seaus

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PROCESS REPORT

ABSTRACT

This is a master thesis project within Industrial Design which has been developed by Seaus, a group of three students from the Aalborg University.

The project deals with the development of a new solution for the commercial fishing industry using creels. A field in which the problematic of the lost or entangled gear it's an evidence, which with time becomes marine litter and thereby, generates ghost fishing by continuously killing marine species. This problem occurs due to the entanglement of creels lines into the seabed or due to propeller cut-off of the buoys which signalize the creels in the sea surface. Current solutions make barely impossible to retrieve this lost gear from the deep seas, so, Seaus wanted to provide a new solution to solve this.

The solution is "Tau", a device which permits fishermen a second chance for retrieval of lost or entangled creels. This device would be placed on the existing creel configurations and would detach the entangled lines and deploy to the sea surface to permit the retrieval for the fishermen. The result of it would permit to reduce fishermen expenses in case of lost creels and, furthermore, it would prevent the risk of marine litter and ghost fishing at the seas.

INFO

TITLE	SEAUS
PROJECT THEME	LOST COMMERCIAL FISHING GEAR SOLUTION
STUDY PROGRAM	MSC. INDUSTRIAL DESIGN
PROJECT PERIOD	04-02-2019 TO 06-06-2019

PROJECT GROUP	MA4-ID3
PARTNERSHIP	HVALPSUND NET
MAIN SUPERVISOR	KAARE ERIKSEN
CO-SUPERVISOR	JØRGEN ASBØLL KEPLER

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seaus

Seaus is a passionate team who are working for innovative solutions within the fishing industry. We need to care more about the sea to ensure a healthy life in the future, to take care of the environment that protects us and to think one more time before we use the biggest resource in the earth, that is what Seaus is about.

Our goal is to minimize the risk of ghost fishing and to reduce the amount of marine litter, by developing a product that functions as an add-on for creel fishing within the commercial fishing industry. The goal of this product is to provide a second chance for the fishermen to retrieve their lost fishing gear.

It is a small step in the fight against marine litter, but it is the right direction to make the world a better place.

ACKNOWLEDGMENTS

This project would not have been possible without the help from different collaborators which have offered their knowledge on the field to permit Seaus to develop this project. From Seaus it has been a pleasure count with their help. Furthermore, the group wants to express our special thanks of gratitude to our Supervisors Kaare Eriksen & Jørgen Kepler from Aalborg University for their help and advices along the project.

READING GUIDE

For the right reading and understanding of the master thesis projects it's recommended to read the reports in the suggested order below:

1. Product report.

2. Process report with Appendix next to it: To follow the different documentation needed while reading the process report.

3. Technical drawings

For the referencing it has been used the Harvard APA 6th as a source citation method.

// OUTCOME

Throughout the development of the project, there has been observed different findings from interviews and new learning. Form these, the group has extracted the most crucial ones which had permitted to continue exploring and defining the project. These will be shown along with the process report in an orange box with the title of "Outcome". Furthermore, all the elements with orange color will refer to crucial insights or findings considered.

INTRODUCTION

Marine litter has become more and more popular over the years as it has become a raising environmental problem worldwide. Most people it's not aware of this problem, but organizations are starting to take action against it and trying to spread this awareness to the worldwide population. Most of these organizations are NGOs (Non-governmental organizations) and are based on volunteers. These organizations do not have enough resources to face and solve the whole problem. Instead, these take action mostly in coastal areas, but, when the marine litter it's still at the sea, the problem increases as there's no one taking care of it.

This problematic has different sources, but, multiple reports show that the fishing industry it's one of the main responsible of it and especially in Scandinavia. As an example, 50% of the marine litter found in the coasts of Denmark, Norway, and Sweden comes from lost or discarded fishing gear. (Nordic coastal clean-up report,2017). This data and the rise of awareness to take action against marine litter has forced governmental organizations in the EU to react. At the present time, the goal of the European Commission it's to reduce up to the 30 % of marine litter in the EU seas by 2022 and, thereby, new regulations are being implemented for it. (Our oceans seas and coasts, 2018)

In the fishing Industry, there are different techniques which contribute more than others to the problem of marine litter. Between them, it has been reported that the fishing techniques used for fishing crabs and lobsters are one of the main marine litter contributors in the deep waters of the sea.

The main technique used for it is the "Creel fishing" which consist of the use of creels in the sea bottom which is temporally collected and replaced during the crabs and lobsters fishing season. The use of this technique has been reported to grow along the next years as the technique which competes with it, the "bottom trawlers", are being criticized for continuously destroying the sea floor and also more risks. Moreover, after the new EU regulations, this technique has been affected and, therefore the use of it has been reduced and replaced by the "Creel fishing" technique. But, there is also a downside using the "Creel fishing" technique, since the creels easily can get lost in its process. As an example, fishermen in Norway using this technique can loss up to the 10-30% of their creels each year, which is 30.000 lost creel yearly. And, the main problem appears when fishermen are not able to pick up them. (Remove lost and abandoned fishing gear, 2015)

These creels remain in the water creating marine litter until someone reaches them and retrieves the and also produce a problem called "ghost fishing", which it's based on the continuous catch of species and the death of them after time.

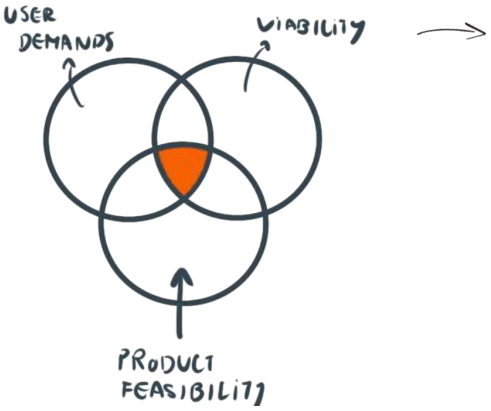
Right now, the main solution appears thanks to NGOs which tries to pick these after the fishing season, even though, the solution is still far from being able to get all these lost creels in the sea bottom due to the depth of these waters, which can reach up to 150m depth, and the complexity to pick up them.

Therefore the focus of this master thesis addresses the development of a product to prevent from the start the problem of marine litter that comes from the fishing industry fishing with creels in the Scandinavian seas by offering the fishermen a second chance to retrieve their creels in case of the loss and therefore preventing the ghost fishing in these areas.

TABLE OF CONTENT

PROCESS APPROACH

During the process there had been used different approaches which had helped the group to develop the Seaus product. Below there's an overview of the main design approaches the team have used along the process.

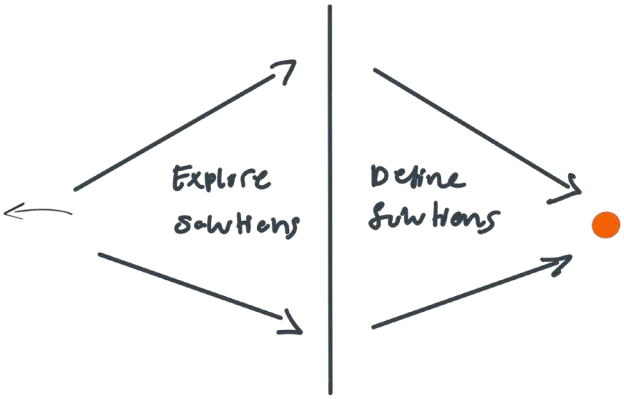


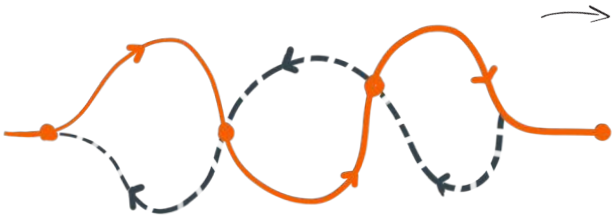
DESIGN THINKING

The Design Thinking methodology (ICED Design Thinking A paradigm) is the approach utilized in the process of this project, that have brought insights, regarding human behavior within the fishing industry, to a desirable product solution. This approach has permitted the group to bring together what was desirable from the fishermen perspective with what is technologically feasible for the product and economically viable to create a business upon it.

CONVERGENT & DIVERGENT THINKING

Along the process, there had been different divergent and convergent thinking. This lead from opening the solution space generating new ideas to afterward frame and define all these different findings. As an example, in the research face, the group had different directions to discover at the starting point. These were finally framed to have a defined focus to dive into.

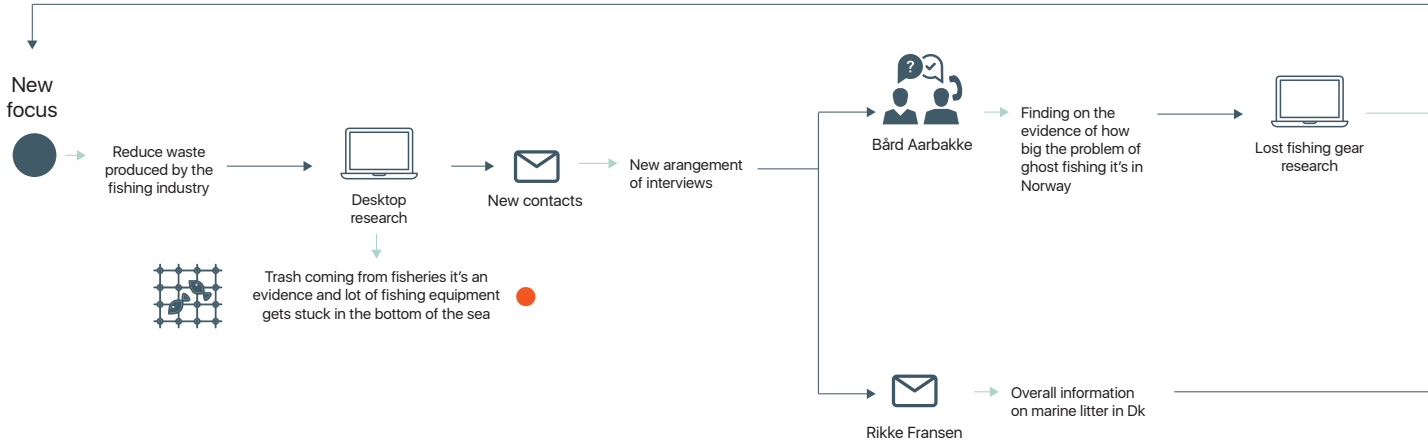


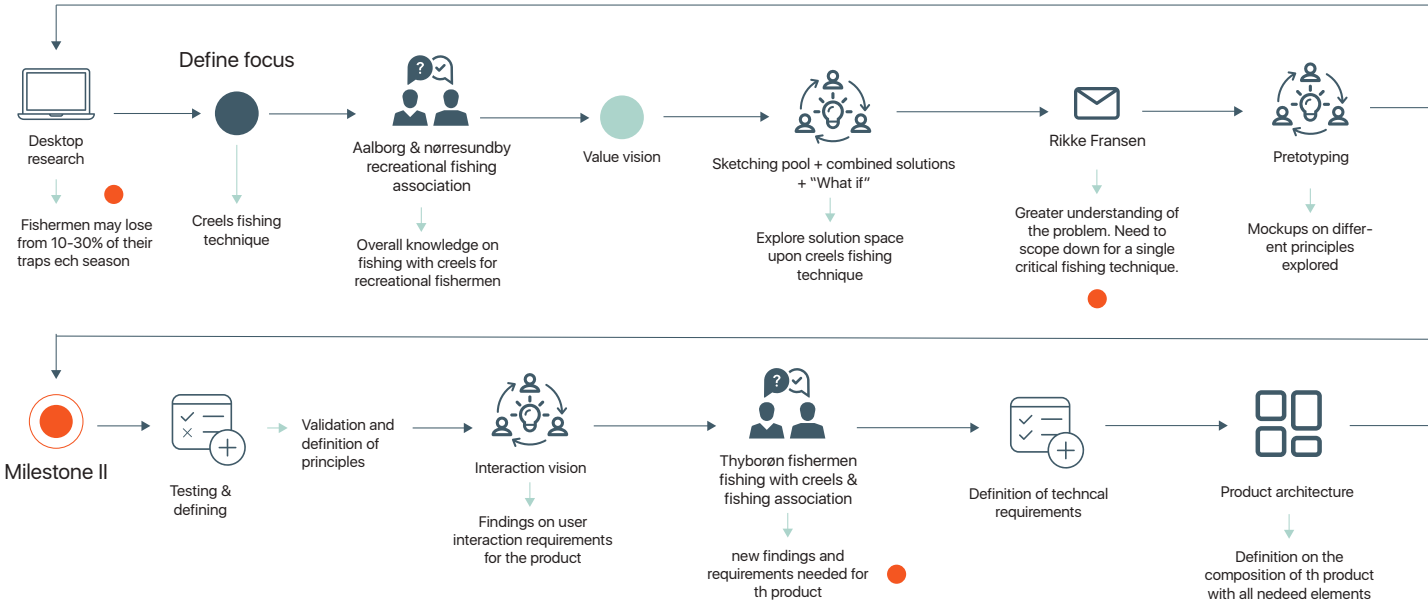


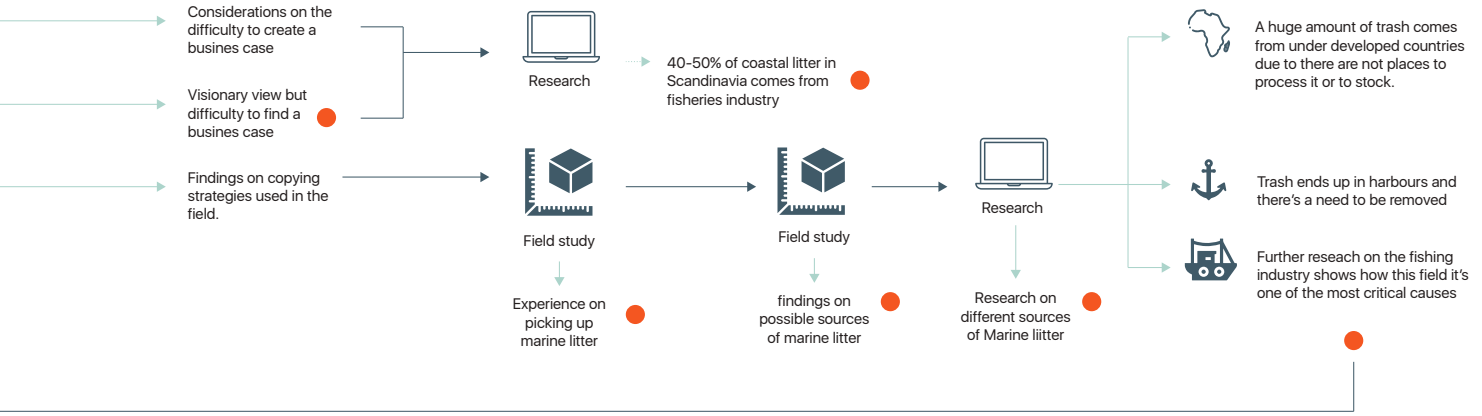
ITERATIVE DESIGN

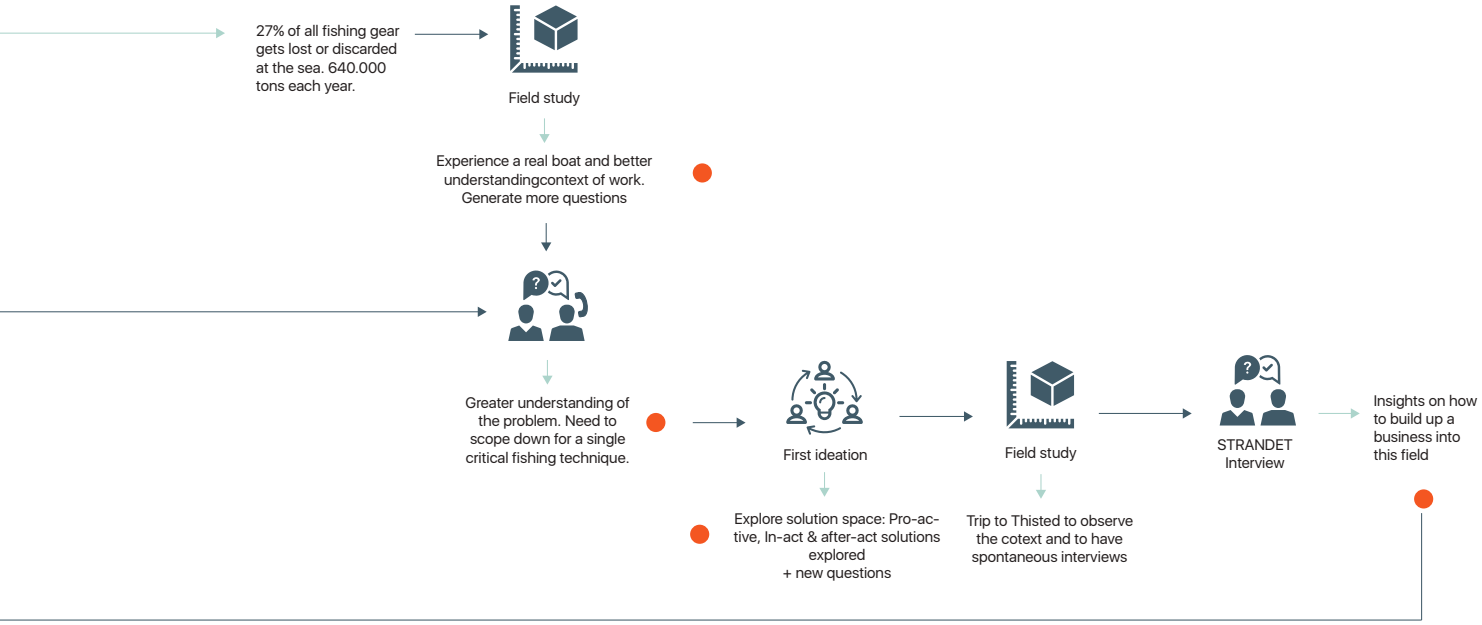
Through the product development, there has been an iterative process in where first ideas had been continuously refined based on new findings. As an example, By using the build, measure, learn the team has continuously iterated from first ideas in order to find the best possible solution.

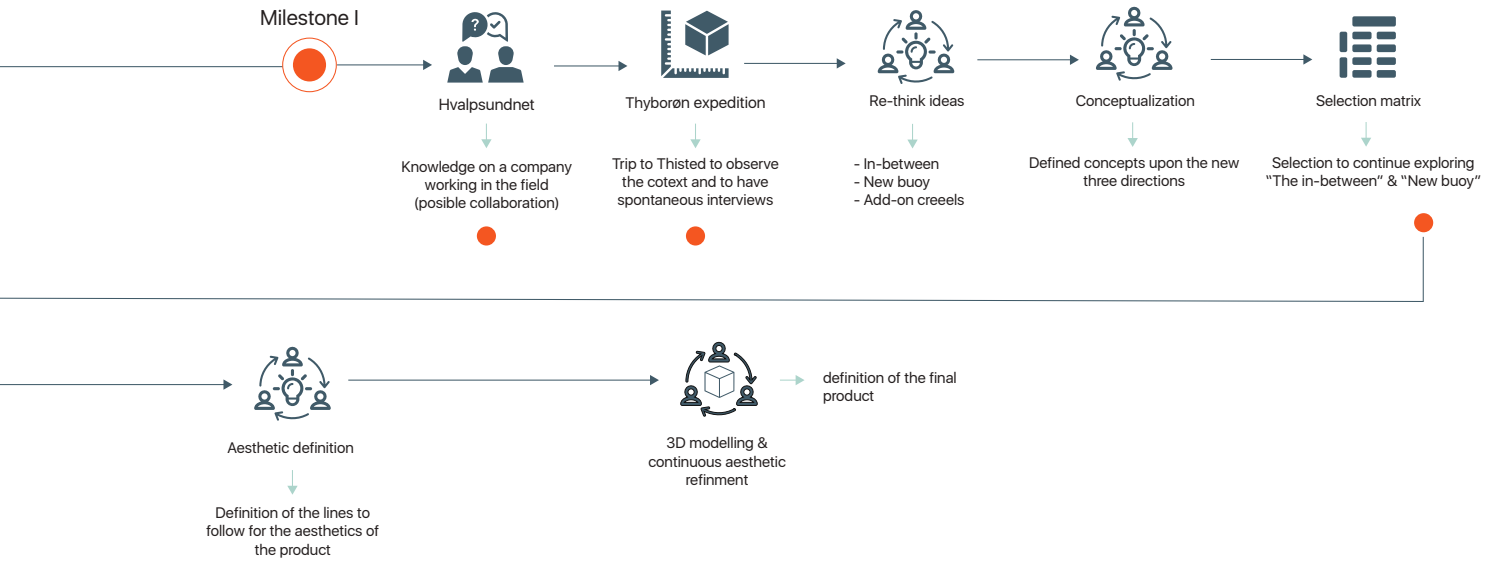
PROCESS OVERVIEW






Considerations on the difficulty to create a busines case
Visionary view but difficulty to find a busines case
Findings on copying strategies used in the field.
Research
40-50% of coastal litter in Scandinavia comes from fisheries industry
Field study
Experience on picking up marine litter
Field study
findings on possible sources of marine litter
Research
Research on different sources of Marine liitter
A huge amount of trash comes from under developed countries due to there are not places to process it or to stock.
Trash ends up in harbours and there's a need to be removed
Further reseach on the fishing industry shows how this field it's one of the most critical causes


27% of all fishing gear gets lost or discarded at the sea. 640.000 tons each year.
Field study
Experience a real boat and better understandingcontext of work. Generate more questions
Greater understanding of the problem. Need to scope down for a single critical fishing technique.
First ideation
Explore solution space: Pro-ac-tive, In-act & after-act solutions explored
+ new questions
Field study
Trip to Thisted to observe the cotext and to have spontaneous interviews
STRANDET Interview
Insights on how to build up a business into this field


Milestone I
Hvalpsundnet
Knowledge on a company working in the field (posible collaboration)
Thyborøn expedition
Trip to Thisted to observe the cotext and to have spontaneous interviews
Re-think ideas
- In-between
- New buoy
- Add-on creeels
Conceptualization
Defined concepts upon the new three directions
Selection matrix
Selection to continue exploring "The in-between" & "New buoy"

Aesthetic definition
Definition of the lines to follow for the aesthetics of the product
3D modelling & continuous aesthetic refinment
definition of the final product

prephase 1.0

This section provides an overview of the background that has been researched to provide the foundation of this project.

In this section, it will be explained the marine littering problem, the impacts of it and the stakeholders involved into it. Moreover, the impacts of the fishing industry will be unfolded, and it will be explained the problem of the creel fishing technique.

// OUTCOME

This pre-phase gave the team the needed insights to build a solid foundation for the project and permitted to tame the core problem for further work.

// NEXT

Once the team had the needed information to frame the problem and to have a more defined focus, the next step was to dive into it in order to find the best solution space in which the team could investigate.

1.1 MARINE LITTER

WHAT?

Over the years the oceans have been filled with items that not belong there. Huge amounts of plastics, metals, rubber, paper, textiles, fishing gear, vessels, and other lost or discarded items enter the ocean every day.

This problem's known as Marine Litter or Marine debris which has been defined by the UN as *"any solid material discarded, disposed of or abandoned in the marine and coastal environment"* (Marine litter, 2019) and has become one of the most crucial pollution problems which are facing the world's ocean nowadays. As an example, it is estimated by the European Commission that more than 150 million tonnes of plastics have been accumulated in the world's oceans until now (Our oceans, seas and coasts, 2018). Furthermore, every year millions of tonnes of litter end up in the ocean worldwide creating different impacts.

Img. - Marine litter seawater

IMPACTS

Marine litter might end up in many different places such as beaches, deep sea floor, and sea surface. This creates different problems which had been categorized by the European Commission in three main categories: Ecologic, Economic and Social Impacts.

ECOLOGIC

The ecological impact, it's one of the main impacts due to the difficulty of controlling the marine litter problem all over the world. This impact, refers to the effect of the marine litter into the ocean's ecosystem and its animal species. (Marine litter impacts on coastal and benthic habitats, 2016)

"Just because you don't see it doesn't mean it isn't there"

European commission

ECONOMICAL

When marine litter ends up in deep sea or offshore, can be unreported and might stay there for years. This can cause economic problems by damaging vessels or affecting the fishery industry in their products (catch).
But, on the other hand a huge part of this litter can end up in the coastlines. This generates cleaning costs for municipalities. For example, it was stated by the European Commission that the cost across EU for coastal and beach cleaning was assessed at almost €630 million per year. Moreover, this affects the tourism of the regions. (Our oceans, seas and coasts, 2018)

SOCIAL

The Social impact which is mainly based on the reduction in aesthetic value and the public safety in local communities where this litter ends up. Furthermore, it affects seafood due to micro-plastics, which get into the seafood and to humans afterward.

STAKEHOLDERS INVOLVED

There are four main types of stakeholders involved in the marine litter problematic: non-governmental organizations, Industries, public authorities, and the general public.

NGO's:

Marine Litter prevention in NGOs works mainly to do something against the problem, but also about trying to raising awareness.

Img. - Marine litter seawater

INDUSTRIES:

Industries have an interest in the marine litter as it can be an innovative way to create value to their brands. Different big companies which have already used the marine litter on their products in order to grow their product values for their customers. An example of it could be Adidas, which used recycled nets to use in their products. (Adidas Parley, 2018)They often collaborate with NGOs via their national trade associations.

Img. - Adidas / Parley recycled shoes component

MUNICIPALITIES:

One of the responsibilities of public authorities is to collect waste and prevent litter. In order to face these responsibilities, most municipalities opt for cost-effective ways to reach their overall objectives.

SOCIETY:

The problem of litter concerns us all and we are all responsible. As well as being the source of the problem, the society can also be part of the solution but the key for it is to have the other stakeholders to help to achieve this.

PROBLEM EXPLORATION

The team at the first stage started to investigate a way to face the problem of coastal marine litter. This, lead the group to arrange different interviews with the main stakeholders involved in the problem.

The team contacted different companies working into this field (Appendix _,_,_). One of them was Kimo Denmark, a company whose goal is to prevent pollution of the seas and coastal waters of North Western Europe (Kimo, 2019) and represents also the Danish municipalities within the area of interest (coastal municipalities). Through an interview with a member of Kimo (Appendix ___), we got insight from the overall problem of marine littering to the costs for municipalities. This interview allowed the group to gather different contacts to explore more into the topic. The group also contacted with different municipalities (Appendix _, _, _) and arranged a meeting with Steen Heftholm, from Frederikshavn (Appendix ___), in which we had the opportunity to talk about different business aspects in which municipalities take part regarding coastal marine litter. This permitted the team the perspective from the municipalities and the difficulty of finding a business case regarding this topic.

Later on, the group visited the west coast Denmark, one of the main locations were marine litter ends up in Denmark. There, we interviewed Jens from Strandet company (appendix ___), a company which created a business case by collecting marine litter and partnering with other companies. This gave the team a business case based on this topic and the benefits and drawbacks of it.
During this visit, the group also had an interview with the responsible of the beaches in Hjørring municipality (Appendix ___) who presented their main problems and the working process they do to maintain beaches clean. It was found that in Hjørring municipality was only focusing on picking up marine waste in flat terrain (beach). The waste which ended up in the uneven terrain (sand dunes) was not being picked up.

These interviews and findings lead the group to consider to focus our solution space to provide a solution to this problem with a new product to be implemented by municipalities to facilitate the collection of litter or to stop the marine littering from entering into un-

even terrains. Therefore, the group did an activity based on collecting trash from two different areas, one in a flat area and the other one in an uneven terrain area. (A08) in which it was found that in uneven terrains there was a big amount of litter as well.

Img. Collection in uneven terrain

For this activity in Tversted, the team collected waste in order to get the experience of it and be able to sort it and compare our findings between two different areas (flat area and uneven terrain area) and with existing data from Kimo Denmark and the European Commission.

The group clustered the waste and found that the collected litter could be categorized in different sources of marine litter and in different sizes or weights which lead the group to have different considerations, as for example, we figured out that lightweight litter is more likely to float or be moved by the wind which is why this type of litter it's more often moved into uneven terrains.

Moreover, by the interview (Appendix ____) done, we figured out that the municipality main coping strategies to clean up the coastlines were based on providing volunteers with pickup tools, plastic bags, and sorting containers and to do cleanups once a week by the department from the municipality. Furthermore, when there was a lot of litter on the coast due to storms and wind, the municipality often was hiring companies with special machines to facilitate this process (Ole MikkelsenA/S).

Img. - Clustering Marine litter from west coast Denmark

So, after this field study and the interview, the group figured out that, even though the high yearly cost of an average of 7,2 million DKK for Danish municipalities to clean up coastlines (A07), the possibilities to implement a product into this field to facilitate to facing the problem would be difficult due to the already existing solutions and as well for the business case to make possible the implementation for municipalities.

But, this activity leads us to consider to research deeper into the different sources of marine litter and to look to the problem from another perspective. This leads us to have a working metaphor, which was mainly based instead of trying to find the solution to the existing problem, to find a solution to eliminate the problem.

"If the pipe it's leaking, first cut the water to solve the problem instead of continuously cleaning the leaking water"

- Seaus team

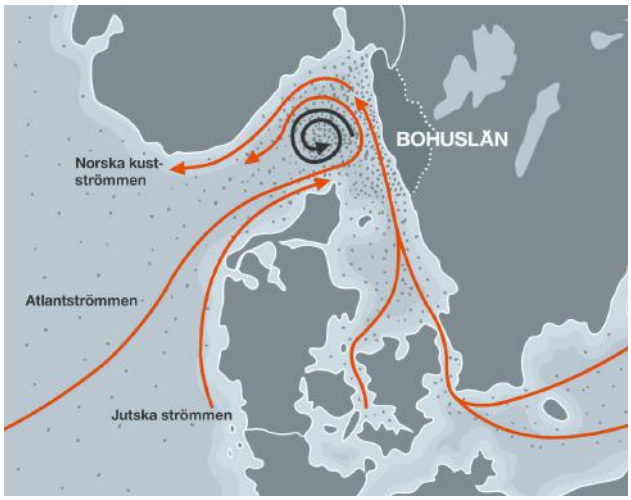
// OUTCOME

- A business case into this fild would need to be reconsidered after all the findings.
- These findings lead the group to dive into the causes and the main sources of the marine litter.

SOURCES

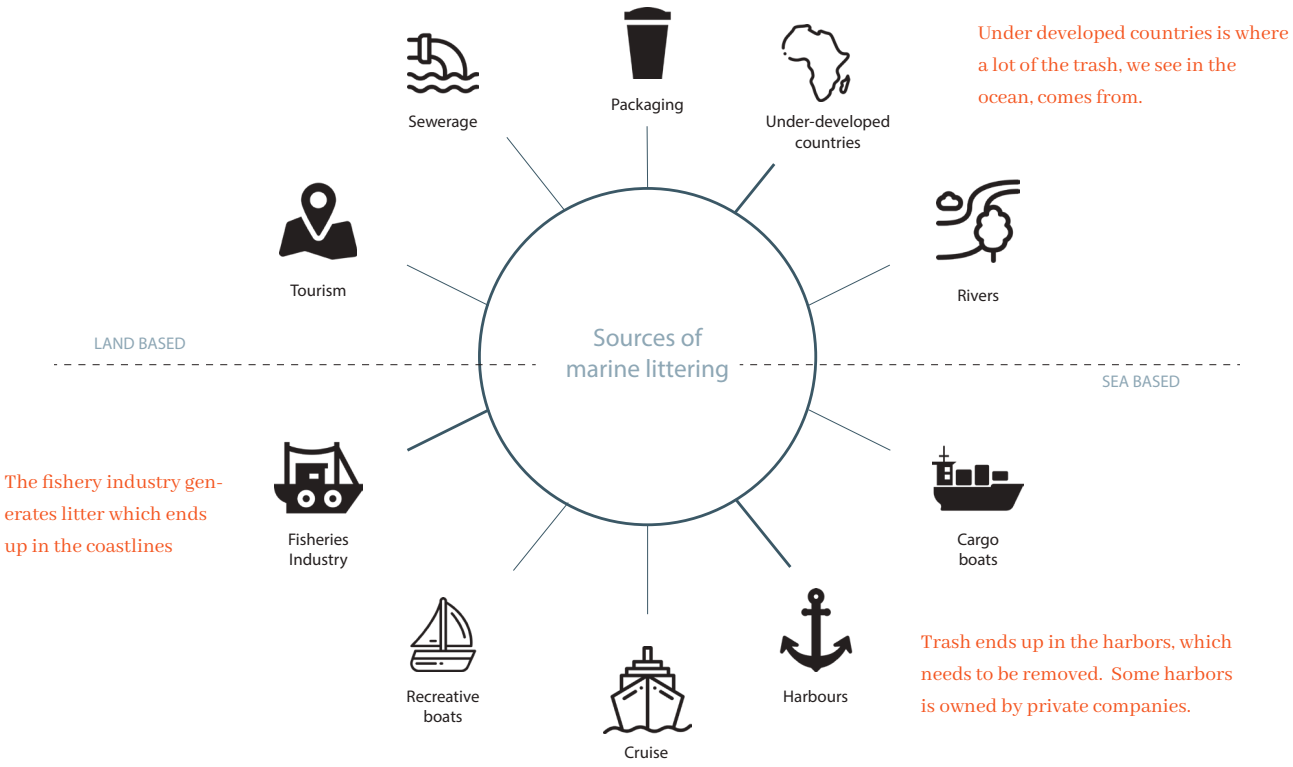
Ocean pollution it's a problem that affect everyone across the globe. When looking into the sources of his problem, one of the most common categorizations and the one that the team has research based on its the division between sea-based and land-based sources. On the one hand sea-based origin relates to litter that is directly (accidentally or purposely) released into the sea. On the other hand land-based sources come from activities which cause littering directly on the coast. (Identifying Sources of Marine Litter, 2016)

According to the UN Environment program, about 80% of marine litter originates from land. (Our oceans, our seas and coasts, 2018) But, it has been found that sea-based sources are more critical in determined regions. As an example, in the northern seas there are different currents which bring litter from the Atlantic and Baltic sea into Norway and Denmark which makes this problem to be highly considered with new solutions into this areas.



Img. - Marine litter currents in the northern seas

The team had a brainstorm session in order to explore on the sources of marine littering (A10). The sources were also divided into sea based & land based sources.



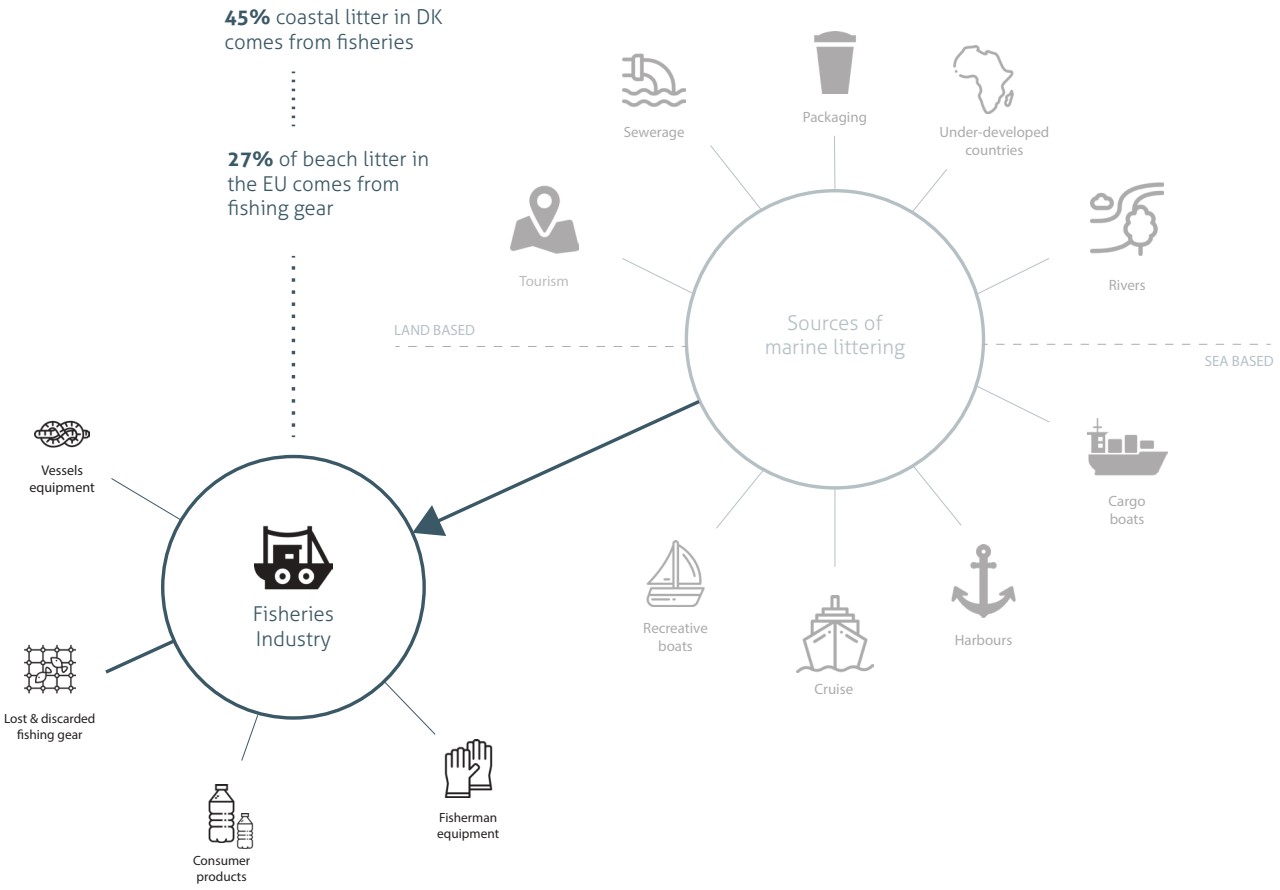
Img. - Marine litter sources

The main goal of this brainstorm was to find most relevant sources of marine litter to research on and to find a solution to implement. Finally, after the discussion of the different sources the team decided to explore into three areas; Fishing industry, Harbor cleaning & under-developed countries (with focus on waste management). These were selected due to the group found these offered more possibilities to work with than the other ones.

After researching in this three areas the group found the fishing industry as the right source to investigate upon as it was one of the main sources of marine litter in Scandinavia. The team found that it's a field which has not changed a lot or been improved with new equipment during the last years and there's a demand for new advances on it. So, the team wanted to put an effort to face marine littering which this field generates and from which gets affected.

1.2 FISHING INDUSTRY

In order to explore into this industry, the group unfolded the main sources of litter into this field. Afterwards, the group differentiated the different type of purpose for fishing that can be found and the most harmful fishing activities which lead to generating marine litter into this field. This was made as a way to open the exploration space and to find the main focus of the problem.



Img. - Marine litter sources & Fishing industry

FISHING PURPOSE

The impacts of the fishing industry could come from different sources, so that, the group anted to differentiate these depending on the fishing purpose as these lead to different type gear, equipment and goals.

RECREATIONAL FISHING

A recreational angler may practice catch and release fishing, fish for food or simply fish as a form of entertainment. This fishing purpose does not involve any profit or award.

FISHING FOR COMPETITIONS

This type of fishing has the main purpose of earning an award or reward. Generally, more advanced fishing line types and uses are required for this type of fishing compared to recreational fishers.

COMMERCIAL FISHING

Use of fishing methods that allow to catch large amounts of fish which is sold for a profit. Commercial fishing licenses are required for those who are fishing for profit.

HARMFUL ACTIVITIES

Once the team had decided to focus on the fishing industry and after knowing the different types of fishing purposes and methods, the group explored which were the main impacts of these activities.
With this exploration, it was found that all these fishing methods can have different impacts into the sea life in different ways which are mainly based into destroying the sea environment, killing species, catching unwanted species or by generating litter into the seas with lost or discarded gear.
All these activities had been unfolded in order to find a solution and so that, explore as much as possible the solution space of this field.

"As demand for fisheries products for the next years, technology must play a crucial role in helping fisheries to fish in a sustainable way."

- International Food Policy Research Institute and World Fish Center

BOTTOM TRAWLING

Img. - Bottom trawling destroying the sea floor

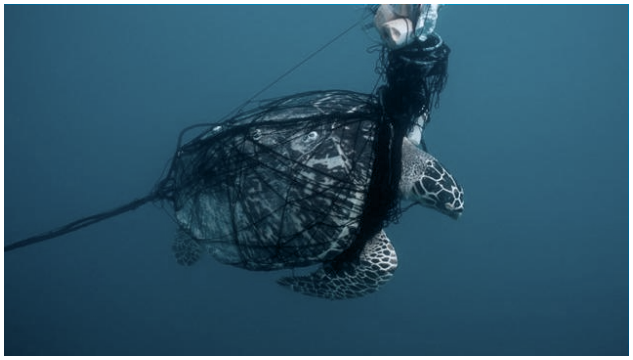
It's a technique used in commercial fishing which is based on fishing in the bottom of the sea floor by pulling a fishing net along the sea bottom behind trawlers. This practice destroys the sea floor marine habitats. it can remove up to 25% of seabed life on a single run.

GHOST FISHING

Img. - Ghost fishing on a lost or discarded creel filled of dead crabs

Ghost fishing impact it's the main impact which is generated from lost & discarded fishing gear. When fishing gear become lost or forgotten these continue to fish animals all the time killing species if this lost aren't reported and retrieved from water.

BYCATCH



Img. - Entangled turttle with fishing gear

Bycatch refers to the fish, seafood and other animals that are not targeted by fisheries but are accidentally caught by different fishing methods (commonly gillnets and bottom trawls).

LOST & DISCARDED FISHING GEAR

Img. - Discarded or lost net in the sea water

All kind of gear used by fisheries which are discarded or lost. Recent research has shown that fishing litter such as nets, buoys, and lines, accounts for a majority of debris found in the oceans.

FINDINGS

After looking into the different fishing purposes and taking into account the harmful activities, it has been found that besides all fishing sectors contribute to generating marine litter in the ocean the one which generates the most are the commercial fisheries and this are mainly caused by lost & discarded gear.

By this point, the group wanted to explore into the lost and discarded gear as it was the main source of it in the fishery industry. So that, apart from doing desktop research upon this topic we had different interviews with people working with the same field.

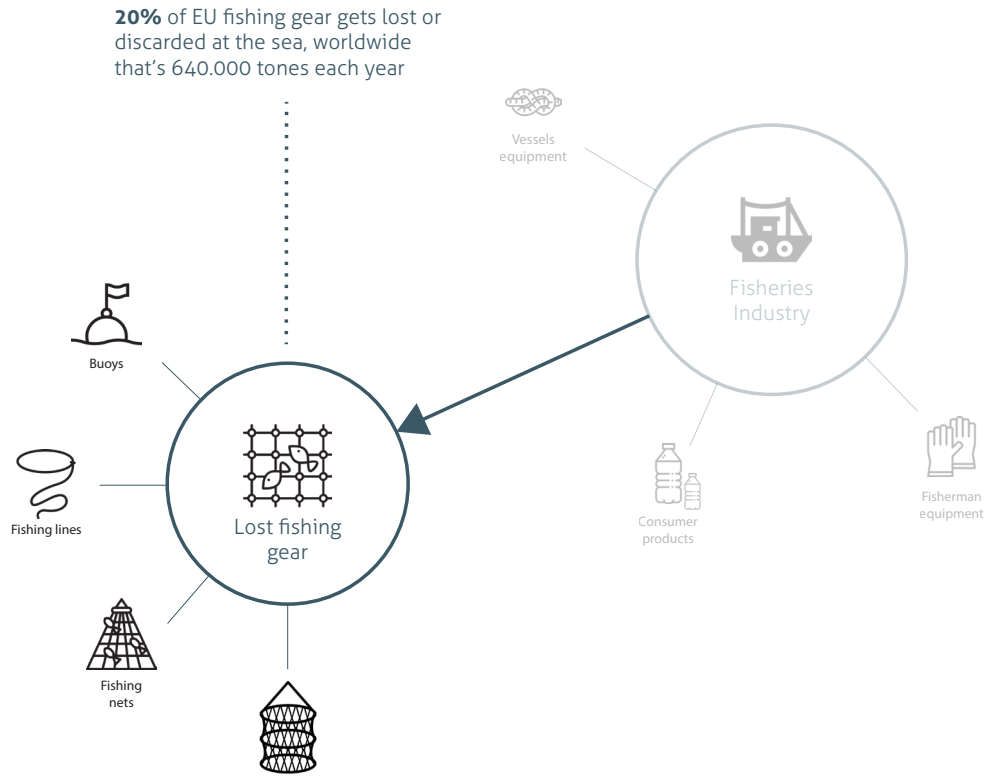
The group contacted on the one hand with Gjermund Langedal and Bård Aarbakke from the Norwegian fishing agency and we got overall insights about the problem caused by the lost or abandoned gear, specially in Norway.

On the other hand we also contacted Rikke Frandsen, PhD scientist from DTU Aqua working on the same field which gave us evidence and a greater understanding of the problem about that the marine litter contribution from the fishing industry in Denmark (lost fishing gear, pieces of fishing net and strings, polystyrene boxes and more) but also the knowledge about that marine litter from other countries also ends up in the Danish coasts. As an example, it was mentioned that fishing gear used in Holland it's commonly ending up in the Danish coasts (A05).

Img. - Dolly rope (orange rope from Holland)

//OUTCOME

The group observed that the scope was still too broad and so, there was a need to dive in the problem of lost and discarded gear and to find which specific commercial fishing technique to create a solution for to avoid this problem.



Img. - Lost and discarded gear in the fishing industry

1.3 LOST & DISCARDED FISHING GEAR

At this point, the group started to investigate into the lost or discarded gear and how big was this problem and the team got different findings. One of the focus we had were into the reasons of why this gear was getting lost or discarded. In the following illustration it can be observed the different reasons of it:

Ill. - Lost or discarded gear reasons

"27% of all fishing gear gets lost or discarded at the sea ,worldwide it's 640.000 tons each year"

EU Comission

"Abandoned gear is one of the more problematic components of marine litter"

Food and Agriculture Organization of the united nations (FAO)

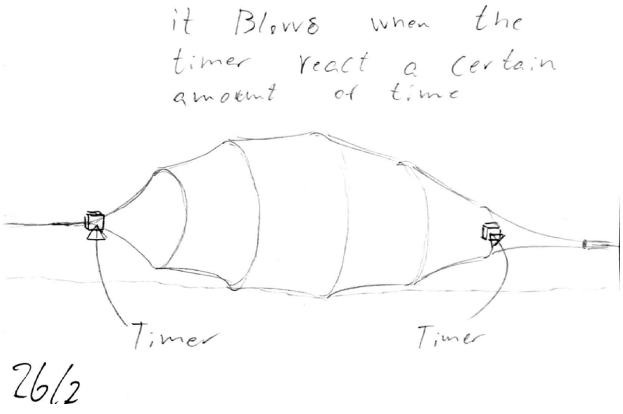
1000 ghost nets were actively fishing in the Baltic sea in 2017

SwAM (Swedish agency for marine and water management)

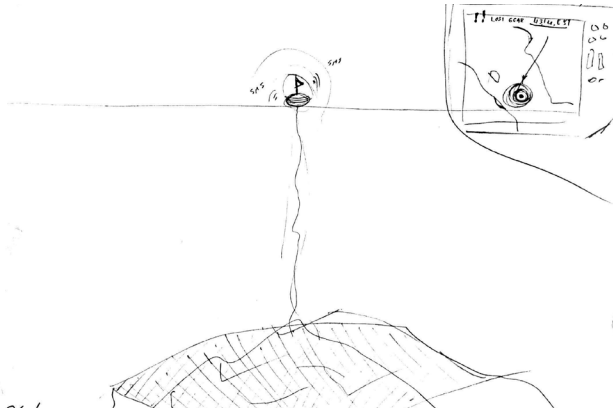
FIRST IDEATION

Once we had explored the main causes and the evidence of the lost or discarded gear problem coming from the fisheries industry we did an ideation round (A12) to get an understanding of the solution space and explore new ideas or principles that might help in the given scenario.

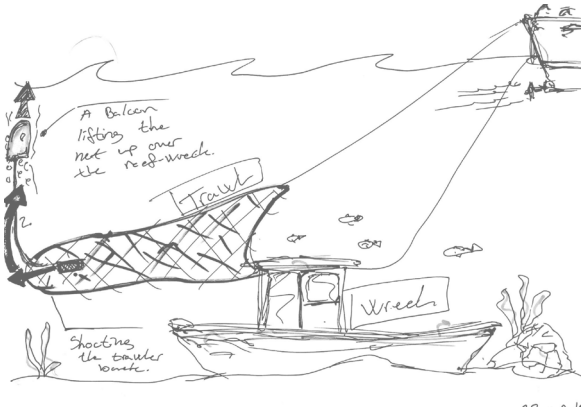
For it, we generated different ideas which were divided into pre-act, In-act and After-act solutions. This activity leads the group to find different questions we needed to answer in order to continue with our research.



Img. - pre-act idea



Img. - In-act idea



Img. - After-act idea

After this activity we visited the context again, for it, the group went to Thisted harbor and had an observation of the context and the boats with the different gear equipment these fisheries commonly use. (Appendix ___) This visit was mainly done to get inspiration and get ideas to work with afterward.

Img. - Fishing vessel in Thisted harbour

Img. - Fishing vessel in Thisted harbour

//OUTCOME

- The initial ideation provided the team with several questions and a need to dive more to scope down the solution space.
- The trip to Thisted permitted to understand more the context and to see different possibilities for further exploration, (A14)

1.4 FISHING WITH CREELS

During the time the group were continuously re-thinking ideas to solve the problem of lost and discarded gear, the group were still doing desktop research and interviews with people knowing about the field.

From the desktop research on the lost and discarded gear, we found that, the main problem of the lost gear is not just the gear that reaches the coast and therefore, creates coastal marine litter.
The problem comes when this gear end up in the sea bed without being reported. And, one of the main causes of that are the lost creels from the fishing with creels technique.

Fishermen lose anywhere from **10-30%** of their creels per year

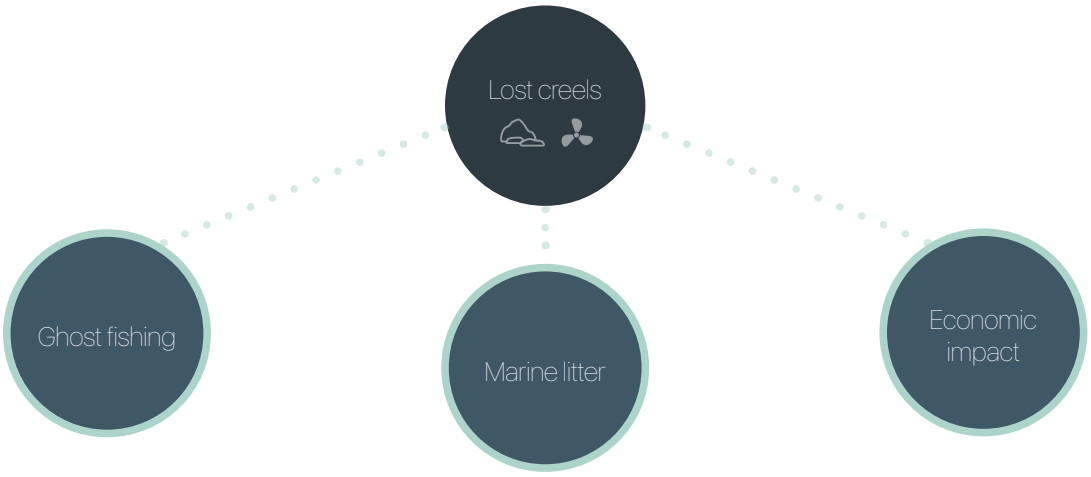
(Remove lost and abandoned fishing gear, 2015)

30.000 creels gets lost per year and remain underwater without been reported

SwAM (Swedish agency for marine and water management)

Img. - Ghost fishing on a lost or discarded creel filled of dead crabs

Furthermore, it has been observed that the cause of the lost of these creels mostly occur due to propeller cut-off and entanglements in the seabed which makes fishermen to not been able to retrieve from there. These loses are not always reported or are just impossible to be retrieved due to the water depth them are. This creates different problems:



If creels get lost, these continue fishing and killing species until these break after a lot of years.

Creels stays in the sea floor, which means that hadn't been reported or there's no way to retrieve them.

Fishermen lose money by losing their creels and having to buy new ones impacting on their yearly profits.

Illustration. - Impacts of fishing with creels

After the group found a gap to solve in this field, contacted again with Rikke Fransen, to know more about this problem and to have the evidence of it. (A05).

> *"**30.000 lost creels** each year in Norway sounds realistic, because it is a big problem and not only in Norway but in the whole world. As it is now, the fishermen can't do anything about it"*
>
> Rikke Fransen, DTU Aqua

From this second interview, we had good insights about the evidence of the problem in Scandinavia, and the need to find a solution for it due to the increase of the use of the fishing with creels technique. Rikke mentioned that fishing for crabs and lobster with creels it's one technique used, but, it's not the most efficient one always. For example, in Denmark, it's more common to use bottom trawlers due to the flat sea-floor. But, on the other hand, in Norway and Sweden, there's more uneven terrain, and so, more lobsters and crabs are them are more used to be in these uneven environments. This means that bottom trawlers are not commonly used there, instead, it's used the creels fishing method.

About the difference between these two techniques, Rikke mentioned that even fishing with creels still have a negative impact on the marine environment, it's more environmental friendly than bottom trawlers. About trawlers, Rikke mentions that nearly 40% of the catch with trawlers is miss-catch and also that it destroys the sea-floor.

Finally Rikke gave the insight which would generate more value to buy our product, which is that even the lost of creels is a problem that you find in Norway, Sweden and other countries, the use of this technique will increase in Denmark in the future since Denmark is looking into new and more friendly environmental ways of fishing.

//OUTCOME

All these new findings and the evidence from the existing problem of fishing with creels with none existing solution, made the group to create a new product to stop it.

EU ACTION AGAINST THE PROBLEM

The group also investigated into the upcoming regulations and found that the European commission was already trying to take action against the problem of marine litter. So that, fisheries are starting to get new regulations they need to follow for the upcoming years. Furthermore, the European commission it's putting attention to new improvements in this field to face the marine litter problem.

Attract innovation for more sustainable products

Mandatory retrieval or reporting of lost fishing gear

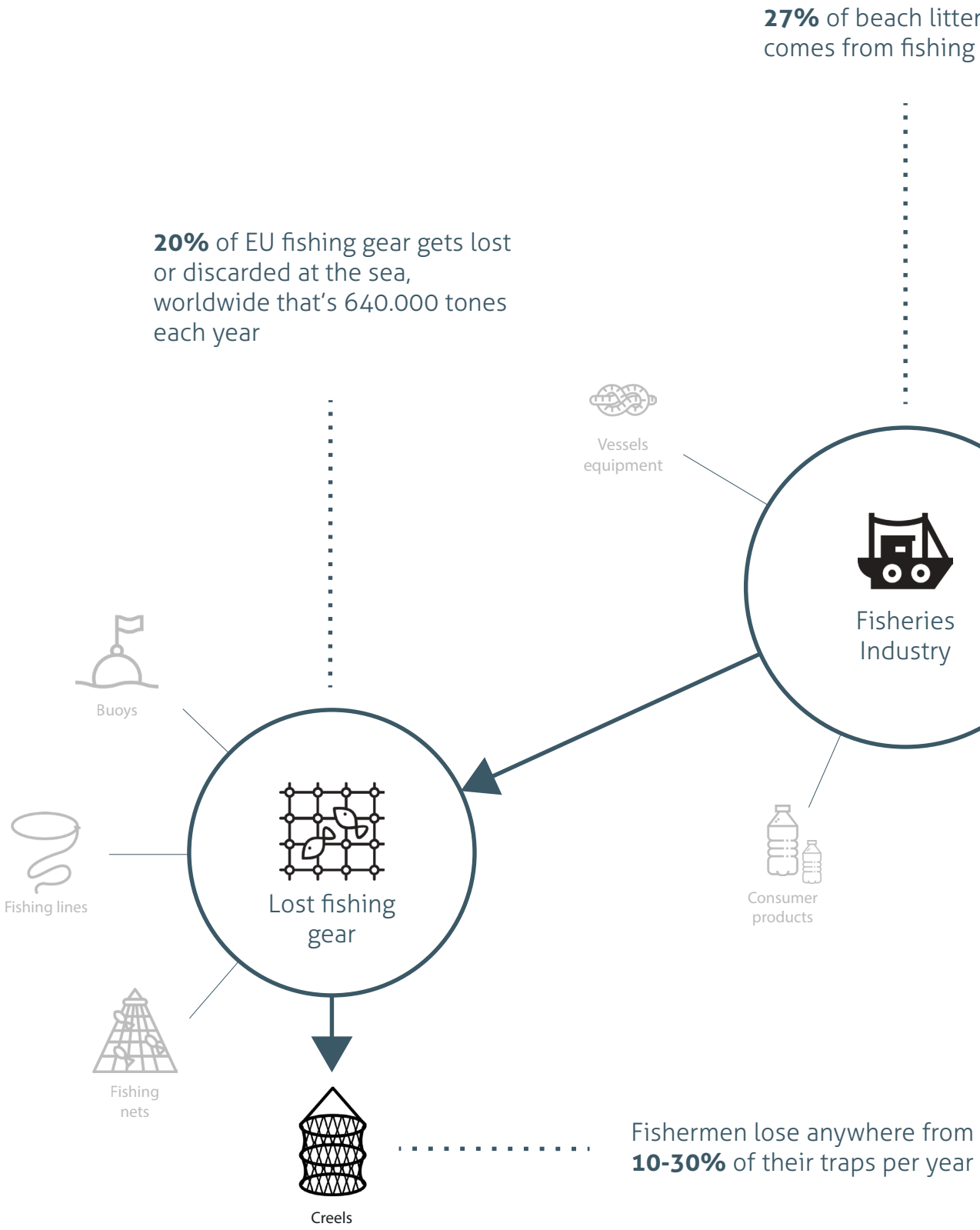
Mandatory marking of fishing gear

€53M funding through the European maritime and fisheries fund

Promote sustainable, innovative, and competitive fisheries

1.5 PREPHASE OVERVIEW

This spread shows the whole journey taken from the starting point of the preface:



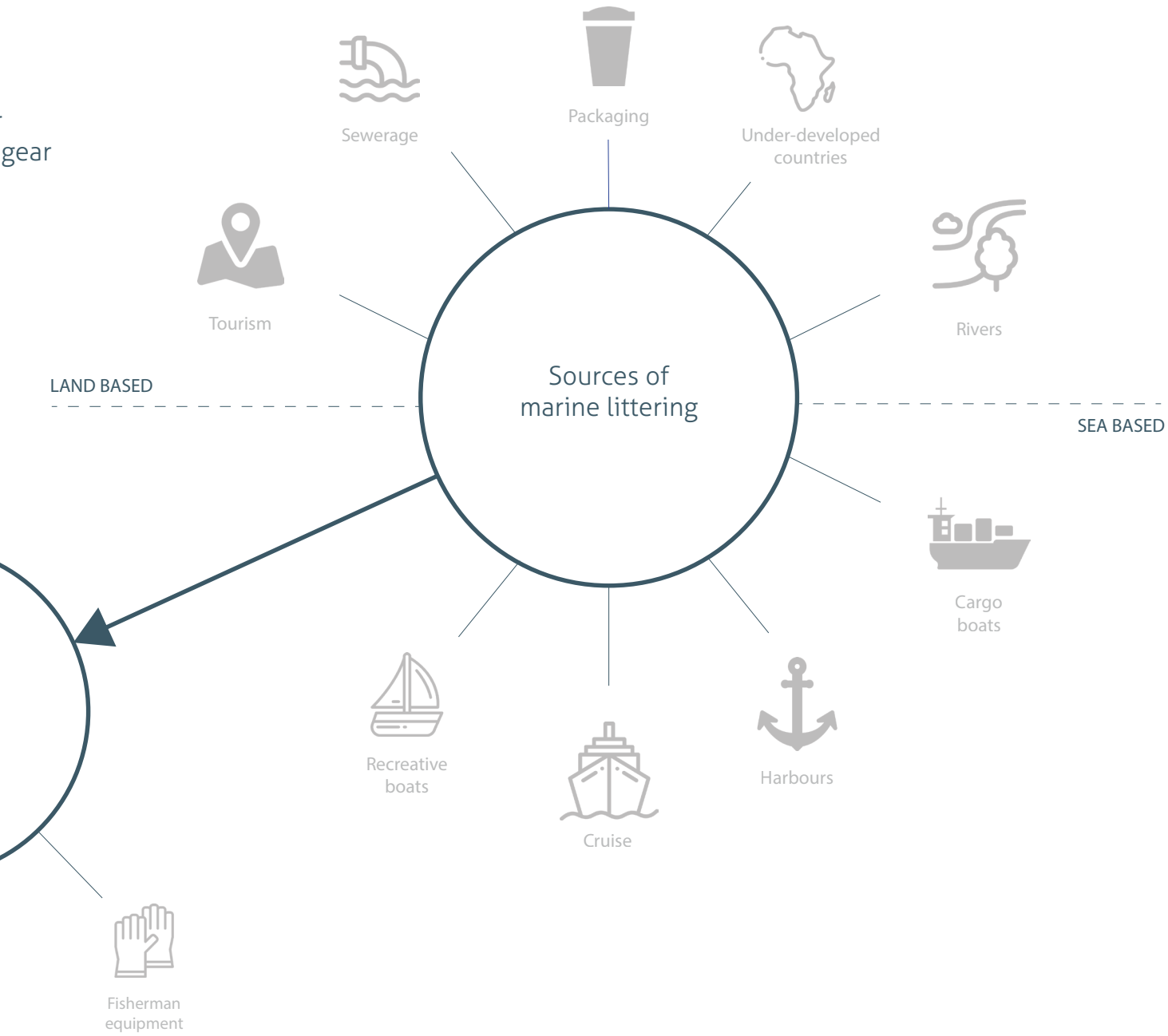


Illustration. - Pre-phase journey


1152189
Lindsay & Lacey II

define 2.0

After the prephase, this section shows the dive into the field of the fishing with creels technique, its different characteristics, and considerations that had been taken from it. The section will show a journey from the creels configuration, continuing to the user journey and storyboard, ending up into the defined problematic and the current coping strategies used to face it.

// OUTCOME

This phase provided the group the needed knowledge on the field to work on, findings on the main problem to solve and the needed considerations for it.

// NEXT

The next step for the group would be to set the final framework of the product to work upon for the next development phases

2.1 FISHING WITH CREELS METHOD

There are a lot of different fishing methods and a lot of different tools. These change depending on what kind of catch fishermen are searching for.

In the lobsters and crabs fishing industry, fishermen also have different techniques and tools to use. Inside this fishing industry, bottom trawling and creels fishing are the most common techniques. But, due to a decline in the European lobster stocks during the last 50 years, new regulations have been implemented and fishing with creels is now the only permitted catching technique. (Traps and Creels – The Ensnarers, 2016)

These new regulations are aiming for new solutions for fishermen to adapt to them and also to give them a better solution to work with.

Img -, Fishermen working with a creel

WHEN

The fishing season traditionally runs from late March to early October depending on fishing location and weather, but can take place all year round in some locations (European Lobster). As an example, lobster fishing season in Norway is restricted to only 2 months in a year: October and November. (Norwegian Lobster, 2017)

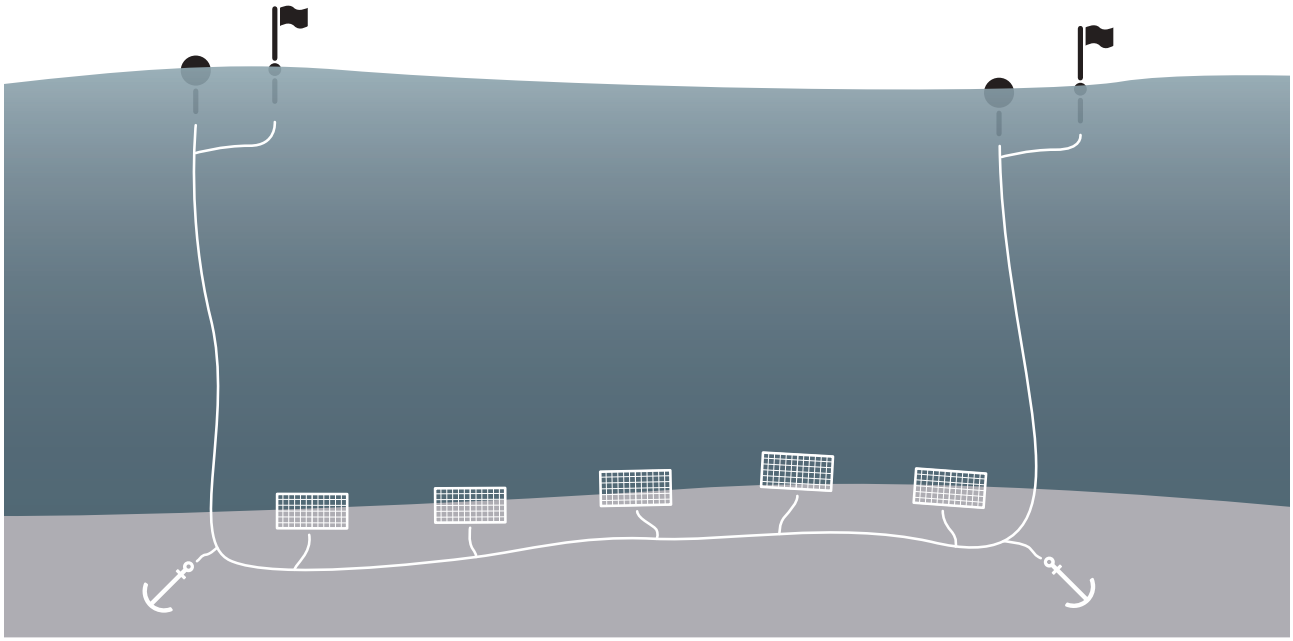
WHERE

Along Europe's coasts the creel fishing industry works mainly from the Mediterranean to Lofoten. Lobsters are found in depths down to 150m, but are most common between 20m and 80m. In recreational use, the creels are used in depths of 20-30 m. And in the professional field the depths are up to 150 m. (Norwegian Lobster, 2017)

CONFIGURATION

In European waters, Recreational fishermen can fish with creels in two ways, place the creels individually or in a line where each creel are connected with a space of 5m between them.

In the professional industry they only fish with a line of creels and up to 80 creels in one row and the space between each can vary a bit depending on the fishermen techniques. Fishing with this many creels also sets requirements to use an anchor in each end of the line in order to make sure that it stays on its place all the time. The total number of creels used is determined by boat size, the number of crew and the fishing ground. (Fishing with crabs and creels, 2001)



Ill. creels configuration

CREEL ELEMENTS

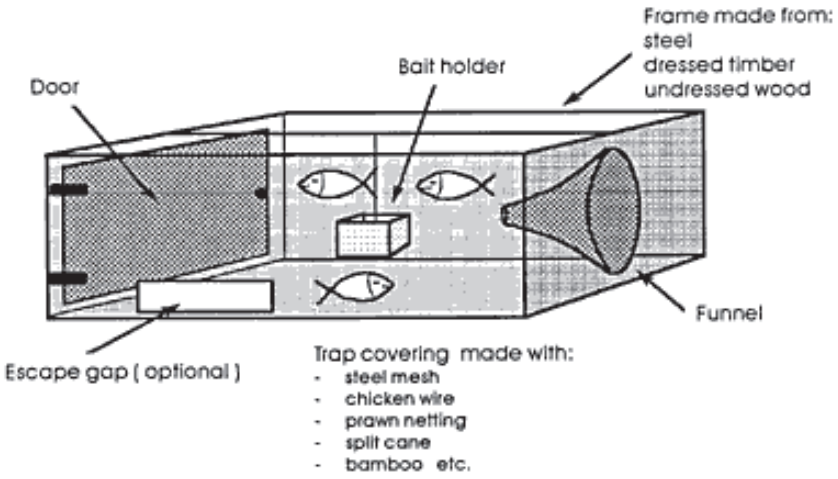


Illustration. - Creels elements

Frames

Strong materials that prevent the creels from losing their shape during fishing and storing. Mainly made from steel.

Covering

Modern rectangular creels are covered with wire netting, nylon mesh, plastic-covered steel, welded steel mesh, etc. The choice of material depends on traditional usage, availability and cost.

Funnels

Although beehive creels have only a single funnel at the top, other creel types may have several funnels.

Door

A door is usually placed in the main body of the creel to make it easy to remove the catch. Lobsters and rock lobsters are normally taken out through the funnel at the top.

Bait holder

Bait is normally secured in the catching chamber of the creel. If small pieces of bait such as small fish are used as bait, these should be placed in a bait container made from wire, plastic or synthetic netting to hold them together and in place.

Escape gaps

Escape gaps are often fitted into creels to make sure that undersizes fish or crustaceans, especially lobster and rock lobster, are not taken.

Ballast

Weights or ballast are often placed in creels before setting to prevent flows and currents from moving them from where they are set. Weights may be concrete blocks, steel bars or other heavy material such as bricks, stones or rocks. Strategically placed ballast may also help the creel to land the right way up.

Corrosion prevention

Because of the corrosive effect of seawater on steel and other metals, an anti-corrosion anode is often attached to steel creels and creels to extend their useful life. Anodes are usually made from a block of zinc with a wire through it to tie it to the creel. (Traps and Creels – The Ensnarers, 2016)

Img -, Creels on Tony's boat

2.2 STORY MAP

PROCESS IN STEPS

1. Putting bait in each creel while loading.
2. Loading the creels on the boat in a certain order.
3. Sailing towards the fishing spot.

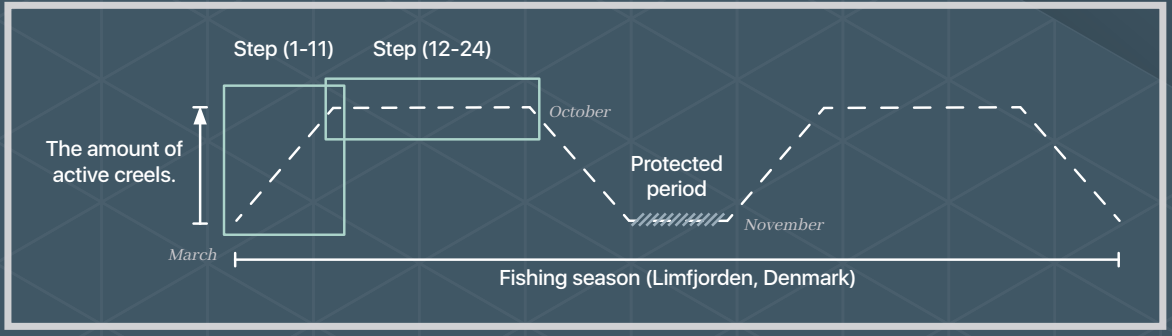
4. Arrives at the fishing spot.
5. Turn down boat speed (Approx 2 knots).
6. Bind a buoy to the first row or line of creels.
7. Throw out the buoy.
8. Place one creel at a time on the railing.
9. Support the creel until it's dragged into the water.
10. Attach the last buoy to the main line.
11. Throw the end buoy out in the water.
12. Sailing towards a setup of creels.
13. Turn down boat speed (Approx 2 knots).

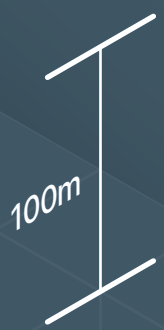
14. Haul in the first buoy.
15. Attach to the hauling tool.
16. Place buoy back in the boat.
17. The first creel arrives on the hauling platform.
18. Detaching the creel from the hauling tool.
19. Empty the creel.
20. Measuring lobster or break of crab claws.
21. Putting in new bait in the creel.
22. Placing creels on the boat in a certain order.
23. Lastly haul in the end buoy.
24. Put out the row at the same spot it was picked up.

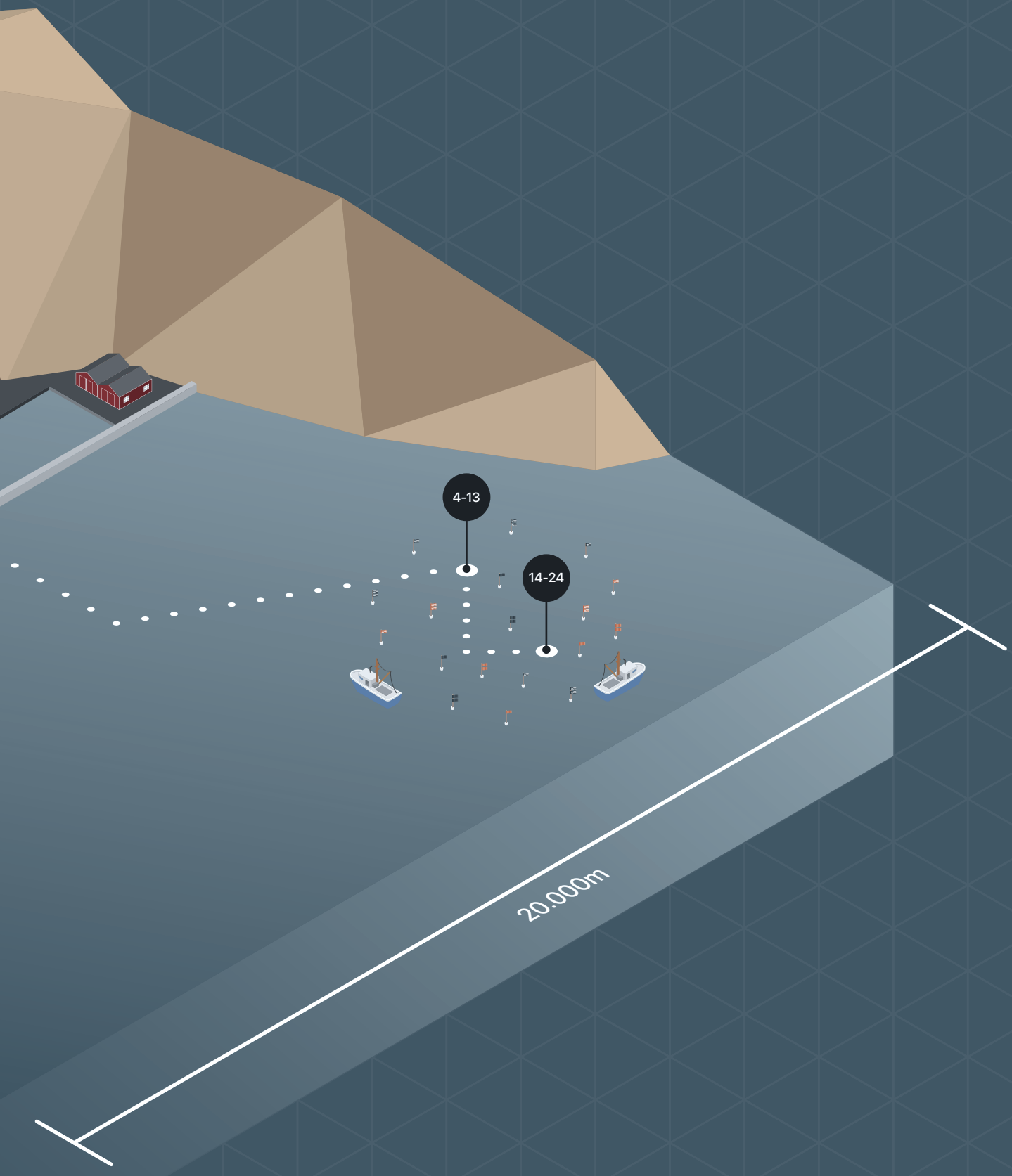
**Based on an expedition day (12-04-2019). The process can differ from vessel type and the user. (A24, A25, A26)*

** Step 12.-4 can be repeated more than once until the season finishes.*

SEASON OVERVIEW







FOR MORE DETAILS
TURN TO NEXT PAGE.

2.3 STORY BOARD

EXPEDITION DAY IN THYBORØN (A25)

1. Putting bait in each creel while loading the boat.

These pallets have 20 creels on each, which are connected to each other as a whole setup. We experienced that it was necessary to grab the right creel in order to avoid haywire. The first and the last creel on each setup are marked with another colour and then you have to follow the rope. Once the creel is handed over to the boat they are being prepared with bait.

2. Loading the creels on the boat in a certain order.

The free space on this small vessel is limit. The more the fisherman can carry the better. This boat can be loaded up to 60 creels. But this requires a specific arrangement to facilitate process 8-9.

7. Throw out the first buoy.

After the first marking buoy is in the water, the process is continuing at a high pace. The boat sails at low speed in a chosen direction. This direction depends on the seabed condition which can be seen on the sonar display.

8. Place one creel at a time on the railing.

The first creel is found and placed on the railing and waits until the rope between the creel and the first buoy are more and less stretched.

12-13. Sailing towards a setup of creels.

This setup of creels are marked with two pair of buoys. One with two flags in red and blue respectively and the other one with only one flag in red. These colours can variate and are chosen by the fisherman, in terms of knowing the difference between his and others in the area.

14. Haul in the first buoy.

Because of the small vessel, the fisherman is able to grab the marking buoys from the boat. Then, there's a need to lift and make force until the first creel is lifting from the seabed.

3-5. Sailing towards the fishing spot.

The distance from the harbour and to the fishing spot was around 6 miles (10 km) which took about 15-20 min at 20 knots (37 km/t).

6. Bind a buoy to the first row or line of creels.

Following the Danish Fisheries Agency, all fishing buoys have to be marked with contact info. Equipment which is not marked will be removed by the government, in order to prevent overfishing. (Tabte redskaber, Udenrigsministeriet)

9. Support the creel until it's dragged into the water.

When the rope is stretched, the first creel is dragged into the water. Process 8 and 9 will be repeated until all the creels in the setup are in the water.

10-11. Attach the last buoy to the main line + throw it in.

The boat is set to stop and the last marking buoy is attached and thrown in.

15-16. Attach to the hauling tool.

The first marking buoy are now placed in the hydraulic hauling tool and the creels are now on it's way up. When the rope is long enough, the buoy is placed in the back of the boat - Then it will later on in the process become the last buoy.

17. The creel arrives on the hauling platform.

When the fisherman hauling in the creels, he placing the boat so the waves hit the starboard (right side of the boat). This makes the creels turn correct in the water and no extra interaction is needed when arrives.

18. Detaching the creel from the hauling tool.

When the creels arrive on the boat it will automatically stop the hauling process until it has been manually moved through the hauling tool. This is in order to prevent a collision.

19-20. Empty the creel.

Each lobsters are measured and if they are under the limit or with roe they are going back in the water. This is to keep the stock of lobsters up. If they pass a rubber-band are placed on their claws, to prevent them from cutting one another.

21. Putting in new bait in the creel.

When the creels is empty, a new bait is placed in a mesh bag. The bait can differ day to day often it's some discarded fish, which are cut in pieces.

22. Placing creels on the boat in a certain order.

Now the creels are empty and reloaded, they have to be placed in a certain order, so they can get in the water again.

23. Lastly haul in the end buoy.

When the last creel is located on the boat, the last buoy is going to be hauled in. But in this case the last buoy was cut by another boat and a new buoy was needed.

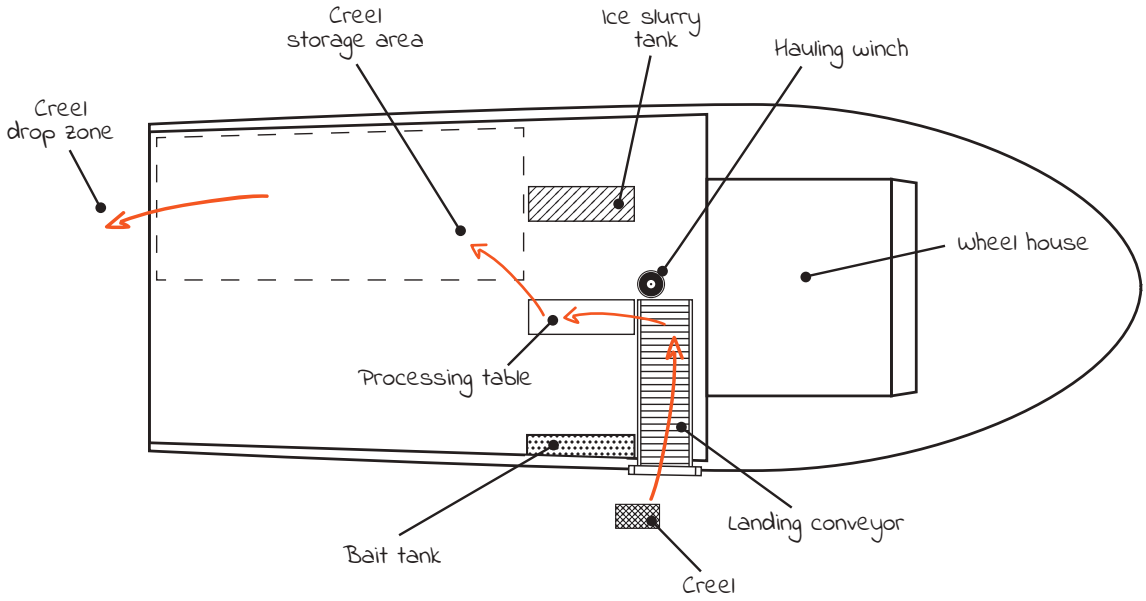
24. Put out the setup at the same spot it was picked up.

If the last fishing spot was satisfied, the whole setup of creels will return. The steps from 12 to 24 will be repeated until the fishing spots are unloaded.

2.4 USER & WORKING ENVIRONMENT

Through our process we have get in touch with different fishermen from two different types; recreational and commercial fishermen (A43, A44, A23 & A26). We experienced a large variation of personalities between the three types of fishermen. With the focus on the commercial fishing industry, we had in the beginning of our research phase, a tough time when we confronting them with our findings about the marine litter in Denmark. So we had to change strategy in order to get closer to the commercial fishers and get information out of them. Which made us visit the coast harbors, rather than phone calling. We focused the interview in a perspective in which the group were going to design a "new fishing equipment". With this approach we were able to get a more constructive insights into the field.

After the new the strategy we learn that the environment can be a tough place to work. Which set some expectations for the product. The weather has an high impact on working environment, and this factor is unreliable but needs to be taken into account. When the waves increase, everything on board that is not fixed moves around. From our expedition to the harbors in Denmark (A11 & A14) we have been told from the fisherman, that the fishing culture has changed since their beginning. In the early days they were more likely to go fishing no matter how bad the weather is. Which often ended with tragic accidents. But with the technology of today, they are checking the weather before sailing out.



The Scandinavia vessel size is typical from around 50 feet (around 15m) and upwards and is often shared between to owners/captains and a crew on four people. The owners are able to switch between work task - One onshore who are in charge of the administrative work and one who are in charge of the ship. The point of this is shared cost and if one is sick the business will still be going.

The crew can be a mix of 1-2 fishing students and 2-3 experienced fishermen (A43). Both the crew and the owners/captains are a part of daily task on deck. It's necessary to helping each other, also with cooking and cleaning. The only difference is the captain has the responsibility. From our experience is our view on the fishermen, they are some people who are doing actions at a high pace or instinctively. Which needs to be facilitated.

"I'm not afraid for the ocean, but I respect it!" (Fisherman, Thyborøn) (A26)

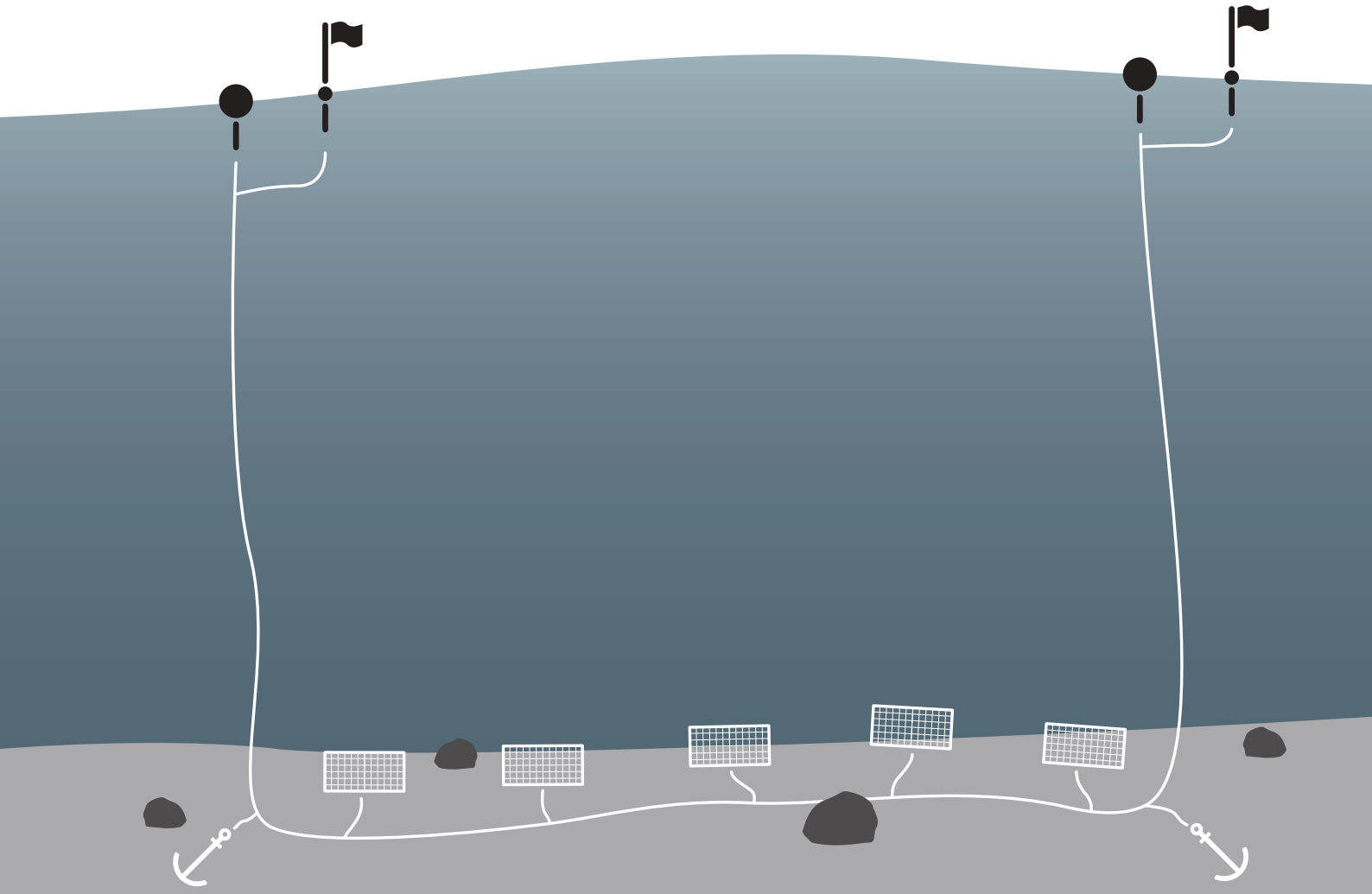
THE CONTEXT

Our findings scoped the focus down to location with rough seabed conditions in water depth from 20 to 150 meters. Which means large rocks, stone or other large object where creels can get lost. This type of context is more common in countries like Norway, Ireland, Scotland, Canada and Northern America. The primarily focus is Norway which are close to Denmark and have some similar rules.

2.5 PROBLEM SCENARIO

FOCUS AREA

Because of a large variety of factors which have an impact on the loss of creels. The most critical area is from the anchor to floating marking buoy. The sections are generally in a high risk of getting in trouble because of increased movement in the water. Depending on the fishing location there can be a larger undercurrent which can make the gear move to other locations. But that is up to the fisherman to determine the needed amount of contra weight. The team have put the focus by solving two factors, propeller cut off the connection and entangled ropes. According to the Norwegian Doctorate of Fisheries and DTU Aqua (A05) these two factors are the most common problems the fishermen experience.

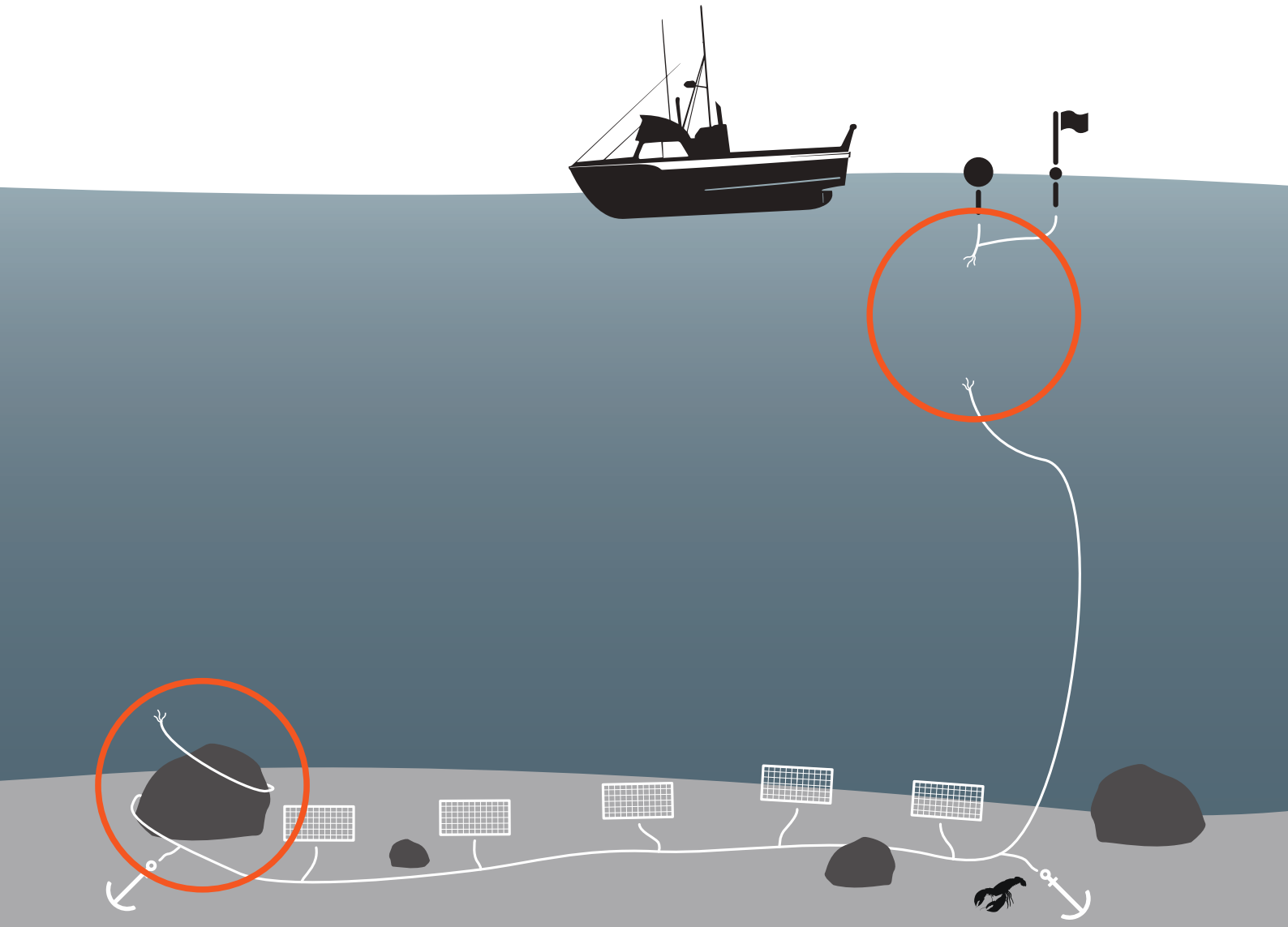


PROPELLER CUT-OFF

When other fishing vessels is working the same area it will increase the risk getting disconnected marking buoys. Which is due to an increased population of lobsters. The propellers working as a vacuum cleaner, so if a marking buoy are getting too close to the vessel propeller, it can either be cut or get entangled.

ENTANGLED ROPE

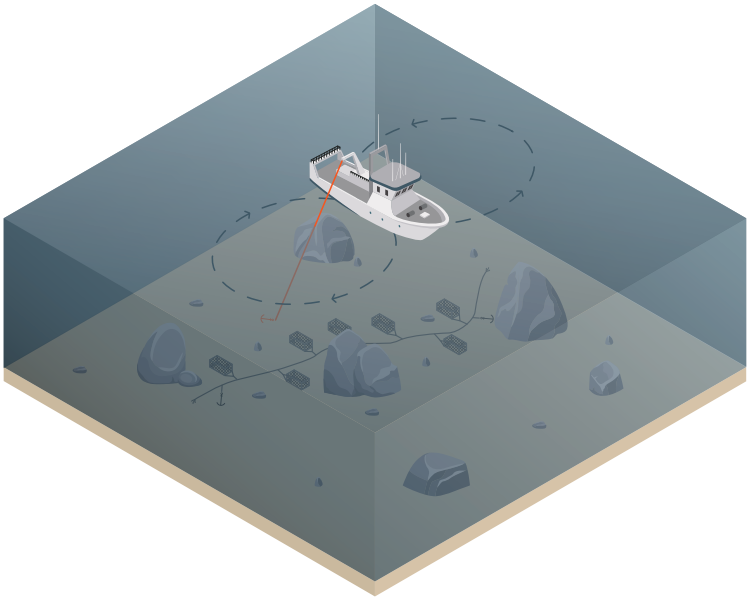
Lobsters are more likely to be found in areas with rocks and stones or other objects where they can take shelter, it increasing the risk of getting entangled end ropes. When the fishermen are hauling in the buoy, with the entangled rope, it will break when it exceeds the Tensile Strength.



2.6 COPING STRATEGY

ANCHOR

The possibilities of getting the gear back is very minimal. At the moment the fishermen are trying to get it back by trying to catch the lost gear with an anchor by lowering down to the seabed. The rough seabed makes it difficult to catch the gear because the rocks and other object difficult the usage of an anchor. The large vessel has to correct around with the anchor. This process is a complex task and can take hours, which can lead to the fishermen are giving up and leave the lost gear at the bottom of the sea. In addition to this operation will there be a risk of make propeller cutoff on nearby marking buoys. (A26)



THE GOVERNMENT

When fisherman in Denmark lost their equipment, they have to try to get it back on their own. If it does not succeed they have to inform the Danish Fisheries Agency within 24 hours (Danish Fisheries Agency, 2019).

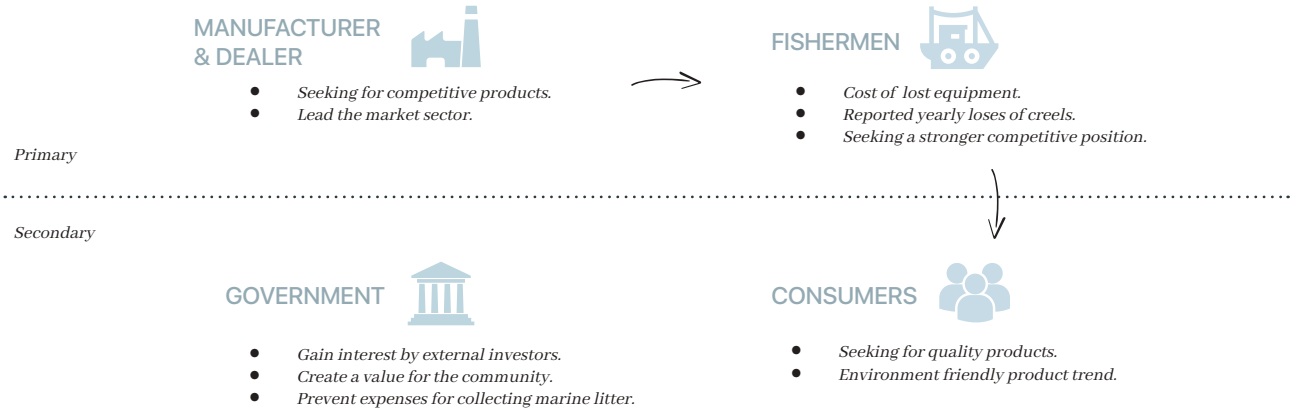
They need to inform (EU rules):

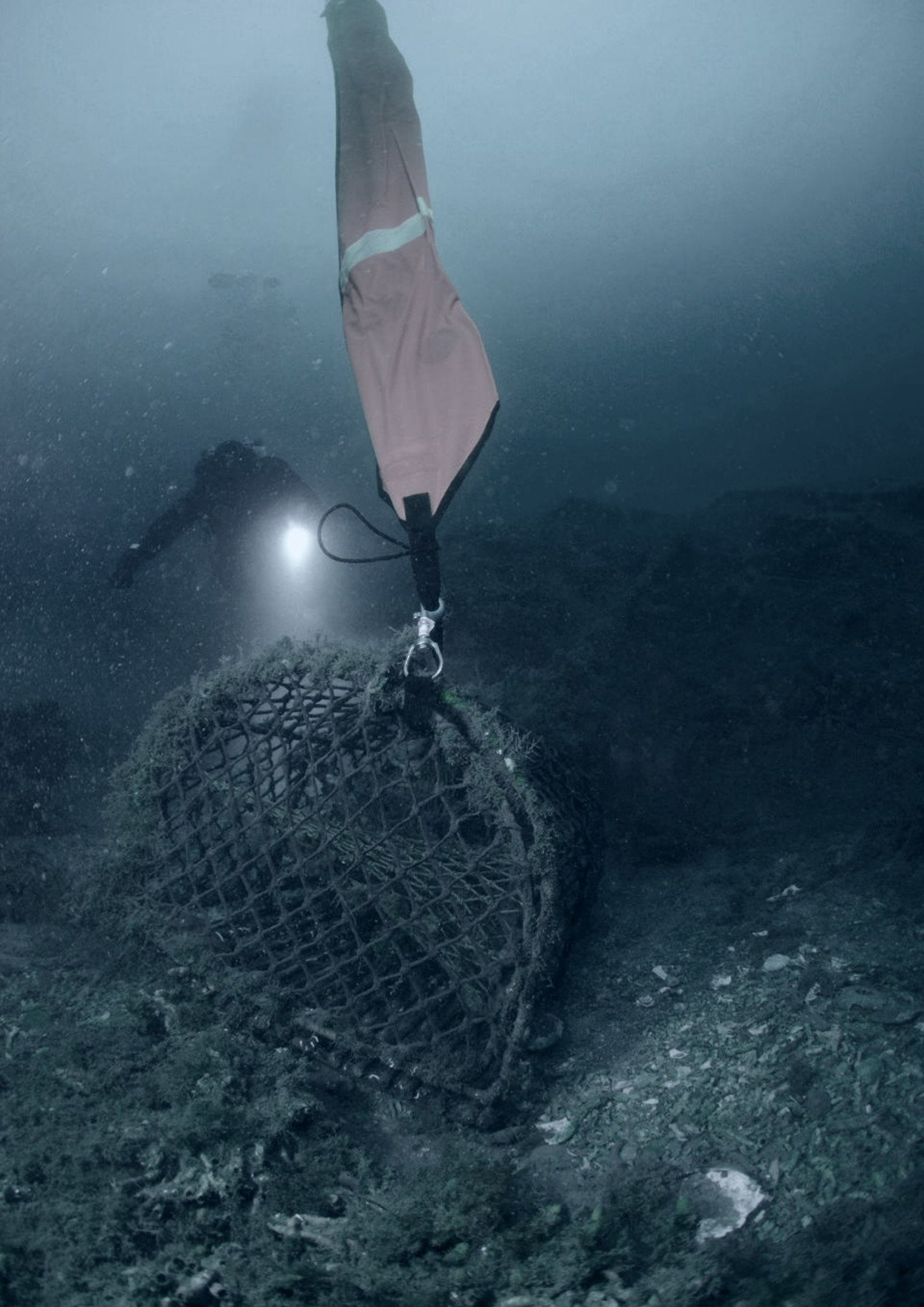
- Position and time
- Vessel information
- type of equipment
- What has been done in trying to get it back?

The government's task can be dangerous and expensive, when its on deep water. From 60 meters of depth and more, the air are going to be more compress. Another option is to use a ROV (Remotely operated vehicle). However it can take up to a year before the Danish government take action and this operation can end up with a fee for the fisherman.

2.7 STAKEHOLDERS

Because of the increased attention to the environment and UN's Goal 14.1 (Conserve and sustainable use the oceans, seas and marine resource, UN) which are topics the fishermen need to take action upon. Seaus will provide a solution to the this upcoming situation which the manufacture and dealer of marine equipments, Hvalpsund net, have shown interest in. With a collaboration between them and Seaus, they could become the first mover in this market sector. Which makes a competitive gap to their competitors. The fishermen will reduce their cost, and they will have the possibilities to catch lobster in even rough seabed conditions and there by gain more profit. The consumers, retail stores will be able to gain value by selling the product as an environmental friendly fishing method. Which means a higher quality product. The government will have the interest in lowering the marine litter expenses and enhances the health and well-being.





framework 3.0

In this section will be described the focus of the group after all the findings gathered until now and the methods used to define this focus in order to have a better group understanding and alignment for the next development phases of the project.

// OUTCOME

The group got a defined framework to continue with the project. This, facilitated to work into the next phases of ideation & conceptualization.

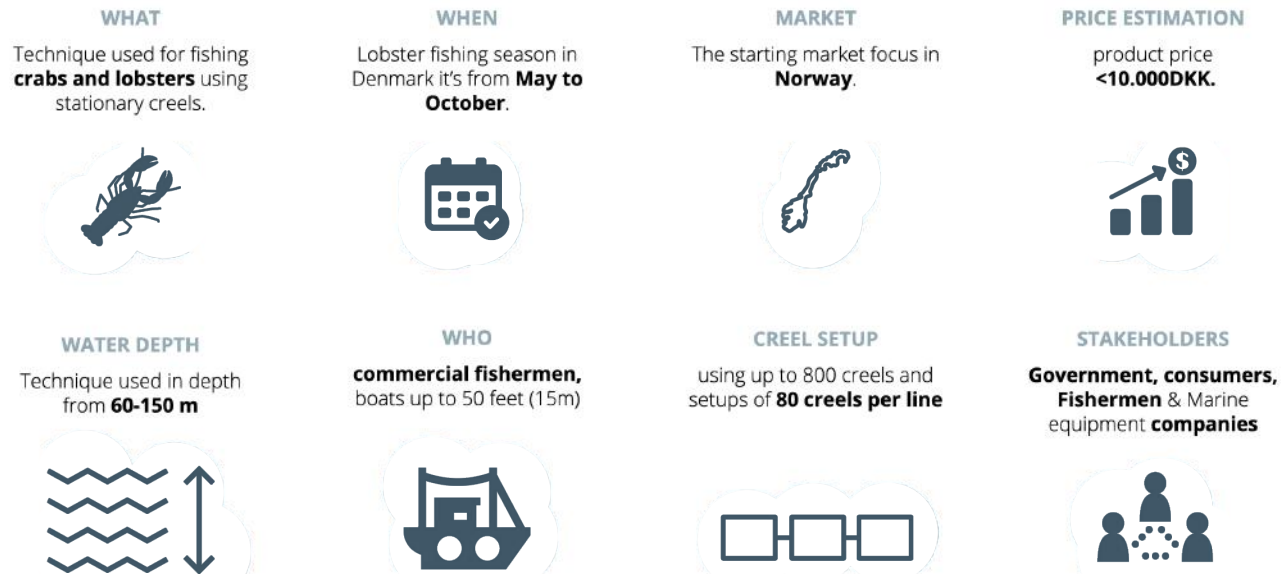
// NEXT

Use the framework as a reference to bring all the previous findings to ideas and concepts to define our product.

3.1 PROJECT FOUNDATION

APPROACH & SPECS

The group, from the start of the project, wanted to have a strong foundation to permit the right development of the project, also to create alignment and have a clear direction to follow. For it was taken into consideration previous findings from research done by the group (Aesthetic decision making,2018), in which it is stated that a good foundation permits a better understating and project decision making. So, at this stage, the group set up the framework to work upon to keep the alignment and to have a clear direction on what to focus taking as a reference our previous foundation.



3.2 PROBLEM STATEMENT, VISION & MISSION

PROBLEM STATEMENT

"How can a physical product give the fishermen a second chance to return their lost gear, and preventing the risk of "ghost fishing" in the seabed and reducing marine litter. "

VISION

"Involve the fishing industry into the UN's future environmental goals regarding marine litter and lost fishing creels, by creating a new standard solution."

MISSION

"create a product to be implemented in the current creels fishing method giving the fishermen a second chance to return their gear and therefore preventing marine litter and ghost fishing."

3.3 VALUE VISION

The purpose of using this method (A18) was to give us a wider view of the values we wanted to transmit/offer with the product. furthermore, this method permits to keep our concepts up against it and thereby create a stronger alignment between the team members.

First of all, we made a brainstorm of the values we thought our Seaus product should transmit. Then we took each of these values and made a mind map with all the words that each of these values we thought could be related with. Finally, we clustered these words into three themes for each value in order to support and make it more precise. Then we found images that could represent these values through the concept that we wanted to transmit (A19). These values were based on all the experience and knowledge the team has gathered through the approx. 2 months of discovery and defining.

In order to understand our value vision, the team created a short phrase to support the pictures and the linked words:

Img. - Value vision brainstorm

COMPACT

- *Stable*
- *Reliable*
- *Packable*

"The help in unforeseen situations."

SUSTAINABLE

- *Responsibility*
- *Reaction*
- *Recover*

"Help each other and take action for a better future"

STURDY

- *Adaptable*
- *Preventive*

"I can protect myself,
but you still have to take care of me"

TRUSTFUL

- *Familiar*
- *Understandable*
- *Safe*
- *Approved*

"You know me well and
know what I can do for you"

SIMPLE

- *Transparent*
- *Instructive*
- *Instinct*

"It's on when it's on and
off when it's off - that's it"

VISUAL

- *Attention*
- *Versatile*
- *Pertinent*

"Even though I'm professional
- I still have the need for assistance"

Ideation & conceptualize

4.0

This section will focus on the idea generation from the previous findings taking reference on our design brief. The section offers an iterative process from the first ideation based on principles until the selection of the concepts the group decided to work with. In this section, the group got insights which helped the group to find the best solution by exploring as much as possible the solution space

// OUTCOME

Definition of the concept to work with based on an iterative process of findings, considerations and continuous ideation.

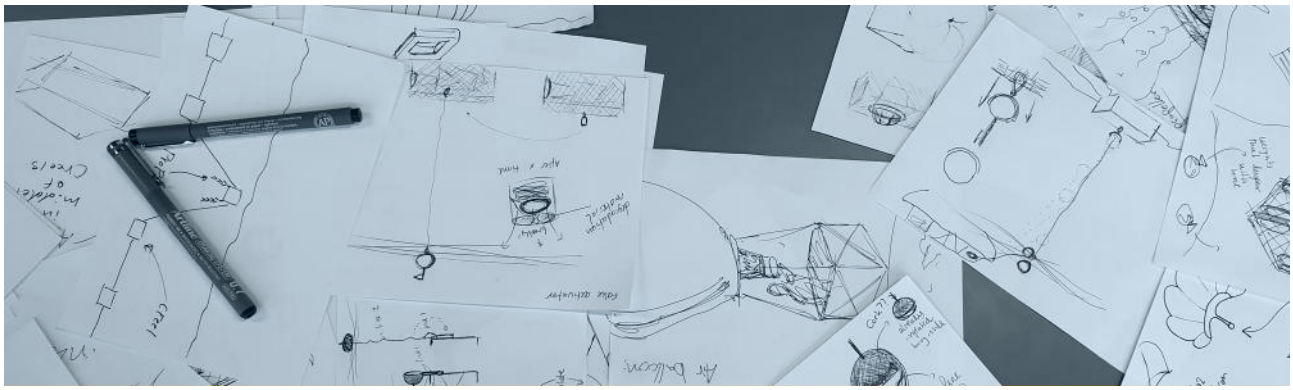
// NEXT

To dive into the selected concept and test the principles considered on it to validate or improve them.

4.1 IDEATION

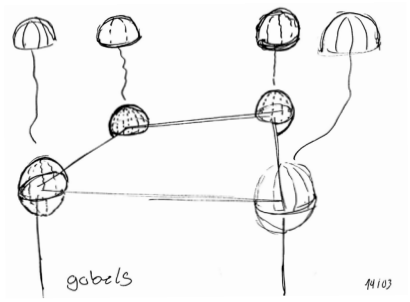
This phase of the project has been a continuous iteration of generating ideas and learning from research and user feedback. These iterations reflect a Build, measure, learn method approach (Steve Blank, 2013). This approach has permitted the team to continuously refine the product based on the findings to be able to explore as much as possible the solution space for the product.

SKETCHING POOL

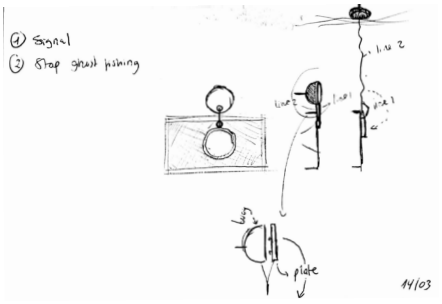


The idea generation started with a Sketch pool (A16). With it, the team wanted to generate ideas based on the knowledge we had at this point and the values we got from the value vision. The outcome of this sketching pool permitted the group to discover into different principles which could be used in our product to solve the problematics we had seen in the field of creels fishing. An example of the different principles found can be observed below:

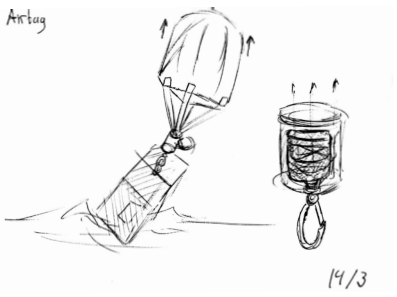
Bumpers



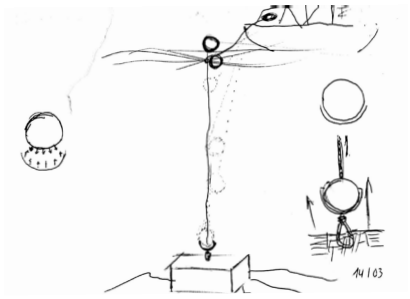
Ghost fishing prevention



Transformation

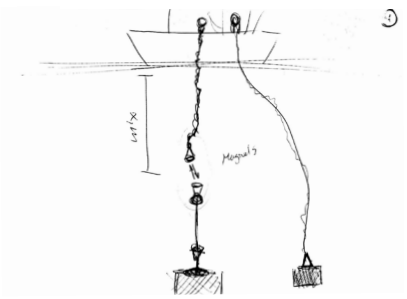


Detection



Human interaction

Magnets

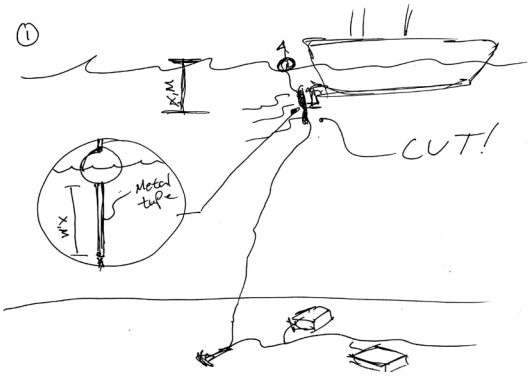


Img. - Examples from the principles discovered after the sketching pool

"WHAT IF "

After the sketching pool (A16) we wanted to explore more the solution space and so, we continue sketching but, this time upon different solutions to problematic situations that the group discussed it could appear during the process of retrieval of lost gear from fishing with creels. For it we used the "What if" method (A17). This, opened the solutions even more and made the group to find more considerations for the product. As an example we used the "What if" in situations like:

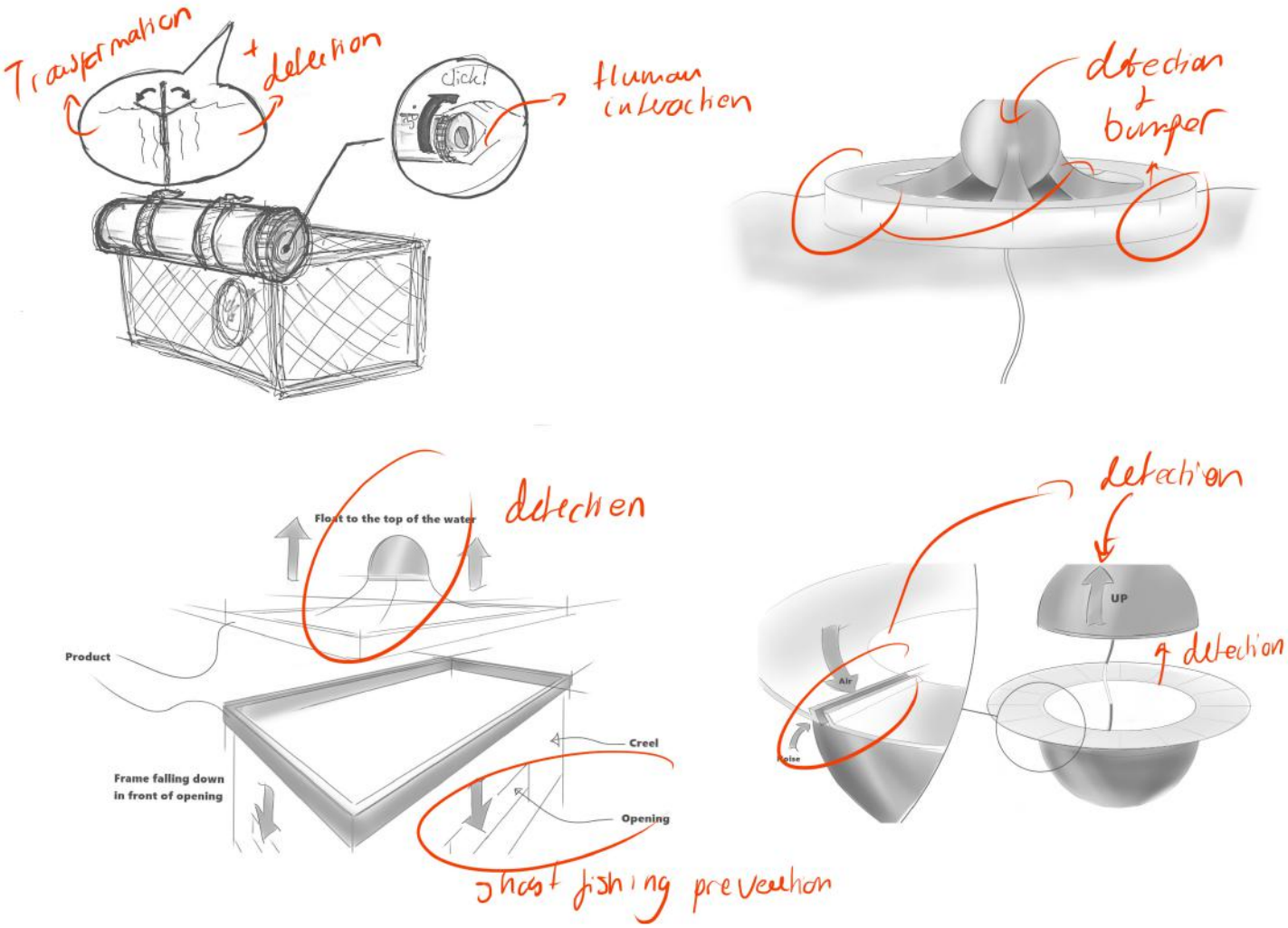
- What if it appears the risk propeller cut off?
- What if there are different creel sizes and/or geometries?
- What if the creel it's 150m depth?



Img. - What if propeller cut-off sketch

COMBINED SOLUTIONS

After using the Sketching pool and the "What if" method, the group decided that it would be interesting to try to mix the different solutions found (A20). This would provide a stronger concept for our product solving more than just one specific problem and therefore increasing the value of it.

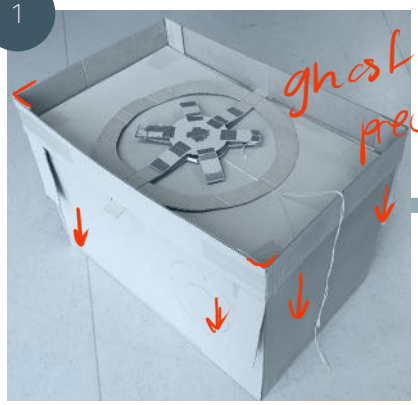


Img. - Combination of different principles in concepts

FIRST PROTOTYPING

The group created different prototypes (A21) based on multiple principles that had been explored before in the first ideation phase. It helped to have a better understanding of the principles and considerations finding the ways to make possible the principles to work.

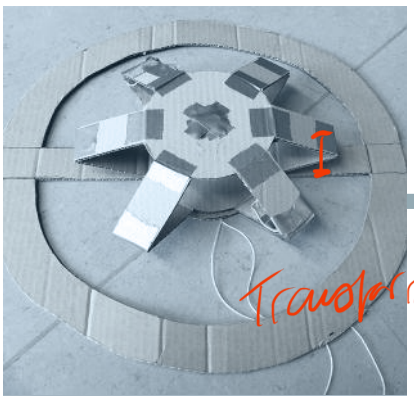
1

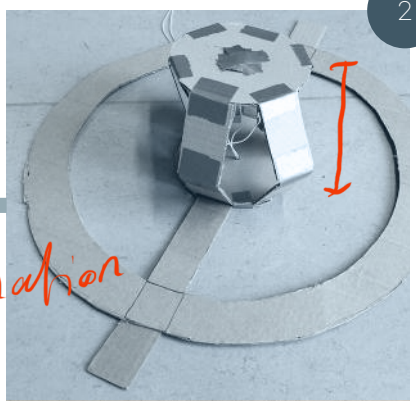


The team made a prototype using the real size of a creel and thinking about to combine the prevention of ghost fishing and a deployment mechanism that could permit the detection of lost creels from fishermen in the surface.

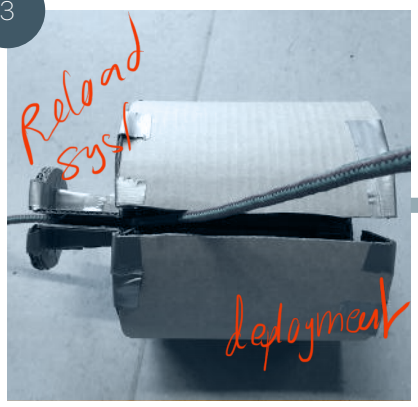
Prototype of the mechanism that would deploy from the creel. It will permitted the transformation from a flat surface to a shape that would permit to be detected when had reached the surface.

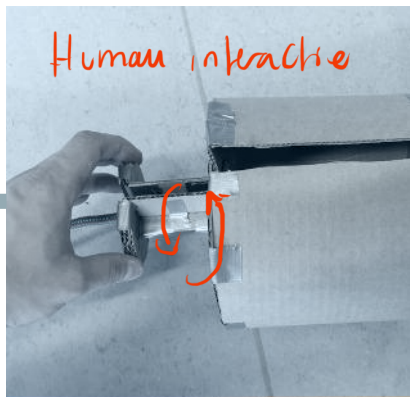
2





3

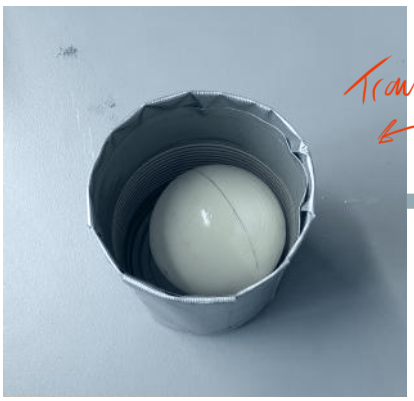




Prototype to think on a mechanism which would deploy and then could be reloaded again by the user. It was considered the alignment of the rope when its loaded and the first ideas upon the reloading.

Transformation prototype which permitted to have a rope attached to a small floating buoy and loaded inside a small cover. This, would deploy and get out from the case to the surface.

4



FEEDBACK

During this period we got different new insights on our ideas and from the field we where working with. These came from the first Milestone, in which the group got feedback from the different mock-ups that we had build and from a second interview with Rikke Fransen from DTU Aqua (A05)

INTERVIEW WITH RIKKE FRANSEN

From this interview the group got insight about the placement of our product. Rikke mentioned the that the lost gear from creels usually have something to do with the long line between the line of creels and the buoy on the top. This is caused by streams making the line wrapping around rocks and getting entangled.

// OUTCOME

Reconsideration on where the product should be placed. The feedback made the group to consider an ideation based on a product in-between the buoy and the first creel.

MILESTONE 1

At this point of this project the group presented the findings from the start to that point. It was shown the prephase findings which lead to working on the topic of lost gear from commercial fisheries. Specially in fisheries using the creels fishing method. Furthermore it was presented the different mock-ups done showing different working principles explored.

// OUTCOME

From the Milestone 1 the group got insights which made consider to explore other principles considering other placements apart from the one on the top of the creels to open even more the solution space.

After getting these different feedback, the group considered to explore more the different solutions and ideate more to define more the direction of our product. For it, the group wanted to consider other options which hadn't been considered before and re-think the already existing ones for the next ideation round.

ACT IT OUT & SHADOWING

The group still needed to get out in the context and get more feedback from the users and that the next thing that was done. For it, we visited Tybhorøn and got the possibility to experience the working environment and the full working process in steps. Furthermore, it gave the team an understanding of the critical situations throughout the working process. (A24 & A25)

Img. - Acting out in the context and with a professional user

With this activity the team got good feedback to consider for our product. The new findings made the group to continue the ideation on the product and to rethink the ideas that had explored before as by this point the team had a better understanding that before hadn't. Nonetheless, we also found that ideas from before were also interesting to still consider.

Img. - Shadowing a professional user process work

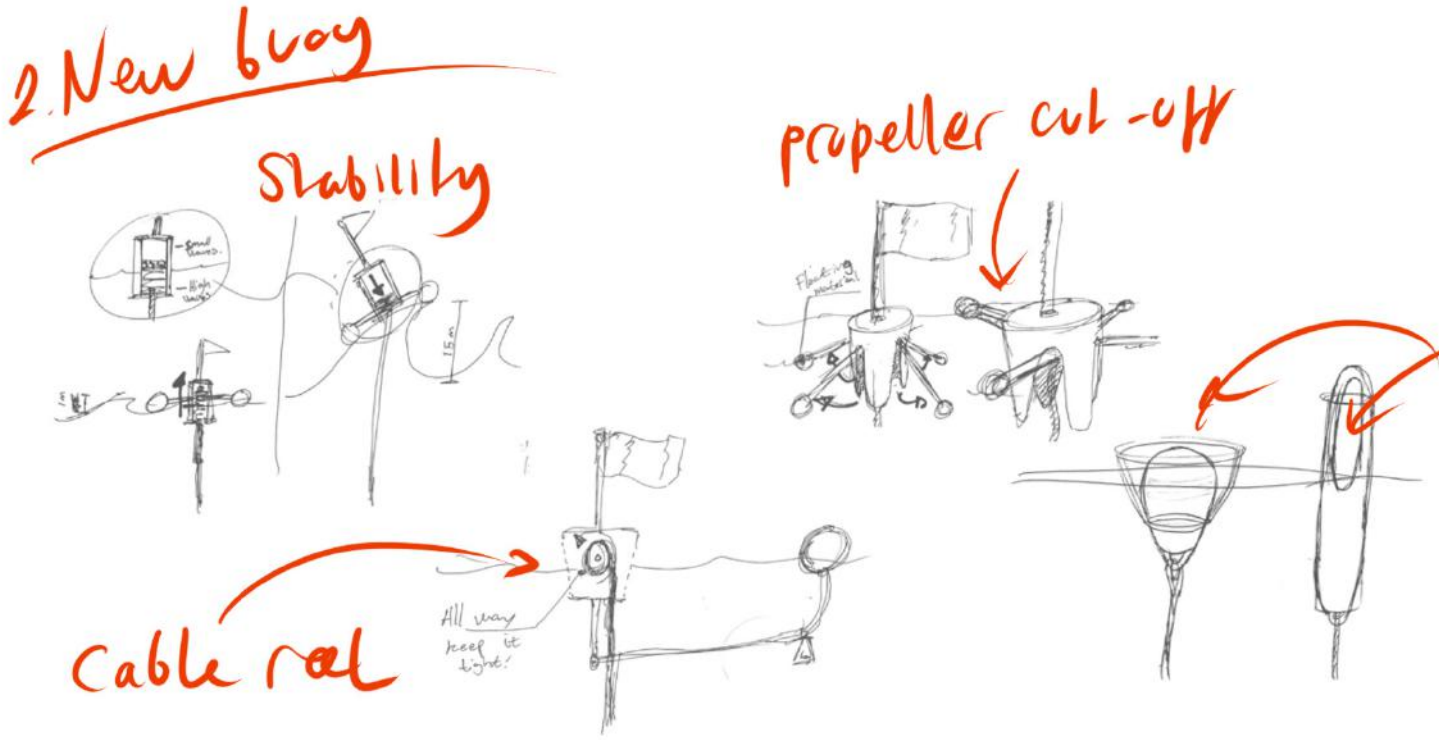
// FINDINGS

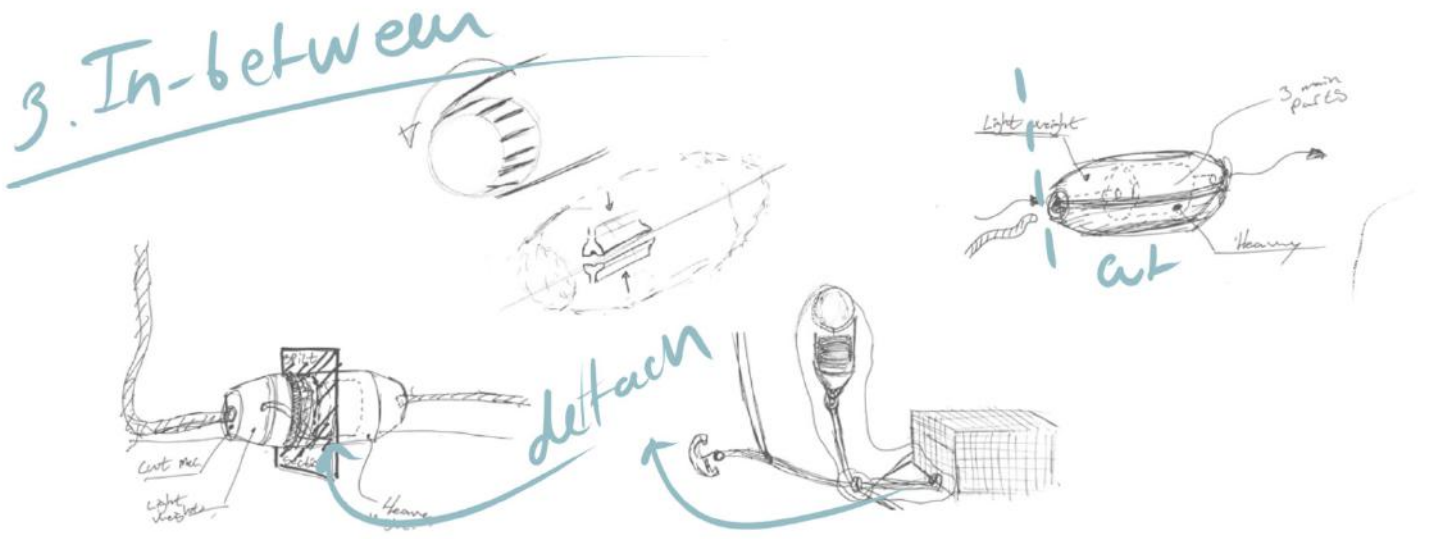
- Need for multitasking in some situations.
- Product needs to fit the fast way of working.
- Product needs to be adjusted so it can go through existing hauling systems.
- Communicate the start / end of the line of creels.
- If he lose a line of creels, it is not only the catch for one day he loss but also for the next time.
- Lost creels occupy a place for new creels.

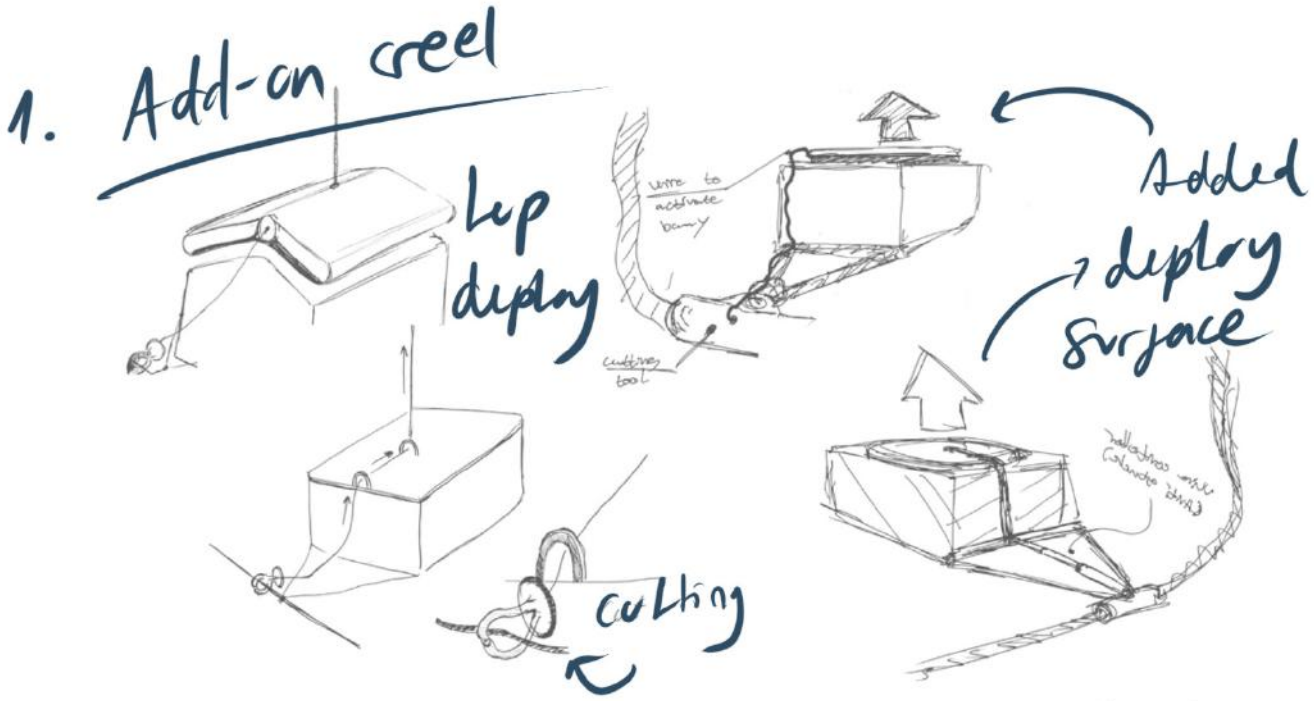
RE-THINK IDEAS

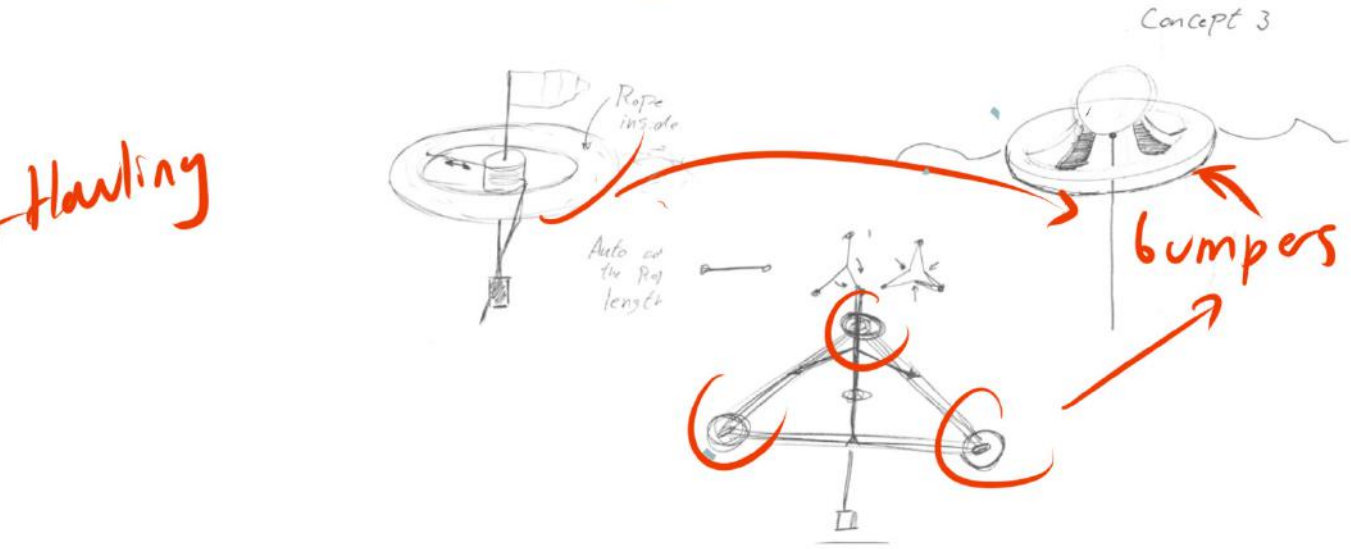
In order to re-think the ideas the group did a new sketching pool (A27). This activity permitted to find more specific solutions with three focus directions based on the feedback and insights we got. These three directions are:

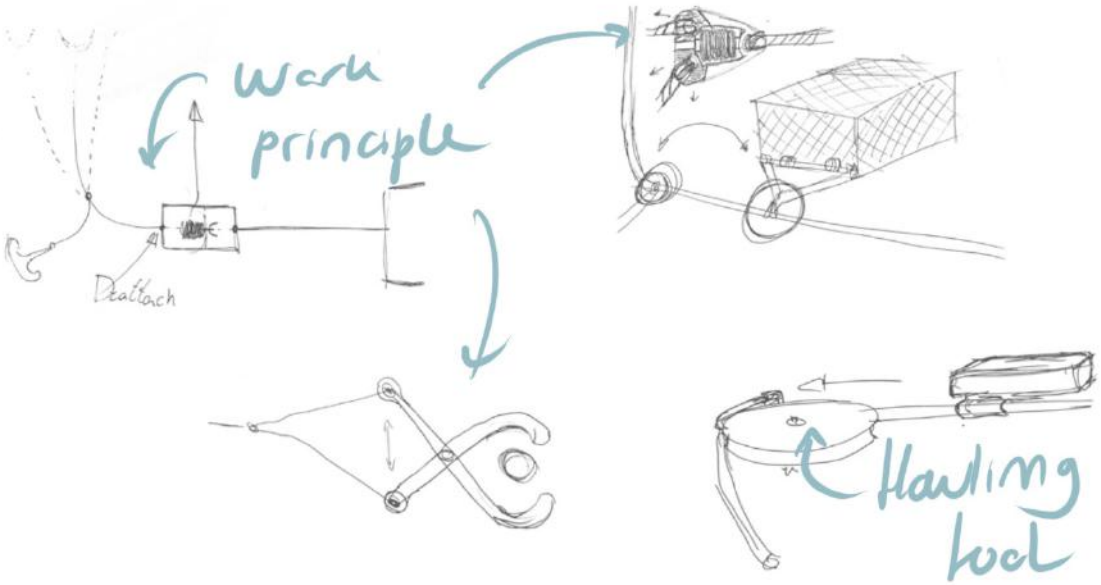
- Ideation on a product which works as an add-on to the creels.
- Ideation on a new buoy concept to be used for the creels fishing method.
- Ideation on a product which works between upper buoy and the first creel from the line of creels.






1. Add-on creel
Lip display
Added display surface
cutting

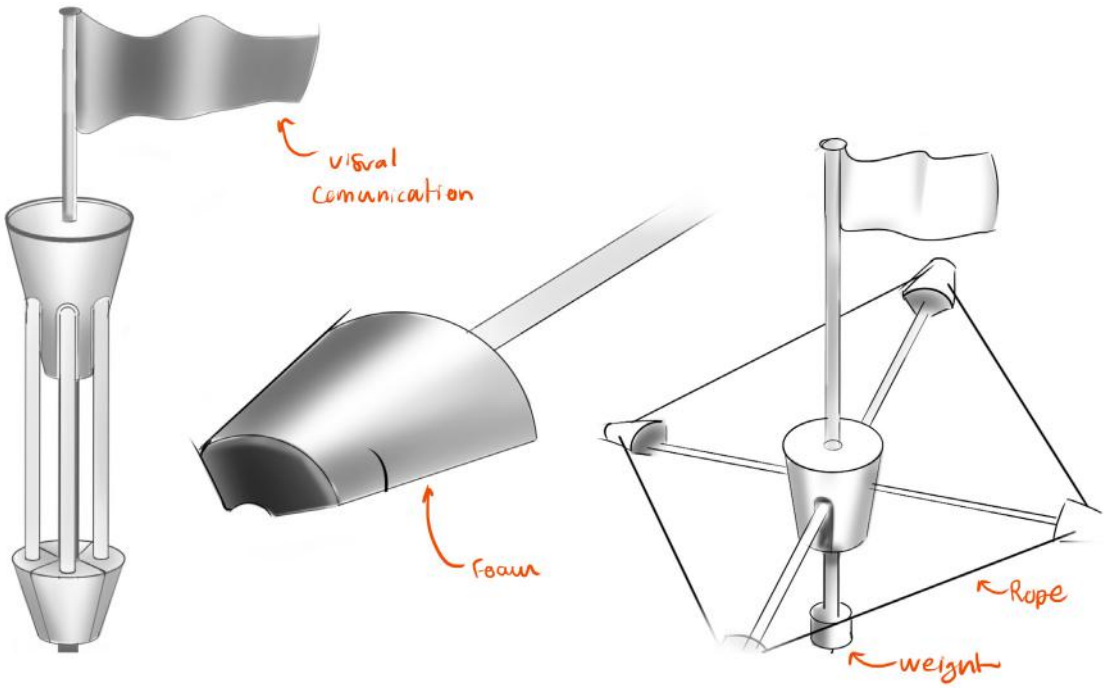

Concept 3
Hauling
bumpers


Work principle
Hauling tool

4.2 CONCEPTUALIZATION

Until now, the group had sketched upon solution ideas and working principles, so, to be able to evaluate the three directions the group decided to create a more detailed concept for each of these directions combining the previous findings. (A28)

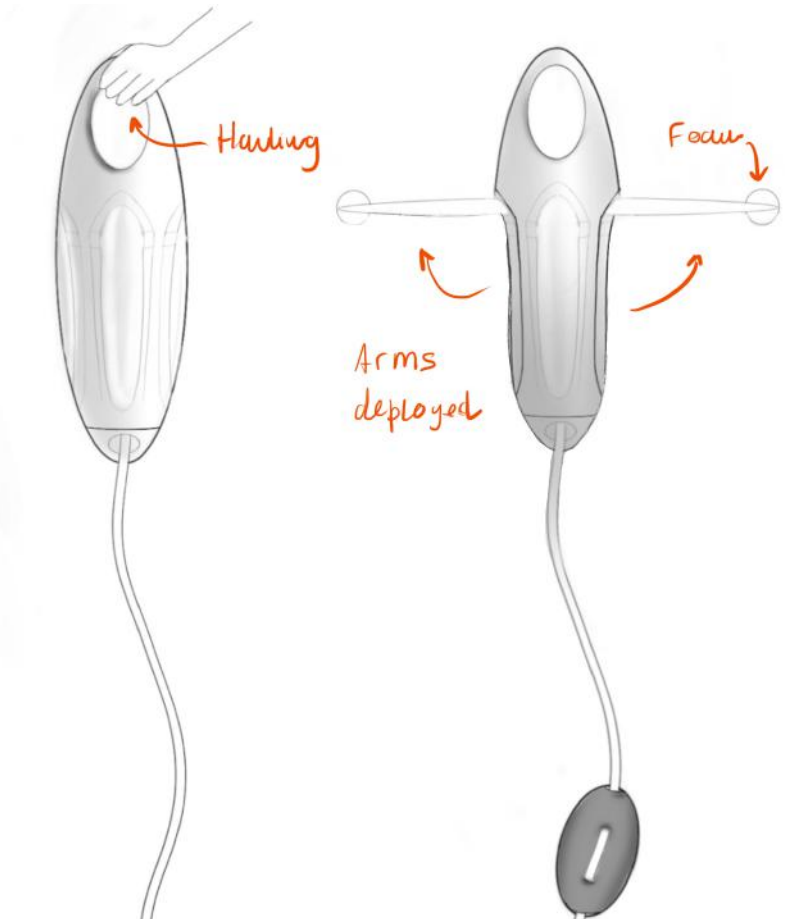
NEW BUOY



NEW BUOY

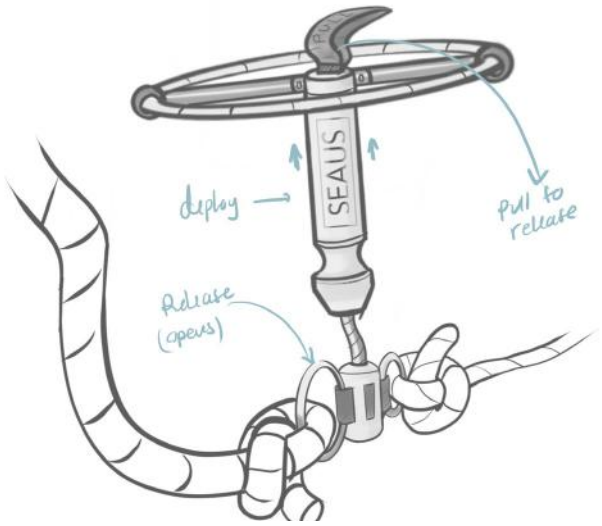
The group opened the solution space creating a new buoy which could prevent propeller cut-off .

- Does not permit a mechanism to retrieve in case of entanglement of the creels.
- There's a risk if the arms doesn't open correctly



Considerations

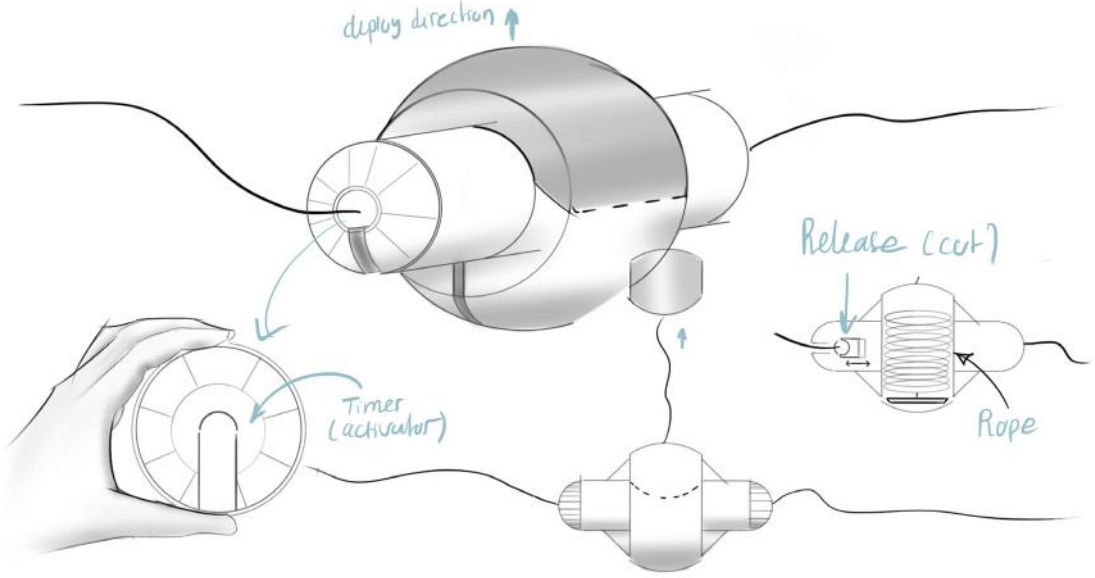
IN-BETWEEN

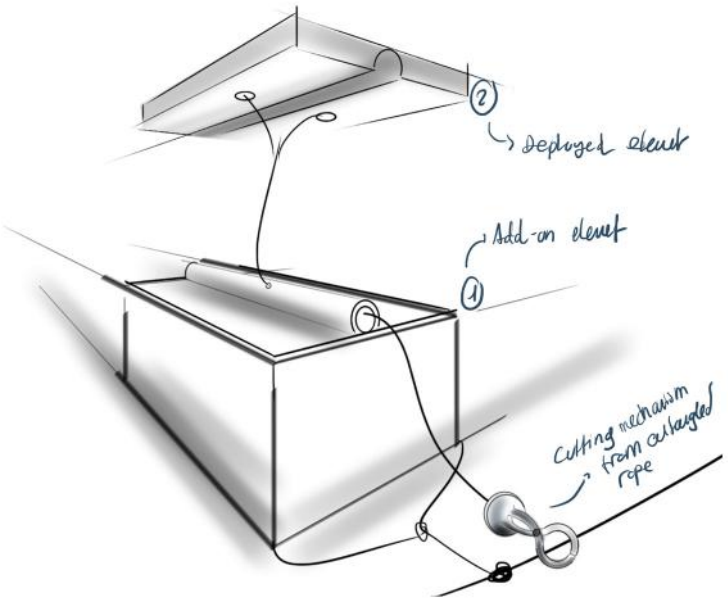


IN-BETWEEN

Permits to detach the entangled rope from the line of creels and offers a solution in case of propeller cut-off.

- There's a need to have a rope enough long to reach the surface (up to 150 m).
- After use it, needs to be reloaded again by the user
- Need for an activation and detachment mechanism





ADD-ON CREEL

Concept to retrieve creels when there's a propeller cut-off or entanglement. It works as an add-on for each creel.

- There are different type of creels and sizes, so it would need to be adaptable.
- it would difficult the placement of the creels in the boat if surface is not flat.

4.2 CONCEPT SELECTION

After the team did the conceptualization of the ideation phase, there was a need to decide which direction to continue exploring. In order to do this the team decided to use the selection matrix method (A29), in which based on a series of requirements for the product it was able to scope down the focus direction for our final product.

SELECTION CRITERIA

In order to have a reference to select the best concept, the group selected different requirements that at this point were necessary to be on our product. These requirements were set with an order of preference to afterwards been used for the selection matrix.

RELIABILITY

Being an "insurance" product there should not be any risk of failure when using the it.

EASE OF ATTACHMENT

To ease the attachment of the product to the current creels configurations and, therefore, reduce the added processes when using the product.

INDEPENDENT FROM THE SYSTEM

The product needs to be as independent as possible from the existing configurations to reduce working processes to implement it.

COMPACT

The space in the context of the use of the product might be reduced (vessels), so, it needs to be considered for the product.

INTERACTION SIMPLICITY

Rough working context with different tasks to take care at the same time. Processes need to be simplified.

RE-USABILITY

After the first use of the product, there should be the possibility to re-use it more than one time.

MISPLACEMENT

When the product it's already attached with the existing creels configurations, there should not be any risk to move from its place.

SCALABILITY

Refers to the possibilities for a product to scale it up to other areas in the future. Would increase the value of the product.

CLEANING

As the product would be in an environment in which objects can get different particles attached to the surface of it. the product needs to avoid small corners and joints.

SELECTION MATRIX

		In-between		New buoy		Add-on creel	
Selection criteria	Weight (%)	Rating (1-5)	Score	Rating (1-5)	Score	Rating (1-5)	Score
Reliability	19	4	76	2	38	3	57
Ease of attachment	17	4	68	4	68	2	34
Independent from the system	16	3	48	5	80	2	32
Compact	14	3	42	4	56	4	56
Interaction simplicity	12	4	48	5	60	2	24
Re-usability	9	3	27	5	45	1	9
Misplacement	7	3	22	5	36	4	29
Scalability	4	3	11	5	18	1	4
Cleaning	2	3	5	4	7	2	4
TOTAL	100	271		371		191	

Ill. - Selection matrix

The results from the selection matrix showed that the new buoy was the direction to go based on our selection criteria. Furthermore, the selection matrix showed that the Add-on creel concept wasn't fitting our requirements as much as the other two concepts and the group figured out that to make a product for each creel it wouldn't be the best solution for our business possibilities and there was no need for it as the same problems could be solved with the In-between concept. So, it was decided to explore more into the other two concepts instead of the Add-on creels.

// OUTCOME

The group considered that the buoy concept was just able to solve one problem (propeller cut-off) while the In-between could solve either solve propeller cut-off and creels entanglements. furthermore, the in-between concept could also implement the principles from the new buoy. So, after these considerations, the group decided the best way to go was to opt for continue exploring on the In-between concept.

detailing 5.0

This section provides an overview of different tests done by the group and the considerations that had been taken from it. Furthermore, it shows the exploration and definition of different technology solutions for the product. There also will be explained how all these findings had been implemented, starting from a product architecture overview and going through a more defined product shape using an aesthetic definition set up by the group. Finally, there will be shown all the requirements needed to take into consideration for the final product.

// OUTCOME

This section permitted the group to define the product and therefore to have a better understanding of its performance and the requirements needed to make this possible.

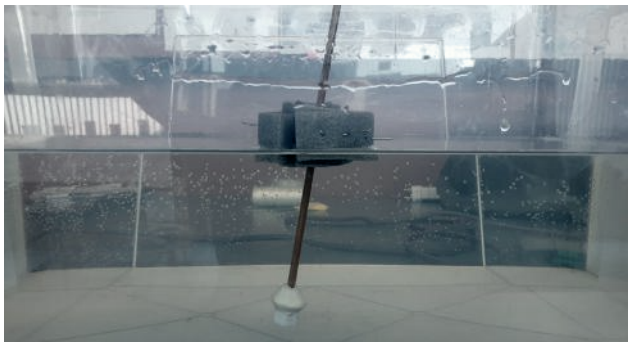
// NEXT

Find the appropriate method for production and the materials needed for it.

5.1 TEST & LEARN

in order to validate the viability of the concept & principles from before selected the group did different tests which would give learnings to be considered from the principles wanted for the final product. in order to make these tests, it was used different mockups made for each test.

WEIGHT DISTRIBUTION TEST

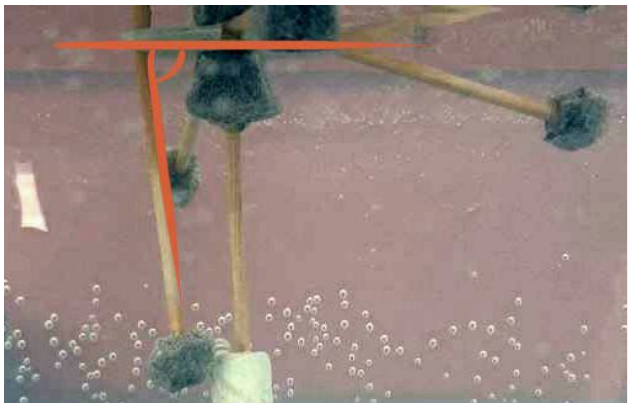


To get an idea of the stability considerations to make sure the product will stay in its right position all the time and at the same time having enough distance from the water to be able to see it from a certain distance. These considerations affect the size, which is connected to the storage capability and weight distribution. This leads to consider these conflicting requirements and to find the optimal balance of them for the product. (A35)

//OUTCOME

Taking the balance point into consideration, the dominating weight needs to be placed underneath the upper floating part. This would reduce the risk of failure of the floating stability since it can lay down to the wrong position in the water.

ARM UNFOLDING TEST



To get an understanding of potential risks to consider when the arms get unfolded. The test was done in two different ways. First, just by putting the model down in the water to simulate unfolding the principle. Second, by letting the model come out from a cylinder underneath the water to see if it still works correctly. When the arms are folded out the product should have a stationary position. (A37)

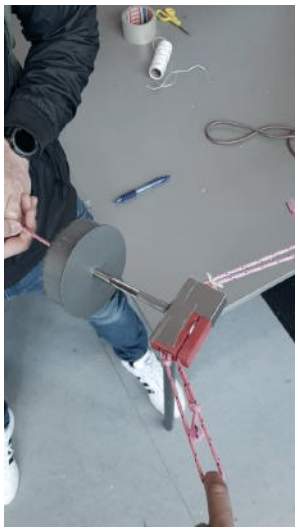
//OUTCOME

- The start angle can prevent the principle to work.
- The start angle needs to be perpendicular to the water surface.
- Simulating, the product coming out from the tube under water end up in a wrong position on top of the water due to the start angle of the arms.

DETACHMENT TEST

//STEPS

1



2

3

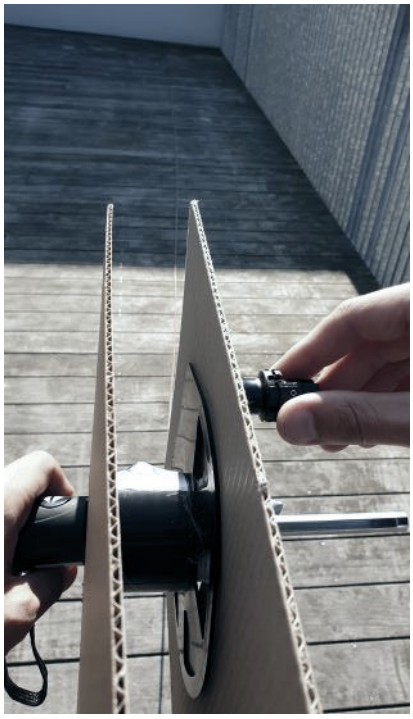
4

The team created a 3D printed a mechanism in order to investigate how the detachment mechanism works while a load is applied in different directions. Furthermore, to observe if any failure could occur. (A34)

//OUTCOME

- Pulling in a certain angle resulted in a failure, which didn't allowed the mechanism to work.
- In the most common scenario, the mechanism works but still gets a bit hard to release.
- The mechanism needs to be optimized to minimize the risk of failure.

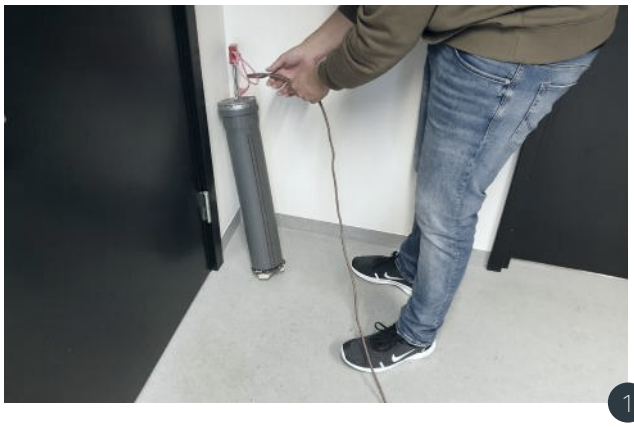
RELOADING SYSTEM TEST



//OUTCOME

In terms of space optimization, the rope has to be tighten around the rod. Which could be done by holding back on the rope. Furthermore, there is a need to develop a system to make sure the rope is not moving on the other side of the reel. (A31)

KNOTTING TEST


1


2


3


4

Since the fisherman is going to attach the product twice on each product. We did this test this in order to increase the ease of the installation and find the best way of attaching and detaching the product to the line of creels. (A42)

// OUTCOME

The simulation of binding knots or attaching the product to the line gave some insights that the product needs to facilitate:

- Knot simulation 1 and 3 was okay but needs to be further developed.
- Even on a non-rocking surface, a stabilizing hand is needed, which means the other hand has to do the job.
- The surface that the product is going to stand on while getting attached, needs to facilitate a stable and strong platform that makes sure that the product doesn't tilt.
- The group considered the use of carabiners in order to ease this process.

RETRIEVE FROM WATER TEST

The team was testing the retrieving of the principal of a circle with a diameter on 1.2m and four arms in order to keep it stretched out. By throwing or lowering an anchor down in between of the circle and thereby catch the frame. (A33)

//OUTCOME

The team experienced no problems in retrieving the buoy with a radius of 1.2 m from the hight of approx 2.5 meters. Even with no experience, all teammates were able to succeed every time. Large waves and tilting ground for the user can eventually make this more difficult.

VISIBILITY TEST

We found that by using a surface popping up from the water surface facilitated much more the search of the product. Also using a visible color also helped to differentiate from other objects at the horizon and water. The different tests gave us the idea of how could our product help the fishermen to found the product by using the eyesight. We made the following table to show our findings (A38).

DISTANCE	INSIGHT
85m	*Easy to spot and differentiate it from other objects. Reflections can be seen if being positioned with the sun in the back of the user.*
120m	*Easy to spot but barely difficult to differentiate from other objects at the horizon. Reflections are difficult to be perceived from this distance.*
220m	*Difficult to spot and differentiate from other objects at the horizon. Reflections can't be perceived from this distance.*
400m	*In a distance of 400 meters, it becomes impossible to spot the object. The reflective part of the product became identical with the reflections from the water. Since the orange sphere was at the same level as the water it also became invisible to the eye.*

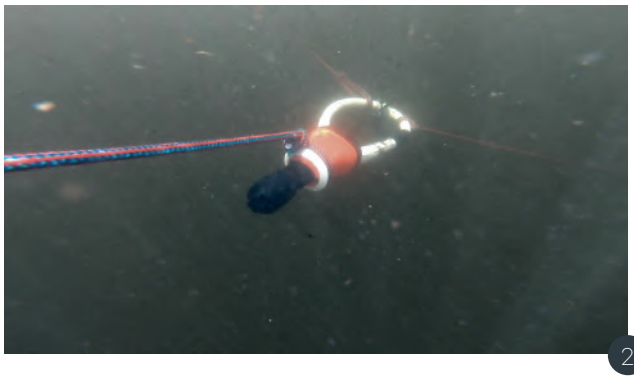
//OUTCOME

After the test, we have found that the prototype works from a distance up to 120 meters, but, after this distance, the visibility of it's more inefficient. Apart from that, it has been seen that reflections worked only when the user it's watching from a point of view in which the sun it's in back of him. Moreover, it has been found that reflections from the water made barely impossible to be differentiated from the ones implemented in the prototype.

8. DETACHMENT UNDERWATER

1

This test would allow the group to validate the detachment of the lost creels from the entangled lines underwater. This test was done using a mechanism which it's used as a security deployment mechanism in the marine field, the group wanted to observe if this mechanism would fit with the needs and requirements we needed for our product and its performance as the principle of it was what we were looking for (A40).



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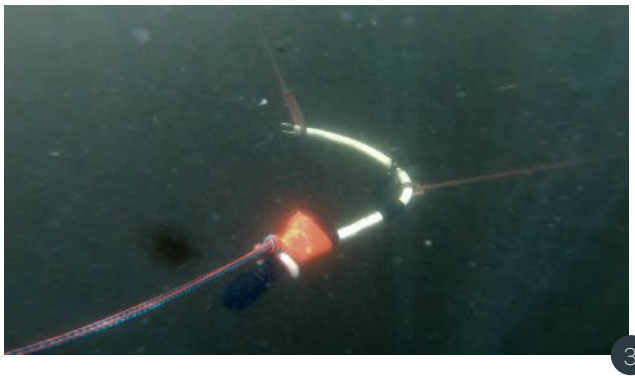


3

//OUTCOME

The test of using this principle succeeded and the group considered to using this principle which was fitting with our product requirements.

4

9. BUOYANCY TEST

The main goal of this test was to validate the buoyancy of the prototype we had in order to be sure that the product maintains the direction upwards underwater. If so, we ensure that the product cannot be misplaced when about to be deployed from the bottom of the sea. We also wanted to see how do the streams affect the prototype underwater (A39)

//OUTCOME

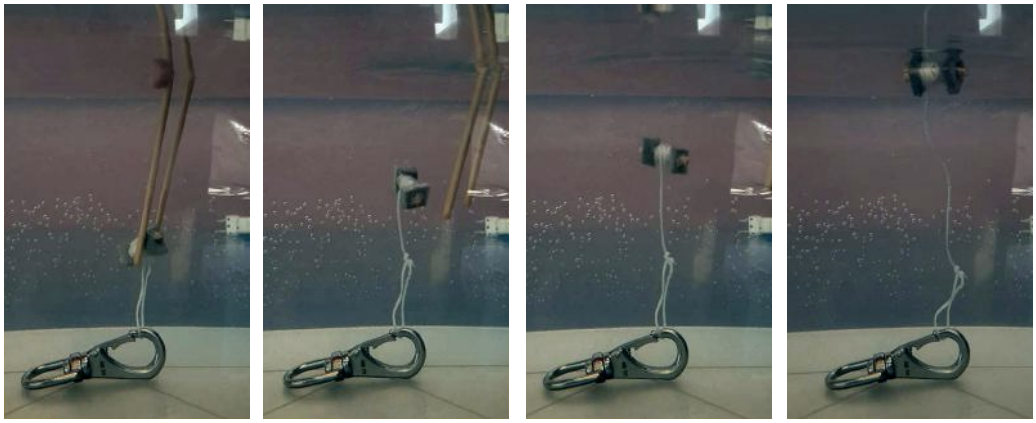
The prototype was pointing upwards as we wanted and, moreover, the reaction to the water stream wasn't affecting to its movement at all.

ROPE UNFOLDING TEST

We wanted to observe how the system of loaded rope are responding when being unfolded. Two deployment principles were tested - Horizontal and vertical. These tests would give us insights on the risks, that we should take into consideration, when deciding how this unfolding method should be. (A36)

//Horizontal - Steps

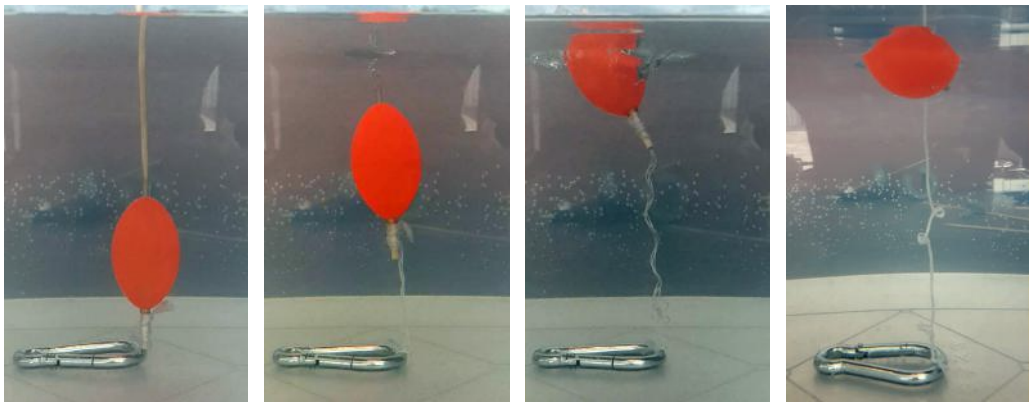
1 2 3 4



The rope is unloaded with the principal of a rotational rod. This principal succeeded by keeping the rod stable enough, all the way from the bottom to the water surface. Depending on where on the rod the rope is pulling, it can tilt a bit from side to side.

//Vertical - Steps

1 2 3 4



The principle of this system is the rope is getting dragged off from a vertical rod. This means that there is no need for rotational parts. But this process makes the rope curls and create knots. So, there's uncertainty to what extent this could give reliability issues.

//OUTCOME

The team experienced that the earlier concept with the vertical principal was lacking in fulfilling priority of reliability. In order to increase the reliability in the needed scenario, the team looked further into the development of a horizontal principle.

5.2 CONTEXT TESTING & USER FEEDBACK

Our last visit in Thyborøn disapproved our solution to prevention against propeller cut-off. The 50 feet fishing vessel, L 47 Camilla, has a propeller of 2.2m that would make a vacuum effect onto the seaus product even using the propeller cut-off prevention arms and in this scale would not work. It means that we can reduce some complexity. One of our users said "because the fisherman knowing the fishing spot best, he will know how many of the seaus product is needed, but I could imagine one for every 5 meters. Then it will be possible to drag from different directions". The team recommend minimum one at each end of the setup because of entanglement but open for the possibilities of additional sales (A43 & A44).

SIZE COMPARISON

//OUTCOME

The product size does not have a large effect on the storage possibilities with a fishing vessel on 50 feet. Thereby the size requirement in terms of storage would not be a crucial factor. But hereby the human interaction and maneuvering have to be taken into consideration in order to grab and control the product from various angles.

//OUTCOME

Hauling in a 4mm DYNEEMA rope on the hauling tool (See picture above) would work, but there could maybe be a chance of failure at the end of a season if the rope gets affected by algae which will result in a loss of friction. If this option would fail, the options to consider could be a thicker rope or binding knots along the rope for more traction.

HAULING TOOL VALIDATION

//OUTCOME

The elements of the tested mockup model were able to go through the two hauling tools and its characteristics were approved. However, it requires some help from the user in the smallest one (See picture above). To optimize the task, it was observed that the element which interacts with the hauling tool should be flexible to be able to go through the hauling tool.

5.3 TECHNOLOGY

FLOW CHART

In order to define the elements needed for our product, the group created a flow chart in which appears all the different steps from when the system starts until the product deploys. Furthermore, we have pointed out the different components needed to make the system work by using boxes and defining its functionality in the following illustration.

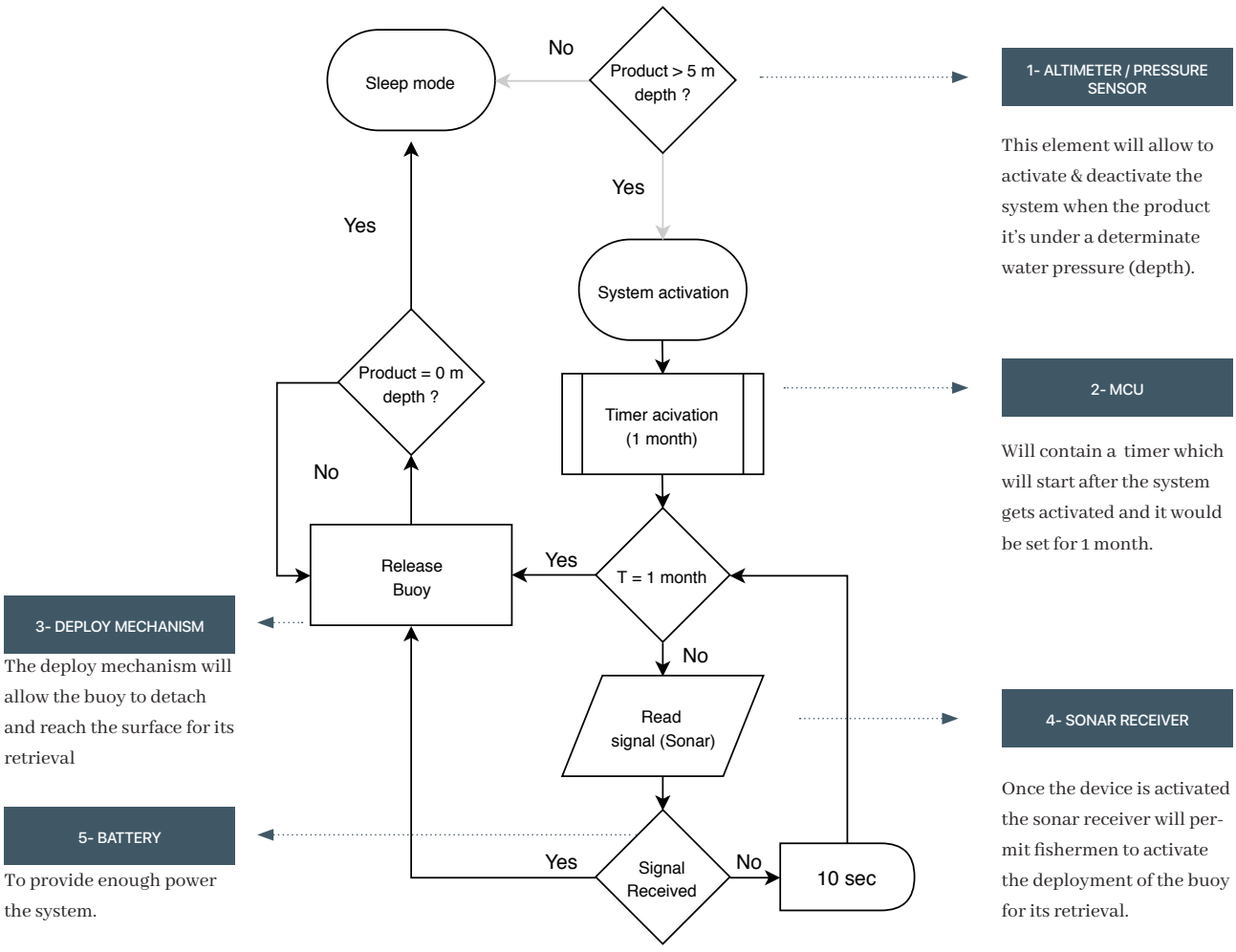


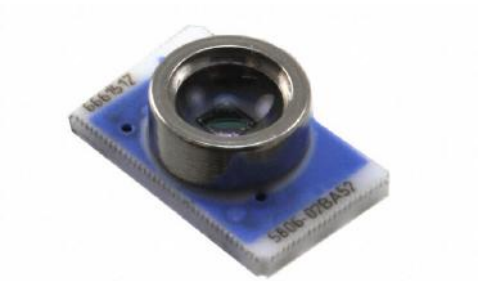
Illustration -Flowchart

1- SYSTEM ACTIVATOR

In order to activate the system, the team has been researching into different methods to find the most efficient solution to implement in our device.

The main parameter we have had into consideration for the selection it's based on the consumption that would require this system activator in case it needed to be running all the time. As the components of the product needed to be mostly sealed due to the context of use, to use a simple on/off switch wasn't the best solution. Also, this solution will increase the risk of failure. Instead, it has been selected to use an altimeter / pressure sensor module.

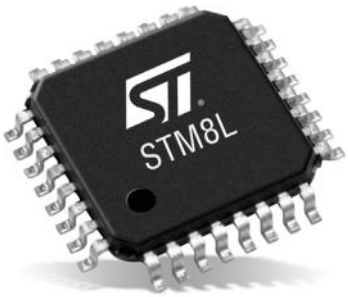
The team decided that this altimeter/pressure sensor would be the right choice as it has a low consumption rate which would barely affect the battery in the long run. As this sensor it's waterproof, it would be sealed in the outer shell of the lid which covers the electronic parts of the product. (A57)



Img. -MS5806-02BA Altimeter

2- MCU

An STM8L microprocessor is a processing unit that acts as the brain of the product. The unit follows predefined, simple and logical commands depending on the input it receives. It is an ultra low power MCU and works perfectly in the temp conditions that the product is going to be exposed for. This unit also has RTC integrated, which is Real Time Clock. Thereby it can control the system and deploy as in an emergency situation.



Img. -STM8L MCU

The module above, would permit a preset timing up to 6 months. Therefore, the operation of it will allow to minimize the current during the time it's not in use. (A55)

3D- DEPLOY MECHANISM

For the deployment of the mechanism, the team has looked into a solution and which is based on a small electromagnetic actuator.

This small actuator would move after the fishermen had activated it or when the timer had reached the settled amount of time. This would let free the reel to deploy by using its own buoyancy up to the sea surface.

The actuator will be placed in the rotational joint of the cable reel and would have waterproof protection. (A58)

Img .- LS-P40/20 actuator

4- SONAR

Sonar is the primary communication tool underneath water. Water absorbs high frequencies really well, which is the reason why high-frequency signals aren't used underwater. As an example, Bluetooth (2.4 GHz), which does not work more than a meter before the signal gets converted to heat.

The use of sonar in maritime environments works in a low frequency, from 10 to 50 kHz. Sonar technology, It's used to locate objects, measure speed, distance, and direction.

The main drawback of low-frequency transmission it's that, besides being able to reach a long distance, the amount of data transmitted is low. While high-frequency transmission does the opposite, has low range distances but allows a high amount of data to be transmitted. (Understanding ocean acoustics, 2015).

	Range [km]	Bandwidth [kHz]
Very Long	>100	<1
Long	10-100	1-5
Medium	1-10	5-20
Short	0.1-1	20-50
Very Short	<0.1	>100

Illustration. -Relationship between the distance range and the Bandwidth with 200dB

Not only the frequency permits the signal to reach long distances, but also the loudness (dB) does it. As it can be observed in the following illustration:

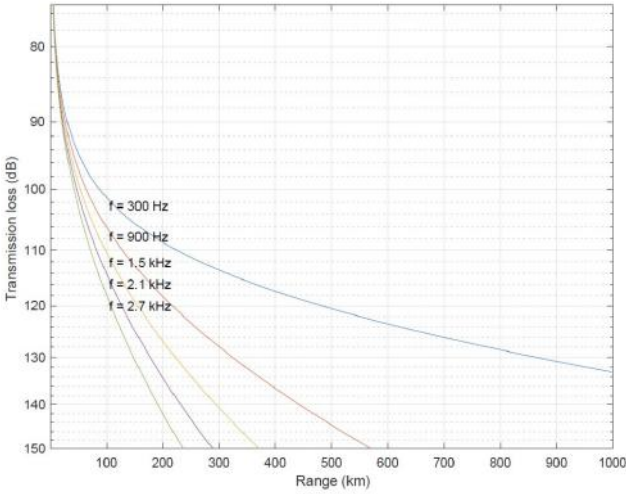


Illustration - Doppler Effect in the Underwater Acoustic Ultra Low Frequency Band

Underwater, most of the devices work within a range of loudness up to 185 dB. That's because loudness behaves differently through the air than through water. The density of water is much higher than air and the sound travels much faster in water (1500m/sec) than in air (340m/sec).

Sound waves with the same intensities in water and air differ by 61.5 dB. As an example, if you are talking with a friend, standing 1 meter from each other you can hear each other pretty well. But, If you do the same underwater, you need to yell, to be able to hear each other. (Doppler effect, Ultra low frequency band, 2017)

TYPOLOGY OF SONAR

There are two types of sonar, which can be used for different purposes, the active one and the passive one. (Sonar. Sounds in the sea)

Active sonar:

sends a signal (sound waves), which travel through the water until it reaches an object, then, the object reflects these sound waves, which return to the sonar. The active sonar has a receiver which permits, for example, to measure the distance from the sonar to the reflection point of the sound waves.

Passive sonar:

On the other hand, the passive sonar when receives a signal (sound waves), permits to perform an action.

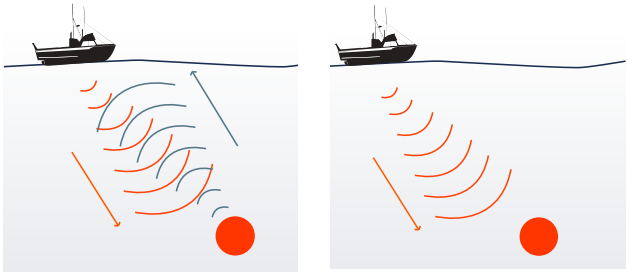


Illustration. -Active vs. passive sonar

Taking the knowledge above into consideration enables the team to choose a setup of a frequency, sound level range and type of sonar.

The type of sonar used in our product would consist in two parts, the first one would be the passive one, directly implemented in our product able to receive a signal. For this one it would be used a ultrasonic transducer for sonar.

Image. -Hydrophone H1C

The second part would be in the surface working as an active sonar. (A56)

Furthermore , since the Seaus product should work in depths up to 150 meters, we want the sonar to be able to reach more distance as the depth where our product it's located. The reason of it, it's because the distance from the boat to the sonar receiver will not be always perpendicular to each other.

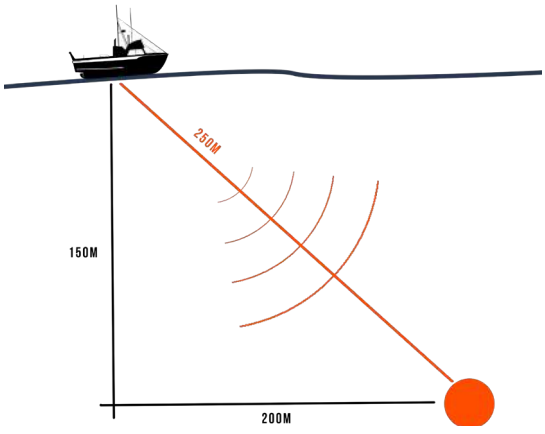


Illustration. -Real range requirement for sonar

Taking this into consideration for the selection of the needed sound loudness and the frequency, we would need a sonar able to be used with a setup of 20-50 kHz with a sound level of 185dB.

5- BATTERY

Since the Seaus product operates in the water, the product might experience a lot of pressure, corrosion and low temperatures. Then, there is a need for picking the right battery for such conditions in our device.

The group found that most batteries don't perform in an optimal way in low temperatures, but, lithium-ion batteries are the ones which perform better in these conditions. Moreover, a lithium-ion battery would be an excellent choice since its performance doesn't get worse over time and keeps up a constant performance. The power consumption curve is much more linear than other batteries. (La pile idéale, 2003)

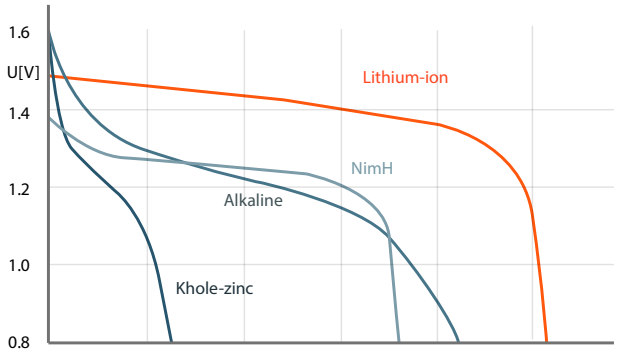


Illustration. -Consumption battery comparison

Furthermore, the performance of each cell is much higher when using and thereby require less space than other batteries. The lithium-ion battery is also optimal when it comes to battery life, it can contain power for a long period of time.
So, the consumption of the batteries has been taken into consideration and the system in our product would use long life capacity (mAh) batteries and these would need to be replaced after a time.

The specific lithium-ion cell that should be implemented would provide 3.7v and have a capacity of 5000 mAh. Placing this in serie connection of 4 cells would provide the system with 3.7v and a capacity of 20.000 mAh.

Our system would require 2 mA (0.3 mA MCU a, 0.3 mA Hydrophone and 1.4 mA Altimeter) and have a consumption rate on 0.7. The consumption might be influenced factors that can affect the battery and needs to be taken into consideration. This leads a battery lifetime on 7000 hours which is in 287 days (A53). This is taking into consideration that the system runs non stop and the hydrophone is searching all the time. On the one hand, the MCU, Altimeter and hydrophone would use a battery delivering 3.7v. On the other hand, the solenoid actuator needs its own battery delivering more voltage but having much less capacity which could be solved by using four 3,7v batteries in parallel to achieve enough voltage than the solenoid requires (12v). (A53)

// QUICK READ

1- ALTIMETER

To activate the system when needs to be used. It offers a low power consumption.

2- MCU

Processing unit which it's also used as a timer to the system and deploy as in an emergency situation. It would have a low power consumption when not in use.

3- DEPLOY MECHANISM

Electromagnet which would permit to deploy the buoy from the sea bottom

4- SONAR

To permit the deployment by the fishermen from the sea surface. It would have a 20-50 kHz frequency randge and 185dB of loudness. Would consist in two parts, an active sonar (surface) and a passive sonar (Product), using an hydrophone.

5- BATTERY

Would permit to power all the components needed in our device. It would be used Lithium-ion batteries. Four 3.7v batteries in serie providing 20.000mAh, enough to power MCU, Altimeter and hydrophone and Four 3.7v in parallel battery to power the electromagnet (12v).

5.4 PRODUCT ARCHITECTURE

The product architecture is a base point used for aligning the team. The composition between the basic needed objects set the rules. The product is separated into three main parts; The top part, lower part & the release mechanism.

THE TOP-PART

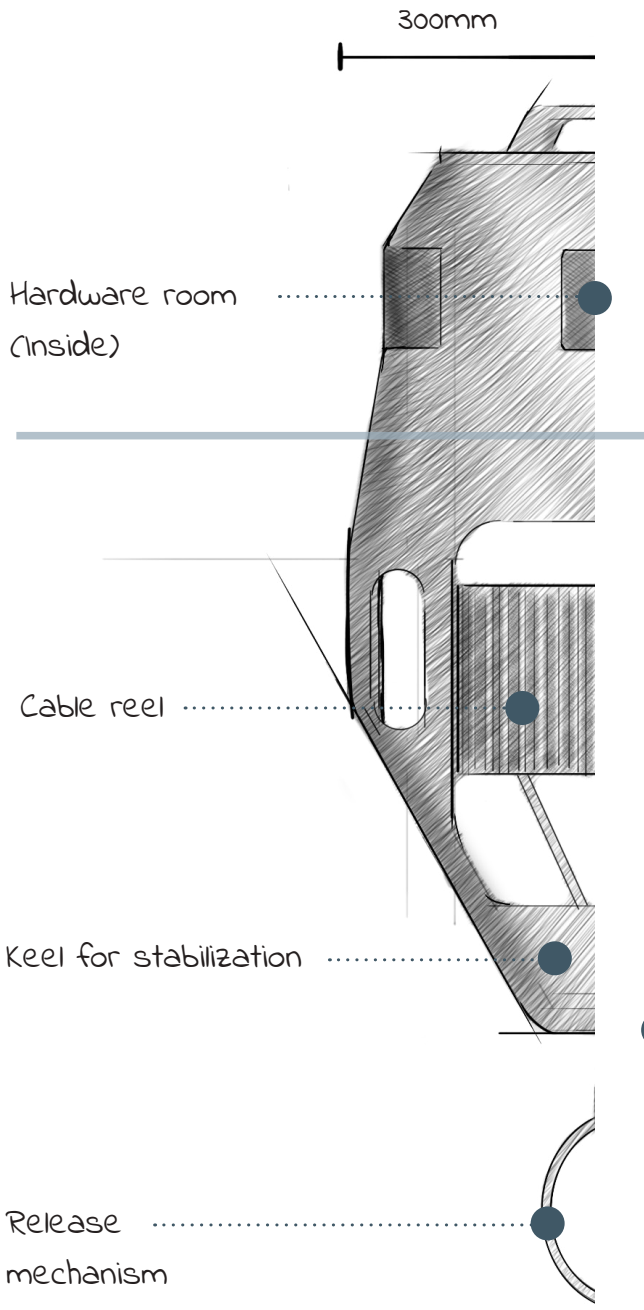
is a hollow shell with foam which makes positive buoyancy. Here is enough space for the "Hardware room" which contains the electronic components. Eg. the hydrophone is pointing upwards and has the best suitable conditions in order to reach the sound train from the transmitter (the boat).
The reflectors would be best arranged vertically on the surface. It will reduce the amount of covering water.

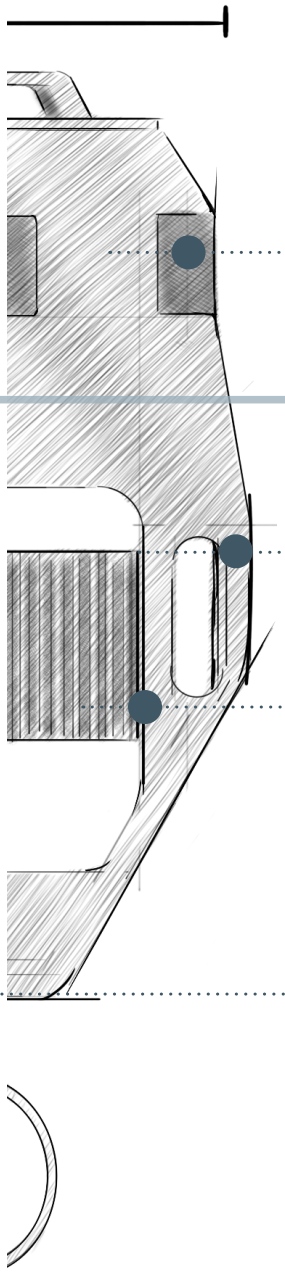
THE LOWER-PART

working as a keel to prevent overturning. The keel makes the product more stable in the water and eases the retrieval process. The buoyancy has to be between neutral and the inverse value of the positive buoyancy. The cable reel with dyneema rope is located in an open space to make the inspection of the rope easily accessible. The rope is managed with a hole in the middle of the product which also keeps the line tight for the reload of it. The friction makes the rope tighten more around the cable reel which makes it occupy less space.

THE RELEASE MECHANISM

Is connected to the rope on the cable reel. This component will be attached to the main rope of the creel setup. The marking buoy rope has to be attached to the releasing part and the main rope which are connected to all the creels need to be attached to a non-releasing part on the mechanism.





POSITIVE
BUOYANCY
(TOP)

Vertical Reflectors

Water Surface

Product arrangement Handles

Deployment mechanism

NEGATIVE
BUOYANCY
(LOWER)

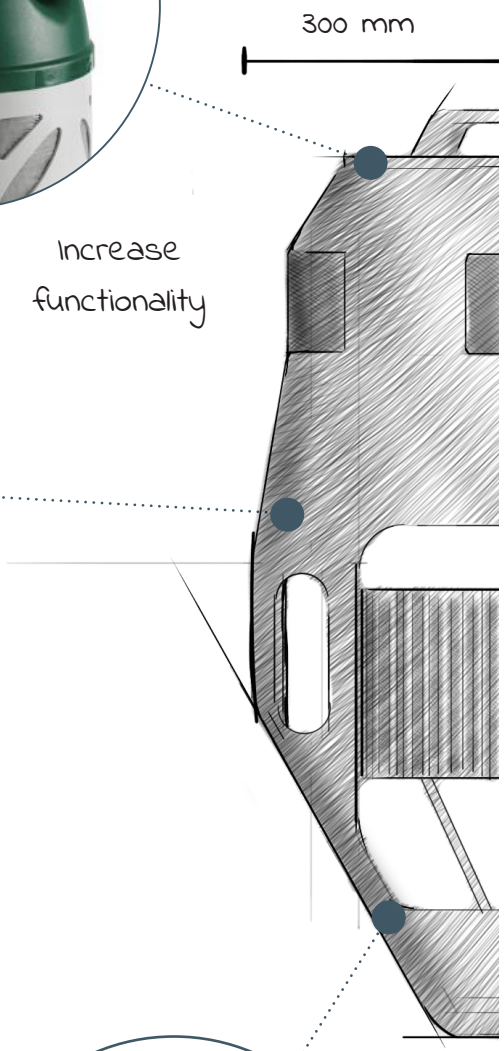
Rope management
& brake

5.5 AESTHETIC FEATURES

The team did a workshop we called aesthetic definition (A47). The goal of this workshop was in to align the team and be able to find aesthetic solutions based on the product architecture and requirements. Both technical requirements and our values from the value vision workshop. By framing the needed values, the team was able to get closer to a whole solution through supported material and thereby make it more tangible.

Familiar → Increase functionality

Double curvature levels → Visual sturdiness / muscle illusion



Direction & volume → Stabilizing shape

AESTHETIC DEFINITION WORKSHOP

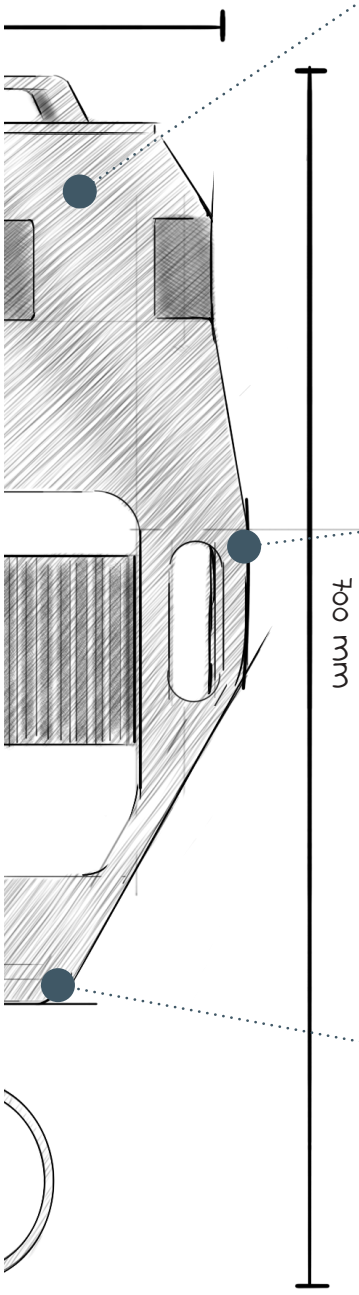
PROCESS

1. Requirements which have an impact on the aesthetic was turned into supported reference pictures which has one or more aesthetic features.
2. Then we pointed out and describe how the supported reference material is connected to the needed value or
3. requirement.

   The team selected the reference material together through discussion.

RESULT:
The selected reference material are our alignment and frame for the next design process. (A47)

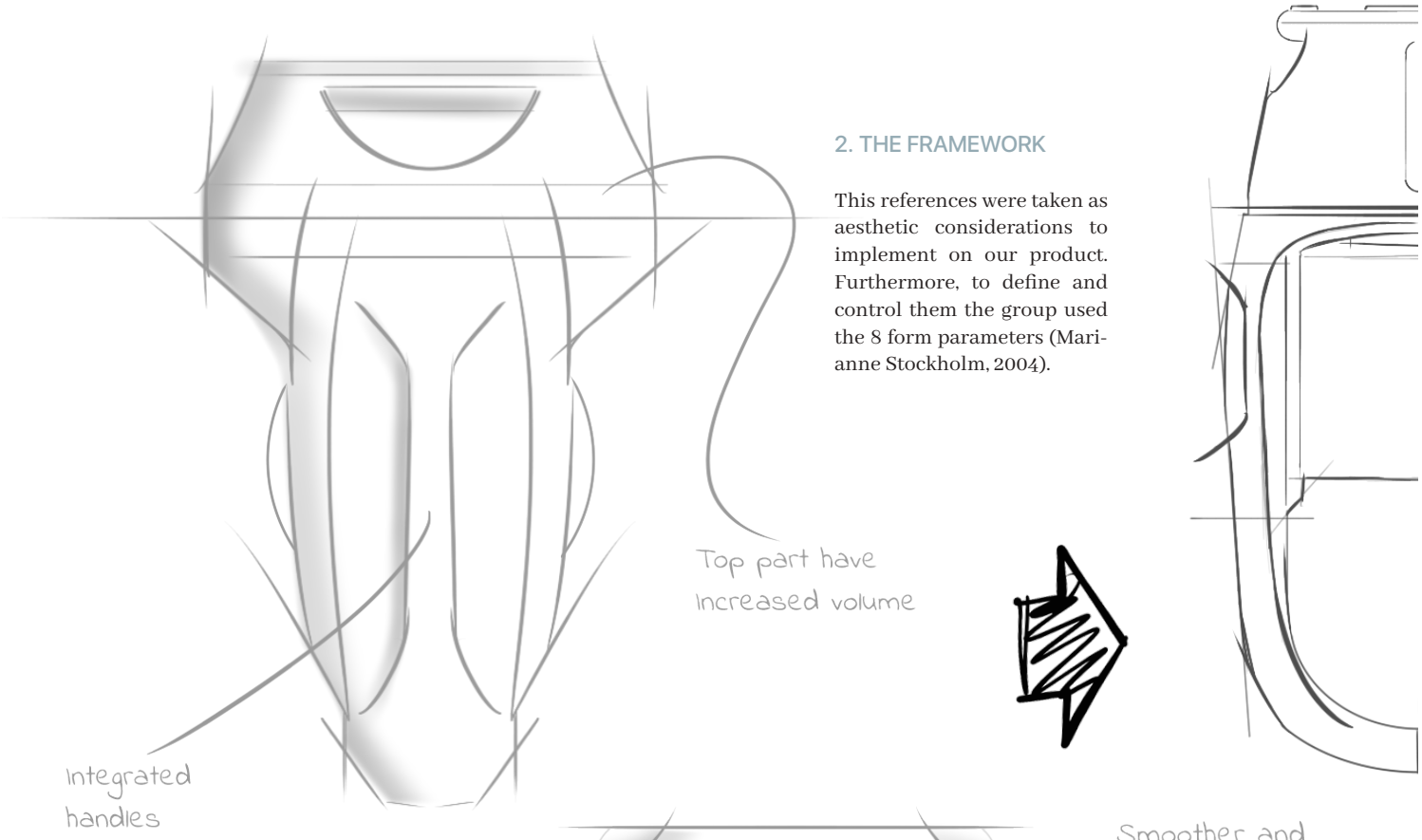
Large surfaces
Less texture → Reduce biofouling



Integrated affordance → Reduce space & the risk of entanglement

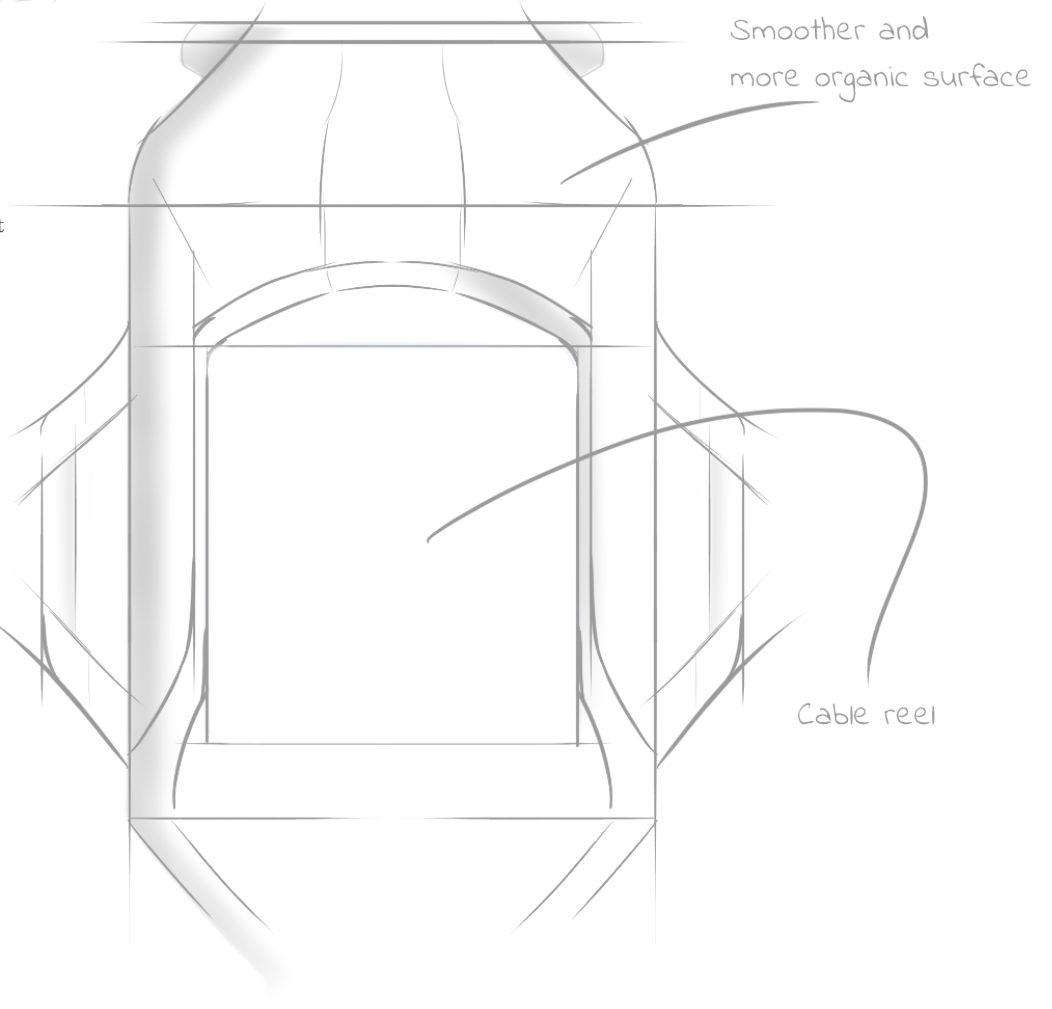
Convex curve corners with small radius → More visually aerodynamic

5.6 AESTHETIC DEFINITION



2. THE FRAMEWORK

This references were taken as aesthetic considerations to implement on our product. Furthermore, to define and control them the group used the 8 form parameters (Marianne Stockholm, 2004).



1. AESTHETIC FEATURES

Were specified previously based on the product architecture, at this point the team was able to lean up against this framework and define them.

1. MODELING & SKETCH REFINEMENT

3D modeling it was used to implement these aesthetics and therefore make iterative changes by sketching upon it. the full process can be found in A47 & A48.

5.7 PRODUCT IMPLEMENTATION

SHOCK RESISTANT

ONE SEASON

ACOUSTIC RELEASE

IP-68

HYDROPHONE

HARDWARE ROOM

SIDE HANDLE & RELOAD

ROPE HANDLES

600mm X 310mm

7 KG

Material & production 6.0

This section provides with the different materials and production considerations taken in order to make possible the production of the Seaus product. Therefore, shows the considerations that should be done for a further development.

// OUTCOME

The group was able to have new findings needed to taken into consideration for the production. Furthermore, got knowledge into the appropriate materials for this type of product.

// NEXT

Take into consideration all these findings and consider solutions that could be implemented to solve them for a further development.

6.1 MANUFACTURING AND MATERIALS

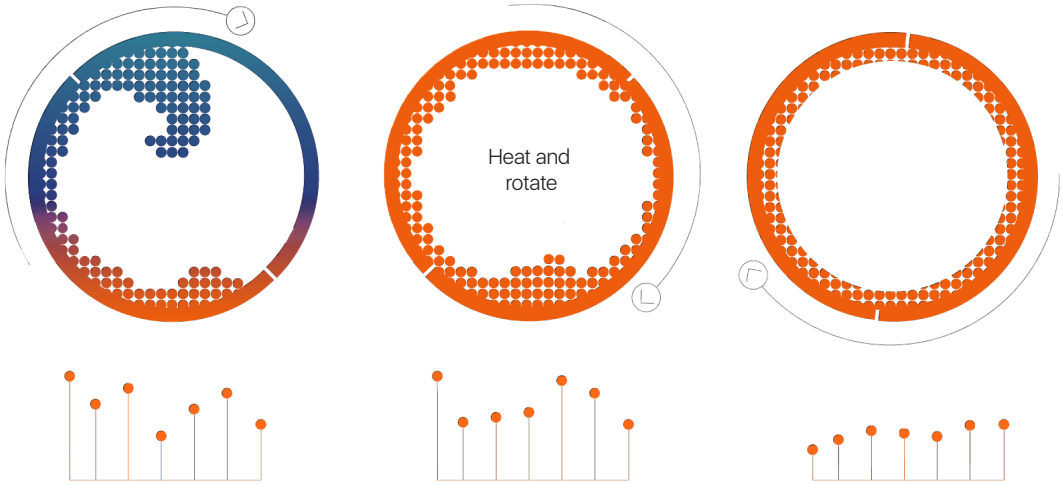
INTRO

To achieve a realistic product, manufacturing needs to be considered. New requirements will be discovered and a more realistic economical estimate per unit will be applied. Some changes will be taken into consideration to make the production of the product more effective. Lastly, several new requirements for the materials will be discovered and applied along with all the previous requirements. This will get further explained in the next section “Choice of materials”.

ROTATIONAL MOULDING

Rotational moulding, also known as roto-moulding or roto-casting, is a process for manufacturing for hollow plastic products or shapes. A very broad collection of different types of resins (materials), can be picked depending on the requirements from the product and its functionalities. Rotational moulding provides several advantages in terms of relatively low residual stresses, inexpensive moulds and embedded elements like thread, fittings, sockets and logos. Residual stresses are stresses that remain in a product after the mould has been removed. Pointing this manufacturing process back to the fishery, a lot of the floating equipment within fishery is actually made by rotational moulding. Most types of buoy and fender are produced this way. Rotational moulding is highly used within series production of 200-3000 pcs per year depending on the size and complexity of the product.

Rotational moulding is a sustainable production method, because of its low use of oil and much less energy is required in this process compared to other production methods. Furthermore, it is also easy to recycle. Most materials used in this production method can be shredded into small pieces of plastics, called pellets, and thereby be reused into new products. (A guide to rotation molding, 2002 & Rotoconnects)



FOAM INFILL

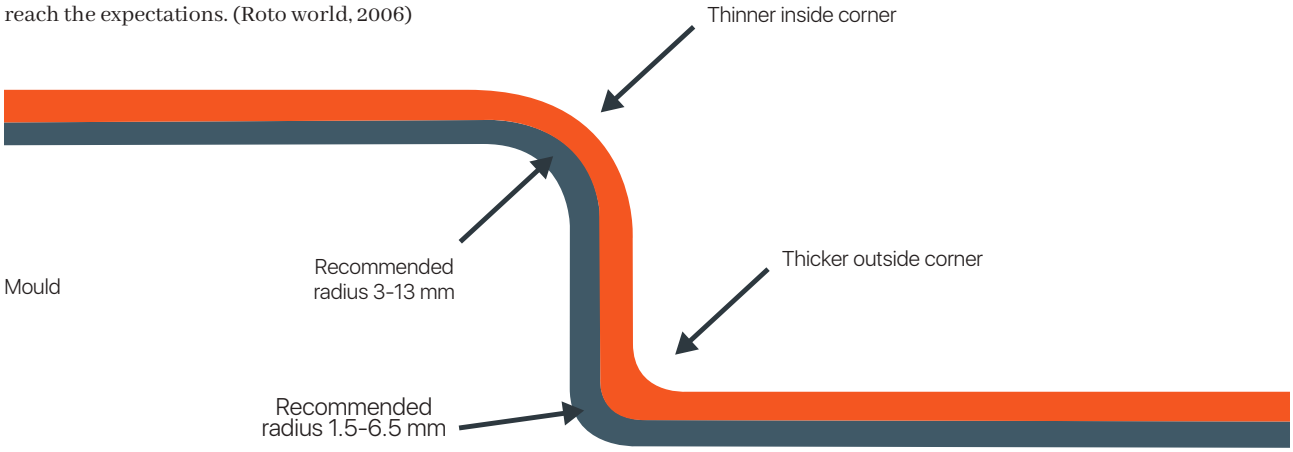
To increase the compressive strength of the product the hollow space inside the product needs to be filled with something light that can withstand the pressure of 150 m depths in saltwater. If the depth gets converted into atmospheric pressure the result will be 14.87 atm, which is 1.5 MPa. Foam infilling require an extra process beside the rotational moulding and will add to the cost of the product. But, foam infilling is not that unusual right after rotational moulding. A lot of manufactures provides this option since it is quite easy for the manufacturer to execute. Right after the moulds get to detach from the rotational moulding machine, the manufacturer can open a hatch in the mould, drill a small hole in the product and do the infilling process. The hole can be patched afterward. The product needs to stay in the mould until the foam is hardened. (A54)(Roto world, 2006)

MOULDS

The majority of moulds for rotational moulding are made from steel or aluminum sheets or CNC machined metals. The shell of the moulds is quite thin which create a structure that allows the heat source to quickly transfer the heat through the metal into the powder. Large simple moulds are usually made from fabricated metal sheets. But if a more advanced mould is needed it is made by CNC cutting which is more expensive. Most moulds are made of 2 pieces but can reach up to 4 depending on the complexity. Tolerances are hard to control within rotational moulding. This means that radius can't get smaller than 3mm, it is impossible to create the same thickness all over the product and thickness is bigger in every corner inside the product. Therefore there is a lot of guidelines that need to be followed, in order to reach the expectations. (Roto world, 2006)

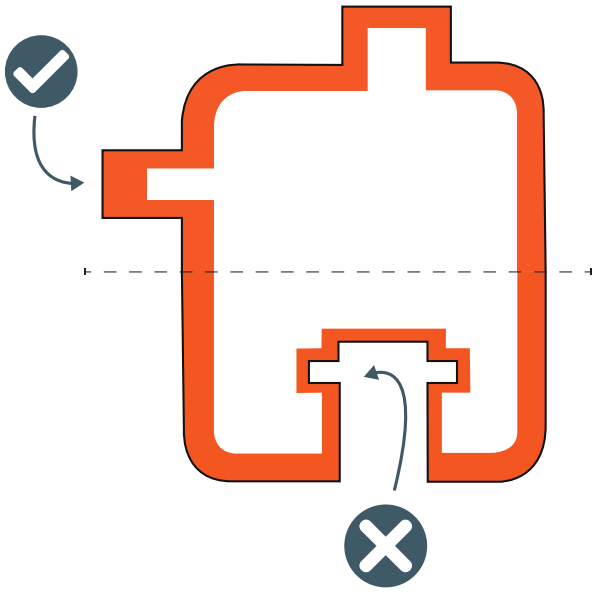
DAN HILL PLAST A/S (DHP)

Dan hill plast is a Danish manufacturer who is using rotational moulding as the primary production method. As secondary, they also have blow moulding and injection moulding. Through a visit and a phone conversation, the team got different insights about the rotational moulding method. This insights had been also considered in combination with the findings. (Dan Hill plast A/S)



GUIDELINES

- Wall thickness can vary from nominal by +/- 20%.
- Minimum wall separation of 5 times the wall thickness.
- Sharp corners should be avoided if possible.
- Avoid flat walls. If this isn't possible it is recommended to add kiss-offs, reinforced ribs or a crown.
- The plastic shrinks and therefore draft angles are not necessary for small structures.
- A secondary process might be added to implement thread or other details.
- Wall thickness should between 3-10mm.



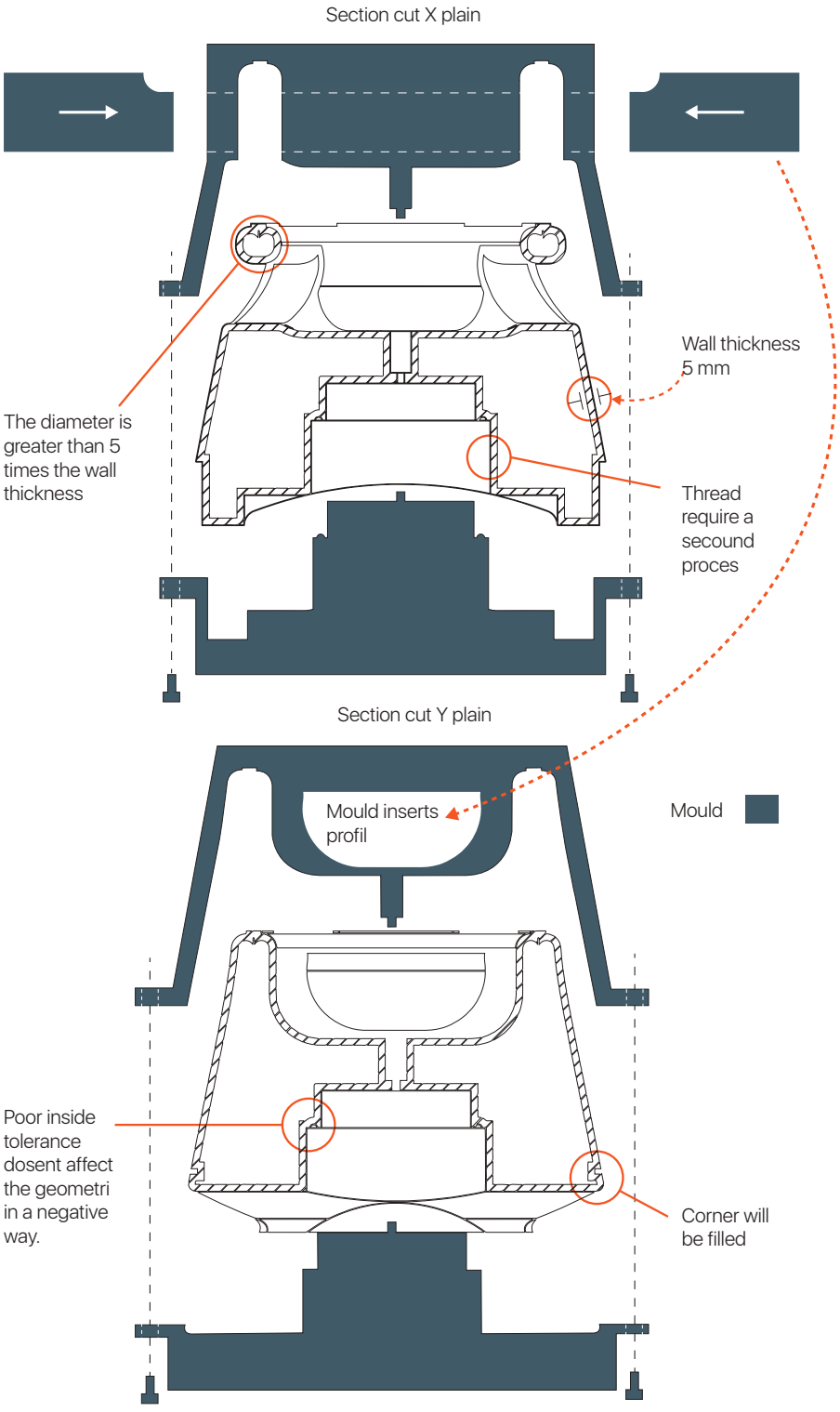
// OUTCOME

- Foam injection needs a secondary process.
- Thread applies the third process to the product.
- Rotational moulding might be replaced by another process when the production reaches above 3000.
- Moulds might consist of more than just 2 parts.
- Guidelines need to be taken into consideration.
- Polyethylene is easy to manipulate in rotational moulding

TOP PART

Applying guidelines and knowledge from Dan hill plast, into the product enables the team to understand critical areas and how to fix them. Few critical parts will be taken into consideration and mentioned in the reflection.
As shown with a section cut illustration in the X and Y plane, is how the team see specific difficulties and how some of them could be solved. Starting from the top and down.

Creating the handles will be a difficult task, since there is a need for a metal frame inside to ensure it doesn't break off several times of use. Therefore the frame needs to be attached to the mould. The frame will be detached after the foam injection process and the foam has hardened. This makes the metal frame stay on its position and adding strength to the product. Secondly, space might be a problem inside the handles, for the fluid plastic to run trough freely, because of the metal frame.



The thread inside the top part is also called an "internal undercut". This is when some specific geometry is needed inside the product. In this situation, the thread is needed to close off the hardware room, where MCU, Batteries, Altimeter and the hydrophone is located. An internal undercut is not possible to create in this situation. Therefore a secondary process is needed. The cut could be created with a cutting process like CNC drilling or turning. There are also specific treading processes that can provide thread as an internal undercut, but the process itself is very similar to CNC turning.

Sharp corners inside the product will not stay sharp after the rotational moulding process since the plastic will generate a filled instead. This doesn't ruin any assembling or details since it is only inside the product. The outside of the product will stay as it is meant to be.

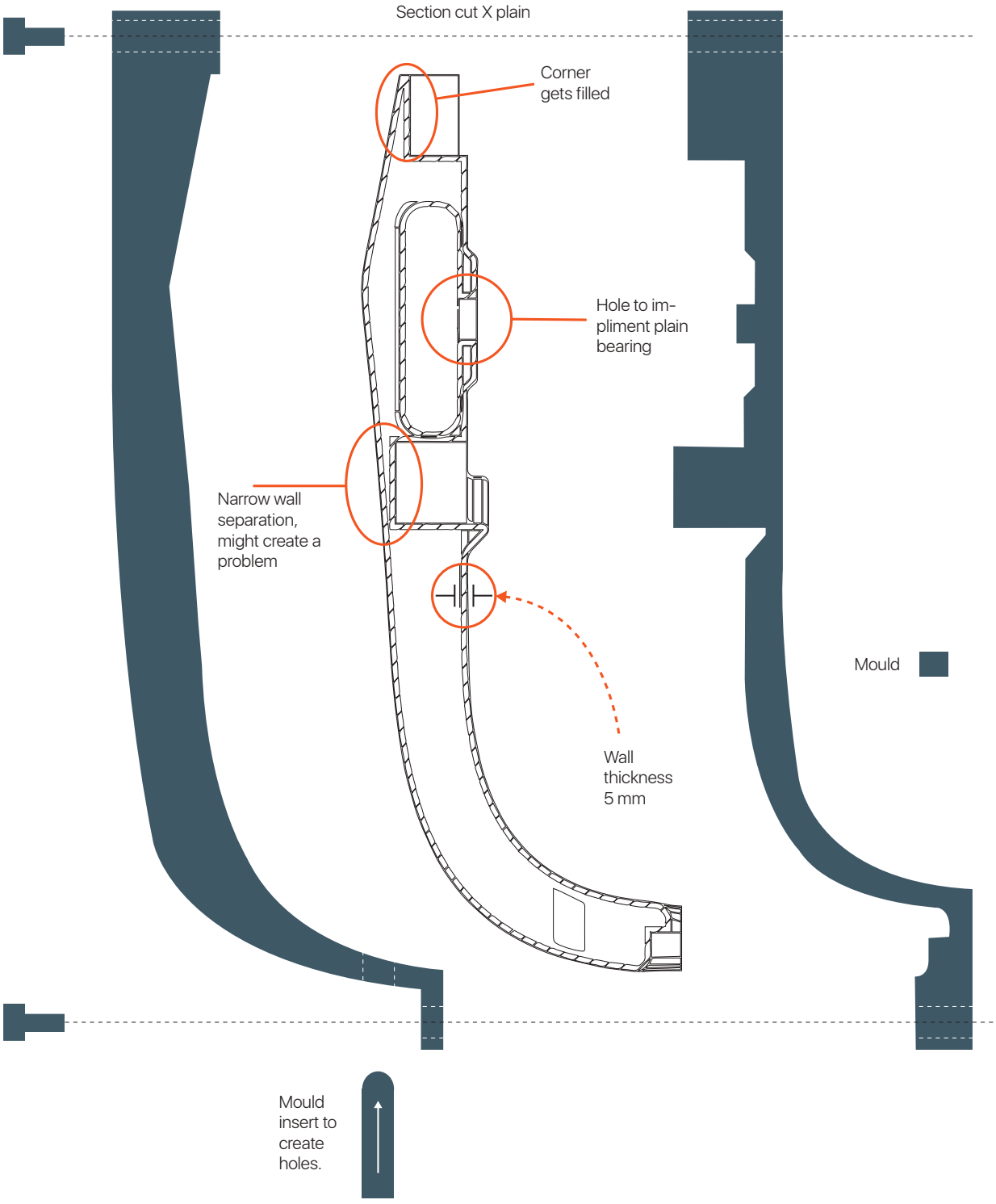
The mould should contain a hatch to enable the foam infill right after the rotational moulding process. This will give the manufacturer access to drill a small hole in the wall of the product which is 5 mm ± 20%. The wall thickness shouldn't be thicker since the foam inside is going to provide the strength.

In order to assemble the top part with the lower part, 4 holes are created to implement screws. These holes are created by the top mould which contains the inverse geometry that's needed to create the holes. Thread in the holes is not needed since it should be implemented on the metal inserts that are going to be implemented in the product as shown underneath the construction.

LOWER PART

The lower part has a lot of critical and narrow wall separations. This can create problems in order to let the plastic flow freely through the geometry. This is only a problem in this specific section cut. The same plastic can run through the sides of the product lower part and thereby cover the whole surface. But further optimization would be needed in the future to ensure minimal risk of failure. A solution could be by changing the wall thickness or by implementing a kiss feature. This also provides an even stronger structure.

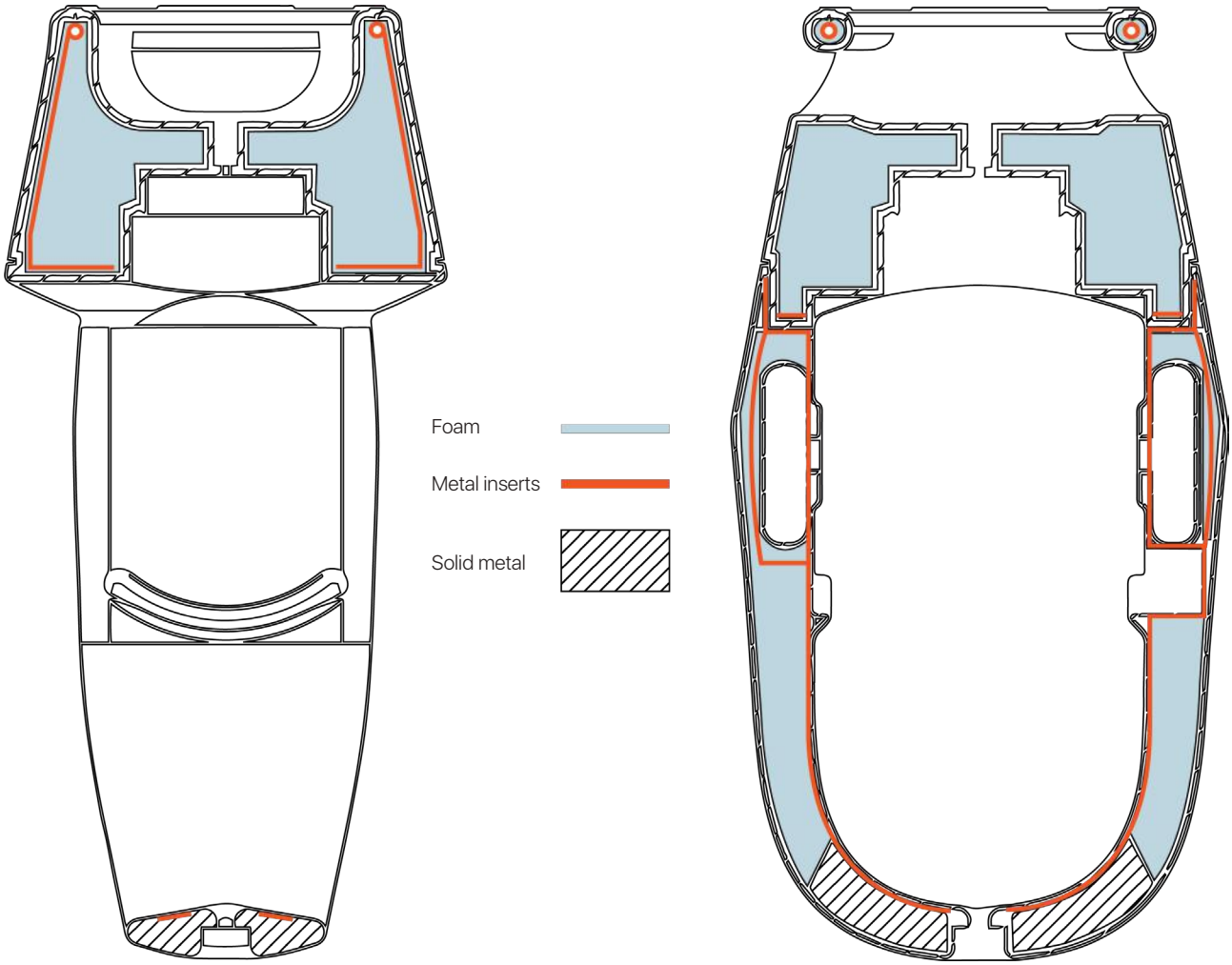
The lower part should also contain the possibility to implement plain bearings in order to let the cable reel rotate freely. This is mainly going to be attached to the metal inserts to ensure the right tolerances. Behind the position of the plain bearing, there is going be a small wall to prevent the water to enter the plain bearing. This wall is going to be 1 mm and can be a critical area of this part since no pressure will be added. This could be fixed by adding a bit to the product width.



CONSTRUCTION

The construction as shown underneath is a very lightweight construction. It is mainly build up by a plastic shell which is foam injected. To strengthen the critical areas of the product, metal insert have been implemented. These are placed as shown in the illustration. It is mainly to strengthen the handles and the assembling of the parts. The metal insert is going to be attached to the moulds inside with removable joints. After the foam injection, these joints get removed and the metal inserts stay on its position.

To get a visual volume distribution the product is built with a bigger top than a bottom. This is done to give it a direction and a feeling of how it is going to float in the water. The top is the part with the biggest volume and just underneath is the position of the cable reel. These two parts are dominating and could give unbalance in the weight distribution, which is something the team has to take into consideration when optimizing for the human interactions.



Looking a bit more into the weight of the product. The top part should be the buoyancy of the product. If we look a bit into the calculations we found out that the weight of the top part exclusive batteries and hardware is 1.9 kg and the buoyancy force is 64 N (A51). This means that the product will pull upwards with 4.5 kg in salt water. This is enough force to make the cable reel unload itself on its way up. Since the product doesn't pull more than this it doesn't create any problem regarding the first creel since the weight is around 14 kg.

The lower part of the product should react more like an equalizer for the rest of the product. This means that metal insert, cable reel and the release mechanism should reach a weight of 2.6 kg. Looking into the calculations, the weight of the lower part is 1.4 kg exclusive the cable reel, release mechanism and metal inserts. The lower part has a buoyancy of 42 N.

The overall weight of the product will reach around 6.9 kg. With such weight, it is safe to say that the product doesn't violate the rules of how much such a product is allowed to weight.

CHOICE OF MATERIALS

DIVINYCELL H (A55) is a foam material which has very good mechanical properties and is made as a core material in sandwich constructions. The material is widely used within the submarine as a way to make it lighter and stronger. It has low water absorption, shock absorbent, low weight and excellent fatigue properties. Looking into this material provides even more knowledge since the material comes in different types. The DIVINYCELL H100 (A55) also delivers a compressive strength of 1.65-2 MPa. This is more than enough to ensure that the product doesn't collapse when getting exposed by the 14.87 atm.

PE is a plastic material which is widely used within the marine environment, because of its very good mechanical and chemical properties and the possibility to get recycled. The material is used to create bottles, pipelines, toys and food containers. This material is cost-efficient and very popular within the rotational moulding industry. HDPE is a stronger version of the material and could be an excellent chose in our situation but this material is not as resistant against shocks, blows and falls as the MDPE. (HDPE-plast, plast.dk) MDPE has greater resistance against stress cracking since it is more ductile. This property becomes very important since the product properly is going to be exposed to a lot of shocks, as an example being thrown.

Stainless steel is a good choice and very popular within the marine industry. It provides high strength and has a good resistance against corrosion. But in some situations, it cants withstand the high corrosive environment off-shore. Specific stainless steel alloys provide extra resistance. UNS S32760 is a duplex (a mixture of austenite and ferrite) alloy stainless steel. It has excellent resistance to general corrosion in chloride-bearing environments. Furthermore, it also provides good weldability.

Dyneema is an Ultra-High Molecular weight Polyethene (UHMWPE) rope and is well known as the worlds strongest fibre and its strength to weight ratio. It has nearly the same density as water (0.97g/cm3) which makes it float on top of the water. Dyneema is widely used within the marine industry because of its exceptional properties. Dyneema is stronger than metal wire, it is flexible, very low elongation and if it breaks, it breaks in a much more controlled and safe way. A 4mm Dyneema rope has a tensile strength that can resist a pulling force of 690 kg. Looking into the worst scenario possible would be 150m with a creel attach every 10 meters. The weight of one creel is 14kg, which is 210 kg above water. A 4mm Dyneema rope will be more than enough.

MARINE BIOFOULING

The group contacted Claus Erik Weinell from DTU Chemical engineering, who works with anti-fouling coatings. According to his thoughts on the field; In order to reduce the biofouling, the surface tension would need to be as lower as possible. By using the MDPE plastic there should not be any problem if the product will be used a whole year. But, in case the product needed to be used longer without maintenance, there would be a need for considering the use of a coating on the product. In this case, there will be a large variety of options.

// OUTCOME

In order to keep up the reliability, there is a need for cleaning the product one per year. But in complex areas, the option is to spray a nano coating on the component in order to get a lower surface tension and therefore, reduce risks.

6.2 PRODUCT REQUIREMENTS

Along the project there had been appeared different requirements to be considered for the product. These appeared from different findings got in either interviews and continuous research on the topic. These requirements are divided mainly into two sections. On the one hand, there are the requirements which come from the user and refer to the user needs which for the product to fulfill depending on their importance. On the other hand, when entering into the development of the product, there had appeared new requirements, mainly technical, which the product needs to fulfill to permit the product to perform as wanted based on the context of use and usability.

TABLE OF REQUIREMENTS

Whishes

No.	Reference	Reference	Importance (1-5)	insights
1.	User	Ease of attachmemt	3	A42
2.	User	Reliability	5	Observation
3.	User	Shape: don't roll around the boat	2	Observation
4.	User	Right size to be manipulated by individual user	1	Observation
5.	User	Avoid risk of misplacement	4	A39
6.	User	Interaction simplicity	3	A41, A42, A45, A46
7.	User	Ease of system reload	3	A31
8.	User	Smaller that distance between hand and floor	1	Observation
9.	User	Able to be retrieved from different distances	2	Observation

Demands

No.	Reference	Metric	Unit	Marginal value	Ideal value	insights
1.	Product	Unit weight (Fit to regulations)	Kg	<11	-	A58
2.	Product	Visibility	Meter	0<	<150	A38
3.	Product	Battery life	Years	1/2	1	A53
4.	Product	Release operational range	Meter	>150		Findings
5.	Product	IP certificate (Electronic box)	Binary	IP69	IP69	Findings
6.	Product	Resisntant to seawater corrosion	Binary	-	Yes	Findings
7.	Product	Shock and vibration resistance	Binary	-	Yes	Findings
8.	Product	High preassure resistance (Electronic box)	Binary	-	Yes	Findings
9.	Product	Resistance to marine biofouling	Binary	-	Yes	Findings

Business 7.0

This section unfolds an exploration into the competition for Seaus and an overview of the business plan that could be implemented for the product. Furthermore, it will be explained the considerations into the cost of the product and the scalability of it for future sales opportunities.

// OUTCOME

Permitted the group to take considerations from the competence products in order to find how to create more value on the seaus product. Furthermore, permitted the group to build up an overview of the business plan in order to have an idea of could be the Seaus work from the starting point and with a view on the future.

// NEXT

Take consideration on what would need to be re-think to make the seaus product as valuable as possible for its future development.

7.1 COMPETITIVE ANALYSIS

After the investigation in technology possibilities, we came across four competitors who all using acoustic releases. None of these products is specifically designed for the scenario of fishing with a large number of creels on a single line. But instead, they can be used for large single crab creels or other types of marine equipment. Like water quality monitoring. But because of the similarities to our solution, we considered them as competitors. In general are their products meant to be bought at a high cost and meant to have a lifetime above 3 years. This requires that the user is maintaining the product and keep them clean for biofouling. In terms of the product price it only possible to find a price on the products from Desertstar company.

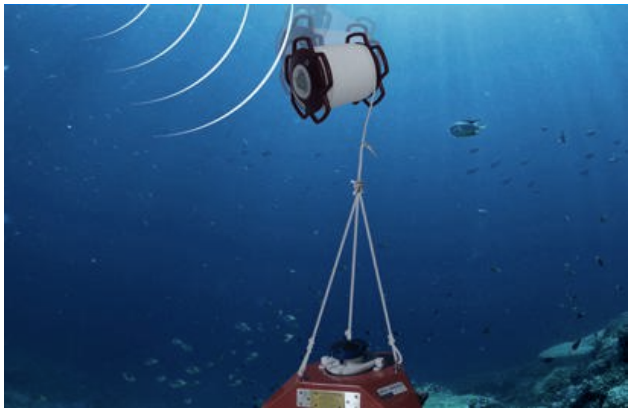
DESERTSTAR

Desertstar is a small company who has existed since 2011 which develops ropeless fishing equipment for lobsters to prevent whale entanglement. The white tube is the acoustic release product which is connected to the bag with a rope which is mounted on each creel. Their solution to retrieval from water is two floating buoys with a line between them, where a small anchor is needed, makes it possible to haul in from large boats. This product could maybe fit the fishermen with a small capacity of creels. But the purchase price of a single release unit is approx. 6500 DKK without the rope bag. The reloading process is a series of complex tasks and needs to be done every single time, which will not support a fisherman with a capacity of 800 creels. The picture above shows one of the procedure to reload the product.

MOORING SYSTEMS

This product is designed for ocean analytic equipment and was developed in the 1990s making this system the longest in production than any other product on the market (Mooringsystems, 2019). The ellipsoid buoy is molded in high strength urethane and is compatible with the acoustic release module from Edgetech. The retrieval of this product, from a large fishing vessel, might be a difficult task in restless water. In this case, there will be a need for a boat hook.

FIOMARINE

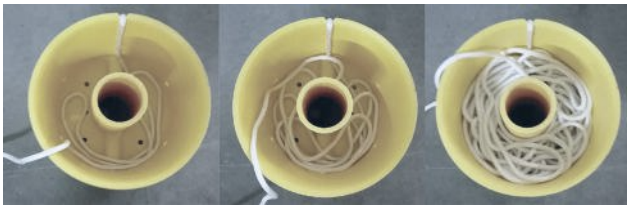


This product from Fiomarine has a versatile design. It can be programmed to release after a specific amount of time through inferred cable. The releasing mechanism is a magnetic solution which eliminates the risk of getting stuck over time. In the case of retrieval, it could be similar to the product from Mooringssytems.

EDGETECH

Edgetech states them self as the leading provider of acoustic releases since 2012 (Edgetech, 2019), but have existed since 1995 as a private company. This product has full transponder capability so by using the acoustic transceiver you will be able to know the location. When it comes to retrieving this product it has the smallest attachment possibilities in terms of a metal ring.

The product is released by a servomotor which rotates a threaded rod until it is disconnected and then it will pop-up to the surface. Edgetech has developed a semi-modular system with these cylindric canisters. They have different variations which can be applied to the pop-up product in order to meet different needs. Such as longer battery life and depths.

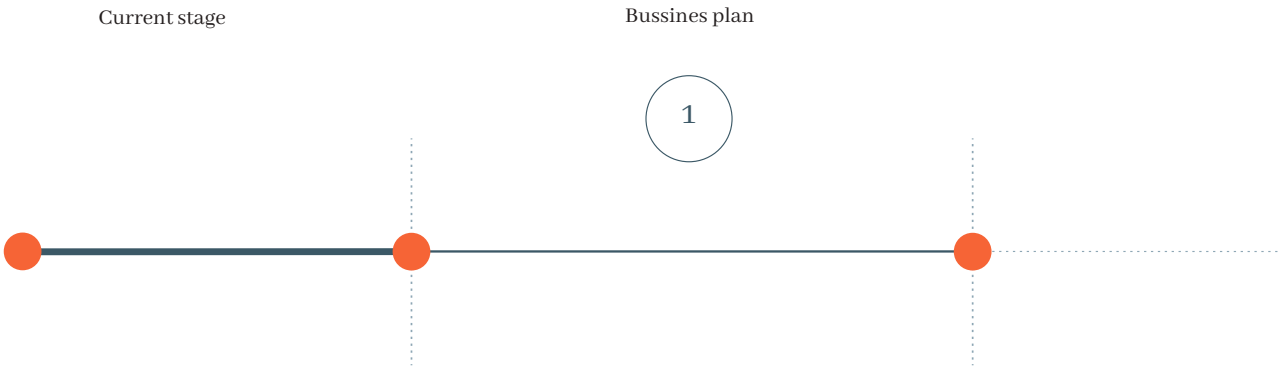


In their product manual, they have a guide on how to load the product. They warn you not to coil the line around the center post due to it could get tangled during the release (Edgetech, 2019).

//OUTCOME

The use of acoustic release technology is approved and within the space of approx. 540 cm2, there is enough space for the hydrophone and a battery capacity life up to 5 years.
Our findings from the "rope unfolding test" (A36) are similar to the solution from Fiomarine. The competitor's products can probably help in a lost gear scenario. But these products are designed for a single creel or another marine object. In general, they are not facilitating the user, when the reloading is needed. In order to achieve two of our value vision goals, reliability, and sustainability, we have the option to consider a subscription-based business model to keep up the maintenance of the product. Which also will differentiate us from the competitors as a service instead of the comparison of the individual product.

7.2 BUSINESS PLAN



The previous line offers an overview of the business strategy that would be followed by Seaus, from the current state in which the group it's right now to the business plan for the next step to finish the development of the project and with a future vision of it. All these stages are defined below:

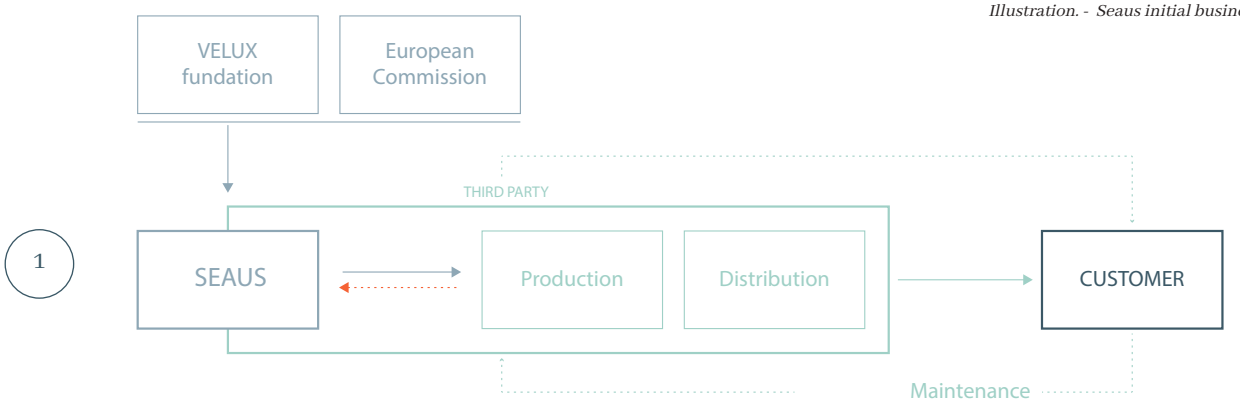
BUSINESS STRATEGY OVERVIEW

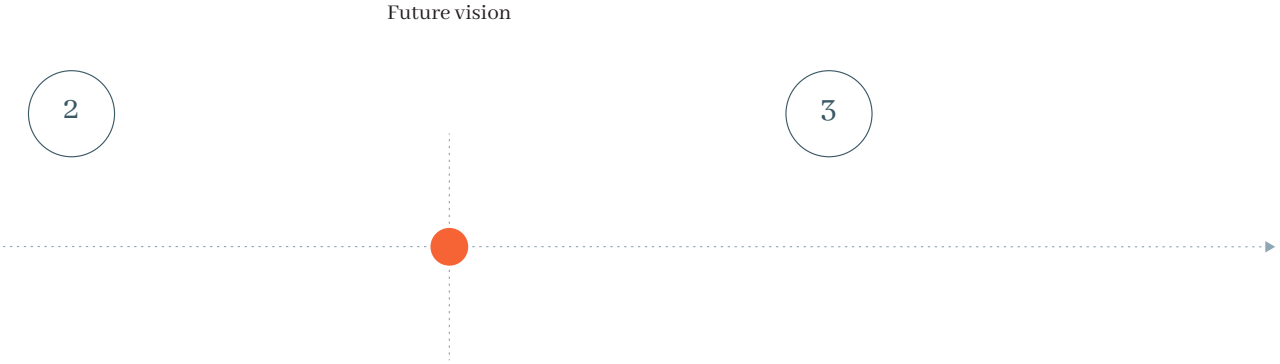
The business plan has been set up considering the stage in which Seaus it's currently and the future vision of it. At the first stage, the team has considered the lean business approach. This approach has been taken as the direction to follow due to Seaus is a starting company in the field and so, the resources to get into the market and for production wise are lower than an already established company.

From this point, the group considers a model in which Seaus, when reaching the manufacturing stage would get fundings to go further with the development of the product. The Velux foundation, which offers funds for products which have sustainable solutions for the marine environments (veluxfoundations.dk) and the European Commission, which also offers funds for projects developing sustainable solutions in the fishing industry (European maritime and fisheries fund (EMFF) Denmark).Furthermore, Seaus would collaborate with a third party company which will provide with the needed resources for production and distribution of the Seaus product which would be placed in their catalog of products. In that scenario, Seaus would be in charge of the final development of the product and future improvements on it. Then, it will be as a B2B business.

The selling strategy could be driven by offering a rental subscription plan which would allow the customer to buy the service that offers the Seaus product in addition to a maintenance plan for it. This strategy has been seen as an opportunity as it's already been used in companies providing fishing equipment for commercial fisheries. This strategy was taken into consideration as an opportunity to increase reliability. The overview of the plan it's illustrated in the following illustration:

Illustration. - Seaus initial business strategy





FUTURE VISION

The next vision of the business strategy it would be based on a model in which on the one hand, Seaus would have their own headquarters with the required production resources for the product. And, on the other hand, the product would be distributed by third-party companies which would buy the product directly from Seaus and would sell it to their customers. In that case, Seaus would also be in charge of the periodic maintenance of the products.

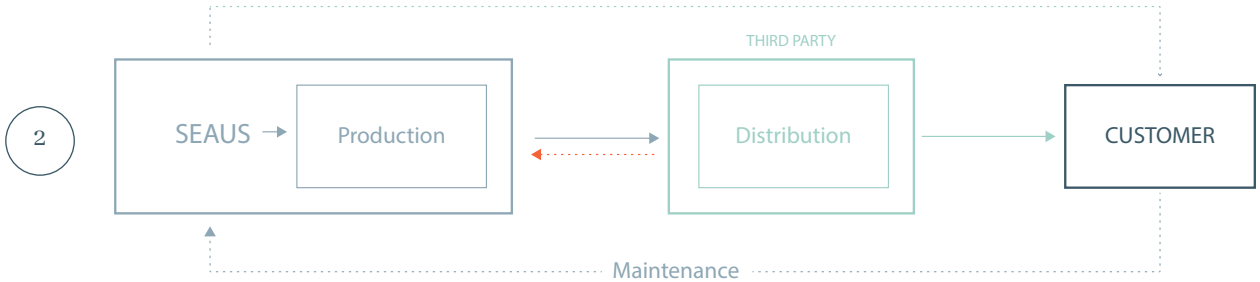


Illustration. - Seaus vision business strategy

finally, the vision for the company when already established in the market would be based on following the previous model but Seaus also being part of their distribution platform. This would be done in that way due to the team considers that by this point, Seaus would be known by the customers and it would be feasible to get in contact directly with them.

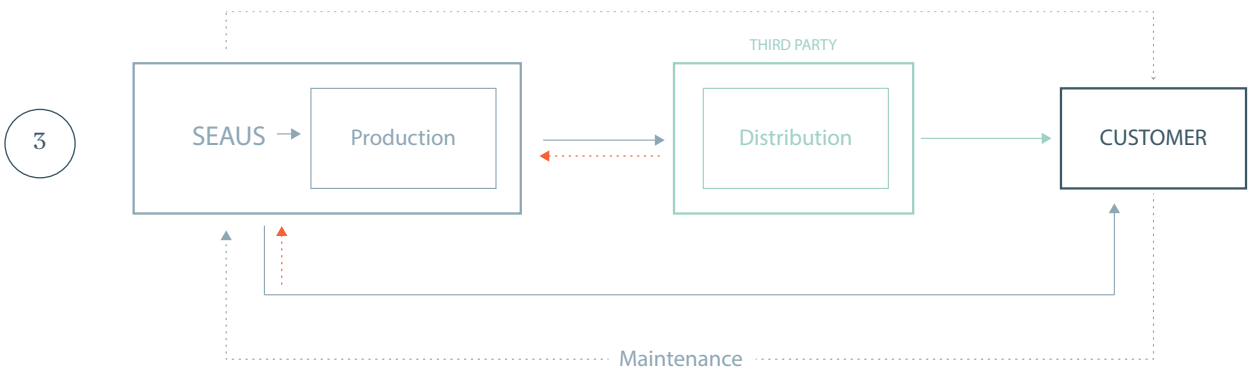


Illustration. - Seaus final vision for business strategy plan

7.3 BUSINESS MODEL

Key partners

Hvalpsund net:

- Manufacturing
- Software development
- Marketing & distribution
- Networking

Key activities

- Design development
- Prototyping & testing
- Technical development
- Manufacturing
- Software development
- Marketing & distribution
- Networking

Key resources

- Office space
- Design engineers
- Manufacturing & prototyping resources
- Material resources
- Software engineers
- Marketing specialist

-Network

Value Proposition

Innovative device for
lobsters fisheries wh
chance to retrieve los
from the seabed. Fur
extra expenses for fis
of these and prevent
litter and ghost fishi
lost fishing gear usin
technique.

- Second chance to re
entangled creels.

- Reduction of added
for new gear in case

- Prevention of the r
once the creels get lo

- Prevention of risk o
underwater marine l

- Innovative and fitti
solution for the com
industry.

- Simple interaction

Cost Structure

- Production
- Distribution
- Human resources

r commercial crabs &
ıich offers a second
st or entangled creels
thermore, reduces the
shermen in case of loss
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of lost of creels.

isk of ghost fishing
ost.

of unreported
litter.

ıng the regulations
mercial fishing

for fishermen

Customer Relationships

- Personal assistance in partnership company (one to one)

- Online partnership company webpage support.

- Via phone call with partnership company

- via partnership company mail

- Official product website

Channels

- Partnership fisic and online fishing equipment stores (Ex.Hvalupsund net)

- Governamental fishing associations

- Regional fishing associations

- Official product website

- Exhibitions for fishing equipment

Customer Segments

European, American & Canadian fisheries associations

Large commercial crabs & lobsters fisheries companies

Autonomous commercial crabs & lobsters fishermen

Revenue Streams

- Seasonal rental subscription

CUSTOMER SEGMENTS

The customer segments for the Seaus business it will be based on a defined niche market, the commercial crabs & lobsters fishermen working with the technique of the use of a long line of creels. It has been found that they either can have their own company, working as an autonomous or instead, work for a large company in this sector. In that scenario the costumer would be more focused into these large companies to protect their gear and reduce risk of losing money. Therefore, also the fisheries associations would be a segment Seaus would consider as it could create an opportunity to introduce the Seaus product as a new regulation for the crabs & lobster fishing with creels technique.

VALUE PROPOSITION

Innovative device for commercial crabs & lobsters fisheries which offers a second chance to retrieve lost or entangled creels from the seabed. Furthermore, generates extra value for these fisheries by reducing the extra expenses for fishermen in case of loss and prevents the risk of marine litter and ghost fishing from lost fishing gear using this fishing technique, which permits fisheries position themselves as sustainable companies to compete into the market.

- Second chance to retrieve lost or entangled creels.
- Reduction of added fishermen expenses for new gear in case of lost of creels.
- Prevention of the risk of ghost fishing once the creels get lost.
- Prevention of risk of unreported underwater marine litter.
- Innovative and fitting the regulations solution for the commercial fishing industry.
- Facilitated interaction for the fisherman

CHANNELS

The channels section for the Seaus business plan would permit the introduction and expansion of the product into the different customer segments. These channels are planned as a starting point marketing strategy for the Seaus to expand the business but, these could variate along the iterative process adhering to the lean approach used for the Seaus business strategy.

CUSTOMER RELATIONSHIP

In this section are unfolded the different customer interactions with Seaus and partnership through the sales and product life cycle. Most of them are related to the maintenance of the product and the ways to make this possible.

REVENUE STREAMS

In this section, the group has described the different sources from where Seaus and the partnership company would get the financial gain. This would come from two main sources:

The seasonal rental subscription offers the user to rent the Seaus products needed to use during the fishing season and maintenance service during this period. Furthermore, it offers the possibility of a replacement for a new Seaus device in case of needed maintenance from any of the rented products.

The second revenue stream it's based on a direct sell of the Seaus product to the customer but maintaining the maintenance service in case of needed.

KEY PARTNERS

This section refers to the external companies/suppliers/parties the Seaus group needs to achieve our key activities and deliver value to the customer. As it has been mentioned before, the first stage of the business of Seaus would be based on a collaboration with a partnership. This partnership could be Hvalpsund net, a company working in the field of the development of commercial fishing products. This company would have the needed resources which the Seaus would need to complete all the key activities. These are mainly based on the manufacturing, software and marketing resources.

KEY ACTIVITIES

This section shows the activities the team would need for the development of the product. These activities are focused on different areas needed to work with for the product. Most of the development activities would be done by the group and the other activities such as software development and marketing would be developed by our partnership

KEY RESOURCES

The key resources are all the resources needed to perform the key activities. Into these, also appear the different resources needed by the partnership. As an example, for our product, the team would need a software engineer to work into finding the best software solution for our product. Also, a marketing specialist would be needed to introduce our product into the market as well as the networking to reach more clients.

PRODUCT PRICE

Looking into the price and the cost of the product, the group has considered an estimation of it due to at the stage on in which is the product, there would be different things which would need to be considered in the next stage of the development of the product which may affect this costs.

When the group visited Hvalpsund net, got the feedback on that the overall quantity of creels used for vessel fishing with creels in Norway per vessel was 800 creels. Also, the group got information that for each creels setup, there were around 80 to 100 of creels and that the price for each creel is 955DKK, which can last up to three years. Furthermore, after an interview with Rikke Fransen (A05) the group got the insight on that the best solution would be to place one in each end of the creels setup.

All these findings permitted the group to have an estimation of 10 setups per vessel fishing with creels in Norway. Which would mean 20 of the Seaus products, two per setup. Moreover, from previous findings, it was found that in Norway 10-30% of creels get lost for each season. This means that as minimum fishermen may lose around 80 creels, which means 75.000DKK. And, in the worst scenario, they can lose up to 240 creels, which would be 230.000DK.

	Best scenario for fishermen	Worst scenario for fishermen
% lost creels	10%	30%
Expenses	75.000DKK	230.000DKK

The vision Seaus was to make the most as possible profit for fishermen by using our product. For it the price of the product needed to be reasonable to make this possible and therefore, to have a price reference for the product to develop.
So, the unit price for each product was set up on 9550DKK. This price would be the higher price the product could be in order to permit fishermen to gain profit even in the case they just lose 10% of their equipment in one season. At this point, Seaus considered a subscription plan for our product:

	Seasonal subscription
Includes	+ Seasonal renovation + Maintenance coverage + Fast replacement
Price	3183* DKK/unit

* Prices of unit per seasonal subscription

PRODUCTION COST

The group has considered the production of 2.000 units for a starting point, which would fit for selling our product to an overall of 200 vessels fishing with creels in Norway.

From this, in order to define the cost of the product it has been taken into consideration the price of the mold, the raw material needed, the electronic components and extra components of the products, which basically it's the Dyneema rope and the extra ropes for the bottom handles. With all these considerations and the required calculations (A52) there was estimated a unit production cost of 3600DKK. This would result in an investment of 7,1 million to produce 2.000 units.

Selling one product there would be a unit profit per sell of 5900DKK. But, this could variate on future adjustments of the product price in further development. This profit would result in a revenue of 19,1 million and a total profit of 11,9 million DKK. Finally, the break-even point would be reached after selling 1190 product units. (A52).

7.3 SCALABILITY

The Seaus product has been developed focusing it into a specific field and specific problem. Nonetheless, The group has also taken into consideration the possible scalability of the product for other uses, permitting to expand the business possibilities of it in the near future. That scalability could slightly variate the features of the product depending on the specific field of use and the requirements for it.

The different fields that the group has considered to scale up the seaus product sale in the near future are:

- Tracking buoy (GPS integrated) for the fishing industry
- Marking buoy in case of boat sink.
- Recreational fishermen retrieval (Scaled down).
- Retrieval of underwater marine litter
- Oceanographic sensors recovery.
- Prevent vandalism for fishermen's gear.
- Rope-less fishing device (In permitted countries)

Summary 8.0

This section will provide a conclusion on the project that has been developed for the last five months and an overall reflection upon it. Furthermore, there is a more detailed reflection from the group upon different solutions that would need to be reconsidered for further development of the product.

8.1 CONCLUSION

The Seaus product has been developed from a starting point by setting up a strong foundation based on a wide research and multiple findings from it. This has permitted the group to ease the decision making along the process. The project has been developed through a collaborative design exploration which has included Interviews with professionals working in the field of interest, visits to the working context, continuous research on the field, learning from the findings, and iterative development.

At the early stage of the project the first findings provided evidence that even though there was an existing concern of the problem of marine littering, there were not many actions to reduce it or to start to solve the sources of it. The reason for it was understood by the group after observing that the responsibility of the problem was not clear by none of the stakeholders involved. This made the group realize the difficulties to create a business case and therefore motivated the group to find a way to approach it.

After continuous findings and by using the Lean thinking approach of build, measure, learn, the group was able to approach the problem from another perspective and to dive into finding a solution of the causes instead of trying to solve the problem as symptomatic treatment. At that point, the group ended up exploring the commercial fishing industry, specifically, the creel fishing method. Diving into this field, the group reached a point in which was able to identify the problem and therefore to formulate the working problem statement: "How can a physical product give the creels fishermen a second chance to return their gear, and prevent the risk of “ghost fishing” and marine litter?"

From this statement and with further findings on the field the group was ready to set up the vision of the project. This vision has consisted into involving the fishing industry into the United Nations future environmental goals regarding the marine environment in the fishing industry and therefore, contribute taking action against marine litter. This vision permitted the group to achieve a goal which solves either the cause and the problem in this field.

The result of it is "Seaus ess 1.0", a retrieval solution for lost gear in the fishing industry fishing with creels. For the product development process, it has also been used the build, measure, learn method. From initial ideas, through continuous findings, visits, and insights from interviews with potential users. This has permitted the group to accomplish the team mission, to create a product to be implemented in the current creels fishing method giving the fishermen a second chance to return their gear and therefore preventing marine litter and ghost fishing.

8.2 REFLECTION

PROCESS

Looking back to the process it has been experienced that the research stage took a big amount of time to discover the core problem and define it. One the one hand this helped the group to have a clear understanding of the frame of the problem to solve and was useful for the next stages of the process to make decisions upon the concept of the product. But, on the other hand, reduced more than expected the time for the development phase, which made the group need to move faster this phase. According to this and even considering that the product has been developed trying to fulfill the desired solution, the group considers the seaus product on a stage of a minimum valuable product. In that way, the main focus has been to find the best solution to generate the most value for the user based on their knowledge and the group's learning. Thereby the product would be more optimized for further development.

DATA COLLECTION

To find the right way to get relevant information from fishermen was a challenge for the team. As working in a field in which, them were one of the cause of a problem, in some cases it was difficult for them to recognize or agree in the problem we were working with. This made the group to reformulate the interviews into a direction in were we where working into a product to provide more benefit to them. This also made the group to re-think the way to focus the overall project for a better business case.

IDEATION & CONCEPTUALIZATION

The group worked most of the time of the development phase into ideation on principles. There was a point on the project these principles needed to be implemented into more defined concepts. By this time there still was a need to validate these principles by testing them and implement in the product to define a product architecture. This reduced the time for a wider exploration for the concepts.

CONCEPT SELECTION

The group used a selection matrix to define the concepts to explore. The results determined that the "New buoy" concept was the one which was fitting more the selection criteria. But, the group realized that even though the result, the "in-between" concept also offered the possibility to implement the new buoy. This made the group to use the selection matrix method as a way to define the direction to discard instead, the "Add-on creels". The group considers that the selection criteria at the end of the project had slightly changed from the initial requirements.

PRODUCT

HANDLES

The handles of the product would need to be optimized by testing different sizes and shapes to improve the product interaction. Furthermore, the stress that these would need to endure when in use would need to be simulated to optimize the right structure and materials to use for it. Furthermore, the reload mechanism would also need to be optimized in order to ease the user interaction when reloading the reel. This consideration comes from the group in order to achieve a better solution due to in the current solution, the distance of the hand when holding the reload handle to the rotation axis it's too short, which limits a smoother reload. Furthermore, the angle of the hand difficult this task. So that for further optimization, more distance from the axis to the hand and a more natural hand position would ease this interaction.

RELEASE MECHANISM

The release mechanism would need to be optimized in order to avoid as much as possible complex geometric pieces which would have a risk using the product in the marine environment were biofouling can affect during the time of use. furthermore, strength analysis to ensure the right performance of it would be needed to optimize it even more.

PART CONNEXIONS

The connexions of different parts in the product would need to be further optimized in order to avoid biofouling between parts and therefore, risk of possible failure after being in the marine environment. As an example the rotational part of the reel where there are planar bearings should need be tested to see how it would react after a time in the context and how could that be cleaned afterwards. Furthermore, a test of different materials for this parts might facilitate to find the right solution.

EASE OF RETRIEVAL

The group made a test of retrieval from water by using the unfolding arms to avoid propeller cut-off which succeed positively. But, after getting new insights from a professional fishermen, this mechanism was eliminated from the product because of it's complexity for the context of use of the product and because it wasn't solving the propeller cut-off for the sizes of boat the group was working with. The current mechanism of retrieval uses the same principle as the one for the existing configurations. Nonetheless, the group considers a further exploration into improve this into the product would be needed and therefore increase the value of the product. For it, different configurations could be tested in a real context and then implemented on the final product in order to improve fishermen daily use.

WEIGHT DISTRIBUTION & USER INTERACTION

To permit a correct vertical buoyancy for the product, the weight was distributed along the different parts of it. But, after this consideration, the group realized that this would change the user interaction with the handles. In that situation, the group considered the need for a further optimization of this weight and the handles distribution in order to distribute the weight in the best way to fit with the position of the handles and so to ease the user interaction with the product.

LOCK / UNLOCK OF THE REEL

The reel would permit the product to reach the surface through a rope. But, after the product reaches the surface, the reel should stop in order to tighten the rope from the creels to the product in the surface to reduce the risk of possible entanglement. The solution for it has been considered by using the altimeter and using the needed software parameters to activate/deactivate the solenoid to stop the reel. but, this should be optimized to permit fishermen to deactivate /activate it again when retrieving the creels from water into the boat and deactivate it again to block it when not in use.

OPENING FOR MAINTENANCE

At the stage of the final product, and as being part of the business strategy, the need of maintenance of the product would require a way to open and close the product for the replacement of recharged batteries or, in case of maintenance for electronic parts. For it the group considers this part should be considered to permit just the company to open it by implementing security screws on it.

SOLENOID IMPLEMENTATION

In order to install the solenoid and its wire to the MCU it would require a hole to go through the middle part where is located the solenoid to the electronic box. This hole creates complexity for the production of this part which would need to be further developed in order to make it more feasible for production and its implementation.

8. FURTHER DEVELOPMENT

INFORMATION TAGS

The need of implementation of information tags of the vessels and the owner of the equipment would be one of the further development to be implemented on the product.

REMOTE ACOUSTIC RELEASE

A controller key which permitted the activation / deactivation of the solenoid to lock /unlock the reel would be a further development to integrate with the product and not need to depend from external devices. Furthermore, this controller would permit to be able to select which of the seaus product is wanted to be released.

TRACKING

To permit fishermen to locate their equipment in case of streams and movement of this. There would be a need to integrate it into existing electronic box of the product and re-consider the scalability opportunities this would incorporate to the product.

PILOT TEST

Before the commercialization of the product, the product should be tested in order to validate the performance of it or to continue developing improving features if there's a need for it. This could also be used as a way to spread product knowledge around potential users in the fishery industry.

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39º 34'16.85" N

57º 26'21.90" N

56º 32'24.88" N

ess 1.0

by Seaus

Info

Title	Seaus
Project theme	Lost commercial fishing gear solution
Study program	Msc. INDUSTRIAL DESIGN
Project period	04-02-2019 to 06-06-2019

Project group	MA4-ID3
PARTNERSHIP	HVALPSUND NET
Main supervisor	Kaare Eriksen
CO-supervisor	Jørgen Asbøll Kepler

Abstract

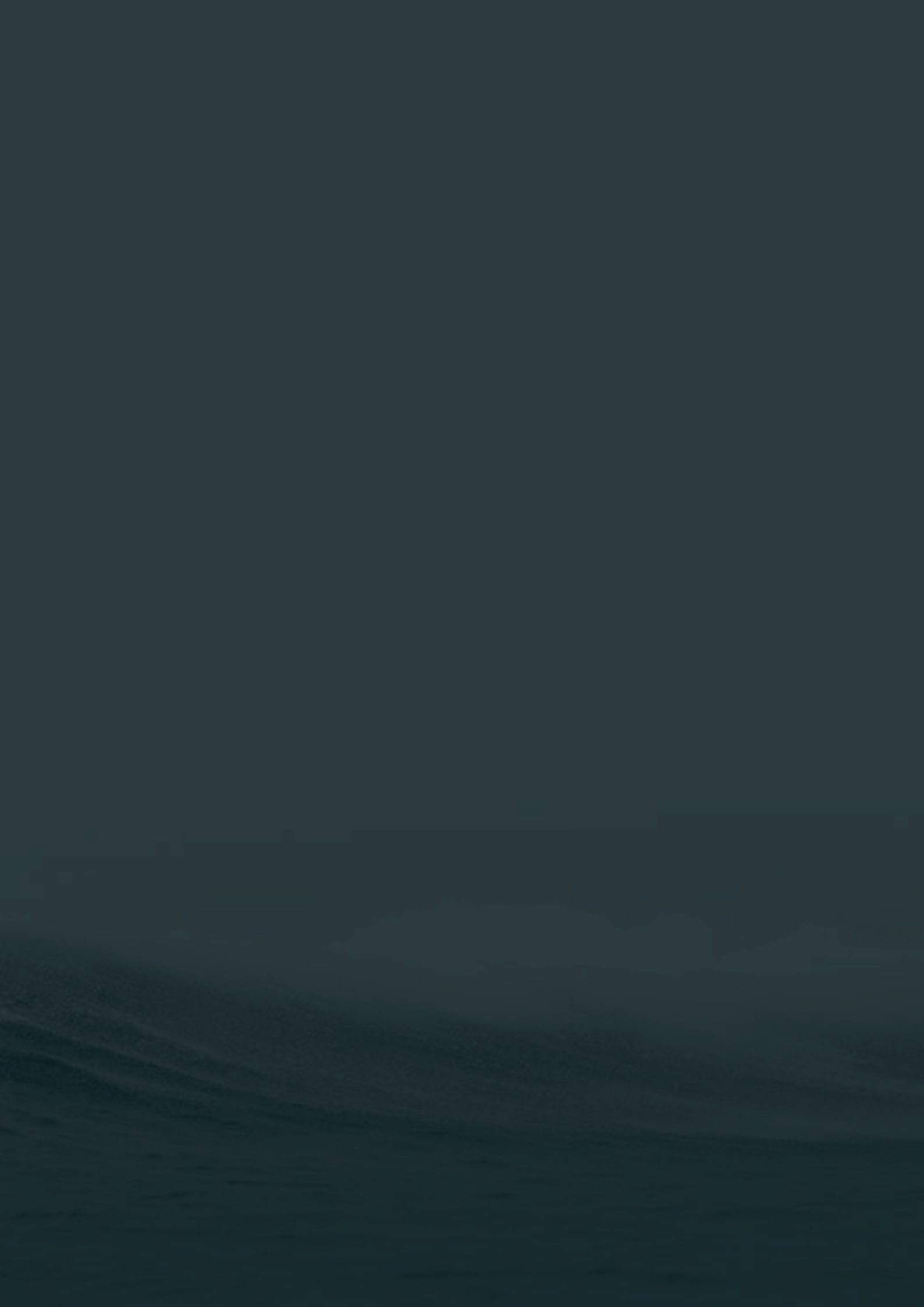
The team of Seaus present a product design which prevents fishing equipment from getting lost within the lobster & crab fishing industry. This project has focused on the environment and is made in collaboration with the fishermen. Seaus believe in a better future within the use of marine resources and the reduction of marine debris. The Seaus ess$^{1.0}$ product gives the norwegien fishermen a second chance to recover their lost equipment from a depth of 150 meters.

Carlos Borrás Juliá

Henrik K. Brogård

Daniel Nørskov Roe-Poulsen

AALBORG UNIVERSITET



lobster fishery.

Around 30.000 lobster creels get lost every season, which corresponds to 10-30% of used creels in Norway. The main causes of this are propeller cut-off and rope entanglement of the marking buoy. These can occur because of bad weather, strong water streams or marine traffic.

equipment loss.

Rough seabed terrains are the most natural habitats for lobsters, these, include large stones, rocks or other elements where lobsters can hide. These conditions in some cases might difficult for fishermen the retrieval of their fishing gear. In case of a propeller cut-off or entanglement of the marking buoys could make the creels to get lost in depths up to 150 meters. This would generate marine litter and "ghost fishing", therefore the fishing spot would become worse reducing future fishermen catch in these spots.

release.

When fisherman returns to the fishing spot it can appear the possibility of experiencing the loss of the marking buoys or a possible entanglement of these in the sea bottom. From Seaus, we want to give a second chance for fishermen to retrieve these lost creels. This would be done by using an acoustic release transponder deck. This unit would permit fishermen to deploy the desired ess$^{1.0}$ which would be already attached on the creels setup. The next page offers a close view of what would happen once the ess$^{1.0}$ gets activated.


Å61722

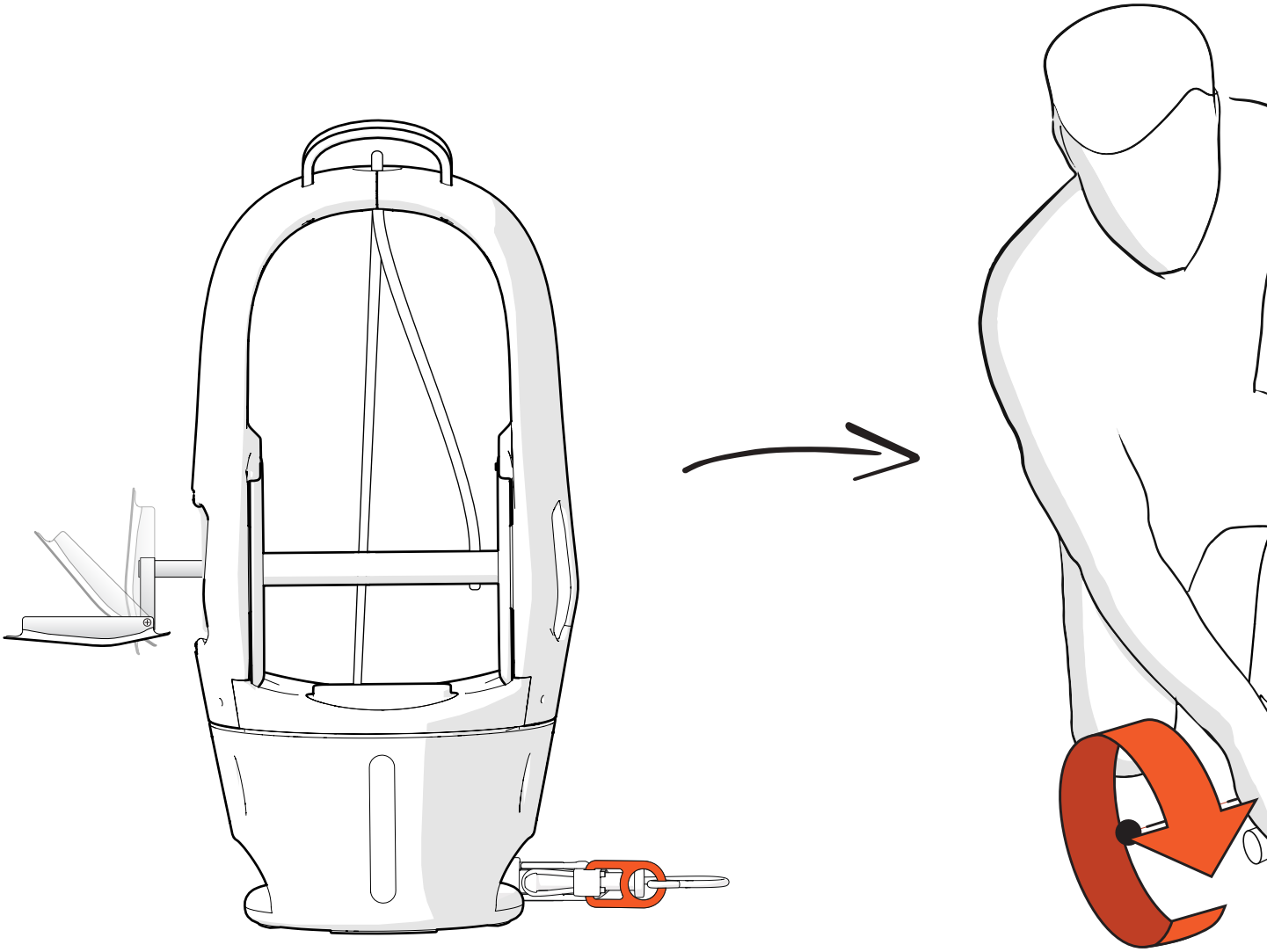
deploy.

The ess[1.0] would be activated and deployed to reach the sea surface and, thereby would permit fishermen to retrieve again their gear. This deployment would be done by using a cable reel which will be unlocked once the ess[1.0] was activated. The product buoyancy would permit to reach the surface.

retrieval.

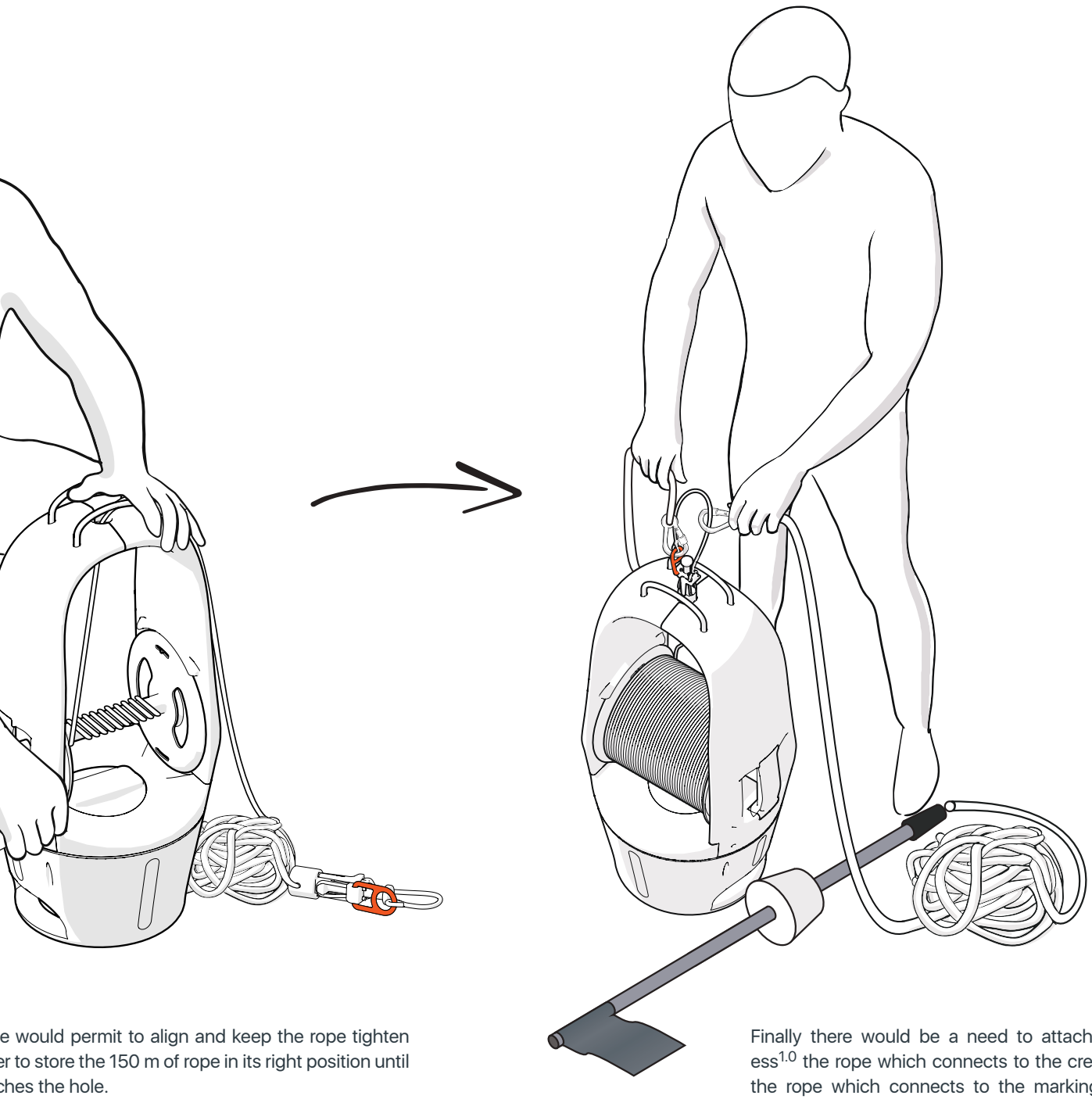
In Seaus we want to consider all possible scenarios. In the case of the ess$^{1.0}$ has not been manually deployed and retrieved by fishermen, the product would do it automatically after a month. This procedure has been considered in case of an emergency if the setup of creels has been forgotten or completely lost. Thereby the ess$^{1.0}$ will be visible and will permit its retrieval for everyone. Furthermore, contact information attached on the Seaus product will permit other fishermen or National fisheries agency to bring it back to its owner.

reload.



After the seaus ess[1.0] has been deployed and retrieved from the water, it will be able to be reused by reloading it. For it, the user would turn the product upside down on the plane surface and tilt the side handle down.

A hole located in the middl
around the cable reel in orde
the release mechanism reac



e would permit to align and keep the rope tighten
er to store the 150 m of rope in its right position until
ches the hole.

Finally there would be a need to attach to the ess[1.0] the rope which connects to the creels and the rope which connects to the marking buoy. then the product would be ready for use.

ess 1.0

"YOUR ACE IN YOUR SLEEVE"

CIRCULAR SEA-GREEN ECONOMY

SUSTAINABILITY

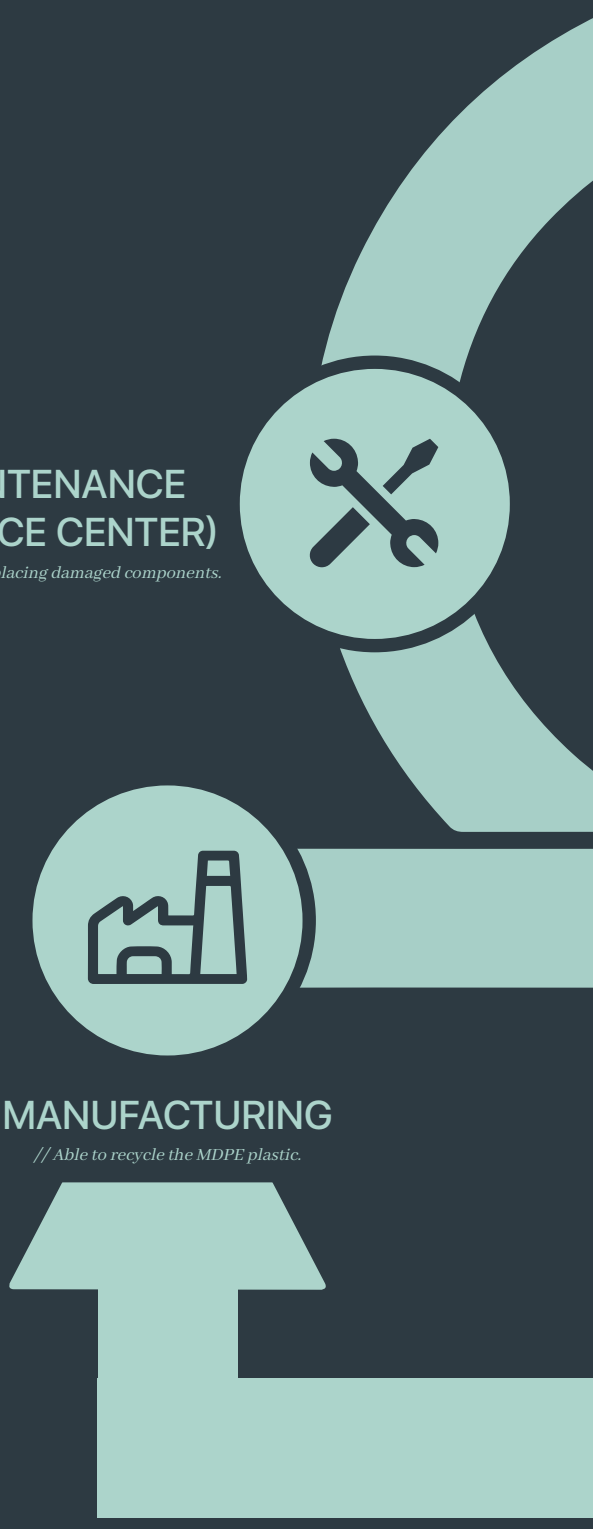
//Seaus has a focus on helping the environment by reducing the non-utilized resources in the ocean and marine debris. It was set as a requirement for the seaus ess1.0 to be as sustainable as possible. 90% of the materials are able to be recycled. In addition, seaus will provide a service team who would take care of every product, so the product would always be ready to use. If a product is declared unusable, the functional parts will be disassembled and reused, while the body will be cleaned and go into new plastic pellets (MDPE).

The vision of Seas would be that the service team is 80% of the full product and the seaus ess1.0 is then only 20%, but it's there to facilitate the process. The team will be at eye level with the fishermen and thereby these will provide seaus with insights to become even better.

SEASONAL SUBSCRIPTION

+ 2x SEAUS ESS$^{1.0}$ PRODUCT
+ SEASONAL MAINTENANCE
+ FAST REPLACEMENT

FROM 6399 DKK/SEASON



FISHING SEASON

GET THE ORDERED PRODUCTS

//The products can picked-up at the nearst service center.

SUBSCRIPTION

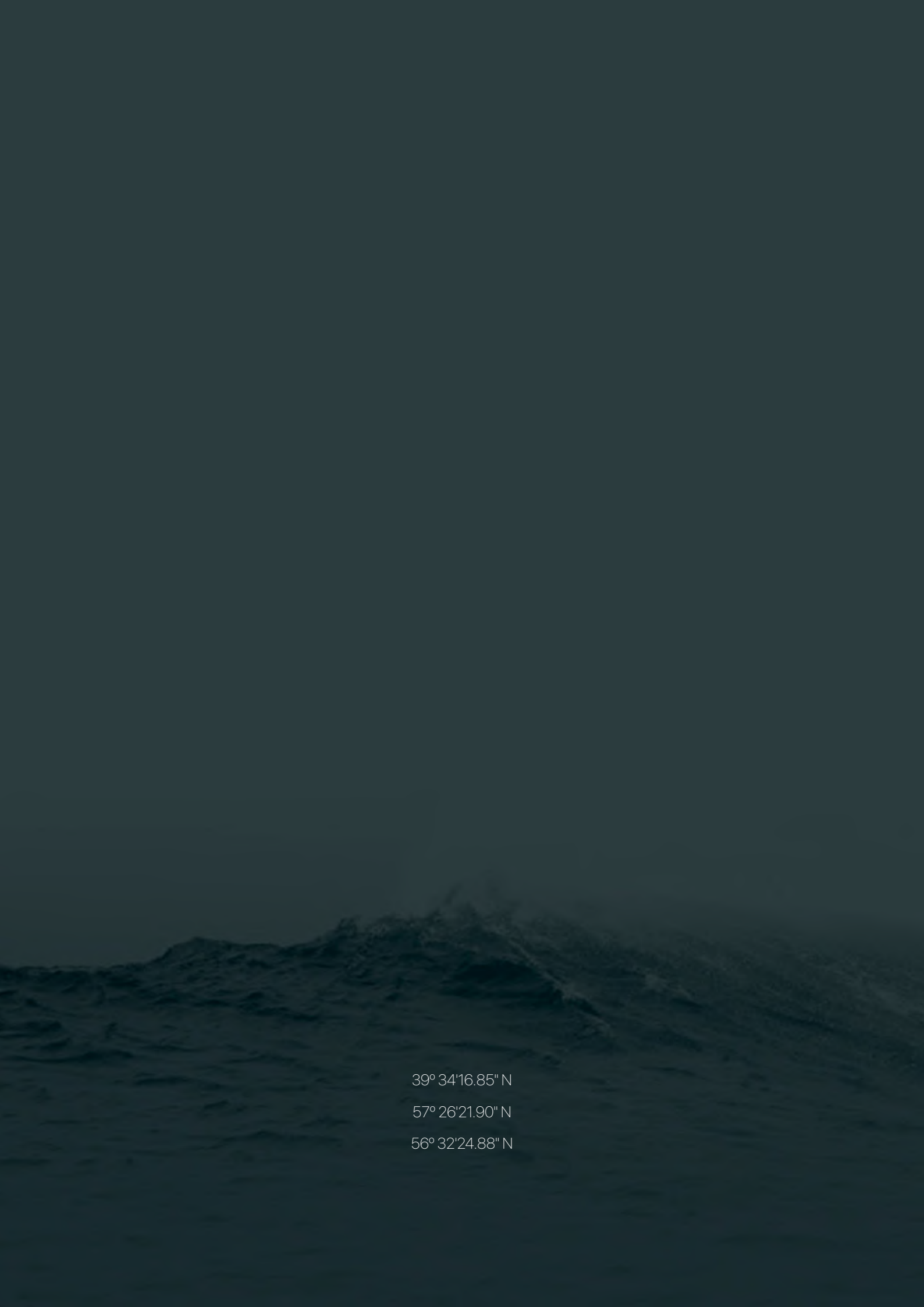
//Subscribe for the amount of products.

DECLARED UNUSABLE

//The product is too damaged to be fixed.

REUSE (SERVICE TEAM)

//The unsuitable product will be cleaned and disassembled and return to the factory for reuse.


39º 34'16.85" N
57º 26'21.90" N
56º 32'24.88" N

seaus

TECHNICAL DRAWINGS

Info

Title	Seaus
Project theme	Lost commercial fishing gear solution
Study program	Msc. INDUSTRIAL DESIGN
Project period	04-02-2019 to 06-06-2019
Project group	MA4-ID3
PARTNERSHIP	HVALPSUND NET
Main supervisor	Kaare Eriksen
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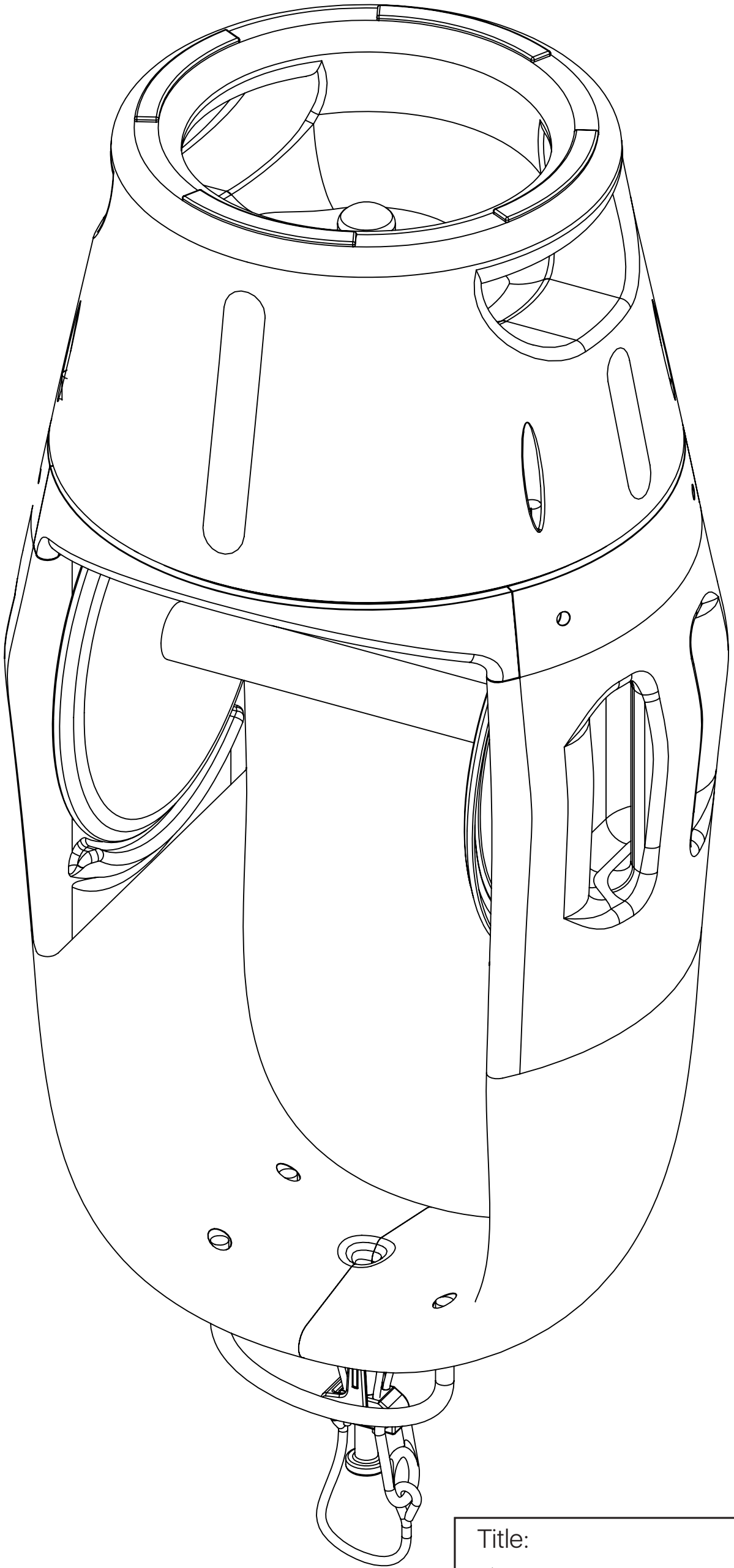
Content



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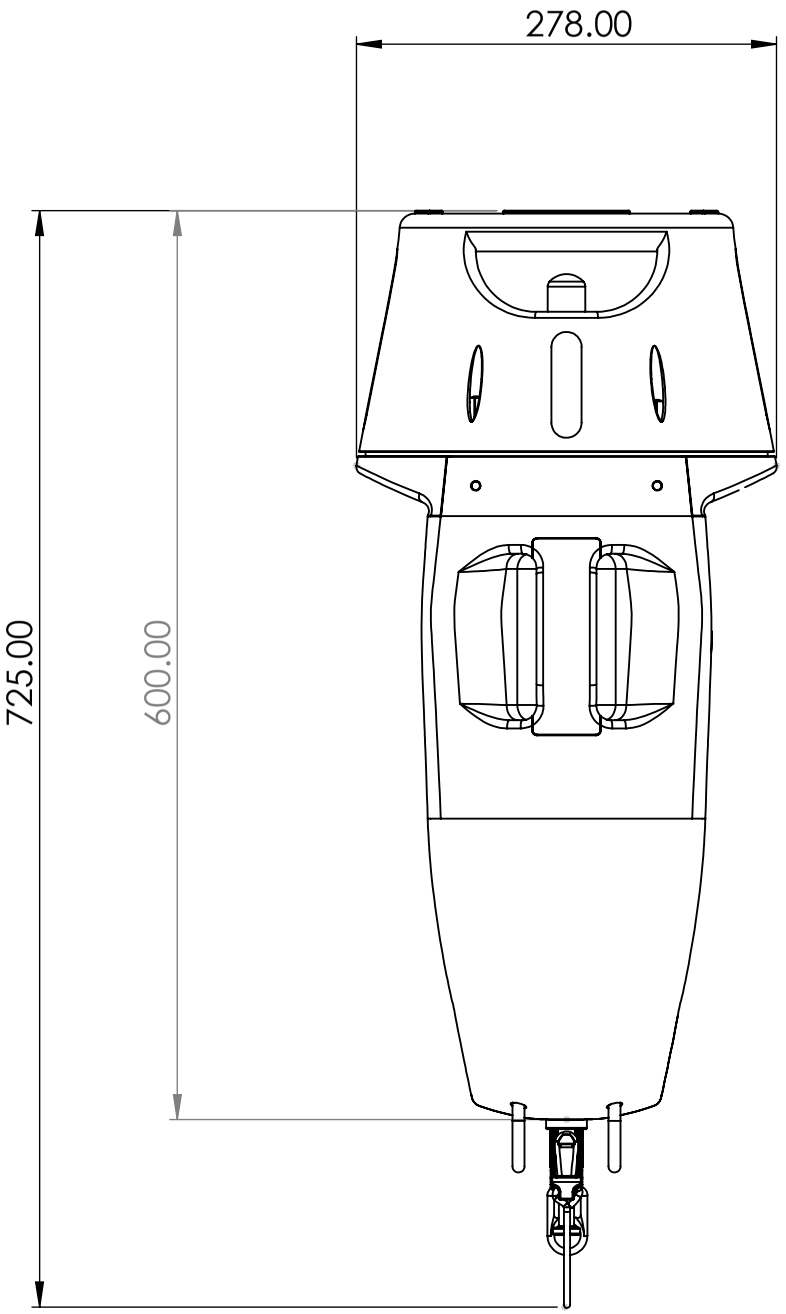
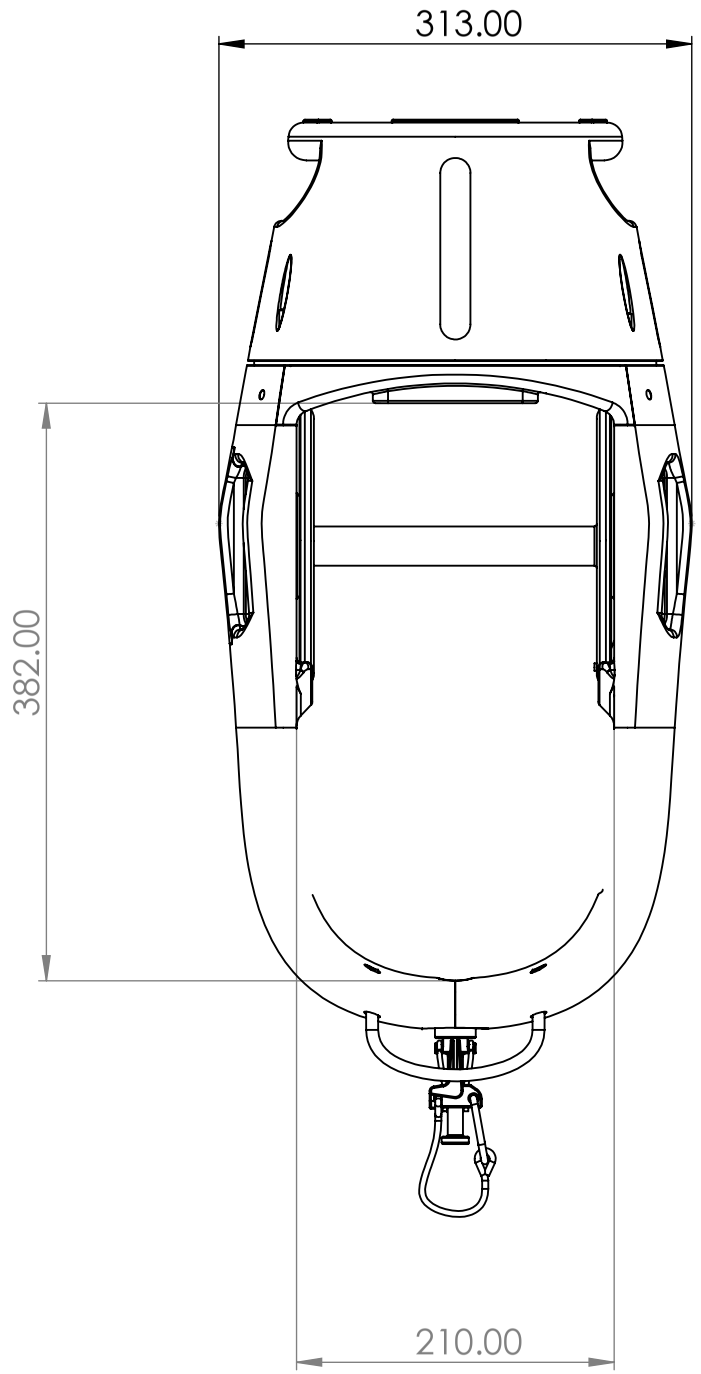
Dimensions in: mm			Perspective





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SEAUS			
Dimensions in: mm	Production method	Drawing no: 2	Date: 06-06-19
		Drawing type: Main drawings	

SEAUS Dimensions in: mm	Scale: 1:5	Drawn by: MA-ID3	Title: Exploede view
	Production method	Sheet: 1 of 1	Material:
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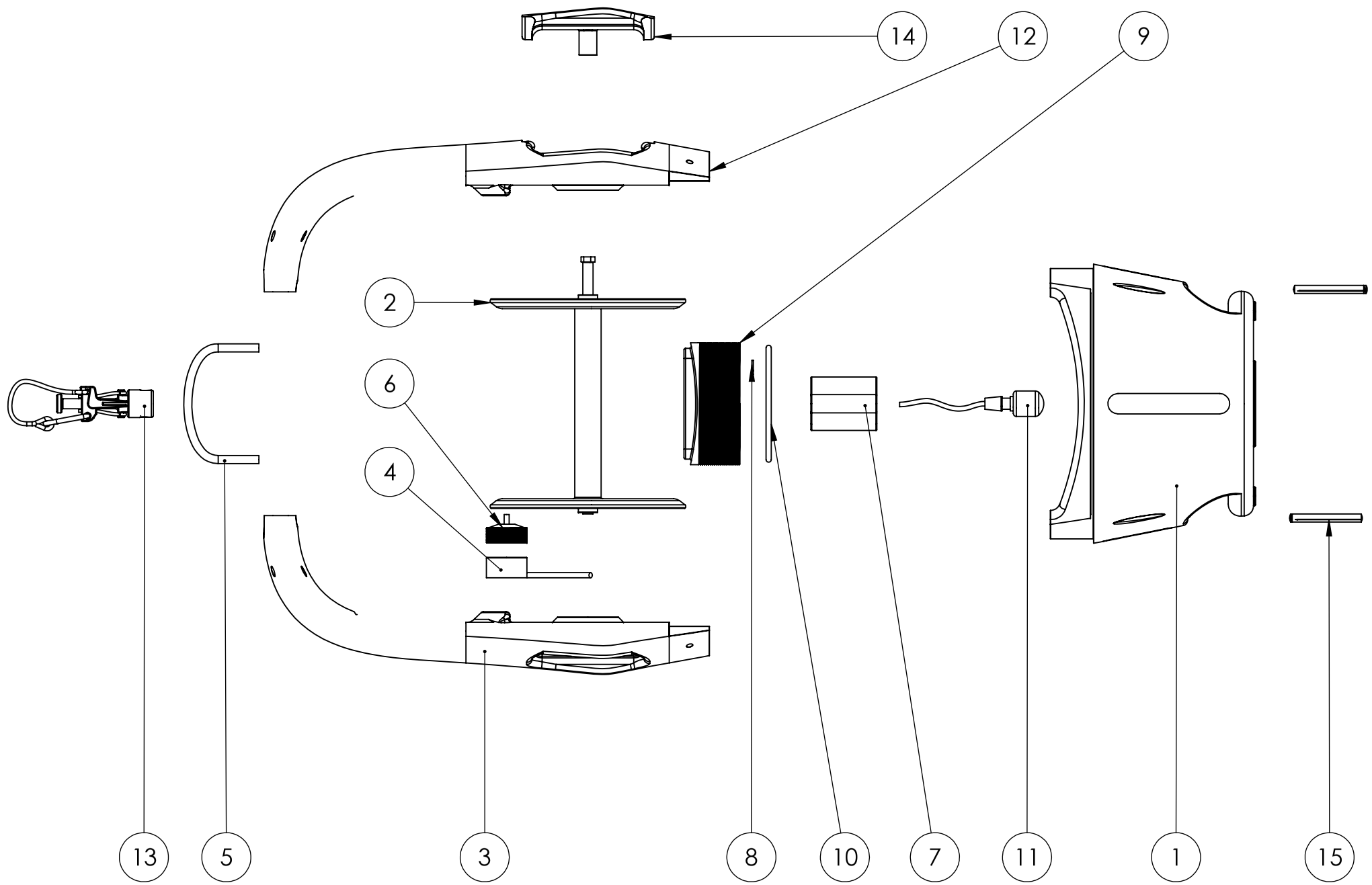

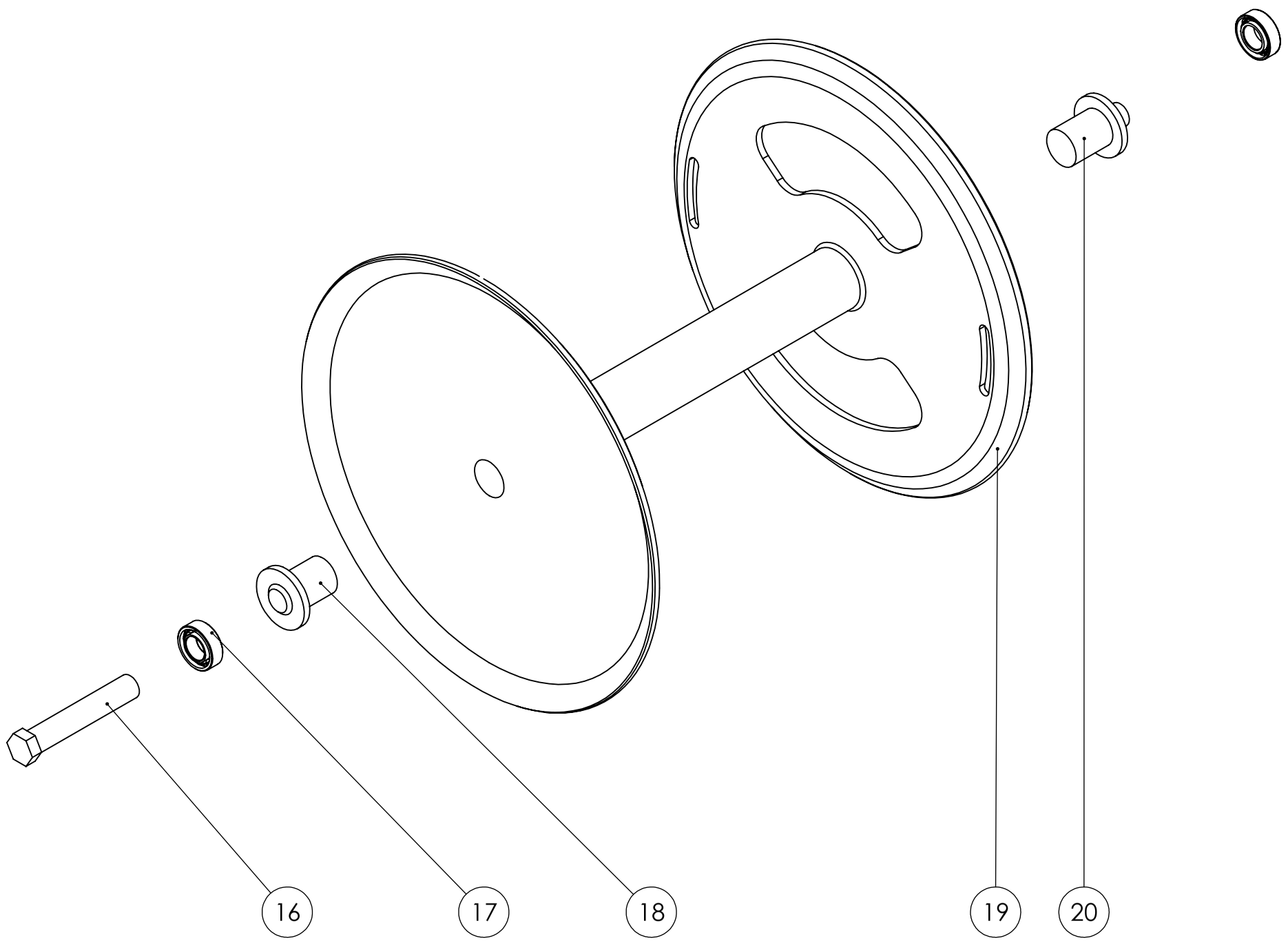

Title: Sub assembly cable reel			
Scale: 1:2	Drawn by: MA-ID3	Sheet: 1 of 1	Material:
SEAUS Dimensions in: mm	Production method		
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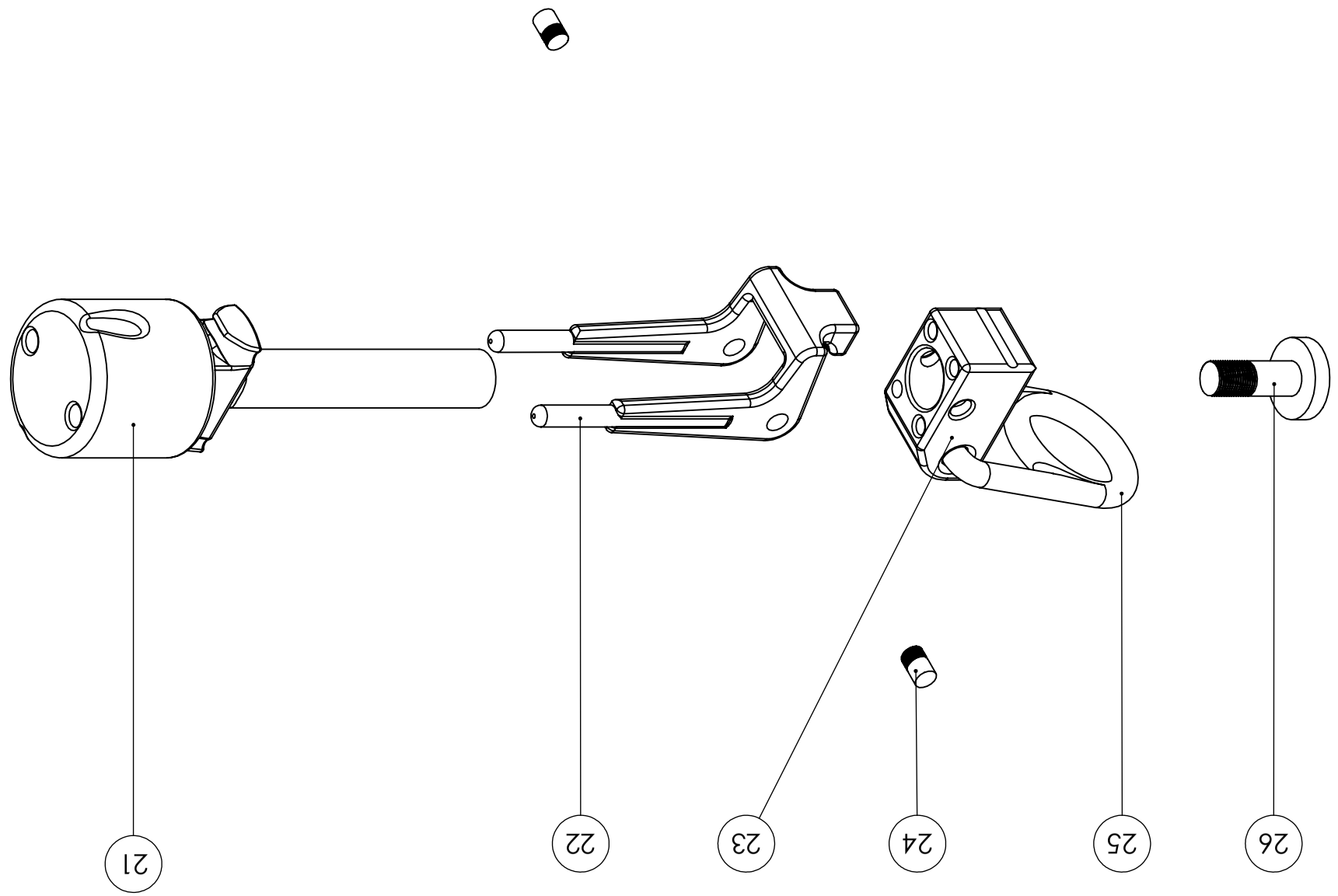
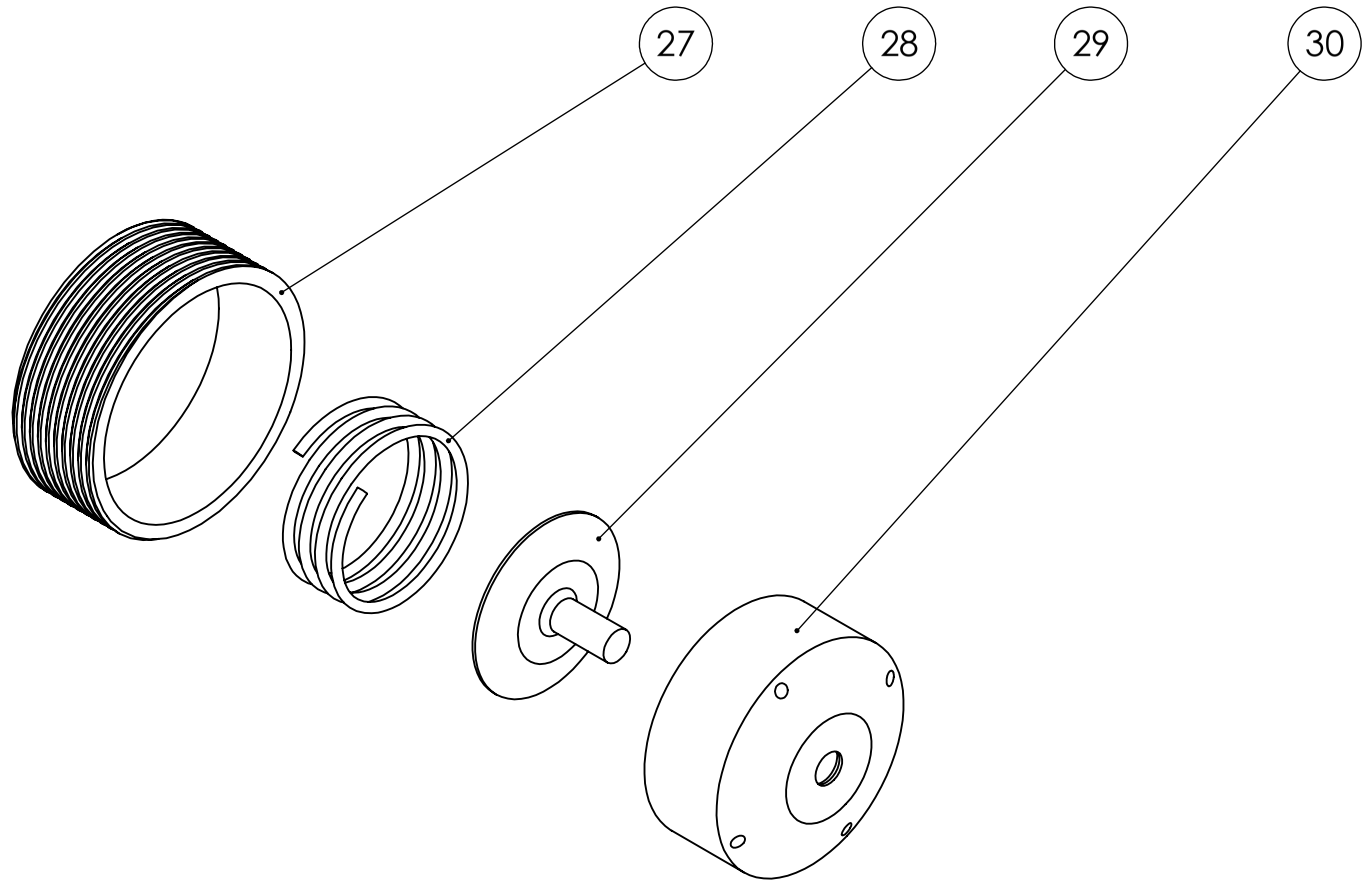
		Drawing type: Exploded	



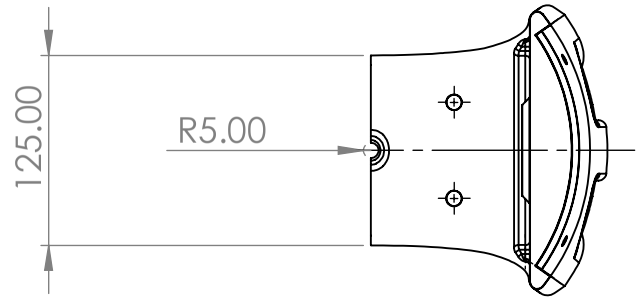
Title: Sub assembly release mechanisme	Material:	Date: 06-06-19	
Scale: 1:1	Drawn by: MA-ID3	Sheet: 1 of 1	Drawing no: 5
SEAUS Dimensions in: mm	Production method		Drawing type: Exploded

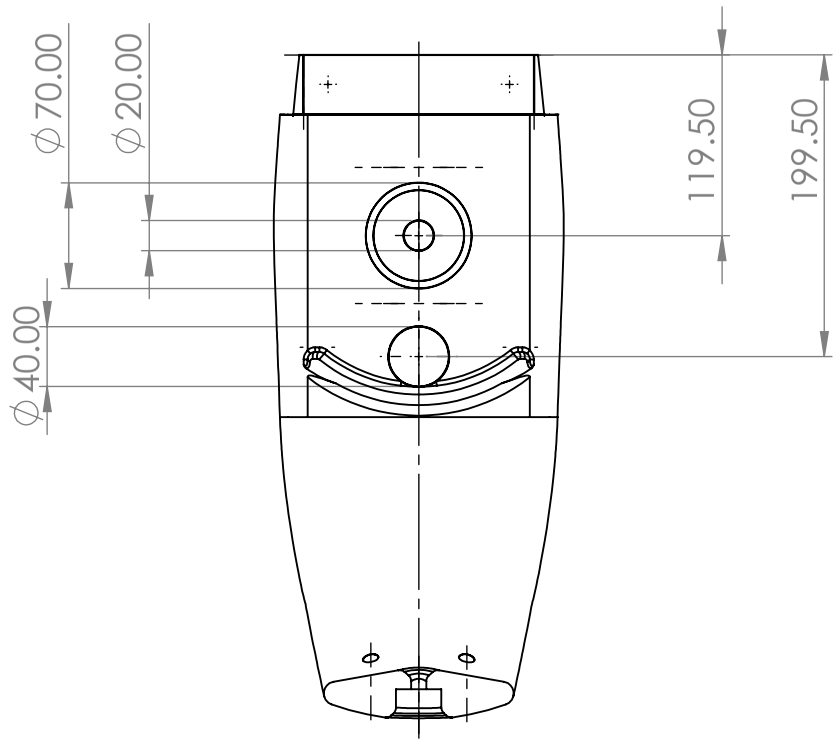


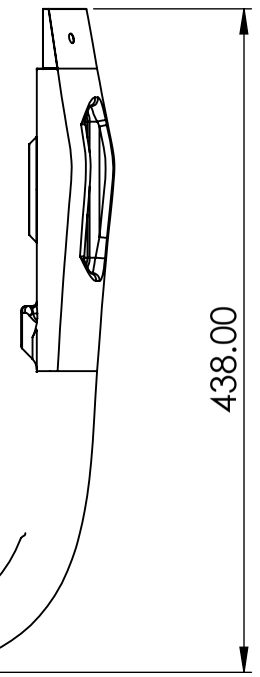
Title: Solenoid front sub assembly			
Scale: 1:1	Drawn by: MA-ID3	Sheet: 1 of 1	Material:
SEAUS Dimensions in: mm	Production method	Drawing no: 6	Date: 06-06-19
		Drawing type: Ecploded	

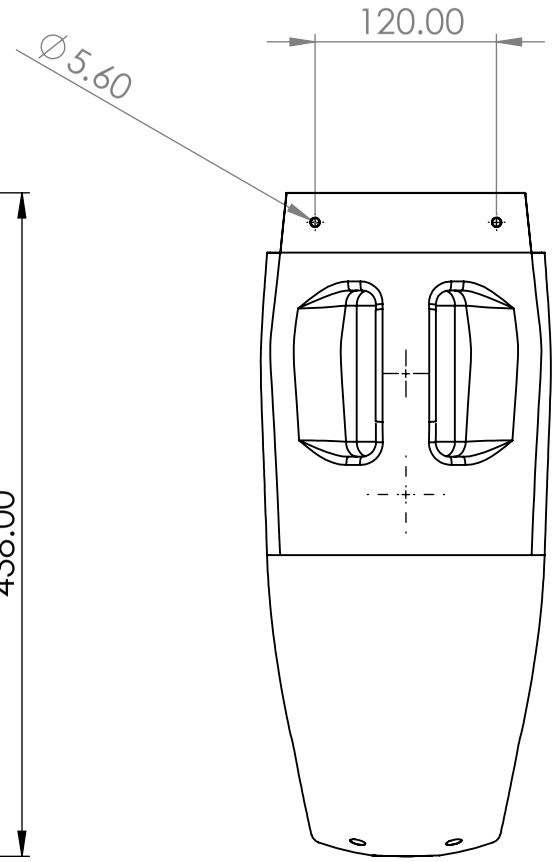
Bill of materials

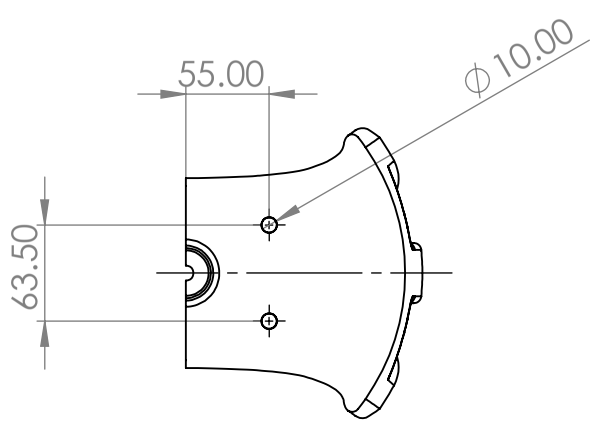
Number	Reference	Qty	Material	Note
1	Top part	1	MDPE	Divinycell foam inside
2	Cable reel (Sub Assembly)	1	-	-
3	Right arm	1	MDPE	Divinycell foam inside
4	Disc Solenoid	1	-	Standard
5	Rope hadles	2	PE	Standard
6	Solenoid front (Sub Assembly)	1	-	-
7	Lithium-ion battery (5000 mAh)	8	-	Standard
8	MCU (STM8L unit)	1	-	Standard
9	Hardware door	1	HDPE	-
10	O-ring 55mm	1	Rubber	Standard
11	Hydrophone	1	-	Standard
12	Left arm	1	MDPE	Divinycell foam inside
13	Release mechanisme (Sub Assembly)	1	Stainless steel	-
14	Handle	1	HDPE	-
15	M8x60mm pinion screw	4	Stainles steel	Standard
16	Left end (Reel)	1	Stainless steel	-
17	Plain bearing (20x10)	1	Stainless steel	Standard
18	Left mid (Reel)	1	Stainless steel	-
19	Reel	1	Stainless steel	-
20	Right mid (Reel)	1	Stainless steel	-
21	Main release part	1	Stainless steel	-
22	Flip release part	1	Stainless steel	-
23	Block release part	1	Stainless steel	-
24	Pinion screw (4x8)	2	Stainless steel	Standard
25	Hinge	1	Stainless steel	-
26	Bottom release part	1	Stainless steel	-
27	Bottom cup	1	HDPE	-
28	Spring	1	Stainless steel	Standard
29	Split part	1	Stainless steel	-
30	Top cup	1	HDPE	-



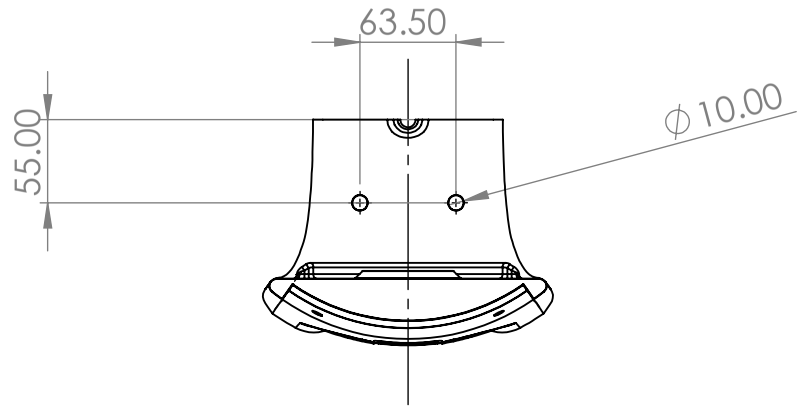


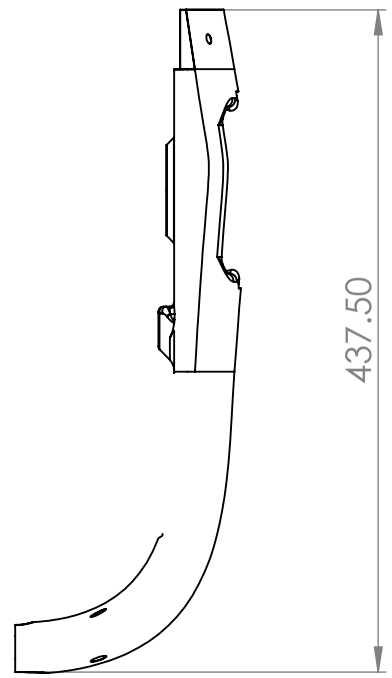


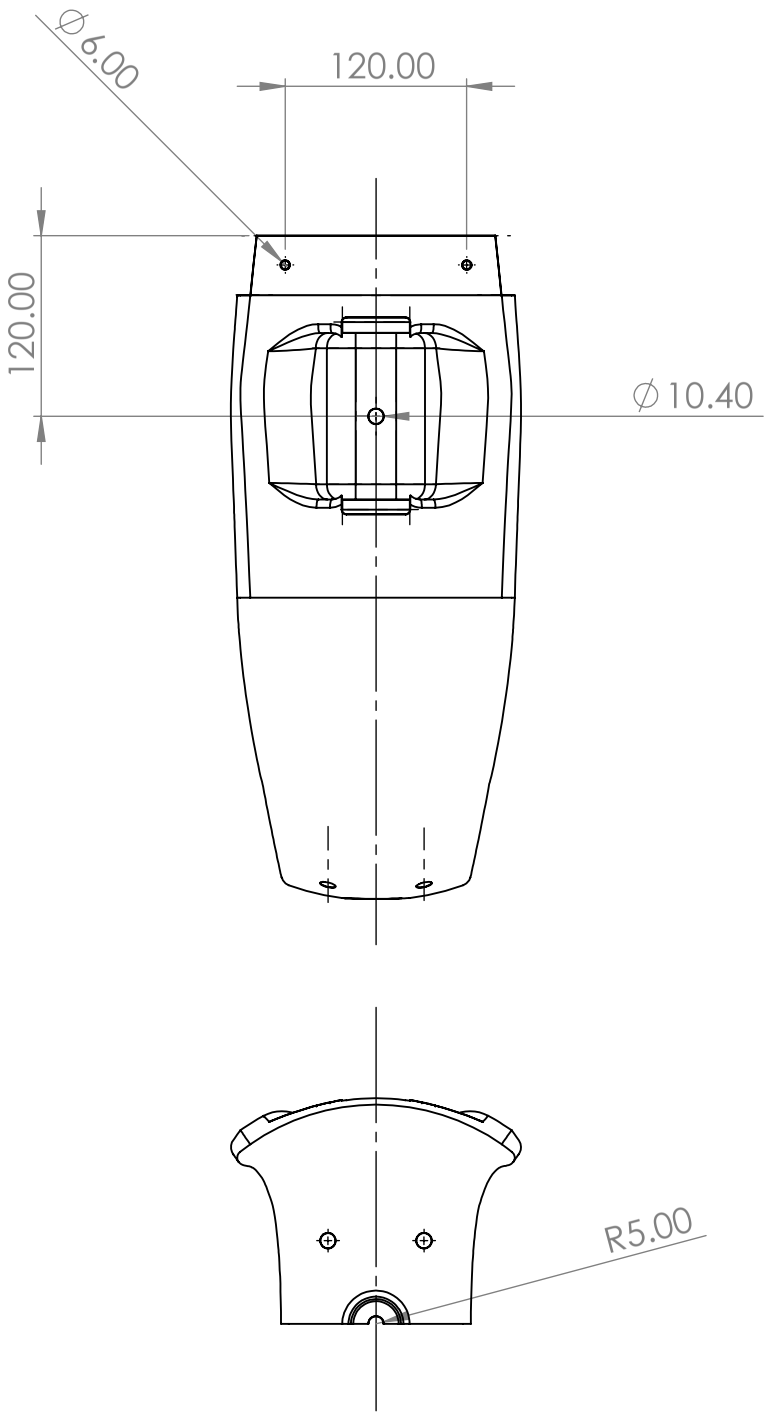


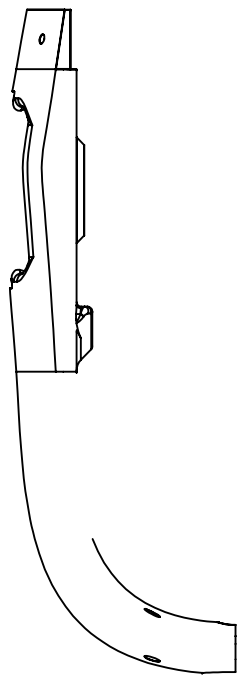


Title: Right arm	Material: MDPE
Scale: 1:5	Sheet: 1 of 1
Drawn by: MA-ID3	Drawing no: 7
Production method: Rotational moulding	Drawing type: Detail
SEAUS Dimensions in: mm	Date: 06-06-19





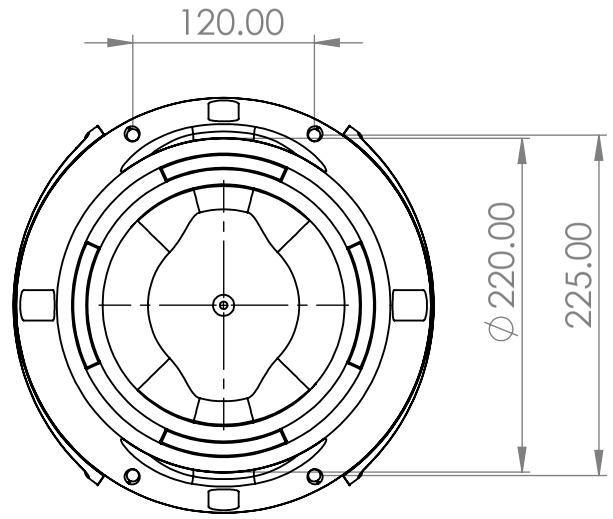




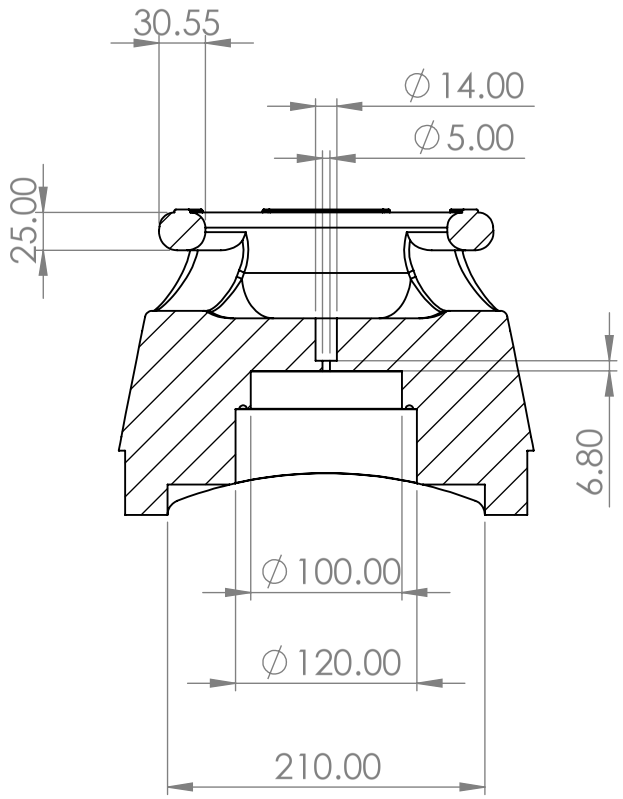
Title:	Left arm
Scale:	1:5
Drawn by:	MA-ID3
Material:	MDPE
Sheet:	1 of 1
Production method	Rotational moulding
Drawing no:	8
Date:	06-06-19
Drawing type:	Detail

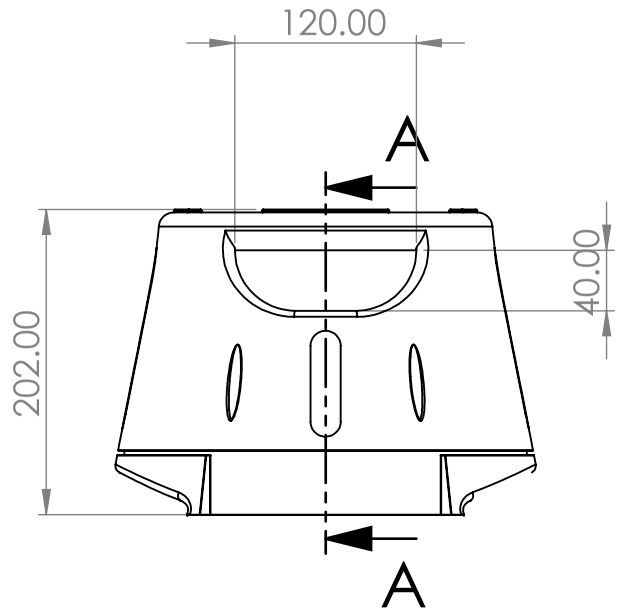
SEAUS

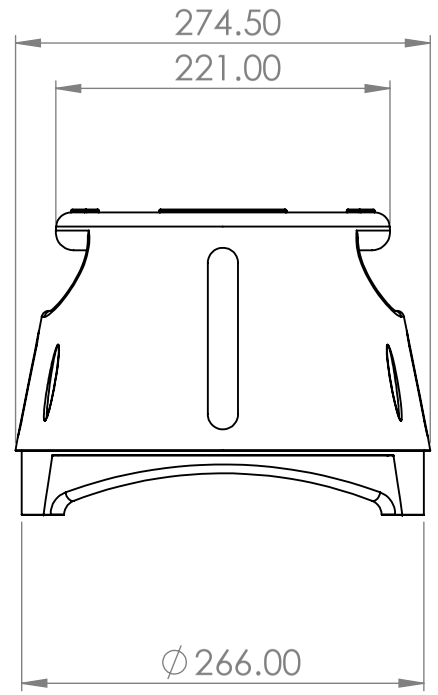
Dimensions in: mm

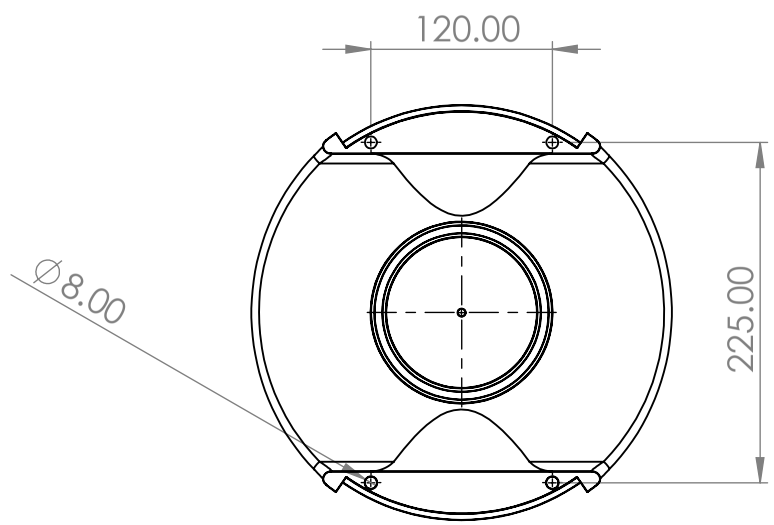


SECTION A-A

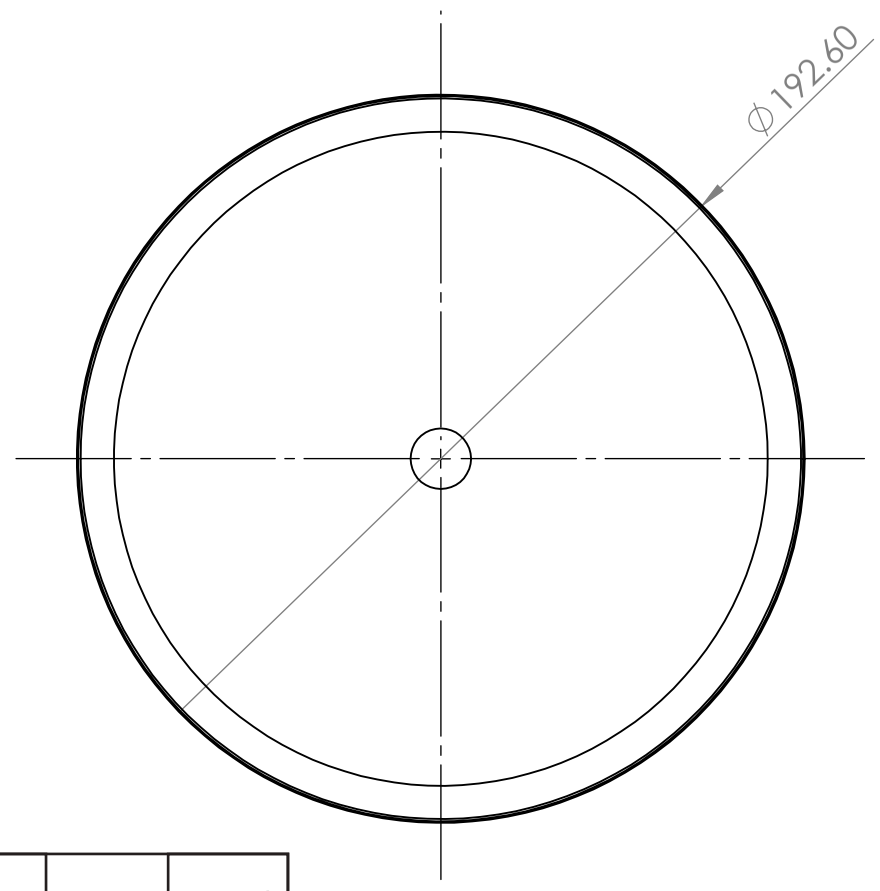


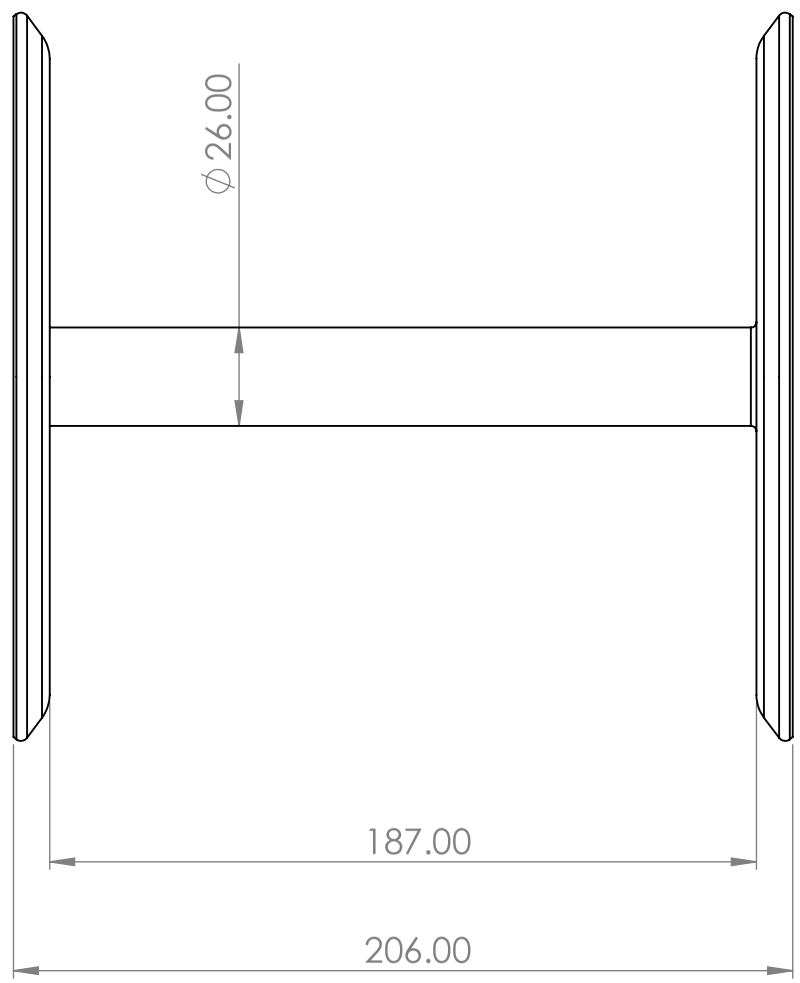


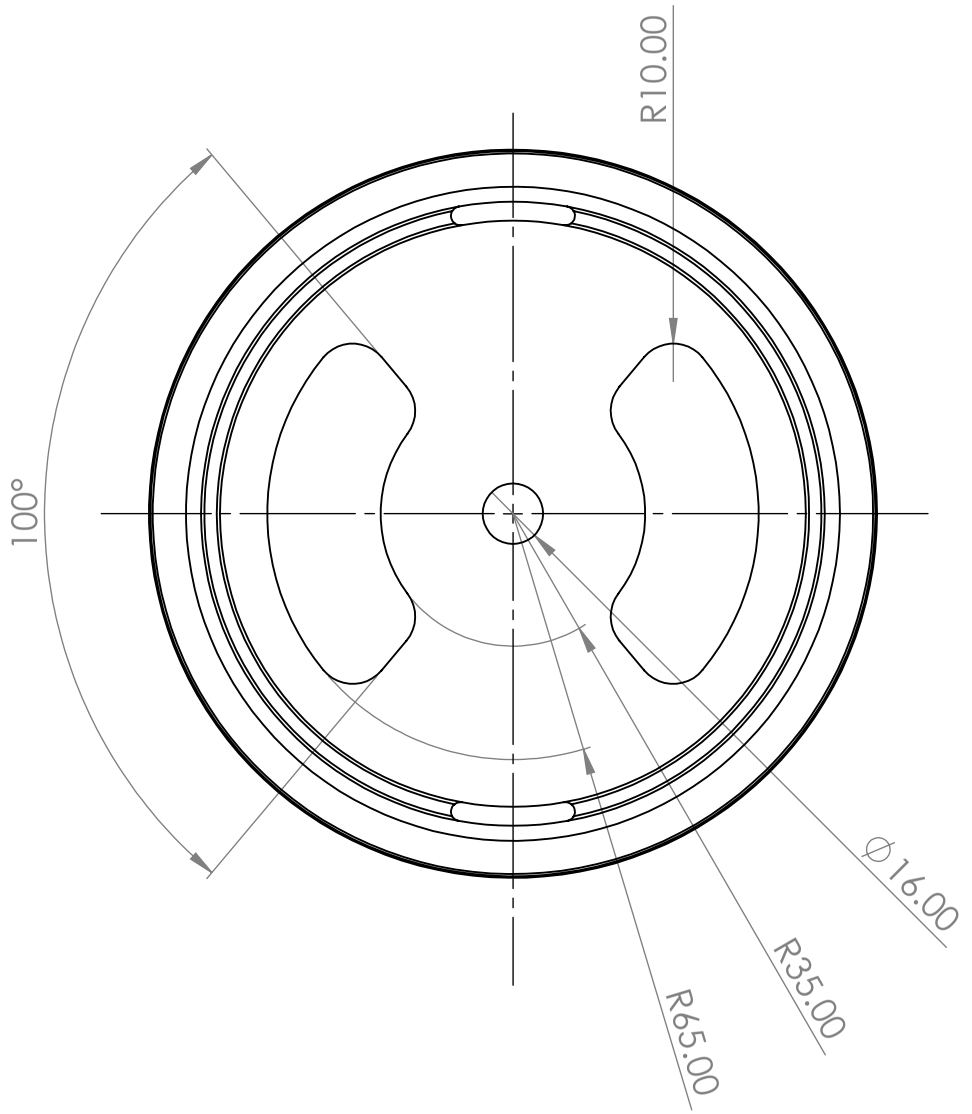




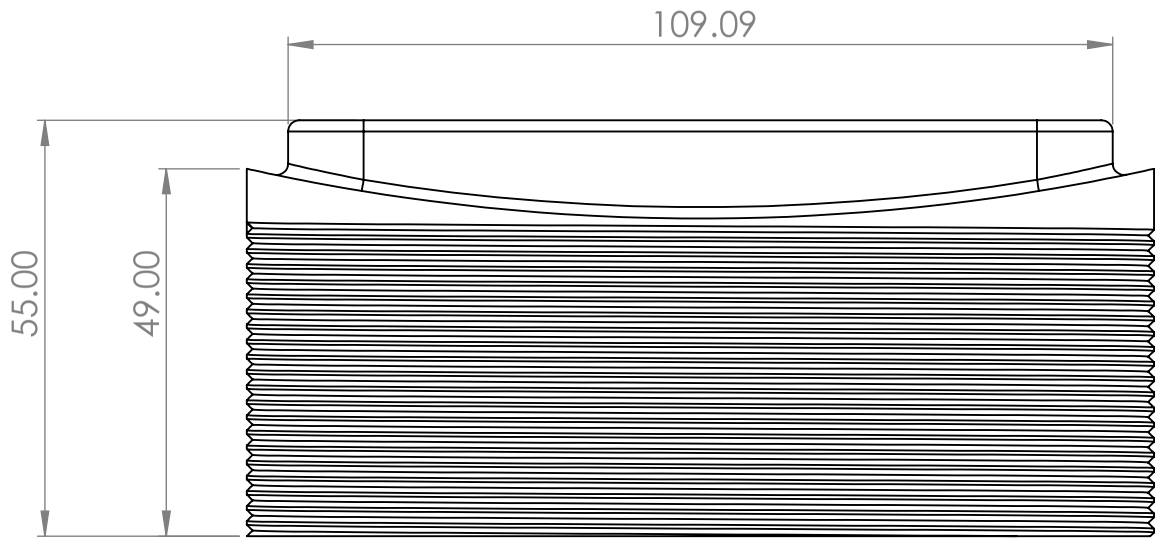
SEAUS			
Dimensions in: mm			
Scale: 1:5	Drawn by: MA-ID3	Sheet: 1 of 1	Material: MDPE
Production method: Rotational moulding			Date: 06-06-19
Drawing type: Detail		Drawing no: 9	Title: Top part

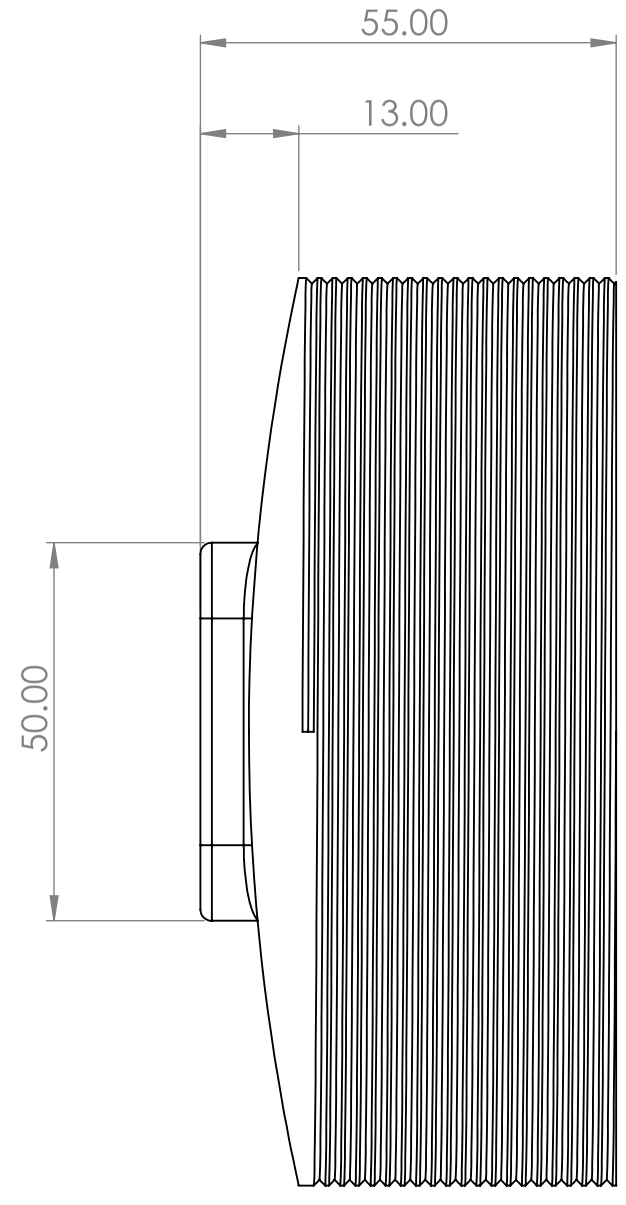


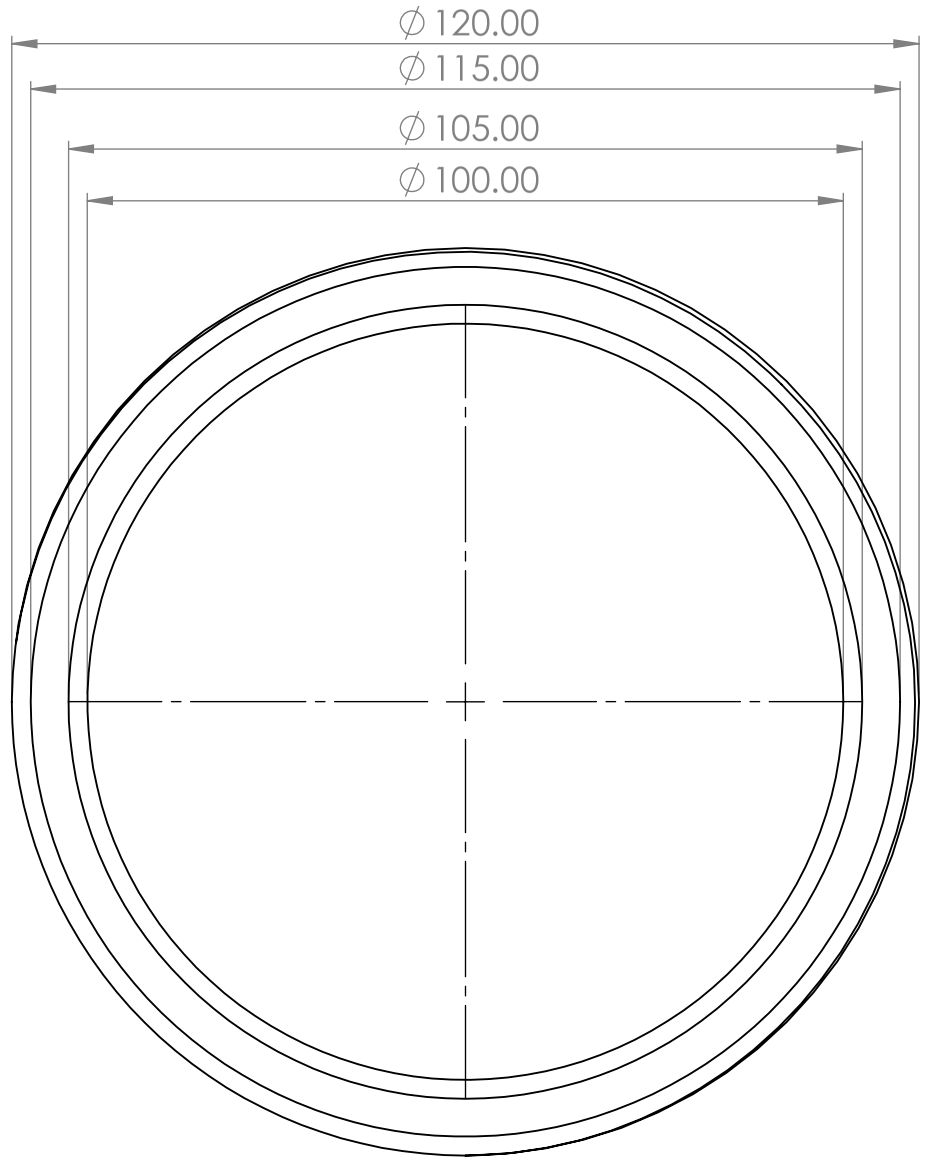




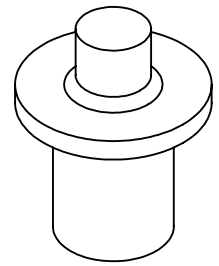
Title: Reel			
Scale: 1:2	Drawn by: MA-ID3	Material: Stainless steal	
SEAUS Dimensions in: mm	Sheet: 1 of 1	Drawing no: 10	Date: 06-06-19
	Production method Rotational moulding	Drawing type: Detail	

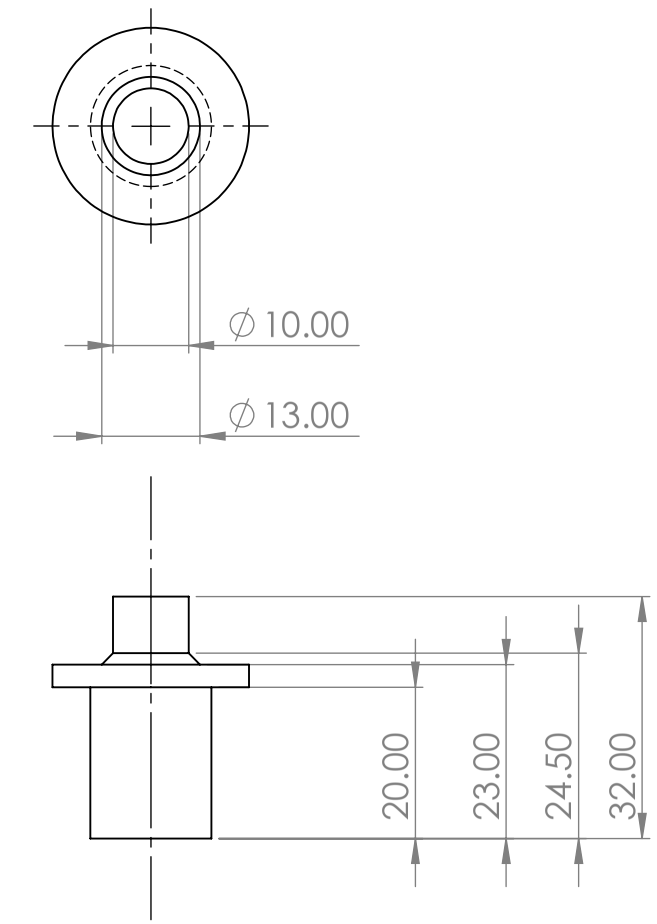




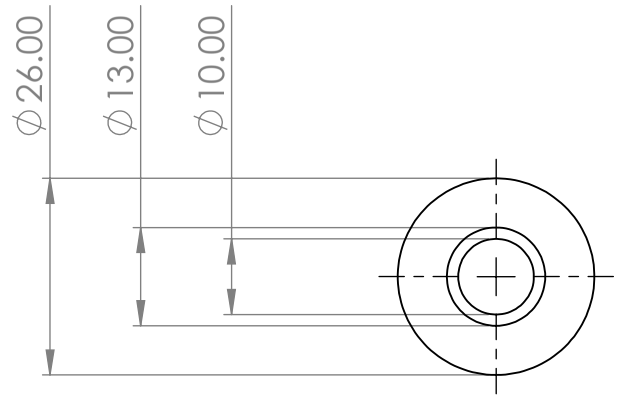


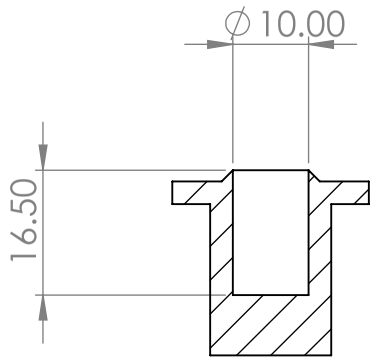
Title: Hardware door		Material: HDPE	Date: 06-06-19
Scale: 1:1	Drawn by: MA-ID3	Sheet: 1 of 1	Drawing no: 11
SEAUS Dimensions in: mm	Production method Injection moulding		Drawing type: Detail

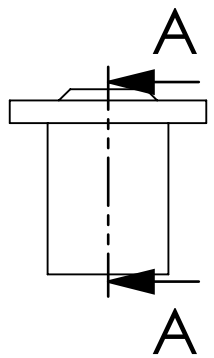


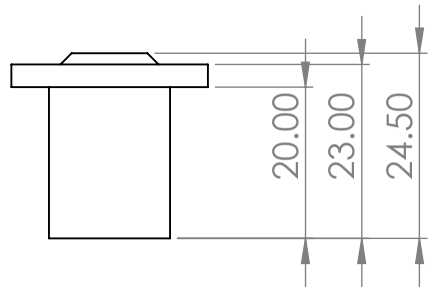


Title: Right mid			
Scale: 1:1	Drawn by: MA-ID3	Material: Stainless steal	
SEAUS Dimensions in: mm		Sheet: 1 of 1	Drawing no: 12
	Production method Cutting		Drawing type: Detail



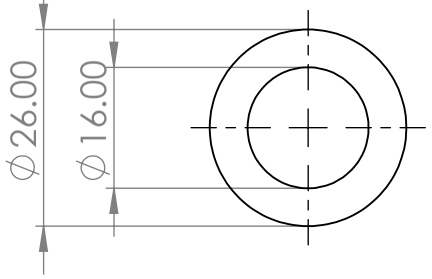




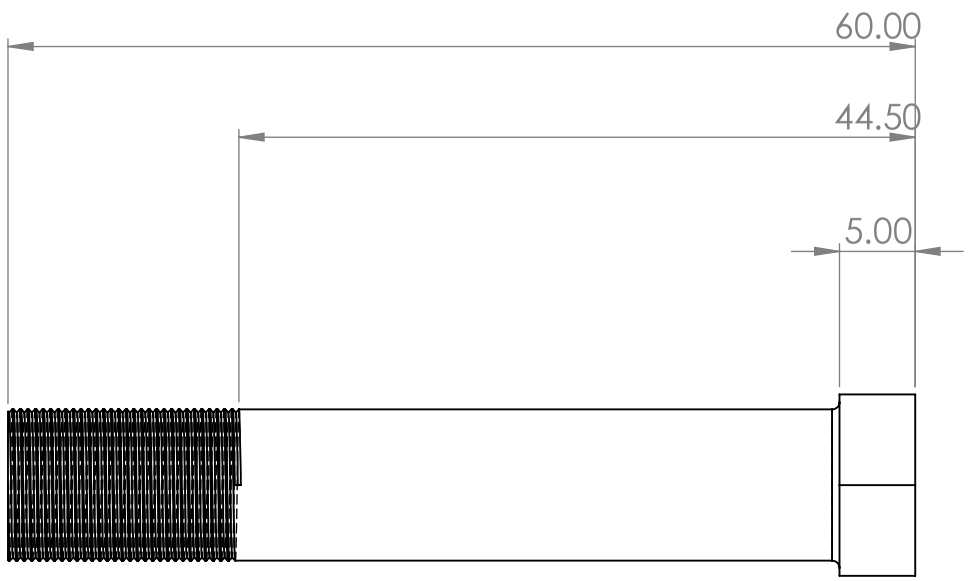


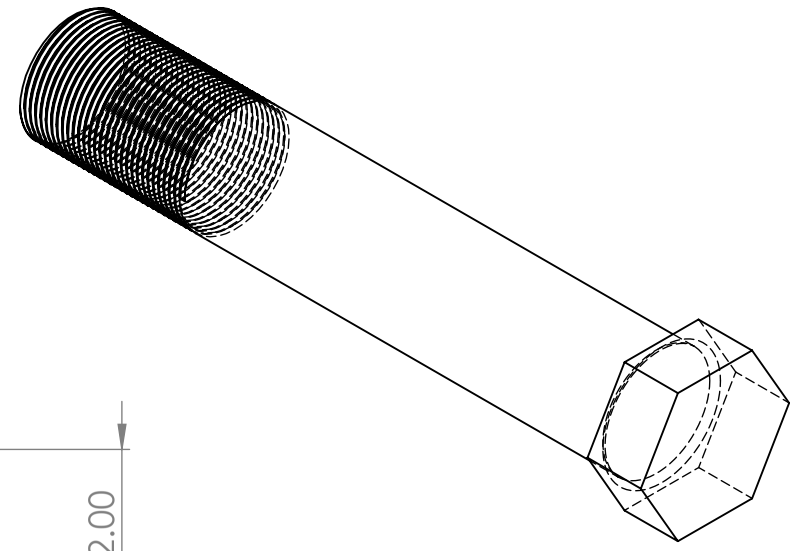
SECTION A-A

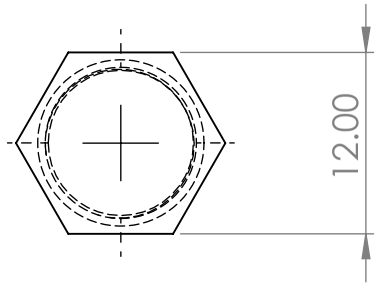
SCALE 1 : 1

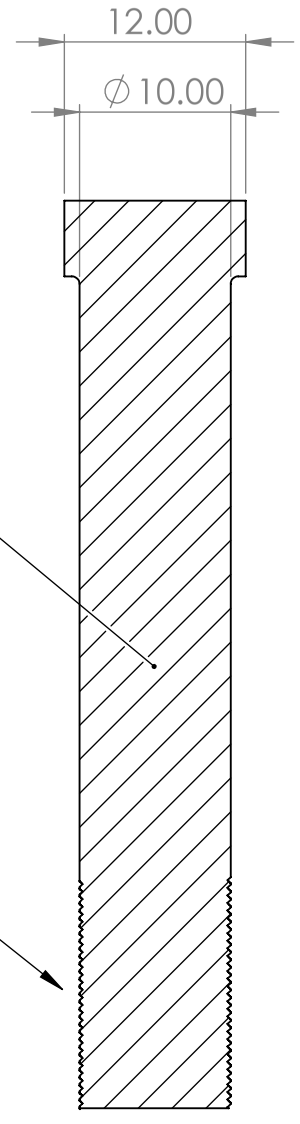


Title: Left mid	Material: Stainless steal	Date: 06-06-19	Drawing type: Detail
Scale: 1:1	Drawn by: MA-ID3	Sheet: 1 of 1	Drawing no: 13
SEAUS Dimensions in: mm		Production method Cutting	

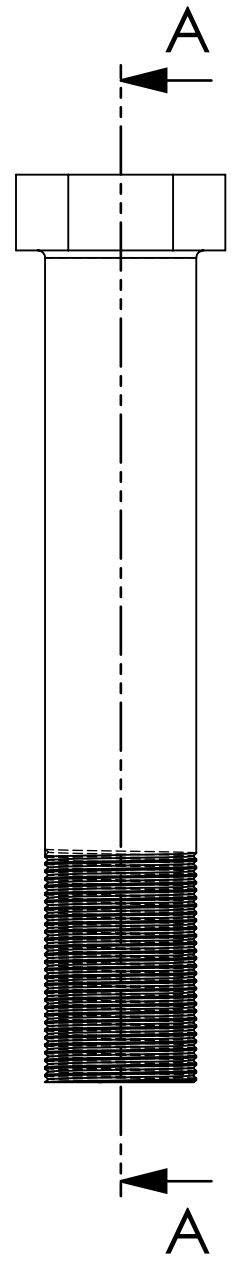




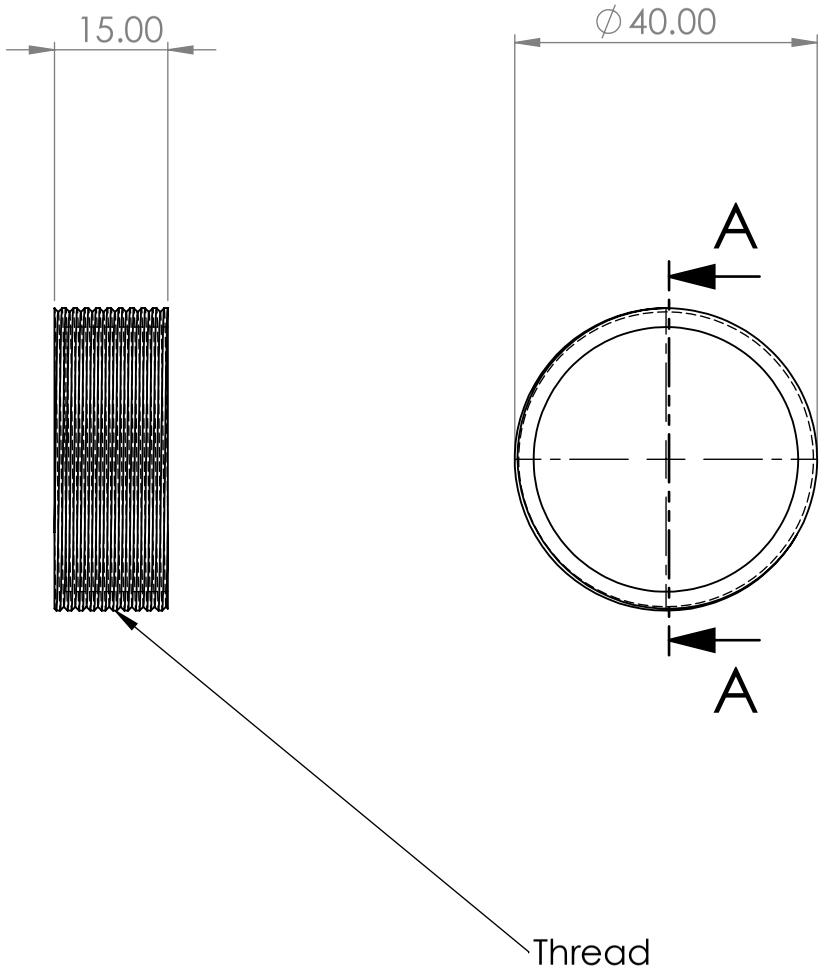


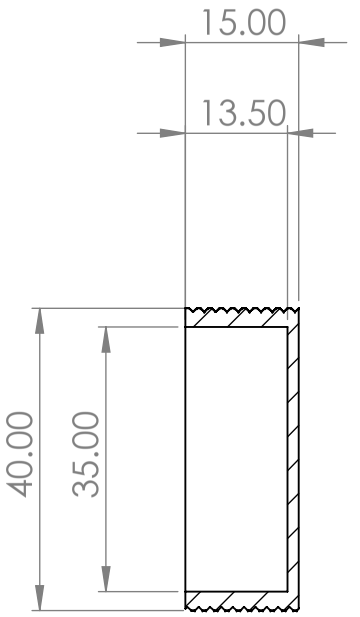


SECTION A-A



Title: Left end			
Scale: 2:1	Drawn by: MA-ID3	Material: Stainless steal	
SEAUS		Sheet: 1 of 1	Drawing no: 14
Dimensions in: mm	Production method: Cutting		Date: 06-06-19
			Drawing type: Detail

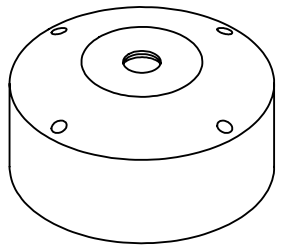


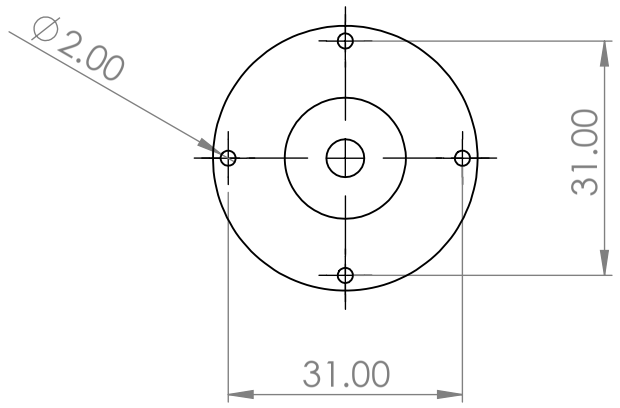


SECTION A-A

SCALE 1 : 1

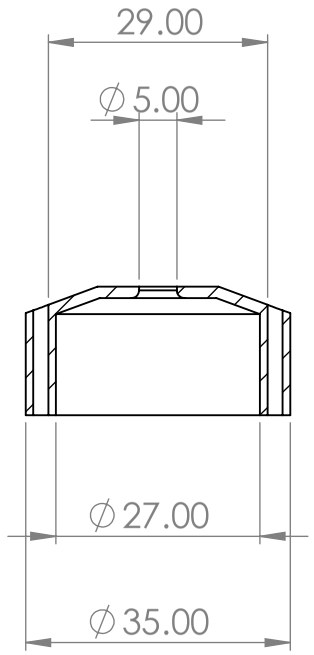
SEAUS	Title: Bottom cup		
Dimensions in: mm	Scale: 1:2	Drawn by: MA-ID3	
Production method: Injection moulding	Sheet: 1 of 1	Material: HDPE	
Drawing type: Detail	Drawing no: 15	Date: 06-06-19	

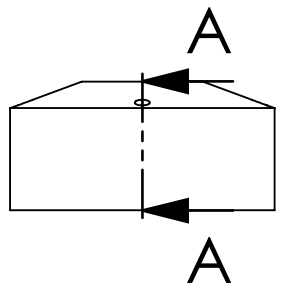


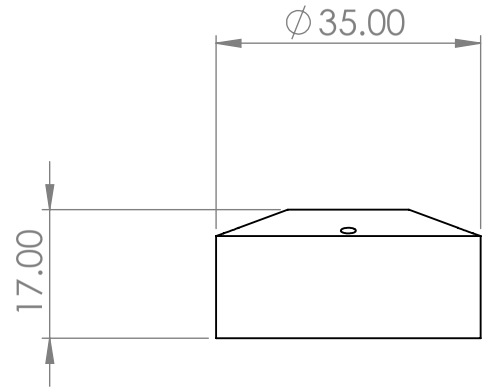


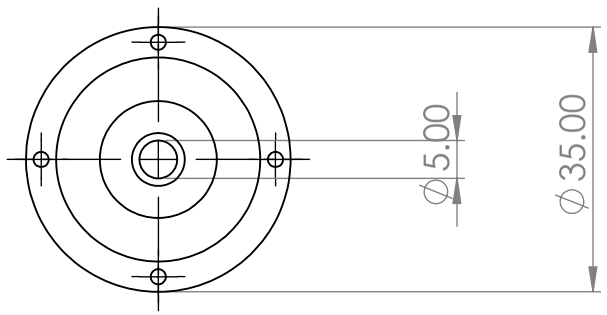
SECTION A-A

SCALE 1 : 1

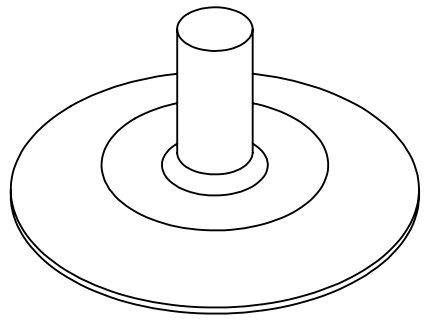


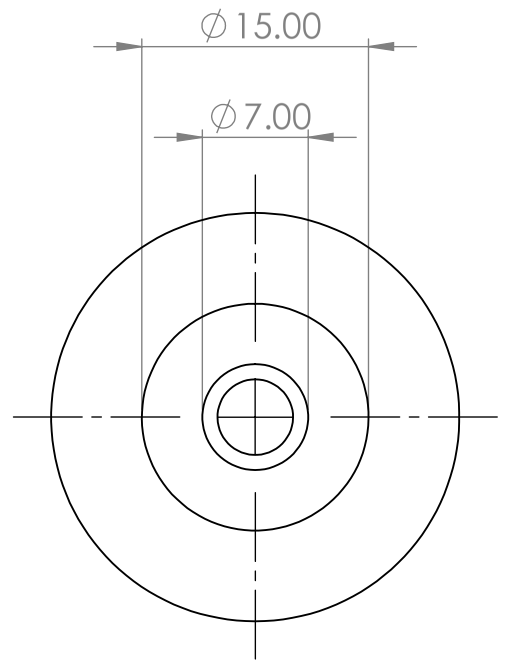


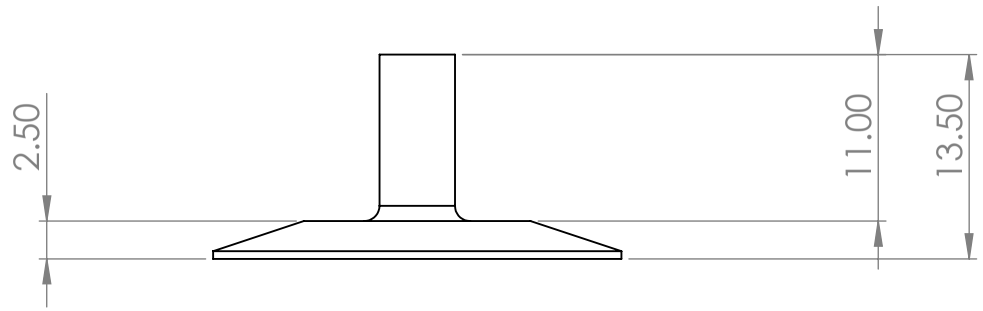


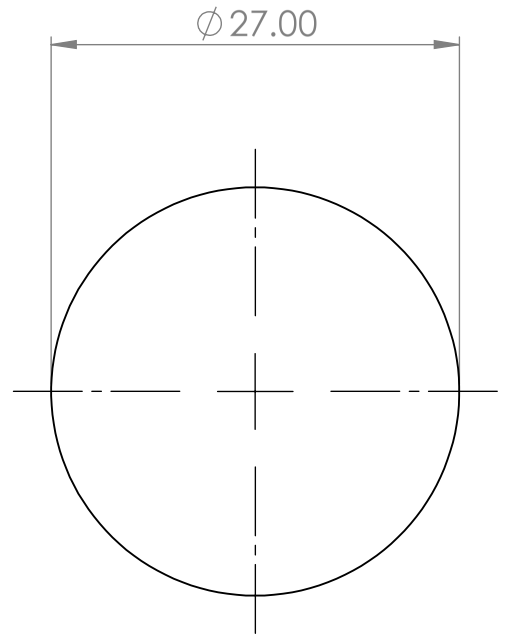


Title: Top cup	
Scale: 1:2	Drawn by: MA-ID3
SEAUS Dimensions in: mm	
Production method: Injection moulding	Sheet: 1 of 1
	Material: HDPE
Drawing type: Detail	Drawing no: 16
	Date: 06-06-19

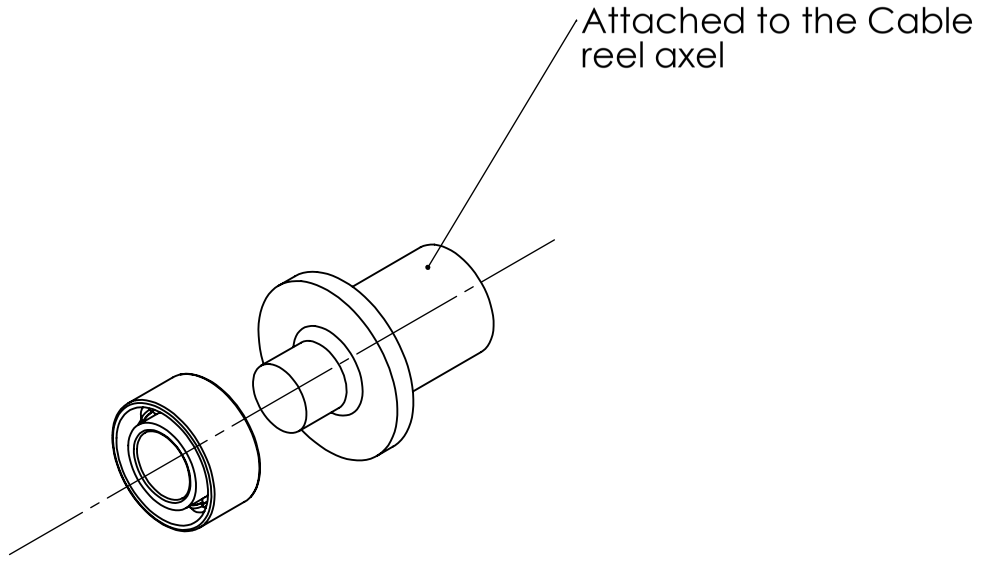


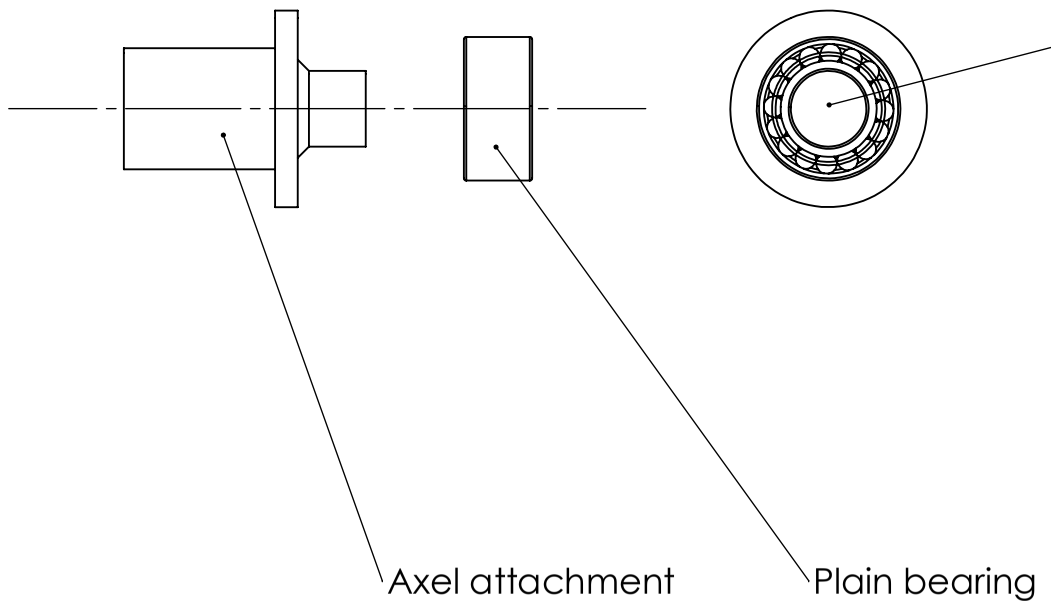


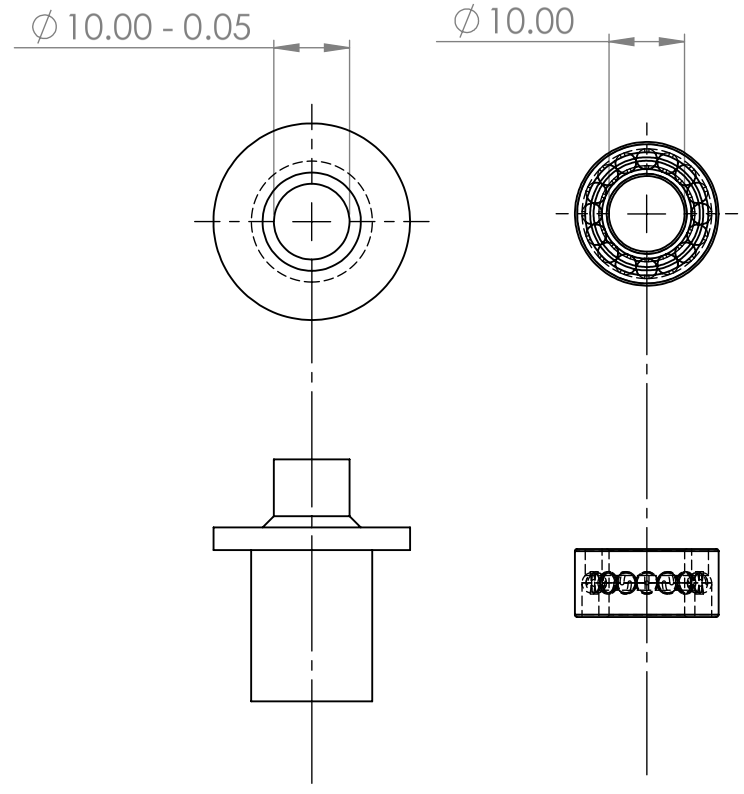




Title:	Material:
Title:	Stainless steal
Scale:	Sheet:
1:1	1 of 1
Drawn by:	Drawing no:
MA-ID3	17
Production method	Drawing type:
Cutting	Detail
SEAUS	Date:
Dimensions in: mm	06-06-19







Title:	
Tolerence drawing	
Scale: 1:5	Drawn by: MA-ID3
Production method	Sheet: 1 of 1
	Material:
Drawing type: Tolerence	Drawing no: 8
	Date: 06-06-19

SEAUS

Dimensions in: mm

seaus

Appendix

Info

Title	Seaus
Project theme	Lost commercial fishing gear solution
Study program	Msc. INDUSTRIAL DESIGN
Project period	04-02-2019 to 06-06-2019

Project group	MA4-ID3
PARTNERSHIP	HVALPSUND NET
Main supervisor	Kaare Eriksen
CO-supervisor	Jørgen Asbøll Kepler

Carlos Borrás Juliá

Henrik K. Brogård

Daniel Nørskov Roe-Poulsen

Content

A01. CONTACT LIST

Marine litter					
Nr.	Name	Company	Phone	Mail	Note
1.	Ryan Metcalfe	Varde municipality	30360642	rydm@varde.dk	Kimo Denmark, coordinator.
2.	Steen Heftholm	Frederikshavn municipality		sthe@frederikshavn.dk	Ideer person and project developer.
3.	Jens Baggesen	Hjørring municipality	41226755	jens.baggesen@hjoerring.dk	
4.	Henrik Damsgaard	Jammerbugt municipality		hed@jammerbugt.dk	
5.	Ulla Nielsen	Thisted municipality		ulni@thisted.dk	
6.	Preben Nielsen	Varde municipality (District leader)	51 24 14 40	prni@varde.dk	
7.	Ole Mikkelsen	Entrepreneur company Ole Mikkelsen	86 93 78 77	sthe@frederikshavn.dk	http://olemikkelsen.dk/
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10.	Julie & Jens	STRANDET	30 23 17 34	jens@strandet.io julie@strandet.io	https://www.strandet.io
11.	Kenneth Mølbjerg Jørgensen	Aalborg Universitet	99 40 99 57	kmj@business.aau.dk	Professor in Finance and Management
12.	Aage Vestergaard Larsen		98 54 16 55	Info@avl.dk	https://avl.dk/

Fishing industry					
Nr.	Name	Company	Phone	Mail	Note
13.	Jes Vollertsen	AAU	28 95 91 95	jv@civil.aau.dk	Director for Marine Plastic
14.	Allan werner rasmus	Plastix	9782 2000	allan@plastixglobal.com	Reusing fishing equipment
15.	Claus Christensen	CEO	98 46 10 66	cbc@saeby.com	Sæby fishing industry
16.	Svend Ole Larsen	Managing director	21 75 67 67	svend@laesofish.dk	Læsø fishing industry
17.	Gjermund Langedal	Project leader	28 95 91 95	gjermund.langedal@fiskeridir.no	Clean Nordic Oceans
18.	Hans Axel Kristensen	CEO - Plastix	9782 2000	allan@plastixglobal.com	Clean Nordic Oceans Danish department
19.	Bård Aarbakke	Development Section and Network leader	+47 97 56 91 98	Bard.Aarbakke@fiskeridir.no	Clean Nordic Oceans

Fishing industry

Nr.	Name	Company	Phone	Mail	Note
20.	Rikke Frandsen	Økosystembaseret Marin Forvaltning	21 32 63 18	rif@aqua.dtu.dk	DTU AQUA
21.	Ryan Metcalfe	Varde municipality	30 36 06 42	rydm@varde.dk	Kimo Denmark, coordinator.
22.	Kaare Manniche Ebert	Fishing biologist	40 97 14 92	kme@sportsfiskerforbundet.dk	
23.	Tage Sørensen	Jeanne Strandby	24 94 54 59	tsprojektleder@hotmail.com	Fisherman, project leader
24.	Per Dencker	Aalborg og Nørresundby Fritidsfiskerforening	52534918	team-dencker@9260.dk	Leader
25.	Lars Peter Jensen	Strandby net	21 42 59 69	lp@strandbynet.dk	CEO
26.	Jan Rønn		61 75 67 48		Lobster and mussels fisher (Own network)
27.	Erik Appel			erikappel1962@gmail.com	Materials Science and Engineering
28.	Mikael Justesen	Hvalpsund net	23 33 44 39	mj@hvalpsund.com	Sales Fishing Equipment
29.	Ernst Egon		20 32 11 51		
30.	Lasse Kristensen	Nordisk Krabbe Kompagni	25 71 65 25		CEO
31.	Bent Toft Bro	Thyborøn Fiskeriforening	40 83 21 44		Fishing consultant
32.	Tonny Nees	Fishing teacher (Lobster fisherman)	40 17 84 26		Thyborøn fishing school, Small boat
33.	Kim Christian Johansen	L47 Camilla	21 79 49 80		Lobster fisherman, Hanstholm, Large boat

Volunteer groups

Name	Link
Ren Strand Nu	https://www.facebook.com/RenStrandNu/
Ren Strand Fanø (Peter)	https://www.facebook.com/renstrandfano/
Ren Kustlinje	https://www.facebook.com/RenKustlinje/

A01A. METHODOLOGIES

	METHODS	DESCRIPTION
PREPHASE	Scrum To do, doing, done (Scrum.org, 2017)	A tool that the team have used to control daily tasks.
	Design Thinking	A way to structure the process and to make sure it going in the right direction.
	Holestic viewpoint	To get all the way around and explorer every little detail of the problem.
	Proces tracking	A way to remember all the steps in the proces towards the product.
	Bird in the hand (Sarasvathys)	To get quickly forward and to get the information needed.
	Mision statement (Ulrich & Eppinger, 2012)	To make sure there is a base to build on (Breif, business, market and stakeholders)
UNDERSTAND	Guided tour (IDEO, 2015)	To get key insight within the working process of fishing with creels.
	Shadowing (Sperschneider & Bagger, 2003)	To get valuable insight within the working proces.
	Act-it out (Sperschneider & Bagger, 2003)	To get an understanding of critical situiations within the working proces.
	Structured and unstructured interview (Sperschneider & Bagger, 2003)	An effective way which provide huge amount of data.
	Inspirationboards	To inspire and provide frames which leads towards a recognizable look.
	Value vision (Tollestrup, 2004)	A way to provide values into the product.
	Mindmap (Tollestrup, 2004)	To give the product a spituel level.
DEFINE/IDEATE	Rapid prodotyping (IDEO, 2015)	Testing in a quick way to provide data and a better understanding of the product.
	Brainpool (Tollestrup, 2004)	To upon up the ideation with high speed.
	What if (Tollestrup, 2004)	To generate wird new ideas that was never thought about.
	Forced relationship (Tollestrup, 2004)	To create ideas in new directions.
	Combinatoric	To combine old ideas with new, into higher fidelity concepts.
	Integrate user feedback (IDEO, 2015)	To involve the user in crucial decision along the way.
	Build, mesure, learn (Steve Blank, 2013)	To learn from previously ideas and implement in new and better ones.
	Product specificaton (Ulrich & Eppinger, 2012)	To assemble all frames and requirement s that the concepts need to fulfil.
	Simulated use (Sperschneider & Bagger, 2003)	A way to test and extract new requirements.
CONCEPT	Selection matrix (Ulrich & Eppinger, 2012)	To validate each concept and thereby have a reason to choose a direction.
	Final specification (Ulrich & Eppinger, 2012)	To get an understanding of the demands and wiches the final product should fullfill.
DETAIL	The Business model Canvas (Osterwalder, 2010)	The get and understanding of every part within the business.
	Flow chart (Frank Gilbreth, 1921)	To get an undertsanding of how the inner part of the product should work.
	Product Architecture (Ron Sanchez)	To understand the basics of the product.

A02 - RYAN METCALFE - KOORDINATOR/LEDER KIMO DENMARK

RESEARCH PHASE | 23/01/19

The team searched for a specialist within the area of coastal marine litter. Ryan Metcalfe is coordinator and leader within the organisation called Kimo. This organisation main goal is to reduce the amount of marine litter in Scandinavia.

Interview topics:

- Existing problems within, removing plastic/waste on coastlines.
- Budget, investments and future economical aspects.
- Events and volunteers
- Existing solutions
- Existing/present coping strategies
- Network (municipalities and industries) example in Thisted municipality.
- Collaboration with KIMO

Transcribing (Recorded):

Daniel(0:37): In general i would like to talk about our situation and where we are in the proces. Furthermore if you have some real problems out there in the field when thinking about picking up plastic and waste.

Ryan Malcalfe(0:57): Yes, let me know you background, what your thoughts is about the topic and how long with the project your are.

Daniel(1:15): Yes. Well as i said in the previously mail, we are in the very start of the project, actually we have not begun jet, since it is stating 1. February. But we are reaching out to get knowledge about real problems that we could solve somehow. We are very interested in the different tools and methods, to pick up plastic/waste. We have seen that there is different machines that can remove a lot of plastic/waste on flat areas. But when it comes to the situation where you are working in uneven terrain, you need to go out there, manually and remove it by yourself. Well that is our perception of the situation.

Ryan Malcalfe(2:00): Yes, hand power in some way.

Daniel(2:04): This is where we want to try to improve the efficiency bye coming up with a solution that makes sense in this context. But we are not sure if this is an actual problem, because we don't have any professionals, in the field, who states exactly this. But it is only a problem that we have found through our current investigation which is mainly desktop research. So we need someone who can say that it is a real problem, and if it is not problem, then maybe this person can come up with a new problem. This is mainly where we are right now.

Ryan Malcalfe(2:50): Ok, well we have just runned through a project up in the north where municipalities like Hjørring, Frederikshavn, Thisted and Jammerbugt
Were actors in collaboration with us. Are you in Aalborg?

Daniel(3:05): Yes we are.

Ryan Malcalfe(3:07): Yes that would make it easier for you to visit this municipalities. It is a 3 year project(ren Kystlinje). The aim was a collaboration to gather/exchange experiences about disposal, collection and recycling of marine waste. It is not only plastic which is on the beach there is also a lot of other things wood, metal and such. With all this waste, we are trying to recycle as much as possible. But one of the biggest challenged we have is picking up the marine waste and then sort it afterwards. This part is difficult because it is not uniform, it is dirty and contaminated with chemicals. That's very challenging. Frederikshavn municipality have also tried things, because they have a lot of big stones or uneven terrain. If you take a beach in Varde or in Jammerbugt, the beach is very flat. They also have had some theme days, where they were showing machinery for everybody to see them in action. But because these beaches is so flat they are just using these machines and then sorting everything (Metal, marine waste and everything you can find). But Frederikshavn can't do that because of the terrain. So they need to use their hands and do the picking up and sorting manually.

Daniel(4:55): Okay, simple because the terrain is uneven and there is this kind of big stones around the beach.

Ryan Malcalfe(5:00): Yes, exactly. We were testing out if it was possible to use some machinery to do the job (both picking up and sorting). It is possible, but was financially problematic. It should sort sand away from the waste so it was recyclable. But we don't have money to focus on sorting the waste all the time. So it is all about the level of ambition in each municipality to have a clean beach. When we get wash ups of materials it could be all from microplast to transporting boxes to plastic bottles to Tv to refrigerator. So it could be anything. So it depends on what the municipality want. If they want to get rid of everything or if it is okay to leave the microplast and only the visual things gets picked up. There is also a lot of volunteer work. This part is what we try to promote.

We see a future in the volunteer work of cleaning beaches. Each year each municipality put a lot of effort in to this part (having volunteers to clean beaches). In the time around easter, there is a lot of events focussing on volunteer work. In this time i think also you guys have the best possibility so check out the machines they use in this context. Furthermore we are also in contact with these volunteer groups. I also think you could use that for further investigation.

Daniel(7:17): Yes definitely!. That is also a thing we have thought about. We have seen there is a lot of promotions that which are addressed to volunteers. We have seen a lot of events on social media and such. And we also see that this is kind of trending right now. So this part do interest of a lot.

But we did get the impression, that this topic (Picking up marine waste) was mainly along the west coastline.

Ryan Malcalfe(7:50): Yes the west coast is where we experience most marine waste. This is because of big sources of waste out in the northern ocean, fishing, container ships. So the eastern ocean dont have that much marine waste in it, but it is mostly tourist who trough trash or someone who just forget it on the beach. But this is another problem that we have focus on. We see that a lot of people just leave their trash on the beach especially in the summer. And i think it is more condensed with people and tourist along the east coast. There is a lot of people per square meter when it comes to summer.

Daniel(8:55): Okay, you talk a bit about the economical aspect of this problem earlier. This is also a very interesting part for us. Like how much money do you have in each municipality to work with this problem. How do the budget look like, what are kind of investments do you do and how are other future economical aspects. How much Denmark are using on this problem in general. Is this some kind of knowledge that you can give us?.

Ryan Malcalfe(9:25): Yes i have some older data/budgets that i can send you. But it is on some specific municipalities. I think the thing you should is to contact each of these municipalities to get some new data about the budget. And also ask them about their current policy, investment, ambition level. Because everything's gets refocused all the time. Some of the beaches is own by the municipalities but there is also private like "naturfreds foreningen". Some places just wait till some volunteers is picking up the trash and some others actually use huge amount of money. So it is very different from each municipality what their ambition level is. And if they are using machines or doing it manually. I know that in varde they use a lot resources on machines. Machines hours is a bit expensive. So there is a difference of how much they use compared to Frederikshavn. If they have a good collaboration with volunteer groups, that would also help on the budget.

But if you want to start somewhere, the municipalities who participated in the 3 year long project (ren Kystlinje) could be a good possibility to contact since this focus is fresh in their mind. Also because they have worked with this in 3 years they are maybe more committed and ready to help you.

Daniel(11:25): Yes and it was Thiested, Hjørring, Frederikshavn and Jammerbug?.

Ryan Malcalfe(11:30): Yes.

Daniel(11:25): Okay, then we will start by getting in contact with these municipalities. And hopefully try to get some new knowledge about budgets and such. So if it is possible you could maybe send us the informations you have about budgets.

Ryan Malcalfe(11:57): Yes i could do that. I will also send a link to the "Ren kystlinje" report and the contacts that i am in contact with up in the north.

Daniel(12:23): Okay that would be very nice. You also talked about events and such here in the beginning of easter, where they in some municipalities will show machines and have volunteer events with a greater focus of cleaning beaches. Or is the volunteering in the summer?

Ryan Malcalfe(12:55): Well there is some groups who participates here around easter and then there is some who arrange events in the summer. Example in skagen (Ren strand nu) which is an event that has been around for several years. There is also a group called (ren fanø strand) and also something called (ren ø dag). Then there is also a group called (samvirke), they will establish an cleaning event 9th of april in Varde which around 100 men will participate in.

Daniel(14:00): Well that sounds very interesting and something that we would like to participate in. Or at least observate.

Ryan Malcalfe(14:10): But yes i can also send you some links to some groups. I am going to make some monitoring by myself. But I need the setup the contact. The monitoring is three times a year, both i Skagen and a beach in Limfjorden and another place (Mindegær?), where I take 100 meters at the time. All the stuff I'm going to find is sorted and categorized. This makes us able to get an insight of these types of objects we find.

Daniel(14:45): Is it possible for us to get the in touch with or observe?

Ryan Malcalfe(14:55): Yes of cause, if I'm getting the contract, it will be no problem.

Daniel(15:00): Okay, we really want to get insight in how bad the situation is. So when you have the contract, can you send us some information about the clock and location?

Ryan Malcalfe(15:25): Yes, but it will take few month. The first time will apparently be in may.

Daniel(15:40): It sounds interesting. As mentioned we really want to participate in most of the activities, and we want to collect a large network to be able to get the insight in the context, in order to develop anything.

Ryan Malcalfe(16:05): We are three employees in both Skagen, Jammerbugten and Hjørring. There are some possibilities if you contacting theses municipalities. You can ask when they are cleaning the beaches, then you will be able to see how they are doing it in practice, with machinery and manually work.

Daniel(16:30): Do you have any contacts on entrepreneur companies?

Ryan Malcalfe(17:00): I know an entrepreneur company who is located near Aarhus called Ole Mikkelsen, who have Machine solutions from anything from oil- to paraffin waste. He was one of them who had a showcase with with these types of machines.

Daniel(18.00): Do you know anyone about this topic in Thisted? It's because that we have discovered that Thisted is one of them who are spending the most amount of money on cleaning because of "Cold Hawaii".

Ryan Malcalfe(18.15): In terms of "Cold Hawaii", the surfer community are very committed to keep the area clean. There is a company that has arisen who collecting plastic for the municipality and reuse it. But I don't know if it's the angle you are seeking.

Daniel(18:40): Right now we are quite open, but with a focus on collecting of plastic.

Ryan Malcalfe(19:00): The big problem is to sort the materials, because it needs to be as close as possible to each other before it can be reused. So if it's possible to get a technology which can sort and recognize the different plastic types and then clean it would help. Right now, most of it is send to incinerator and to make energy. Which are a okay solution (Straight economy). But if we talk about circular economy it would be here you should influencing, in the future.

Daniel(19:45): Do you see the picking up and sorting as where we can contribute with something.

Ryan Malcalfe(19:50): Maybe, but it certainly costly task. Maybe in areas where they have a huge problem with plast, would make more sense. E.g. In Asian where the beach can be completely covered by waste. But the technology could be tested in Denmark.

Daniel(20:40): Right now we have the in mind, a solution which can work in Denmark, but can be scaled to bigger scenarios as in Asia.

Ryan Malcalfe(21:10):
Yes, that sound as a good idea. I will also send a link to http://www.oceanplasticforum.dk/ which we are a part of through a engineer association in Copenhagen who had taken initiative to gather people who work in this area, with the purpose of find technical solutions to many of these problem. You could maybe get a some good contacts through this association.

Daniel(22:00):
The last thing is about collaboration between us. Our wish is get information about the context and your tasks and to be able to test our concepts in the context where you can maybe give us some concrete feedback.

Ryan Malcalfe(23:00):
You are welcome to participate in the monitoring task and if you want to participate in some purifications then I would recommend you find some people who are working on the location in the northern jutland. There is a great guy in Frederikshavn called Steen. He is a project developer in the municipality of Frederikshavn, and he has working a lot within "Ren kystelinje" the last few years, and he had doing some test on the beaches in Frederikshavn. So he should know some things about what works and which does not work. So he might be the man to discuss ideas with. But if you have any questions you are welcome to contact me again.

// OUTCOME

- New contacts (Steen Heftholm, Jens Baggesen, Henrik Damsgaard, Ulla Nielsen, Preben Nielsen)
- Existing solutions that work mostly within flat terrain
- The Westcoast is more exposed to marine litter than the Eastcoast.

A03 - STEEN HEFTHOLM

RESEARCH PHASE | 8/02/19

The purpose of meeting up with Steen Heftholm this early in the process was to get a different point of view, from a professional who is used to deal with the problem, marine littering. Since Steen Heftholm is known as the idea man, by the community(people dealing with marine littering), we thought he could kickstart the project by telling his vision of how this problem should be solved.

As a usual meeting or semi-structured interview, we had established a questionnaire that we could follow. This enables us to control the meeting and to ensure that we got answered all the questions that we want answered. By implementing sub questions while doing the meeting, enabled us to gather even more data and to make it more fluid and comfortable.

FACTS:

- When does the danish municipalities acting on the marine littering

The impacts before the municipalities along the coastline take care of the marine waste is when the wind/weather and the amount of waste in the stream hitting the beaches.

- Norway pay the danish municipalities (Help other countries by collecting their waste)

The waste stream goes along the danish west coast and later ending up in norway.

- Marine littering value

What's the value of the marine littering? Why would anyone take this marine littering (beside environmental thinking)?

- Recognised companies are interested in this marine littering

Big companies want this in order to create a CSR (Corporate Social Responsibility) (A way to be well looked by their customers offering a social well-look action). Used as a marketing strategy.

- Collect marine litter it's expensive

it requires equipement / Men power / Machinery / Diesel oil

- The owner of the problem

Being a public space, the problem it's owned by municipalities, which have to approach it in order to beneficiate the tourism (they want the places they visit clean) and also due to an environmental issue (that's less important for them)

- Volunteers "rewards" method

Volunteers and NGOs organisations still cost something to municipalities. municipalities use a "Reward" method in order to get more people on the cñeaning coasts task. (Ex: Surf schools free classes or so.) Also rewards between Norway and Denmark (Win win method, "I give offer you X If you help me with X").

- Tourism claims for clean coasts

They have received disclaimers from tourists or tourism related business in order to solve the problem in case of litter in the coasts.

- Not all plastics can be used after being marine littering

These plastics may be contaminated and so unable to being reused in some cases.

- #PlasticChange

NGO company which wanted to solve the problem of marine littering creating something and en up just providing awareness to organizations.

- Trash Cans

Not always are enough to permit to put all rubbish on it. Trash may be affected by wind and moved to the sand. Also, seagles move it around while searching for food.

- Governments pushing industries

Governments are asking the industries which produce with inadequate materials to change them to a less environmental impact ones. (Asking or forcing?)

- Remove waste in the morning

In Frederikshavn municipality they remove the marine waste in the morning before the tourist.

- Recycled plastic

In Denmark can be used to create new plastic or to create oil (burnt) (Heat & Electricity) while in England for example it cannot be burnt, so that, Denmark imports england waste to burn it in Denmark.

- People in charge to pick up marine litter

It's people from the same municipality, just in one case they use external companies for it. (You win around 1000 DKK / tone of litter). The main problem it's to source this material found.

- Amount of marine littering

It depends on the marine currents and the wind. When there are more of these then more marine litter.

- "Certificate" Label

Companies are seeking for "certificate" to catalogue their products as products with X added value (Ex: SAS was seeking for certificate to declare their company the most environmentally friendly).

- Leasear tourism

New trend of people traveling for free to exotic places in order to clean up.

QUESTIONS/VISIONS:

Classified stamp on product to make it authentic
B2B story selling, then to the consumers.

Selling area/location classification stamp.

Blue washing strategy

Metaphor: Make marine litter valuable as amber

Which plastics can be reused after being marine litter?

Price on 1 ton marine littering vs 1 ton of new plastic
How to calculate the price of 1 ton of picked up marine plastic vs produced plastic.

Make companies have a demand on marine littering to improve their brand and sales chain.

From marine waste to gold.

Is there any mixed plastic waste material?

Reduce costs or increase costs?

What you can win with 1kg of marine litter?

The value of make it visible that we helping the environment
Could maybe nudge people to participate or make them clean up by them self.

Steen Heftholm is a visionary. By saying this, we mean that he look at the whole world and how it gets affected by plastic, in the oceans and on the beaches. The solution to the problem is also a worldwide solution. The outcome of meeting was therefore very visionary. In addition to the outcome, we now see the problem with different glasses since it can be attacked in a lot of different ways.

// OUTCOME

- New contacts (Aage vestergaard larsen and Kenneth Mølbjerg Jørgensen)
- An economical point of view.
- What Frederikshavn municipality do in the war against the marine coastal littering.

A04 - JENS BAGGESEN

RESEARCH PHASE | 12/02/19

Jens Baggesen is working at the Hjørring municipality as a leader above nature employees, who are going to clean the coastlines along Hjørring. Jens`s job is to manage how to clean properly, strategy and who is going to clean where. A small interview, 1 hour, gave a lot of insight within the area:

They only concentrate on flat areas, since it takes too many resources to clean the sand dunes and uneven areas.
They use 1.3 miles each year on cleaning coastlines.
There are 3 guys who are cleaning the coastline along Hjørring in a daily ratio.
With not that many resources, they are only using a tractor to drive down the coastline, stopping and then picking up waste and then trough it in a trailer.
Volunteers use their hands and only a plastic bag as a tool. Some might use the handheld one (snapper).
The financial aspect within the area is critical and it is hard to find a business case.

// OUTCOME

- Work limitations in uneven terrain
- How many resources it takes to clean the coastline
- What is the most common type of waste they see on the coastline

A05 - RIKKE PETRI FRANDSEN DTU AQUA

RESEARCH PHASE | 22/02/19 - 20/03/19

Rikke is working at DTU aqua as a scientist within the area of marine litter in Denmark. The team search for even more knowledge within the area, specific knowledge that Rikke without doubt, could give us.

Interview topics:

What kind of problems do you see within the professional fishing industry and sparetime fishing?
Which of these two fields, produce most marine waste?
How big is the problem "Ghost fishing" in Denmark?
Can we arrange another meeting when we have established a focus?

Transcribing (Not recorded):
First interview (22/2)

There is a lot of problems regarding the ecosystem in the oceans. If we take a walk along the danish coastline there is a huge chance that we can find small orange strings. These is from the fishing industry in Holland/ Netherlands. They use Dolly ropes when fishing, which is a fishing technique that allows the fishers to fish in the bottom of the oceans. But dolly ropes gets wears up and thereby releases a lot of small orange strings in the water that ends up on the coastline in countries close to holland.

When talking about the danish professional fishing industry, it is more about general waste and if they pick of marine litter it just goes out in the water again. Marine waste from the danish fishing industry is lost fishing gear, pieces of fishing net and strings, polystyrene boxes and more. Hanstholm fishing industry have a hugh focus on marine waste and thereby trying to reduce the marine waste trough there fishermen.

It is unknown who is producing the most marine litter but, sparetime fishermen are more likely to trough there equipment i the nature because it is much cheaper. Ghost fishing is not that big in Denmark compared to other asian countries, but happens a lot all the time. Since there is no rules of how sparetime fishermen should act in the nature it is a problem and the easiest way to get rid of their fishing waste just by throwing it away.

You can call me next time you have a more specific focus and then we can talk more in depth with in this.

Second interview (20/3)

Trap-fishing is one way to fish for lobsters or crabs, but it is not the most efficient one. In Danish waters, we use mostly bottom trawlers. But we are only able to use these because of the flat seafloor. If we are located in Sweden or Norway, we have a whole other seafloor, with a lot more uneven terrain. This mean that you are not able to use trawlers. If you are looking into the difference between the two fishing methods, then we have a slow but very friendly environmentally way of doing it and then we have the trawlers. Nearly 40% of the catch with trawlers is a misscatch, which mean you catch fish that you don't want. Anyway, it is also very bad for the environment, since it is destroying the seafloor.

Losing traps is a problem that you find in Norway, Sweden and other countries where trap fishery is the primary fishing methods for lobsters and crabs. It is not a problem in denmark, but it might be in the future since Denmark are looking into new and more friendly environmental ways of fishing. 30.000 lost traps each year in Norway sounds realistic, because it is a big problem and not only in Norway but in the whole world. As it is now, the fishermen can't do anything about it. If a trap or a line traps is lost, they only have one thing that they can try, but with a small chance of success. Using the anchor to pick up the traps, if that doesn't work, it is just reported and then left behind. Ons a year, a big ship sail out to the positions where there might be lost equipment. The success of retrieving equipment is high, but it takes a lot of resources and man hours. Professional divers is needed, but sometimes it is not possible to retrieve anyways.

I think the two most common ways, a line of traps can disappear, have something to do with the long line between the traps and the buoy. Because of streams down in the water, the line is very likely to wrap around things. If it when wrap around a big rock and the fishermen then pull in the line with their hauling tools, the line will break. Propeller cut off, as you mention, is also on of the common ones.

// OUTCOME

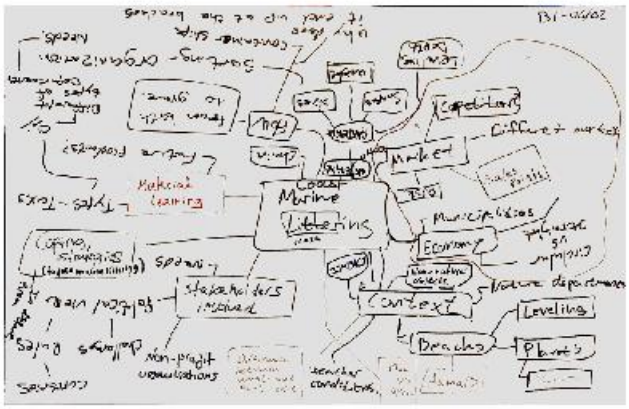
- The most common reasons why traps get lost
- A huge amount of traps is lost in Norway each year
- The problem is bigger in Norway and Sweden

A06 - Brainstorm - Research area

RESEARCH PHASE | 06/02/19

We wanted to open up the research area (convegating). Furthermore, to get a understanding of the aspects that we should look into at the current stage in the process. At least to align, such as each of the team members view on the context, problem and general picture is more equal.

Each member had a pen in a certain color. A brainstorm was made with a header in the middle (Marine littering). Each member than had to write down what comes to mind when thinking about this topic. Doing this with a focus of investigation.



// OUTCOME

- Ideas to field studies
- A much larger research area.
- Discussion upon certain topics, which lead us closer to an alignment of the understanding of the problem.

A07 - HJØRRING COASTLINE EXPERIENCE CONTEXT

RESEARCH PHASE | 12/02/19

One of the most important things we wanted out of this exercise/ test, was to experience the context. Turn the imaginations into real memories and thereby get a better understanding of the context. This would improve our argumentation within the field. Lastly, getting closer to the core problem and experience on our own body.

We arrived at Tversted strand at 10:15. The first thing we did was to get an overview of the equipment that was suited for the volunteers. A box with, plastic bags and one handheld tool, in it, was the first thing that we noticed. Afterwards we collected some plastic/ waste on the flat area which is where most volunteers and the nature employes is doing their work. Half an hour after we did the same thing in the uneven terrain.






The outcome from this exercise is fundamental and is very important for the project. We experienced that collecting waste in flat areas with no obstacles, was a lot easier and manageable than collecting waste in the uneven terrain (sand dunes). It is not only the terrain which makes it harder but also the obstacles like bushes (Rosehips). Furthermore, it is a lot harder to get an overview when working in a uneven terrain and you are left back with a feeling of uncertainty, that you don't know if you collected everything. The time it takes to collect waste in the uneven terrain is nearly double by the time it takes to collect in even tarrien.

// OUTCOME

- Collecting waste in even terrain is a much more manageable than in uneven terrain.
- Tools for volunteers is limited.
- None of the waste we found in the uneven terrain is going to be picked up since it is no one's responsibility.

A08- PICKING UP TRASH

RESEARCH PHASE | 12/02/19

One of the most important things we wanted out of this exercise/ test, was to experience the context. Turn the imaginations into real memories and thereby get a better understanding of the context. This would improve our argumentation within the field. This test should also give the team an idea of how big the problem is.

Field study

To get a real understanding of the problem and figure out how big the problem is, the team needed to set a test that could show how much waste was generated within a certain area. Furthermore to get an understanding of how much time it would take for 3 guys to pick up the trash. This could give insight into the economic perspective of the problem and the resources that were assigned.

The exercise was mainly to mark up an area, remove all the trash within the area and take time, to see how long of a process it is. The team marked up an area of 20x20 and afterwards 30x30 at 2 different places. This generated a pile of trash as shown in the pictures below.

20 x 20m

20 x 20m

Generated waste in even terrain of an area of 20m2

30 x 30m

30 x 30m

Generated waste in even terrain of an area of 30m2

The team also wanted to do the same tests in an uneven terrain to compare the 2 situations. The team marked up an area of 30x30 two times at two different places.

This also generated a pile of trash. It was noticed that the most common materials in the uneven terrain were very light materials.

30 x 30m

Generated waste in uneven terrain of an area of 30m2

Even terrain 30x30 took 8:02 minutes for 3 guys to clean.
Even terrain 50x50 took 10:15 minutes for 3 guys to clean.
Cleaning even terrains ends with a feeling of good overview and certainty.
Uneven terrain 30x30 took 15:07 and 14:58 minutes for 3 guys to clean. Left back with a feeling of uncertainty.

// OUTCOME

- Cleaning even terrains ends with a feeling of good overview and certainty.
- Cleaning uneven terrain, left back with a feeling of uncertainty and no clear view of the situation.
- Light materials in the uneven terrain is the most common

A09 - CATEGORISING WASTE

RESEARCH PHASE | 13/02/19

The team generated 2 bags of waste from the privious days exercise. This waste need to be sorted so the team can extract knowledge and important information. To see what kind of waste we would find in the uneven terrain vs the even terrain. To get an understanding of the size, weight and type of waste. Maybe to discover a pattern that would help the team in the right direction.

Starting by sorting after type of materiale. First going through the two bags with waste that we found in the even terrain. Afterwards going through the things to try to categorize the waste in specific categories. The same thing we did with the waste from the uneven terrain. Sorting of waste is difficult because of sand, oil and dirt that makes the plastic impure.

Light items is flying up in the uneven terrain. (porexpan, light plastic parts, fishing net and plastic bottles). Half the waste that we found in the flat area, we found in the uneven area. Heavier items stay in the flat area. There is different sources who produce marine littering (Fishing industry, Consumer or turisme, container ships, bottles from england, others).

// OUTCOME

- The fishing industry was the main source of marine litter that was found.
- Sorting is a difficult task because of sand and oil.
- The waste was basically different types of plastics and glass bottles.

A10 - BRAINSTORM ON SOURCING OF MARINE LITTER

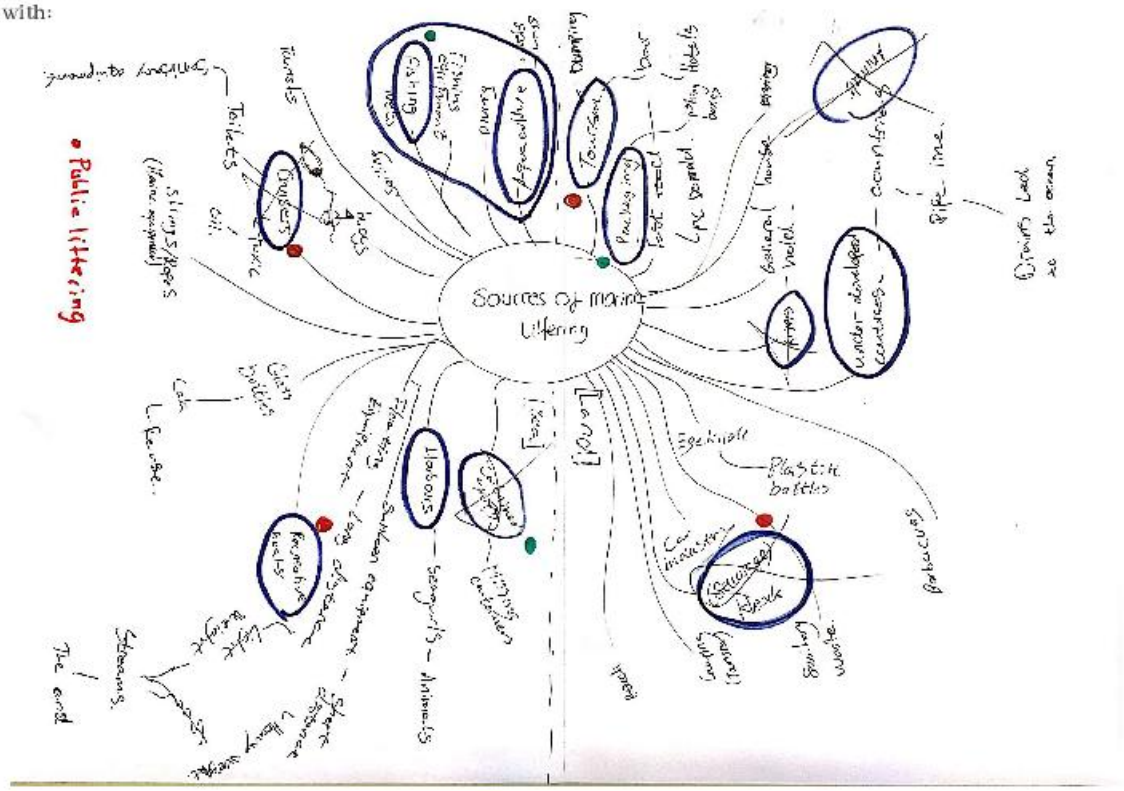
RESEARCH PHASE | 19/02/19

After categorising the marine litter found in the previous field study (Worksheet No.:4) in which two different areas were used as a test to pick up marine litter in Hjoørring coastline. We wanted to know the main sources of this marine littering found and as well other existing sources of marine littering.

In order to find all possible sources we did a previous desktop research to find the main sources focusing on Denmark and the surrounding seas. Afterwards we did an internal timed brainstorm in which we write down possible sources based on the research done. With it then we clustered and validated the most relevant areas in which we could focus the project. We divided the sources into two main groups: Sea based & land based sources. Found the most relevant marine littering sources to work with:

Fisheries industry, Harbour cleaning & under-developed countries littering. Selected Fisheries industry as the main source to work with as it was one of the main source of marine litter in Denmark. Obtained an overview of where all the marine litter comes from. It provided a way to dive in to the marine littering sources.

Opened to new areas which weren't considered before the brainstorm.



// OUTCOME

- Fishing industry seems like the main responsible of marine litter in Denmark.
- A business case could be possible within the fishing industry
- Other fields which create interest as a possible source of marine litter: sewer and tourism.

A11 - TRIP TO STRANDBY (FN 462 JEANNE)

RESEARCH PHASE | 20/02/19

From the sources of marine littering, we chose to discover the commercial fishing industry. We needed to get in touch with some expert users and to get an insight into the working process. Therefore the team took a trip to standby to talk with commercial fishermen to get their point of view and to see if new parts of the problem would show it self.

To get in touch with the commercial fishers we visited three harbours along the coast(between Aalborg and Frederikshavn) by doing an informal meeting. We did this because it can be difficult to know exactly when they are in the harbours and they are not always in the same harbour. The first thing that the team noticed was the huge piles of broken gear as shown below. This gear was brought back to shore but a lot of the gear gets abandoned at sea.

This gear needs repairing or then it is going to get recycled. In some situations, it might be easier and more economical correct for the fishermen to just buy new gear depending on the quality. Some nets can reach a price of 1 million with trackers implemented.

We were then invited on board on an older trawler boat and an on a new one. Tage Sørensen was the owner of a big trawler boat called FN 462 JEANNE which can be seen in the pictures below. Trough an interview with Tage gave the team important insight within the economical part of the fishing industry. Furthermore, they focus to not trough out waste in the ocean but it might happen since it is the easiest way to get rid of it.

Sale price for old trawler ship 8 million DKK
Buying price for a new trawler ship 25 million DKK
Annual turnover about 15 million DKK, 50% of the profit goes to the company/boat - The rest is distributed on wages.
Insight in the process fishing process of the old boat and what are optimized on new boat. Ergonomics - Lifting. Fewer process. Lower fuel consumption. Larger storage.

Trawler reels.

Trawler reels.

Picture of the new trawler fishing boat FN 462 JEANNE.

// OUTCOME

- A new expert user within consumer fishing (Tage Sørensen)
- Economical insight within the fishing industry.
- Equipment in use are very expensive.

A12 - IDEATION 1, EXPLORING THE SOLUTION AREA

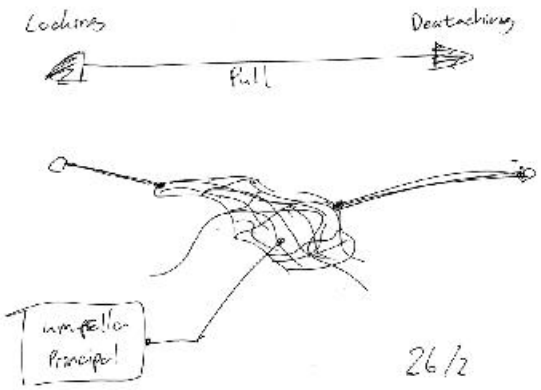
RESEARCH PHASE | 26/02/19

To get an understanding of the solution space and explorer new ideas or principles that might help in the given situation. Furthermore to create questions that we want answered from the main user and experts within the field. Lastly to obtain an alignment within the team.

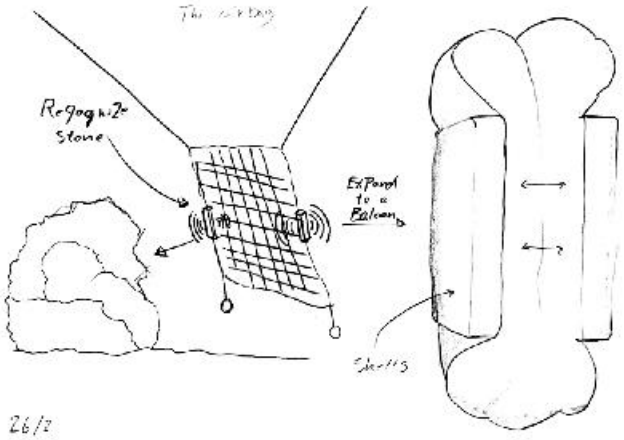
The first step was to fastly create some ideas that could be discussed. This first round was "free sketching" without any role or frames, but only the problem to solve. Afterwards the ideas was discussed, resulting in a list of questions that. The ideas was clustered in different categorize pro-active, in-act and after act.

A second round of "free sketching" was performed since the team still had a lot of ideas in mind. New ideas were discussed and generated even more questions. Sketches are listed below with small describing sentences. The categories will be presented in the following order: Pre-act, In-act and after-act.

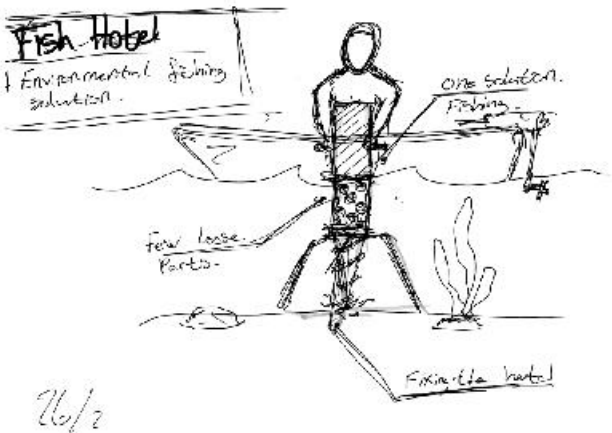
Pre-act



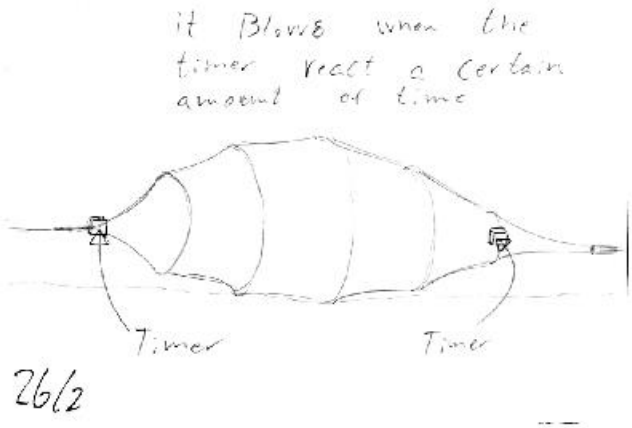
Enables the ship to pull in different directions to allow the fishermen to retrieve their gear.



Small airbags at each end of the net, that will blow up if the product gets to close to a rock.

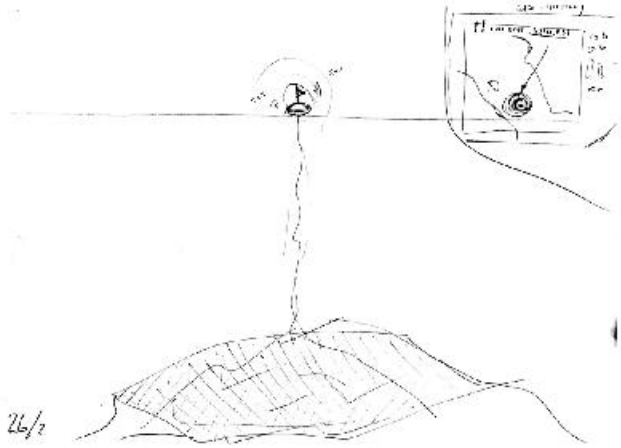


A way to fix the product into the ground, by drilling.

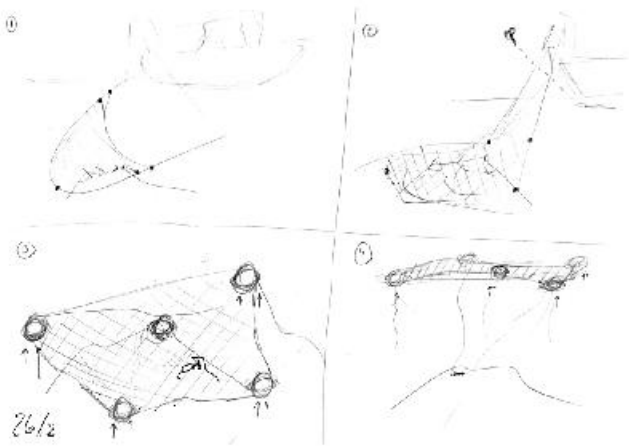


Small airbags that will fill up the rose. Reacting by a timer to ensure it doesn't stay underwater too long.

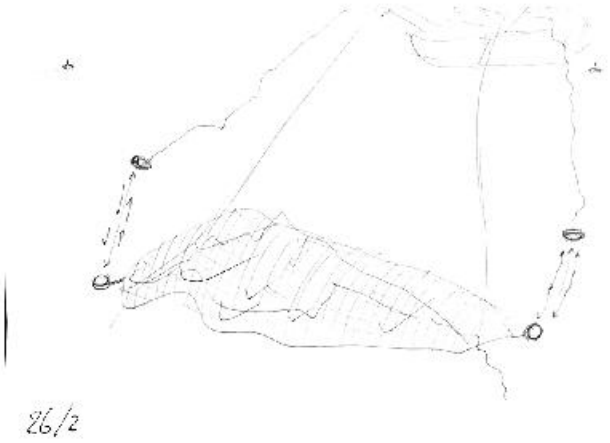
In-act



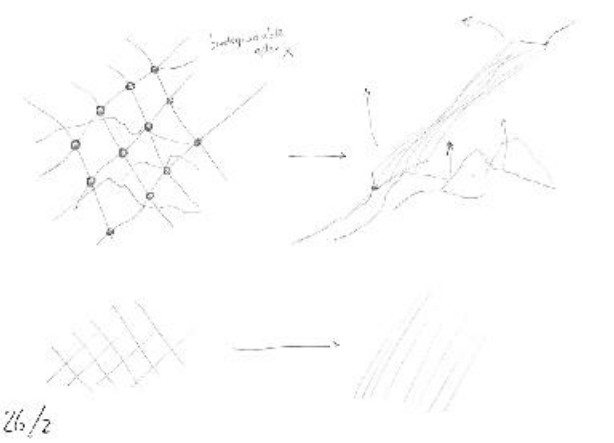
A small secondary buoy that can pop up to the surface and send a signal " here I am".



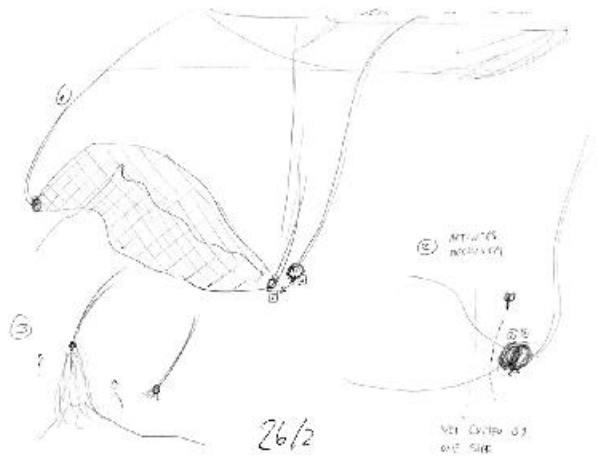
Small balloons that make the equipment float.



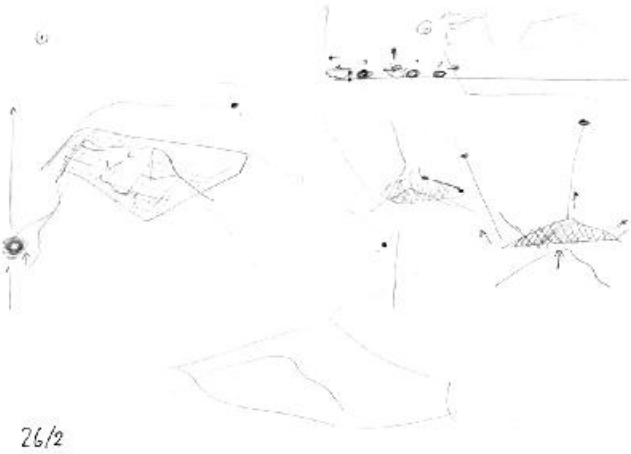
Attaching magnets at each end of the net and thereby having a chance to retrieve the equipment again.



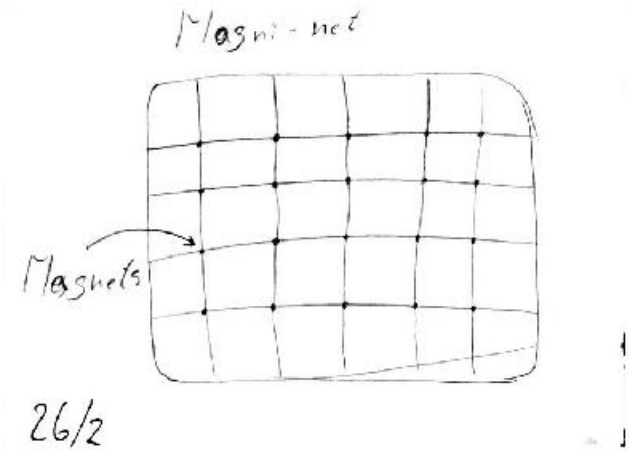
Breakable stitches or joints, that can easily be united again. To ensure that they get broken before the fisher loses the gear.



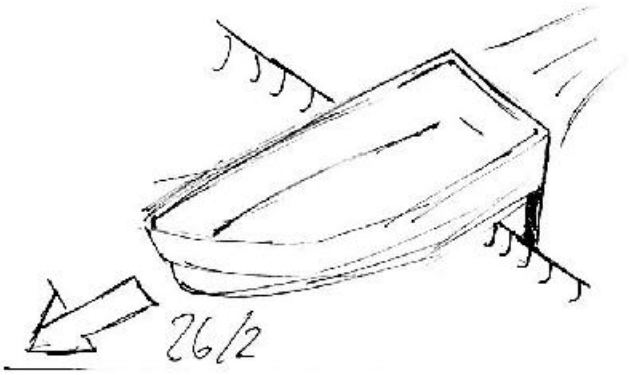
Small electromagnets which can be controlled by the fishermen and attach to the metal joints in the lost equipment.



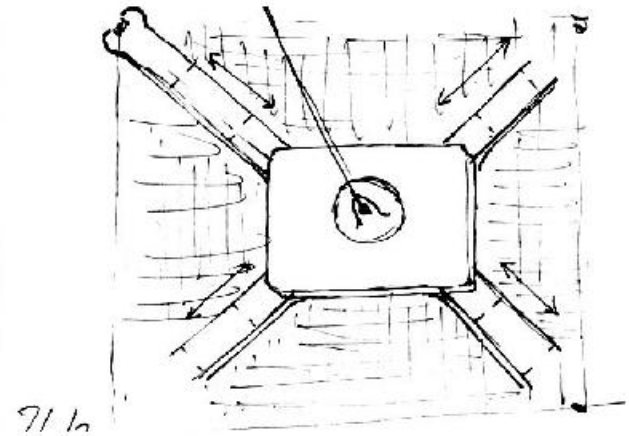
Ballons that keeps the equipment stretch out to avoid it getting stock.



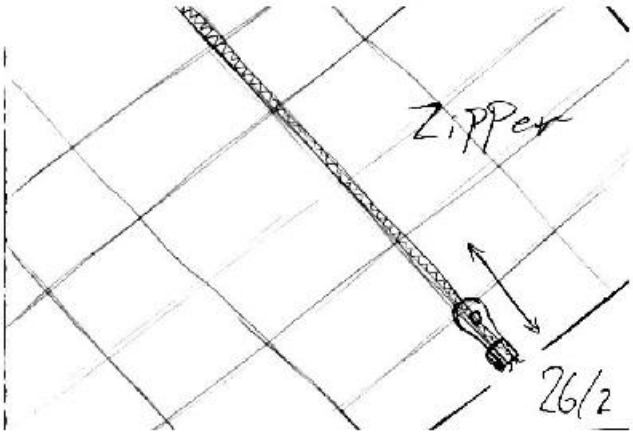
Magnets in every little joint in the equipment, which can get deattached and attached again.



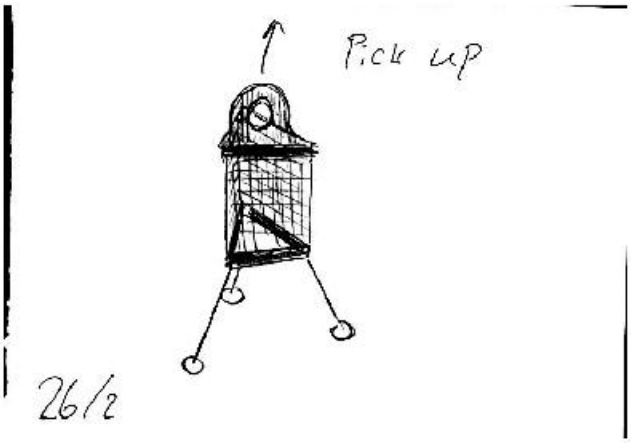
A row of hooks is attached to the boat which allows the boat to retrieve gear.



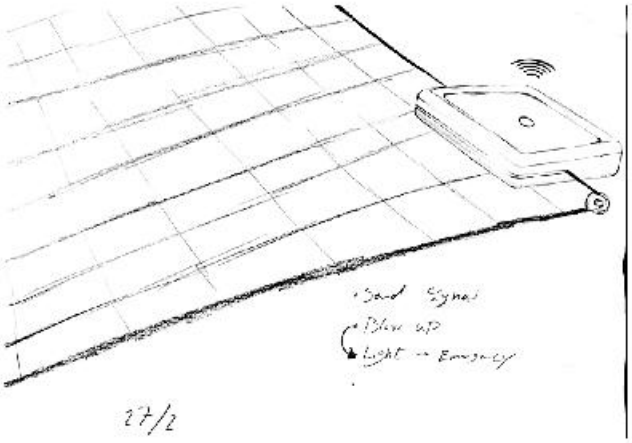
If the net is stock in the water around a rock, this concept can stretch it out to release it again.



A zipper is attached to split the net into 2 or 4 pieces, so it can get free from rocks.

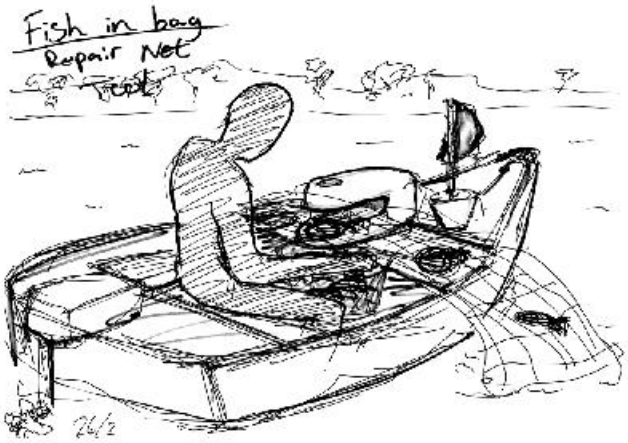


A metal creel with 3 legs that enables the recreational fishermen to just put their arm down the water and pull up a bag of fish.

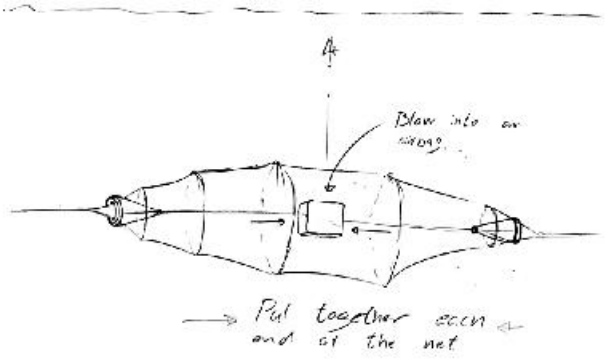


An emergency tracker which is applied to the nets. This can send a signal, blow-up and send out light when it has reached the top of the water.

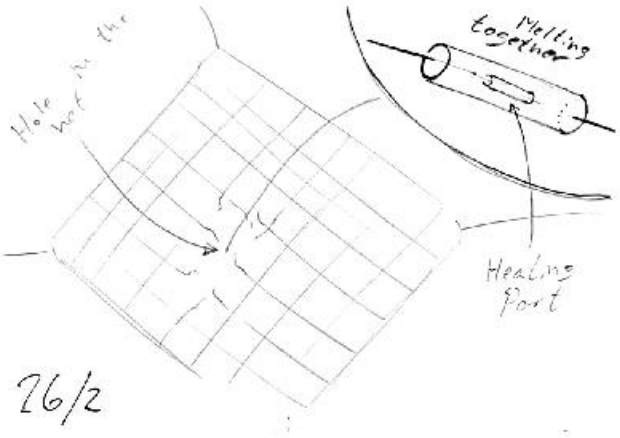
After-act



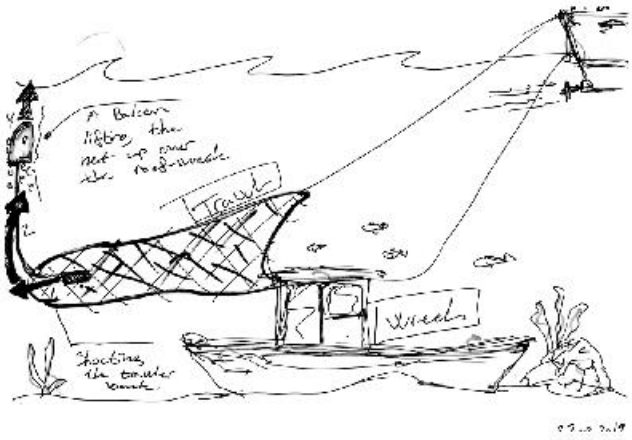
A transportable repairing tool like a sewing machine, that the fishermen can bring them.



An airbag which gets deployed when it is exposed for certain stress.



A handheld tool to quickly repair nets and other equipment, be having a heating source that melts broken pieces together.



A balloon which gets shot out from the net and thereby lifted up the net before it hits the wreck.

// OUTCOME

- 20 questions was generated.
- 22 new ideas was generated.
- A better understanding of the problem and a alignment among team members.

A13 - VISIT THE COMPANY STRANDET

RESEARCH PHASE | 01/03/19

To get more involved and know more about a business strategy around marine littering. Also to get inputs on the focus of the project and open to new opportunities to explore. Strandet is one of the few companies which survives within this field. Since marine litter isn't a problem that is owned by anyone it is hard to build a business case upon it, this is why it is important for the team to talk with the company Strandet.

Visited Thisted (Voørupor) to meet with STRANDET is a company which collects and processes marine litter creating high-value products using marine plastic. The company it's also developing new strategies to be implemented in the field and trying to expand around Denmark in order to create a solid structure to be able to act against the problem or to focus it with another perspective by using a circular economy strategy.
We had a meeting with one of team member of the company, Jens Wilhelm Jørgensen. We asked him different questions we had on mind regarding the business strategy they followed for the company and the problems they see in the field as well as the opportunities for us to create something to help in the field.

- The main reports found are just based on "big" plastic, so, the amount of trash in the sea it's even higher than what reports mention. Aswell, there's marine litter which remains in the deep sea which it's not reported.
- The main source of litter in Denmark also comes from England, Holland and Belgium.
- STRANDET mainly wants to show to the people that the problem exist in Denmark and they have to be part of the solution to it.
- Fishing boxes are a huge source of litter in Denmark.
- Plastic it's the most common material found as marine litter in the sea.
- They have an agreement with Thisted Kommune in which they get all the fishing boxes found in the coasts and clean ups and they give it to STRANDET in where they process this material (Cleaning and recycling creating new products).
- Plastic it's the challenge to face. But, it's not about to get rid off plastic, it's about how to re-think plastic strategy.
- Circular economy it's the key for a plastic strategy.
- The main challenges in the re-use of marine littering field it's on the Collection/ Sourcing/ Cleaning & Recycling.
- The cost of marine plastics it's much higher than first use plastic. Future view of the value of this plastics. Many companies are getting really interested in the use of this plastics.
- This field it's moving really slowly, so, it's difficult to create a business upon it right now. But, it's increasing along the times. By now, awareness it's the main direction

STRANDET

- The clean of the plastic picked up in the coastlines it's a challenge as right now there are not specific tools for it.
- The developments on the field right now are moving in a small scale. So, the market or business on it has not been highly developed yet.
- Biodegradable plastic also has drawbacks as it also needs to be processed and generates CO2 anyways.
- There's a company which rents fish boxes to fishermens, then they don't have to have it to have with them and take care of them. But it creates a need to keep them on board as if not they would have to pay if the lose them.
- There's also this project named Ocean clean up in which Maersk it's involved.
- In the actuality there's just political talk about marine littering strategy but there's no real action on it.
- STRANDET as a company mainly wants to 1- Show that the problem it's also in Denmark, 2- Create awareness about the topic and push authorities to fight against it, 3- Create awareness in the upcoming and existing producers, 4- Create value on this plastic coming from sea.
- The consumers plastic it's one of the most difficult ones to work with. Just the 9% of consumer plastics ends up being recycled.
- As a company STRANDET's goal would be to be obsolete, then would reflect that their action upon the problem has worked well. They would find other areas to work with to continue the business (change of strategy).
- Municipalities are mostly interested in to get involved into this topic for get know by media and attract investors and tourists. They want to gain community value by "Recycling". But, they don't have resources for it or they prefer to spend these in other things.
- Renting nets would make it valuable for fishermen but they already care about their nets because them are expensive.
- The main problem of nets from a perspective of using them as material to be recycled and reused it's a difficult task as nets are difficult to clean & recycle.

- One of the things they are exploring it's the use of marine plastic to 3D print. Future business on marine plasti use perspective.

// OUTCOME

- The worst type of marine litter is the one which lies on the bottom of the sea. This is hidden away
- To build a business case means close collaboration with municipalities.
- Reusing marine litter have a lot of potentials but the cleaning process is too expensive.

A14 - TRIP TO THISTED

RESEARCH PHASE | 1/03/19

The team used the same strategy as on the trip to Strandby. To get out visit the context and hopefully get in touch with fishermen that provide knowledge or even become a contact that could be used later on in the project. The main purpose was to observe and figure out if the fishermen have solutions to keep track of all equipment that they have on the boat, to minimize the risk of lost gear.

Throughout the trip, it was possible to get in touch with fishermen. It was not possible to create a contact that could be used later on but it was possible to visit their boats and see their equipment. This leads the team forward in the process. Pictures are listed below with comments of the things that the team noticed.

Placement of buoys seems to be placed in a risky way. Hauling tool in front.

Typical boat from the old commercial fishing industry. A lot of these boats is still on the water and works fine. In front is the hauling tool for nets.

Free equipment, like fishing boxes, milk boxes. Things that get a mentioned from the visit with the company Strandet (See A13).

Robe and other equipment just lie up the side of the boat without any fixture.

Free buoys up against the wall.

Free buoys up against the wall.

A huge pile of rope, nets, boxes and baskets, without a fixture and thereby it can easily fall off when the fisher is out on the sea.

Buoys placed freely in the corner of the boat.

Buoys placed freely in the back of the boat and sticking out.

// OUTCOME

- No tool or product to fix equipment, which results in equipment just lying around.
- The smaller the boat the higher the risk of losing equipment.
- There are different types of hauling tool depending on the equipment in use.

A15 - NØRRESUNDBY RECREATIONAL FISHING ASSOCIATION

RESEARCH PHASE | 06/03/19

The main purpose with this interview was to get indoor and be able to get a tour with a recreational fisherman within the working process.

A friendly small talk; To be able to meet up with them again.
We did unstructured interviews to open up for more insights.

Questionary and average answers:

How long have you been fishing?
+/- 20 years

Which types of methods do you use?
Hoop nets for eel's

How long did it take you to learn?
It's about continuing experience you have with the other recreational fishing mens.

Why do you exercise this method and not others?
It's because of the regulation and rule the very strict rules by the government.

Yearly cost?
Club expenses = 2900 DKK
Recreational fishing license = 300 DKK
For each hoop net = 2000*4 hoop nets = 8000, 8000 / 3 lifetime = 2600 DKK per year.
Maintenance of boat/motor = 2000 DKK
Total cost per year (estimated) = 7800 DKK

What makes recreational fishing interesting?
To be on the water when the sun goes up - that is peaceful! And then the social life and the events we have.

When do you have enough fish?
Until it covers the whole year (Hopefully) - You are not allowed to sell the fish only for own use.

What do you do with the leftovers?
Freeze them

How many times a week do you fish?
In the season it nearly every second day.

If I should start recreational fishing, what does it takes?
The legal equipment and the amount you are allow to use - which you can find at fiskeristyrelsen.dk.

Have you seen any changes or new trends?
There are a very low amount of eel in our area compared to 20 years ago.

Which is the most difficult process?
To repair and craft your own nets.

Which fishing method is the most common?
In our area it is loop nets and gill nets.

// OUTCOME

- A book with a detailed description of how creels and other traps are using within the fishery.
- A lot of the fishing association around in Denmark consist mainly of old fishermen.
- An opportunity to get on board with an old fisher called Frederik who are using traps.

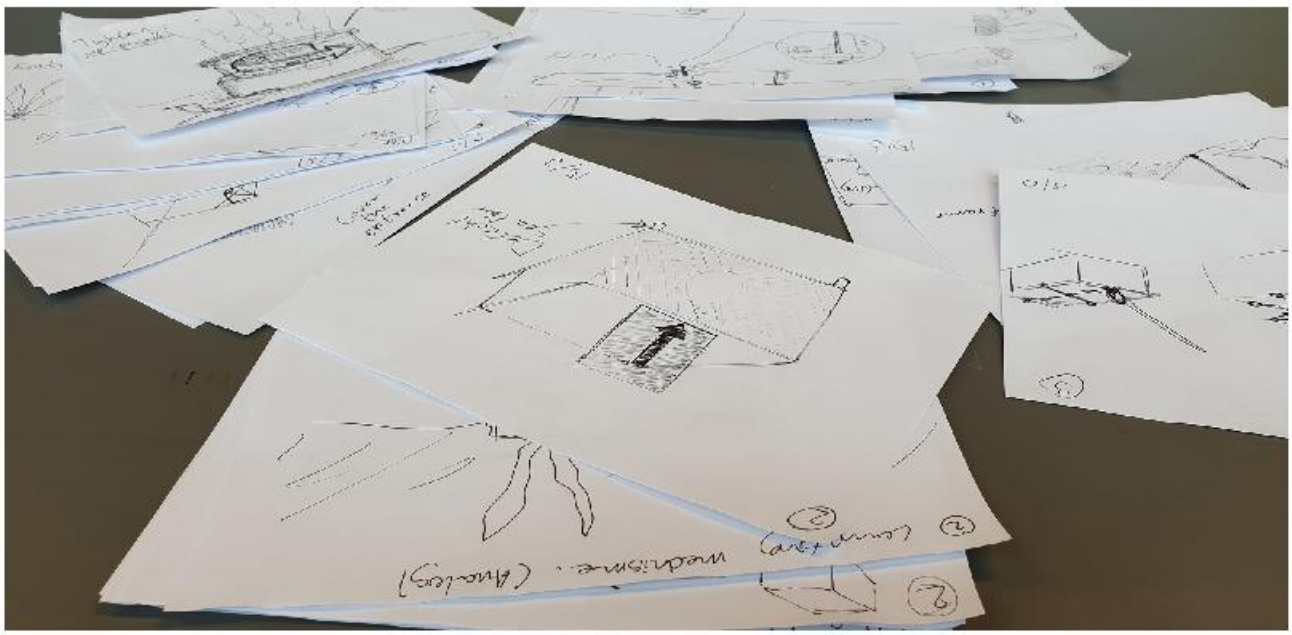
A16 - SKETCHING POOL

DEVELOPMENT PHASE | 14/03/19

Having the previously sketching round ideation 1 (See A12) in mind, we now wanted to supply with new ideas in a fast and effective way. This time we didn't want to create questions, but just start generating ideas that could turn into a concept. The main goal was to discover principles that later on could be mixed together to create a working concept.

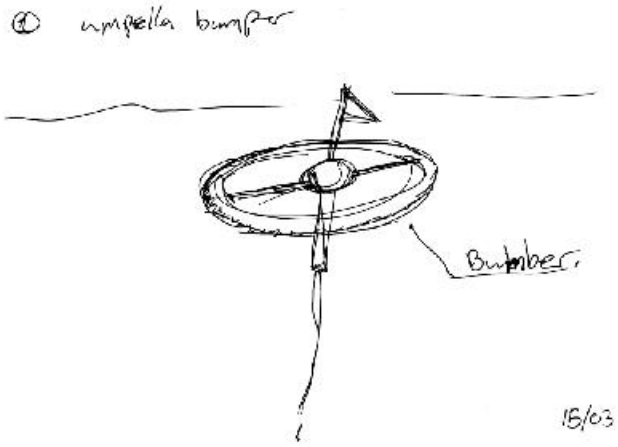
The first part of the sketching pool was free sketching for 10 min. The second round, you were allowed to sketch on already existing ideas, or just create a new one, for 10 min. A discussion was made upon the ideas that were created and later on principles was extracted.

All the generated sketched was clustered into categories. Transform, detection and information, Bumper, magnets, human interaction and closing. Ideas are explained in the following pages with comments underneath.

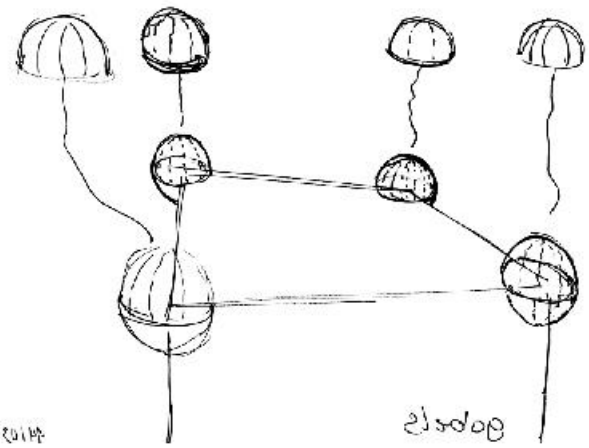


Principles extracted:

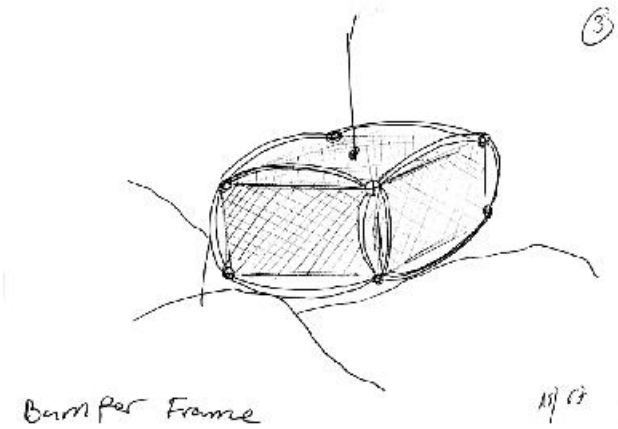
Transformation, flat packed to something with more volume.
To enable stackability and get from a quite to a product that generated a lot of attention.
Guid rope. Using a thin rope to guide a thicker rope down to the product. To save space within the flat package product.
Generating air in a chemical reaction
Easy Attachment. Click to attach.
Bumpers to absorb shock.
Light or sound to attract prey.
Sandbags to change upforce and downforce.



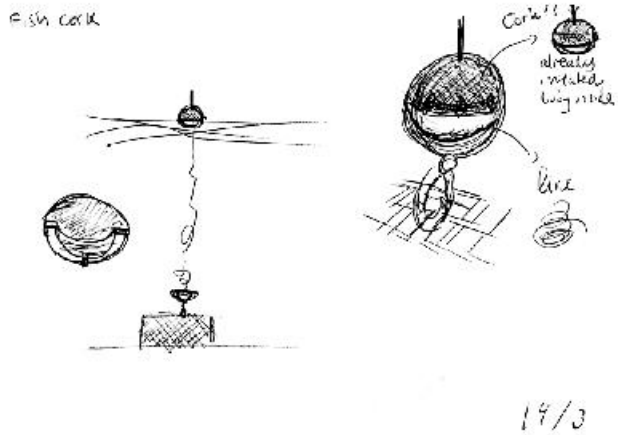
Creating space between ship and buoy to prevent propellor cut-off.



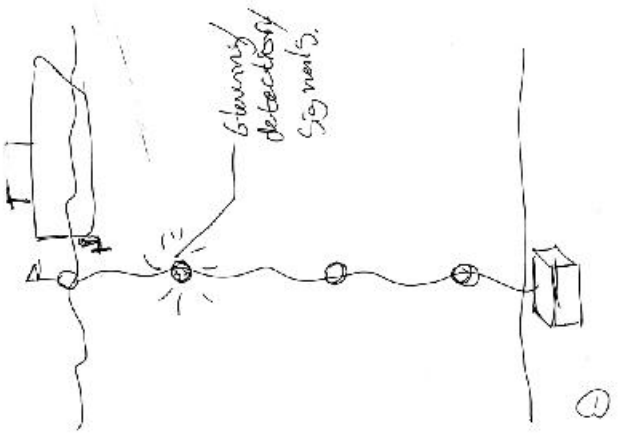
Attach the ball in each corner of the creels, to lift the creels up the the surface.



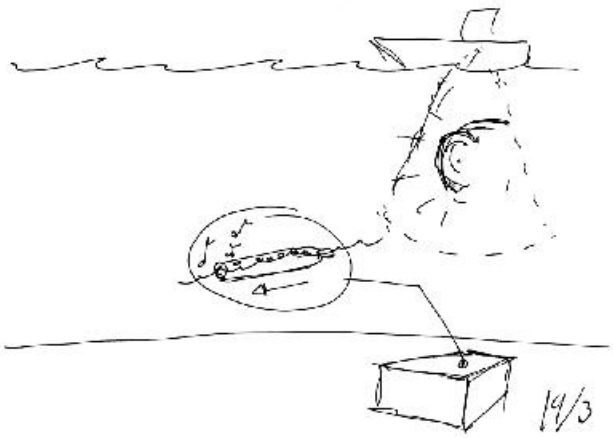
This solution is static solution, to prevent it from getting stucked in the rocks.



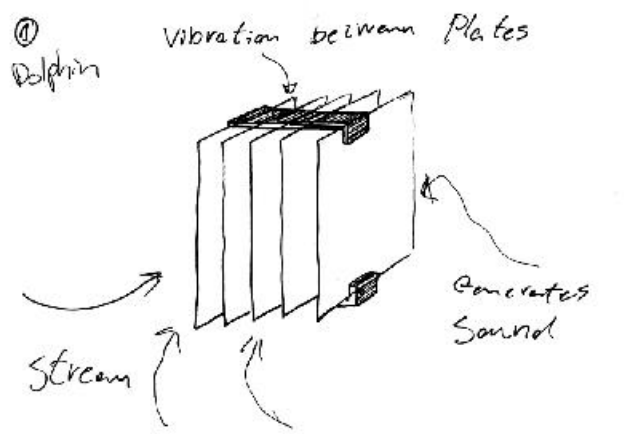
This solution is attach with a carabine and after a specific amount of time, it will deploy and you will be able to drag it up from the water.



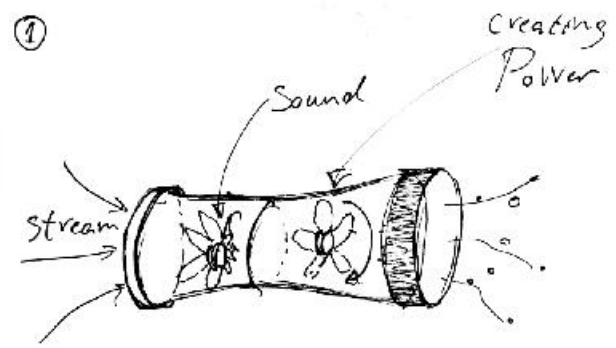
If the buoy gets cut-off, a light will glow in the water.



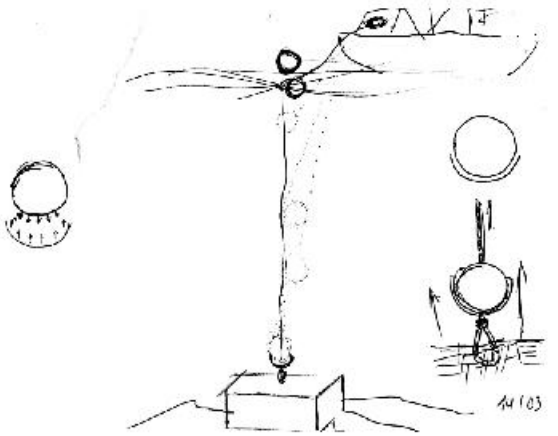
A solution where a flute create a acoustic sound when water streams go through it, and permits the boat to find it and activate the product in the water.



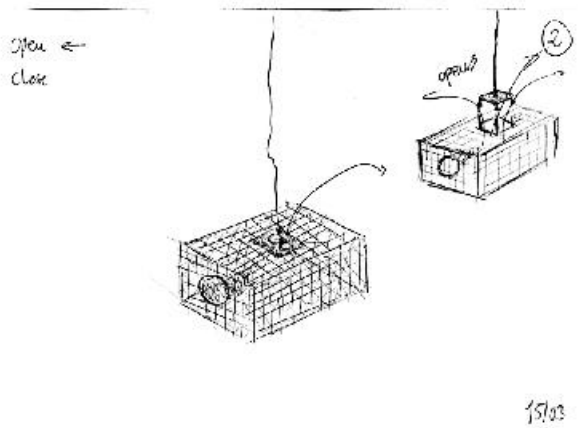
An acoustic sound is created by vibrating plates, when water streams through it.



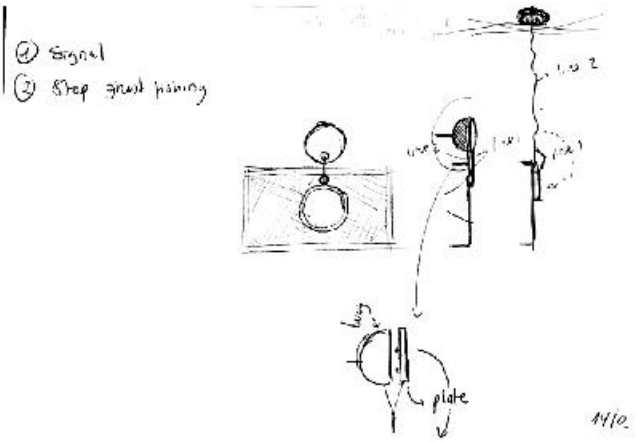
An electrical sound is created by tubines.



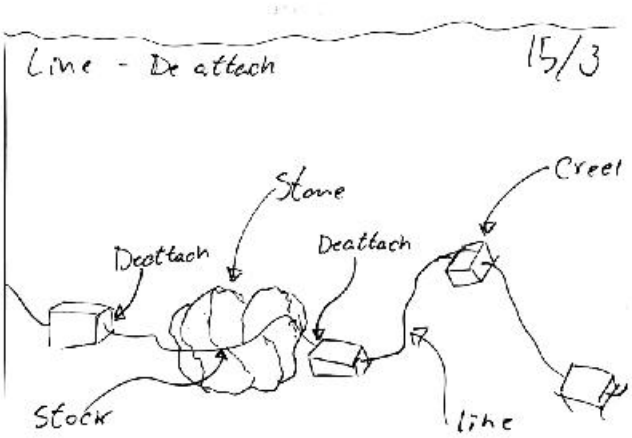
This solution makes a ball float up to the surface and permits the fisherman to bring down a larger and stronger rope, in order to haul in the creels.



This solution open the creel after a x-amount of time. To free the traped lobsters.

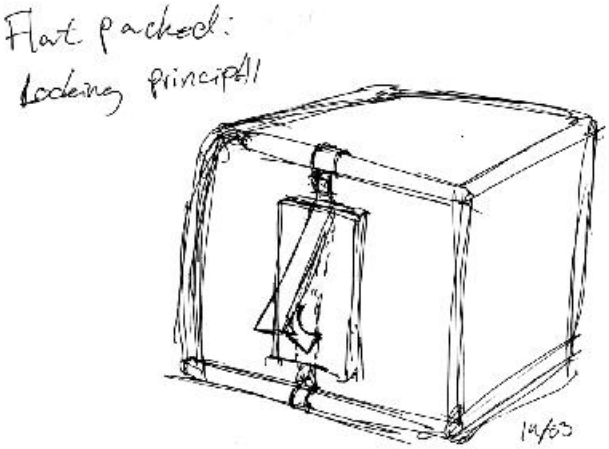


When the creel has been too long at the bottom, a floating buoy will go up to the surface and in the same time, lock the entrance to the creel. In order to prevent more traped lobsters.

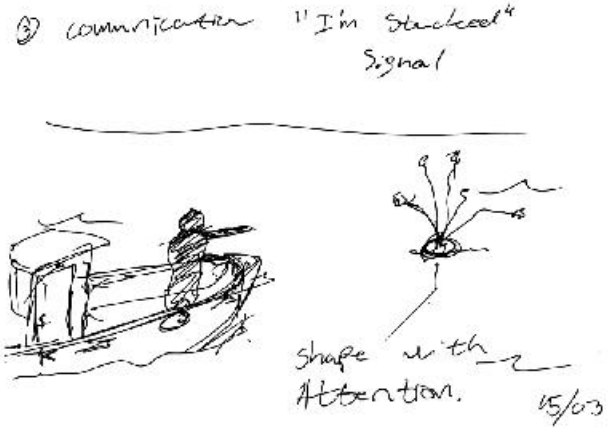


This solution permits the fisherman to deattach the creels from each others. This makes it possible to haul in the individual creel at the time.

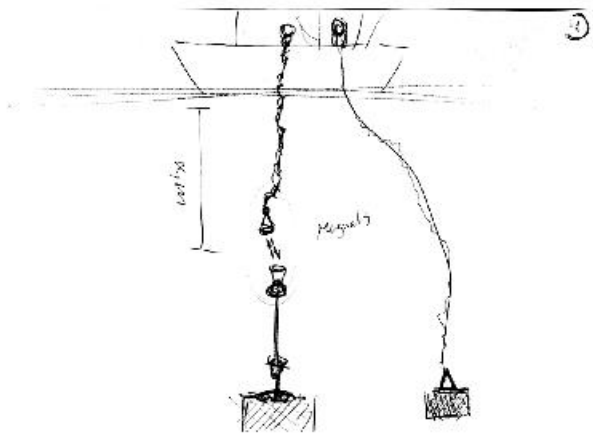
An user interaction, to set when the product has to be deployed.



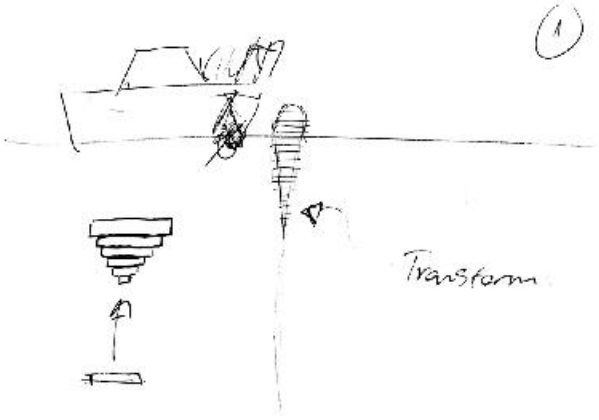
An interaction for mounting the product on the creel.



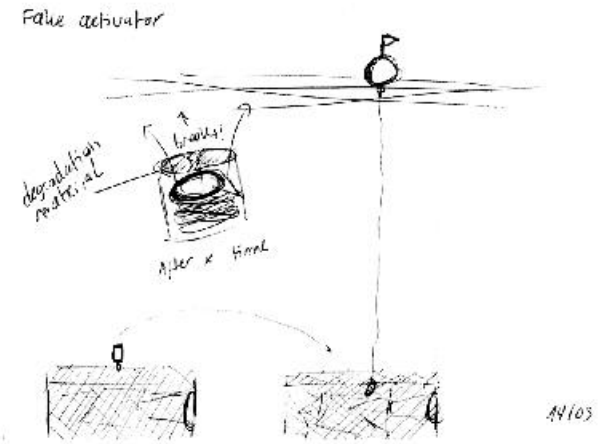
This concept is about to transform from a compact object to a large visible object - in order to get attention.



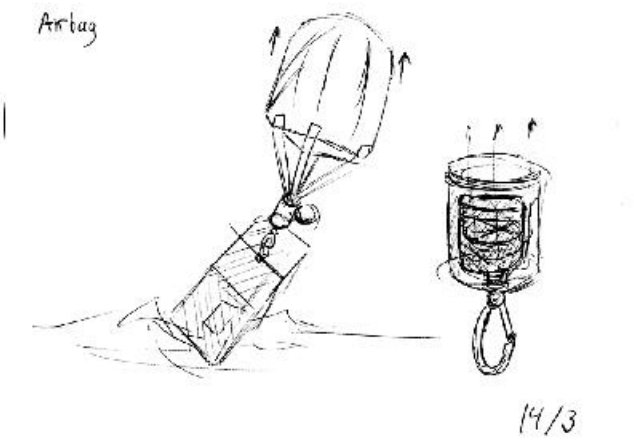
A new fishing method which is a magnetic solution to pickup the traps from the buttom, without having marking buoys.



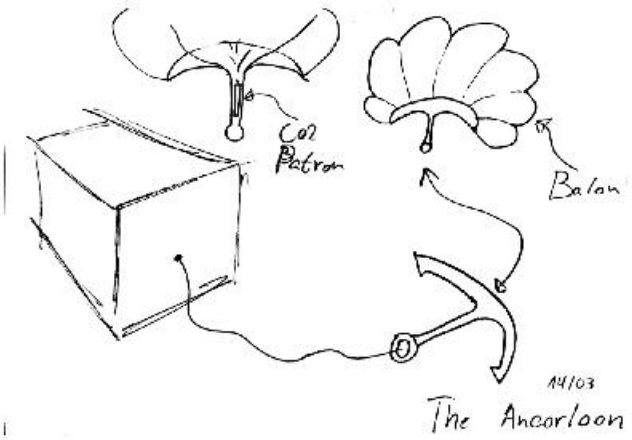
This is a foldable silicone cone, which goes deeper than the propeller from the boat, to avoid propeller cut-off.



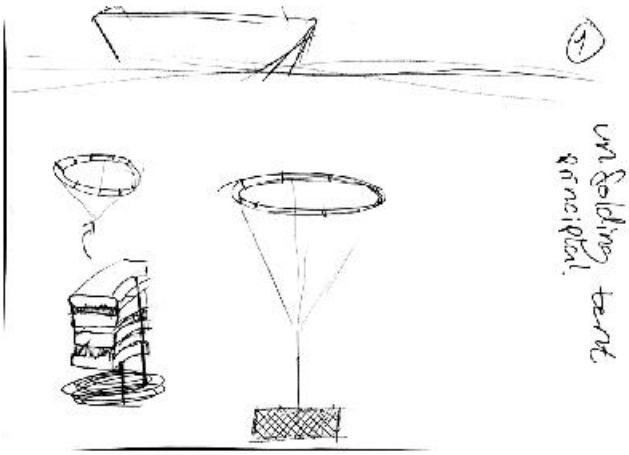
This concept is a floating ball which are attach and inside of a small container. When it's released it will go to the water surface.



This concept is similar to a parasuit. But air from the container will fill up the parasuit and the creel will go to the water surface.



A CO2 petrone is filling up a balloon which lifting the anchor up and the creels.



A compact foldable ring, can be realsed and go to the water surface. The ring will then ease the process of retrieve it from water.

// OUTCOME

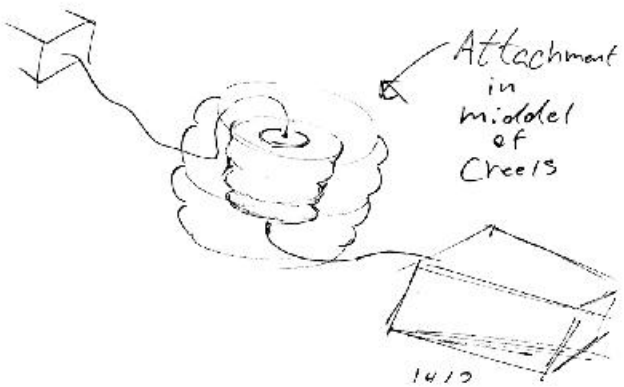
- New ideas and principles was discovered.
- Opened up for more ideas which require a secound sketching round (See A17).
- New potential discovered, by making an add-on which is attached to the line.

A17 - "WHAT IF?" SENTENCE SKETCHING

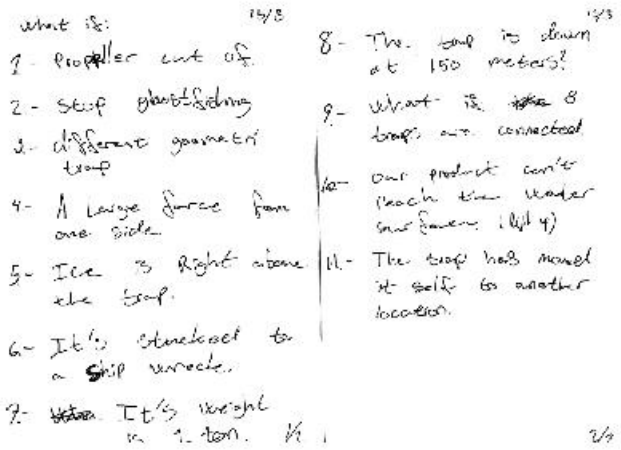
DEVELOPMENT PHASE | 15/03/19

We wanted to explore the solution area even more. But this time the sketching should be more focused into specific areas. Thereby, a wide range of ideas has been discovered. This should be done in a way to ensure that the team have ideas that could solve every little problem in a separate way. By doing this, even more, principles can be combined in another sketching round taking inspiration in combinatorics.

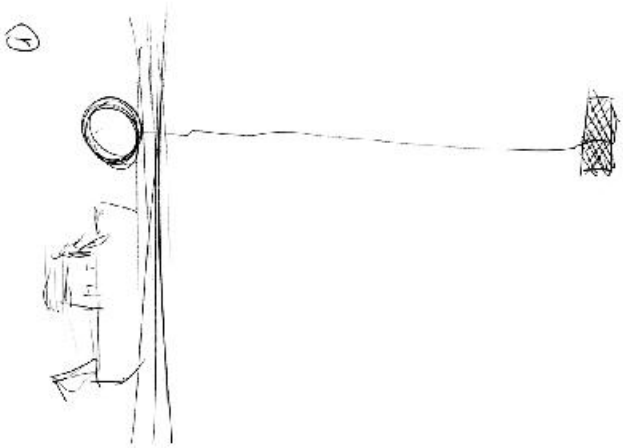
We established different "what if scenarios" like the buoy cant enter the surface of the water, the creel have different geometries, ice just on top of the creel, the creels are to a new location.



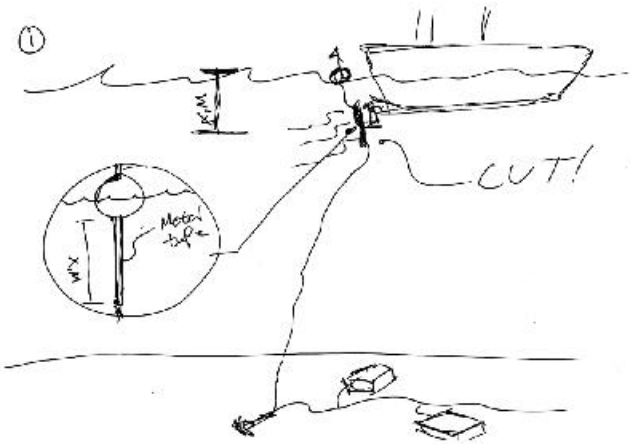
A balloon is attached in between of the creels, which will then go to the water surface.



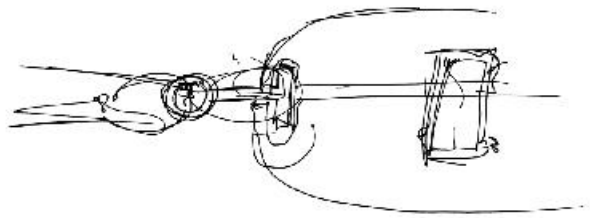
The team writed 11 "what if" sentences to find a solution for difference situations and problem.



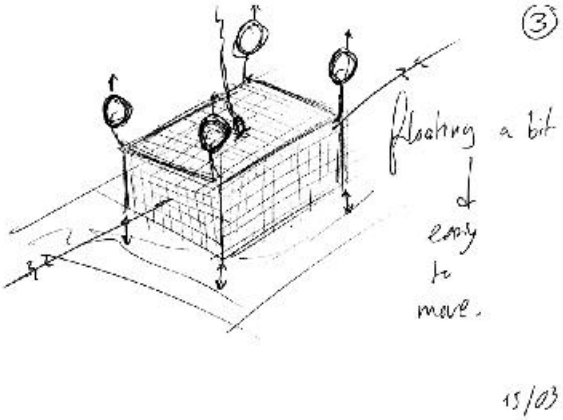
Avoid propeller cut-off: A large buoy which avoid the boat propeller to get close to the rope.



Avoid propeller cut-off: The marking buoy have a longer pole down in the water in order to avoid the propeller to get close to the rope.

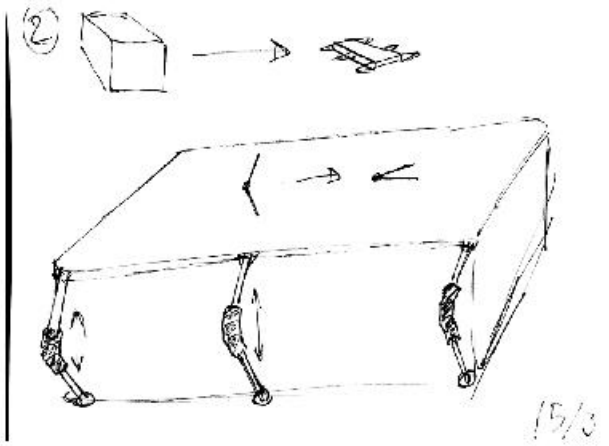


A mechanical solution to let the fisherman not to bind a knot.

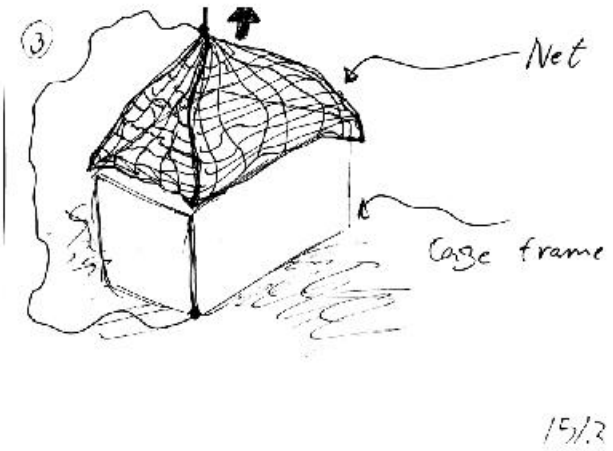


Making the creel floating a bit to avoid getting stucked in objects.

This concept is placed between the creel and the anchor. Each rope is placed inside of the product. When the product is closed, it's locking them in place. When the product is realsed, the one rope will be deattached and the top part will go to the water surface.

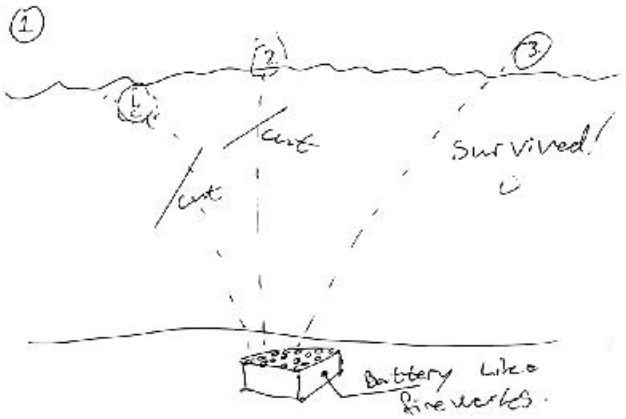


A compact foldable trap to make the fisherman able to store more creels on the boat.

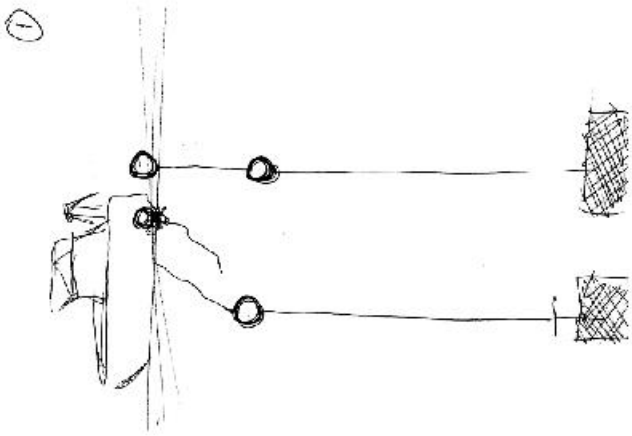


The net from the creel will be deattached from the creels. Which permits the lobsters and crabs to get out.

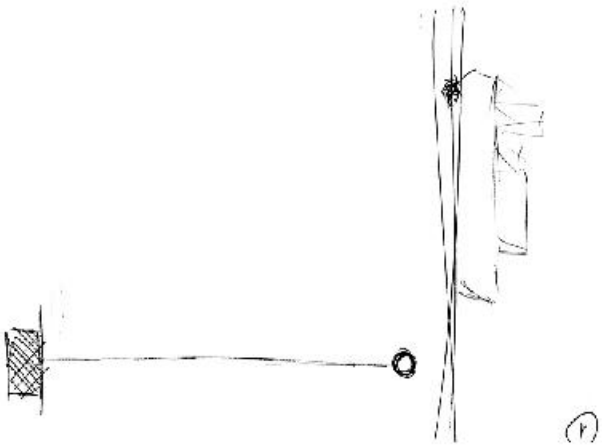
A visuel interaction for the recreation fisherman who not have sonar messurement on boat. This concept works as a measuring tape.



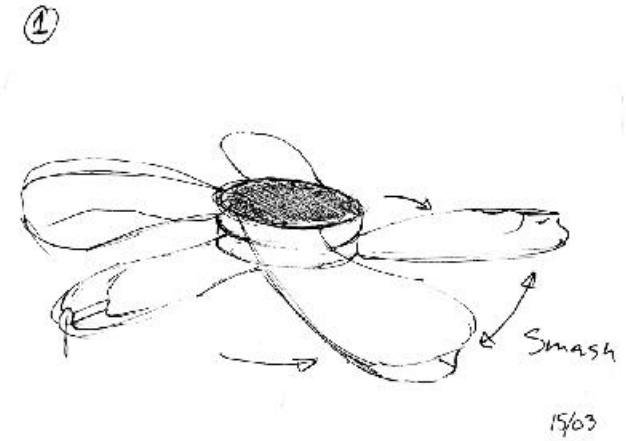
A concept which work as a firework battery. When a buoy is cut, a new buoy is on it's way and so on.



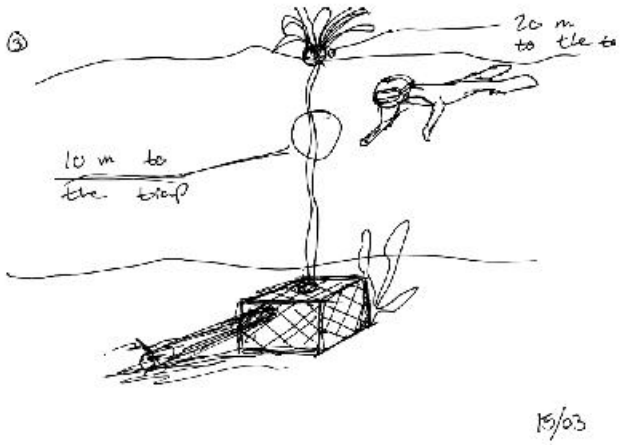
A small weight is located under the marking buoy in order to keep the rope straight. Which prevent it from floating in the water.



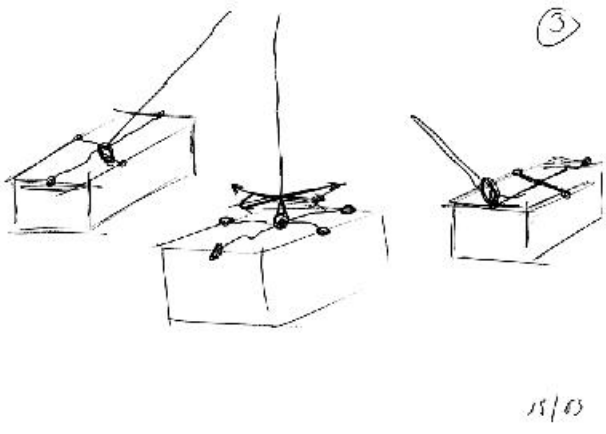
This a solution where the marking buoy is under the water an then the boat can sail over it and haul it in.



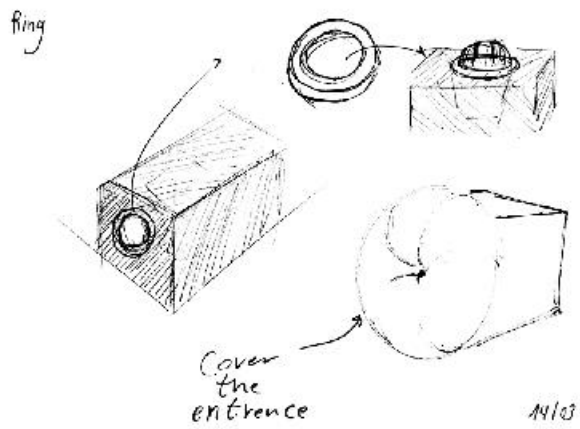
The first step was to fastly create some ideas that could be discussed.This first round was "



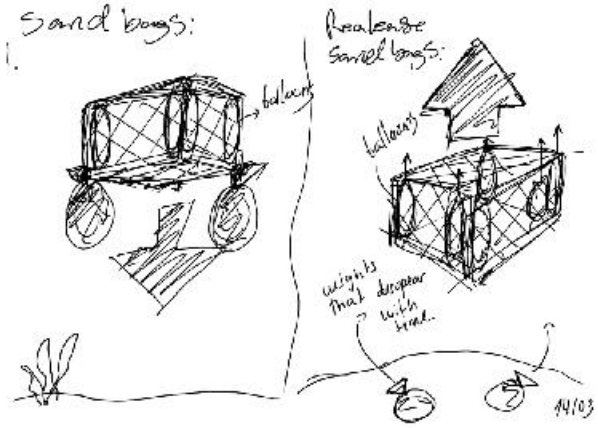
Rope which shows how deep the diver is to the lost creels.



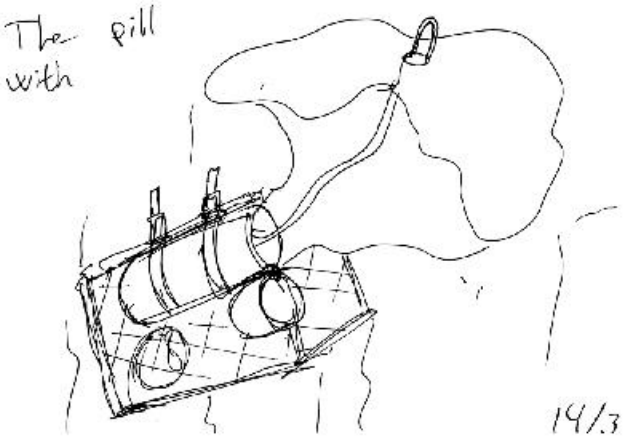
This solution permits the fisherman to drag in the creel from different directions.



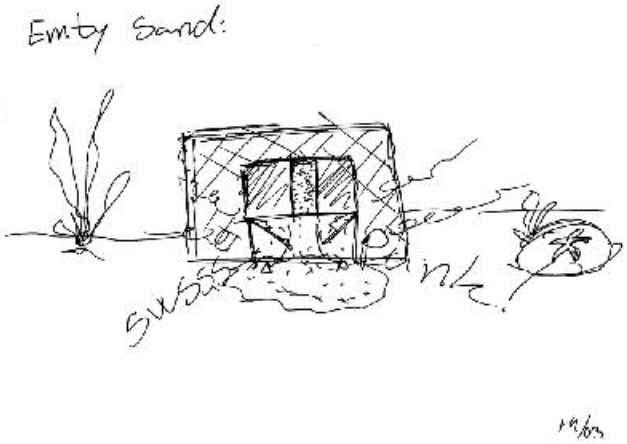
A ring is attach to the entrances of the creel, and when it has been down in the water for too long, a balloon will popup and close the entrance.



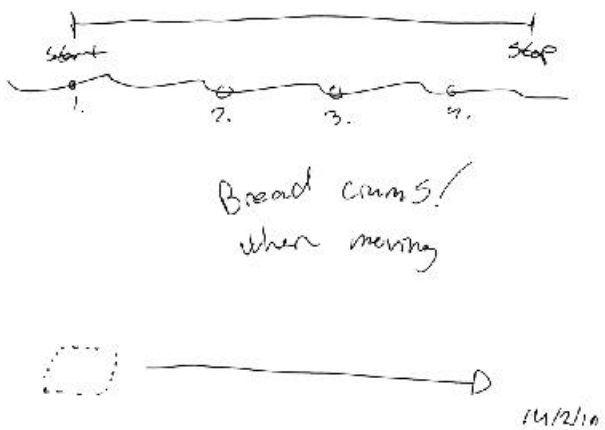
This concept is similar to an air balloon. Sand bags keeps the creel down at the seabed. When it's release the bags will emty the sand and then float to the surface.



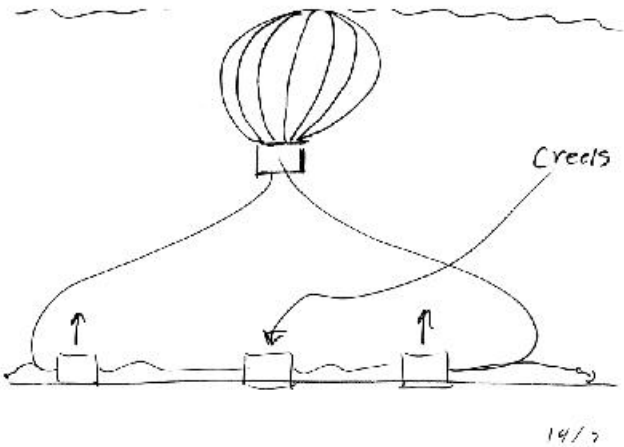
A tube/pill can be placed on the side of any creel with belt straps. When it's released a balloon pops out of the tupe/pill and goes to the water surface.



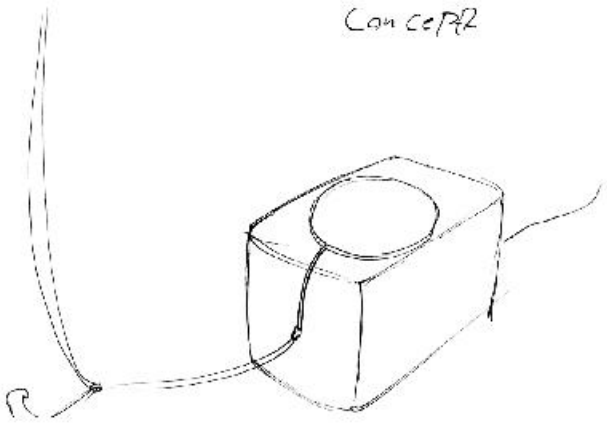
Another option for empy a canister with sand.



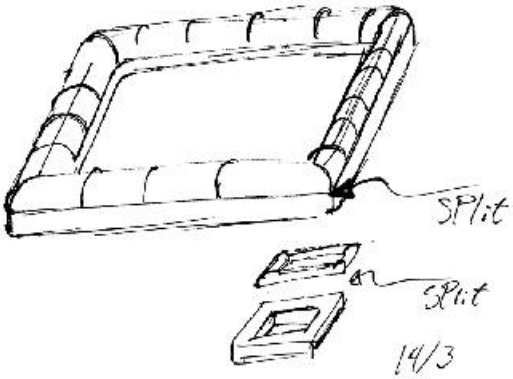
This solution is for help the fisherman to find the creels if they are drag or moved to another location.



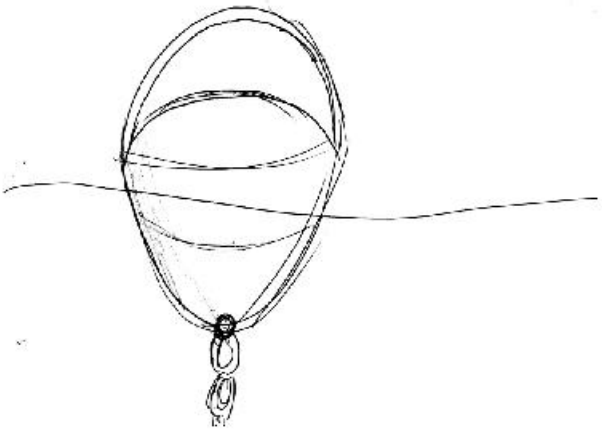
A concept where a large air balloon can lift up all creels.



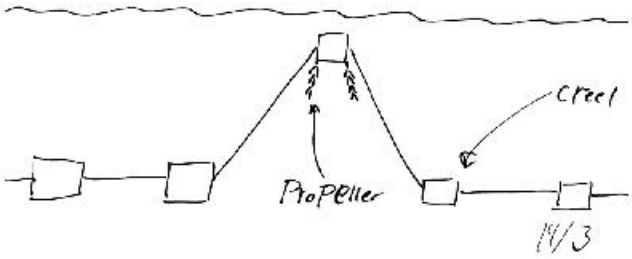
A way of deataching the entangled marking buoy rope from the creels. It's located on top of the first and the last creels.



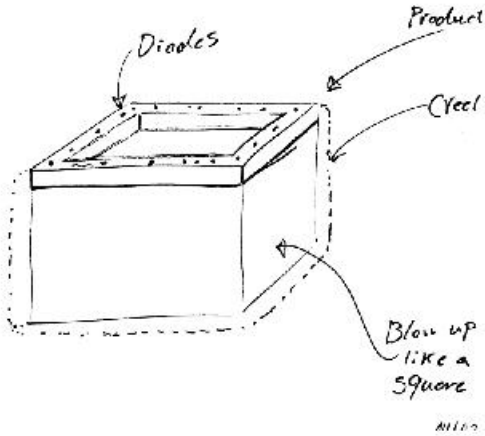
A frame which fits to the single creel. When it's released it can lift up the creels to water surface.



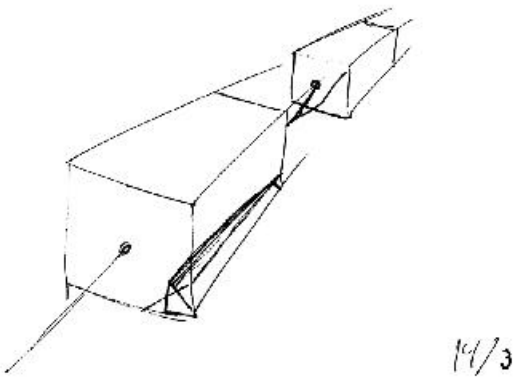
A way of ease the retrieving the product from water.

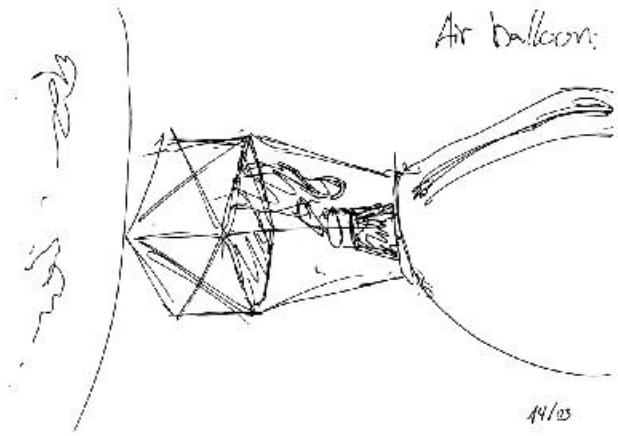


Mechanical propeller which can lift up the creels.

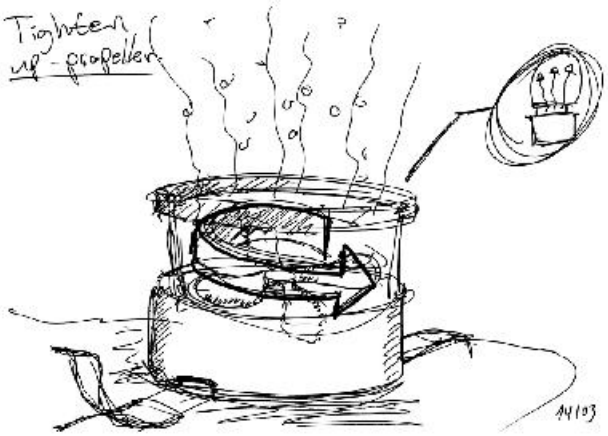


A balloon which can lift the creel up. The diodes makes it more visible for the fisherman in the night time.

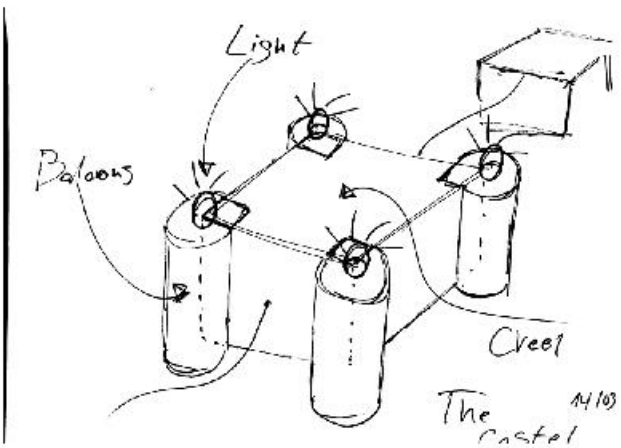




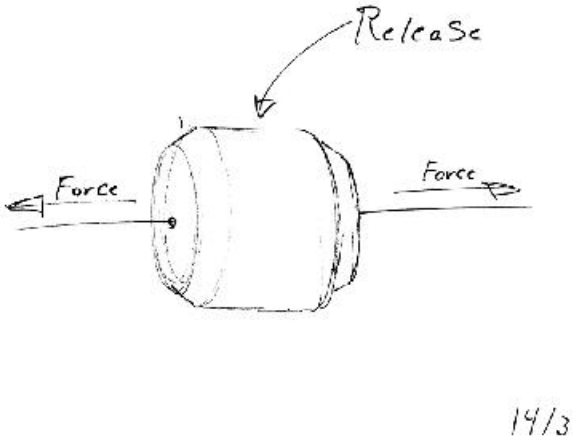
This is an air balloon. A way of getting principles solutions.



An electric propeller spins an moves the air bubbles up in a balloon. Which can lift the creel up.



Balloon in each end with blinking LED's.



A mechanisme for releasing and deattaching the creels from the entagled rope, by using a larger force. Then a new buoy will go to the water surface.

// OUTCOME

- New ideas of how a mechanism can be triggered in a simple mechanical way.
- New ways of how to avoid ghost fishing.
- Working with transformation. Going from something quiet to something with volume.

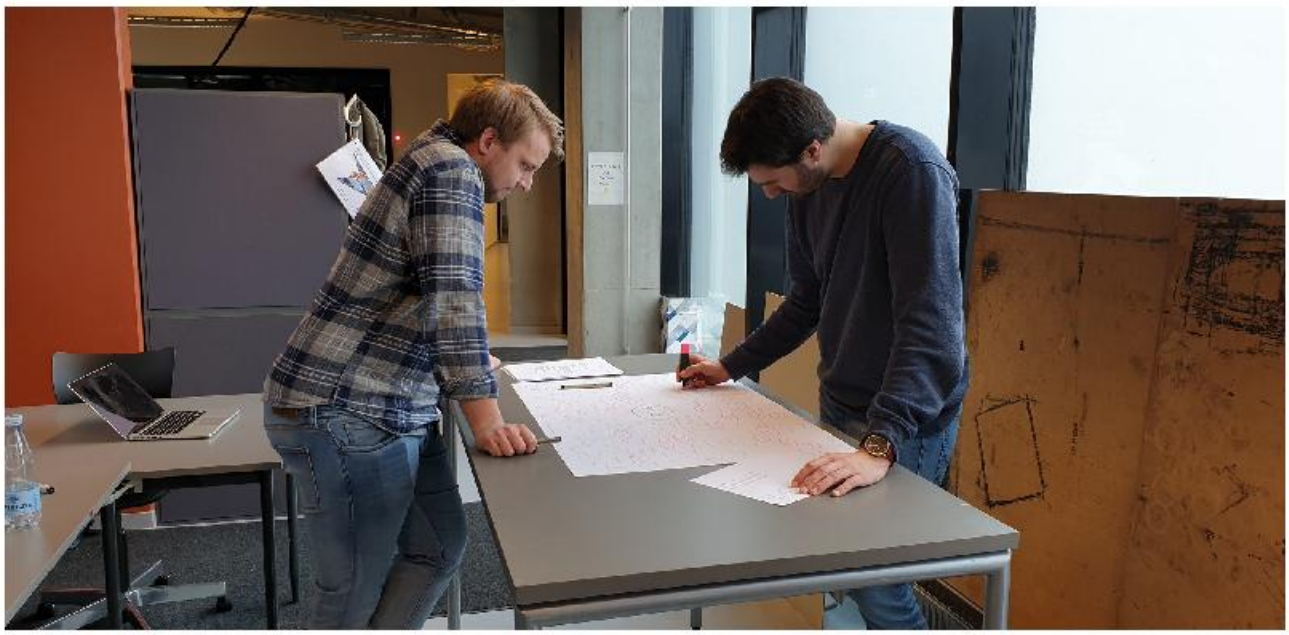
A18 - VALUE VISION

DEVELOPMENT PHASE | 14/03/19

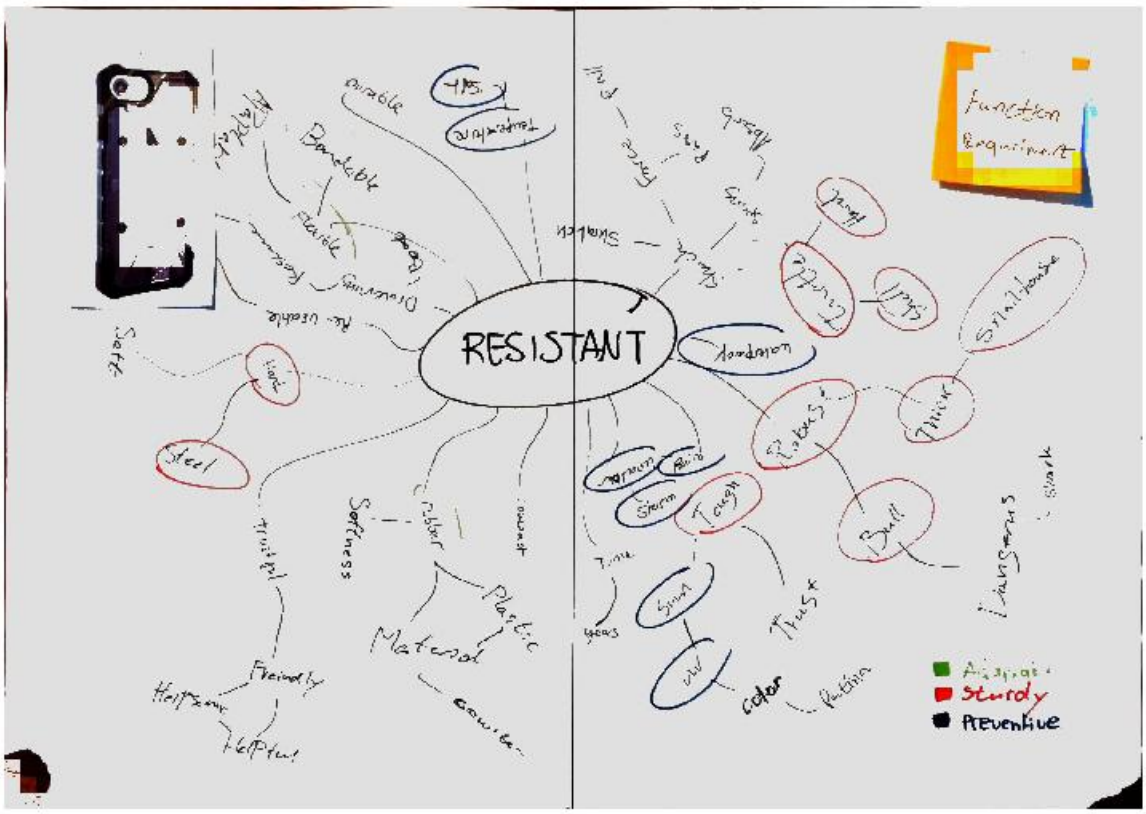
The idea of using this method will give us a wider view of the values we wanted to transmit/offer with our product. That would guide us to ideate with the product and create a stronger foundation for the product. It would also create a stronger alignment for the groups to have a better understanding of the product and its values.

As showen below and the following pages the team created a value vision, to get and understanding of the values that should be provided troughout the product. This method is a way to give the product a soul or a spitual level which. In other words it should facilitate all working processes without being anoying to have on board.

What we did was basically to gather around a table and writing down on a paper. This paper had one word in its middle, and from that thought and feeling should be described next to, trough single words.
Then, we took each of these values and made a mind map with all the words that each of these values we thought could be related. Finally, we cluster these words into three themes for each value. Then, we tried to find an image that could represent these values to easy the concept that we wanted to transmit.

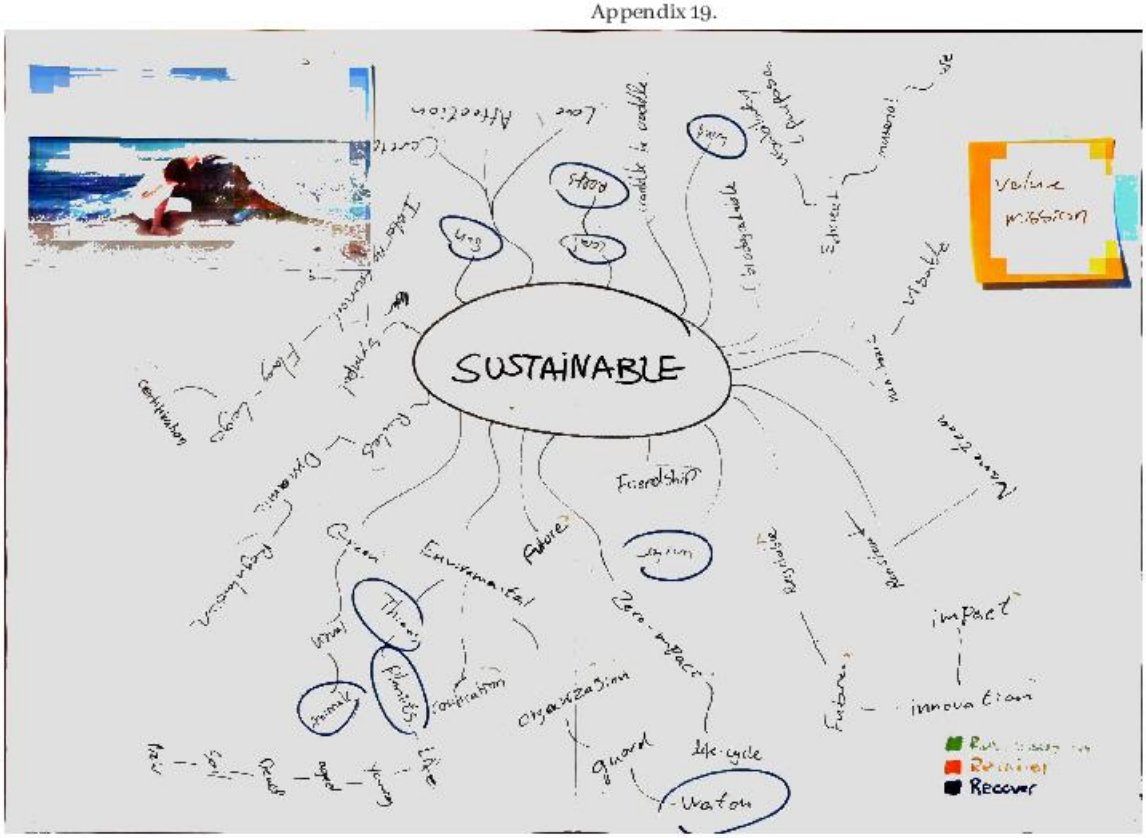


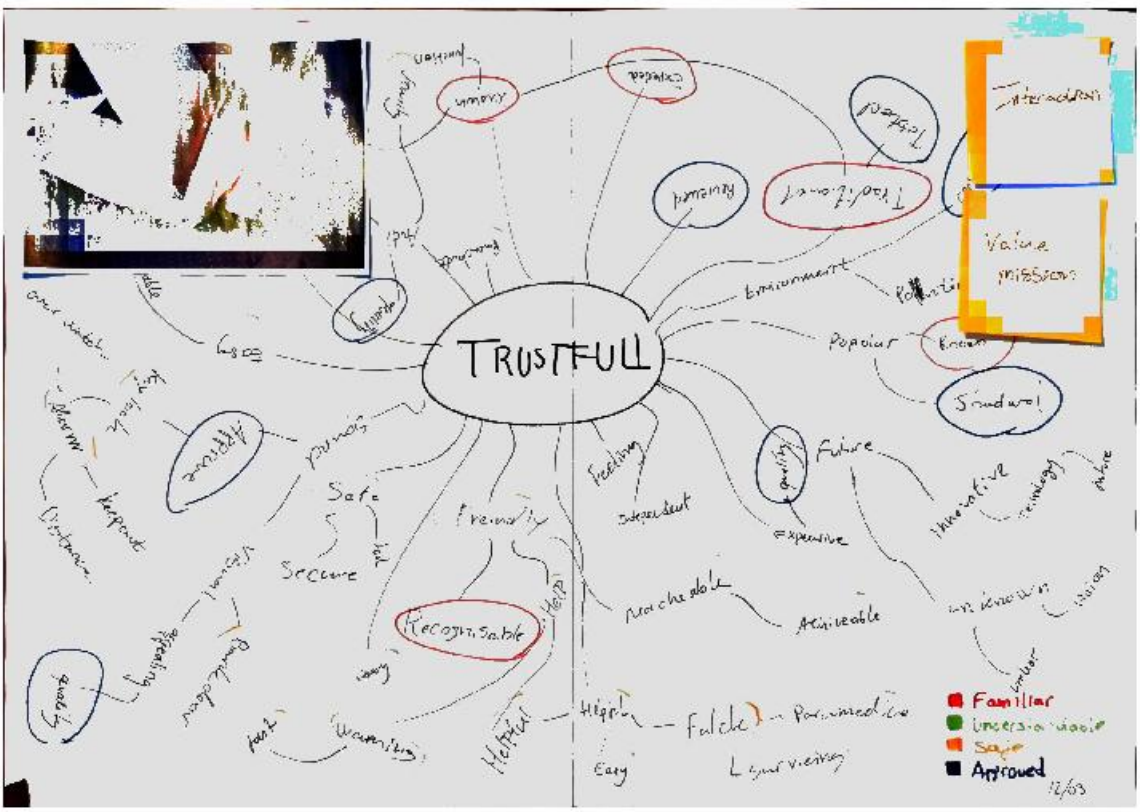
This picture is showing the scenario in which the team are working with the value vision and trying to generate a purpose for the product.



Resistant is one of the main words which an important factor for the product. The related words are Adaptable, sturdy and preventive. This is described with a picture which can be seen in appendix 19.

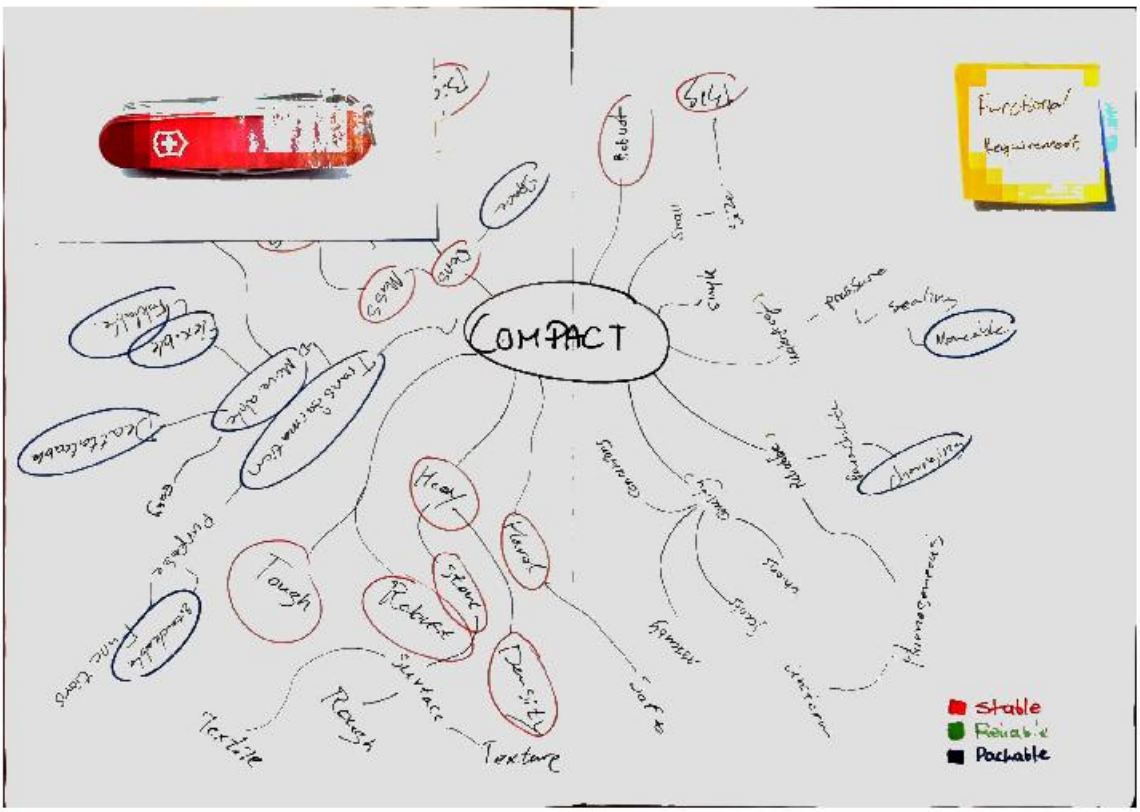
Sustainable is a more spiritual value which the team try to fit in when the selection of materials begins. Describing words is responsibility, reaction and recover. It is all described with one picture which can be found in Appendix 19.

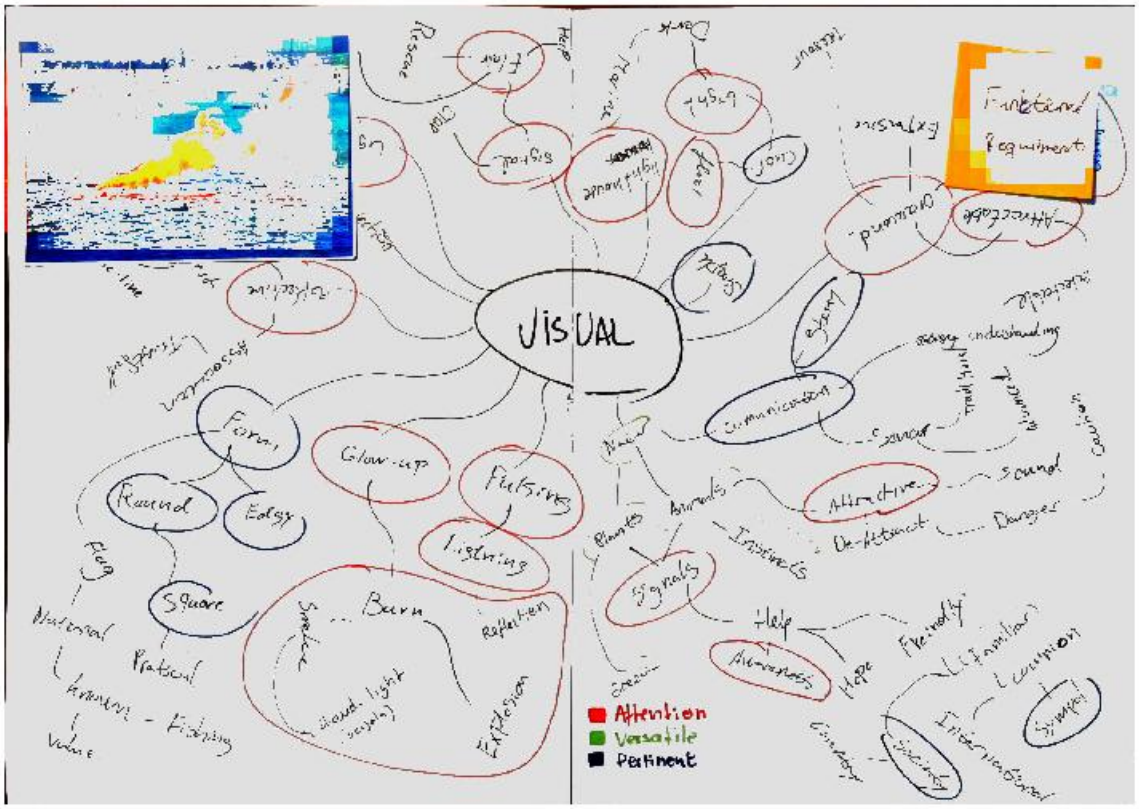




Trustful is maybe the most important word. This value describes the reliability of the product. Without being truthful in the environment the product is created for, the product will not survive. Related words are familiar, understandable, safe and approved.

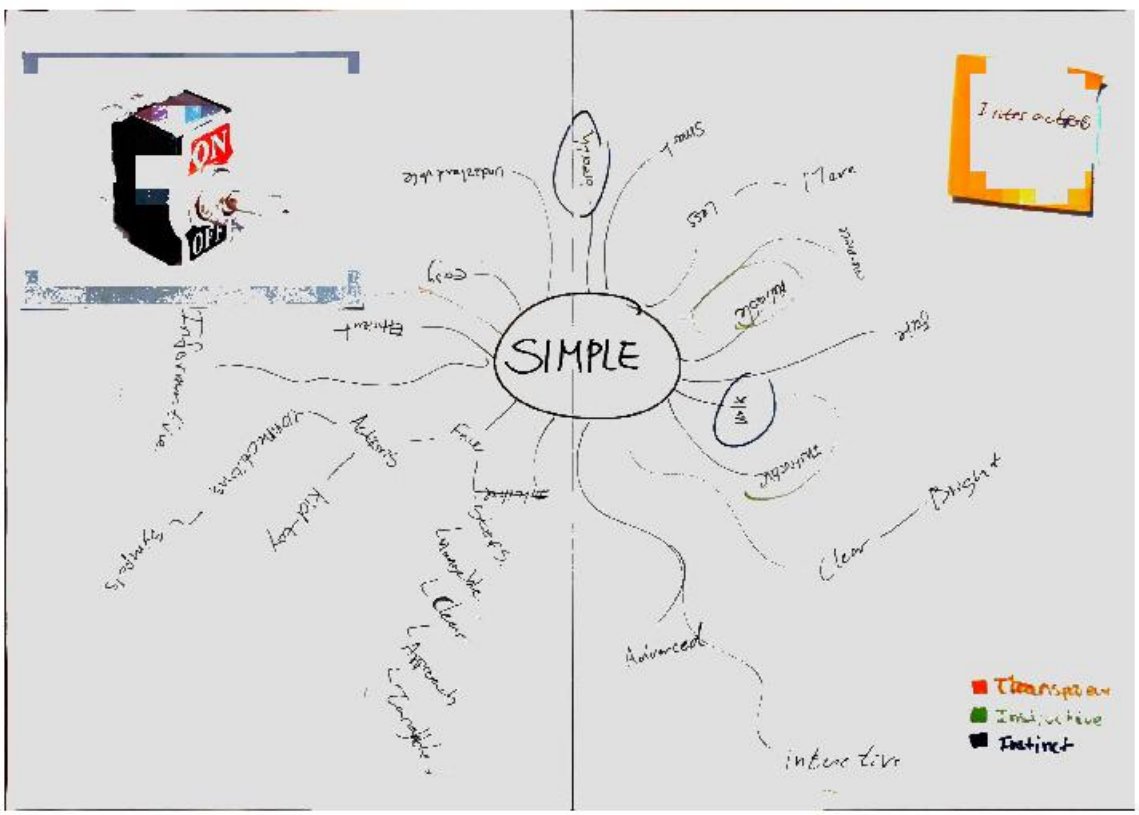
Compact is also a very important value. Since the product needs to survive a harsh environment it needs to be compact in some way. Related words are stable, reliable, packable. The related picture can be found in Appendix 19.

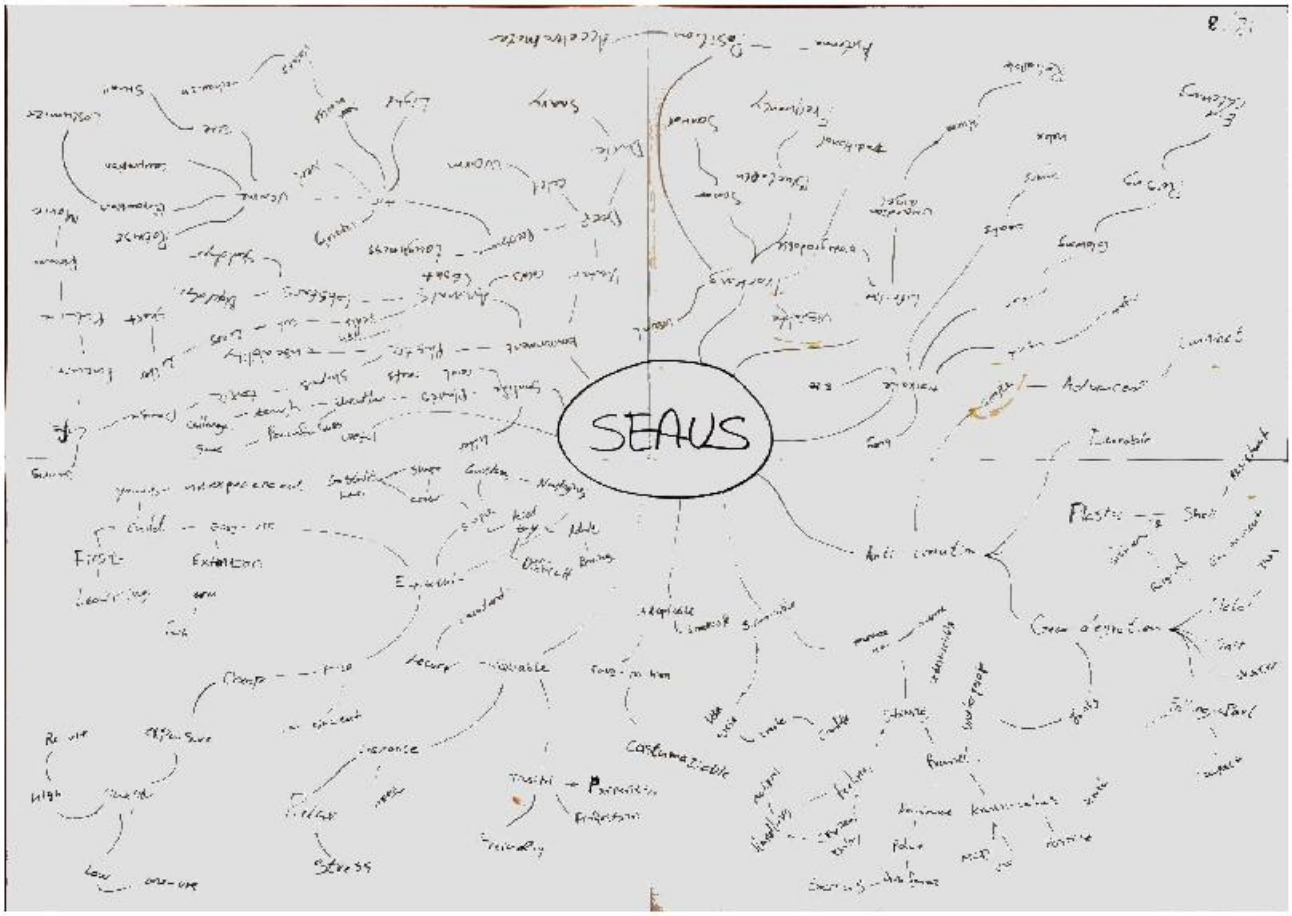




Visual is important because of the need to get attention when needed. It also needs to be quiet and doesn't take to much attention when it is inactive. Related words attention, versatile, pertinent.

Simple is very important within the interaction of the product. It needs to be intuitive and easy to read how the product is going to be used. Related words, transparent, instructive and instinctive.





The first part of value vision was to find out which values is important for the company seaus. The result was the following words, which is also described in the pictures above: compact, truftfull, visual, sustainable and simple.

// OUTCOME

- Alignment of the values that the product should provide.
- Frames within interaction and eastetics.
- A better definition of the end goal which should be achieved by the product.

A19 - "METAPHOR, CONCEPT, METAPHOR METHOD"

DEVELOPMENT PHASE | 14/03/19

We wanted to obtain a clear vision of the values for their implementation in our concept ideas. For it, the team thought that by using the "metaphor ,concept, metaphor method" would facilitate this task.

The team worked into finding a metaphor that could represent the different values and could be used afterwards in our concepts as a vision. Each of the members search for the images and then afterwards these were putted in common and discussed selecting the ones we thought fit better with the group understanding of the product values.

This picture is related to resistant and is a greate methaphor for the words, which is Adaptable, sturdy and preventive.

A seatbelt is related to truthfulness. It is a life saviour, but that means that it is also very important that it works properly every time. Familiar, understandable, safe and approved

Interact with this on/off switch is pretty easy and understandable. Either it is on or off. This is a great metaphor to show how easy it should be to interact with our product. transparent, instructive and instinctive

When the product is deployed it is important that everybody can see the product. Like a flair in the water. This you can see from a long distance.

Since the team is working with a product that should prevent a specific type of marine litter, the team also need to take sustainability into consideration. Responsibility, reaction and recover

Thinking of something compact. Something that is completely filled out inside and afterwards can transform into something with more volume. A schweizerknife covers the words very well. Stable, reliable, packable.

// OUTCOME

- A very clear vision of which values that should be recognizable in the product.
- A well defined describtion of the values that is going to be implimented.
- Allignment.

A20 - COMBINATORIC SKETCHING

DEVELOPMENT PHASE | 15/03/19

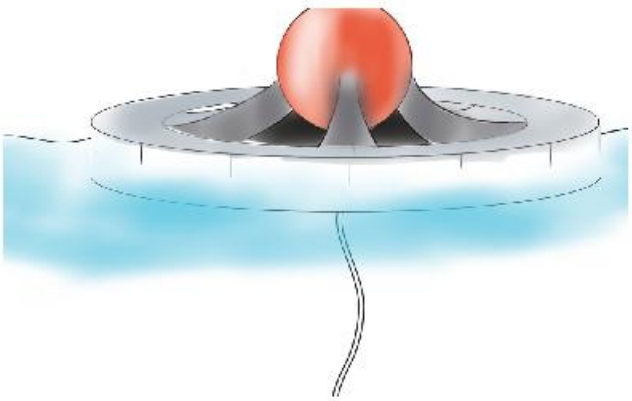
Doing "Combinatorics" we wanted to a achieve ideas that were using multiple principles from earlier ideation. To react a result that looks more like a concept.

The purpose of this "Forced relation" was to combine the main ideas we already had from the sketching pool into a single concept. The idea of it would give us an understanding of how these could be combined in the future and a better understanding of the solution area and the implementation on it on our product.

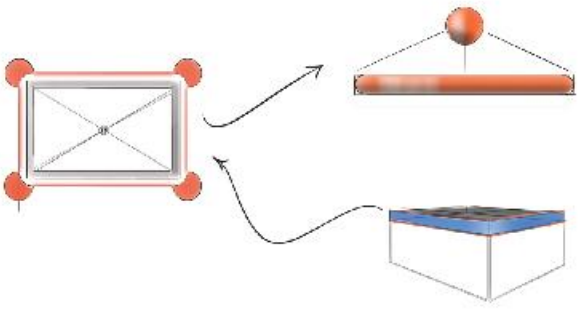
For it, each of the group members selected the different ideas/ principles he wanted to sketch upon. Than sketching in different ideas and end up with more concepts to explore and consider.

--> Clustering previous sketches into categories.
--> Naming the different categories.
--> Combining categories with each other for 10 min.
--> Discuss the outcome.
--> Repeat combination and discussion 3 times.

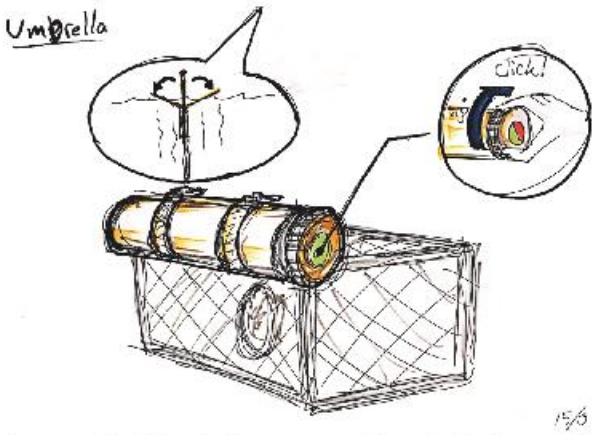
The main outcome was 3 concepts that took inspiration in 2 or more principles from previous ideas.



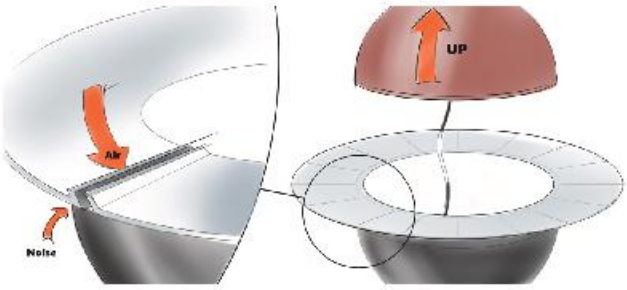
A more refined sketch: A flexible ring is attach to a floating ball.



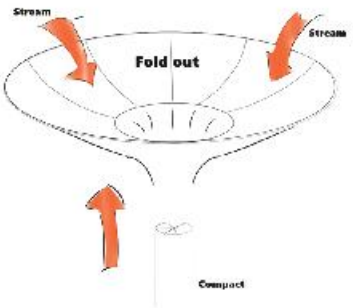
A more refined sketch: Floating balls which lift the single creel up.



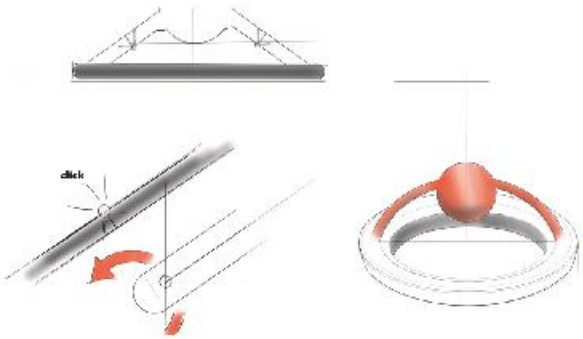
A more refined sketch: The user can adjust the deployment time on the product. When it's deploy it will open up like an umbrella, which ease the process of retrieval - because of it increased size.



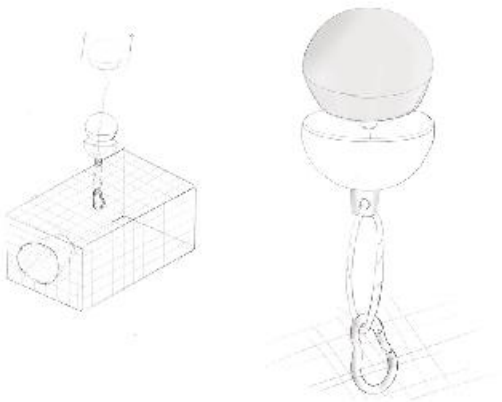
A simple metal sheet, which reflect sound back to the ship - this permits the user to locate the creels on the buttom.



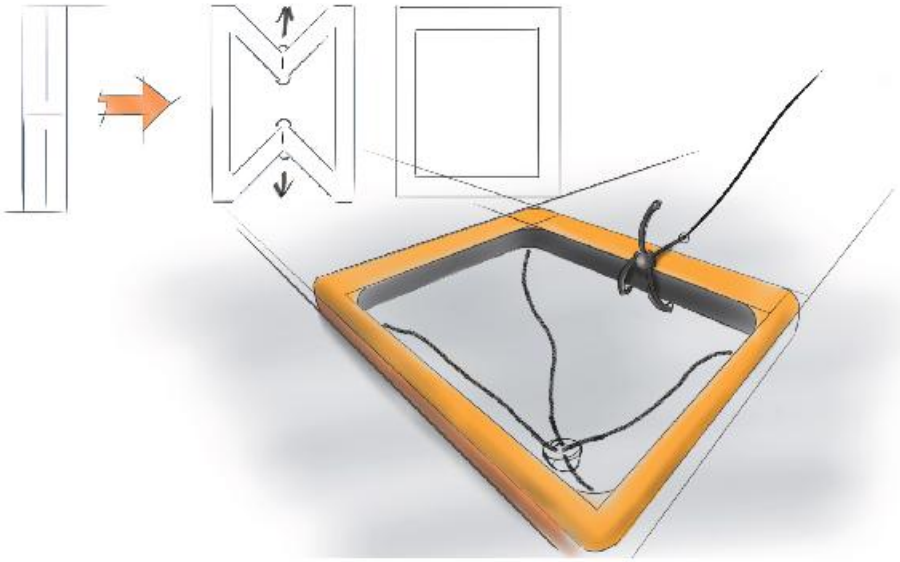
A try on go from compact object and increase in size by using a flexible material.



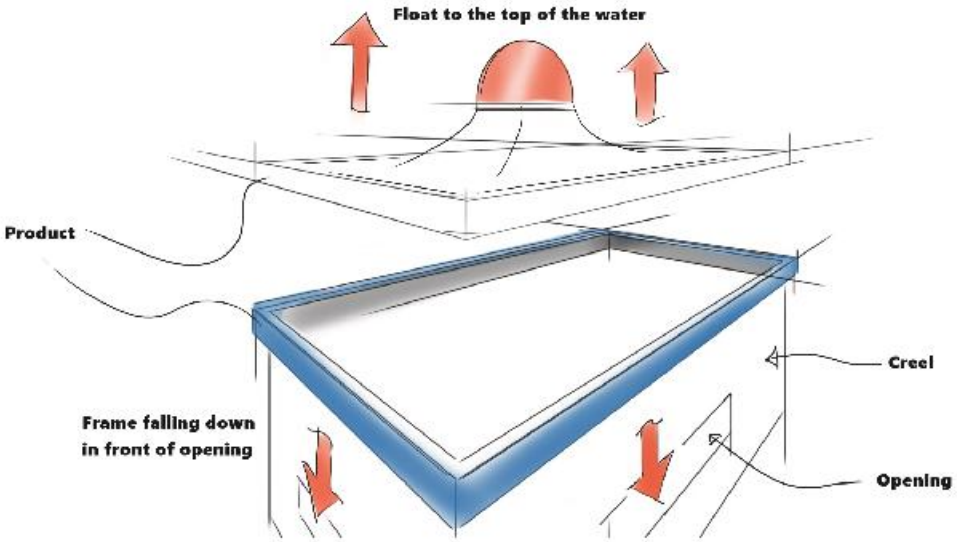
A try to make a flexible concept where it can go from a compact object to a larger one and ease the process of retrieving the product.



A more refined sketch: Of the ball which are attach to the creel with a carabine.



A more refined sketch: Of a flexible concept solution.



A more refined sketch: Of a flexible concept solution.

// OUTCOME

- Higher quality concepts whch is using more principles to solve the problem.
- A better difinition of which direction the team want to go.
- A better understanding of the collaboration between new buoy and closing creel.

A21 - MOCKUP BUILDING

DEVELOPMENT PHASE | 18/03/19

To get an understanding of the size and overall dimensions concerning the product itself. Furthermore to get an understanding of the interaction and function of the product. Also to have a product which can be used as a way to talk trough. To make our product easier to understand when the team needs to visit user and companies in the future.

Building mockups is a unique way for the designer to exploring the ideas that come to mind. The team have used this very much to get an understanding of the product physical form even though it is represented through a low fidelity mockup.

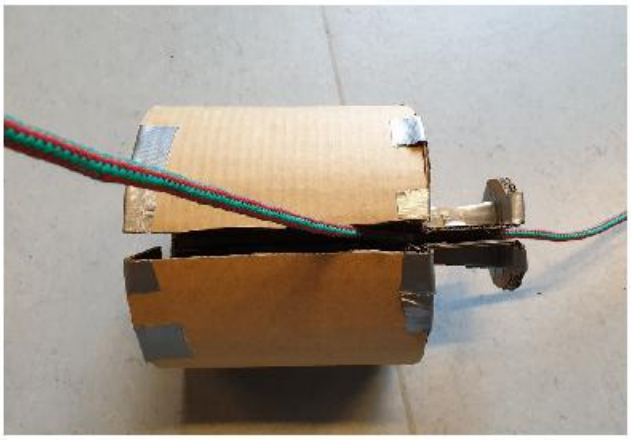
As shown below and on the next page, the team have created multiple mockups which explain different principles. These are not only for understanding but is also a strong communication tool, which can be used later on when the team visit fishermen.

This mockup is explaining the principle of one part leaving the creel while another part is closing the creel to prevent ghost fishing.

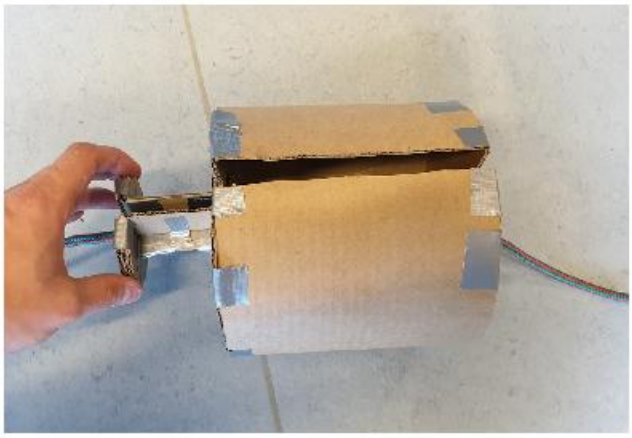
When the top part leaves the lower part, it transforms from something flat into something with more volume.

This mockup is a simplified version a popular idea from earlier sketching rounds. It is basically just a ball within a tube which gets a release after a certain amount of time.

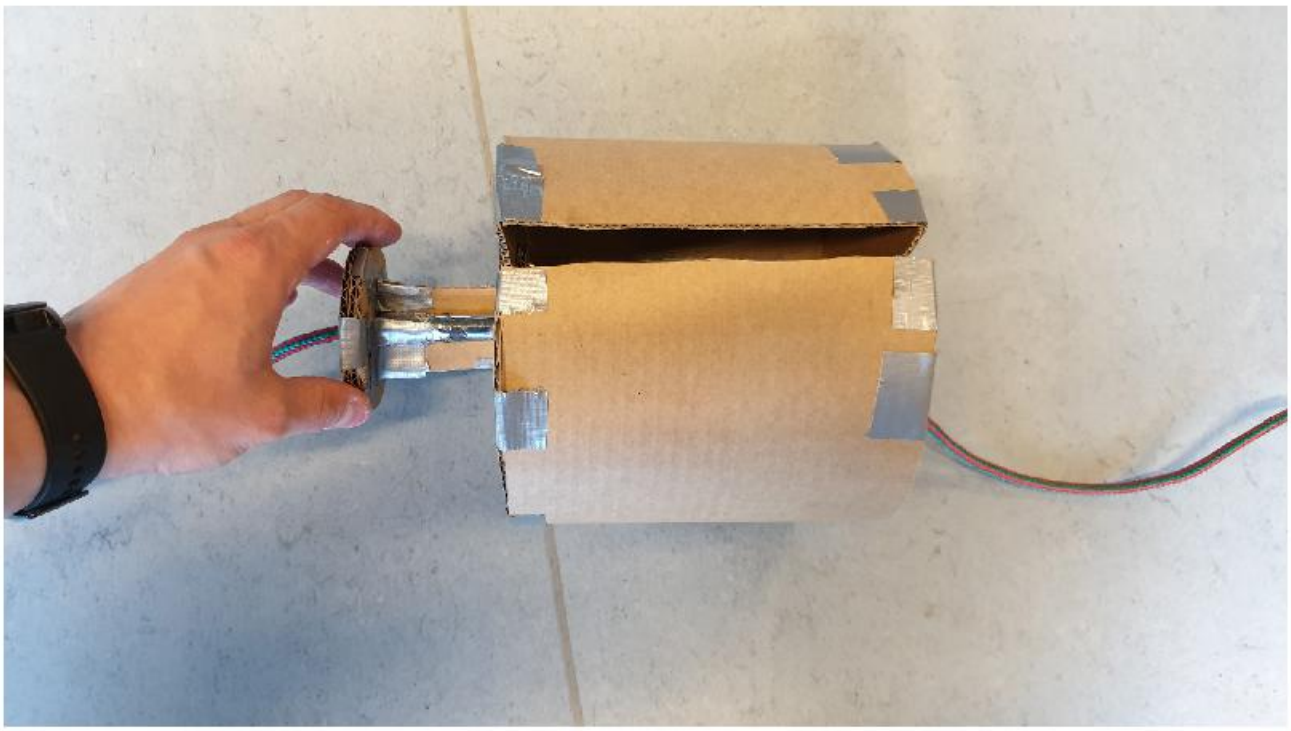
After it gets released a long rope is attached between the two parts and thereby the fishermen can pull in the rope to retrieve the creels.



Impliment robe into metal cylinder inside the cardboard mock-up.



Using your hand, grab around the handle in the left side of the product.



Rotate the handle 180 deg and the rope is stuck within the products metal cylinder. This is a way to attach the product in an easy and understandable way, without any risk of doing something wrong.

// OUTCOME

- Understanding of size and the product physical form.
- A communication tool which can be used in interviews with the end user or companies.
- Principles and interaction get refined.

A22 - VISIT HVALPSUND NET

RESEARCH PHASE | 22/03/19

Hvalpsund net is a large manufacturer of fishing equipment and has a lot of experience within the business aspect. They are selling equipment to fishing nations around the globe since 1934. Because of their experience - we set up a meeting with them in order to make them validate our project in its current direction. Furthermore to see which possibilities there would be in a future collaboration with Hvalpsund net.

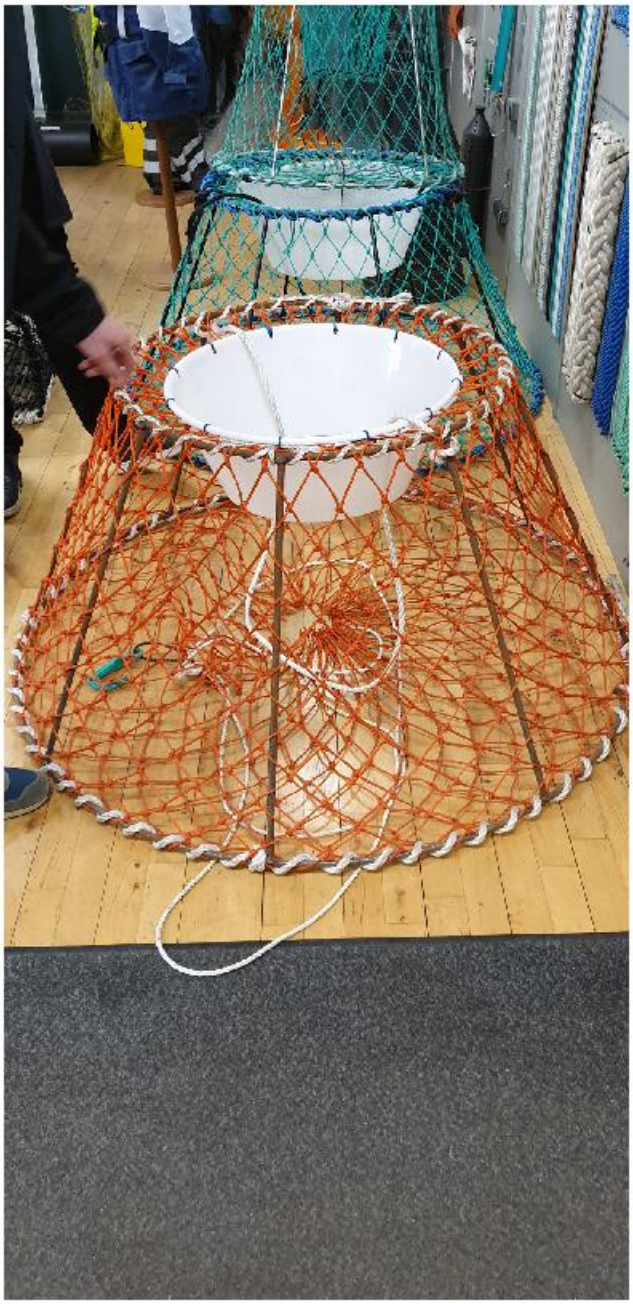
The team did an 8 min presentation with a focus on the core problem, our solution and what the commercial fisherman will gain using our solution. For this presentation, the team included previous mockups to ease the understanding of its functionalities (See A21). The team received a huge amount of information on how to continue in the same direction. The presentation creates huge interest and the company could see future economic benefits, by having such a solution implemented. In other words, the project got approved and the team could continue the same path into the development of a high fidelity mockup.

Key notes:

Our investigation says that Norwegian fishermen losing approximately 10-30% of their traps every year, but Hvalpsund net has data that says it is even more.
New contact (Lasse Kristensen, 25 71 65 25).
A tragical story about a boat with 2400 creels which were burning and sunken in Norway. Because of the government, the owner had to pay to get all the traps up again. Firstly he tried by himself but without luck, since it was impossible to retrieve with an anchor of existing hauling tools. It was a huge operation and it could have been much easier if the Seaus products were attached.
Maybe B2B or B2C together with Hvalpsund net.

As shown in the picture above, Hvalpsund net provides a lot of different solutions. Here is a small selection of the different creels that they produce. It is important that these creels are made in different shape and forms.

Small locking mechanisms are applied in a very simple and understandable way. While it is locking it also close the bait entrance.



A creel special made for snow crabs. The creel is much larger than a usual one but working with the same principles. heavy in the bottom to make sure it lands in its right position.

// OUTCOME

- Valuable insight into the difference between creels.
- Future economical considerrations and colaboration with Hvalpsund net.
- A professional creel that the team could bring home and do tests on.

A23 - VISIT JAN RØN

DEVELOPMENT PHASE | 24/03/19

The intention to have an interview with the fisherman was to get the concept validated and to get new requirements or insights. Even though that this fisherman is not using creels, he uses a similar method and has huge knowledge within the use of creels as a fishing method. The goal is to get new contacts within the use of creels and to gain user insight that can turn into requirements.

We did an 8 minutes presentation with a focus on the pain, core and profit. Throughout the presentation, the team used mockups to communicate trough. This made it easier for the user to understand what the team wanted to solve and how. Afterwards, Jan returned with valuable feedback, mostly how to interact with the product. Interaction surfaces weren't that clear and need a more clear definition. Afterwards, Jan showed the team what kind of equipment he was using. This gave ideas of what level of simplicity the product needs to aim for.
Overall he thinks the idea is great if it can solve the problem fully without taking to much time from the fishermen. However, he mentioned there could be a problem that a button trawler are able to move it a long way from its ordinary fishing spot. Maybe there will be a need for having GPS or AIS technology when this scenario happens.

The team also got a new contact to a fisherman (Ernst Christensen, 97 96 11 51) who are using creels in Limfjorden in west coast Denmark.

Jan røns boat and his equipment at the harbor Oddesund in westcoast Denmark.

// OUTCOME

- New contact (Ernst Christensen 97961151).
- Feedback within interaction.
- Implimentation of technology (GPS or AIS)

A24 - ACT IT OUT WITH TONNY NEES

DEVELOPMENT PHASE | 1/04/19

The main purpose was to try the working process or fishing technique with creels, on our own body. This should give a better understanding of the working environment and the full working process in steps. Furthermore, it should also give an understanding of the critical situations throughout the working process.

With the help from a professional fisherman, each member of the group experienced every single step in the working process with creels. From the point of taking the creels from the harbor on the boat to the point of pulling the creeps up from the sea, empty them and throw them out again. Even though the conditions was perfekt (no wind, warm and no rain) the risk of failure in any situation was still high. As showen below and the follwing pages, the team experienced all steps in the working proces. A describing sentence for each picture have been applied.

Valuable insight:

- Insight within every little step of the working process.
- Need of multitasking in some situations.
- A dangerous workplace so you need a clear mind.
- Product cant take too much attention in the normal working process.
- Everything needs to go quickly.
- Propellor cutoff is a common problem and was experienced at the same day the team visited Tonny.
- A product which can run trough the hauling tool is a demand.
- The product cant take to much space since the space on the boat is critical.

A team member are putting rubber bands on the claws of a lupster.

A team member are putting rubber bands on the claws of a lupster.

The hauling tool is hauling in the first creel and a knot can easely go trough t. This means that our attachment

The first creel arrives at the ship.

Cutting fish which are used as bait

Load the creel with bait

Move the creel to another postion.

Plave the creel in a logistic way.

Keep an eye on the rope around the boat, to not get intanglet.

Place the creel at the side of the boat.

Trow the creel in the water.

Putting on rubber bands on the claws of the lopsters.

// OUTCOME

- Some situations like entanglment could be dangerous if the boat is manage by one man.
- Multitaking is a part of the job.
- Product needs to go trough the hauling tool, if it should survive in this field.

A25 - SHADOWING WITH TONNY NEES

DEVELOPMENT PHASE | 1/04/19

To observe how a professional fisherman do his job, when working with creels as a fishing tool or technique. This should provide an understanding of the complexity of fishing with creels. Furthermore, to get an idea of where the placement of our product would be best.

From the start of the day, at 9am, the team was curious and observed all the movements that the fisherman did. While doing this a lot of photos and short films was taken so further investigation and documentation could be added. The team was looking for certain ways of doing things, walking patterns, handling of creels, use of hauling tool, risk of failure, critical steps and the need of speed in certain situations. While observing, small interviews was made, simple to get questions answered. This was also to get an understanding of the fisherman's opinion and attitude.

Load the boat and load the creels with bait.

Attach ID on the buoy.

First buoy is trowen out.

First creel gets trowen in the water.

Hauling in front buoy and attach the rope.

First creel arrives.

Empty the creel and put in new bait.

Place the creel in its position.

Product needs to fit the way of working.
Product needs to be adjusted so it can go through existing hauling systems.
Product can't be placed in the middle of the main line, because of walk pattern on the boat.
Need of minimal attention when it is not deployed is required.
When deployed, the working process needs to go quickly.
An understand of which part in the working process could be optimized.

// OUTCOME

- Minimal attention of secoundary product is a need. Anyways it gets annoying.
- Cant take to mush space because of the small area that the fisherman have.
- Mistakes in the cronocal creel setup on the boat can end up in a critical situation.

A26 - INTERVIEW TONNY NEES

DEVELOPMENT PHASE | 1/04/19

Tonny Nees is a daily user of Creels and knows everything within the area. Therefore an interview with Tonny Nees would provide the team with Valuable insight and a lot of feedback that the team could work further with. A short presentation of the project and its direction should provide Tonny with enogh data to give feedback.

The main goal was to get the 3 concepts validated by the fisherman, to gain an understanding of their pros and cons. This was also a part of the build, measure, learn principle. Furthermore, to get an idea of the mindset of a fisherman both while he was working but also while he wasn't. At least also to get stupid questions answered and to get a more clear idea of the context, business and needs within this area.

What we did?

A quickly walk through of the teams milestone 1 presentation, was made to shortly explain our focus to the fisherman. Afterward a short explanation of the 3 concepts was performed. A short discussion upon the concepts provided valuable insights and information to work further with. After the validation of the 3 concepts a walkthrough of a short questionnaire was made, to gain the last information needed.

What we got? (Result)

Valuable insights:
Communicate the start and the end of the main line of creels.
Placement on top of creel do not disturb exiting working process.
A price of 20.000 kr for a full setup does not work for Tonny (Too expensive).
If he lose a line of traps, it is not only the catch for one day he loss but also for the next time.
Lost traps occupy a place for new traps.
If the fisherman have time he can try to throw out an anchor to retreive his gear.
This have a very low succes rate and Tonny have tryed it a few times

// OUTCOME

- A price of 20.000 kr for a full setup does not work for Tonny (Too expensive).
- Lost traps occupy a place for new traps.
- Retrieve gear with an anchor have very low succes rate.

A27 - SKETCHING, CONCEPT EXPLORATION

DEVELOPMENT PHASE | 3/04/19

As a last sketching round, the main purpose was to generate ideas upon the feedback that the team got from previously field research. This is done to cover the last adjustments to make the 3 concepts solve the problem as well as possible in each of its ways.

What we did? (Description)

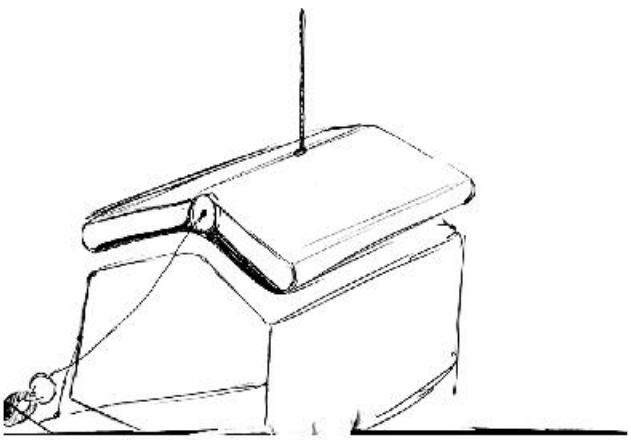
The main assignment was to generate upon the 3 concept directions, to improve their ability to solve the problem, and to find new principles within each direction that could solve the problem better.

10 min ideation per direction.
30 min dicusion.

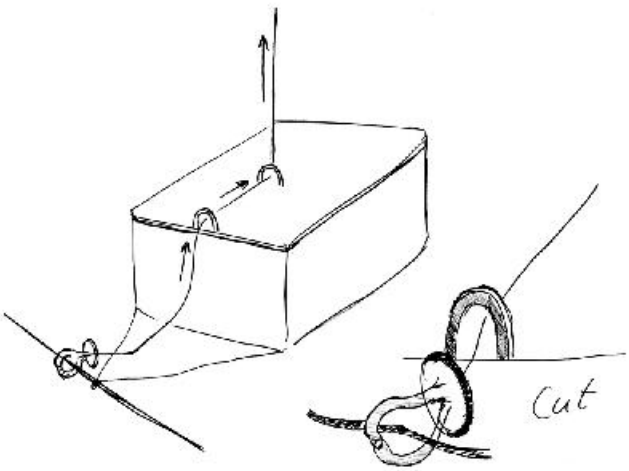
What we got? (Result)

Every concept got new and improved ways of solving the problem, mostly in a more simple way. Since each of the directions now have more ways of solving the the problem, one specific way needs to be chosen.

Buoy 2.0, got arms affected by gravity, as a more simple way of holding the propeller away from the main line.
The inbetweener, a new deployment mechanism and a new design.
The Creel add-on, a more compact design that leads to a more feasible solution.



This concept is placed on the top of the first and the end creel. When the fisherman pulls in the buoy it will cut the rope to the entangled marking buoy.



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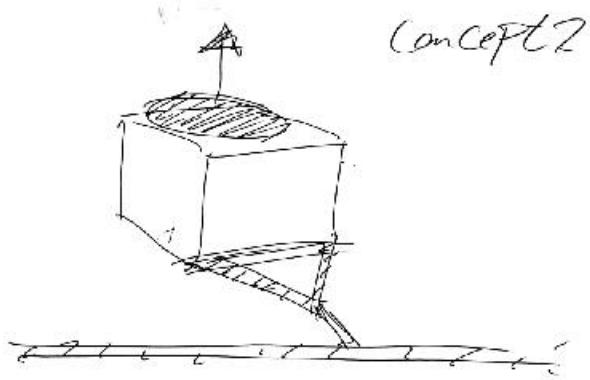
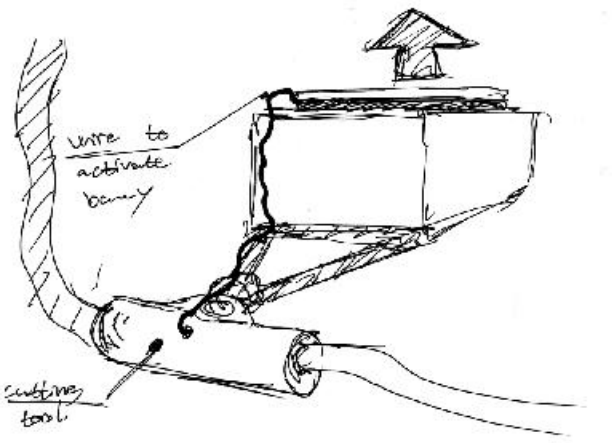
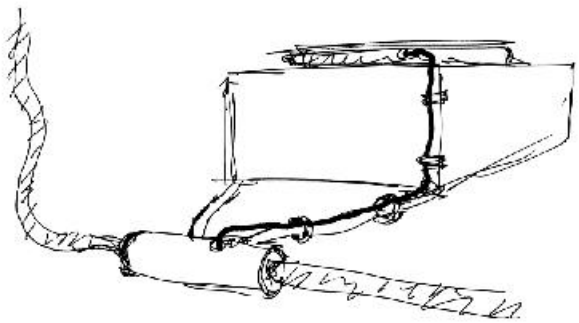
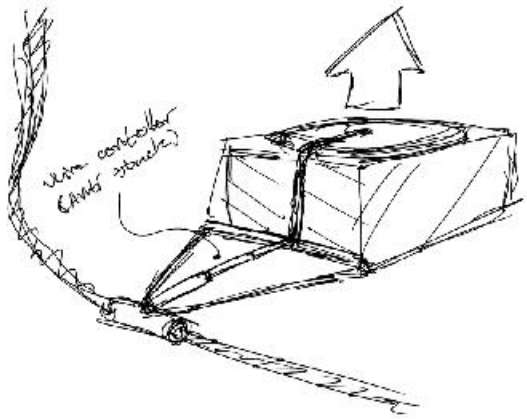




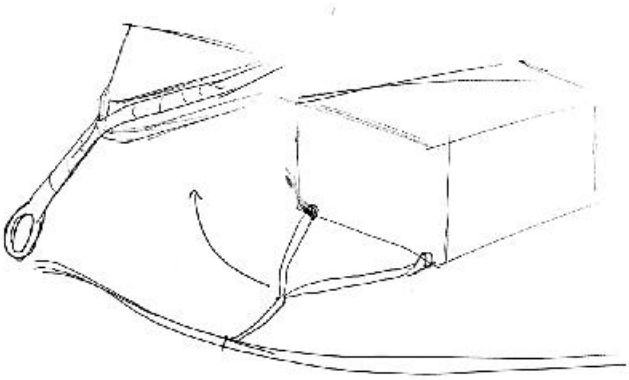
A wire is connected to the deployment mechanisme. When it's pulled the rope to the marking buoy will be cutted.

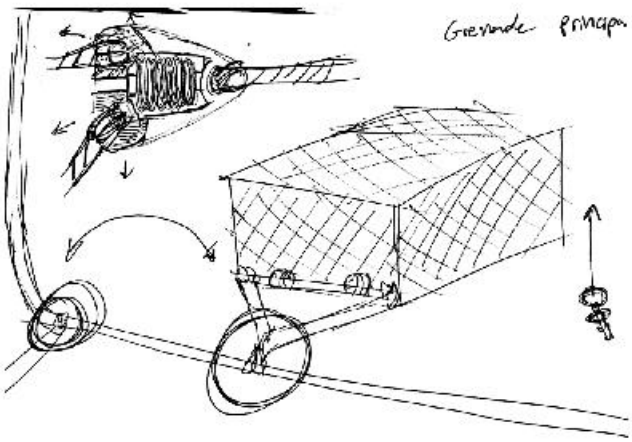


This this same solution as the last one, but here we experienced the problem with the wiring.

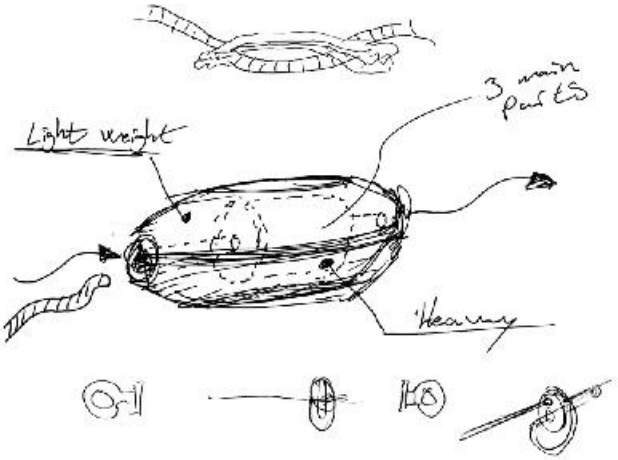


A further development on the wiring in a hard shell.

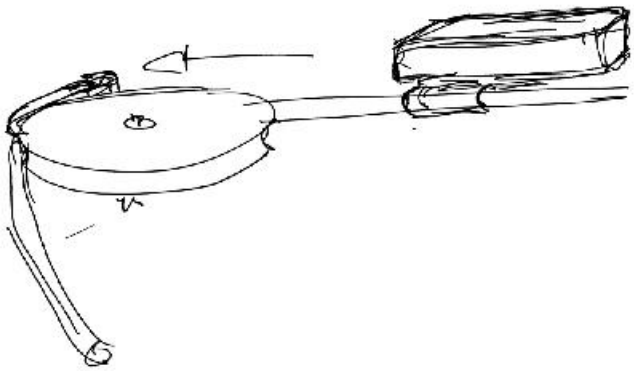




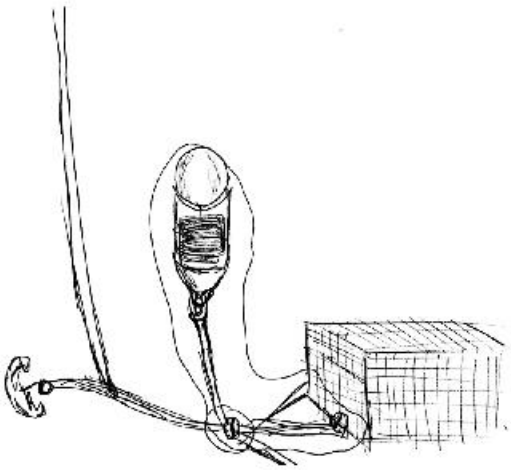
This concept is the begining of a mechanical spring solution to deattaching the entangled rope.

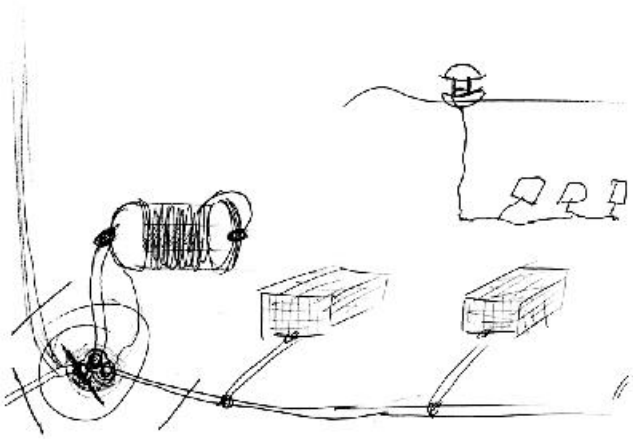


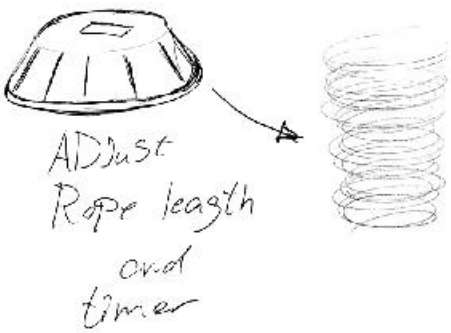
The first concept of a cablereel inside of hard case. When hauling in the emergency buoy the rope will be cut to the marking buoy.

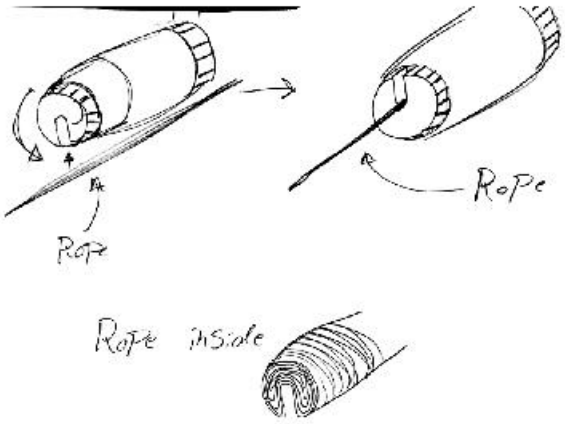


Exploration of the hauling tool and to get it through it.

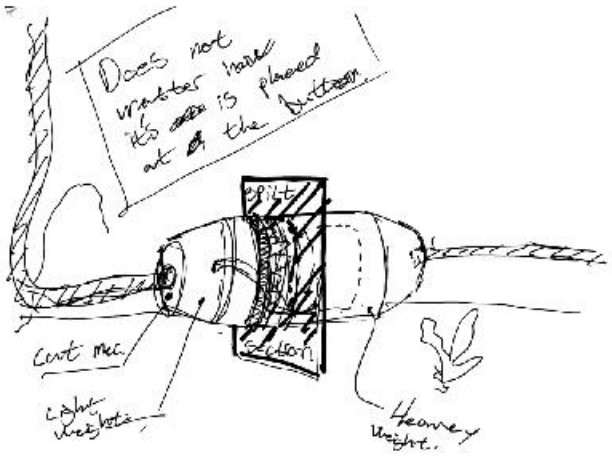




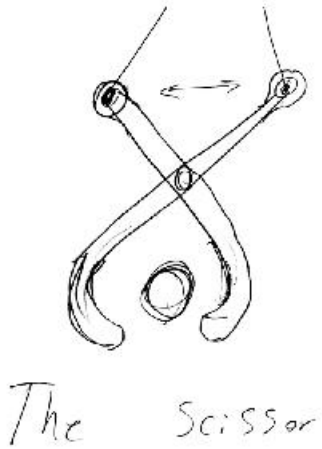




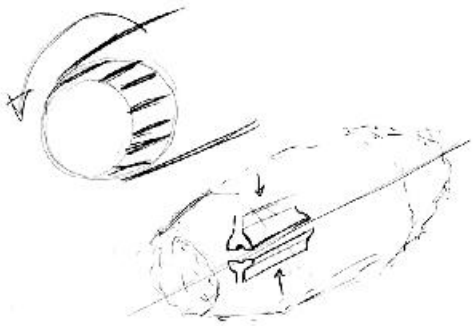
A way of attaching the concept to the main line in few steps. The only need is to rotate the end which enclosing the rope.



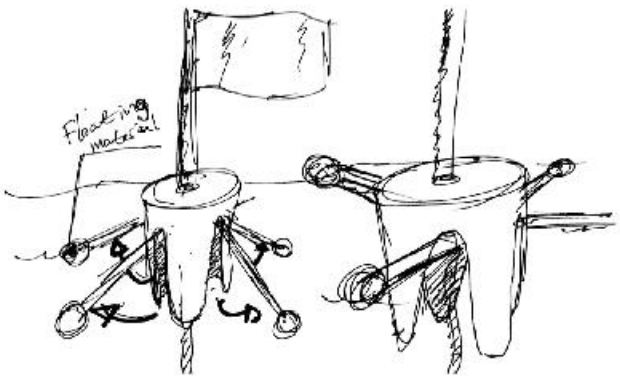
The same principal as the one to the left, but splitting vertically.



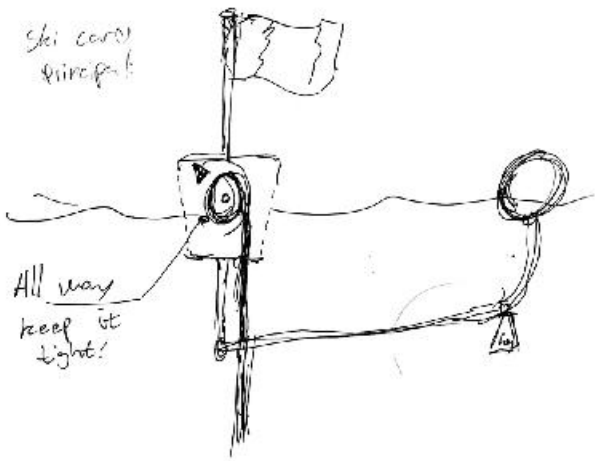
The principal of a scissor.



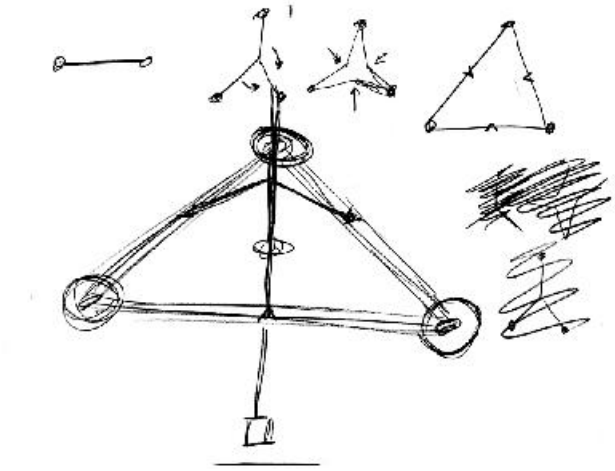
Detailing of the eailier concept.



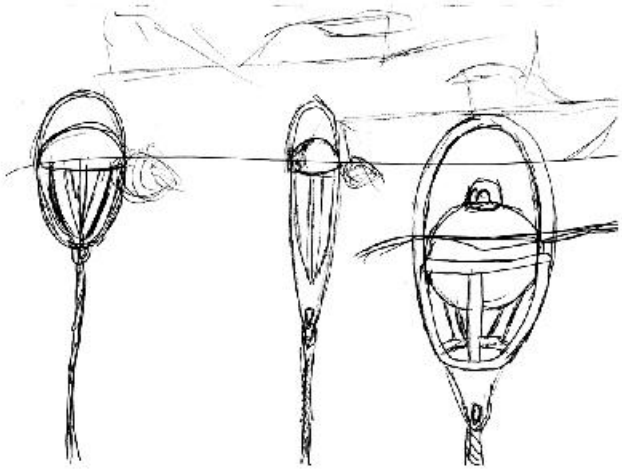
The first concept of the buoy with floating arms which should keep a distance to the boat and thereby prevent propeller cut off.



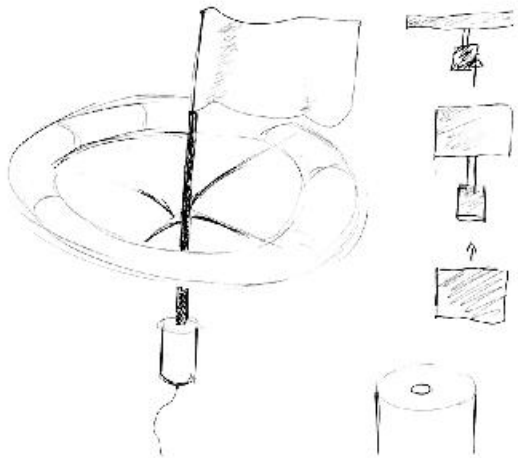
A concept which unfolding the problem of increasing and decreaing water height, which can make the rope loose. This principal is like the cable reel of a vacumcleaner - this should keep the rope tight.



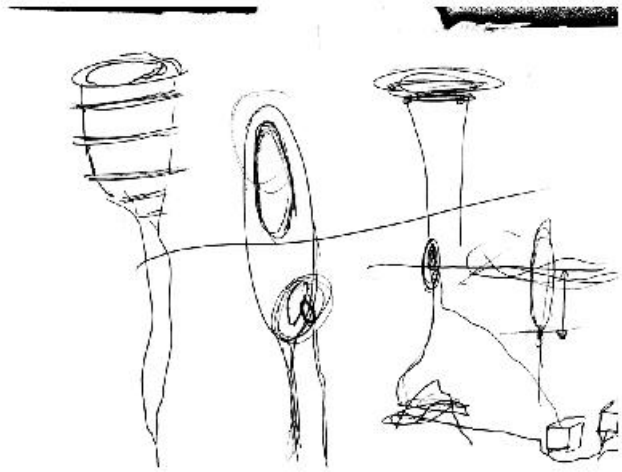
This is a further development on the umprella principal. Which is a concept which goes from small to large in volume.



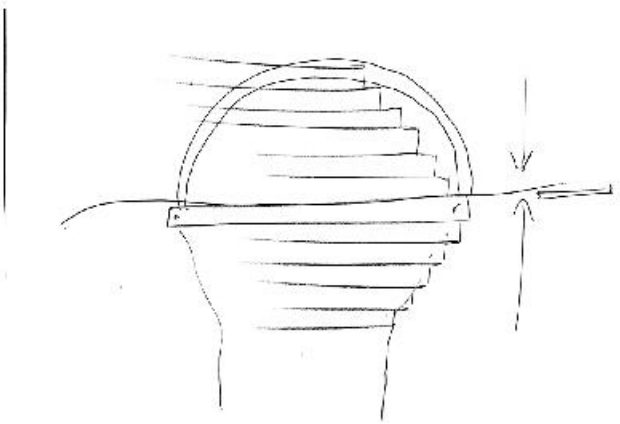
The new buoy - a buoy which goes deeper than the boat propeller.



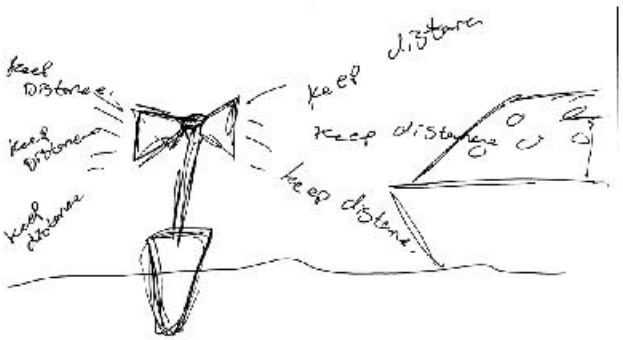
A flexible and foldable solution for the buoy to the product.



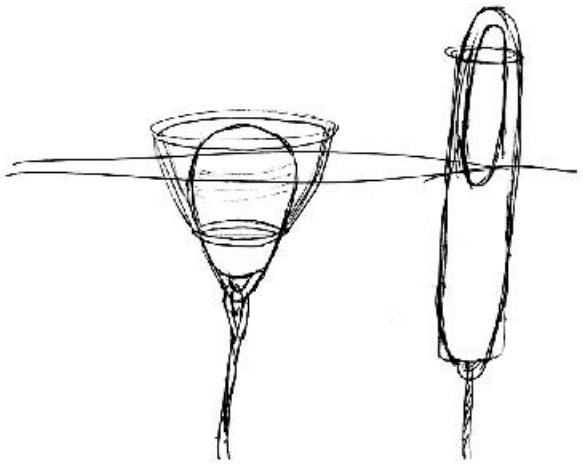
A flexible and foldable principal.



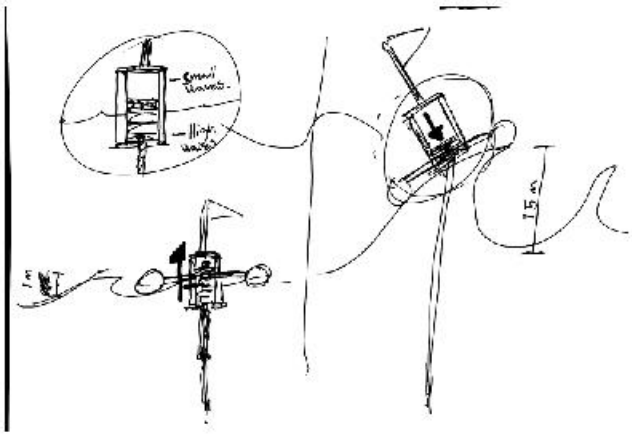
A flexible and foldable principal.



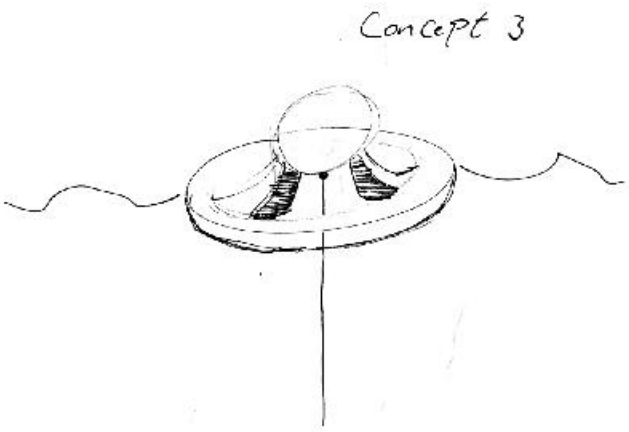
A buoy which making a lot of noise if you come too close to it.

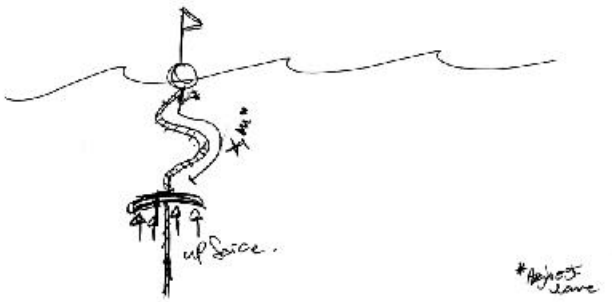


The new buoy - a buoy which goes deeper than the boat propeller.



An exploration within the cause of the large variation of wave sizes.





An exploration of how to keep the rope tight to the buttom - To avoid rope entanglement around large objects.

// OUTCOME

- The directions god new and improved principles and funktionalities.
- Each direction is more clear and defined.
- Alignment in which each concept direction should work and provide of features.

A28 - SKETCHING CONCEPT REFINEMENT

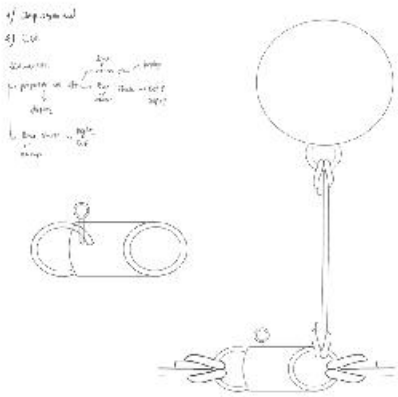
DEVELOPMENT PHASE | 5/04/19

Refining the 3 concepts to a certain level of quality is necessary, before any chose can be made. Furthermore, all concepts needs to be at the same level, so the decision or selection is made on a fair basis.Lastly, to make a refinement of each concept so they are fully understandable in its way of solving the problem and its way of working.

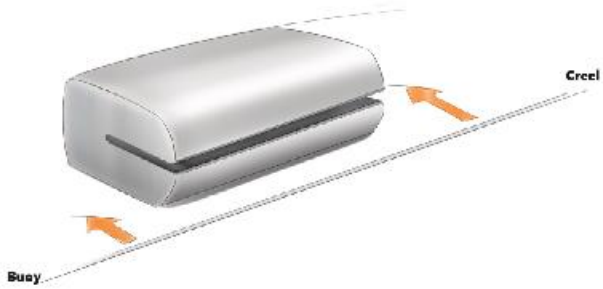
What we did? (Description)

Taking the findings from previous sketching round into consideration and use it into a refinement of the 3 concept directions.
Each of the group members generated 3 new concepts, 1 within each direction.
Lastly a 1 hour discussion was made to end up with 3 main concepts again.

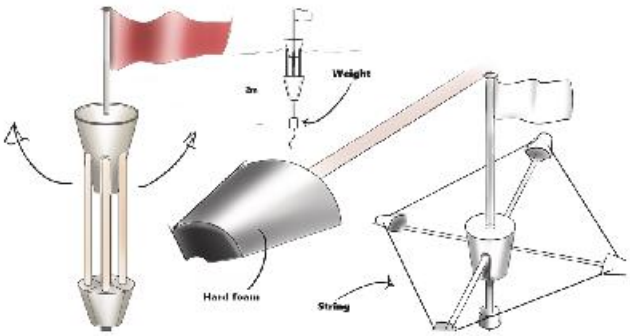
This task was needed to achieve a same level of quality within each concept direction. This would give the team the possibility to choose the right direction using a selection matrix. This should validat the concept next to critirias that the 3 directions have in common.



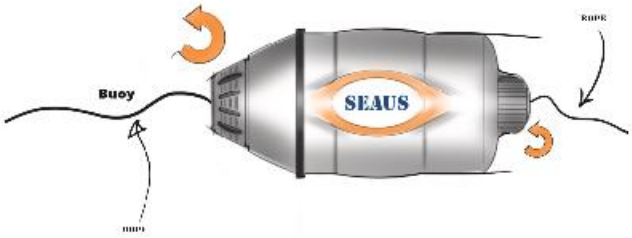
A refined solution of the release machanisme.



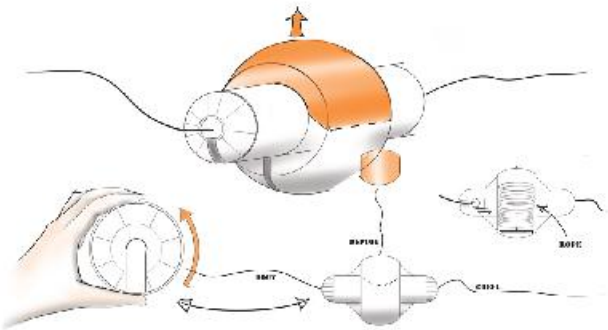
A refined solution to the ease of product attachment.



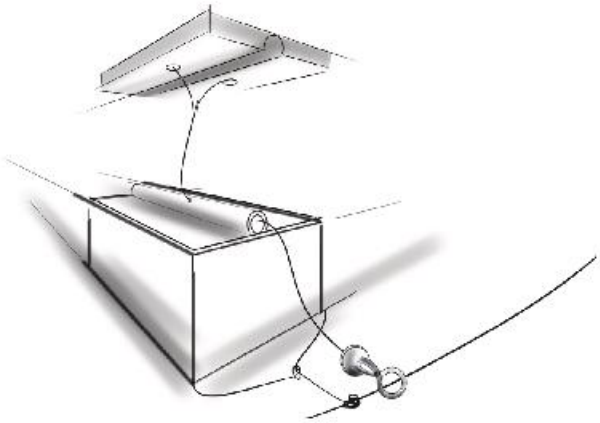
A refined solution of the umprella to keep a distance to the boat.



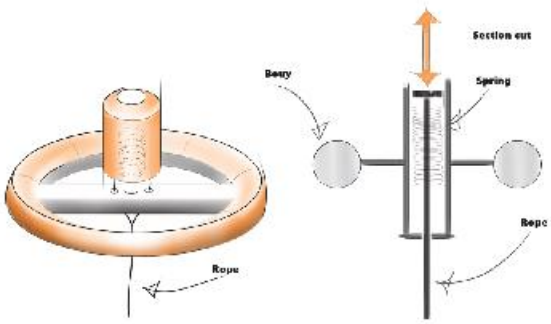
Another refined solution to ease of attachment of the product.



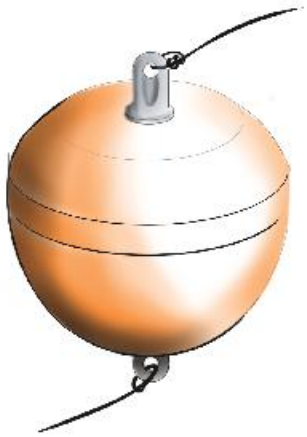
A refined solution to ease the product attachment.



A refined solution of the rope cutting principal.

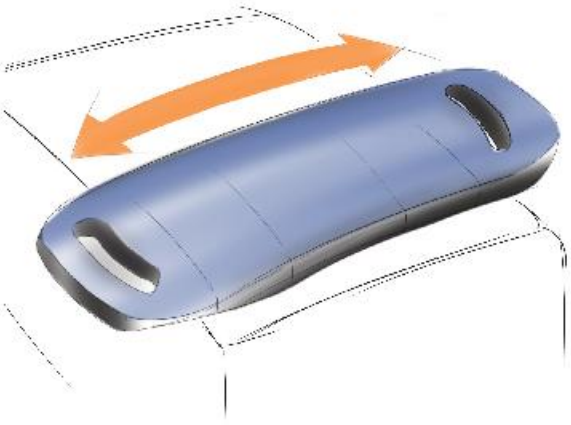


A refined buoy solution to the differance in wave size.

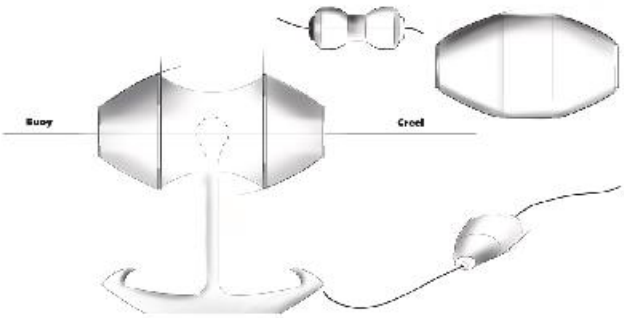


Early aesthetic exploration.

A refined sketch of the product on the creel. An aethetic exploration.

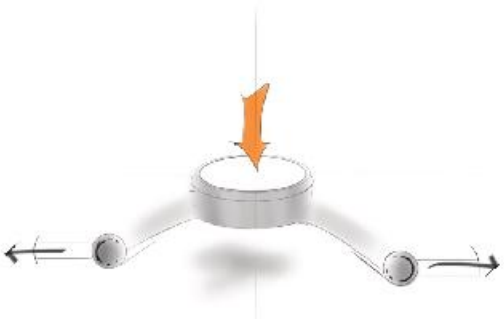


Early aesthetic exploration.

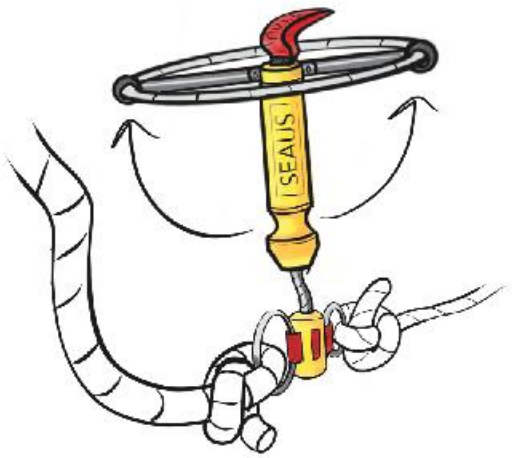


A shape exploration for the product "In-between".

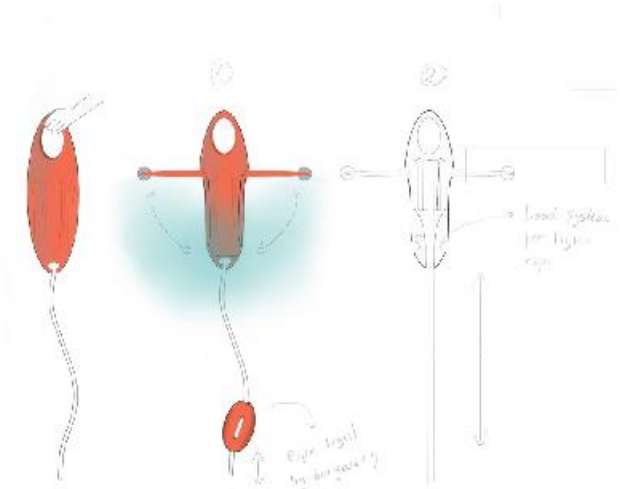
A shape exploration for the product "In-between".



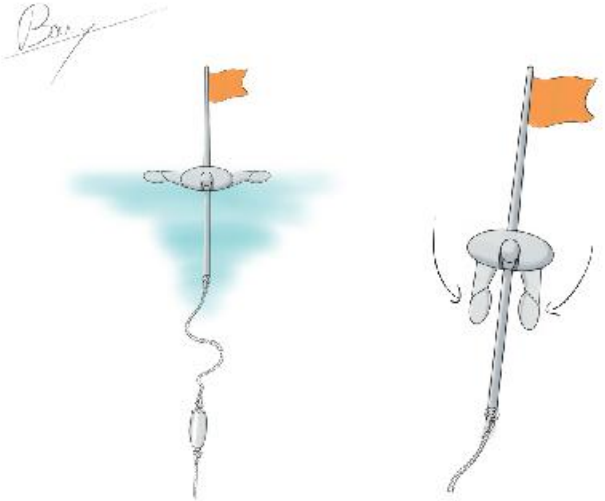
A shape exploration for the product "In-between".



A refined sketch of the product "in-between" - which are a futher development of the umprella principal.



A refined sketch of the product "in-between" - which are a futher development of the umprella principal.



A refined sketch of the product "in-between" - which are a futher development of the umprella principal.

// OUTCOME

- 3 well defined concept in the same level of quality.
- Presentation material which can be used to explain the concepts.
- Insight into the Aestetics and form.

A29 - CONCEPT SELECTION

DEVELOPMENT PHASE | 5/04/19

To choose which concept to go for is a tough task and somtimes imposable if the choose needs to make sence. Somtimes there is a favorite, other times it is only principles within each concept, that finds the teams interest. In this situation selection matrix might be the right way to go if a choose should be made.

Several criteria have been establishing in order for the team to take a decision on which concept would solve the problem in the best way possible. As shown below criteria as Reliability, ease of attachment and reusability is important factors which need to be fulfilled to some extent. Each concept fulfils all criteria but each of them do it better than others.

This selection matrix is the average of each team members opinion. Each team member did a selection matrix by it's on, afterwards, all 3 was assembled which ended up in the result shown below.

SELECTION MATRIX

		In-between		New buoy		Add-on creel	
Selection criteria	Weight (%)	Rating (1-5)	Score	Rating (1-5)	Score	Rating (1-5)	Score
Reliability	19	4	76	2	38	3	57
Ease of attachment	17	4	68	4	68	2	34
Non-invasive	16	3	48	5	80	2	32
Compact	14	3	42	4	56	4	56
Interaction simplicity	12	4	48	5	60	2	24
Re-usability	9	3	27	5	45	1	9
Misplacement	7	3	22	5	36	4	29
Scalability	4	3	11	5	18	1	4
Cleaning	2	3	5	4	7	2	4
TOTAL	100	271		371		191	

Ill. - Selection matrix

// OUTCOME

- New buoy was the one which got the higest score.
- The in-betwenener got the higest score in reliability.
- A combination of the two concepts might be at solution to achieve a better result.

A30 - MOCKUP BUILDING V.2

DETAIL PHASE | 22/04/19

To achieve insight about the physical scale and visualize principles, another mockup building session was made. This time the mockup quality should be higher to achieve a mid-fidelity mockup which could be used to internal use of understanding but also as a communication tool when the team needs to explain its ideas.

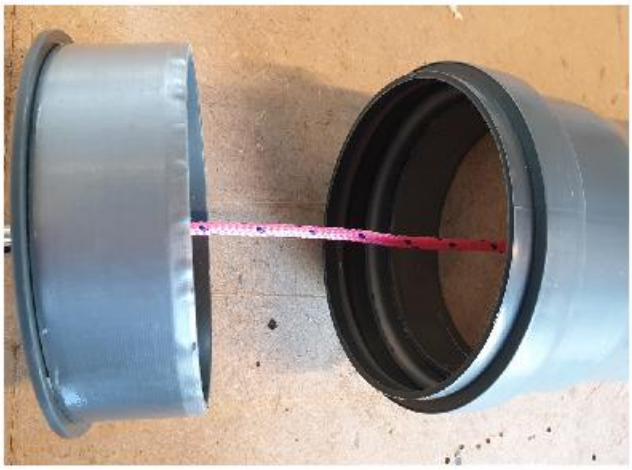
Visiting the nearest DIY marked (Silvan) the team got all the materials needed to build the mockup. The mockup should show how to create buoyancy, a strong outer shell, transformation and a way of releasing itself from or in other words, splitting itself in two. As shown in the following pictures principles or functionalities have been implemented to show and test how it works. The mockup is only for functionalities and not aesthetical.

Mockup is made of PVC tube, PE foam, polystyren ball, plastic rodes, robe and a 3D printet release mechanisme.

Showing the outer PVC tube which is acting as a protecting shell..

Showing the arm and is hinges which implimentet into the tube .

Showing the foam infill of PE.



Showing the rope which is connected to the release mechanism.

Showing the polesterene ball which is a part of the buoyancy.

Showing the end of the cable reel. This act as a brake which prevent all of the rope to fall of at once. .

// OUTCOME

- Permits the team to do tests which will bring the team a much better understanding of the product.
- A better understanding where buoyancy can be created.
- A better understanding of its physical scale.

A31 - RELOADING SYSTEM TEST

DETAIL PHASE | 29/04/19

In order to make our product a reusable product, there was a need to make a reliable system to reload it again by the user. To know which would be the best system to reduce failure risks we needed to test these and then note the benefits and drawbacks for the user experience for one or other proposed solution. Furthermore, we could observe risks that we didn't know that could occur while reloading the proposed systems. This test will permit the group to evaluate and validate the direction to take for further implementation.

We used a mock-up to recreate the principal mechanism for two proposals. One, using a reload system based on rolling a rope of 10 meters along a tube and the other reload system concept by using a cable reel with 10 meters of rope. (Show pictures here*)

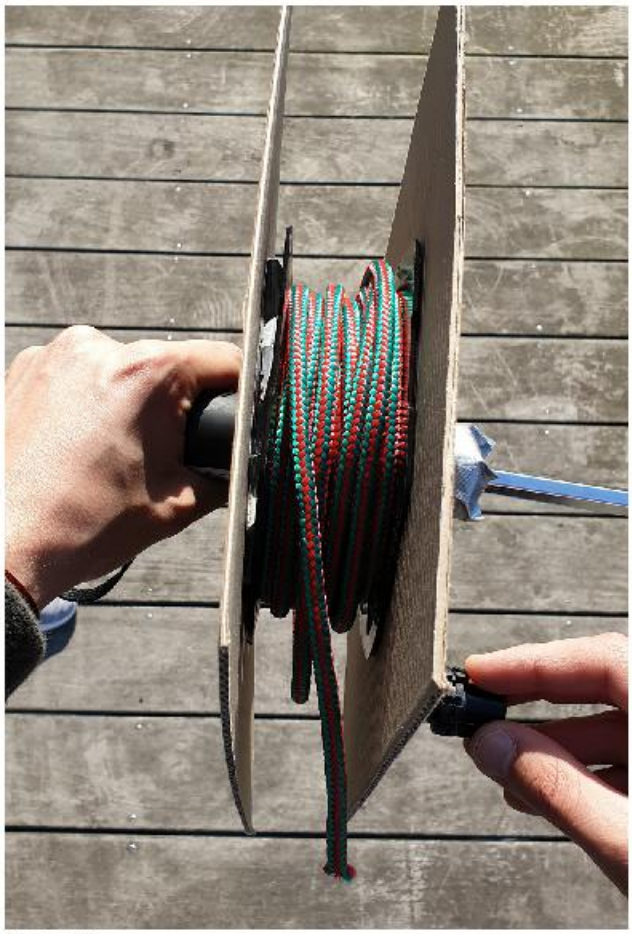
The first test was focused on the first concept ("The tube reload system") in which we recreate and timed five reloads. Afterward, we did the same with the other concept ("The cable reel reload system").

Observed that it took much more time by using the "Tube reload system" instead of the other concept. This reduces the effectivity for the user.

The movement to be done by using the "Cable reel" makes the reload more natural, easy and faster for the user to perform. This leads to an easy manipulability by using the " Cable reel" concept instead of " The tube".

Besides "The tube" concept takes more time to reload, it permitted to create a more compact product than the other concept.

The "Cable reel" concept reloads the rope on top of the other rope, which could lead to taking a risk of entanglement when detaching the rope.



Concept 1

As shown to the left, 5 tests with each type of reloading mockup ended with the result as showen. Concept 1 or mockup 1, is doble as fast as the other one.

	Concept 1 "The tube"	Concept 2 "Cable reel"
Test 1	35 "	1' 14"
Test 2	32 "	1'
Test 3	31 "	57"
Test 4	34 "	1'
Test 5	33 "	53"

Concept 2

As showen in the picture above, this way of loading the concept is critical because it creates an anoying movement which makes the reloading much more difficult.

Reloading in the way as concept 1 shows makes the movement much more natural and easy. But the grib needs to be more rough so the whole hand is in use. Avoid the fine grip.

// OUTCOME

- Concept 1 takes half the reloading time than concept 2.
- The grip needs to be more rough.
- Concept 1 is a much more natural movement.

A32 - ROPE UNFOLD TEST

DETAIL PHASE | 29/04/19

We wanted to observe how was the system of loaded rope responding when being unfolded. This test would give us insights on the risks that we should take into consideration when deciding how this unfolding method should be.

We create the unfolding mock-ups, which were the same used for the previous reloading system test ("The tube" & "The rope reel"). These, had the loaded system with a 10 m length rope for both concepts.

Recreated the unfolding of the two concepts by pulling from one direction and holding from the other part.

Recreated the unfolding of the two concepts in a small scale and used a water tank to recreate the unfolding in context as realistic as possible and with similar characteristics as a real context.

Found that "The tube" system was creating knots due to the twist of the rope when unfolding it. This, would create risk that the team want to avoid on our product as being a safety product.

As showen below on both pictures. The unloading with concept 2 from the reloading test, creates problems which might end up in knots. This is risky and does not increase the reliability of the product. See Appendix 31 for more information of concept 2.

// OUTCOME

- A wird twist on the rope when unloading with concept 2.
- Concept 1 was natural without problems.
- Concerning reliability concept 1 might be the way to go.

A33 - RETRIEVE FROM WATER TEST

DETAIL PHASE | 29/04/19

In order to gain understanding of the retrival a test of this needs to be performed. With this test the team should gain insight of its dificulties and how the poduct should be in the water when it is deployed.

As showen in the pictures below the test takes place in Limfjorden next to the building "Create". This place permits the team to do the test at different ranges and thereby find out in which distance it is easy to perform the action and when it begins to get complex.

This test does not take external impacts into consideration. There is no waves and the ground dosent swing from side to side. This test is done at a distance of 4-8 m.

// OUTCOME

- In a distance of 4-8 meters, the retrieval keeps at an easy level which doesn't create any problems.
- The bigger the area the easier it is to retrieve.
- At the distance Tonny (A25) haul in this test dosent creae any problem.

A34 - DETACHEMENT TEST

DETAIL PHASE | 29/04/19

To investigate how the detachment mechanism works while a load is applied in different directions. Furthermore, to observe if any failure would occur when pulling from different angles. This should provide the team with an understanding of its reliability.

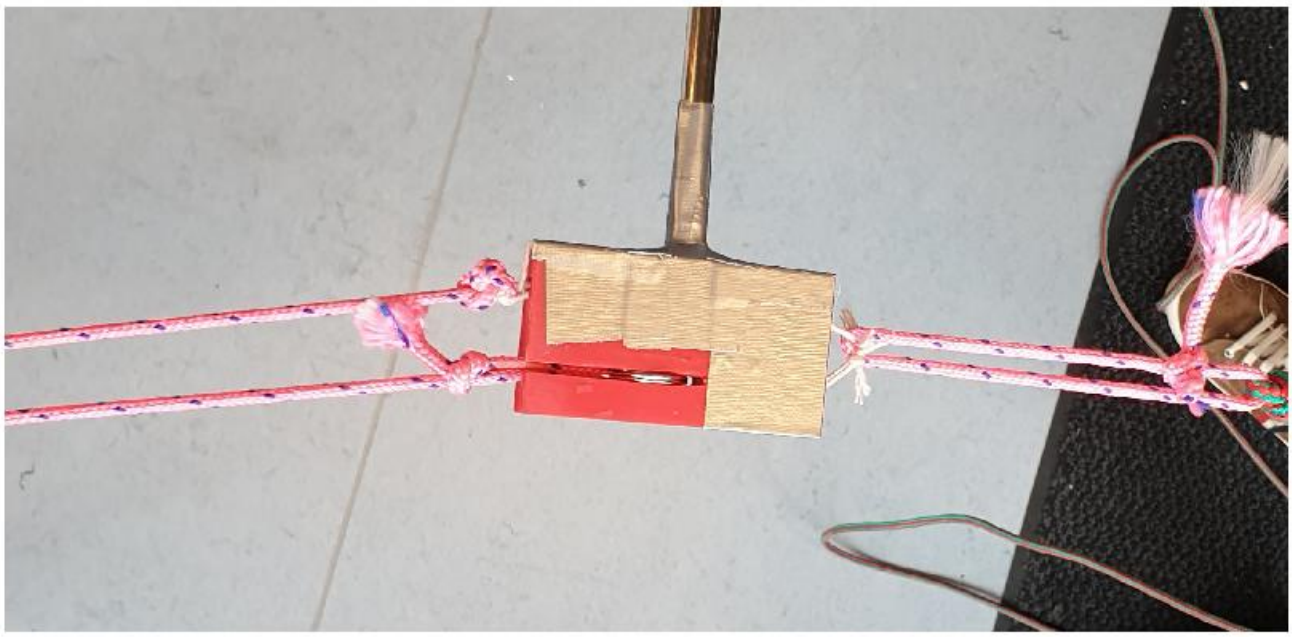
What we did? (Description)

One team member pulls in each direction to simulate the most common scenario. Afterwards, a pull in different angles was performed to simulate critical scenarios. While one team member was pulling, another team member was trying to activate the release mechanism by simulation the hauling of the product, also applying a pull.
No matter the angle of the pulls the release mechanism should work to keep up the reliability.

What we got? (Result)

Pulling in certain angles result in a huge failure, that is not allowing the mechanism to work.
In the most common scenario, the mechanism works but gets a bit hard to release.
The mechanism needs to be optimized to minimize the risk of failure.

The team assumed that the pull, which is shown below, is a normal pull. In this situation, the release mechanism works perfectly without any failures.



As shown above a angular pull is applied. This creates a critical situation as shown above. The metal ring is stuck since it dosent gets pulled directly out of the slit. Thereby, this solution only works when a normal pull is applied.

// OUTCOME

- An angular pull makes the release mechanism fail.
- Normal pulls makes the release mechanisme work perfectly
- Another release mechanisme needs to be applied.

A35 - WEIGHT DISTRIBUTION TEST

DETAIL PHASE | 29/04/19

To get an idea of the overall properties, to make sure that no matter the weather, the product will stay in its right way all the time and how can this be done with without using to heavy objects. Furthermore, to figure out what is absolutely not a possibility.

What we did? (Description)

The team made a small mockup made of a wood stick, foam and clay. Placing these materials in different ways, helped the team to understand what the right proportions, of a product that would turn it self right all the time, would be.

What we got? (Result)

Taking the balance point into consideration. The dominating weight needs to be placed underneath the foam with a certain distance.
If the height is placed just underneath the foam (with no distance inbetween), there might be a risk of failure, since it can lay down vertically in the water.
Having the weight long away from the foam enables the product to work with less weight attached.

As showen above the weight is placed away from the products mid. This create stability and ensure that the product will only stay in it rigth way in the water.

As showen above weight is placed near the buoyancy of the product, this create a unstability and the product can be placed in a wrong way in the water.

// OUTCOME

- Weight needs to be placed away from the part which create buoyancy.
- Weight needs to be placed from a certain distance of the product mid.
- The weight cant be placed in the middle of the product.

A36 - ROPE UNFOLD TEST UNDER WATER

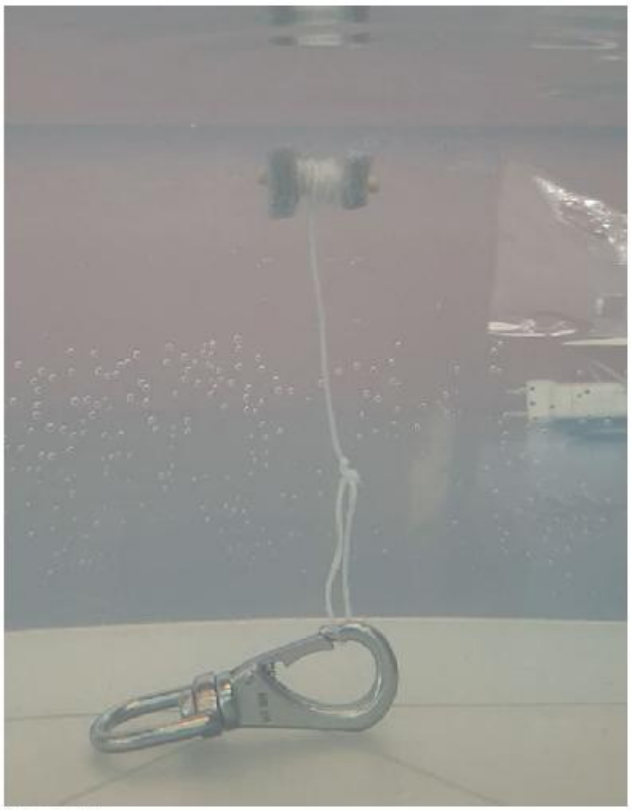
DETAIL PHASE | 30/04/19

As an upfollowing test on the previous unfolding test, this on should show the same deficulties but underwater. The team wanted to create the situation in more realistic circumstances. Previous unfuld test can be found in A32.

As shown below, concept 1, the rope makes twist when it gets unfolded. This can in some situations create knots and thereby decrease the reliability of the product.

Concept 1

As shown below, concept 2. unfolding with a cable reel is much more safe and do to the risk of failure.



Concept 2

// OUTCOME

- Concept 2 is the most reliable solution.
- Concept 1 generates a twist on its rope on the way towards the water surface.
- Concept 2 generates a high rotational speed on its way up.

A37 - ARM UNFOLDING TEST

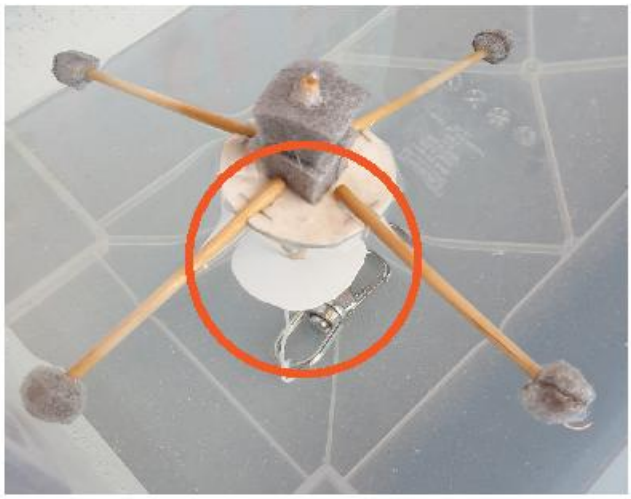
DETAIL PHASE | 30/04/19

To get an understanding of potential risks when the arms gets unfolded. The test should be done in two different ways. First, just by putting the model down in the water to simulate unfolding the principle. Second, by letting the model come out from a cylinder underneath the water to see if it still works correctly. Lastly, could any solutions be applied to avoid failure. When the arms are folded out the product should have a stationary position.

The team created a small scaled mockup of the arm principle to simulate the scenario. The team tried to do everything to make the mockup end up in a position that's not the stationary position. This was done by simulating waves using hands, throwing it in a weird way in the water, turn it upside down. But the product turned it self into the right position all the times.

As shown in the picture below one of the arms gets stuck because of the starting angle when it is in the water. This angle force the arm to go the wrong direction which mean it gets stock . Thereby the team applied a small disc as shown in the picture to the left.

The main principle works.
The start angle can prevent the principle to work.
The start angle needs to be perpendicular to the water surface.
Simulating, the product coming out from at tube under water can result in a wrong position on top of the water.



// OUTCOME

- Applying a disc in the bottom of the product helps it unfold its arm correctly all the times.
- Starting angle under water needs to be taken into consideraction.
- Arms gets very unstable.

A38 - VISIBILITY TEST

DETAIL PHASE | 30/04/19

With this test, the group wanted to validate and find a suitable solution to implement in the product being developed. With it we wanted to test, by one hand, the visibility from a long distance, which would represent the seeing distance that fishermen would have when trying to find our device to retrieve their lost creels. And on the other hand, we wanted to validate the performance of the reflection effect on the reflective parts of the buoy.

We build a prototype of the visible part of our product with the arms after been deployed. After that, we attached a rope to the model and brought it to the fjord, in which we throw it into the water. Then, we tested its visibility from different distances and heights (Bird perspective and human perspective). The distances where: 85m, 120m, 220m, and 400m. We took different pictures and noted different insights we got from the test to use them afterward to improve the visibility of our product.

What we got? (Result)

We found that by using a surface popping up from the water surface facilitated much more the search of the product. Also using a visible color also helped to differentiate from other objects at the horizon and water. The different tests gave us the idea of how could our product help the fishermen to be found using the eyesight. We made the following table to show our findings:

Distance	Insights
85m	Easy to spot and differentiate it from other objects. Reflections can be seen if being positioned with the sun in the back of the user.
120m	Easy to spot but barely difficult to differentiate from other objects at the horizon. Reflections are difficult to be perceived from this distance.
220m	Difficult to spot and differentiate from other objects at the horizon. Reflections can't be perceived from this distance.
400m	In a distance of 400 meters, it becomes impossible to spot the object. The reflective part of the product became identical with the reflections from the water. Since the orange sphere was at the same level as the water it also became invisible to the eye.

After the test, we have found that the prototype works from a distance up to 150 meters, but, after this distance, the visibility of it's more inefficient. Apart from that, it has been seen that reflections worked only when the user it's watching from a point of view in which the sun it's in back of him. Moreover, it has been found that reflections from the water made barely impossible to be differentiated from the ones implemented in the prototype.

85m

120m

// OUTCOME

- The concept can easily be seen in a distance of 120m in good weather conditions.
- The concept becomes invisible in a distance of 400m.
- Reflections gets too simular to the water.

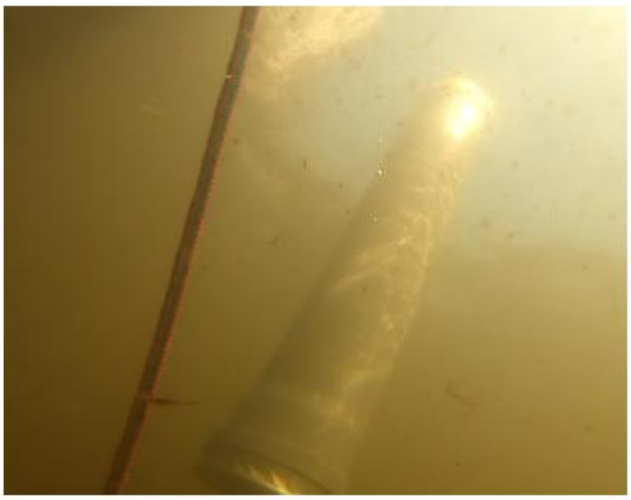
A39 - BUOYANCY TEST

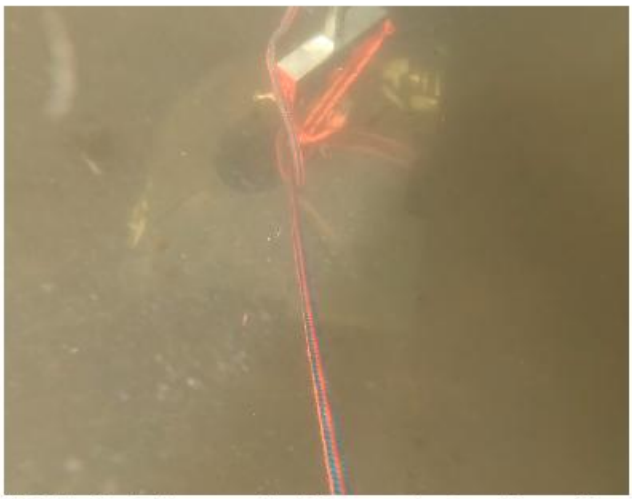
DETAIL PHASE | 01/05/19

The main goal of this test was to validate the floatability of the prototype we had in order to be sure that the product maintain the direction upwards underwater. If so, we ensure that the product cannot be misplaced when about to be deployed from the bottom of the sea. We also wanted to see how does the streams affect to the prototype underwater.

We took the prototype of our product and attached it to weight to simulate the weight of the creels and the anchor underwater as in a real context. Then, we place it underwater in a place where there were water streams and observed how the prototype was reacting to it.

The group observed that the prototype was standing upwards to the bottom as wanted for our product and, moreover, the reaction to the water stream wasn't affecting to its movement at all.





Weight attached to ensure that the concepts stays at its position.

// OUTCOME

- Enough buoyancy to ensure its direction upwards.
- Streams might have a high impact.
- The need of making the product waterprof is high.

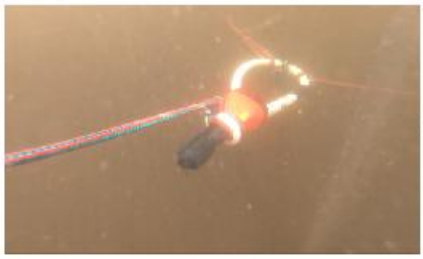
A40 - DETACHMENT UNDER WATER TEST

DETAIL PHASE | 1/05/19

This test would allow the group to validate the detachment of the lost creels from the entangled lines underwater. This test would be done using a mechanism which it's used as a security deployment mechanism in kitesurfing, the group wanted to observe if this mechanism would fit with the needs and requirements we needed for our product and its performance.

The group created similar fishing with creels configuration by using a real creel attached to the release mechanism on the one hand and on the other hand, at the other side of the release mechanism, an anchor attached with weight to simulate a real entanglement. Furthermore, in the middle of the mechanism and as a part of it, there was attached a rope which would be the same line from where fishermen would pull from to retrieve their lost creels.

This test was done underwater with real tides to recreate the context as similar as possible as real context. The test was recorded in order to be able to observe underwater and extract findings from it.






// OUTCOME

- Deattachment becomes easy no matter the angle of pulling.
- Works perfectly in both conditions.
- The rope can get stock as showed with the orange ring at picture 3.

A41 - INTERACTION TEST 1 HAULING IN

DETAIL PHASE | 2/05/19

Getting an overview of where the need of interaction surfaces is, when using the SEAUS product in the context. How are the fisherman going to attach the product, how is he going to haul it in, how is he going to get it through the hauling tool. Can a handle, or other grabbing surfaces, be implemented to facilitate these situations. Interaction test 2 will explain interaction of attaching and interactions test 3 will explain how the product goes through the hauling tool.

What we did? (Description)

We want to facilitate the interaction in every work task that the product includes, by simulating the work tasks and thereby figure out where it would make sense to implement.

Simulating the context of hauling in was done with a overturn table to create the edge of the boat. Thereby it was possible to haul in the product up against the side of the simulated boat. This situation should force the tests person to grab in the product.

Interacting with the product while hauling in gave a lot of knowledge and some crucial insights.

The product gets retrieved to the boat in a upside down way, since the attachment of the rope is in the bottom of the product and that it what comes up first.
The user want to grab in the middle of the product, since that is where the balance of the product is.
The arms can get annoying when interact with the product.
Hauling in the product from the side of a boat, needs a handle in the top of the product.
To avoid entanglement with rope, the outer shape needs to be without pointy ends.
The outer shape needs to facilitate a stable position so it doesn't move around while the ship swing from side to side.
Placing of grabbing handles to facilitate work situations.
The deattacheing part needs to be close to the product.

Handle at the top of the product

Handle in the center of the product to keep the balance.

// OUTCOME

- Handle in top and center of the product needs to be implimentet.
- Arms gets annoying when interacting with the product.
- Handle in the bottom of the product might also be a need.

A42 - INTERACTION TEST 2 BINDING KNOTS

DETAIL PHASE | 02/05/19

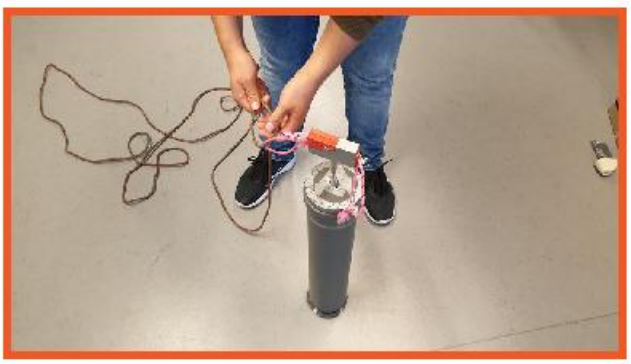
Since the fisherman are going to attach the product two times in every line of creels, this operations needs to be done in a satisfying way. To facilitate the best way of attaching and detaching the product to the line of creels. This is to eliminate the risk of the product getting annoying to have.

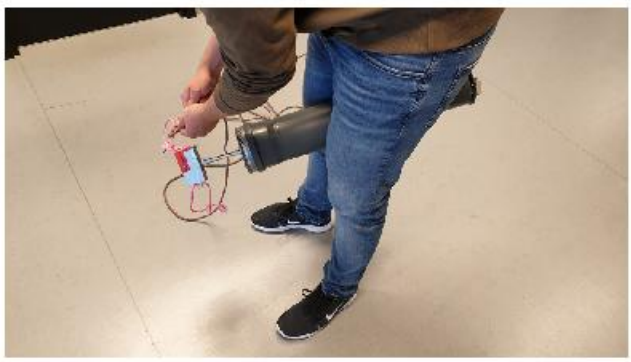
Placing the product in different ways as if the fisherman would do it, when attaching the product to the line of creels. Between legs, on the floor or up against the shipst wall. These different ways of handling the product while attaching and detaching, was explored by simulating the scenario on our self.

The simulation of binding knots or attaching the product to the line gave some insights that the product needs to facilitate:

Placing the product perpendicular to the floor makes most sense and is absolutely the easiest way of handling the process. The surface that the product are going to stand on while getting attached, needs to facilitate a stable and strong platform that makes sure that the product doesn't tilt.

Even on a non-rocking surface, a stabilising hand is needed, which means the other hand has to do the job.





// OUTCOME

- Placing the product perpendicular to the floor creates the best facilities of this proces.
- Binding knots or doing the attachment could be done by one had with the use of carabiner clip.
- Placing between legs is the abselutly worst way of doing this proces.

A43 - VISIT KIM JOHANSEN TO VALIDATE CONCEPT

DETAIL PHASE | 03/05/19

To validate the concept in a prober way, the team visitet Kim johansen, which is a fisherman who are using creels. Actually he have the biggets boat/vessle in Denmark for this perpose. Bringing the mockups with us and use them as a communication tool shoul help in the understanding of the product.

The team presented in 8 minuts. In this presentation, the project and the solution got explained trough sketches and mockups. These tool made it pretty clear for Kim what it all was about.

Kim unfolded every single aspect concerning the product in order to improve our solution. As showen underneath kim explains about the hauling and its properties. No matter the thikness of the rope, the hauling can handle it. But if it gets too small it can get stock.

Kim was worried about the arm on the product since they created a unstable construction with too many joints. These joints whold get detroyed in a short time.

Kim just bought a huge amount of new creels. half a milion of new equipment. He could defenently use a product which could secure his creels and give him another chance to retreive his gear if he should experience a propellor cut-off or entanglement.

Troughout the presentation the team used mockups to explain their ideas.

As a size comparison. The seaus product next to 4 plastic fender.

// OUTCOME

- The use of arms might not be the right solution because of the enviromental conditions.
- The distance that the arms provide is not enough since the proppelor of the boat is 2.2m in diameter.
- The product can easely be bigger if it gets compared to other products in the boat.

A44 - VISIT TONNY NEES TO VALIDATE CONCEPT

DETAILPHASE | 03/05/19

The team needed to validate the concept, not just with one fishermen, but with 2. First the team visited Kim Johansen on his big boat, afterwards the had a interview with Tonny Nees to get even more feedback on the solution and its direction.

As in the interview with Kim, the team brought mockups as a communication tool as shown in the pictures below. This also enables Tonny to explain his ideas with the use of our mockup. Here we got valuable insight like the fishermen might need the possibility to choose where he wants to instal the product.

Maybe a placement of the product in the middle of the line of creels could be a possibility for the fishermen. This would give the fishermen to chance to customize.

Overall the product is a very good solution to the well knowen problem of losing creels and Tonny belive that it would work. But it might need a aethtical touch to create attention within the fishing industry.

// OUTCOME

- If the fishermen them self could have the posebility to place the product it would create even more value.
- An aethetic toutch would definently increase the product value.
- The arms might be too vulnerable.

A45 - INTERACTION TEST 3 (GOES THROUGH HAULING TOOL)

DETAIL PHASE | 03/05/19

It is absolutely necessary that the product easily can go through the hauling tool, since this process is going to get repeated several times a day. If this doesn't gets fulfilled the product gets annoying to the user and might not be used as it should be. Therefore it is very important that the team tests this out to make sure that the product facilitate this process in the best way possible.

Simulating this out on a fishing boat was the best way of testing this scenario. Therefore the team brought several mockups out in the real context to test it out. Using the hauling tool in a simulation was easy and reliable. Attaching the first concept to the line and start the hauling tool was the first step. This was done several times to get and understanding of how it reacts. Same procedure for the next concept.

The release mechanism needs to be flexible and small to get through the hauling tool.
To prevent unhandy situations the deattachement tool might need to be attached in a certain distance from the product. This would make the process easier since the user don't need to use both hands to go through the hauling tool.
Concept 2 was better since it could be controlled with one hand in a easy way, because of its flexible parts.





// OUTCOME

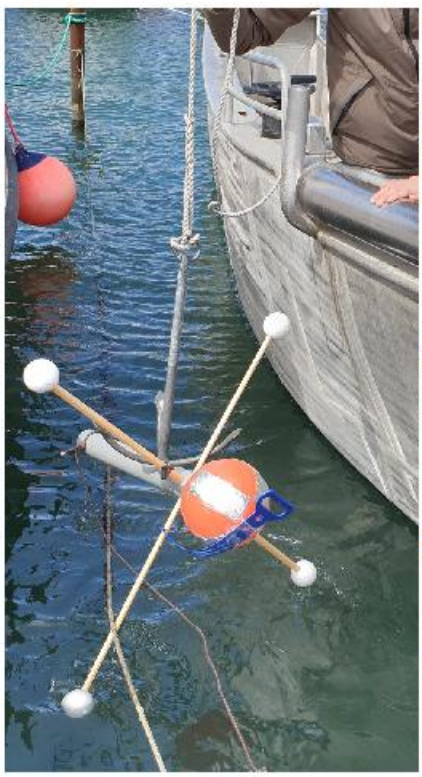
- The product can go through the hauling tool without a problem.
- The movement becomes a bit akward.
- The product is just going to be handled like another creel.

A46 - INTERACTION TEST 4 HAULING IN 2

DETAIL PHASE | 03/05/19

In addition to the earlier Hauling in test (A41), this one is made in realistic circumstances. This test is done to ensure that nothing is mission.

Underneath and in the upfollowing page, is the hauling in showed in steps. This is done to figure out if the handle is placed in the right spots.



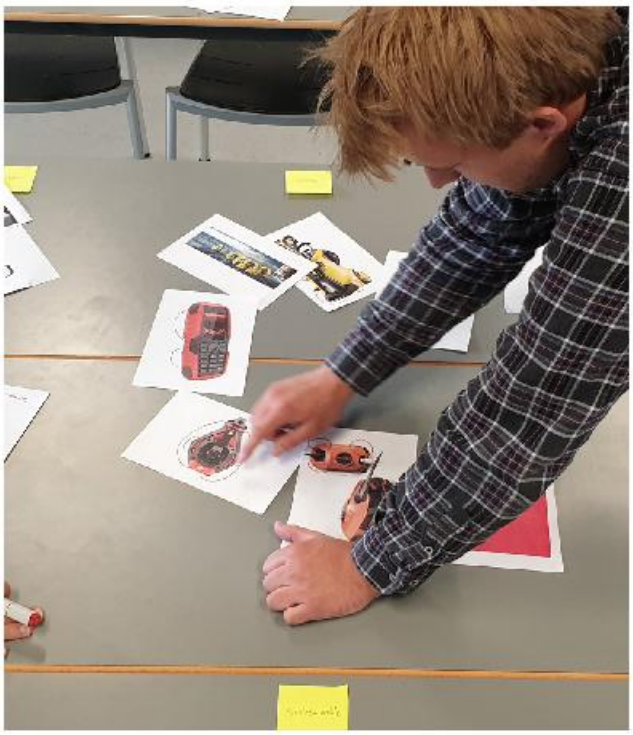
// OUTCOME

- Handling the rope with one hand and the product with another is the prober way.
- When the product is inactive, it creates a akward proces when it needs to go trough the hauling tool.
- The handles are places correctly and facilitate every interaction.

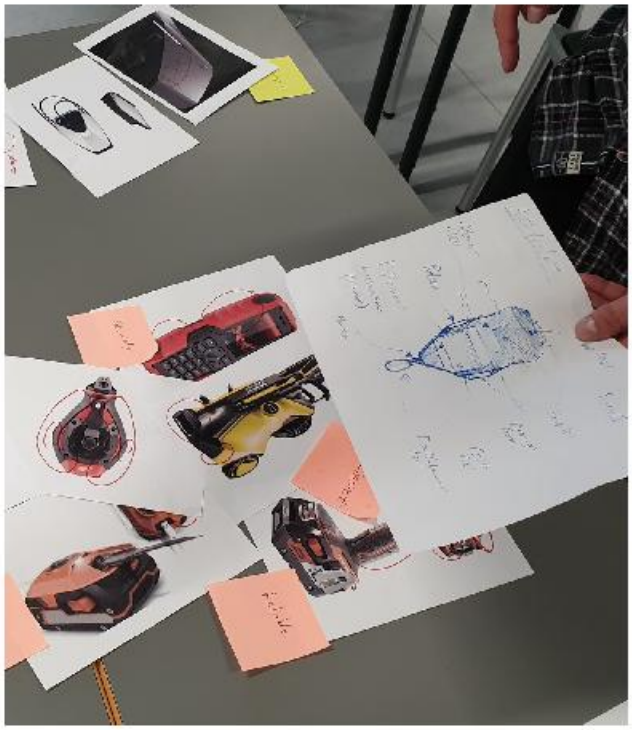
A47 - AESTHETIC DEFINITION

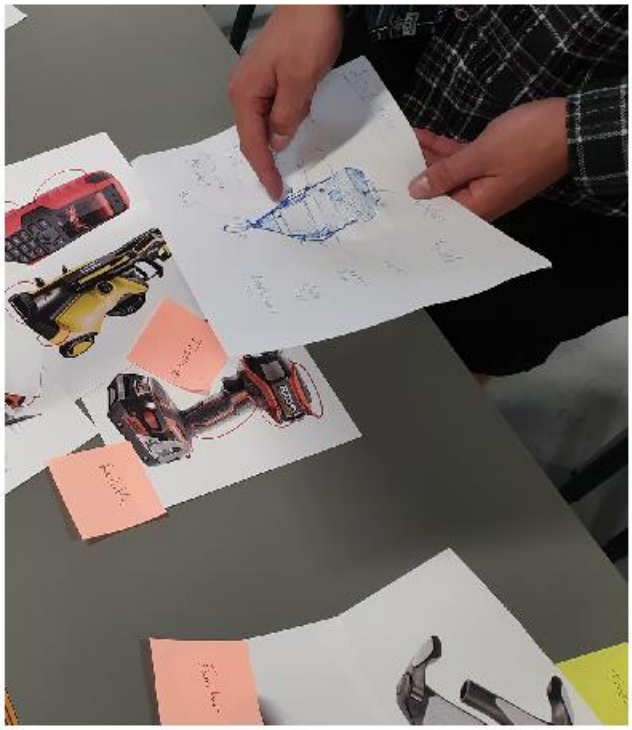
DETAIL PHASE | 09/05/19

The team did a workshop upon the Aesthetics of the product. This should give the product a better feeling of the values that the team want the product to signal. This is done upon the product architecture which is fully defined by technical parameters.



As showen in the pictures below. The team had a product architecture in the beginning. To make this more appealing the product needs another layer. Also to provide the needed values.





// OUTCOME

- The team wanted a smooth outer surface to facilitate cleaning and aviod entanglement.
- Handles should be integrated into the surface of the product to avoid entanglement.
- Handles should be showen with another color to fastly spot where to grip.

A48 - AESTHETIC DEFINITION PICTURES

DETAIL PHASE | 09/05/19

The team needed reference pictures to allign in which direction to go. Underneath is all the pictures listed.





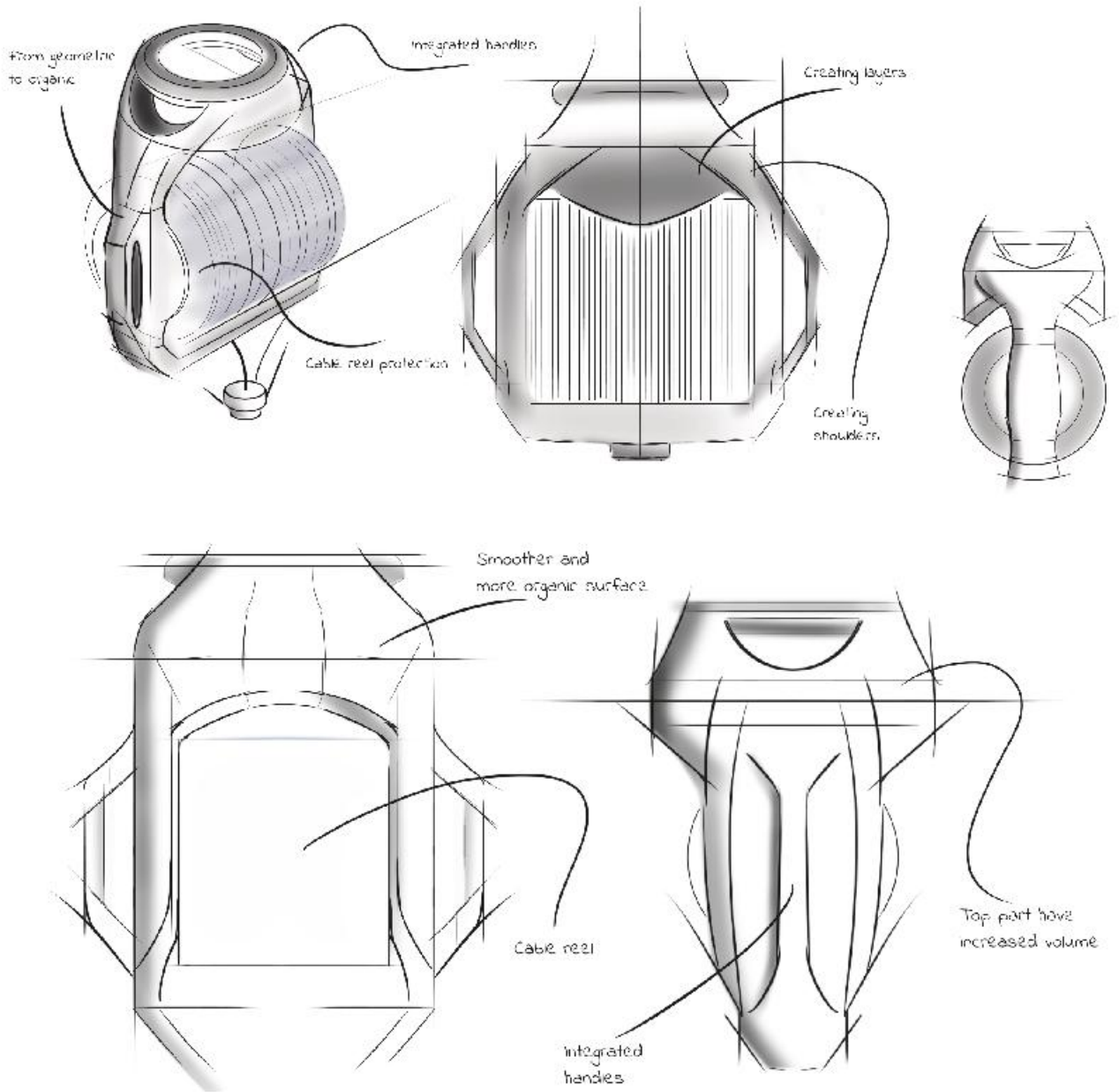

// OUTCOME

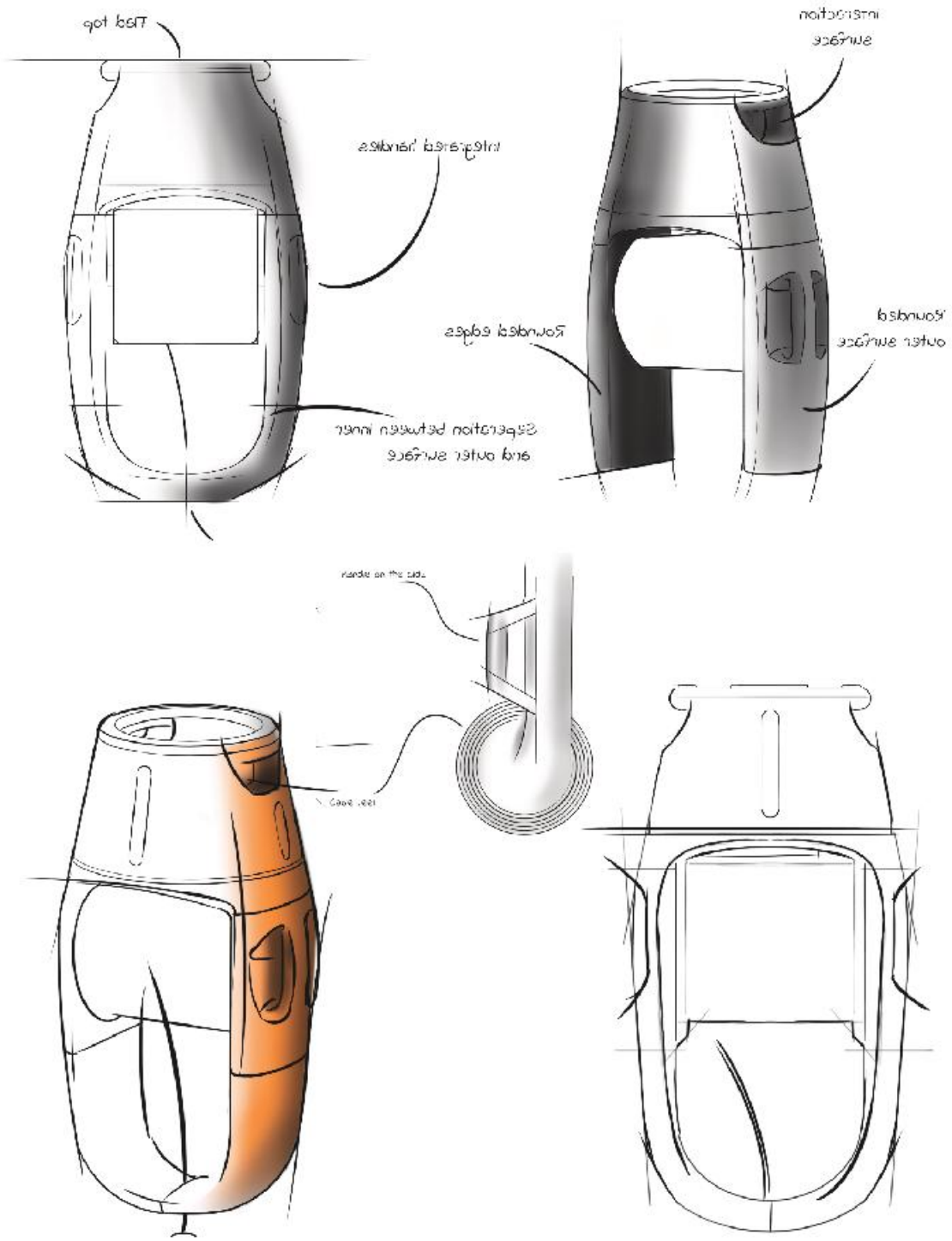
- Gave ideas on have to integrate handles into the surface of the product.
- A better understanding of which Aestehtical direction the product should go.
- A better allignment of which direction the product should go.

A49 - FINAL SKETCHING

DETAIL PHASE | 09/05/19

Final sketching provides a clear picture of what the end result should be.





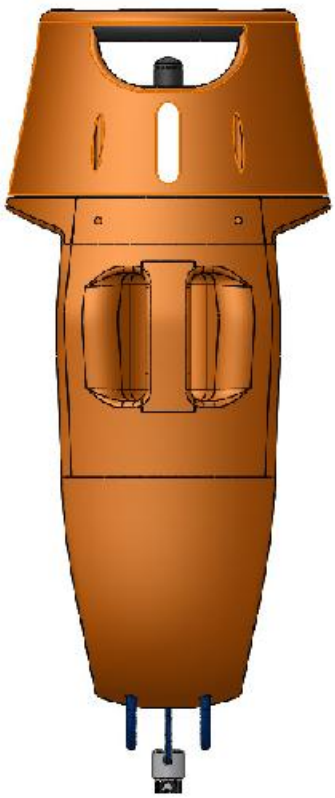
// OUTCOME

- A much more defined visualisation of the product.
- Integration of handles.
- A better understanding of the product proportions.

A50 - SOLID WORKS

DETAIL PHASE | 17/05/19

Solidworks has been used as a visualisation tool as mush a it has been used for the final modelling of the product from seaus. Solidworks have also been used to generate funktionalities along the way for testing (A34).



// OUTCOME

- The last visualisation.
- Final proportions.
- Enable to 3D print for the high fidility mockup.

A51 - BUOYANCY AND WEIGHT CALCULATION

General

Density of HDPE $D1 := 950 \frac{kg}{m^3}$

Density of divinycell $D2 := 100 \frac{kg}{m^3}$

Force of gravity $g := 9.8 \frac{m}{s^2}$

Density of saltwater $D := 1030 \frac{kg}{m^3}$

Top part

			Buoyancy
HDPE	$V1 := 1524048\ mm^3$	$W.1 := V1 \cdot D1 = 1.448\ kg$	$F.b1 := V1 \cdot D \cdot g = 15.384\ N$
Divinycell	$V2 := 4836002\ mm^3$	$W.2 := V2 \cdot D2 = 0.484\ kg$	$F.b2 := V2 \cdot D \cdot g = 48.815\ N$

$Weight1 := W.1 + W.2 = 1.931\ kg$

$Buoyancy := F.b1 + F.b2 = 64.198\ N$

Lower part

			Buoyancy
HDPE	$V1 := 611564\ mm^3$	$W.3 := V1 \cdot D1 = 0.581\ kg$	$F.b3 := V1 \cdot D \cdot g = 6.173\ N$
Divinycell	$V2 := 1479551\ mm^3$	$W.4 := V2 \cdot D2 = 0.148\ kg$	$F.b4 := V2 \cdot D \cdot g = 14.935\ N$

$Weight2 := (W.3 + W.4) \cdot 2 = 1.458\ kg$

$Buoyancy := (F.b3 + F.b4) \cdot 2 = 42.215\ N$

Weight calculation

Batteries and hardware is estimated to 1 kg. Cable reel, release mechanisme and metal inserts is estimated to 2.6 kg

$Weight1 + Weight2 + 2.6\ kg + 1\ kg = 6.989\ kg$

A52 - BUSINESS & ECONOMY

MANUFACTURING COST

Injection Molding | Reports | Additional Processes

Part Information

Rapid tooling?:	Yes / No
Quantity:	2000
Material:	Acrylonitrile Butadiene Styrene (ABS), Molded [Browse...]
Envelope X-Y-Z (mm):	600 x 300 x 300
Max. wall thickness (mm):	5
Projected area (mm²):	180000.000 or 100 % of envelope
Projected holes?:	Yes / No
Volume (cm³):	9020 or 16.70 % of envelope
Tolerance (mm):	Low precision (<= 0.5)
Surface roughness (µm):	High-gloss polish (Ra <= 0.2)
Complexity:	Complex — Show advanced complexity options

Process Parameters

Cost

Update Estimate

Material:	$74,386 ($37.193 per part)
Production:	$7,610 ($3.805 per part)
Tooling:	$140,010 ($70.005 per part)
Total:	**$222,007 ($111.003 per part)**

Feedback/Report a bug

PRODUCT PRICE ESTIMATION

	Traps	DKK	Time (years)
Availability	800	764000	
Trap price	1	955	
Trap durability	1	-	3
Min. loss each year	80	76400	
Max. loss each year	240	229200	
Our product can cover	40	38200	
Product price		9550	
Safe factor		1,2	
Price for fisherman	20	191000	
Min. Money saved (3 years)		38200	12733,33333 Per year
Max. Money saved (3 years)		496600	165533,3333 Per year

Blue is changable factors

Green is results

BUSINESS

Total production (Phase 1)

800	Creel capacity
80	Creels per setup
100	Vessels
80000	Total amout of creels
1000	Setups/lines
2	Recommended products per setup
2000	Units

Customer price:

9.550,00	Unit sell price (3 years lifetime)
3.183,33	Customer price per year
265,2777778	Subscribtion price per unit

Unit cost:

	2000	Units
Cost (Shell)	750,00	DKK
Cost (Electrical)	1.458,00	DKK
Dyneema	1.360,00	DKK
Total unit cost	3.568,00	DKK

Unit profit	5.982,00	DKK

Invest:

Injection molding	1.475.570,00	DKK
Electrical components	2.916.000,00	DKK
Dyneema	2.720.000,00	DKK
Total investment	4.391.570,00	DKK

Revenue (2000 units)	19.100.000,00	DKK
Profit (2000 units)	11.964.000,00	DKK
Break even	734	units

A53 - BATTERY CONSUMPTION

MAIN SYSTEM

Unit name	Power supply	Consumption	Note
MCU STM8L	3.6v	0.33mA	Have a sleep mode and a timer implimentet.
Hydrophone	0.6v	0.3mA	-
Altimeter MS5806	3.6v	1.4mA	Have a sleep mode (0.14 µA)
			-
Battery	**Output**	**Capacity and quantity**	**Connection**
Lithium ion cell (GTL 18650)	3.7v	5000mAh x 4	Serie
			-
	Enoght output	**Lifetime (hours)**	**External factors**
Calculation	Yes	6.896 (287days)	0.7

SOLENOID SYSTEM

Unit name	Power supply	Consumption	Note
Disc solenoid	12v	0.57A (570mA)	-
Battery	**Output v**	**Capacity and quantity**	**Connection**
Lithium ion cell (GTL 18650)	3.7v x 4 (14.8v)	5000mAh	Perallel
			-
	Enoght output	**Lifetime (hours)**	**External factors**
Calculation	Yes	6.1	0.7

The specific lithium-ion cell that should be implemented provides 3.7v and have a capacity of 5000 mAh. Placing this in a series connection of 4 cells provides the system with 3.7v and a capacity of 20.000 mAh. These cells are rechargeable. An external factor of 0.7 has been applied to take external conditions into consideration.

If the lithium-ion cells are placed in a parallel connection, the battery pack will thereby provide 14.8v which is enough output to run the solenoid. It also has a capacity of 5000 mAh, which mean that the solenoid can run in 6 hours continuously. An external factor of 0.7 has been applied to take external conditions into consideration.

Divinycell H — Technical Data

The high performance sandwich core

Divinycell H provides excellent mechanical properties to low weight. The unique IPN chemical structure, yields impressive mechanical performance to a low weight. Divinycell H has been widely used and has a proven track record in virtually every application area where sandwich composites are employed including the marine (leisure, military and commercial), land transportation, wind energy, civil engineering/infrastructure and general industrial markets.

Divinycell H is ideal for applications subject to fatigue, slamming or impact loads. Other key features of Divinycell H include consistent high quality, excellent adhesion/peel strength, excellent chemical resistance, low water absorption and good thermal/acoustic insulation. Divinycell H is compatible with virtually all commonly used resin and manufacturing systems.

Mechanical properties Divinycell® H

Property	Test Procedure	Unit		H45	H60	H80	H100	H130	H160	H200	H250
Compressive Strength[1]	ASTM D 1621	MPa	Nominal	0.6	0.9	1.4	2.0	3.0	3.4	5.4	7.2
			Minimum	0.5	0.7	1.15	1.65	2.4	2.8	4.5	6.1
Compressive Modulus[1]	ASTM D1621-B-73	MPa	Nominal	50	70	90	135	170	200	310	400
			Minimum	45	60	80	115	145	175	265	350
Tensile Strength[1]	ASTM D 1623	MPa	Nominal	1.4	1.8	2.5	3.5	4.8	5.4	7.1	9.2
			Minimum	1.1	1.5	2.2	2.5	3.5	4.0	6.3	8.0
Tensile Modulus[1]	ASTM D 1623	MPa	Nominal	55	75	95	130	175	205	250	320
			Minimum	45	57	85	105	135	160	210	260
Shear Strength	ASTM C 273	MPa	Nominal	0.56	0.76	1.15	1.6	2.2	2.6	3.5	4.5
			Minimum	0.46	0.63	0.95	1.4	1.9	2.2	3.2	3.9
Shear Modulus	ASTM C 273	MPa	Nominal	15	20	27	35	50	60	73	97
			Minimum	12	16	23	28	40	50	65	81
Shear Strain	ASTM C 273	%	Nominal	12	20	30	40	40	40	45	45
Density	ISO 845	kg/m³	Nominal	48	60	80	100	130	160	200	250

All values measured at +23°C
1. Properties measured perpendicular to the plane

Nominal value is an average value of a mechanical property at a nominal density
Minimum value is a minimum guaranteed mechanical property a material has independently of density

Divinycell H is type approved by:

Product Characteristics

- Low water absorption
- Superior damage tolerance
- Fast and easy to process
- Good chemical resistance
- Excellent fatigue properties
- Low resin uptake
- Wide range of properties
- Provides excellent mechanical properties to a low weight

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A55 - STM8L

STM8L151x6/8 STM8L152x6/8

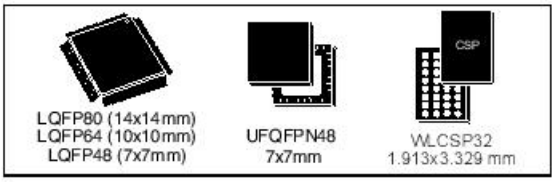
life.augmented

8-bit ultra-low-power MCU, up to 64 KB Flash, 2 KB data EEPROM, RTC, LCD, timers, USARTs, I2C, SPIs, ADC, DAC, comparators

Datasheet - production data

Features

- Operating conditions
  - Operating power supply: 1.65 to 3.6 V (without BOR), 1.8 to 3.6 V (with BOR)
  - Temp. range: -40 to 85, 105 or 125 °C
- Low-power features
  - 5 low-power modes: Wait, Low-power run (5.9 µA), Low-power wait (3 µA), Active-halt with full RTC (1.4 µA), Halt (400 nA)
  - Consumption: 200 µA/MHz+330 µA
  - Fast wake up from Halt mode (4.7 µs)
  - Ultra low leakage per I/O: 50 nA
- Advanced STM8 core
  - Harvard architecture and 3-stage pipeline
  - Max freq: 16 MHz, 16 CISC MIPS peak
  - Up to 40 external interrupt sources
- Reset and supply management
  - Low-power, ultra safe BOR reset with five programmable thresholds
  - Ultra-low-power POR/PDR
  - Programmable voltage detector (PVD)
- Clock management
  - 32 kHz and 1-16 MHz crystal oscillators
  - Internal 16 MHz factory-trimmed RC and 38 kHz low consumption RC
  - Clock security system
- Low-power RTC
  - BCD calendar with alarm interrupt,
  - Digital calibration with +/- 0.5ppm accuracy
  - Advanced anti-tamper detection
- LCD: 8x40 or 4x44 w/ step-up converter
- DMA
  - 4 ch. for ADC, DACs, SPIs, I^2C, USARTs, Timers, 1 ch. for memory-to-memory
- 2x12-bit DAC (dual mode) with output buffer
- 12-bit ADC up to 1 Msps/28 channels
  - Temp. sensor and internal ref. voltage

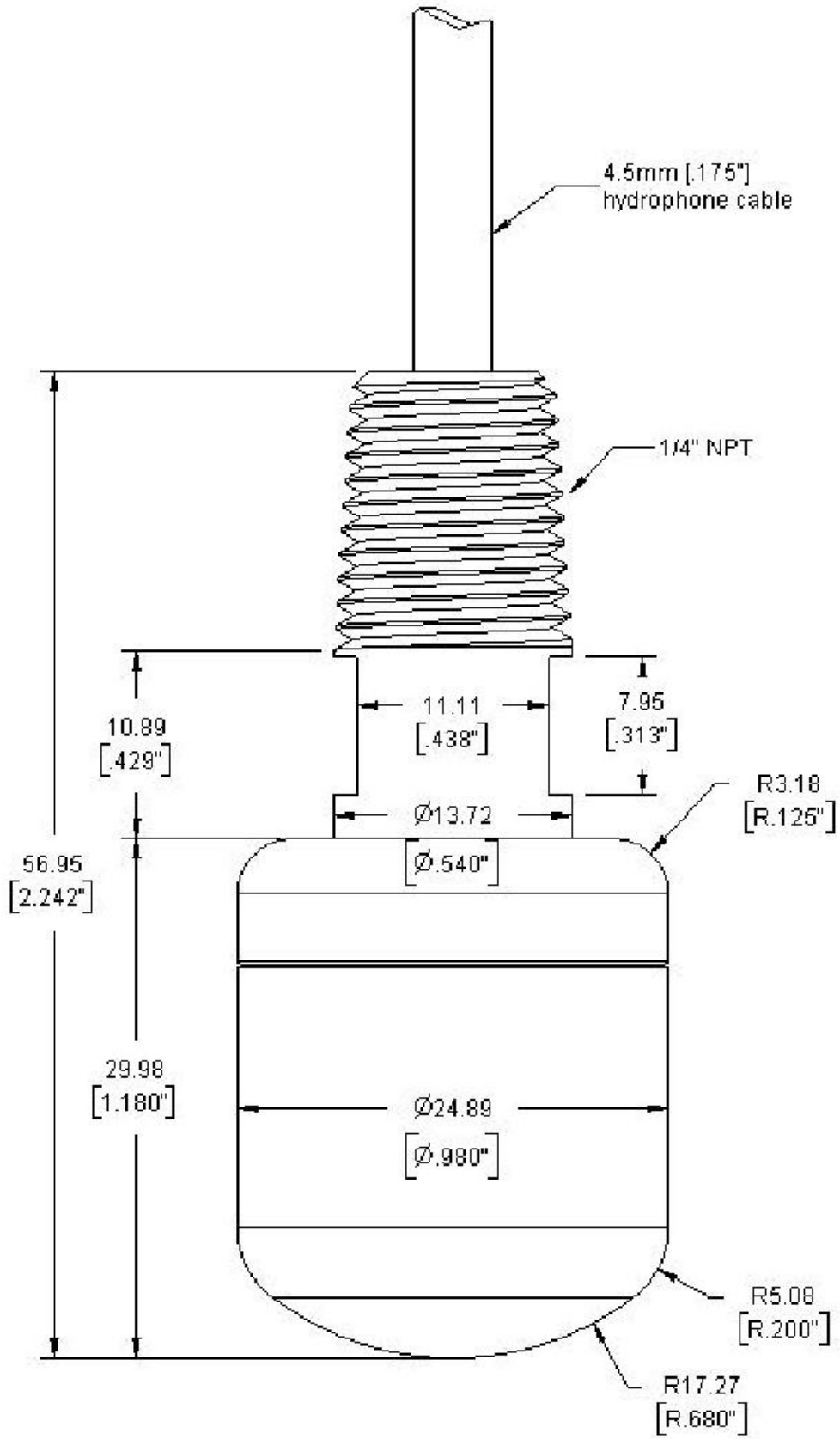


- Memories
  - Up to 64 KB of Flash memory with up to 2KB of data EEPROM with ECC and RWW
  - Flexible write/read protection modes
  - Up to 4 KB of RAM
- 2 ultra-low-power comparators
  - 1 with fixed threshold and 1 rail to rail
  - Wake up capability
- Timers
  - Three 16-bit timers with 2 channels (IC, OC, PWM), quadrature encoder
  - One 16-bit advanced control timer with 3 channels, supporting motor control
  - One 8-bit timer with 7-bit prescaler
  - One window, one independent watchdog
  - Beeper timer with 1, 2 or 4 kHz frequencies
- Communication interfaces
  - Two synchronous serial interface (SPI)
  - Fast I^2C 400 kHz SMBus and PMBus
  - Three USARTs (ISO 7816 interface + IrDA)
- Up to 67 I/Os, all mappable on interrupt vectors
- Up to 16 capacitive sensing channels supporting touchkey, proximity, linear touch and rotary touch sensors
- Fast on-chip programming and non-intrusive debugging with SWIM, Bootloader using USART
- 96-bit unique ID

Table 1. Device summary

Reference	Part number
STM8L151x6/8	**STM8L151R6**, STM8L151C8, STM8L151M8, STM8L151R8
STM8L152x6/8	STM8L152R6, STM8L152C8, STM8L152K8, STM8L152M8, STM8L152R8

A56 - HYDROPHONE



A57 - ALTEMETER/PRESURE SENSOR

RoHS

MS5806-02BA

Miniature Altimeter Module

SPECIFICATIONS

- **High resolution module, 20cm**
- **Fast conversion down to 1 ms**
- **Low power, 1 µA (standby < 0.15 µA)**
- **Integrated digital pressure sensor (24 bit ΔΣ ADC)**
- **Supply voltage 1.8 to 3.6 V**
- **Operating range: 300 to 1100 mbar, -40 to +85 °C**
- **Extended Pressure Range: 10 to 2000mbar**
- **I²C or SPI interface (Mode 0, 3)**
- **No external components (Internal oscillator)**
- **Excellent long term stability**
- **Hermetically sealable for outdoor devices**

The MS5806-02BA is a new generation of high resolution altimeter sensors from MEAS Switzerland with SPI and I²C bus interface. It is optimized for altimeters and variometers with an altitude resolution of 20cm. The sensor module includes a high linearity pressure sensor and an ultra low power 24 bit ΔΣ ADC with internal factory calibrated coefficients. It provides a precise digital 24 Bit pressure and temperature value and different operation modes that allow the user to optimize for conversion speed and current consumption. A high resolution temperature output allows the implementation of an altimeter/thermometer function without any additional sensor. The MS5806-02BA can be interfaced to virtually any microcontroller. The communication protocol is simple, without the need of programming internal registers in the device. The gel protection and antimagnetic stainless steel cap allows the use in 100m water resistant altimeter/compass watches. This new sensor module generation is based on leading MEMS technology and latest benefits from MEAS Switzerland proven experience and know-how in high volume manufacturing of altimeter modules, which has been widely used for over a decade. The sensing principle employed leads to very low hysteresis and high stability of both pressure and temperature signal.

A58 - THE DANISH LABOR INSPECTION