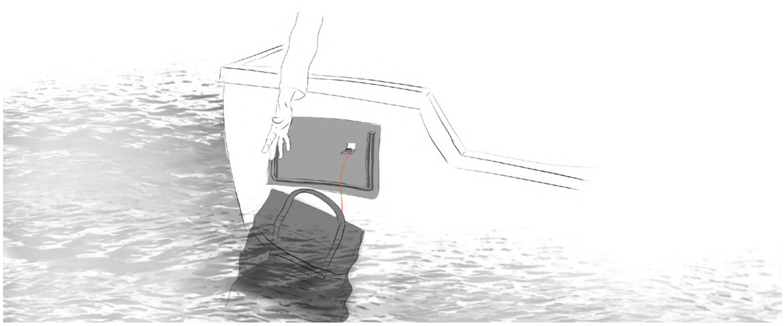
In any distress situation, activate the Rescue Beacon manually. When activating the product, the soft-box container will fall off the boat and open for the Rescue Beacon to inflate out of. The Rescue Beacon will begin to inflate and immediately start broadcasting the emergency signal, fully automated. That means that you can, from the first point, focus on the situation at hand instead of calling for help and wait to help arrives in your boat.

Product Activation

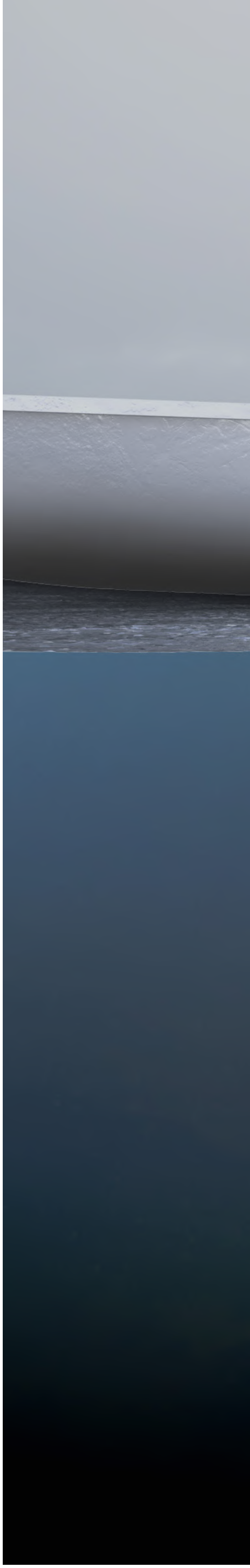
Pull the first orange handle to access the activation handle.

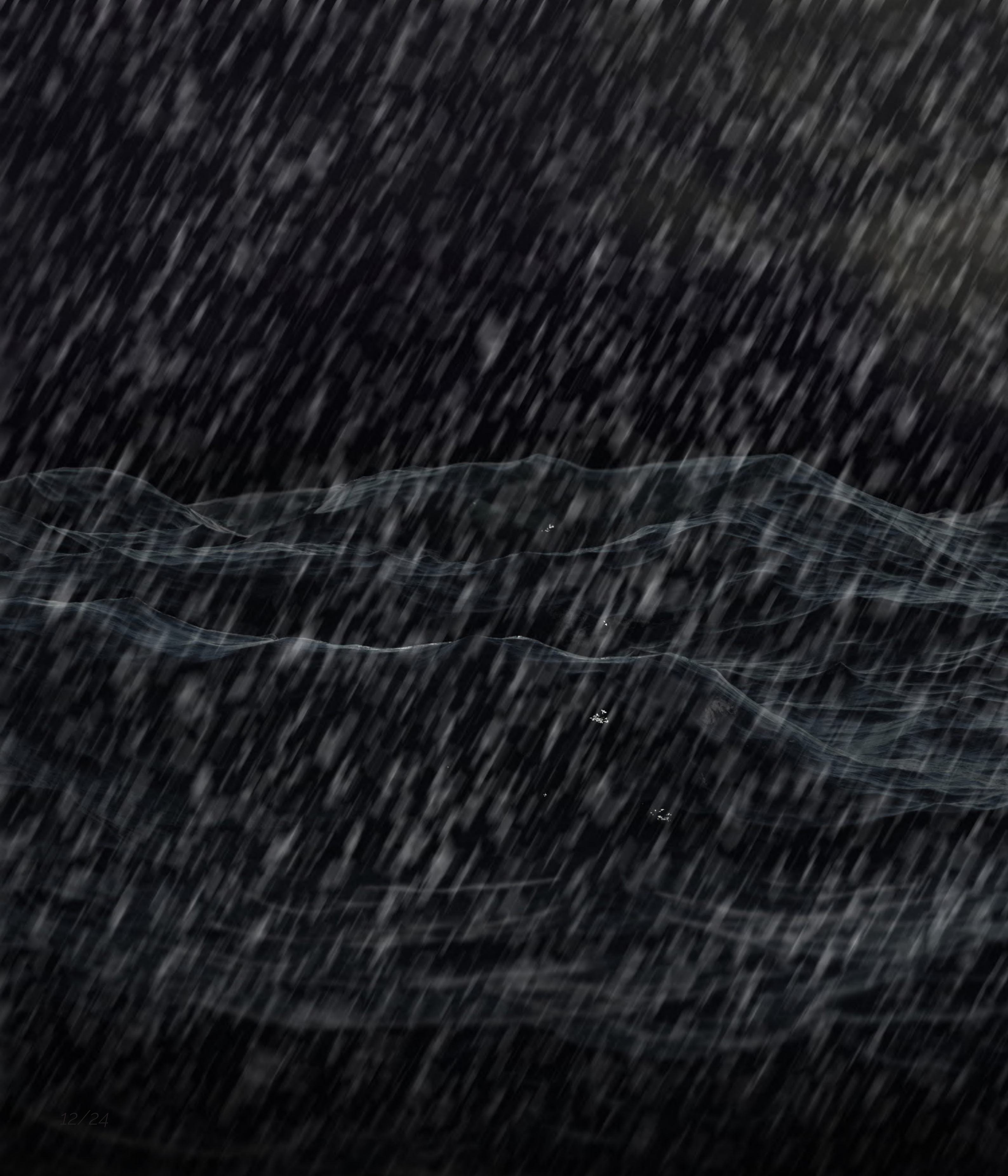


Pull firmly the orange activation handle away from yourself.



Make sure the box is fully detached from the boat mount.




12/24

Call for help!

No matter the situation, no matter the weather condition, the Rescue Beacon will act accordingly and make sure that the call for help will be heard by someone!

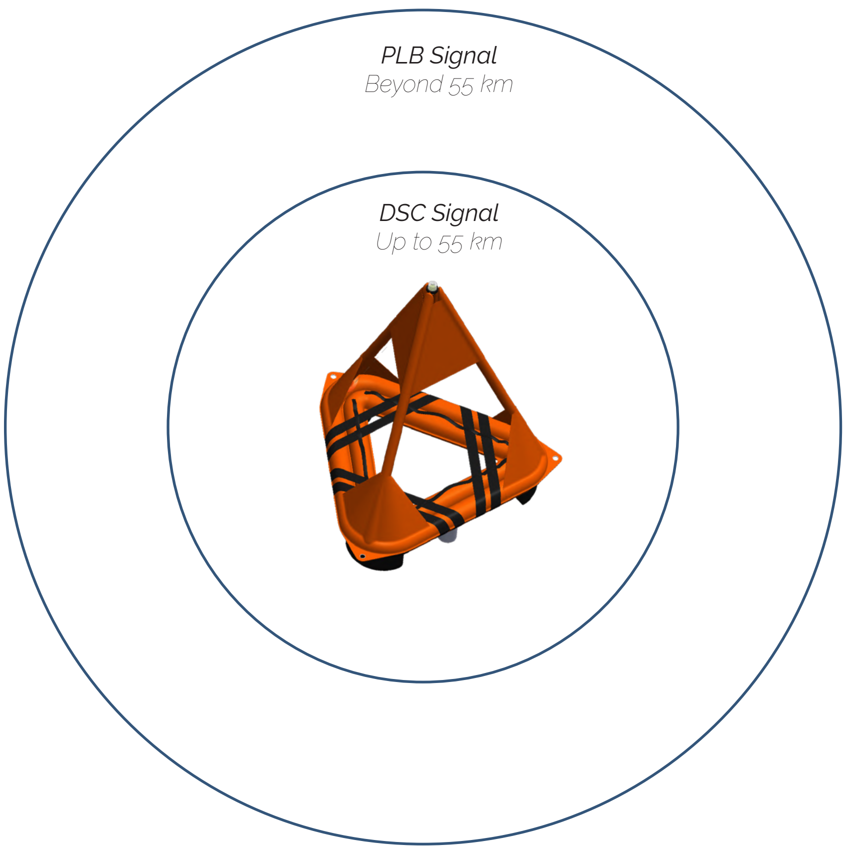
If a fellow sailor hears the DSC signal, help should arrive within 3-6 hours.
When the search and rescue personnel register the PLB signal they will arrive within 12-36 hours.

DSC signal

Utilizing the VHF radio bandwidth with the 'Digital Selective Calling' which is used for maritime emergency distress calls with ranges up to 55 km away from the unit.

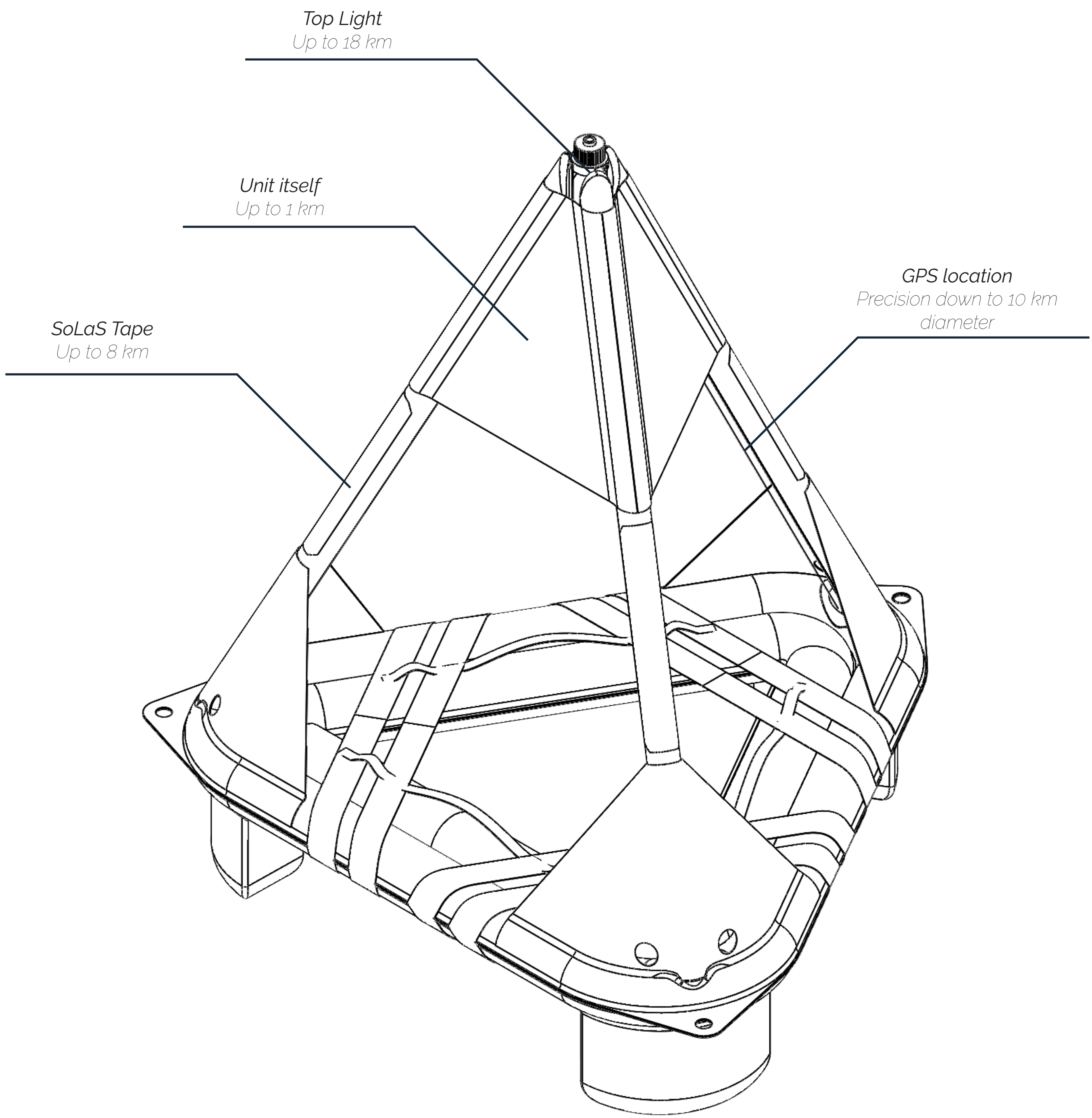
PLB signal

ARC Rescue Beacon will also broadcast a satellite based signal, which will be picked up by the nearest professional emergency service, to initiate a Search and Rescue operation. Your position can be located with a precision up to a 5 km perimeter.



Be located!

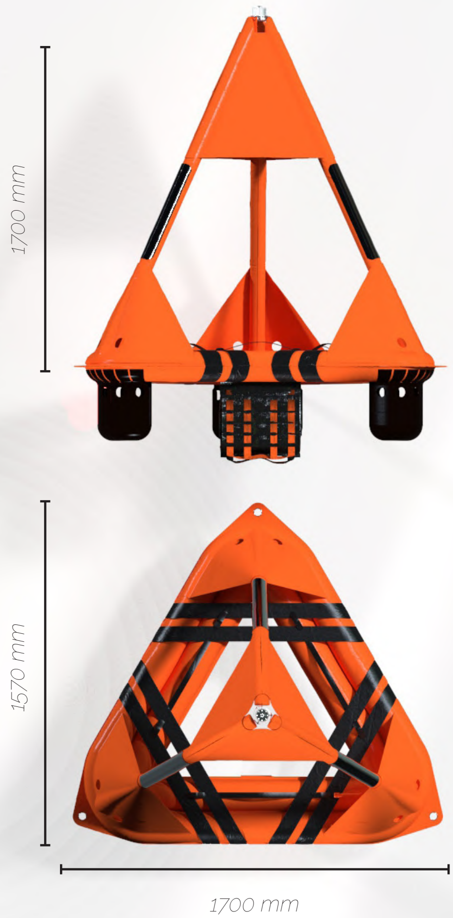
ARC Rescue Beacon makes sure, that the ones who are looking for you are able to see you, both at night and day and in all weather conditions!




Visible even in the dark
Highly radar visible
The Rescue Beacon's covers in the top is made of sheets of Mylar foil. This allows for thermal camera visibility if used by the search and rescue personnel.
High thermal visibility
Taking advantage of the Mylar foil allows for a radar reflective surface. When searching with radar or satellite based imagery, the Rescue Beacon will be visible.

Basic Specifications

Title	*Rescue Beacon*
Type	*Emergency Broadcast Buoy*
Dimensions	*Height: 1800 mm* *Width: 1700 mm* *Length: 1700 mm*
Operation temperatures	*Maximum +55˚C* *Minimum -55˚C*
Storage temperatures	*Maximum +70˚C* *Minimum -60˚C*
Materials	*1 mm thick reinforced PVC*
Colours	*Orange and black*
Other	*SOLAS reflective tape with visibility up to 8 km* *Emergency light with visibility up to 18 km* *Up to 5 days of operation* *Up to 10 years of storage*

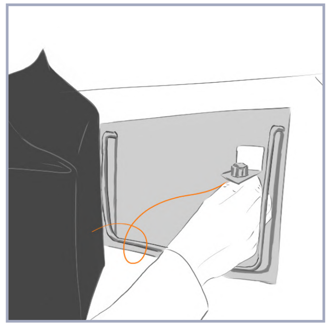



YAMAHA
Four stroke
PULL
Royal OC
SUZUKI
140
FOURSTROKE
PULL

Maintenance

If product has NOT been used

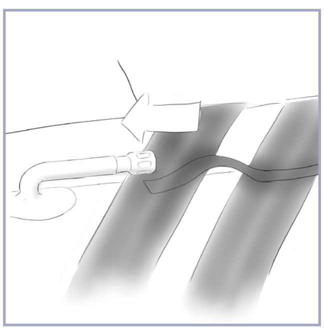
Detach the box from the boat mount.



Carefully remove the split wire from the boat mount.

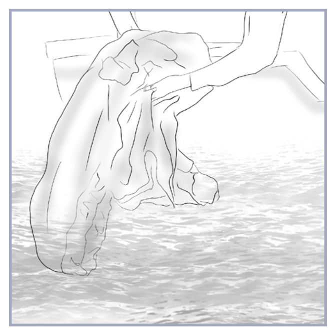
Please bring the container to a professional service provider. During the service, the Rescue Beacon will be checked for structural damage, change the batteries and dry air canister. The package is sent back afterwards to the user for reattachment to the boat.

If product has been used



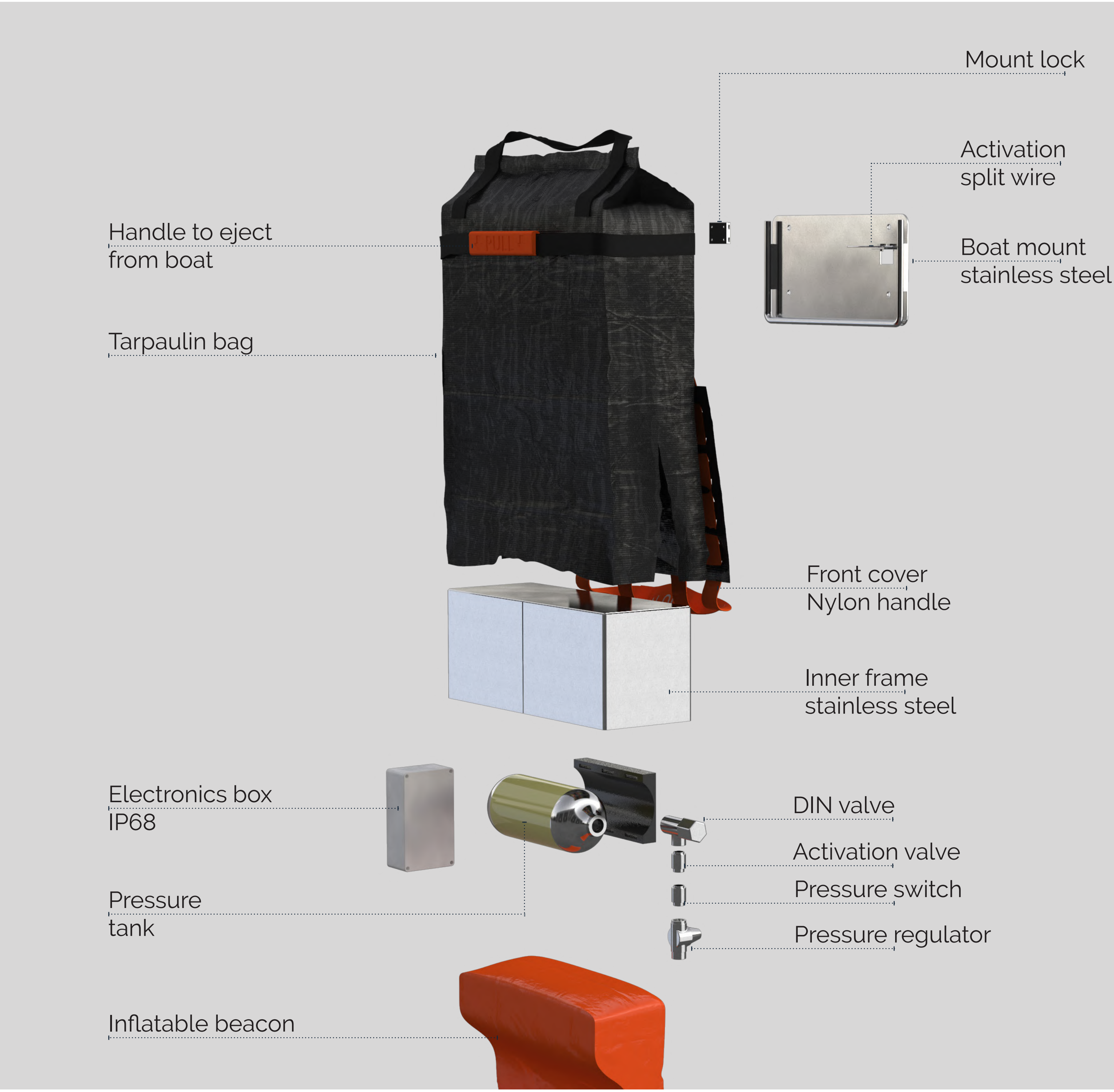
Deflate the beacon by opening valves indicated for deflation.

Access and rotate the top section on the lamp until light stops flashes.

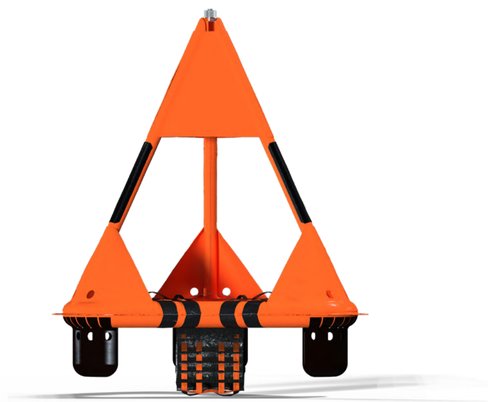


Gather the deflated beacon together.

Please make sure not to leave the ARC Rescue Beacon behind, when help has arrived. Instead, deflate the device and bring it to the professional service provider for service.


Mount lock
Activation split wire
Boat mount stainless steel
Handle to eject from boat
Tarpaulin bag
Front cover Nylon handle
Inner frame stainless steel
Electronics box IP68
DIN valve
Activation valve
Pressure switch
Pressure tank
Pressure regulator
Inflatable beacon

Price Comparison



	ARC Rescue Beacon	PLB, Flare, GPS, VHF-Radio, Life jacket, Flashlight...
Simple all-in-one solution	ARC Rescue Beacon solves the entire emergency situation	Up to six different devices needed
Calling for help	High signal strength for calling both other nearby sailors and the SAR personnel	PLB and VHF-radio
Improved Visibility	Highly visible with strong flashing light, orange colour, radar reflectivity and thermal visibility	Flare and Flashlight
Not in the way of work	Place on the outside of the boat where it will never be in the way your work	VHF and PLB communicators
Total Price	10.000 DKK	Estimated price of all necessary features +15.000 DKK

Contact your local KNAPK representative!

1. The ARC Rescue Beacon can be ordered directly through your local KNAPK representative. The Rescue Beacon will be delivered to you in no time.

KNAPK

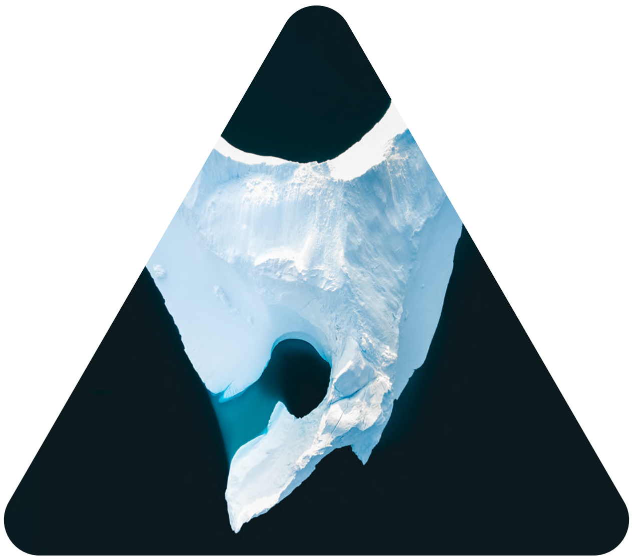
2. KNAPK will contact ARC and order a product, produced on-demand!

ARC
Rescue beacon

3. Install the product on the boat and get on with sailing!

4. Within 10 years, batteries and compression tank will need service. Simply send it in an we will fix it up for you in no time!

Available soon in...



ARC

A master thesis project

Appendix

Project title: *Rescue Beacon*

Report type: *Appendix*

Project group: *MSc. 4 - ID.6*

Main supervisor: *Louise Møller Haase*

Technical supervisor: *Jørgen Asbøll Kepler*

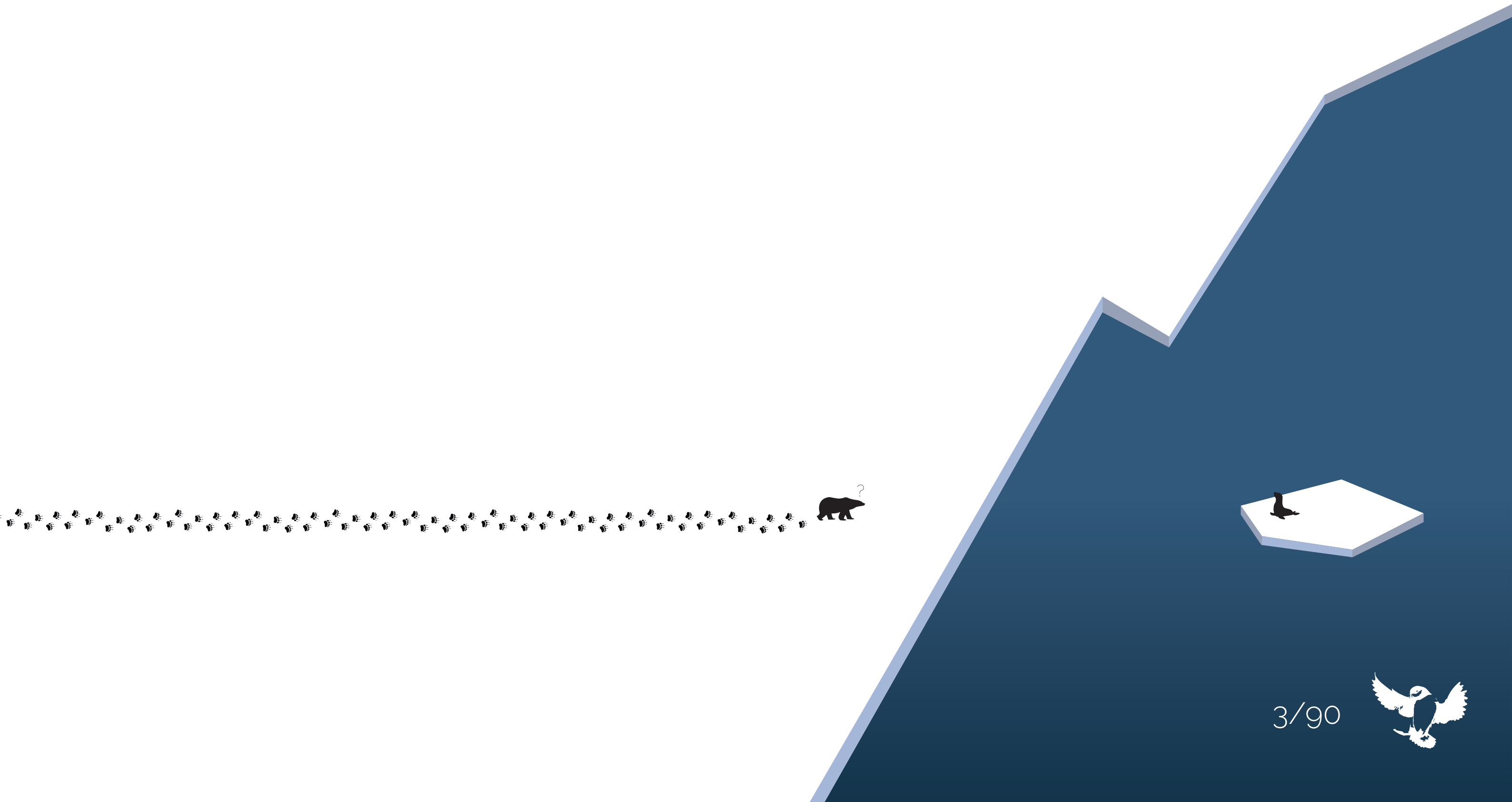
Project period: *February the 4th - June the 6th 2019*

Authors: *Martin Lundberg, Peter Byrial Jensen, Sebastian Hougaard Andersen*

Total pages: *31*

ARC
an AAU Master project

Content



A.01 Mail interview: Joint Arctic Command w/ Rasmus Kimer

Date: 25. Nov 2018
Interviewer: Sebastian H. Andersen
Interviewee: Rasmus Kimer, Chef Joint Operations Center at Joint Arctic Command.
Interview format: Mail

Goddag Rasmus,
Tusind tak for dit svar. Vi er en gruppe ingeniørstuderende fra Aalborg universitet, og i vores afsluttende kandidatspeciale arbejder vi med at udvikle udstyr til at forbedre Search and Rescue missionerne i det arktiske miljø. Vi er endnu i den indledende fase af vores projekt og vi søger på nuværende tidspunkt indblik i hvordan nuværende SAR missioner foregår og de problematikker/udfordringer der er ved disse. Det håber vi du kunne være behjælpelig med.

Følgende spørgsmål er hvad vi på nuværende tidspunkt søger svar på. Alt info er relevant, så hold dig endelig ikke tilbage med svarene, selv hvis du ikke er sikker på dets relevans.
Det er naturligvis også i orden hvis der er noget du ikke kan svare på.

1. Hvad går jeres daglige/ugentlige opgaver ud på i de to afdelinger?
Arktisk Kommandos operationscenter består af to dele; en JRCC, der alene varetager redningsopgaver I og omkring Grønland, og en JOC der beskæftiger sig med en bredere palet af militære opgaver og disponering af enheder.
De daglige opgaver for JRCC består af:
- Løbende kontakt til den Grønlandske kystkontrol (Aasiaat Radio), det Grønlandske politi og Air Greenland.
- Kontinuerlig monitering af skibs og flytrafik i og omkring Grønland samt i farvandet mod Canada og mod Island.
- Kontakt til alle skibe der rapporterer til Grønlands positionssystem (GREENPOS) hver sjette time.

2. Hvor mange er stationeret i Grønland?
For Forsvaret er ca. 80 personer udstationeret til Grønland, heraf er ca. 50 udstationeret til Nuuk, og resterende er fordelt på de stationer Forsvaret har rundt om hele den grønlandske kyst, samt Siriuspatruljens slædehold.

3. Hvilken uddannelse har reddere der deltager fast i search and rescue operationer?
AKO anvender mange forskellige typer af reddere kva de afstande der opereres på, generelt kan siges:
- Helikopterbesætninger har en redder ombord der muliggør at man kan gennemføre hoist af personer både om bord på skibe eller fra vand.
- Skibsbesætninger har et par dykkere, der udover de kurser også har særlige redder kurser der muliggør ombordtagning fra vand af tilskadekomne.
- Civile skibe, som vi typisk bruger har meget varierende uddannelse, hvor almindelige førstehjælpskurser og skibskistekurser er typiske.

4. Hvad er de typiske Search and rescue operationer, hvis man kan kategorisere dem?
I Grønland er SAR opdelt i tre typer, luft SAR (fly i nød), land SAR (personer i nød), hav SAR, (Skibe og besætninger i nød). De hyppigst forekomne er hav SAR hvor vi yderligere kategoriserer efter skibsstørrelser (over eller under 30 fods længde)

Hvordan bliver i typisk alarmeret om en mulig operation?
I dag kommer mange SAR opgave ind igennem automatiserede lokations beacons (EPIRB) der ved stød eller vand aktiverer og sender en melding direkte til os ved JRCC.
Alternativt bliver SAR ringet ind, enten fra pårørende for hvem deres familie ikke er kommet frem til aftalt tid eller igennem Grønlands Politi.

Hvad er det typiske forløb for de forskellige operationer? - hvad er fremgangsmåden fra at i alarmeres til slut?
Fra alarmering af starter alle SAR med en visitation om hvilken kapacitet eller enhed der bedst ville kunne håndtere situationen. Herefter allokeres en eller flere enheder til at assistere. Hvis flere end en kapacitet aktiveres, udpeges en stedansvarlig (OSC) til at tage praktikken på stedet for SAR uheldet.

5. Er der nogle bestemte ting der gør jeres arbejde meget besværligt?
Den største udfordring for arbejdet ved JRCC er de geografisk enorme afstande, der til tider bevirker at der kan være rigtig langt til nærmeste enheder der kan støtte i en SAR situation.
Udover dette så er kommunikation via primært satellitbaserede systemer en udfordring når man er så langt nord for satellitternes primære baner.

6. Har i et samarbejde med Grønlands politi? Hvis ja, hvordan samarbejdes der med dem?
Grønlands Politi har det primære redningsansvar på land, og ud til 3 sømil fra kysten – og der samarbejder vi ofte om at gennemføre redningsaktioner.
Det er AKO der har indsættelsesansvaret for redningshelikoptere i Grønland, og derfor samarbejder vi altid når der er behov for at indsætte en sådan.

7. Hvor mange operationer vil du vurdere der bliver udført årligt, når det kommer til Search and rescue i

jeres kommando?
Henover de sidste 3 år har vi i gennemsnit haft 80 reelle SAR operationer om året.

8. Vil du vurdere, at det er et stigende antal operationer der bliver afviklet år for år? Har du en ide om hvad årsagen er til dette?
Tallet er rimelig stabilt, dog ses der i sommersæsonen en lille stigning, baserede på en stigende turisme, og tidligere mulighed for at anvende Nordvestpassagen.

9. Hvad er det årlige budget til vedligeholdelse af udstyr (værktøj, køretøjer mv) samt hvad er rammerne budget til indkøb af nyt udstyr? Har i adgang til satellit kommunikationsudstyr (her tænkes på både opkald med lyd, men også live overvågning med satellitter)
I SAR tjeneste på Grønland anvendes stort set ikke landbaserede køretøjer eller værktøjer, men alene luft og søbårne kapaciteter. Jeg har ikke et overblik over den samlede økonomiske ramme til vedligeholdende af skibe og fly.
Vi har daglig adgang til satellit informationsudstyr (med live feeds), samt satellit kommunikation til data og voice.

10. Hvordan vurderes det hvor mange reddere der skal deltage i en operation? Og hvordan relatere det sig evt. til de forskellige typer af operationer?
Det er altid et vurderingsspørgsmål der hvilke på rigtig mange kriterier. Jeg lister lige et par af vores kriterier:
- Antallet af personer i nød
- Positionen (afstand til nærmeste kapaciteter)
- Farbarhed i områder (isbjerg, fjeldområder, uopmålte farvande.)

11. Hvad er de fem første ting, som er kritisk at vide når den første information kommer?
Position
Antal nødstedte
Redningsudstyr ombord
Situation
Kommunikationsmidler

12. Hvad er de typiske transportmuligheder som i anvender til at komme frem til lokationen?
Politiets indsættelsesbåde (SISAK)
Forsvarets skibe

13. Anvender i droner til at finde frem til mennesker? Hvis ja, hvilke typer droner bruger i? (Det er for at høre, om i bruger nogle med termiske/infrarød kamera? I hvilke situationer anvender i dem? - er det når i skal decideret lede efter dem, da i intet ved om deres lokation?
Vi er endnu ikke påbegyndt anvendelsen af droner. Primært på grund af disses rækkevidde.

14. Hvilke typer af mennesker er det, som bliver reddet i operationer? - er der tale forskere/fiskere/civile? Hvilke bliver reddet mest? og ser i stigninger i antallet af nogle grupper?
Det er ikke til grundlæggende at sige noget om typerne af mennesker.
Det er alt mellem rutinerede fiskere, lystfiskere, ekspeditionsrejsende og folk på vandreture.

15. Hvilke ting går oftest går galt i rednings aktionerne?
At de der skal reddes ikke har redningsudstyr med selv – eller ikke anvender det de har.
At folk tager afsted uden faste kommunikationsmidler.

Hvis spørgsmålene er for besværlige at besvarre på skrift via. mail kan vi også sagtens gøre det over et Skype opkald. Tidsforskellen gør os ikke noget. Vi passer os gerne ind efter jeres arbejdstider. Afslutningvis ville vi høre om du kan hjælpe os med at danne kontakt til ansatte inden search and rescue feltet som vi måske kunne interview i Danmark? Det ville hjælpe os en del med at forstå deres arbejde.

På forhånd mange tak for din hjælp.

Mvh.
Sebastian Andersen
MSc. Industrial Design Engineering, Aalborg Universitet

Conclusion
This interview provided great insight into the project framing and case study. It revealed that there as indeed a problem that could be worked with. It appeared as the main struggle was Search and Rescue operations at sea which includes both experienced sailors as well as fishermen and tourists.

The interview also revealed a curiosity of the lack of safety equipment on bard the vessel.. The team needed to find out why this was a problem.

The limited usage of drones for Search and Rescue indicates that there is a struggle with large distances in Greenland - this is to be verified.

With 80 operations a year it seems like they will get an emergency call every fourth day! This sees to be a lot simply because of the small population of Greenland.

A.02 Phone interview: Polog w/ Henrik P. Ølgaard

Date: Dec 2018
Interviewer: Sebastian H. Andersen
Interviewee: Henrik P. Ølgaard, COO at Polog.
Interview format: Phone

Notes from the interview:

Kulden
- Materialer knækker.. Materialeskøblighed: Kæden til slædehundene
- Jo flere funktioner et stykke udstyr har jo nemmere går det i stykker (Henriks egen erfaring)
- Mere fremkommeligt om vinteren isen giver et solidt underlag hvor man nemmere kan komme frem. Fly kan endda lande på isen.
Omkostninger: 'tommelfingerregel' 150kr pr kg. at medbringe.

Transport
- Helst med skib men ofte også med fly.

Afstanden til reservedele
- Man medbringer helst ingen reservedele da det er for dyrt. Man medbringer hellere to 500W generatorer end en 1000W selvom man skal bruge 1000W."
- Meget svært at få eksperterne til at bruge nyt udstyr. De holder sig klart helst til hvad de kender og ved virker.
Nemmere når der er vinter

Overvågning
Search and Rescue: Henrik ser også dette som et område behov for bedre udstyr. Meget svært at se folk både i vandet og på jorden/sneen. Primære problem er at områderne er så enormt store.
Tracking: Henrik ville gerne have at dem de har med til Arktis alle havde trackere på sig, men oftest vil kunden ikke have det.

Kig på
Svalbard er bedst at besøge da det er "billigt" og meget nemmere at komme til.
DTU – Arktis udstyrs uddannelse

Trusted (trackere)
Wellahaven (telt)
Lyst til nyt vs. Konservatisme

Vestersvig flyveplads

Conclusion
This interview was conducted because of an interest and need of understanding what professional logistics works with in the Arctic region.

The fact that multi-purpose equipment is used with hesitation is considered a crucial insight for the team, and to be used as further framing of the different concept development.

A.03 Interview: Ivik Jensen

Date: 15. Apr - 28. Maj 2019
Interviewer: Martin Lundberg
Interviewee: Ivik Jensen
Interview format: Facebook Chat

About: Ivik Jensen is a sailor and working fisherman, that the team first made contact with during the trip to Greenland. From the first meeting, the team has had several "interviews" with messages via Facebook.

Concept Development Presentation 01 (See A.16)
Martin: Hej Ivik. Så der nyt fra os! Det er nu en måned siden vi kom hjem fra Grønland, og en del er sket. Du har tidligere skrevet, at du/i gerne vil følge med i hvor projektet bevæger sig hen og vi er et sted nu, hvor vi meget gerne vil præsentere det vi sidder med pt. Ud af de tre koncepter vi startede med at præsentere, har vi valgt at arbejde med et personligt produkt til sejlere i de arktiske områder, der i nødsituationer kan forbedre deres muligheder for at blive fundet og dermed også reddet, hvis de ikke er i stand til at komme derfra selv. Produktet er et oppusteligt stykke værktøj udstyret med lys og radio kommunikation, som ikke kun alarmere om at man er i havsnød, men også øger synligheden af den nødstedte. Vi har allerede gang i en dybere udviklingsproces i forhold til placeringer af produktet inden det er slået ud (på kroppen eller i båden) og vi vil gerne skrive til dig igen snart når materialet er klart, vedrørende kommentarer på de 2 ideer. I forbindelse med indholdet, har vi et par spørgsmål. Oplever i at mange stadig vælger at sejle, enten for at fiske eller for almen transport, hvis temperaturen er -20˚C, -25˚C eller -30˚C? Netop fordi at produktet har en god flydeevne har vi indbygget de samme funktioner man ser i en redningskrans. Altså at hvis personen er kommet langt væk fra båden, kan man holde og spænde sig fast til produktet. På den måde at hæve overkroppen over vandet og øge overlevelseschancerne. Har du kommentarer til dette? Mvh Martin

Ivik: Synes i har gjort jer nogle gode tanker om selve produktet - jeres prototype/model havde i hvert fald potentiale, men jeg er spændt på hvordan forholdet mellem opdrift og produktets endelige størrelse og vægt spiller sig ud. Men det så positivt ud på billederne. Jeg har svært ved at finde spørgsmålet til brugeren, men jeg forestiller mig det er om vi synes det skal være et personligt eller fastmonteret apparat. Jeg søger selv en fastmonteret løsning, helt alvorligt - jeg sejler med flydedragt eller redningsvest, og burde bruge min dødemandsknap. Det sikrer mig i tilfælde af jeg falder i vandet under fart. Jeg søger et produkt der kan redde mig, hvis båden uventet går under. Det kan eksempelvis ske ved at der kommer hul på skroget, så snakker vi muligvis sekunder før den er væk.

Så... først skal der styr på et produkt og hvilken størrelse det vil have. Jeg vil anbefale at i tænker rigeligt opdrift til 200 kg, eller 2 personer, og derefter kigger på monteringsmuligheder. På de fleste nye MOB både placeres det automatiske redningsudstyr på radiobøjlen.

Martin: Rigtig mange fede inputs! Det hele er noteret, og især det med opdrift og stabilitet er ekstremt vigtigt for os. Vi har faktisk også valgt at arbejde med den installerede løsning på båden, da produktet vil fylde og veje for meget til at have på kroppen. - også det feedback vi har fået fra andre.

Indtil videre har vi hørt lidt om placeringen af det fastmonteret produkt, om siden af båden måske ikke er så smart - men enden, ved siden af motoren er bedst. Er du enig i dette eller har du andre tanker? De andre snakkede om at det måske ville komme i vejen når man havde båden i havn, eller brugte den til fiskeri.

Ivik: Jeg er enig i, at siden på båden er en dårlig ide. Enheden kommer, udover at blive tævet af vejr, i vejen for bådens sikre navigation samt for ethvert arbejde det går udover rælingen - fungerer IKKE på ydersiden af rælingen. Den vil blive smadret meget hurtigt. Har i kontakt med jolle producenten Poca? Det er den mest populære jolle i Grønland, og de bliver produceret i Danmark - mener de er i nærheden af Fredericia. Måske de er interesseret i at snakke med jer

Concept Development Presentation 02 (see A.17)

Martin: Så der nyt fra os! Vi arbejder stadig med et personligt produkt til sejlere i de arktiske områder, der i nødsituationer kan forbedre deres muligheder for at blive fundet og dermed også reddet, hvis de ikke er i stand til at komme derfra selv. Produktet er stadig et oppusteligt stykke værktøj udstyret med lys, radio og GPS kommunikation, som ikke kun alarmere om at man er i havsnød, men også øger synligheden af den nødstedte. I forbindelse med indholdet, har vi et par spørgsmål. Har i information på hvor lang distance sejlere "typisk" har til hinanden? Det er selvfølgelig et svært spørgsmål, men måske et sådan "worst / best case" scenarie ville hjælpe os meget til at formidle hvor alene/ikke alene sejlere på Grønland generelt er.

Ivik: Mht til konceptet - har i kigget på nogle af de lokaliserings redskaber der bruges i handelsflåden? SART, EPIRB osv..

Martin: korrekt, EPIRB er en maritim PLB. Årsagen til at vi bruger begrebet PLB er faktisk mest formidling, *da vores vejledere og andre videnspartnere ikke ved hvad EPIRB er.*

Ivik: *Yes, men SART'en har nogle fordele når selve redningsaktionen er gået i gang. Alle små og store fiskekuttere har radar for eksempel.*

Martin: *ah! det er noteret!*

Ivik: *Også distancen til hinanden... det bliver rigtig svært at svare på. Vi sejler nogle gange klods op og ned af hinanden og i andre tilfælde føler jeg mig absolut helt alene i hele verden. Og det er i Nuuk, hvor vi trods alt er 17.000 mennesker, i modsætning til eksempelvis Uummannaq hvor de knap er 4.000 mennesker. Oven i det, har man en meget begrænset synsvidde når man står i en jolle. Jordens krumning også videre. Jeg har ikke det absolutte tal, men det er forbavsende lidt man kan se hinanden.*

Ivik: *Så er der også skibstyperne. Det grønlandske redningsindsats koordineres mellem politiet og arktisk kommando. Til rådighed har de 1 Challenger fly, 2 meget gamle SAR helikoptere (en i syd og en i Kangerlussuaq), 3 politikuttere og 2-4 inspektionsfartøjer. Det skal dække hele Grønland. De har dog mulighed for at trække lokale kapaciteter ind, som hurtiggående charterbåde og fiskefartøjer der må ligge i området. Igen, kan der være rigtig langt imellem dem.*

A.04 Interview: Martin Hjort

Date: 15. Apr - 1. Maj 2019
Interviwer: Martin Lundberg
Interviewee: Martin K. Hjort
Interview Format: Facebook Chat

About: Martin is a sailor and working fisherman, that the team first made contact with during the trip to Greenland. From the first meeting, the team has had several "interviews" with messages via Facebook.

Martin: *Hej Ivik. Så der nyt fra os! Det er nu en måned siden vi kom hjem fra Grønland, og en del er sket. Du har tidligere skrevet, at du/i gerne vil følge med i hvor projektet bevæger sig hen og vi er et sted nu, hvor vi meget gerne vil præsentere det vi sidder med pt. Ud af de tre koncepter vi startede med at præsentere, har vi valgt at arbejde med et personligt produkt til sejlere i de arktiske områder, der i nødsituationer kan forbedre deres muligheder for at blive fundet og dermed også reddet, hvis de ikke er i stand til at komme derfra selv. Produktet er et oppusteligt stykke værktøj udstyret med lys og radio kommunikation, som ikke kun alarmere om at man er i havsnød, men også øger synligheden af den nødstedte. Vi har allerede gang i en dybere udviklingsproces i forhold til placeringer af produktet inden det er slået ud (på kroppen eller i båden) og vi vil gerne skrive til dig igen snart når materialet er klart, vedrørende kommentarer på de 2 ideer. I forbindelse med indholdet, har vi et par spørgsmål. Oplever i at mange stadig vælger at sejle, enten for at fiske eller for almen transport, hvis temperaturen er -20˚C, -25˚C eller -30˚C? Netop fordi at produktet har en god flydeevne har vi indbygget de samme funktioner man ser i en redningskrans. Altså at hvis personen er kommet langt væk fra båden, kan man holde og spænde sig fast til produktet. På den måde at hæve overkroppen over vandet og øge overlevelseschancerne. Har du kommentarer til dette? Mvh Martin*

Martin K. Hjort: *Hej igen. Der sejler om vinteren er for at fiske og fange. Der er ikke mange transport ture eller fragtture som sådan. Ved ikke om det er en god idé at holde kroppen over vandet med mindre man er overdækket og i læ for vind. - 20 eller under er slædeturs temperatur. Her i syd Grønland "Nuuk" er det sejlture. Ikke for sjov men for erhvervslivet fisker og fanger.*

Jep det at den hænge udenfor jollen er boob boob da der ligesom idag er overisning. Altså mest på siderne bag på båden er bedre. At de sidder på låret bedre men men. Var det ikke muligt at lave dem lidt som de der skulderstropper/retter. Lidt ligesom dem der retter ryggen når men er pukkelryggede.?

Martin: *Vi tænkte at hvis den sad ved skulderen, ville den være i vejen hvis du var på jagt med riffel? Og vi har desværre fundet ud af at produktet vil veje op mod 3 kg, som betyder at det vil trække meget i skulderen. Men mange tak for info! Du må gerne være 100% ærlig og gerne sige, hvis noget er totalt dumt, så bare sig det*

Martin K. Hjort: *Total dumt..... Bare det når man sejler, skal det over eller inden for tøjet?*

Martin: *Den skal sidde yderst på tøjet*

Martin K. Hjort: *Nåå så det er det sidst man tager på. Og det kan tåle vand og slag osv*

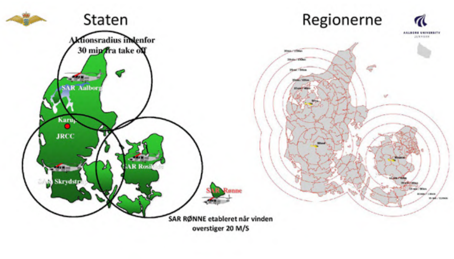
Martin: *Nemlig, der bliver stillet nogle ret hårde krav til produktet. Det er derfor, det faktisk er nemmere at have installeret på siden af båden. men rigtig god pointe med tilisning. Vi tænkte også, med siden af båden. At det skal holde til at andre både rammer ind i den, når de holder til i havnen. jeg smutter lige til frokost, men super fedt at du bare skyder løs med info. Det er virkelig fedt.*

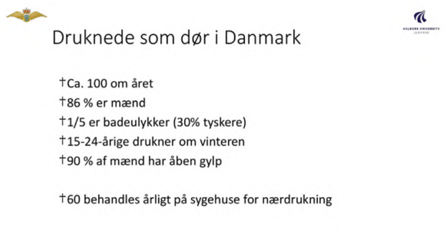
Martin K. Hjort: *Årsagen er at når men som erhvervsfiskere og fanger, så er arbejdspladsen ofte fra brystet og ned. Både med fangst såsom sæler og småhvaler. Fisk med garn og Line er det fra navlen og ned. Måske en plads ved siden at motoren er måske mere passende*

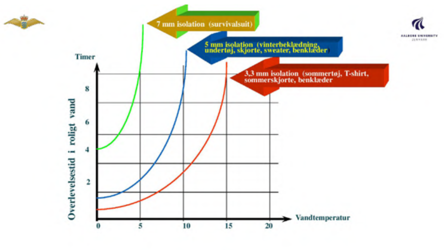
Martin: *Hvad er årsagen til det?*

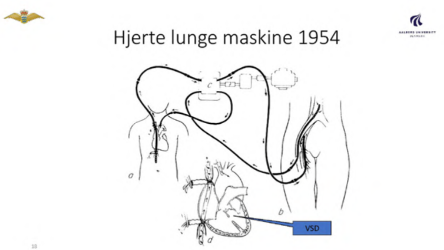
Martin K. Hjort: *Vi bruger ikke pladsen så meget og så er det stedet hvor der oftest er tættest på ræling eller motorbeslag*

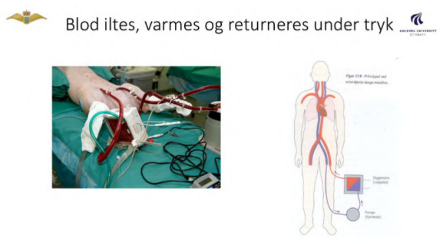
A.05 Presentation: Benedict Kjærgaard

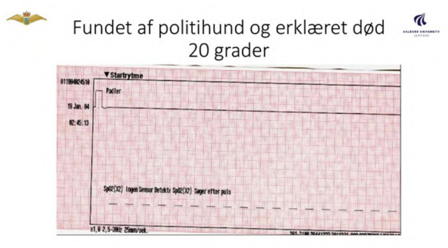












Asystoli, 2 timers hjertestop, 20 grader

Teoretisk inddeling

- < 35 °C let
- < 32 °C moderat
- < 28 °C svær

ABC kommer før opvarmning

☺ Vågen lettere	< 35 °C
☹ Bevidstløs moderat	< 32 °C
☹ Klinisk død svær	< 32 °C

Fysiologi

Nedsat perifer gennemblødning

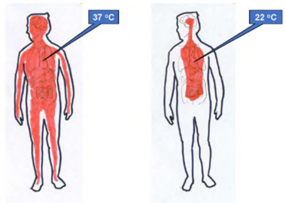
Kulderystelser

Øget fedtforbrænding

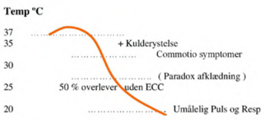
Vi kan næsten ikke mærke temperatur

Vi er gode til temperatur forskelle

Kroppens afkøling



Kroppens afkøling



Ved 7 grader er der ingen neuro-muskulær overledning

Iltbehov

37 °C = 100 %

20 °C = 20 % (CO_2 prod lav)

Hypotermi < 36°C
er hyppigste årsag til

Koagulations-Forstyrrelser

Hos traumepatienter

ATLS

Januar 2005

✈78-årig kvinde

✈GCS 6 – 8

✈Tp 25,8 °C

Så enkelt som muligt

Varm kun aktivt,
hvor der er cirkulation

Hypotermi kan være gavnlig

- 11 år, ½ time under vand
- Indbragt til Thisted
- Bevidstløs, kramper, lysstive pupiller, dårlig cirkulation
- Tp 28 °C

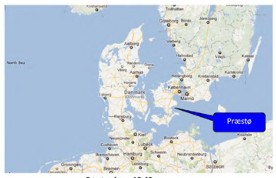
Overflytte drengen?

✈Helikopter til Thisted

✈Opvarmning til 33 grader med varm vand i pleuradræn

✈Herefter overflytning, men så svært hjerneskadet ud

Præstø 11 februar 11.22?



Første alarm 12.42

Hypotermihold på vej 14:07

På toppen af Rigshospitalet

På vej til lunge ECMO i Skejby senere

VF, temp 27 grader, livløs

Behandling

- Lettere: Vågne, forkomne:
  - varmt bad og varme drikke
- Moderate:
  - ABC
  - nogen kan varme op selv - andre varmes indefra
- Svær hypotermi:
  - HLR + måske hjertelungemaskine

Alle skal beskyttes

Man er kold og død ved

Manglende livstegn
&
Asystoli
&
Kalium i central blod > 10 mmol/l

SØSPORTENS 10 BUD

1. Lær søens færdselsregler.
2. Hold båden i orden.
3. Hold udstyr og rednings midler i orden.
4. Lær at sejle.
5. Undersøg vejrforholdene
6. Lær at svømme.
7. Vis hensyn overfor store skibe.
8. Ved kæntring bliv ved båden
9. Bland ikke spiritus og søsport.
10. Giv ikke anledning til unødig ængstelse - ring hjem.

A.06 Mail interview: Benedict Kjærgaard

Date: Mar 2019
Interviewer: Martin Lundberg
Interviewee: Benedict Kjærgaard - Clinical Associate Professor
Interview format: Mail

About: Benedict is an expert in hypothermia and revival techniques with victims who have hypothermia. He has been researching in the topic for many years, and is widely known for his work around the world.

Hej Benedict
Vi har arbejdet lidt videre med vores ideer fra sidst samt været på vores studietur i Grønland. Vi har dertil et par spørgsmål til det med at redde folk i de hypotermiske stadier.
Er der cases hvor personer er blevet genoplivet hvor deres kropstemperatur var under 20, 15 og 10 grader celsius?
Kan det være afgørende for behandling hvis redderne på forhånd ved:
- Alder på nødstedt
- Kendskab til sygdomme, allergier og evt. Sygforløb
- Tidsrummet for hvornår skaden er sket (stopurprincip)
- Tidsrummet for hvornår hjertestop indtraf (stopurprincip)
- Evt. Hvor længe personen har ligget nedkølet i vand (falde overbord)
Hvor mange praktisere proceduren som du snakker om, med at opvarme blodet mv. Eller er det et stigende fokus blandt læger?
Er det altid en god ide at pakke nedkølede personer ind i tøj/tæpper, når de bliver fundet?
Er det altid en god ide at fjerne vådt eller fugtigt tøj fra en nedkølet person?

Mvh
Martin, Peter og Sebastian

Benedict:
Den koldeste jeg har kendskab til er fra 1999, i Tromsø, hvor en person var 13,7 grader og havde hjertestop i 6 timer. Hun belv reddet, men systemet var ikke helt som i dag, og visse komplikationer var der. Hun er selv læge, svensker, selv om hun bor i Norge, Hu hedder Anna, og jeg får sommetider mails fra hende. Hun var faktisk for få år siden medforfatter på en artikel, der kun handlede om hende.
Præstø-eleverne var med temperaturer ned til 16 grader og blev alle reddet.
Detr med jhvad redderne ved på forhånd er dybest set lige gyldigt, idet men alliogevel aldrig kan være sikker, og de skal alle behandles lige godt inden de er på hospitalet. På hospitalet betyder det noget, og især livsbegrænsende sygdomme vil klart kunne begrænse brugen af de mest invasive indgreb såsom hjertelungemaskine med opvarmning af blodet, da der måske forudsigeligt vil komme komplikationer til dette.
Det med at opvarme blodet med en mobil hjertelungemaskine kan nu om dage foregå på universitetshospitaler, men i DK er vi de eneste med et udrykningshold.
Det er altid en god ide at pakke afkølede ind, så de ikke bliver mere kolde. Man skal passe på med skrive altid når det drejer sig om at fjerne vådt tøj. Det kræver at man har noget tørt at give dem på. Ellers skal de beholde det våde tøj og isoleres mod blæst,
Held og lykke med opgaven
Benedictw

Martin: *Hej Benedict*
Mange tak for svaret, det afklarer en helt masse for os. Det er altid lidt svært at snakke med vores vejleder om netop denne her type projekt, da universitet ønsker kvantitativ information (ligesom grafen, død på grund af kulde) imens vi kan se at det her ikke rigtigt kan ses på den måde men meget mere kvalitativt.
Så dine informationer give hjælper os meget mange tak!
Det kan godt ske at vi tager fat i dig igen, men samtidig vil vi også være ærlige og sige at vi tror at projektet går i en lidt anden retning der desværre ikke har så meget med hypotermi direkte.
Vi synes stadig emnet er sindsygt spændende! Efter et par gode med vejleder og netop nogle af de ting du nævner her så kan det godt betyde at vi ikke kan bringe så meget konkret på bordet som et resultat fordi vi ved for lidt om emnet + vores fokus område med jollefiskere i nød.
Men ihvertfald er vi super glade for at du havde interesse i os! Og hvis du nu skulle have lyst til at se hvordan projektet udvikler sig, vil vi gerne sende dig info undervejs. Flere i Grønland ville gerne, hvilket har betydet vi Ca en gang om måneden fra nu sender et dokument ud (1 a4) som bare lige formidler projektet.
Mvh
Martin Lundberg

A.07 Interview: Lars Stange Jensen

Date: 19 Feb. 2019
Interviewer: Peter Byrial Jensen
Interviewee: Lars Stange Jensen
Interview Format: Interview

GoMore interview med Lars Stange Jensen – officer i forsvaret og Geodatastyrelsen

- Poca joller er Grønlands svar på en bil
- Han er med til at optegne kystlinjer langs Grønland, men siger at dybtekort og GPS optegnelser sjældent passer sammen. Det betyder at det er nødvendigt med stor kendskab til farvandet og ekstrem forsigtighed
- GPS netværket er efterhånden brugbart over det meste af Grønland
- Isen på vestkysten er brudbar af større skibe, men langs østkysten er det skrue is, som kan være 4-6 meter højt og skabe problemer for selv forsvarets skibe.
- Foreslår at vi snakker med politiet i Nuuk der også hjælper med nødstedte til havs.

A.08 Mail interview: Niels Johannes Kritmøller

Date: 15. Apr - 1. Maj 2019
Interviewer: Martin Lundberg
Interviewee: Nils Johannes Klitmøller
Interview Format: Facebook Chat

About: Nils is an educated chemist, that Martin learned to know through his internship at Asetek. Nils has throughout the project helped with initial knowledge for quick guidance for the team.

Martin: *I vores kandidat projekt arbejder vi med redningsudstyr i det arktiske klima i Grønland, da der hvert år foretages mange search and rescue operationer fordi jollefiskere kommer i nød. Vi har fundet ud af at der skal en ballon til at løse produktet, så de her reddere nemmere og hurtigere kan finde de nødstedte. Har du nogle fede ideer til hvordan vi kan lege med forskellige typer af opdrift? Da vi skal afprøve nogle forskellige ting. Indtil nu har vi prøvet lattergas og varme via alm olie til en olielampe. Men jeg tænker du har nogle fede ideer.*

Nils: *Altså, taler vi en luftballon?*

Martin: *Jah det kan man godt sige, men vi er bare ude i at høre om alle muligheder for at få en luftballon til at komme op i luften. Vi er ved at prøve og se om vi kan teste med den type kul som fx bruges i en engangsgrill da de er hurtigt antændelige. Men vidste ikke om der være nogle Spændende kemiske ideer hvis man blandede noget/brændte noget. Alle muligheder er faktisk accepteret.*

Nils: *Den er svær! Altså gasser olier osv er i forvejen det mest energiholdige man kan komme i nærheden af, og er nemt at brænde kontrolleret*

Martin: *He he jaaah det er ikke sådan man kan lave noget lækkert kemi med noget salt og nogle gasser eller noget? skabe en kemisk forbindelse som kan generer varme måske? fordi den "nemme" og faktisk dyre løsning er bare at bruge helium. Men det kunne jo være fedt hvis der var nogle andre spændende løsninger.*

Nils: *Altså hvis det er ligemeget hvor farligt og upraktisk det er, så er der masser af muligheder! F.eks. dannelse af hydrogen med saltsyre. Hydrogenen kan enten bruges som let luftart der svæver, eller brændes af for at danne varme (tænk kontrolleret Hindenburg) Eller kaliumpermanganat/aluminium pulverr som antændes ved at dryppe noget glycerin på. Blandingsforholdet mellem alu/KMnO4 bestemmer om det springer i luften eller bare brænder hurtigt*

Martin: *Vi søger lidt mere ekspert viden. Lige kort så har projektet udviklet sig en del, og vi laver nu et oppusteligt produkt. Dertil vil jeg høre om du har noget info, som vi kan læse lidt op på med følgende: Puste et objekt op med compressed air vs. CO2. indtil videre er det eneste vi kan se forskel i, er de trykflasker, om den sikkerhed, som er ligger bag hvordan luft-trykflasker skal opbevares pga brændsikkerhed, hvor CO2 er "ligeglad". Men mere, hvis vi skal puste et produkt op med luft i -40 grader atmosfærisk luft, hvorfor skulle man vælge luft og hvorfor skulle man vælge CO2 - det har vi lidt svært ved at finde et ordenligt svar på.. Så tænkte om du havde noget litteratur, eller et svar på det?*

Nils: *Jamen i så koldt vejr er det helt klart komprimeret atmosfærisk luft der er at foretrække. Luft følger nogenlunde idealgasligningen, så et fald i temperatur ændrer kun en smule på trykket. CO2 derimod er ret langt fra en idealgas, så et lignende fald i temperatur sænker trykket drastisk, og der kan også dannes tøris i processen (fast CO2) = en CO2 drevet oppustningsmekanisme i -40°C tager meget længere tid end en med komprimeret luft*

Og ved -40°C kan du ikke få meget højere tryk end 20 bar i en CO2 beholder før det bliver til tøris. Så der skal også en større beholder til Atmosfærisk luft er faktisk også mere sikkert end CO2, da CO2 forgiftning kan forekomme.

Martin: *Vil det sige at hvis jeg fylder en beholder med co2 ved 50 bar og så tager den med til Grønland så vil trykket sænkes til 20 bar pga co2 egenskaber?*

Nils: *Det er fordi man sådan set kommer under kogepunktet ved det tryk. Så den reagerer ved at blive til fast tøris, og derved sænke trykket i beholderen.*

Martin: *Men genvinder vi ikke trykker når vi tømmer beholderen igen? Eller skal vi varme beholderen op for at få maksimal volumen ud?*

Nils: *Jo, trykket i beholderen burde holde sig konstant indtil al CO2 er på gasform igen. Men det vil være besværligt*

Martin: *Så du vil anbefale at vælge luft pga dens egenskaber mv. Food for thought*

Nils: *Absolut!*

A.09 Mail interview: Joint Arctic Command w/ Michael Hjort

Date: Apr. 2019
Interviewer: Martin Lundberg
Interviewee: Michael Hjort¨, Cheif Joint Arctic Command
Interview Format: Mail

Concept Development Presentation 01 (See A.16)
Martin: *Så der nyt fra os! Det er nu en måned siden vi kom hjem fra Grønland, og en del er sket. Du har tidligere skrevet, at du/i gerne vil følge med i hvor projektet bevæger sig hen og vi er et sted nu, hvor vi meget gerne vil præsentere det vi sidder med pt.*
Ud af de tre koncepter vi startede med at præsentere, har vi valgt at arbejde med et personligt produkt til sejlere i de arktiske områder, der i nødsituationer kan forbedre deres muligheder for at blive fundet og dermed også reddet, hvis de ikke er i stand til at komme derfra selv. Produktet er et oppusteligt stykke værktøj udstyret med lys og radio kommunikation, som ikke kun alarmere om at man er i havsnød, men også øger synligheden af den nødstedte.
Du er nok interesseret i hvorfor vi fravalgte ballonen i luften. Det gjorde vi af flere årsager, herunder bl.a. komplikationer med mængden af helium/hydrogen til at løfte ballonen samt den begrænsede størrelse af produktet. Tommelfingerreglen lyder 100 liter til 100 gram materiale og gassen siver ud af en trykflaske allerede med moderat tryk.
I forbindelse med indholdet, har vi et par spørgsmål.

- Oplever i at mange stadig vælger at sejle, enten for at fiske eller for almen sejlads, hvis temperaturen er 20˚ C, 25˚C eller 30˚C?
- Vi arbejder med at lave produktet så stort som muligt for højest synlighed, men tænker stadig på at brugeren ikke skal døje med et klodset og tungt produkt, når det ikke er i brug (som det er meste af tiden). På nuværende tidspunkt ser vi at det er realistisk at skabe et produkt på 1,5 til 2 meters højde og et masse på ca. 11,5 m^3. I hvor stor grad, vil du/i vurdere at det forbedre synligheden fra de eks. støtteskibe, helikopter og Challenger?

Michael: *Tak for det fremsendte og hermed svar på de stillede spørgsmål omkring:*
- At sejle ud i minus 20, 25, 30 grader gælder det mest for de koldeste områder af Grønland, hvor fiskere og fangere tager ud, hvis vejret er godt (ingen vind og nedbør). Det er der sjældent hvis temperaturerne er så lave som ovenfor nævnt.

Om synligheden vil forbedres – Det vil den givet.

A.10 Phone interview: Henning Christensen

Interviwer: Martin Lundberg
Interviewee: Henning Christensen
Interview Format: Phone interview

About: Henning is a Martins uncle, how have worked in maritime radio manufacture and satellite company T&T in R&D (Research and Development).

Interview 1: Date: 18. Apr 2019

Martin: I vores kandidat projekt arbejder vi med redningsudstyr i det arktiske klima i Grønland, da der hvert år foretages mange search and rescue operationer fordi jollefiskere kommer i nød. Vi vil gerne have noget teknologi ind i produktet, for at gøre det nemmere at finde sejlere.

Hvordan er det VHF virker? Kan flere tale på samme tid?

Henning: Nej, på VHF båndet kan kun én person tale af gangen. Den er præcis som en Walkie-Talkie.

Martin: Okay, så det med DSC, det er lavet for at gå unden om VHF båndet?

Henning: Ja præcis. DSC er også digitalt, mens VHF er analog. Så de to systemer er faktisk uafhængige af hinanden. Det DSC bruger en anden frekvens end VHF'en, og så sender den konstant et digitalt signal ud. DSC'en bruger samtidig GPS lokation, for at fortælle andre om dette.

Martin: Så det er ikke muligt at lave et pre-recorded bånd, og sende ud på kanal 16, som er nød kanalen?

Henning: Nej, det er ulovligt at sende noget på den måde. Det skal ske med at han selv siger det, eller via DSC.

Martin: Men DSC kræver det ikke en maritim GPS?

Henning: Det kræver bare en GPS. I dag fylder det jo intet, så selv håndholdte VHF radioer kan fås med GPS, så de endda har indbygget DSC. Så i skal bare tage og kigge på sådan en.

Martin: Cool. Hvad med signalstyrke? Vi er lidt i tvivl om antenne længden.

Henning: En tommelfingerregel er sendefrekvensen / 300 og så ¼ bølge. Som er ca 0,5 meter for alm VHF til indbyggede løsninger. Håndholdte har kortere antenner, og kan derfor ikke række så langt.

Martin: Mange tak for info!

Henning: Ja, og det er det samme med PLB.

Martin: Cool. Hvad med antallet af antenner. Skal man dele det op eller?

Henning: Man kan sagtens kører de 2 systemer over én antenne. Det gør man i forvejen med smartphones - med endnu flere frekvenser både digitale og analog. Man kører bare filtre i mellem frekvenserne.

Interview 2: Date: 11. May 2019

Martin: Hej igen, vi har lige nogle opfølgende spørgsmål om DSC funktionalitet. Det første drejer sig om hvor meget strøm der skal bruges til at broadcaste det her signal.

Henning: Det er selvfølgelig meget forskelligt, men hvis i går med 5 W ved 50 mAh eller mindre, så er i godt kørende. Det er noget med at der er en virkningsgrad på 70% af signalet, så i burde være godt dækket ind ved de 5 W.

Systemet sender jo ikke konstant, men en til tre gange. Efter mindst én har modtaget og svaret på signalet. DSC giver mulighed for at sende besked tilbage til den nødstedte at hans signal er blevet modtaget - om så GPS lokation var muligt eller ej, signalet er stadig modtaget.

Ved brug af DSC skal i huske på, at det er vigtigt at registrer sin båd med ID, så folk ved hvem de leder efter - og en formodning om hvor mange der er i nød.

Martin: Men der er ingen regler med at registrere joller i Grønland.

Henning: Nej okay, så skal der måske bare registereres personlig data, navn og antal, så burde det kunne løses.

Martin: Det lyder godt, hvad med VHF. Da de 2 systemer måske ikke kører sammen, kan man da undlade VHF delen?

Henning: Ja og nej. DSC sender på 156.525 Mhz, så i princippet kan man godt undlade det du mener med VHF (walkie talkie delen), men de sender på næsten samme frekvens.

Martin: Det lyder godt, hvad med antenne? Kan vi køre det hele på samme antenne, og evt. bruge samme kabel som strømkabel til lampen i toppen af vores produkt?

Henning: *I princippet ja. Hvis i har adgang til at have en 5/8 del antenne, så burde der slet ikke være problemer for jer.*

Martin: *Mange tak!*

Interview 3: Date: 16. May 2019

Martin: *Hej igen, vi har lige nogle opklarende spørgsmål. Nu når VHF er landbaseret, og vi har fundet en kilde på at den ca rækker 55 km, er det så "line of sight"?*

Henning: *Ja det er korrekt. Man kan godt få det til at række lidt længere, men det kræver stationer der kan opfange og styrke signal styrken - antenner i princippet.*

Martin: *Ja okay, det er ikke noget de har til havs normalt vel?*

Henning: *Nej, kun nær kysterne typisk ved redningstationer eller politistationer.*

Martin: *Vil det sige at de 55 km kan blive reduceret af fx isbjerge?*

Henning. *Ja det kan det sagtens. Det er altid svært at estimere hvor meget du i teorien vil miste af sende styrke, men signalet kan jo ikke komme igennem alle materialer på grund af materiale og tykkelse, men et isbjerg eller et almindelig bjerg kan sagtens reducere signalstyrken. Merkant endda. Hvis der er tåge eller tung regn vil signalet også blive ødelagt og få reduceret styrke på grund af vandpartiklerne i luften.*

Martin: *Mange tak!*

A.11 Mail interview: Joint Arctic Command w/ Klaus Dupont

Date: Apr - May 2019
Interviewer: Martin Lundberg
Interviewee: Klaus Dupont, Duty Officer Joint Arctic Command
Interview Format: Mail

Martin: *Her er den vi sendte ud til vores videnspartnere fra start april. Jeg har faktisk også et spørgsmål som jeg vil høre dig om hvem betaler for SAR operationer? I Danmark vurderes det vel om der var tale om dumhed eller en ulykke, da "dumhed" kan risikeres at blive betalt af den nødstedte selv. Er det, det danske folk/stat som også betaler for SAR i Grønland og Færøerne? Der kommer en ny (måske også med lidt spørgsmål) i slutningen af april. Mange tak fordi du vil bruge tid på at hjælpe os! :)*

Klaus: *Godt at høre fra jer!*
Heroppe er det som udgangspunkt staten der betaler. Politiet har i enkelte tilfælde efterfølgende sendt regninger til de reddede, f.eks. hvis redningsaktionen blev startet på baggrund af manglende meldinger i tvungen meldesystemer.

Er I gået væk fra "ballon" ideen?

Martin: *Ja desværre. Vi fandt for mange komplikationer ved ideen. Det gik op for os a hydrogen og helium, som var de bedste gasser, ikke har en "god" løfteevne. Ved stue temperatur kræver det groft sagt 100 liter gas til 100 gram materiale. Denne løfteevne bliver ringere og ringere ved faldende temperatur. Begge gasser har lav densitet og siver derfor nemt gennem materialer. For at holde en beholder skal holde sig svævende ved stuetemperatur i over 48 timer kræver det en dyr behandling på indersiden. Som desværre hæver vægten yderligere. Selve trykbeholderne har udløbsdato grundet gassen langsomt vil sive ud og sænke trykket. Selve udløbsdatoen er stadig ukendt for os men noget tyder på 1 år. Begge gasser er dyre, hydrogen er nemmest at få fat i da man kan bruge det til at svejse med. Så alt i alt, mange komplikationer, som risikerede at løsningen ikke ville være for god, som vi også snakkede meget med vores vejleder om. Så vi valgte at tage ballonen og fylde den med co2 og så have den på jorden/vandet i stedet.*

Hej Klaus
Du skal heller ikke snydes for en projekt opdatering. Vi arbejder stadig med et personligt produkt til sejlere i de arktiske områder, der i nødsituationer kan forbedre deres muligheder for at blive fundet og dermed også reddet, hvis de ikke er i stand til at komme derfra selv. Produktet er stadig et oppusteligt stykke værktøj udstyret med lys, radio og GPS kommunikation, som ikke kun alarmere om at man er i havsnød, men også øger synligheden af den nødstedte. Jeg har vedhæftet 2 PDF'er som går mere i dybden med konceptet vi arbejder på.

Hvis du har mulighed for det, har vi også en række spørgsmål, som vi forsøger at finde svar på:
Hvad er dine tanker om den fysiske størrelse af produktet i relation til at blive set?
Med lys i et par meters højde, er sandsynligheden væsentlig forbedret i forhold til at ligge i vandet og maks stikke 30 cm ud af vandet.

Hvad er dine tanker om den teknologi vi arbejder med (VHF med DSC + PLB)? Ser i problemer eller fordele ved disse?
Synes det er rigtig fint og en god combo. Cospas Sarsat til at få sat aktionen i gang umiddelbart efter ulykken og VHF til dirigerer enheder ind, herunder evt. fly der ikke kan lande i terrænet.

Hvordan arbejder i med PLB signaler med modtagelse og behandling af signaler deraf? Hvor hurtigt kan i reagere på en modtagelse af et signal?
COSPAS sarsat systemet er automatiseret. Helt konkret for os betyder det, at kommer der en alarm, bliver vi adviseret med en høj lyd og vil iværksætte analyse og evt. start af aktion inden for ganske minutter. Det er vigtigt, at I bruger en PLB med GPS!!! Så får vi den korrekte position i første signal. Ellers kan det kræve flere satellit passager at få den korrekte position. Også er det rigtig vigtigt at i tænker for kunden i indkøbsprocessen. En PLB skal kodes og ofte ser vi meget mangelfulde informationer, som gør det svært at erkende, hvem der er i nød. Dette kan have stor betydning for aktionen (især hvis det ikke er en GPS PLB.)

Oplever i problemer med GPSsignaler for lokation? Om der er overvejelser vi skal inddrage i vores projekt? Hvor præcist kan i lokalisere personer med denne teknologi?
Nej, det virker fint.

Hvor store skal overlader med radar refleksivt material (eks. Mylar folie) være for at have en signifikant effekt på radarsignalet? Den har jeg ikke baggrund for at komme med input til.

Har i information om hvor stor distance sejlere "typisk" har til hinanden? Det er selvfølgelig et svært spørgsmål, men måske et sådan "worst / best case" scenarie ville hjælpe os meget til at formidle hvor alene/ikke alene sejlere på Grønland generelt er.
Når der sejles fra Island til Grønland kan en privat sejler være flere døgn fra andre. Internt i Grønland vil

jeg sige de fleste kan nåes inden for 36 timer af andre sejlere. Og indenfor 12-36 timer af professionelle redningsenheder på vestkysten. Uden garanti

I hvor mange dage vil i typisk søge efter en nødstedt person? Vi har hørt om flere operationer, som varede i flere dage (5+). Vi tænker at hver operation vurderes på hvor længe, der fortsat skal eftersøges men er der nogle rammer for hvor mange dage man maksimalt vil søge før eftersøgningen afblæses?
Nej, det vurderes i hvert enkelt tilfælde. Hvis man f.eks. vidste, at de bruger "Beacon" og har en redningsdragt på, vil vi jo søge længe:)

Hvilke symptomer ser i ofte ved de nødstedte? F.eks. udmattethed, dehydrering, hypotermi, vand i lungerne? Hvis ikke de er døde, er mit indtryk, at de som regel er ok. Alt i mellem overståes nok så hurtigt, at vi sjældent ser det. Er de nødstedte som oftest ved bevidstheden når de bliver reddet og hvilke konsekvenser for missionen har det om de er eller ej?
Ja, se ovenfor.

Er folk der bliver reddet ofte i et chok lignende stadie og har dette konsekvenser for redningen?
Nej, de er som regel meget fattede, her i Grønland.

I tilfælde af tegn på hypotermi, hvilken behandling anvender i som reddere da? Førstehjælp i forhold de enkelte tilfælde.

A.12 Mail interview: Joint Arctic Command w/ Michael Hjort

Date: Apr - May 2019
Interviewer: Martin Lundberg
Interviewee: Michael Hjort¨, Cheif Joint Arctic Command
Interview Format: Mail

Så der nyt fra os!
Hvad er jeres tanker om den fysiske størrelse af produktet i relation til at blive set?
Jeg vil gerne vende tilbage med svar herpå, da vi skal lave test med satellitbilleder, hvor vi udlægger bl.a. metalfilm, joller, redningsflåder mv.

Hvad er jeres tanker om den teknologi vi arbejder med (VHF med DSC + PLB)? Ser i problemer eller fordele ved disse? Mange fordele – dette arbejde anbefales dog koordineret med Claus Munk

Hvordan arbejder i med PLB signaler med modtagelse og behandling af signaler deraf? Hvor hurtigt kan i reagere på en modtagelse af et signal?
Normalt reagerer vi meget hurtigt på PLB signaler. Det vil sige mindre end 6 min. fra vi modtager signalet til vi har disponeret en enhed.

Oplever i problemer med GPS signaler for lokation? Om der er overvejelser vi skal inddrage i vores projekt? Hvor præcist kan i lokalisere personer med denne teknologi?
Vi bruger de GPS informationer vi modtager. Vores erfaring er, at har vi GPS signaler er de præcise.

Hvor store skal overlader med radar refleksivt materiale (eks. Mylar folie) være for at have en signifikant effekt på radarsignalet?
Se svar omkring radartest.

Har i information om hvor stor distance sejlere "typisk" har til hinanden? Det er selvfølgelig et svært spørgsmål, men måske et sådan "worst / best case" scenarie ville hjælpe os meget til at formidle hvor alene/ikke alene sejlere på Grønland generelt er.
Det afhænger meget af geografien og årstiden. I eksempelvis Nuuk området om sommeren, er der altid mange joller ude. Andre steder, som eksempelvis på Østkysten, der er tyndt befolket, kan der være mange 100 sømil mellem joller. Om vinteren har næsten alle lystsejlere deres joller på land, mens erhversfangere/fiskere fortsat arbejder.

I hvor mange dage vil i typisk søge efter en nødstedt person? Vi har hørt om flere operationer, som varede i flere dage (5+). Vi tænker at hver operation vurderes på hvor længe, der fortsat skal eftersøges men er der nogle rammer for hvor mange dage man maksimalt vil søge før eftersøgningen afblæses?
Nej – Vi fortsætter eftersøgningen hvis vi vurderer, at der chancer for at finde overlevende.

Hvilke symptomer ser i ofte ved de nødstedte? F.eks. udmattethed, dehydrering, hypotermi, vand i lungerne?
Kulde, sult og forkommenhed.

Er de nødstedte som oftest ved bevidstheden når de bliver reddet og hvilke konsekvenser for missionen har det om de er eller ej?
Som oftest ved bevidsthed. Som oftest glade for at blive fundet og i nogle tilfælde klar til at fortsætte, hvad de nu end var i gang med (jagt, fiskeri etc.).

Er folk der bliver reddet ofte i et chok lignende stadie og har dette konsekvenser for redningen?
Det varierer meget. Der tages altid udgangspunkt i den nødstedtes situation.

I tilfælde af tegn på hypotermi, hvilken behandling anvender i som reddere da?
Som oftest tæpper.

Hvor stor indflydelse har vandets kontra luftens temperatur på overlevelsestiden?
Enorm stor indflydelse. Tommelfingerreglen er, at de der overlever, er dem der har redningsdragter og redningsveste på.

Hej Michael

Vi har lige siddet og gennemlæst at vores materiale fra vores tur til Grønland og de her mails. Vi har opdaget at vi mangler et spørgsmål, som kunne hjælpe os med at argumentere vores sag overfor vejleder og censor. På vores tur til Grønland spurgte vi ind til hvor mange sejlere i nød, som havde mistet deres båd (den var sunket). Dengang fik vi at vide, at i de fleste tilfælde er de stadig i deres båd og få falder i vandet.

Vi ved godt, det er lidt af et "long shot", men hvad vil du/i mene hyppigheden er for hvor nødstedte sejlere er fundet uden deres båd, fordi den er sunket? Snakker vi 1 ud af 10 tilfælde eller 1 ud af 50?
Nærmere én ud af halvtreds.

A.13 Article: Defend Arctic Presentation

EXT Pe6B - B 70

To follow up on the increasing interest in the Arctic area, a group of companies in the Northern part of Jutland, Denmark has decided to follow a new approach into an operational collaboration aiming to develop equipment for a system concept for the Arctic area. The companies have formed an informal group – Defend Arctic - where the target is to bring companies together in a common project, aiming to make the equipment work in conjunction and be able to operate in a very cold climate with temperatures down to -51°C in order to support operations in the Arctic area.

The system concept demonstrators will be presented at the EUROSATORY exhibition in Paris.

The system concept is targeted towards Search and Rescue (SAR) operations as well as assertion of sovereignty in the Arctic area. The system should be seen as a box concept where it is possible to acquire certain parts of the system, combinations or the entire system solution for the purpose in the defensive role.

The spectrum covers all levels from space to ground and can best be illustrated going through two short scenarios.

Search and Rescue (SAR)

In this Scenario – for instance a sinking cruise ship situated in the Arctic Ocean or a sudden surge of seawater such as the one that that hit the Greenlandic fishing village of Nuugaatsiaq in June 2017 - *The following elements can be provided by the Defend Arctic system:*

Low Flying mini-Satellites that can show the AIS picture for the area.
Space Inventor

Radar and camera integration that can be fast deployed to cover the actual area.
Weibel and CTS (Associated with the Defend Arctic group during the Eurosatory exhibition)

A Mobile Command Post (MCP) can be deployed to the actual area either by truck (on the ice), airlifted or by sea transport.
DC Supply, Hydrema, TechPartners, Polog

All electronic components and communication means can operate down to -51°C or installed in heated containers with fuels cells or diesel driven heaters.
DC Supply, Ballard, Alpcon, NECAS, Hydrema, Dantherm

Drones and anti-drone defence in order to avoid for instance press drones into the operational area – which can hinder the rescue helicopters from flying, and on the same time create an operational overview with own drones.
Sky Watch, MyDefence

Transport and housing containers along with tents.
DC supply, Polog and Dantherm (associated with the Defend Arctic group during the Eurosatory exhibition)

General advice on cold climate solutions.
TechPartners, Polog

All containers in this scenario can also be used in another role as they will be able to be armored. Even mortar protection can be available with more stationary installations.
Scanfiber, DC Supply

Assertion of Sovereignty

As an assertion of Sovereignty, it should be possible to set up an Arctic Mobile Patrol Base (AMPB) that should be capable to screen foreign activities and be able to survey on a 200 km survey line.

The idea is to deploy up to 3 containers which can hold 4-6 men in each container, with durability on the ice or on land 4-6 weeks depending on the overall task.

Should be deployable either by truck, ship or airlift.

To support this scenario, the Mobile Command Post (MCP) would consist of a Mobile Survey and Tracking Center (MSTC) as well as a Drone Coordination Center (DCC) and a Satellite Operations Center (SOC), which can be established and where the main effort is given by Command authorities.

The MCP could alternatively be based on a ship, otherwise in land to free the ship for other tasks.
This MCP will also be able to support other help and relief operations in the Arctic area.

The basic idea behind the concept is that it is a mobile solution so the counterpart never know where you will be next time, and it will give the flexibility to counter any assertion of sovereignty in the area.

EXT Pe6B - B 70

To better understand the elements in the system, the different parts of the system and the partners are described in the following:

Low flying satellites to create a situational awareness picture of specific areas, consisting of already existing satellites and some ready for launching if the situation get more tense.
Space Inventor

Mobile Survey and Tracking Center (MSTC) , Radar and camera integration to be mounted on the container patrol bases to track and identify movements.
Weibel, CST and DC Supply

Additional Mobile Command Post (MCP) that can be deployed either by ship air or transported on special trucks on the ice to coordinate patrol bases, sensors and other means.
DC Supply, Hydrema, Scanfiber, Polog

Drone coordination center (DCC) and Satellite Operations Center (SOC). Container based coordination center for own drones and detection and disturbance of enemy drones. These centers will normally be situated with the MSTC.
DC Supply, Sky Watch, MyDefence, Space Inventor

Communication and electronic components designed for the Arctic area, telephones, etc.
NECAS

Heating solutions on all elements, containers, trucks etc. and supplementary tents.
Alpcon, Ballard, Dantherm

Light Armor Solutions potentially with integrated insulation that can keep its performance even at low temperature on all containers.
Scanfiber and DC Supply

The group can also execute coordination of the logistic effort to support the operations.
Tech Partners, POLOG

In both scenarios, the system concept could also be a subject for equipment cooperation between USA, Canada Norway and Denmark as a form of pooling solution, where for instance Canada could deliver transport capacity (Helicopters) and Denmark the containers

Summary

The Defend Arctic group has already experienced that a collaboration searching for combined solutions provides a much better understanding of the overall task and ability to supply suitable equipment, specially designed for Arctic use where among other things the temperature is essential.

The idea behind a turnkey solution seems to be the way ahead, and the group will continue to test and develop new equipment for Arctic use so this should be seen as the first step in delivering an overall system solution.

The actual demonstrators will be exhibited at Eurosatory 2018 in Paris, where we will be located at the stand:

DEFEND ARCTIC
Danish Land Mobile Systems
EXT Pe6B - B 70

Associated partners:

A.14 Cost Calculation

Tech components

VHF	1.5	USD
GPS	15	USD
Beacon	0.7	USD
System Chip	3	USD
LED	6	USD
Battery	36.15	USD
Pressure switch	0.8	USD
IP67 Box	3.15	USD
Price per unit	66.3	USD
Converted	442.2	DKK

Balloon production

If a single unit produced

PVC Fabric	1200	DKK
Manufacturing	3500	DKK

If produced in large quantities - Denmark (estimated)

PVC Fabric	1200	DKK
Manufacturing	1000	DKK

If produced in large quantities - abroad (estimated)

PVC Fabric	500	DKK
Manufacturing	500	DKK

Testing

Production company is payed to check for leaks

Pressure tank test	200	DKK

Price per unit if produced aboard

500 + 500 + 200 =	1200	DKK

Transportation

Aalborg to Nuuk	510	DKK/m^3
Aalborg to Nuuk	0.84	DKK/kg
Minimum price	3900	DKK

Calculated when transporting min. 65 units (Royal Arctic Lines, 2019)

Transportation per unit	59.4	DKK

Top light production

Estimation if injection molded (Custom Part, 2019)

Tooling price	260.000	DKK
Price per part	5	DKK

Estimation if CNC tooled parts

CNC turning par part	50	DKK
O-Rings	0.2	DKK

If buying over 1000 units

LED PCB	20	DKK

If buying in bulk

Price per unit 50 + 0.2 + 20 = 70.2 DKK

Box production

PVC Fabric	100	DKK
Metal construction	100	DKK
Pressure tank	134	DKK
DIN valve	220	DKK

(Ebay, 2019)

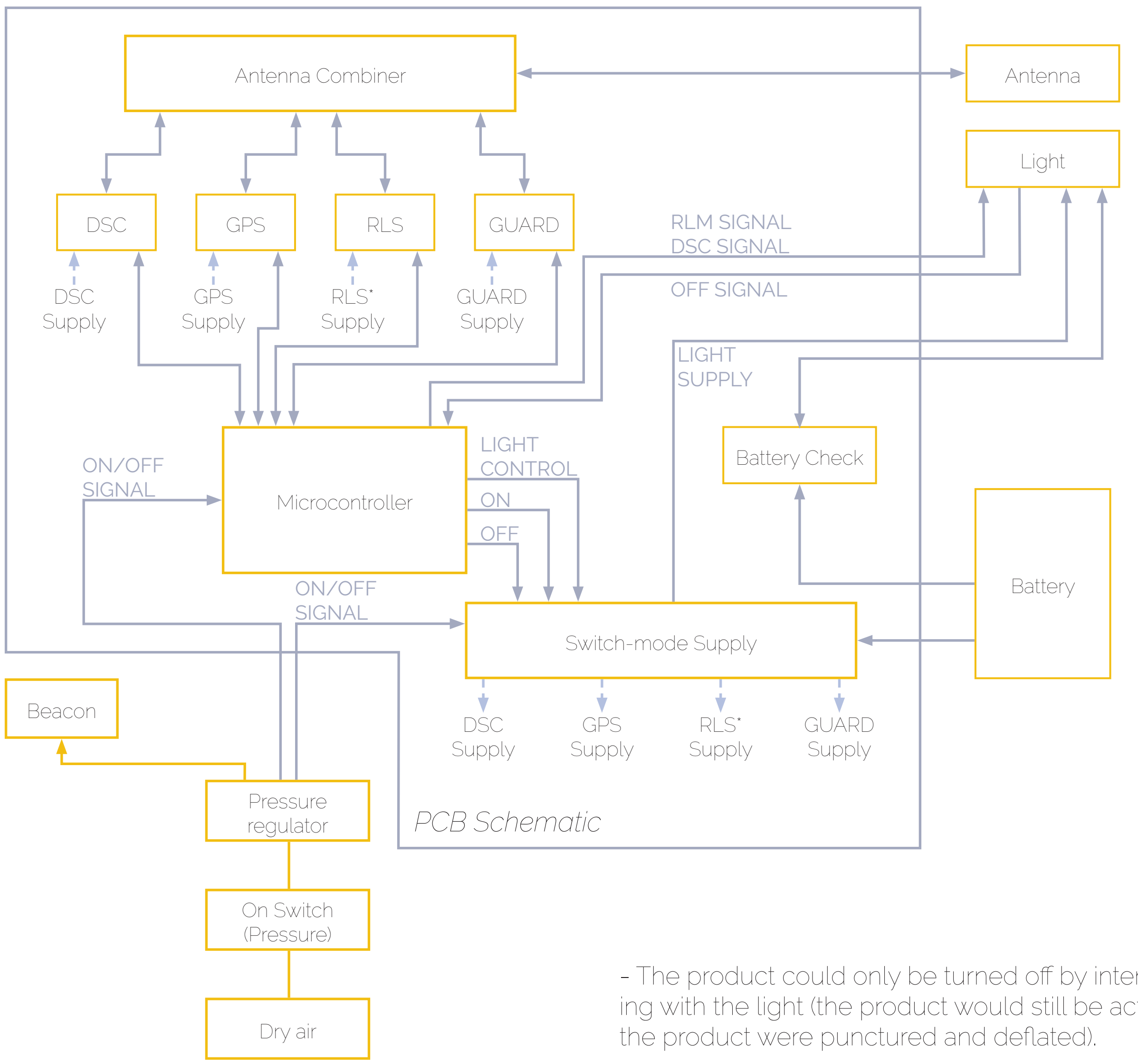
Price per unit	554	DKK
Total price per unit	2325.8	DKK

A.15 Product functionalities and PCB design

With help from two experts (Jes Lundberg, Asetek Aalborg and Henning Christensen, LiftUp Støvring) the team was able to create a basic PCB (printed circuit board) layout, to better understand what components are required in order to acquire the wanted functionalities of the product.

For this the team presented the project and working concept, to start a dialog of how to accomplish the wanted functionalities of the product.

Jes Lundberg is Martins dad, and works on a daily basis as an electrical engineer at Asetek. He has experience with PCB-design in Bluetooth headsets at Jabra. Henning Christensen is Martins uncle. On a daily basis he works at LiftUp as an electrical engineer and has experience with maritime radios in Research and Development of new units. Together they helped the team in understanding the technical needs for the product, the initial selection of components and help in power consumption calculation (A.16).



The schematic shows the intention of how the PCB works in theory. The team presented several ideas of how the product would be activated and how the user could get feedback. A series of wishes were discussed:

- The product would be activated by a pressure switch.

- The product could only be turned off by interacting with the light (the product would still be active if the product were punctured and deflated).

- The user will be given feedback if SAR or fellow sailors have picked up any of the two distress signals via a green LED in the light.

- The system will have an option for a battery check, without activating the whole system.

A.16 Product power consumption calculation

To calculate the final power consumption, the team had help from experts, Jes Lundberg, Asetek, Aalborg and Henning Christensen, LiftUp, Støvring. Together the team was able to first find the necessary PCB elements for making the product theoretically function (A.15) and second to calculate the power consumption.

The team had a product requirement that the inflatable beacon must be able to broadcast emergency signals and have the light turned on for 120 hours (5 days), because of the insights provided by the Joint Arctic Command.

Second is the temperature in which the unit is able to operate. In the Arctic Climate and the information available, the calculations of three scenarios were done.

Scenario 1: Where the temperature is constant of -40 degrees C during all operation.
Scenario 2: Where the temperature is constant of 0 degrees C during all operation.
Scenario 3: Where the temperature is averaged over 10 years of standby and is 0 degrees C during all operation.
Scenario 4: Scenario 3 at -40 degrees C.

The calculation starts with a series of predefined attributes:
Reference lamp (http://www.weems-plath.com/SOS-Distress-Light-Electronic-Flare.html)
Battery (https://www.saftbatteries.com/download_file/6X7JMGAnv3Fm6HdmtEv%252B2gtlbZ1bRRVHk-jS11M6md92GD2EF7vU%252F3Oybbz3WOlG%252BxR8srpA5iCdJ%252FV3IQzTVHQyiTucngZKEg9KkYCL-kowAvgaG1hurnHtLHSqYlv9vcxPxiihlZ6Gv6LgL%252BGoEfzBbNsgYh5dBhebRv%252FfMbWcIH1S1Y%252F-w%253D%253D/LO26SXC_0604.88df1153-cf64-4d4b-8204-2b308100f580.pdf)

Calculating scenario 1 (-40 degrees C Constant)

Ch 1. Reference lamp calculations

One cell
1.5 V
8 Ah

Three cells

3 · 1.5 =	4.5 V
	8 Ah

Max on time	60 h

Calculated consumption

(8/60) · 1000 =	133.3 mA

Ch 2. Reference battery

One cell
2.7 V
9 Ah

Four cells

2.7 · 4 =	10.8 V
	9 Ah

Ch 3. DSC Consumption Calculation

Transmit power	2.5 W
Used from battery	5 W
Power consumption	5 W / 10.8 V = 0.463 A
DSC up time	10 s
No. Of times an hour	4
Time every hour	(10 s · 4)/(60 · 60) = 0.01 h
Amps every hour	0.01 h · 0.463 A = 0.005 Ah
Operation time	120 h
Operation consumption	0.005 Ah · 120 h = 0.617Ah

Battery Graph for reduced capacity and power at desired temperature of -40 degrees C.

Factor for power	2.11
Total DSC consumption	2.11 · 0.617 Ah = **1.302 Ah**

Ch 4. Battery capacity calculated to 4.3 V

Battery capacity (-40C)	9 Ah
DSC battery discharge	9 Ah - 1.302 Ah = 7.698 Ah
Remaining capacity	7.698 Ah
Switch mode voltage	4.3 V
Switch mode efficiency @ 95%	
Batteries voltage	2.7 V · 4 = 10.8 V
Capacity @ 4.3 V	7.698 Ah · (10.8 V / 4.3 V) · 0.95 = **18.4 Ah**

Ch 5. GUARD Consumption Calculation

Used power	1 W
Switch mode power	1 W / 4.3 V = 0.233 A
GUARD up time	30 s
No. Of times an hour	4
Time every hour	(30 s · 4)/(60 · 60) = 0.033 h
Amps every hour	0.033 h · 0.233 A = 0.008 Ah

Ch 6. GPS (PLB) Consumption Calculation

Used power	0.02 A
GPS up time	60 s
No. Of times an hour	4
Time every hour	(60 s · 4)/(60 · 60) = 0.067 h
Amps every hour	0.067 h · 0.02 A = 0.0013 Ah

Ch 7. PLB Consumption Calculation

Used power	1 W
Switch mode power	1 W / 4.3 V = 0.233 A
PLB up time	30 s
No. Of times an hour	4
Time every hour	(30 s · 4)/(60 · 60) = 0.033 h
Amps every hour	0.033 h · 0.233 A = 0.008 Ah
RLS power	0.02 A
RLS up time	30 s
No. Of times an hour	4
Time every hour	(30 s · 4)/(60 · 60) = 0.067 h
Amps every hour	0.067 h · 0.02 A = 0.0013 Ah

Ch 8. Total consumption of GUARD, GPS, PLB and RLS

0.008 Ah + 0.0013 Ah + 0.008 Ah + 0.0013 Ah = **0.018 Ah**

Operation time	120 h
Operation power cost	120 h · 0.018 Ah = **2.18 Ah**

Ch 9. Light consumption @ 120h

Light consumption	120 h · (133.3 mA / 1000) = **16 Ah**
Renaming capacity	18.4 Ah - (2.18 Ah + 16 Ah) = **0.22 Ah**

Calculating scenario 2 (0 degrees C Constant)

This calculation requires simple change due battery characteristic.
Battery capacity (0C)

Ch 2. Reference battery

One cell
2.8 V
9 Ah

Four cells

2.8 · 4 =	11.2 V
	9 Ah

Ch 3. DSC Consumption Calculation

Power consumption	5 W / 11.2 V = 0.446 A
Amps every hour	0.01 h · 0.446 A = 0.00496 Ah
Operation consumption	0.00496 Ah · 120 h = 0.595Ah

Battery Graph for reduced capacity and power at desired temperature of 0 degrees C.

Factor for power	1
Total DSC consumption	1 · 0.595 Ah = **0.595 Ah**

Ch 4. Battery capacity calculated to 4.3 V

Battery capacity (0C)	9 Ah
DSC battery discharge	9 Ah - 0.595 Ah = 8.405 Ah
Remaining capacity	**8.405 Ah**
Batteries voltage	2.8 V · 4 = 11.2 V
Capacity @ 4.3 V	8.405 Ah · (11.2 V / 4.3 V) · 0.95 = **20.8 Ah**
Renaming capacity	20.8 Ah - (2.18 Ah + 16 Ah) = **2.62 Ah**

Calculating scenario 3 (10 years standby and 0 degrees C Constant)

This calculation requires to incorporate the battery self discharge factor of 1.5 % yearly:

Capacity after 10 years 9 · 0.985^10 = 7.737 Ah

Following scenario 2, only change is the available battery capacity of 7.737 Ah instead of 9 Ah.

Renaming capacity	17.7 - (2.18 Ah + 16 Ah) = **-0,5 Ah**

In reference this means that the unit theoretically only will work for 115 h and not 120 h

Calculating scenario 4 (10 years standby and -40 degrees C Constant)

This calculation requires to incorporate the battery self discharge factor of 1.5 % yearly:

Capacity after 10 years 9 · 0.985^10 = 7.737 Ah

Following scenario 1, only change is the available battery capacity of 7.737 Ah instead of 9 Ah.

Renaming capacity	15.4 - (2.18 Ah + 16 Ah) = **-2.8 Ah**

In reference this means that the unit theoretically only will work for 102 h and not 120 h

Conclusion

The calculations revealed that the unit will work of 4 D-cell type batteries and that the team can say that the product will operate 100% as intended 8 years, knowing that the product will be operated submerged in 0 degree water.

If the product is operated on land with a surface temperature of -40 degrees constant, the unit will only operate 5 days after 1 year of storage. After 10 years, the product will only last 102 hours (4.5 days).

Solution could be to add an additional battery to the unit. This would allow for extended operation time and allow for 5 days operation time a -40 degrees after 10 years of storage.

A.17 Concept Development 1 - Presentation for partners

Koncept Udvikling

Opdatering #01 - April 2019

I de sidste uger har teamet indsats fokuseret på projektrammen og idégenerering. Projektets fokus er at udvikle et produktkoncept, der vil hjælpe nødsituerede sejlere med at signalere hjælp i det grønlandske arktiske område. Dette vil hjælpe redningspersonalet med at hjælpe i 'Search and Rescue' operationerne, som i Grønland både udføres af fagfolk og civile.

Teamet har til sinde at udvike en lokaliseringsenhed, der forbedre muligheden for at lokalisere en nødsted person. Produktet skal være letvægt og nemt at betjene. Det skal kunne fungere aktivt i flere dage i det hårde arktiske klima. Der arbejdes med et oppusteligt produkt, som bliver fyldt med CO_2.

Bærbarhed eller holdbarhed?
Teamet udfordrer konstant ideen om at have produktet en bærbar løsning, der er meget mindre og let, men også manglende synlighed og holdbarhed på grund af produktets mindre størrelse og lettere materiale.

Et installeret produkt ville give en bedre mulighed for de nødstedte med et større produkt overordnet.

Kompleksitet eller fleksibilitet?
Holdet er stadig i et stadie, hvor "løsningsrummet" stadig udvikler sig ved at teste ideer. Selve forståelsen af et koncept kommer ved at prøve det ud.

Dette er meget vigtigt for os, fordi vi lærer meget af den erfaring.

I sidste uge gjorde vi en test med et 1:1 skala af et koncept, der fokuserer på en skeletstruktur. Dette er at forsøge at reducere mængden af CO_2, der kræves for at blæse produktet op.

A.18 Concept Development 2 - Presentation for partners

Koncept Udvikling

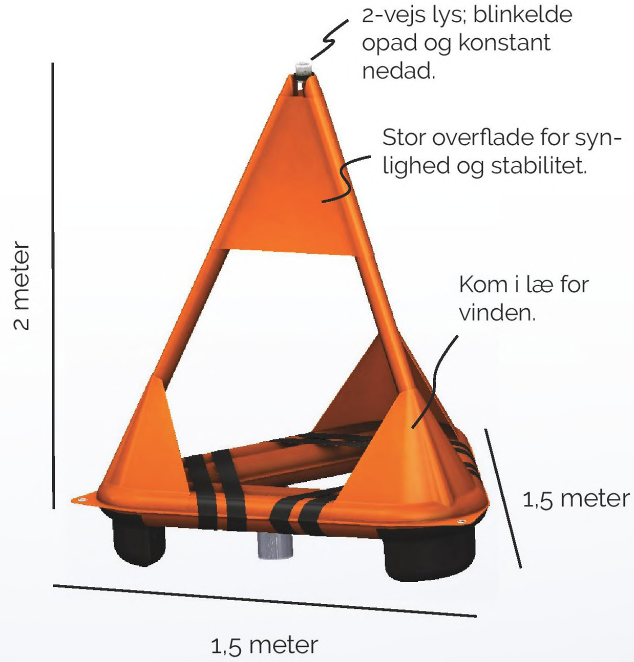
Update #02 - May 2019

Siden sidste opdatering er vores projekt blevet mere detaljeret. Flere test og tilbagemeldinger fra søfolk har hjulpet teamet til bedre at forstå interaktionen og anvendeligheden af det produkt, som vi er i gang med at detaljere lige nu.

Det er vores hensigt at skabe et produkt for at hjælpe nødsituerede sejlere signalere og tilkalde hjælp. Konceptet hjælper med at gennemføre forskellige måder at infomere andre sejlere, at man er nødt til at få det, samt informere Search and Rescue personalet om hvor de skal igangsætte søgningen.

"The Beacon"
I øjeblikket kalder vi den oppustede enhed "The Beacon". Dette skyldes simpelthen, at produktet fungerer som et stort kommunikationsværktøj både visuelt og med brug af teknologi.

Konceptet gør det muligt for brugeren at klatre op på og kravle ind i - hvis det ønskes. Dette vil hjælpe brugeren til at overleve i længere perioder, fordi han/hun ikke er i det kolde vand. Det er planen at der skal sættes håndtag på produktet også - så det er nemmere at kravle op på den.



"The Box"
For at opbevare produktet skitserer vi på en kasse, der skal monteres på bagsiden af båden. Gennem interviews og test, lærte vi, at dette var det oplagte valg at placere den. Kravene til placeringen er, at hvis brugeren skulle falde i vandet, skal produktet aktiveres fra uden for båden - og i vandet. Vores nuværende overvejelser er isning af kassen kan være et problem. Vi undersøger om dette kommer til at være et problem for designet.

Hvorfor teknologi er vigtig
Vi arbejder med den værdi, at "Alle i nød til havs vil blive fundet". Vi mener, at teknologi også er en væsentlig faktor for at gøre denne værdi til virkelighed. Produktet er udstyret med en fuld funktinsdygtig VHF-radio for at kunne sende DSC-nødsignalet til andre medmennesker i nærheden. Ideen er, at brugeren ikke behøver at interagere med systemet - det er helt automatisk, når produktet er aktivertet.

Udover VHF vil vi også implementere en PLB (Personal Location Beacon), for at anvende Cospas-Sarsat satellit Search and Rescue system. Systemet er gratis at bruge i Danmark og Grønland, og gør det muligt for redderne at bruge GPS-lokationen til at bestemme positionen mere præcist. Med den evige voksende funktionalitet og mængden af satellitter vil dette i fremtiden være standarden for Search and Rescue operationer overalt i verden.

A.20 Concept Presentation for Viking Life-Saving Equipment

Konceptpræsentation til Viking

Sommer 2019
Martin Lundberg, Peter Byrial Jensen og Sebastian Hougaard Andersen

AALBORG UNIVERSITET

Introduktion

Vi er en gruppe på 3 mand, som snart er færdig med vores kandidat projekt om en ny ide til et redningsudstyr målrettet mod det Arktiske miljø i Grønland. Vi studerer til Civilingengiør i Industrielt Design på Aalborg Universitet med vores endelige eksamen til sommer om en måned.

Gennem research, fandt vi ud af at der er enorme udfordringer i search and rescue operationer i de arktiske områder grundet de store afstande.

Via interviews med mange interessenter; Arktisk Kommando, Grønlands Politi, Grønlands interesseorganisation for sejlere og fiskere, det Grønlandske Selvstyre, den Maritime Sikkerhedsbevægelse og lokale fiskere fik vi bekræftet problemet og vi fik opstillet nogle grundlæggende rammer for hvilken type løsning der kunne danne rammerne for en koncept udvikling til vores kandidat projekt.

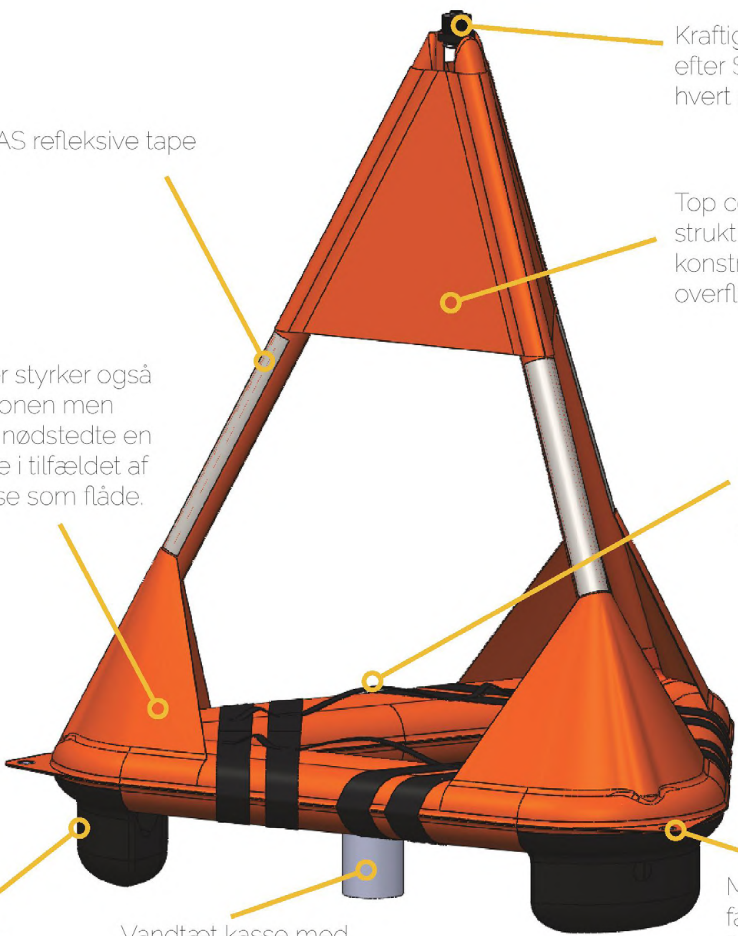
Vi vil meget gerne komme i dialog med jer hos Viking – Life-Saving Equipment, fordi vi på flere aspekter berører de samme værdier og funktioner. Vi vil gerne høre om jeres aspekter med redningsudstyr generelt og i forhold til det Arktiske klima - som i dette projekt er vores fokus. Slutvis vil vi også meget gerne høre om jeres kritisk punkter til vores koncept.

Konceptpræsentation til Viking

Sommer 2019
Martin Lundberg, Peter Byrial Jensen og Sebastian Hougaard Andersen

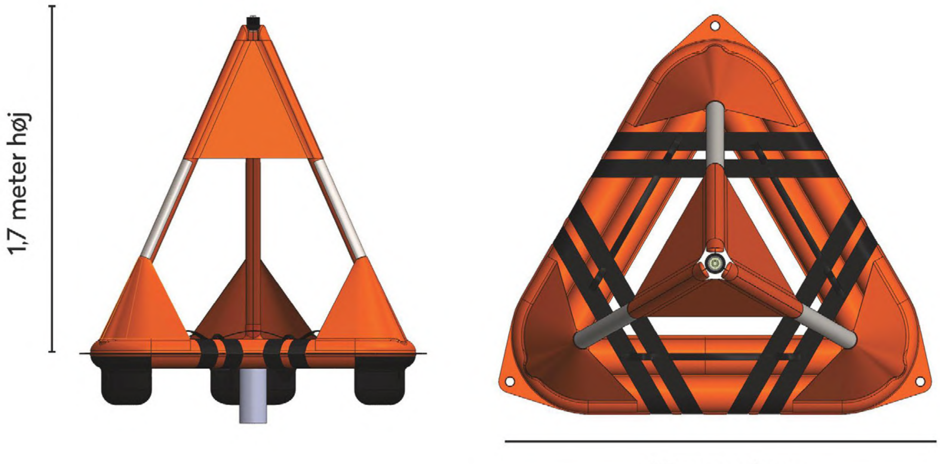
Koncept præsentation

Kort fortalt er reddernes største problem at finde de nødstedte. Dette lokationsproblem har vi prøvet at løse med udviklingen af et koncept der kan ses under. Konceptet er en selvoppustned bøje som småbådsejlerne kan medbringe på deres båd. Productet udløses og oppustes i nødsituationer hvorefter det tilkalder hjælp via satelit, radio og GPS samt gør den nødstedte langt mere synlig så rederne hurtigere kan lokalisere. Da sejlerne i de fleste tilfælde stadig er i deres båd men har motor problemer eller lignedne, fokusere konceptet primært på denne situation, men kan også anvendes som en flåde, hvis båden skulle synke.



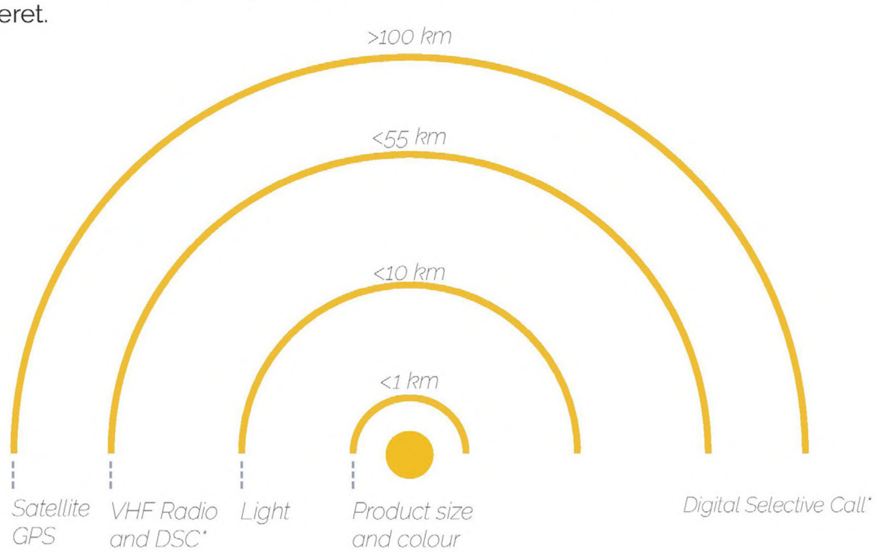
Konceptpræsentation til Viking

Sommer 2019
Martin Lundberg, Peter Byrial Jensen og Sebastian Hougaard Andersen



Teknologi ombord

Produktet vil være udstyret med samme teknologi som man kender fra en Personal Location Beacon (PLB), som bruger satellit baseret kommunikation til at tilkalde efter hjælp. Dernæst vil produktet også være udstyret med den maritime nød-funktion som er det digitale signal Digital Selective Cal (DSC). På denne måde sikre vi at både nærlæggende sejlere eller Arktisk Kommando vil få oplysningerne om nødsituationen idet produktet bliver aktiveret.



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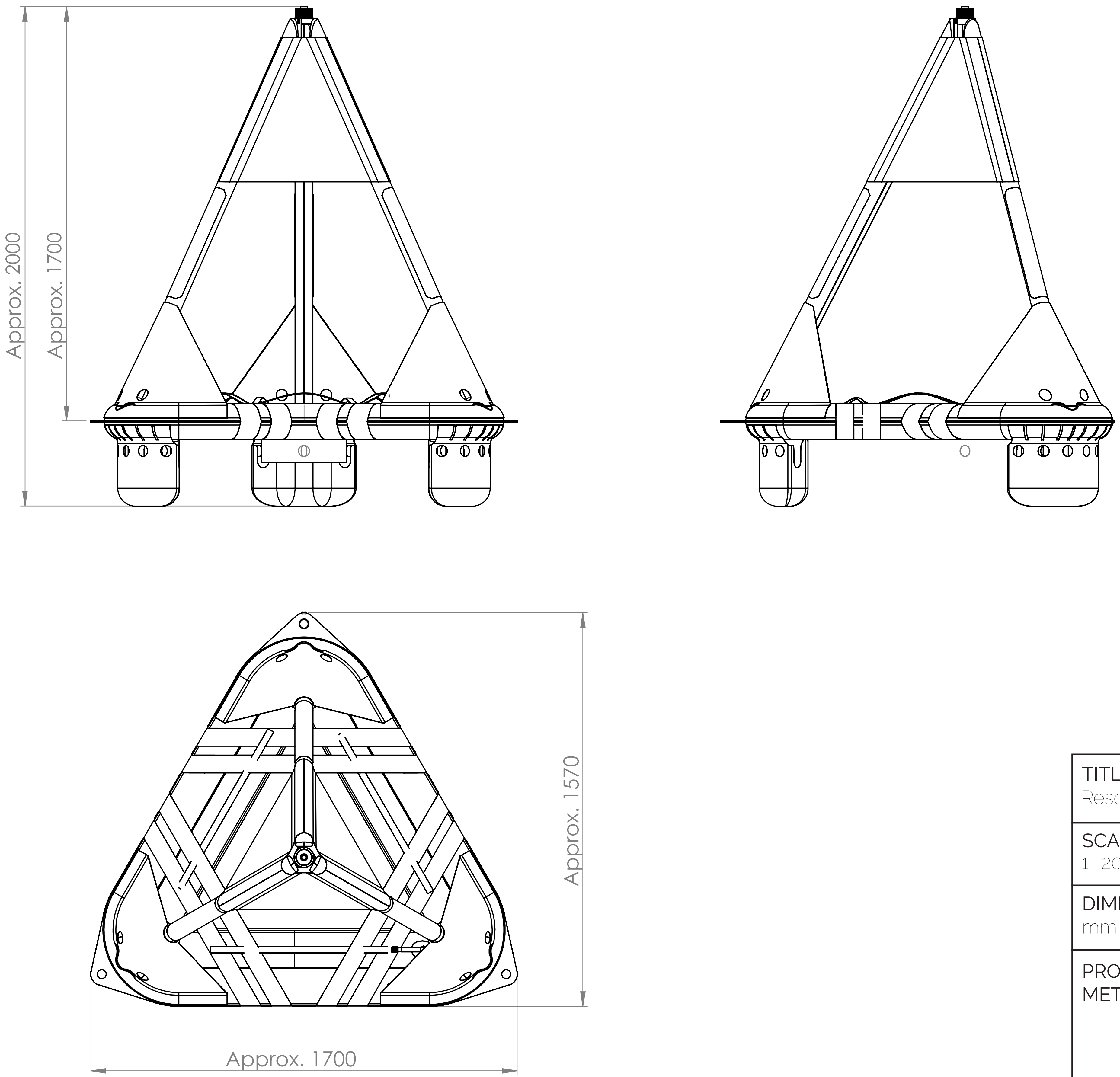

TITLE: Rescue Beacon	MATERIAL:	DATE: 05/06/2019
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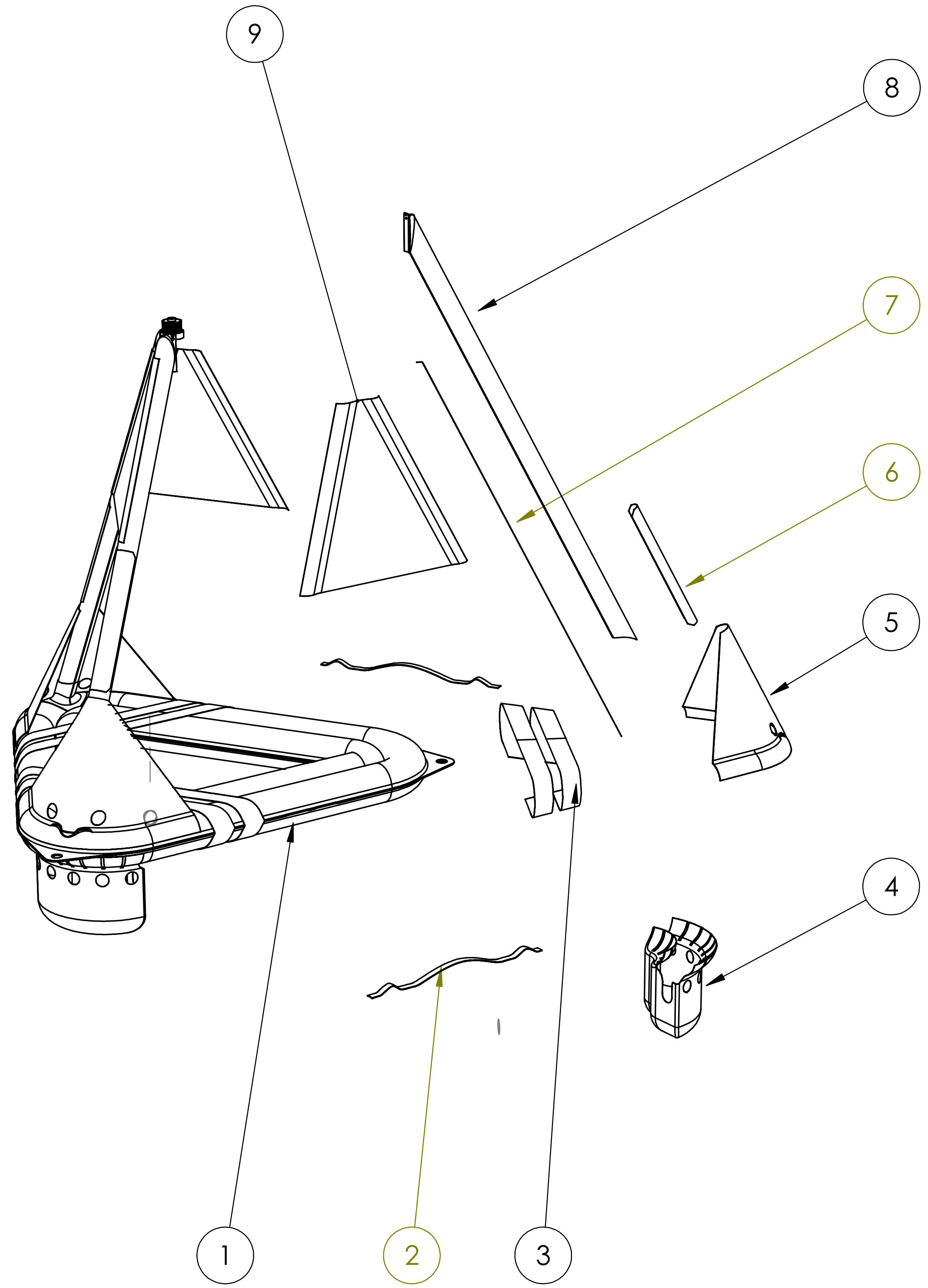
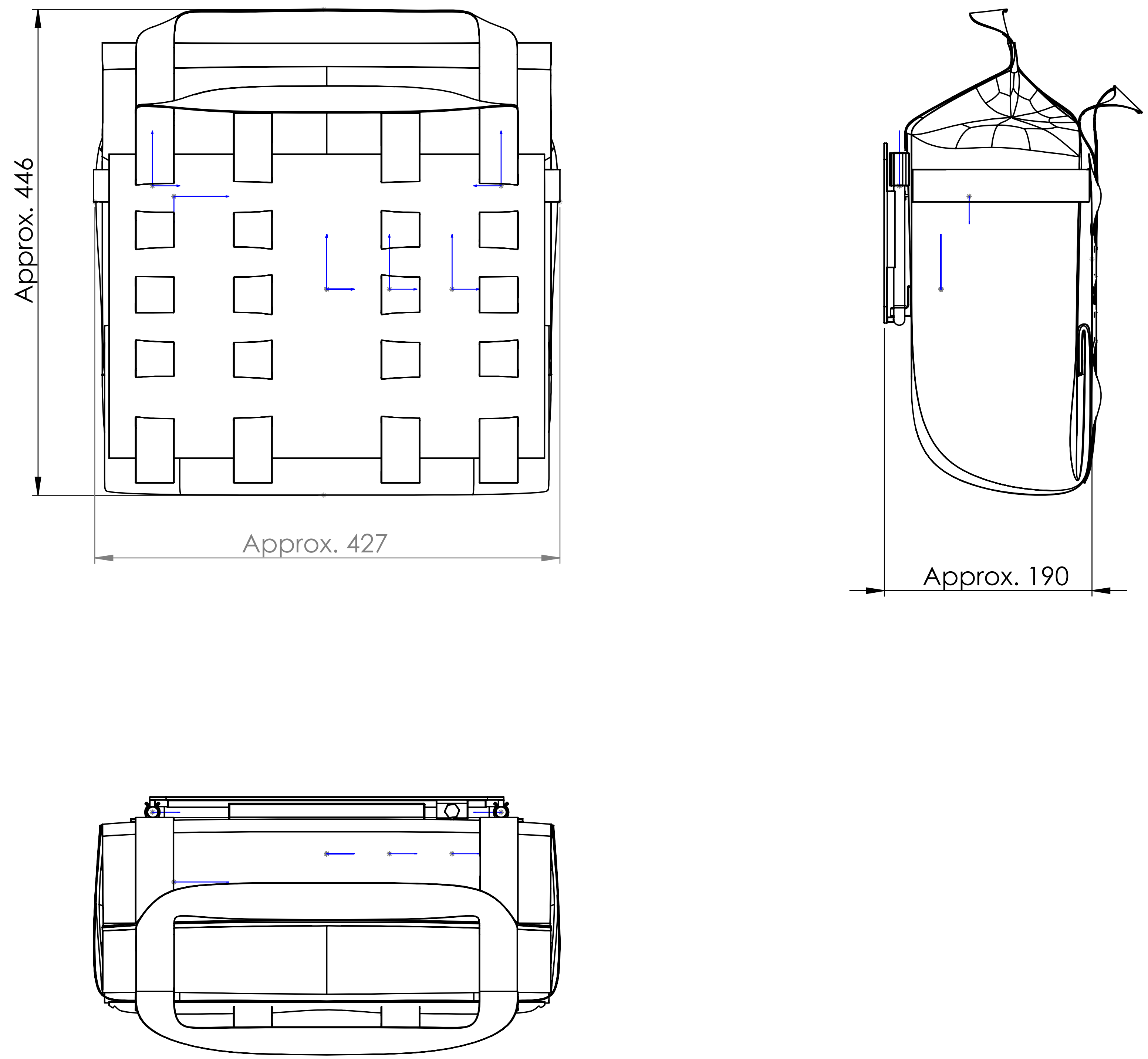
DIMENSIONS: mm	FIRST ANGLE PROJECTION	DRAWING NO. 1
PRODUCTION METHOD:		DRAWING TYPE: Assembly

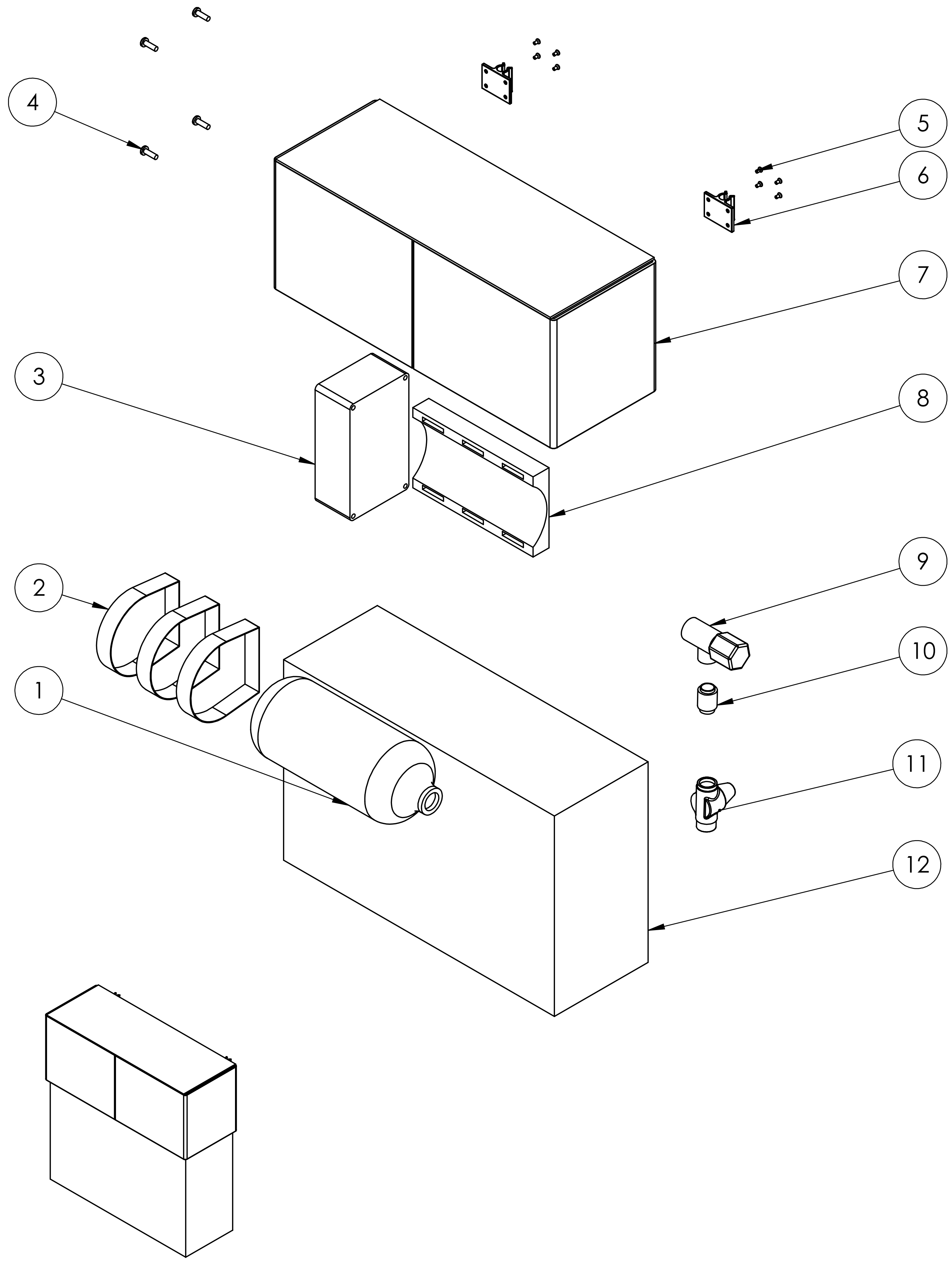


NO.	DESCRIBTION	MATERIAL	AMOUNT
1	BASE UNIT	PVC	2
2	HANDLE BAND	PVC	3
3	BAND	PVC	9
4	FLOAT ANCHOR	PVC	3
5	SIDE COVER	PVC	3
6	SOLAS REFLECTIVE BANDS		3
7	ANTENNA		1
8	PILLER	PVC	3
9	TOP COVER	PVC/MYLAR COMPOSITE	3

TITLE: Rescue Beacon	MATERIAL:	DATE: 05/06/2019
SCALE:	DRAWN BY: MSC04-ID6	SHEET: 2 of 2
DIMENSIONS: mm	FIRST ANGLE PROJECTION	DRAWING NO. 2
PRODUCTION METHOD:		DRAWING TYPE: Exploded with BOM

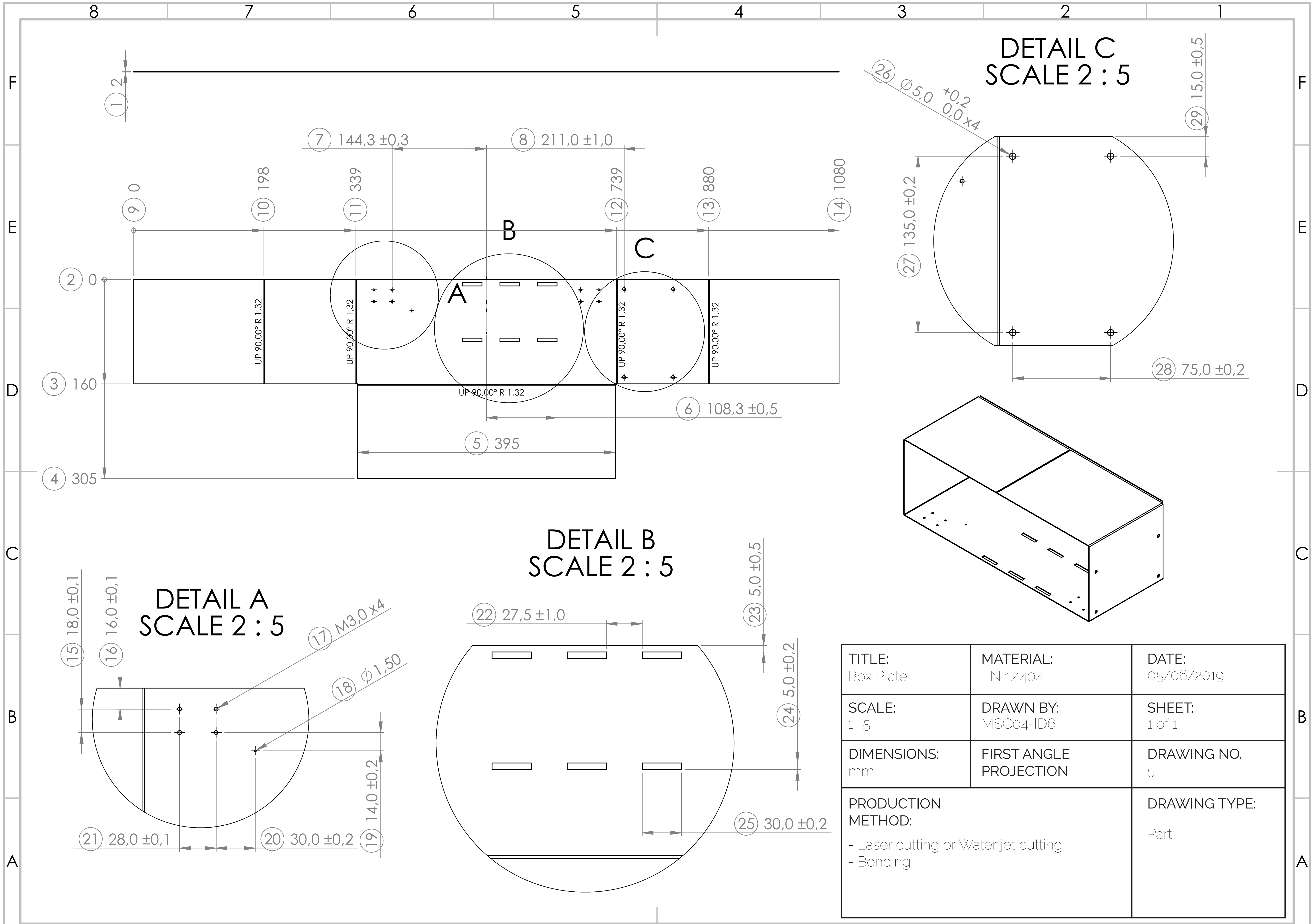


TITLE: Box	MATERIAL:	DATE: 05/06/2019
SCALE: 1 : 5	DRAWN BY: MSC04-ID6	SHEET: 1 of 1
DIMENSIONS: mm	FIRST ANGLE PROJECTION	DRAWING NO. 3
PRODUCTION METHOD:		DRAWING TYPE: Assembly

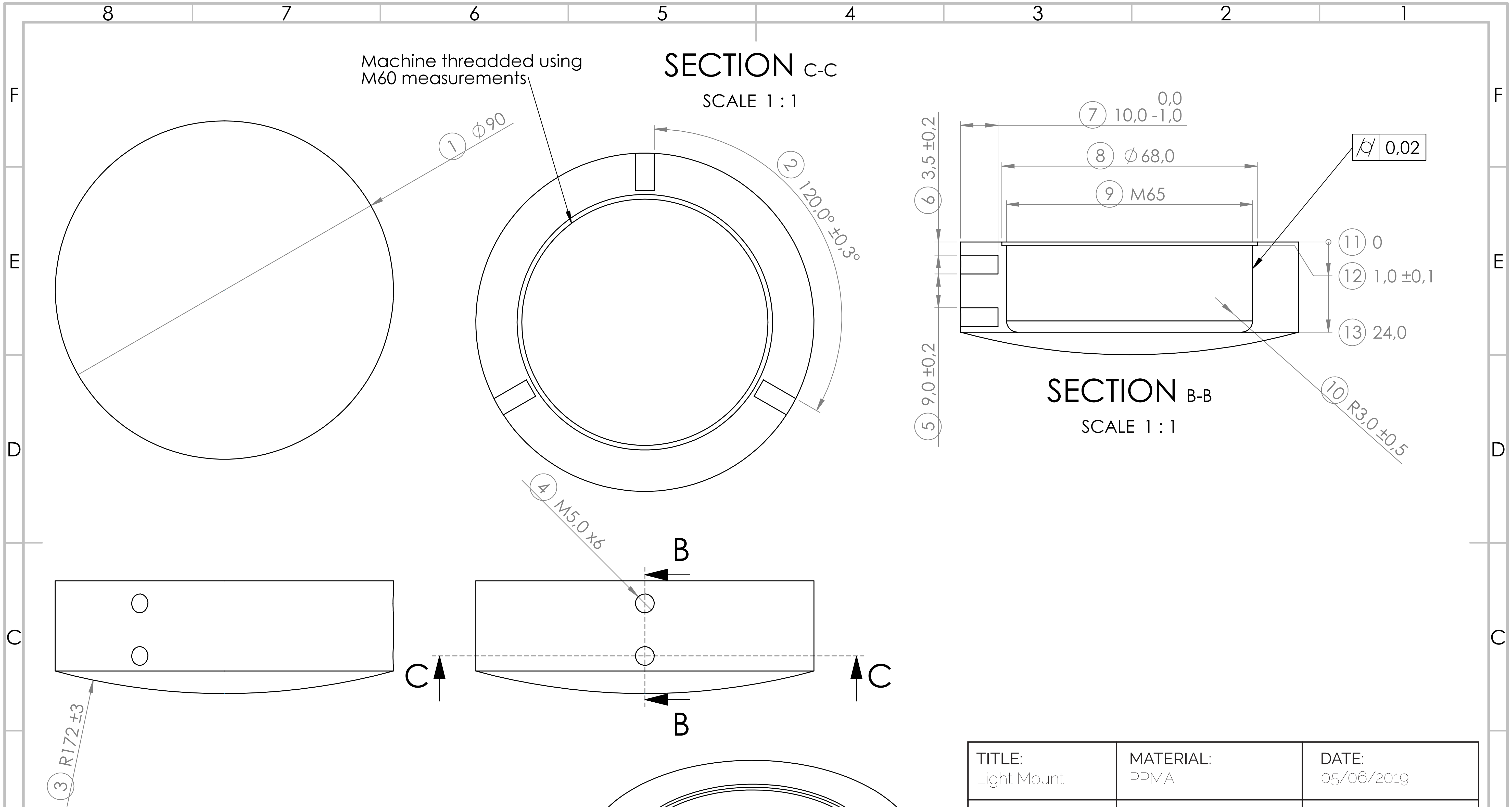


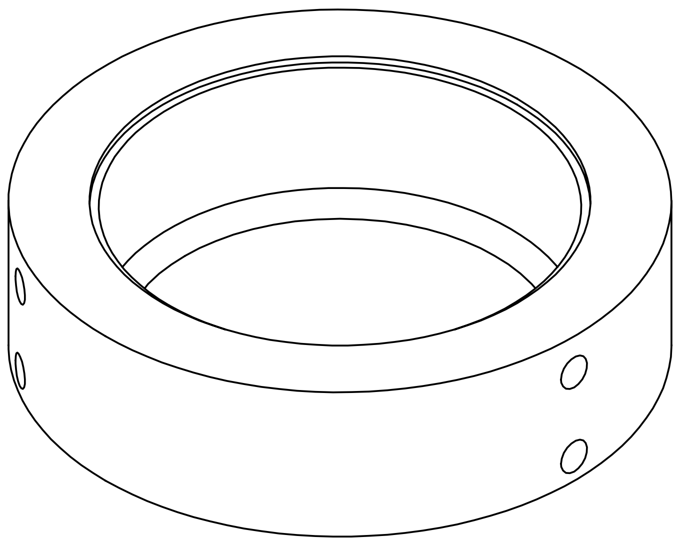
NO.	DESCRIPTION	MATERIAL	AMOUNT
1	DRY AIR CANISTER		1
2	CANISTER WRAP	PU	3
3	IP68 BOX		1
4	M5x0,8x16 PHMS	A4	4
5	M3x0,5x16 FCHS	A4	8
6	ATTACHMENT LOCK	EN 1.4404	2
6	METAL FRAME	EN 1.4404	1
7	SHOCK ABSORBER	PUR	1
8	DIN VALVE		1
9	PRESSURE VALVE		1
10	PRESSURE REGULATOR		1
11	RESCUE BEACON	PVC	1

TITLE: Box	MATERIAL:	DATE: 05/06/2019
SCALE:	DRAWN BY: MSC04-ID6	SHEET: 1 of 1
DIMENSIONS: mm	FIRST ANGLE PROJECTION	DRAWING NO. 4
PRODUCTION METHOD:		DRAWING TYPE: Exploded with BOM



TITLE: Box Plate	MATERIAL: EN 1.4404	DATE: 05/06/2019
SCALE: 1 : 5	DRAWN BY: MSC04-ID6	SHEET: 1 of 1
DIMENSIONS: mm	FIRST ANGLE PROJECTION	DRAWING NO. 5
PRODUCTION METHOD: - Laser cutting or Water jet cutting - Bending		DRAWING TYPE: Part





TITLE: Light Mount	MATERIAL: PPMA	DATE: 05/06/2019
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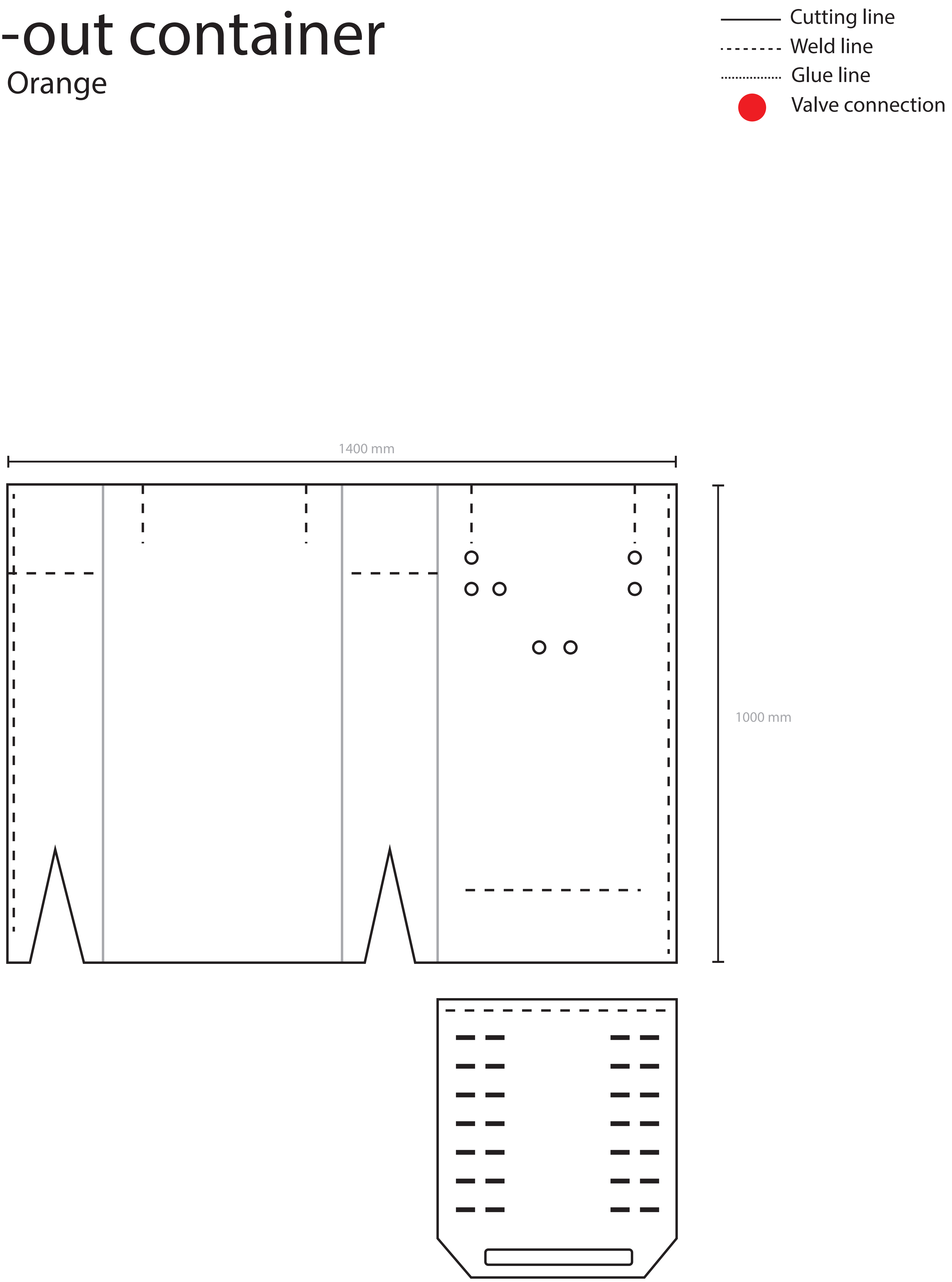
DIMENSIONS: mm	FIRST ANGLE PROJECTION	DRAWING NO. 6
PRODUCTION METHOD: CNC milling		DRAWING TYPE: Part

Cut-out container

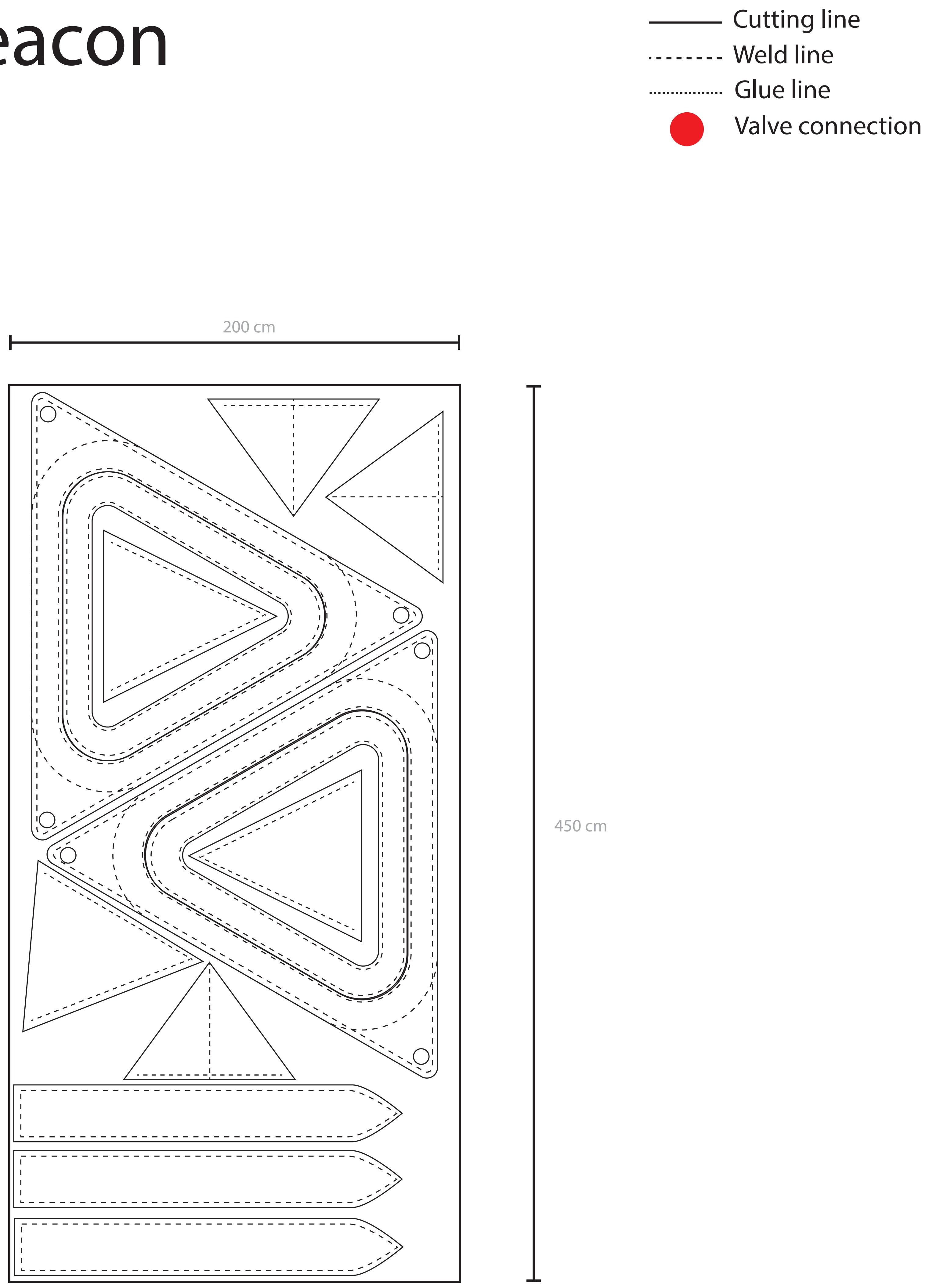
colour: Orange



These drawings are for discussion use, to be used in collaboration and developed further in close collaboration with a professional manufacturer of inflatable objects.

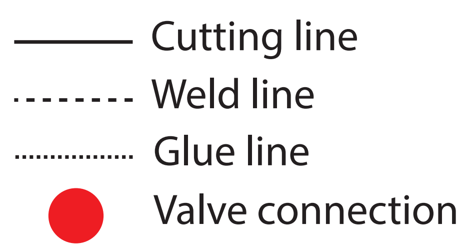
Cut-out Beacon

colour: Orange



These drawings are for discussion use, to be used in collaboration and developed further in close collaboration with a professional manufacturer of inflatable objects.

BASE



OUTER TUBE

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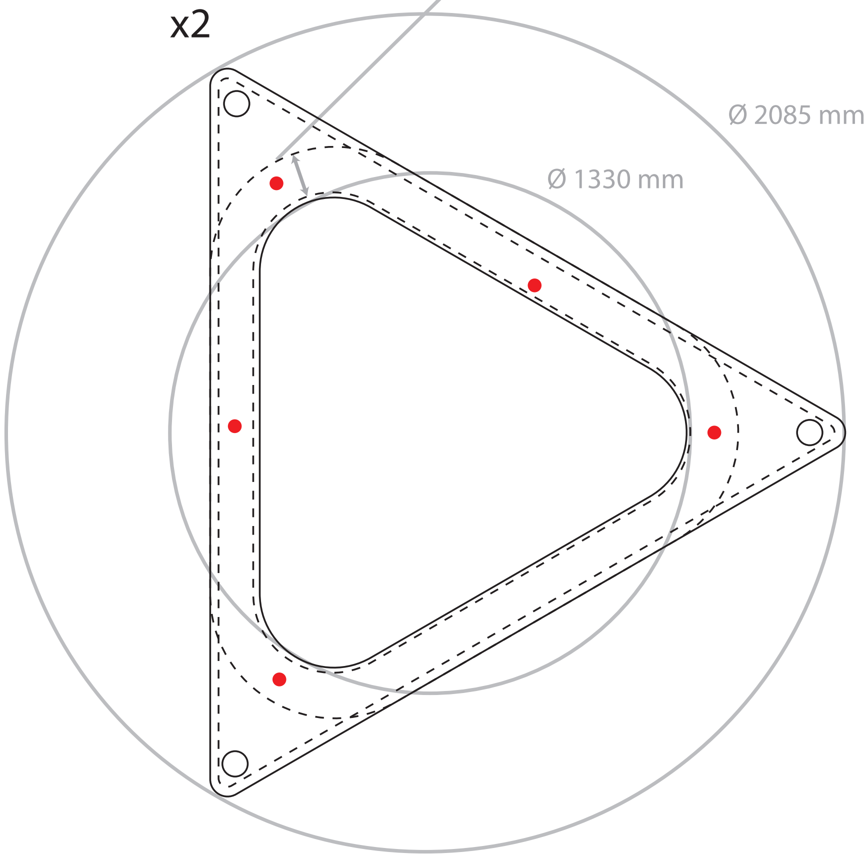
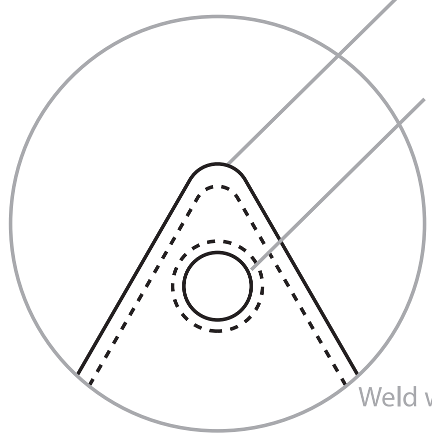
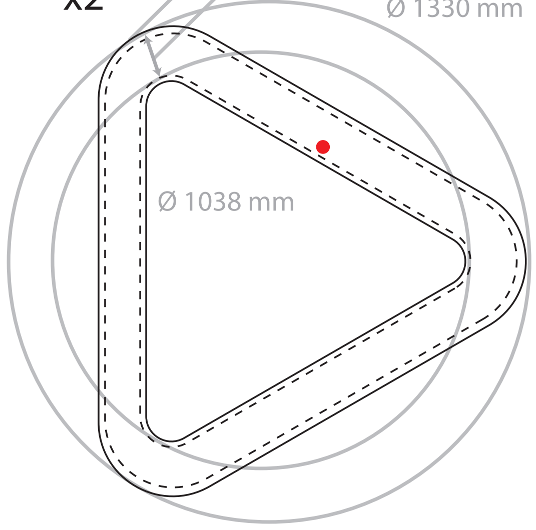
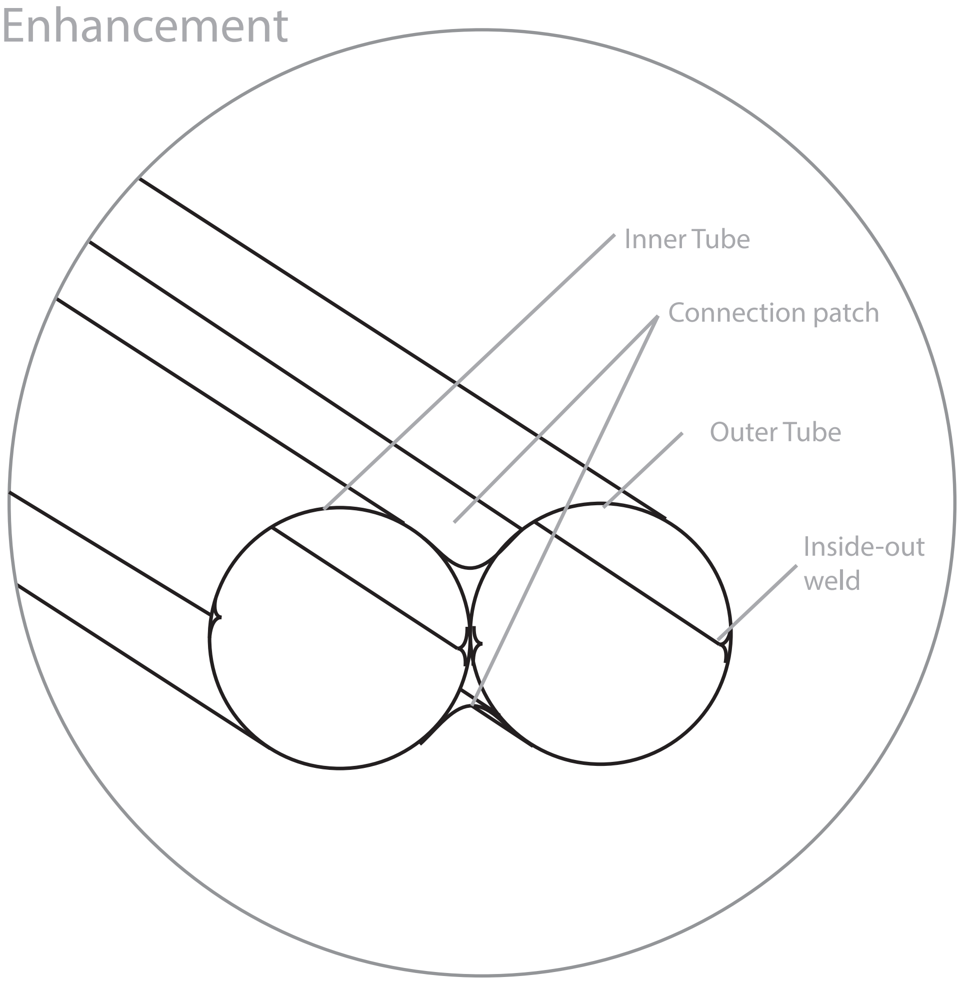




INNER TUBE

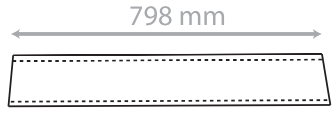
x2





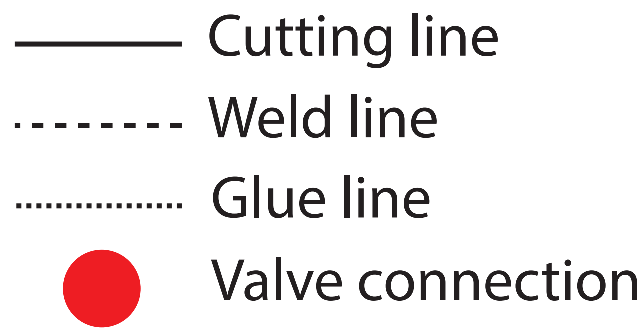
Connection patch

x6

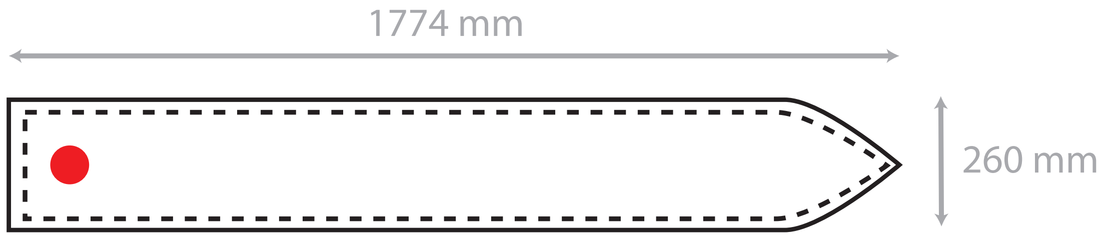


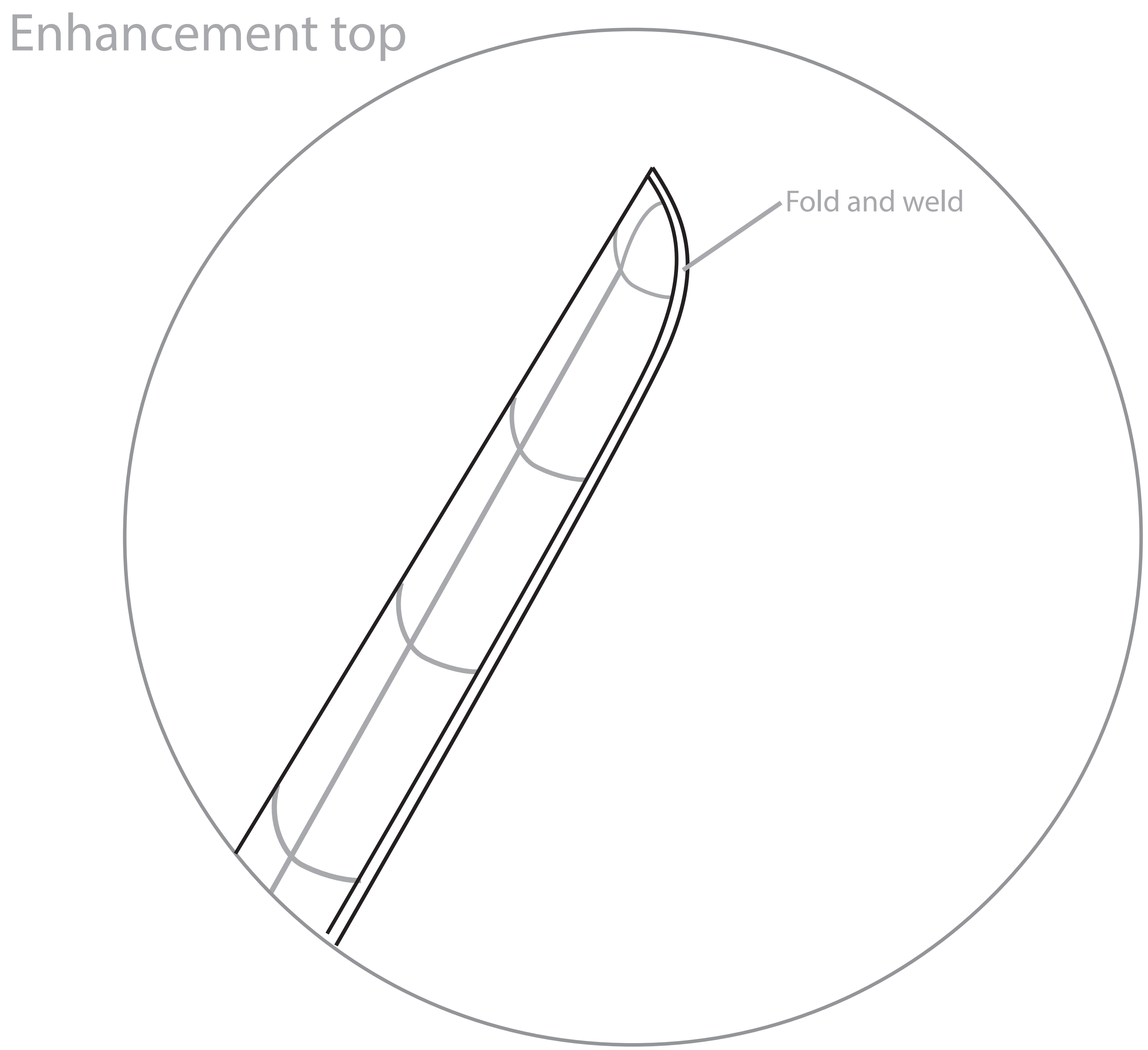
These drawings are for discussion use, to be used in collaboration and developed further in close collaboration with a professional manufacturer of inflatable objects.

PILLARS



Pillars





ARC Rescue Beacon Product Specification						
Issue	Need	Elaboration - Aditional insight	Demand	Unit	Marginal value	Ideal value
Requirements for the Rescue Beacon						
1	The Arctic climate research defined the range accepted for storage temperatures that the product must withstand (A.13; P. 012).	The minimum and maximum temperature in which the product is able to be safely storged without damage to product functionalities. Aditionally defined by Cospas-Sarsat Regulation §2.5 that 406 beacon devices (S. 01).	Minimum storage temperature Maximum storage temperature	Degrees Celcius	-35 +60	-60 +70
2	The Arctic climate research defined the range accepted for operating temperatures that the product must withstand (W.007; P. 012).	The minimum and maximum temperature in which the products is able to function properly without product damage. Aditionally defined by Cospas-Sarsat Regulation §2.5 that 406 beacon devices (S.01).	Minimum operational temperature Maximum operational temperature	Degrees Celcius	-35 +40	-55 +55
3	As the product is used in maritime environments, the product must withstand being submerged (W.020; P.015).	Also defined by Cospas-Sarsat regulation §2. 3 that 406 beacon devices should function in enviornmental conditions. Being in a maritime enviroment, the container need to be able to withstand being submerged in water with damaging the product (10 meters for 5 minutes) (S.01).	Electrical component enclosure in a IP68 Standard* container	Binary	Pass	Pass
4	The interview with Klaus Dupont at the Joint Arctic Command, indicated a duration of an operation could be extended up to 5 days (W.018; P.016).	Also defined by Cospas-Sarsat regulation §2. 4 that 406 beacon devices should have battery capacity to operate atleast 48 hours (S.01).	Battery capacity in operation	Hours	48	120
5	The interview with Klaus Dupont at the Joint Arctic Command, indicated a duration of an operation could be extended up to 5 days (W.018; P.016).		Duration of active inflation	Hours	120	200
6	The research on hypothermia, indicated that the users can survive longer if they get as much of the body out of the water as possible (W.004; P.018).	Boyancy is based on weight of a person, wet clothe, weight of the product etc.	Required boyancy of the inflatable beacon	Newton	2500	3000
7	The interview with KNAPK indicated the need for extending the service life for as long as possible to heighten the convenience for the user (W.019; P.25).	Defined by SOLAS Regulations Annex IV/15. 9 406 beacons must be tested anually (S. 01).	Battery capacity in standby time	Years	8	10
8	The research on existing equipment revealed the use of strong colours must be applied to the main product to be more visible (W.12; P.029).	With aditional insight, strong colours are more visible in hazy conditions (W.029).	Make use of bright colour for improved product visability	Binary	Pass	Pass
9	The research on existing equipment revealed that the product must have access to manual inflation options (W.012; P.029).	To ensure that if the user is still alive and not yet found within the 5 days, a manual inflator should be equipped on the device.	Allow for manual inflation	Binary	Pass	Pass
10	Interview with Klaus Dupont from the Joint Arctic Command revealed that other sailors are often the closest help to the distressed and would in many situations be the quickest response (A.11; P.037).	The research on communication technology revealed an oppotunity to have fellow sailors to help each other using existing radio equipment (W.036; P.048).	Broadcast distress signal on the maritime Digital Selective Calling band	Frequency Megahertz	156.525	156.525
11	The interview with the chemist, Nils Kritmøller indicated the best solution for inflation would be dry air or nitrogen (A.08; P.043).	Dry air and oxygen is preferable to other types of gas in price, affected by temperature and danger.	Gas to be used for inflation	Gas	Dry air	Nitrogen
12	The research on maintenance for gas canisters revealed a maximum service life for the inflatable beacon (W.033; P.043).	The requirement for service life for gas (S. 02)	Service life for inflatable beacon	Years	5	10
13	The interaction test with concepts attached to the boat revealed the need for attaching the beacon to the person or boat (W.035; P.044).		Attach safety line between boat and beacon	Binary	Pass	Pass
14	The interview with local sailor, Martin Hjort expressed the product needs to withstand to be covered in ice (A.04; P.047).	The product must be able to be deployed and function in frozen conditions with icing coverage.	Container enclosure must be designed to withstand icy conditions	Binary	Pass	Pass
15	The interview with Klaus Dupont from Joint Arctic Command indicated the need for utilize GPS functionalities (W.020; P.049).	Being able to contact SAR and Police with the GPS location can help ease the process og locating the distressed.	Broadcast distress signal on GPS based distress band	Frequency Megahertz	406	406
16	The interview with Michael Hjort from the Joint Arctic Command indicated a minimum size of the inflatable beacon (A. 09; P.051).	In interviews with Arktisk Kommando in Greenland they said that "the bigger, the better, but anything bigger and higher than a person is great!"	The minimum height of the inflatable beacon The minimum width of the inflatable beacon The minimum footprint of the inflatable beacon	Meters Meters Cubic meters	1.5 1.5 2.5	>1.5 >1.5 >2.5
17	The research on battery capacity revealed a maximum service life for the electrical components (A.16; P.065).		Service life for battery capacity	Years	5	10
18	The interview with expert, Henning Christensen indicated the need for a long antenna for better signal transmission strength (A.10; P.065).	The product will have an antenna to broadcast the distress call on several frequencies. The length helps determain the signal strength. Using 1/4 wavelength, the product would be able to broadcast the signal as far as regular products do (A.10).	Antenna length	Millimetres	300	500
19	The interview with sailors, Martin Hjort indicated the benefit of having a light on top of the inflated beacon (W.020; P.065).	Light greatly improve visibility of the beacon in both darkness and daylight.	Equip a light on top of the product	Binary	Pass	Pass
20	The research on existing equipment revealed the power of the light needed for great visibility (W.050; P.065).	The watt usage of the light to be seen up to 18 km away (S.03).	Watt usage of the light	Watt	0.5	1
21	The research on SOLAS regulations demands that the emergency light must flash with between 50 and 70 flashes per minute (W.023; P.065).		Light flashing intervals	Hertz	f = 1.0 Hz	f = 1.0 Hz
22	The research on SOLAS regulations revealed a demand for the colour of personal distress lights to be white (W. 023; P.065).		Use the colour white for lights	Binary	Pass	Pass
23	The research on satellite based communication revealed the need for broadcasting distressed signal on other bands (W.046; A.15).	Also defined by Cospas-Sarsat regulation §4 that 406 beacon devices must broadcast on aircraft emergency channel (S.04)	Broadcast GUARD* distress call	Frequency Megahertz	121.5	121.5
24	The research on satellite based communication revealed the need for receiving signal for user feedback of distress call (W.046; A.15).	Also described by Galileo, the unique feature of resend a confirmation signal to the distressed that help is on its way (S.05).	Receive Galileo's smart RLS*, to get feedback on help	Frequency Megahertz	1575.42	1575.42

ARC Rescue Beacon Product Specification

Issue	Need	Elaboration - Aditional insight	Demand	Unit	Marginal value	Ideal value
Wishes for the Rescue Beacon						
25	The interview with the SAR personal 'Eskadrille 722' indicated the benefit of utilizing thermal visibility to improve search operations (W.002; P.050).	With large surfaces of clear mylar foil, the beacon will have an increased visibility on thermal cameras (W.037).	Visable on thermal camera	Binary	Pass	Pass
26	The interview with Klaus Dupont from the Joint Arctic Command indicated the benefit of utilizing radar reflective materials to improve search operations (W.018; P. 051).	When helicopters, aircrafts or SAR ships search for sailors in distress they use radar scans. Improving the visibility on this would improve general visibility of the product.	Use radar reflective materials	Binary	Pass	Pass
Requirements for the storage container						
27	The interview with sailors indicated that the product should have a manual activation for inflation (W.020; P.015).	Also defined by Cospas-Sarsat regulation §2. 6 that 406 beacon devices should have a manual activation (S.01).	Product is possible to activate manually by the user	Binary	Pass	Pass
28	Interviews revealed that the product must not be an annoyance, to accommodate the users daily work. Otherwise the product will not be used (W.020; P.015).	Explained by sailors in Greenland, They deem most existing equipment annoying and many do not use it due to it being in the way when fishing or hunting.	Product is non-intrusive while operating the boat, hunting or fishing	Subjective		
29	The research on existing equipment revealed the use of strong colours must be applied to the products interaction points (W.12; P.029).	Also defined by Cospas-Sarsat regulation §3. 2 that 406 beacon devices should have clear indications of interaction points. As panic influence the decision process should the product be clear in where interaction are located (S.01).	Extensive use of bright colours to indicate interaction points	Subjective		
30	The interaction research revealed that the user must be able to activate the product using only one hand (W.030; P.036).	This is tested in an interactiontest (W.030;)	Single handed operation	Binary	Yes	Yes
31	The interview with local sailor, Martin Hjort indicated that a product on the boat should be placed on the outside not inside (A.04; P.046).	For maximal convinience and minimal space consumption, the outside of the boat would be better suited for products used few times.	The Product should be able to be installed on the outside of the boat	Binary	Pass	Pass
32	The research on product placement revealed that the product must be able to withstand salt water splashes, and not collect water during storage (W.54; P.047).	Also defined by Cospas-Sarsat regulation §2. 5 that 406 beacon devices should be able to be stored approateably in any enviornmental condition (S.01).	Product container must withstand watersplashes	IP Standard	IP11	IP44
33	The interview with local sailor, Martin Hjort expressed the product needs to withstand to be covered in ice (A.04; P.047).	The product must be able to be deployed and function in frozen conditions with icing coverage.	Container enclosure must be designed to withstand icy conditions	Binary	Pass	Pass
34	The research on measuring boats, indicated the maximum size of the container, to fit as many boat types as possible (W.052; P.047).	Dimentions of the container should not exceed the dimentions allowed by the common boats.	Maximum height of the container Maximum width of the container Maximum depth of the container	Millimetres	H:450 W: 650 T: 400	H: <400 W: <400 T: <300
35	The research on container interaction, revealed the need for at least two step activation to reduce risk of accidental activation. To simplify the product, the minimal amount of interactions should be present (W.063; P.067).	Also defined by Cospas-Sarsat regulation §3. 3 that this should be process of two independent actions (S.01).	Activation by two independent actions	Binary	Pass	Pass
Wishes for the storage container						
36	The interviews with local fishermen showed that the users often use gloves. Therefore handles should be oversized and not rely on fine motor function (W.020; P.014).		Interaction handle size	Subjective		
37	The interview with local sailor, Ivik Jensen expressed the need for the product to always be within reach (A.03; P.046).	As an emergiency can develop in many different scenarios, the product needs to be placed, so that the user easily can get access to it, even though he is in contact with the water.	The product is easily accessible	Subjective		
38	Container detailing revealed a business strategy that requires a professional service provider for product maintenance (W.061; P.068).		Product should be able to be rearmed by a professional service provider	Binary	Pass	Pass

Sources

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Word catalogue

No.	Abbreviation	Describtion	Source
1	GUARD	The aircraft emergency frequency band	S.02
3	IP Standard	A standard definition on enclosures ability to keep out dust and moisture	ICE 60529-2013
5	RLS	The Return Link Service, is a unique feature of Galileo satellites, that allows the user to get feedback of acknowledgement of signal. This could be a spoken message, a sound or a light (led colour on/off or colour change)	S.05