ReBuild

Process Report

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ReBuild

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Mikkel Bech Nielsen

Synopsis

This project entitled ReBuild revolves arround development of a modular system for commercial vessels.

The report presents a new and innovative system for modular re-assembly of commercial vessels. The system is developed based on requirements gathered through out the process.

The design dive is the mechanism fastening modules on to the deck of the re-assembly vessel platforms. The use scenario is in focus, and ReBuild is easy to use for operators of the system.

Preface

This project is the 10. semester master thesis of Mikkel Bech Nielsen. at Industrial Design of Architecture & Design at Aalborg University.

The project is based on a collaboration with Tuco Marine Group. A collaboration continuing an internship collaboration of fall 2013.

Through out the process Nis Ovesen and Jørgen Kepler worked rezpectively as main supervisor and technical supervisor for the project. Appart from guidence from the supervisors, Tuco has been very generous in the amount of communication and resources spent on the project.

The documentation of the proposed solution consists of two parts. The first part is a process report which shows the process behind the development of the product. The second report is structured as a brochure from Tuco presenting the final product poposal.

Reading guide

Each iteration begins with an introduction and ends with a sumup. The process is able to be understod, reading only these two sections of every iteration, in order to enable quick overview.

A flexible requirement specification is updated during the process as every iteration add new knowledge and demands for the project.

Thank you..

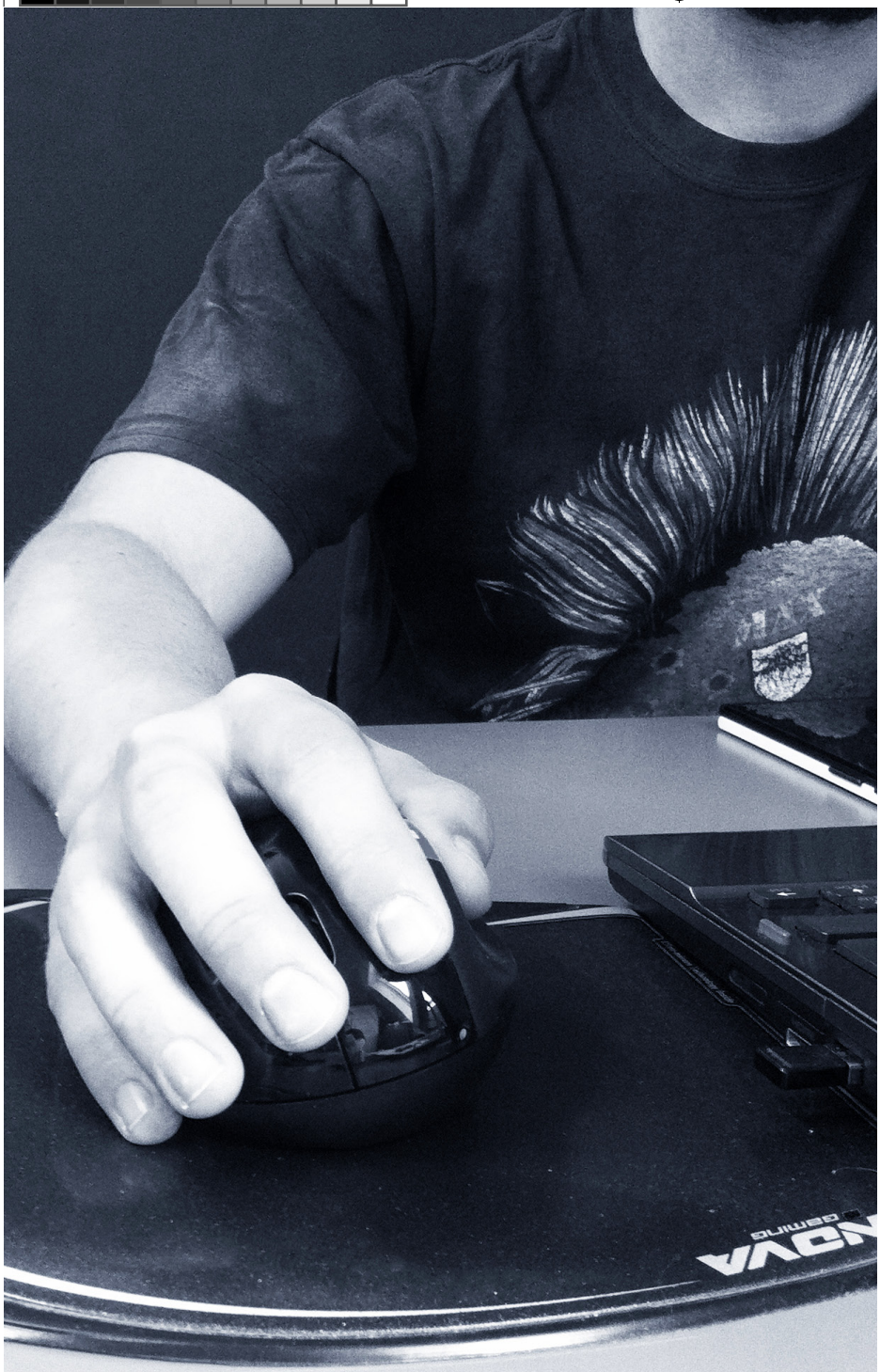
Jonas Pedersen
CEO, Tuco Marine Group

Jakob Rasmussen
Design Manager, Tuco Marine Group

Nis Ovesen
Main Supervisor

Board of content

PRE FACE



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The aim of this project is to identify, verify and develop a product in collaboration with Tuco Marine Group in order to reinforce their current product portfolio.

The project takes place over 17 weeks and is based on a continued collaboration after ended internship in the fall of 2013.

This section discribes the project poposed by Tuco Marine Group and end up in a requirement specification which, during the project, will be updated.

The section contains:

- Project poposal
- Requirement specification V1.0

Project poposal from Tuco

The project poposal from Tuco was presented during a internship in the fall of 2013 and during that period the project has been developing. In order to argue a continuous process where decisions are based on process results, the project is reset and taken back to the starting point, being Tuco's original poposal for the design task.

ill.06A

The original design task from Tuco reads:

"Design of a catamaran powered by engines which must be able to function as a multi purpose platform.

The size of the vessel should span from 12 to 17 meters in length. It must be able to work as a commercial vessel accompaning up to 12 passengers. A posibility is to make a yacht version as well.

The largest platform should be able to ship an emergency viechle on deck.

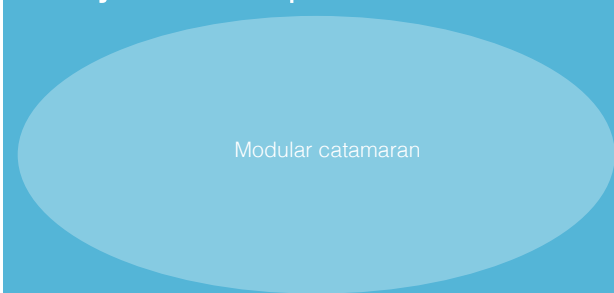
The caramaran must feature a slim design, and be economic and light."

In order to meet these requirements, an adaptive requirement specification is made, ensuring emerging requirements during the design process are implemented and taken in to account.

Requirement Specification V1.0

- The vessel must consist of a catamaran platform
- It has to be powered by engines
- It has to be a multi purpose platform
- The platform has to exist in 12, 15 and 17 meters of length
- The vessel has to work as a commercial vessel with room for up to 12 pax.
- The vessel may be able to be converted to a yacht version
- The largest platform must be able to support an ambulance or another viehcle on the deck
- The vessel has to be slim and be fuel cost effective

Project scope V1.0



The project scope is design and development of a modular catamaran.

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RESEARCH

This section revolves arround understanding Tuco Marine Group as a company and investigate their profile through relevant methods.

User insight will validate the original design poposal.

- Business analysis
- Costumer survey
- Case studies

Who are Tuco ?

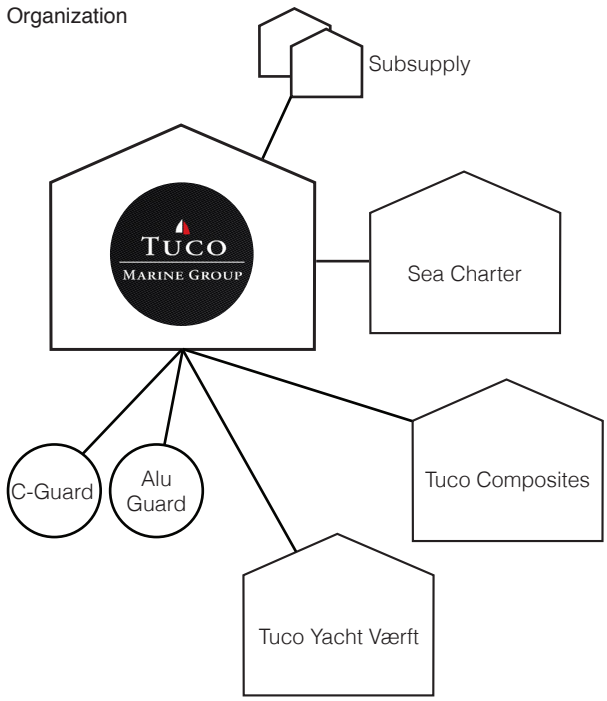
In order to understand Tuco as a company, a description of their profile is made. This will explain the context to which the project has to relate.

ill.09A

Tuco is a shipyard that specializes in production of commercial vessels in composite. They build vessels in the span of 7 to 40 meters. Tuco initially was a manufacturer of private luxury yachts of up to 85 foot, but the negative impact of the financial crisis on the luxury consumer market made Tuco realign their market segment and change their profile to adapt

Instead of now seeing themselves as a ship yard, exclusively, they see them self as a company with a large know how within composites. This comes to show in recent projects they have involved themselves in, such as high voltage electricity masts in collaboration with BYSTRUP A/S.

As Tuco specializes in composites, glass and carbon fiber are their primary materials. They utilize these materials in combination with different core materials and resins and their primary manufacturing method is vacuum infusion. In order to cost optimize production, they manufacture as much as posible in flat panels, excluding expencive mold costs.



Sumup

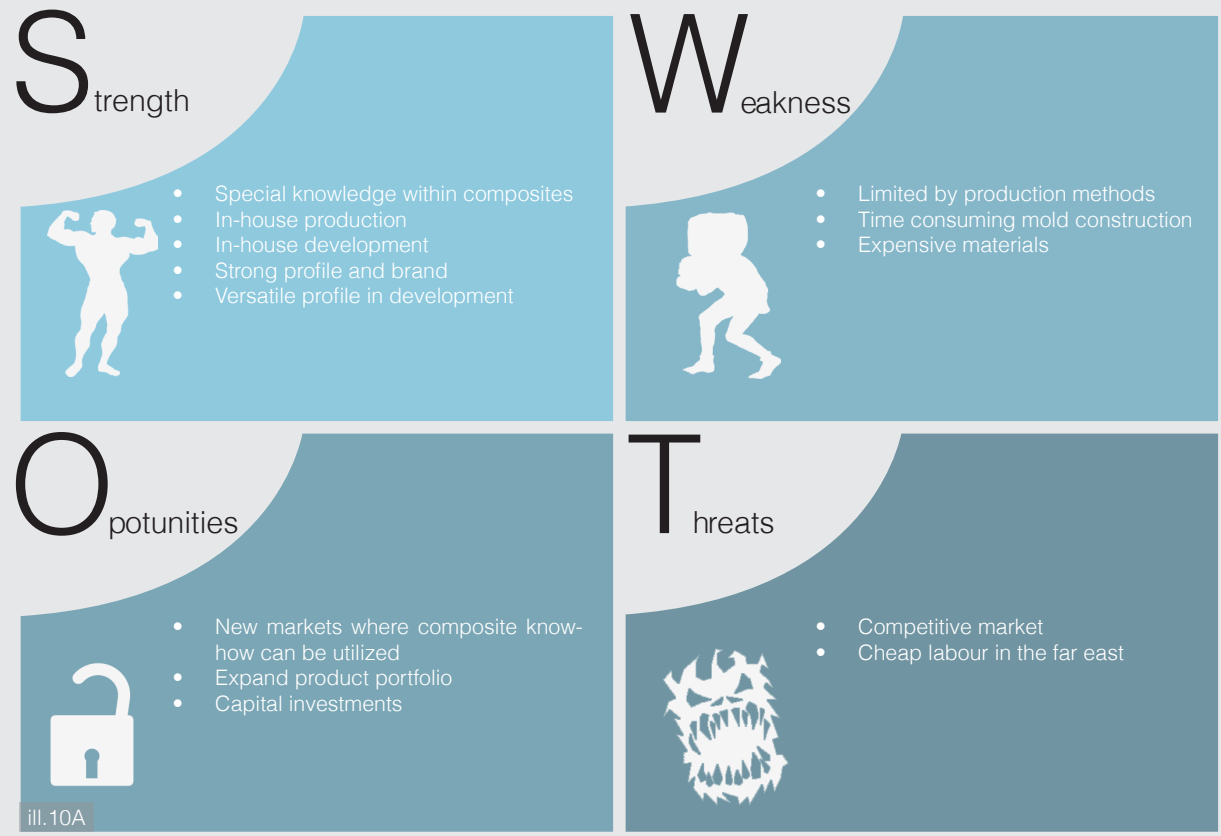
Tuco is a versatile company within their market segment with a profile not only aiming at the maritime segment, but also at the composite market in general as they sell their expert knowledge within glass and carbon fiber constructions.

Within the martime segment they specialize in modular designed commercial vessels enabling targeting of different industries.

SWOT

A swot analysis is made in order to establish an understanding of the strengths and weaknesses of the company. The SWOT is based on both an internal and external perspective in order to cross examin the results.

External perspective



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Strengths

Tuco Marine Groups strength lies in being a flexible organization with expert knowledge and expertice within the market they are in, and the materials they utilize. This results in diverse competences as they apply their knowledge, not only within their primary market, but in all markets where this knowledge and expertice needs to be applied.
They emphasize production optimazation and ensure a time and cost effective production process. Tuco relies on good supply chains as project startup can happen over night, and both materials and extra workers can suddenly be required.
All production happens in house, in Tuco's own facilities. This allows a high level of communication between the development and the construction. This optimizes production as problems occurring can be met with face to face communication.

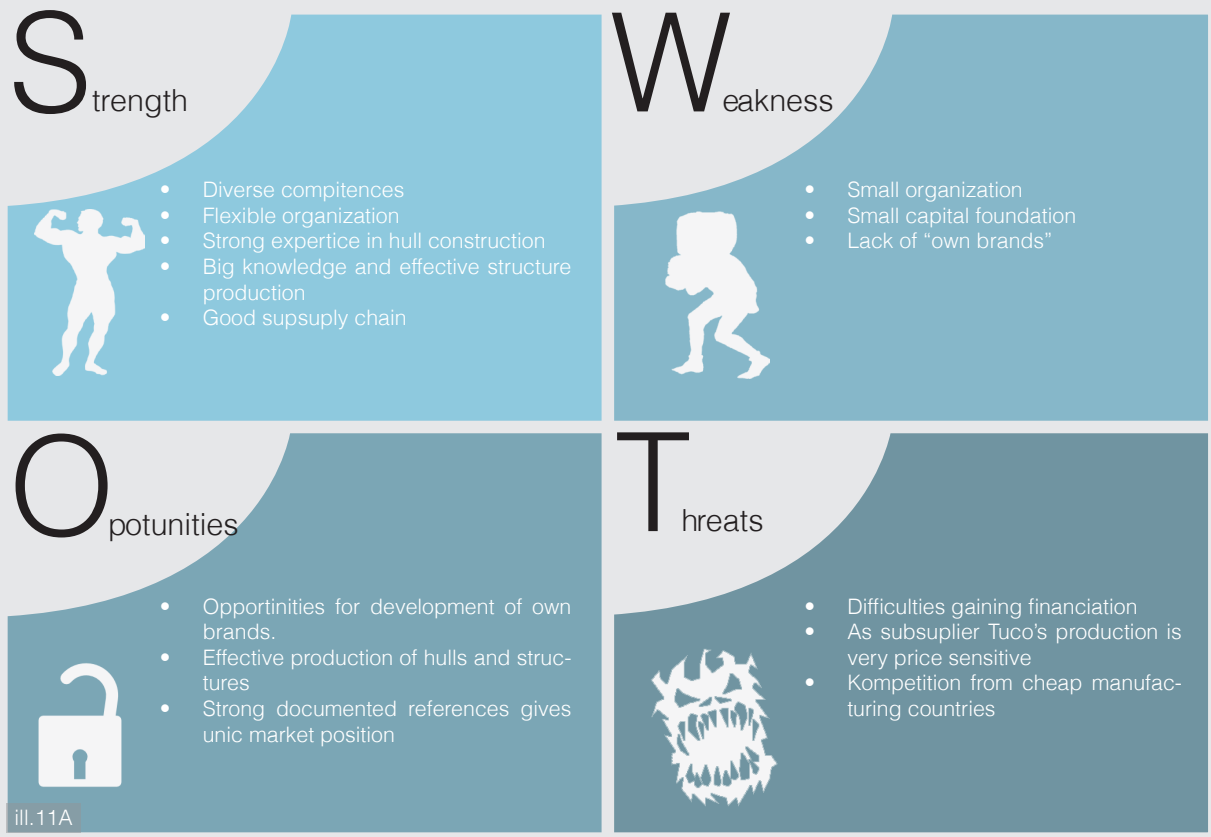
Weaknesses

Tuco experience their weaknesses in being a small organization with a small capital foundation. This means that Tuco has to find customers and founding to each vessel prior to production, in stead of being able to build up stock when orders are low.

Tuco's designs are limited to flat panels due to cost optimization and the materials used are expencive, driving up the price compared to similar aluminum vessels.

According to CEO Jonas Pedersen, one of Tuco's weaknesses is a lack of "own brands". Their main brand C-Guard covers monohull workboats up to 15 meters, but lacks the ability to compete in industries such as off shore where requirements are for larger platforms.

Internal perspective



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Opotunities

Tuco's oppotinities lie in development of of additional own brands, and with these, an optimized effective production of hulls and structures.
As Tuco sell expert knowledge within composites, future market applications of composites will automatically increase Tuco's market potential.

Threats

Tuco, as well as any other Danish industry suffers the threat of cheap labour productions countries, making it difficult to compete in a global scale.
Difficulties gaining finaciation for projects can be a struggle, as many projects are government financiated.

Sumup

The SWOT analysis indicates that tuco has a lack of "own brand" products, and that it lies in their market oppotunities to develop aditional own brands.

Product portfolio

After investigating Tuco as a company and organization, their products are discribed in order to understand Tuco's current product portfolio. The general link between Tuco's products is composite. Products therfore differ and in order to understand the products market placement, the Boston Matrix is utilized.

C-Guard

ill.12A

Within the maritime segment, Tuco's focus is on their main brand C-Guard. C-Guard is a vessel based on a multipurpose platform in carbon and glass fiber, suited for commercial use in different industries. The size of the C-Guard spans from 7,5 to 15 meters.

Alu-Guard

ill.12B

An other of Tuco's brands is Alu-guard which is aluminum versions of their C-guard platform. Like the C-Guard it is a work boat build to endure rough conditions and apply to different commercial uses. The size of the Alu-Guard also spans from 7,5 to 15 meters.

Special vessel orders

ill.12C

Except for Tucos own brand productions, they participate in production of special orders. For instance 3 carbon ferries for person transport in the northern part of norway, where aluminum vessels have been replaced.

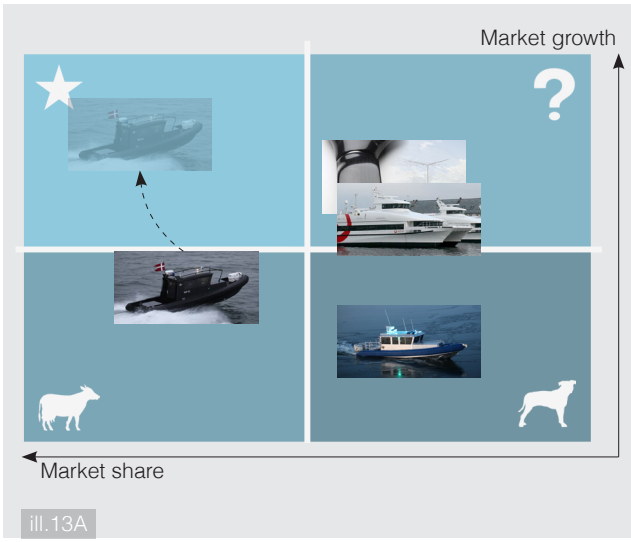
Composite knowledge

ill.12D

Appart from maritime products, Tuco offers their knowledge within composites to participate in other industries where carbon and glassfiber production requires expert knowledge. In many scales. Two examples are repair of expencive carbon bikes, and development and construction of future high voltage masts to replace the steel constructions of today.

Boston Matrix

Tuco's products are placed in the boston matrix according to external oberservations. The Boston Matrix rates Tuco's products acording to market share and growth. This is done in order to understand existing platforms, and see if a new product platform is suitable.



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C-Guard

C-Guard is placed as the company cash cow. Being a stable successfull product with potential for market growth and a relative large market share C-Guard generates revenue of 4 million DKK every year. It is sold to different industries, and is both bought and leased by the customer. The modularity of the platform ensures a generic market position, and adaptivity to emmerging markets. It is Tuco's vision that C-Guard will experience a large market growth within a near future.

Alu-Guard

Alu-Guard is a sister product of C-Guard, only the entire body is build in aluminum in stead of composites. The market share for this vessel is smaller as Tuco's focus lies on composite strructures. The aluminum platform is in case of a specific costumer requirement for an aluminum hull.

Special vessel orders

The competition in manufacturing of special vessel orders are high, as most projects are put up for tender. This require companies to compete in both prize and quality, pushing their margins to the limit. It is therfor placed in the mid/low end, as these projects generates revenue for Tuco' but at a lower market share. However the future market is expanding as old aluminum and steel vessels will be traded in for new, light, energy efficient platforms such as a vessel manufactured in composites. It therfor rates high on market growth.

Composite knowledge

Composites become more and more frequent, as methods develop on how to allow composites to replace traditional building and manufacturing materials. By seeing themselves as a company selling knowledge and skills within composites, rather than a traditional ship yard, Tuco enters a future market with a large potential. By entering pioneer projects, knowledge is gathered on future required solutions, giving Tuco a firm future market share and position. Composite knowledge is therfor placed with large market share and growth potential.

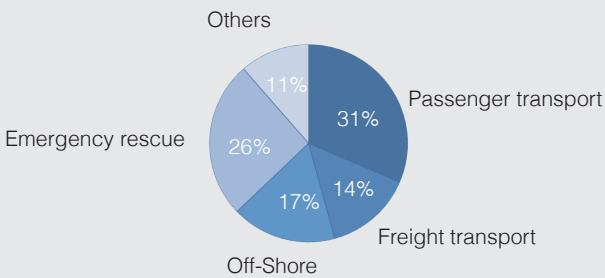
Sumup

Within the maritime segment, Tuco's primary brand, and generator of steady revenue is C-Guard. Though it generates 4 million DKK of revenue every year, it is Tuco's vision that the market growth for C-Guard will increase exponentially within a few years. One of their main focuses to achieve this vision is by market differentiation through design. Design is therfore a prioritzed factor when developing products for Tuco.

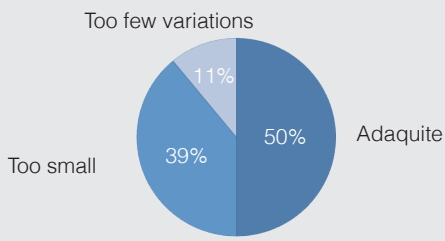
Customer query

An investigation and elaboration of Tuco's initial requirements and wishes is made in the form of a customer query. By enabeling potential clients to comment on the initial project poposal, the requirement specification can become more specific and the project platform will be validated.

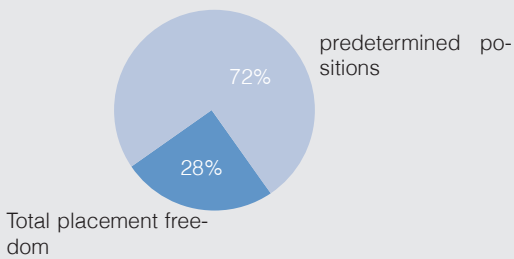
Which industries are suitable for this platform?



Is sizes 12, 15 and 17 meters adaquite for the platform?



To what degree should the costumer be able so order the superstructure build?



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The questionary (Appendix A) is made based on requirements listed in the original project poposal in order to verify the details stated by Tuco. The questionary is send to all potential partners and clients on Tuco's mailing list ensuring that feedback comes directly from clients and users.

When asked which industries suits a catamaran platform of the given size, 4 industries stands out. The primary is passenger transport, followed by emergency rescue, off-shore support and freight transport. For these industries the platform size range of 12 to 17 meters is rated to be adaquite.

It is a whish that build up of the platform is posible when ordering the vessel. When given the posibilities of few, many or indefinate placement positions, it shows that pre determined placement oppotunities is the most attractive, as only 28% are interested in the positility to place functions without any pre determined layout.

Among many posible facilities on a commercial vessel, the ones highlighted in the questionary are seating for all crew menbers and passengers and toilet facilities.

Use of the catamaran requires the service range to be 300 km or more with a service speed of up to 30 knt. It also has to be able to carry more than 8 tonnes of cargoe on the teck. This has to be powered by inbord diesel engines.

Sumup

The questionary was met with a lot of curiousity and mails following, asking questions about the extent of the project. Paramters stated in the original project poposal was validated and the elaborate awnsers stated in the questionary enables an adition to the requirement specification.

ill.14B

Requirement Specification V1.1

- The vessel must consist of a catamaran platform
- It has to be powered by engines
- It has to be a multi purpose platform
- The platform has to exist in 12, 15 and 17 meters of length
- The vessel has to work as a commercial vessel with room for up to 12 pax.
- The vessel may be able to be converted to a yacht version
- The largest platform must be able to support an ambulance or another viehcle on the deck
- The vessel has to be slim and be fuel cost effective

Primary targeted industry: Passenger transport

Secondary targeted industries: Freight, Offshore-support and Emergency alert

When ordering, platform buildup is posible in pre determined positions.

There must be seating for all crew members

The vessel must facilitate toilet facilities

The vessel must have a range of more than 300 km

The vessel should have service speed of up to 30 knt

The platform should support at least 8 tonnes of cargo weight

The engines must be in-board diesel engines

What exists?

A brief market screening is made to gain inspiration from existing produts in order to elaborate and deliminate project parameters in the project framing. Also to get an understanding of existing competing products within the market it has to compete in.

C-Truck

ill.16A

ill.16B

C-Wind is a company leasing out their own brand product C-Truck. The C-Truck is a modular catamaran platform with a composite hull and structure. It has great manouvrability and due to it's light weight composite structure, it has great fuel efficiency. In stead of mounting functional structures to the hull permanently, it allows functions to be added or removed, and shift position on the deck, depending on the use scenario. This enables the vessel to target multiple markets and user preferences. C-Truck is in a niche market of its own as no other product competes by enabling re-asembly of the platform. The modules are mounted manually by bolting the modules on to the deck. These bolts are hidden by panels and are not visible to the user or passenger.

Brdr AA

ill.16C

Brdr AA is a manufacturer of carbon vessels, mainly for passenger transport. These vessels are light weight catamaran structures, enabling high speed passenger transfer, while achieving efficient fuel consumption. This platform is not able to adapt to other use scenarios as it does not allow restructuring of the functional structures.

CarbonCat

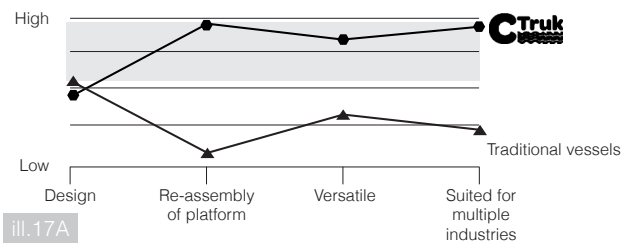

ill.16D

CarbonCat is a platform aiming specifically at the off shore market, being able to transfer maintnance crew, and transport materials in high volumes. It is also made from composites, allowing high speed operation and optimal fuel efficiency.

Sumup

It is posible to find numerous competitors manufacturing commercial composite vessels. Some allow costum build up of the vessel prior to production, while others provide a pre determined platform. Only one allow re-assembly of the vessel. The C-Truck is an innovative platform facilitating a platform able to adapt to a given scenario by re-assembeling the deck. This allows it to brand on modularity not only in design of the vessel, but through out it's entire life.

As the strategy canvas shows, this means that C-Truck is operating in a blue ocean, by radically differentiating itself from existing competitors.



ill.17A

The project will incorporate re-assembling of the platform as a way of market differentiation. This will insure a generic product relying on modularity in order to target different industries.

Requirement Specification V1.2

- The vessel must consist of a catamaran platform
- It has to be powered by engines
- It has to be a multi purpose platform
- The platform has to exist in 12, 15 and 17 meters of length
- The vessel has to work as a commercial vessel with room for up to 12 pax.
- The vessel may be able to be converted to a yacht version
- The largest platform must be able to support an ambulance or another viehcle on the deck
- The vessel has to be slim and be fuel cost effective
- Primary targeted industry: Passenger transport
- Secondary targeted industries: Freight, Offshore-support and Emergency alert
- When ordering, platform buildup is posible in pre determined positions.
- There must be seating for all crew members
- The vessel must facilitate toilet facilities
- The vessel must have a range of more than 300 km
- The vessel should have service speed of up to 30 knt
- The platform should support at least 8 tonnes of cargo weight
- The engines must be in-board diesel engines

→ The platform has to enable modular Re-assembly in order for the same platform to suite different use scenarios

→ Platform functions has to be divided into modules that are able to attach to the platform

PROJECT FRAMING

ill.18A

Research conclusion

In order to sum up findings in the research, a conclusion is made. This is intended to narrow down the project scope and deliminate the requirement specification.

The original project poposal states: "*Design of a catamaran powered by engines which must be able to function as a multi purpose platform.*"

The SWOT and Boston Matrix highlights that Tuco is in need of a new "own brand", and that it should be able to achieve a high market share and growth.

Turning the primary development focus to modularity would enable design of a unique multi purpose platform. Competing not in a read ocean, but differentiating it self from existing platforms and creating a blue ocean niche, in wich only one close competitor exists. With intellectual properties, this whould enable Tuco to launch a product, achieving high market shares and growth.

The questionary points towards 4 broard industries being suitable for the platform. By developing a vessel that enables re-assembly of platform functionalities, a single vessel would be able to target all 4 industries. Two cases emerge. Either a costumer orders a modular vessel as re-assembly is a prefered feature within a specific context. Or Tuco's daughter company Sea Charter order a vessel allowing companies to charter it. This way it will be able to work within a specific context for a period of time. Be re-assembled, and suit a new context for an other charter period.

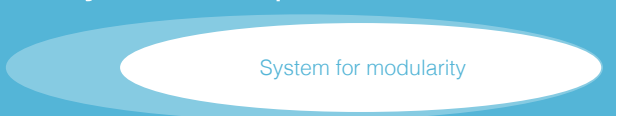
By choosing the product scope; Development of a modular re-assembly system for a commercial catamaran, deliminations has to be made in the requirement specification, as only some of the requirements relates directly to the platform and its functionalities.

Sumup

Research concludes in a change of scope The new focus for the project is development of a modular re-assembly system for a commercial catamaran.

Deliminations are made in the requirement specification as only some of the requirements relate directly to the platform, functions and modularity.

Project scope V1.1



Project scope is changed to: Development of a modular re-assembly system for a commercial catamaran.

Requirement Specification delimination

- ✗ The vessel must consist of a catamaran platform
- ✗ It has to be powered by engines
- It has to be a multi purpose platform
- The platform has to exist in 12, 15 and 17 meters of length
- The vessel has to work as a commercial vessel with room for up to 12 pax.
- ✗ The vessel may be able to be converted to a yacht version
- ✗ The largest platform must be able to support an ambulance or another viehcle on the deck
- ✗ The vessel has to be slim and be fuel cost effective
- Primary targeted industry: Passenger transport
- Secondary targeted industries: Freight, Offshore-support and Emergency alert
- ✗ When ordering, platform buildup is posible in pre determined positions.
- There must be seating for all crew members
- The vessel must facilitate toilet facilities
- ✗ The vessel must have a range of more than 300 km
- ✗ The vessel should have service speed of up to 30 knt
- ✗ The platform should support at least 8 tonnes of cargo weight
- ✗ The engines must be in-board diesel engines
- The platform has to enable modular Re-assembly in order for the same platform to suite different use scenarios
- Platform functions has to be divided into modules that are able to attach to the platform.

Design Brief

Introduction

Modularity versatility and flexibility are important factors when developing vessels for commercial industrial purposes. Tuco Marine Group is a shipyard with expert knowledge within development and manufacturing of modular commercial vessels in composites.

Aiming at improving their market position, they wish to expand their own brands with a modular catamaran platform spaning from 12 to 17 meters.

It is Tuco's wish that this vessel should be of a versatile nature, enabling the platform to target multiple industries.

Business

Tuco Marine Groups business model is based on costumer orders prior to production. When an order is made, development of the vessel begins in Tuco's inhouse development department. The vessel is manufactured in own facilities, and when larger project occur, they rely on subsuppliers to facilitate workers.

Tuco's daugher company Sea Charter however, is a new company which enable charter of vessels in stock.

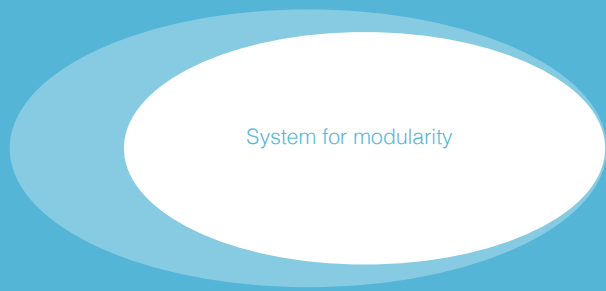
Mission

Design of commercial vessels target individual industries with individual ships. This project revolves arround creating a system for enabeling a single vessel to target multiple industries through re-assembly.

Vision

It is the goal to aid Tuco in developing a vessel that optains modularity through re-assembly of its platform. This will expand the existing product portfolio of the company while providing an innovative solution.

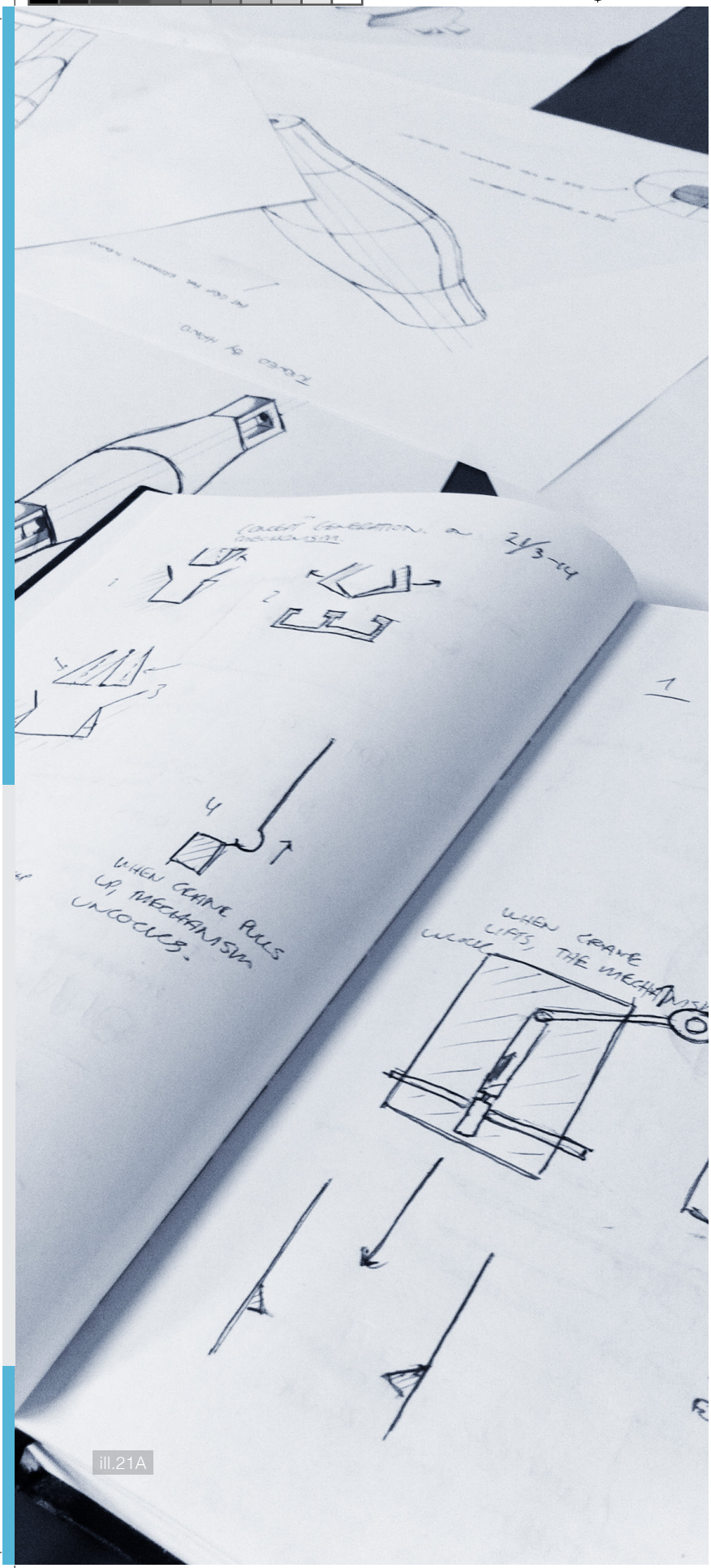
Project scope V1.1



The original project poposal is design of a modular catamaran. A research concludes that in order for Tuco to be presented with an innovative solution, the project scope is changed to be a system for modularity for the commercial catamaran.

Requirement Specification V2.0

- It has to be a multi purpose platform
- The platform has to exist in 12, 15 and 17 meters of length
- The vessel has to work as a commercial vessel with room for up to 12 pax.
- Primary targeted industry: Passenger transport
- Secondary targeted industries: Freight, Offshore-support and Emergency alert
- There must be seating for all crew members
- The vessel must facilitate toilet facilities
- The platform has to enable modular Re-assembly in order for the same platform to suite different use scenarios
- Platform functions has to be divided into modules that are able to attach to the platform.



ill.21A

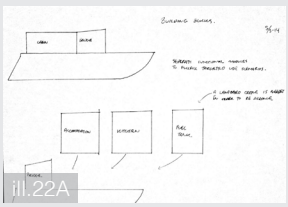
CONCEPT DEVELOPMENT

This section revolves around deveoping a final concept based on parameters stated in the Design brief.

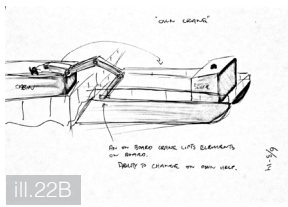
- Sketching workshops
- Model workshops
- Brainstorm
- Eliminations
- Company pitch
- Workshop facilitation

Concept generation

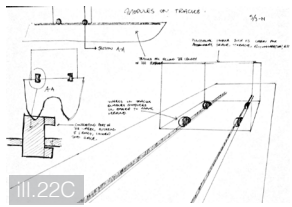
This concept generation is a 2D sketch workshop, allowing an empty of mind sketching of ideas and concepts. The workshop also allows new concepts to form. Concepts are going to be presented for Tuco in order to gain feedback. The output is expected to be general concepts. A delemination of these concepts will decide the direction for the modular system.


ill.22A

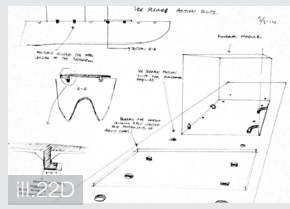
Functions are divided in to modules which are able to be placed on deck independently by a crane on land. Re-assembly is possible as the modules are locked in place by a mechanism allowing allowing the module to be released. Modules placed on deck are able to interact with eachother.


ill.22B

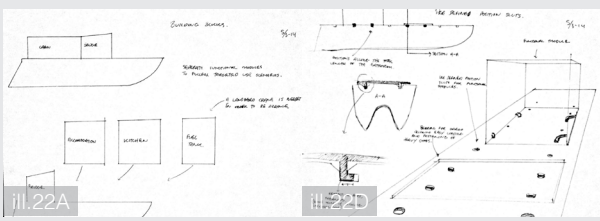
Functional modules are lifted on board by an on-board crane, allowing re-assembly without the pressence of a crane on land. Also the on-board crane is able to mount cargo on to the deck.


ill.22C

The mechanism for locking the modules on place is based on a track system. This not only allows re-assembly of the platform while at port, but also while at sea, as the modules on board are able to move independantly along the tracks.


ill.22D

Pre determined mechanism placement slots are integrated in the platform. This system relies on the pressence of a crane in order for re-assembly to take place.


ill.22A ill.22D

The initial concepts discribing the direction of the project is met by Tuco with curiousity and an open mind. It is a different direction and with a different focus than the original project poposal. They evaluate the concepts based on a use case scenario, and it becomes clear that the functions divided in to different modules will not be re arranged often, so they attatch to the platform in pre determined positions, relying on a crane for re-assembly.

As the modular system consist of functional modules, the scope of the project is narrowed down from focussing on an overall modular system for the vessel, to focussing on the functional modules

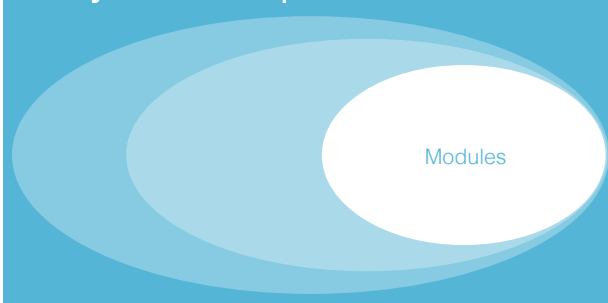
TUCO MARINE GROUP
ill.22E

Sumup

After presenting the concepts for Tuco, it becomes clear that the functional modules has to be attatched to the platform in pre determined positions, as re-assembly will not occur very often.

As the modularity of the system lies in the functional model, the project scope is narrowed down to a focus on these modules.

Project scope V1.2



Project scope is changed to: Development of functional modules to be attatched to the platform.

Requirement Specification V2.1

- It has to be a multi purpose platform
- The platform has to exist in 12, 15 and 17 meters of length
- The vessel has to work as a commercial vessel with room for up to 12 pax.
- Primary targeted industry: Passenger transport
- Secondary targeted industries: Freight, Offshore-support and Emergency alert
- There must be seating for all crew members
- The vessel must facilitate toilet facilities
- The platform has to enable modular Re-assembly in order for the same platform to suite different use scenarios
- Platform functions has to be divided into modules that are able to attach to the platform
- Modules must be attatched in pre-determined positions

Brainstorm on module functions

In order to map different functions able to be incorporated in to modules, a brainstorm is made. The branstorm on functions is based on requirement outputs from the costumer query.

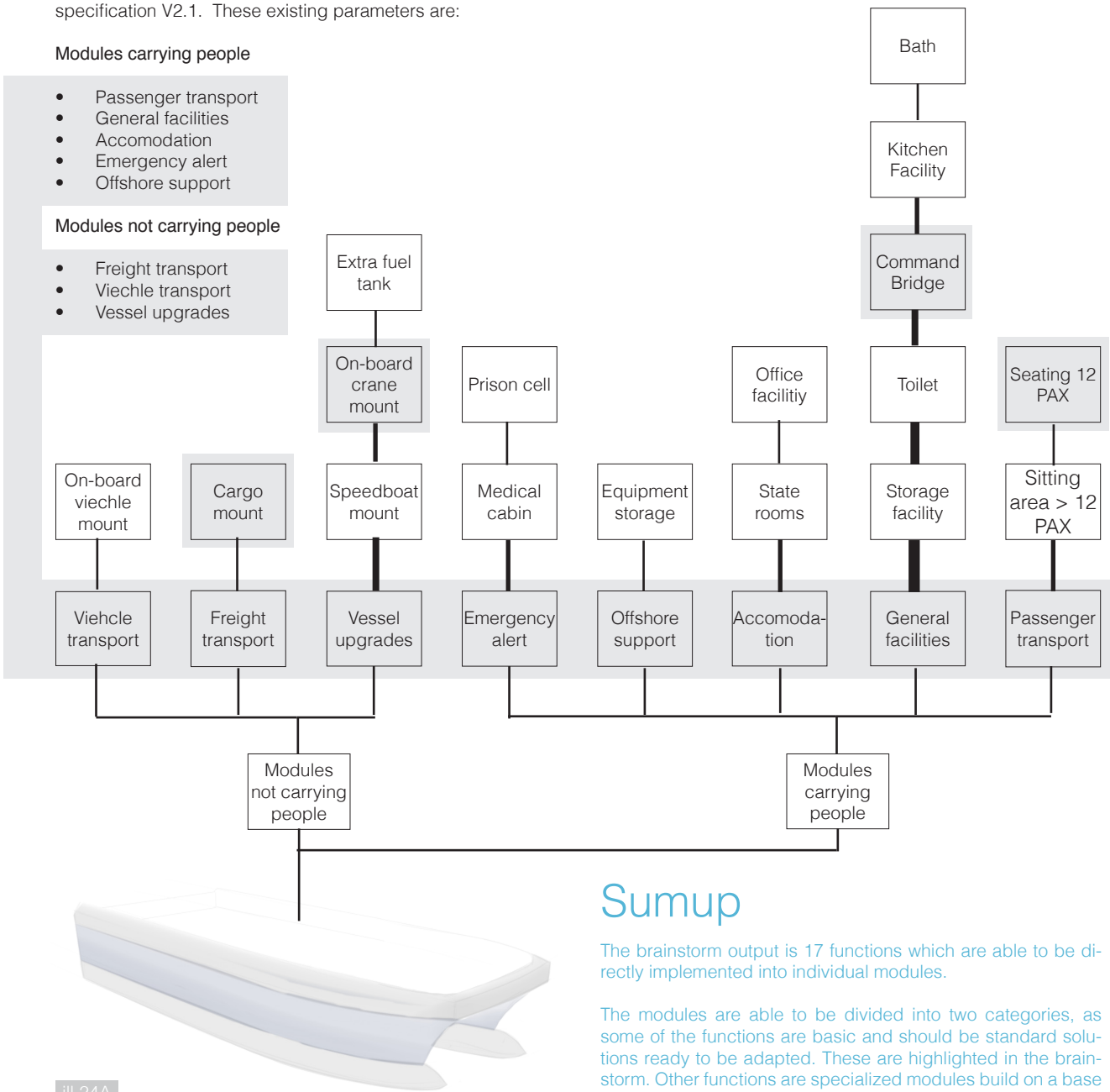
The brainstorming on potential functions for the platform modules, has its starting point in parameters based on the require specification V2.1. These existing parameters are:

Modules carrying people

- Passenger transport
- General facilities
- Accomodation
- Emergency alert
- Offshore support

Modules not carrying people

- Freight transport
- Viechle transport
- Vessel upgrades



ill.24A

Sumup

The brainstorm output is 17 functions which are able to be directly implemented into individual modules.

The modules are able to be divided into two categories, as some of the functions are basic and should be standard solutions ready to be adapted. These are highlighted in the brainstorm. Other functions are specialized modules build on a base of specific individual requirements.

Chosen modules

A delimination is needed in order to choose the modules in focus for further development. The elimination is based on groupation of the modules from the brainstorm.

Standard modules

- Seating 12 PAX
- Command Bridge
- Cargo mount
- On-board crane mount
- Extra fuel tank

Costumer specific modules

- On-board viechle mount
- Prison cell
- Medical cabin
- Equipment storage
- Bath
- Kitchen Facility
- Speedboat mount
- Office facilitiy
- Sitting area > 12 PAX
- State rooms
- Storage facility
- Toilet

The modules are divided into two main categories. The standard modules which are based on general requirements and therby are able to be manufactured unaware of the industry the vessel has to surround itself in.

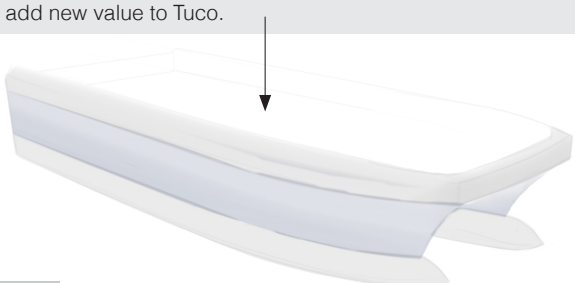
Then there are the modules which require individual specific input. These modules require knowledge of the specific use scenario of the industry in which the vessel has to surround it self in, and can therfore not be manufactured in advance.

The standard modules enable gathering of user and customer input to be generalized and contribute to development of generic modules which are able to suit all industries. The standard modules are therfor optimal for the project focus.

When looking at which concept focus components are contained in development of a standard module, 3 focuses emmerge.

- Development and styling of cabin exterior
- Development and styling of cabin interior
- Development and styling of fastening mechanism

The development of attatchable modules requires development of a mechanism fastening the modules onto the deck. As Tuco has excelent knowledge within development of vessels and vessel functions, changing the project scope to development of the mechanism in stead of the modules will enable the product to add new value to Tuco.



ill.25A

Sumup

Out of the modules from the brainstorm, the standard modules are chosen as modules in focus. These modules are

- Seating 12 pax
- Command bridge
- On-board crane mount
- Cargoe mount

However when concidering how to add value to Tuco and Tuco's development of a new brand, development of the mechanicle system fastening the modules onto the platform would add value to Tuco exceeding the knowledge and expertice they currently posses. The project scope is therfore changed from development of platform modules, to development of the mechanism that locks the chosen standard modules into place. The new project scope leads to a delimination in the requirement specification.

Project scope V1.3

The project scope is changed to development of the mechanism that locks the modules into place.

Requirement Specification delimination

- It has to be a multi purpose platform
- ~~The platform has to exist in 12, 15 and 17 meters of length~~
- ~~The vessel has to work as a commercial vessel with room for up to 12 pax.~~
- ~~Primary targeted industry: Passenger transport~~
- ~~Secondary targeted industries: Freight, Offshore-support and Emergency alert~~
- ~~There must be seating for all crew members~~
- ~~The vessel must facilitate toilet facilities~~
- The platform has to enable modular Re-assembly in order for the same platform to suite different use scenarios
- Platform functions has to be divided into modules that are able to attach to the platform
- Modules must be attatched in pre-determined positions

Requirement Specification V3.0

- It has to be a multi purpose platform
- The platform has to enable modular Re-assembly in order for the same platform to suite different use scenarios
- Platform functions has to be divided into modules that are able to attach to the platform
- Modules must be attatched in pre-determined positions
- Modules in focus are: Standard modules
- A locking mechanism for attatchement of platform modules must be devloped

Presenting scope for Tuco

By presenting the new project scope for Tuco, they will be able to validate the project direction and be able to contribute to the requirement specification for the locking mechanism.

The new project scope V1.3 is presented for Tuco in a phone meeting with their development engineer. After the presentation of the scope, an open interview is conducted in order to gain insight in demands for the requirement specification. The open interview allowed the subject to expand within the project scope. The requirements stated during the interview was:

"The mechanism should be generic and work for all modules."

"The mechanism should be easy to use."

"Grabble and other minor obstacles are to be insignificant to the functionality of the mechanism."

"The mechanism needs to be corrosion resistant."

"No solution with sensitive elements or tolerances in the attatchment scenario."

"The mechanicle system needs to adapt to a heavy duty environment and be suited for ware and tare."

ill.27A

Sumup

The idea was met with interest and curiousity when presented for Tuco.

The requirements stated by tuco are inserted into the requirement specification prior to mechanism concept generation in order to ensure that the development meet Tuco's demands.

Requirement Specification V3.1

- It has to be a multi purpose platform
- The platform has to enable modular Re-assembly in order for the same platform to suite different use scenarios
- Platform functions has to be divided into modules that are able to attach to the platform
- Modules must be attatched in pre-determined positions
- Modules in focus are: Standard modules
- A locking mechanism for attatchement of platform modules must be devloped

The mechanism should be generic and work for all modules

The mechanism should be easy to use

Grabble and other minor obstacles are to be insignificant to the functionality of the mechanism

The mechanism needs to be corrosion resistant

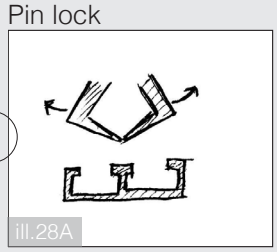
No solution with sensitive elements or tolerances in the attatchment scenario

The mechanicle system needs to adapt to a heavy duty environment and be suited for ware and tare

Mechanism sketch workshop

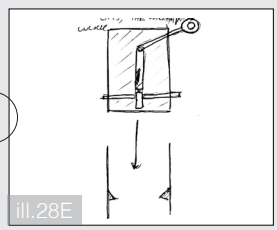
A 2D sketching workshop is initiated in order to ideate and develop concepts for the mechanism locking the modules into place. The concept ideation workshop develop and deliminate ideas based on requirement specification V3.1

Pin lock


ill.28A

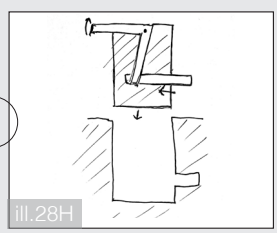
A lockcing mechanism relying on pins to lock the module into place.

The pins need a mechanism for lock/unlock


ill.28E

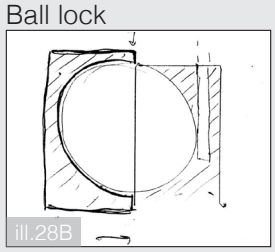
The mechanism activated by an external vertical force enables the pins to retract and the mechanism to unlock.

Needs rougher elements.


ill.28H

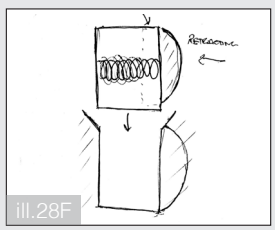
The mechanism consists of a simple leaver system enabling the vertical lifting force of the crane used when mounting to unlock the mechanism and release the module.

Ball lock


ill.28B

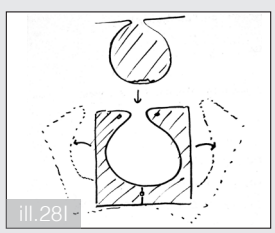
A ball lock, locking the mechanism into place and unlocking by retraction of the ball.

A mechanism is required fo the ball to retract.


ill.28F

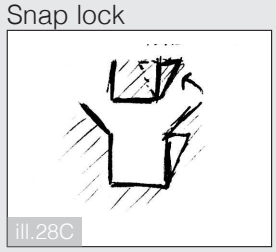
The ball is changed in to a retractable calot being able to both slide in to position and slide out again because of the spherical geometry.

Needs rougher elements.


ill.28I

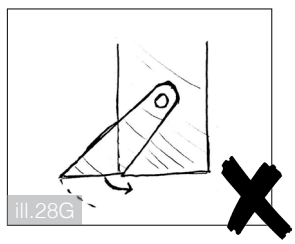
When attatched, a ball joint seperates two jaws, then clamping on to the ball. When unlocked, the geometrical conditions enables the joint to retract as easily as when placed.

Snap lock


ill.28C

A tap is retracted mechanically when module is lowered onto deck, and locks when the tap is in place.

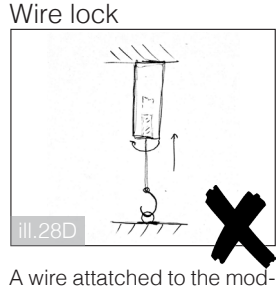
The tap need a mechanism for lock/unlock


ill.28G

The tap is mounted in a joint allowing it to rotate when attatched and detatched.

This mechanism is excluded as the geometrical conditions require external effect in order to both place and release. The use case is therfore unnecessarily complicated.

Wire lock


ill.28D

A wire attatched to the module hooks on to the deck and is tightened by a mechanism within the module.

This mechanism is excluded as relying on a wire to mount the modules onto the deck does not meet the requirement of being suited for a heavy duty environment.

Sumup

The 2D concept ideation sketch workshop consisted of 3 iterations in which solutions was deliminated and developed. The workshop concluded in 2 concepts. These concepts are chosen for further development.

Physical mechanism models

The 2 chosen concepts needs to be converted from 2D to physical 3D models in order to verify the system and understand the functionality and use case. This is done by CAD and 3D printing.

Ball lock

4


ill.29A

A physical 3D print of the ball lock validate the functionality of the concept, and shows the need for a clamping force added to the jaws, in this case an elastic band. The jaws need a lock.

5


ill.29C

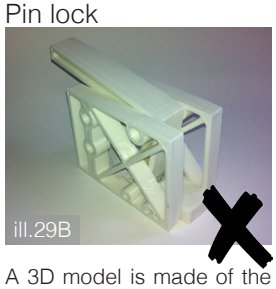
A beam locking the jaws is added to the top. When the beam is in place, the jaws are locked and when removed, the ball joint can freely move. An integrated spring replaces the elastic.

6


ill.29D

In stead of relying on elastic bands and springs to clamp the jaws arround the ball joint, two jaws are added internally, forcing the jaws to clamp arround the ball joint when lowered into place.

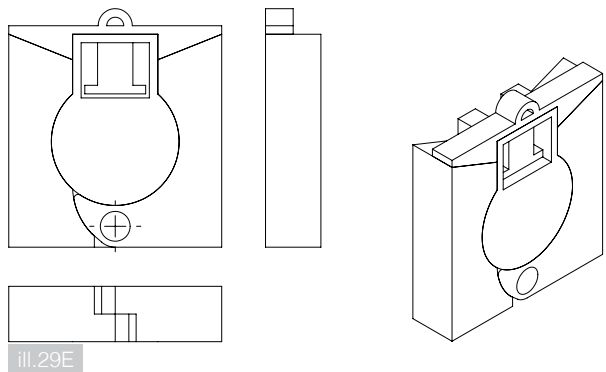
Pin lock

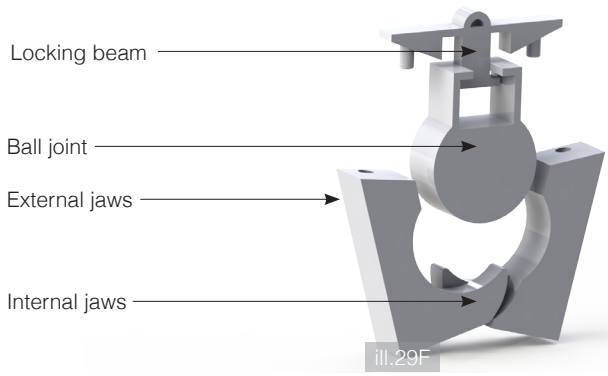

ill.29B

A 3D model is made of the pin lock and the function is validated.

The mechanism is deliminated as it requires fine tolerances for sliding mechanic elements inside the mechanism.

The ball lock is chosen as the optimal mechanism suited for the scenario. The exploded isometry shown in ill... clearly illustrate the inner jaws forcing the outer jaws to surround the ball joint when lowered in to place. This solution intales the fewest amount of moving parts, and rely strictly on mechanicle forces applied by the weight of the module. It is robust and will be able to withstand wear and tare in a heavy duty environment while being easy to clean .


ill.29E



ill.29F

Sumup

The physical 3D prints both validate the functionality of the mechanisms and enable the use scenario the be acted out.

The chosen mechanism is the ball lock, relying entirely on mechanicle forces applied by the module when lowered into place.

Presentation and workshop at Tuco

A visit to Tuco is made in order to present the project at its current state.

The goal for the visit is to determine the concept for the final mechanism in order to conclude the concept fase and lead the devlopment into the detailing fase.

The visit at Tuco consists of 3 fases. The first is presentation of concept for the chosen mechanism. The second wis an evaluation of the presented concept, and the last is a workshop, finalizing the concept.

The presentation shows not only the chosen concept but the entire journey starting with the design brief.

The evaluation

The validity of the mechanism is discussed as it is Tucos estimation that the mechanism will be utilized very few times as modules will be placed in determined positions several months at a time without the need for re-assembly. The scalability aspect of using the system for also mounting cargoe and potentially an on-board crane therfore adds alot of value to the system as it will enable often use of the system.

Choosing the presented mechanism forces 3 aspects on to the platform. First the mechanism has to be lowered into pits to enable unused attatchment slots to be hidden. Next, the pits put up requirements for pit drains in order for water to exit. The last aspect is that the mechanism will have to dampen vibrations from the platform.

A critical aspect in development of a mechanism suited for a scenario of mounting people, as it is the case with the modules in focus, is classification aproval. Getting a new system classified require a lot of resources and time, and being a shipyard resources can not be focussed on classification. Therfore it is ideal that the mechanism consist of standard components.

ill.30A

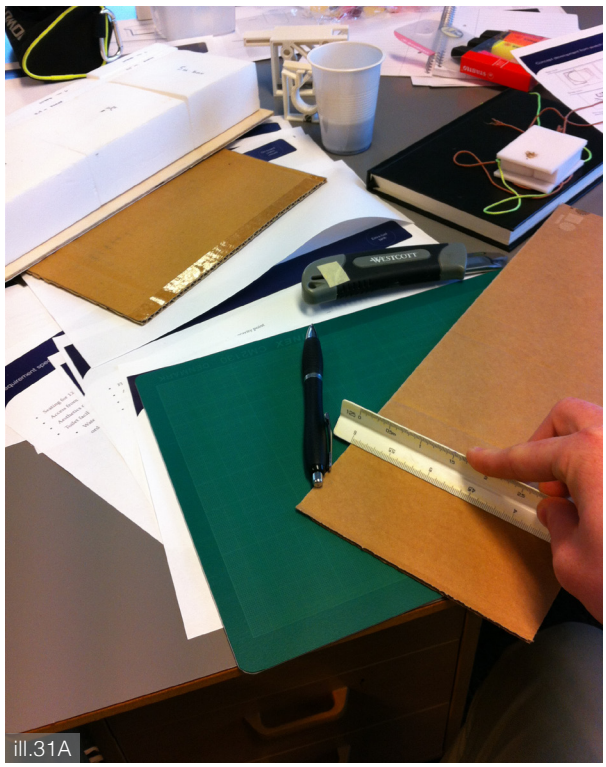
This will make the classification process require much less resources.

Prior to the development workshop, the new requirements update the requirement specification.

Requirement Specification V3.2

- It has to be a multi purpose platform
- The platform has to enable modular Re-assembly in order for the same platform to suite different use scenarios
- Platform functions has to be divided into modules that are able to attach to the platform
- Modules must be attatched in pre-determined positions
- Modules in focus are: Standard modules
- A locking mechanism for attatchement of platform modules must be devloped
- The mechanism should be generic and work for all modules
- The mechanism should be easy to use
- Grabble and other minor obstacles are to be insignificant to the functionality of the mechanism
- The mechanism needs to be corrosion resistant
- No solution with sensitive elements or tolerances in the attatchment scenario

- The mechanicle system needs to adapt to a heavy duty environment and be suited for ware and tare
- The mechanism has to be invisible on deck when not in use
- The mechanism is not allowed to trap water
- The mechanism has to dampen vibrations from the platform
- As much of the mechanism as possible has to consists of standard components



ill.31A

ill.31B

ill.31C

Tuco development workshop

After evaluating the concept and updating the requirement specification, a workshop (Appendix B) in finalizing the concept is initiated. It is expected that a final concept for detailing will be the output. Participating in the workshop is the development engineer from Tuco, Jakob Rasmussen.

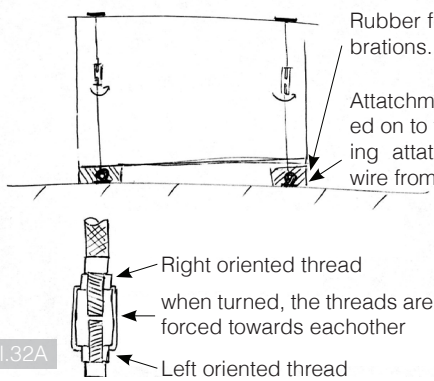
Initially, Tuco's development engineer Jakob Rasmussen suggest a step back into the initial mechanism concepts. After the first iteration, a wire system was discarded as it was estimated that a wire would not be able to cope with a heavy duty scenario.

This however is not the case, and according to Jakob Rasmussen, a mechanism relying on synthetic rope wire will be optimal for the system as it is light weight, and mechanism and mechanism weight can be moved in to the modules. This means that the attatchment slots not in use, does not add unwanted weight to the light weight vessel. A system for tightening the wire mounting the module can be based on a standard turning buckle, avoiding classification of the entire mechanism.

By moving the mechanism from deck and into the modules, pits and rains on the platform can be avoided.

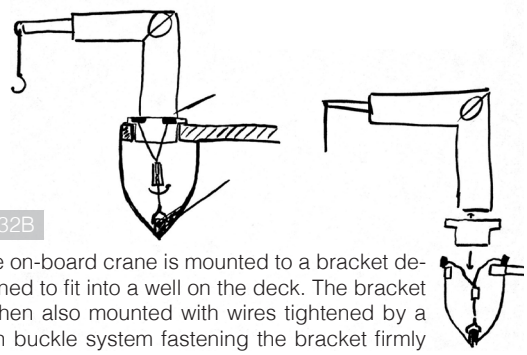
The mechanism can be used both for mounting modules, on-board crane and cargoe.

System for mounting module on to the platform



ill.32A

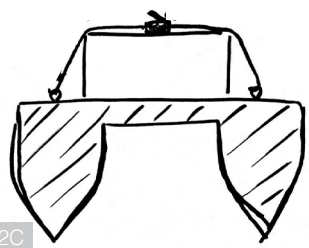
System for mounting on-board crane to the platform



ill.32B

The on-board crane is mounted to a bracket designed to fit into a well on the deck. The bracket is then also mounted with wires tightened by a turn buckle system fastening the bracket firmly on to the deck.

System for mounting cargoe on to the platform



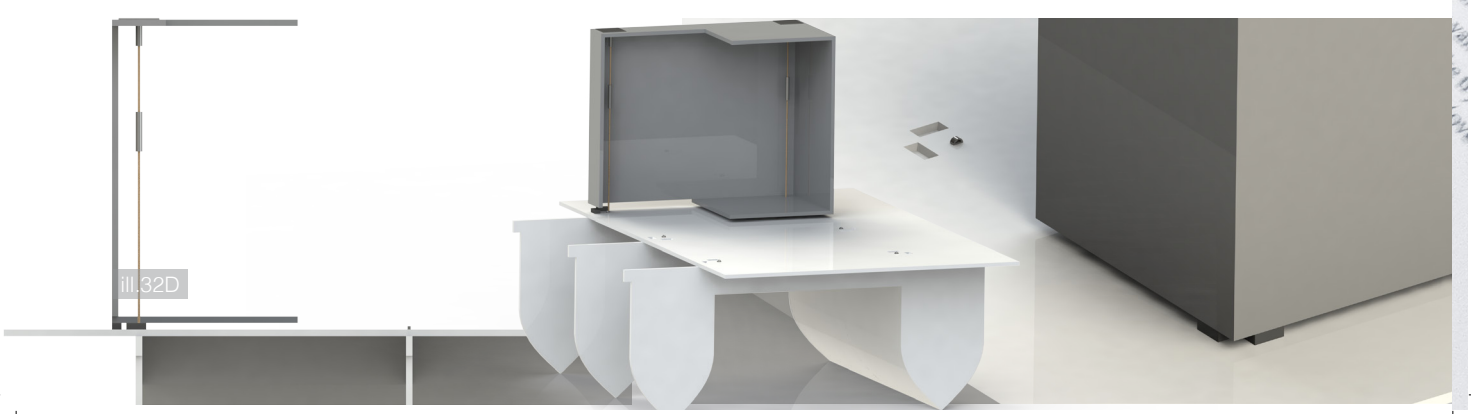
ill.32C

Gargoe is mounted on to the deck using standard cargo lashings. The lashings are attatched to the mounted eyes used for module mounting.

Sumup

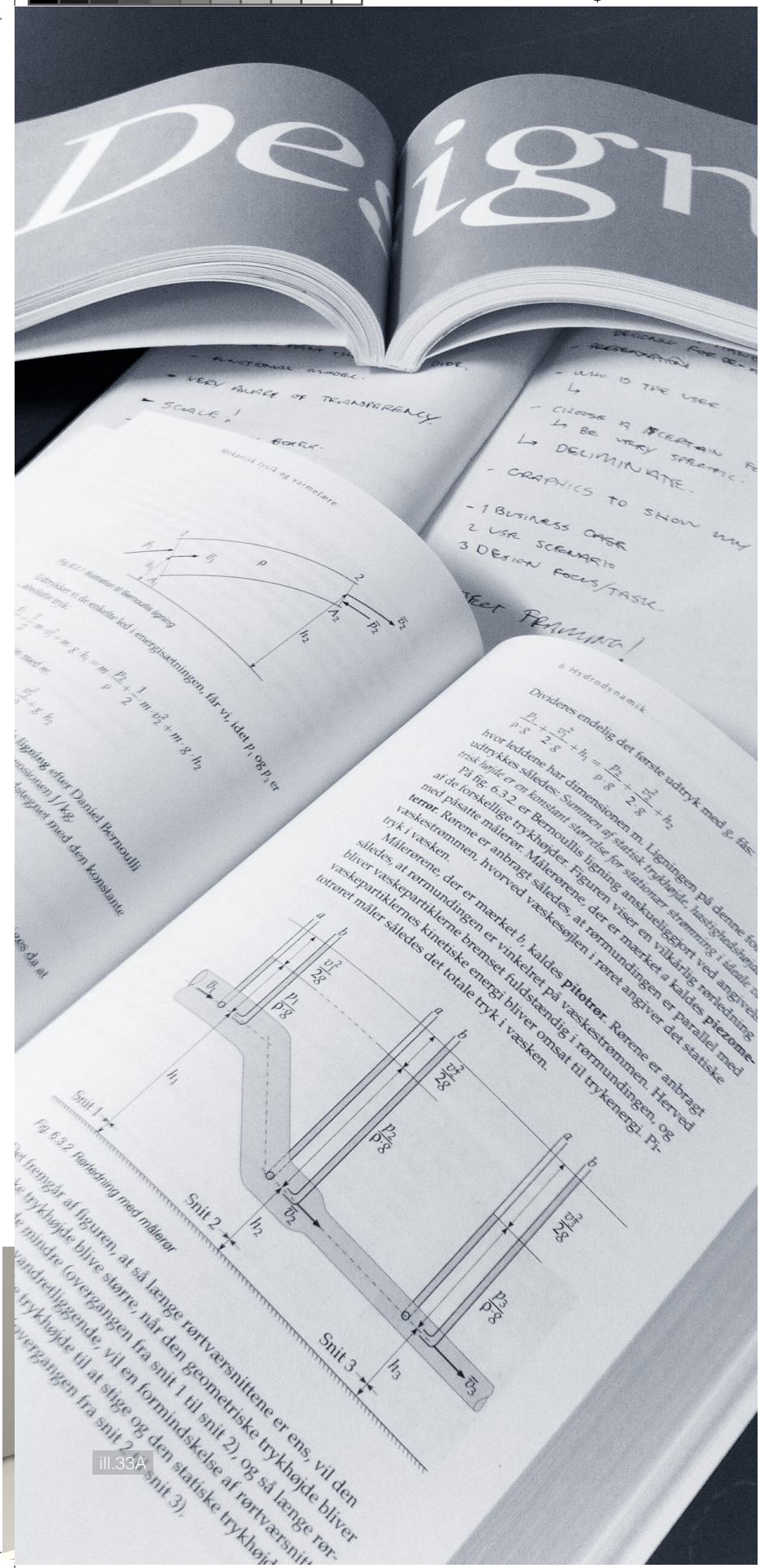
The physical 3D prints both validate the functionality of the mechanisms and enable the use scenario the be acted out.

The chosen mechanism is the ball lock, relying entirely on mechanicle forces applied by the module when lowered into place.



ill.32D

DETAILING



ill.33A

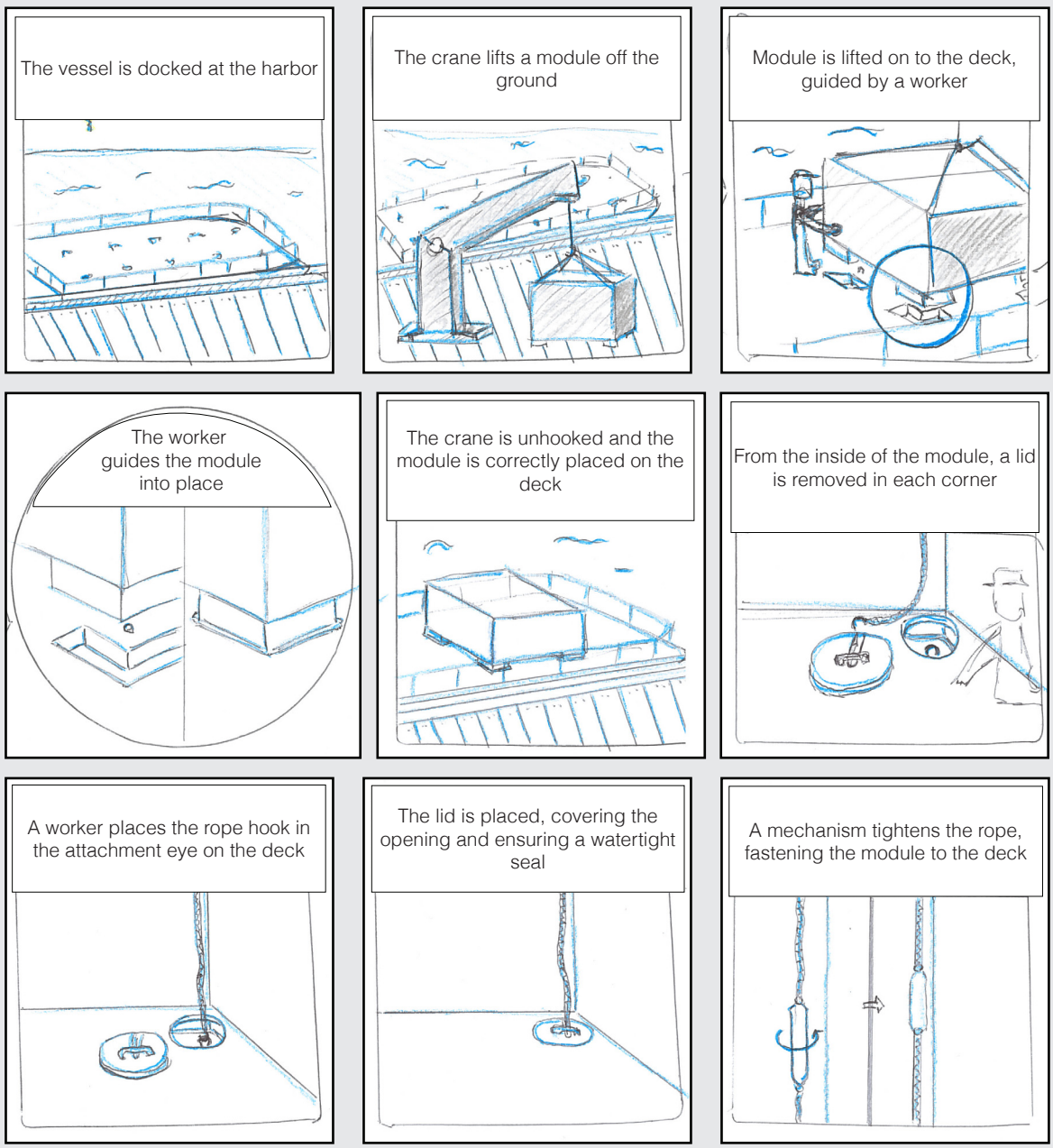
This section deals with detailing of the chosen concept.

- Use scenarios
- Functional models
- Sketching workshop
- Clay modeling
- User testing
- Renders
- Visual models
- Technical estimations
- Business evaluation
- Process tracking

Use Scenarios

After ended concept development, use scenarios for the chosen concept have to be made in order to place and understand the concept in its context, and understand the steps involved in utilizing the system.

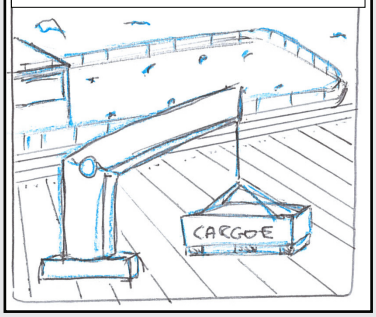
Attatchment of module



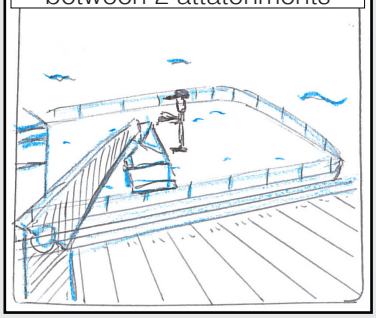
ill.34A

Loading of cargo

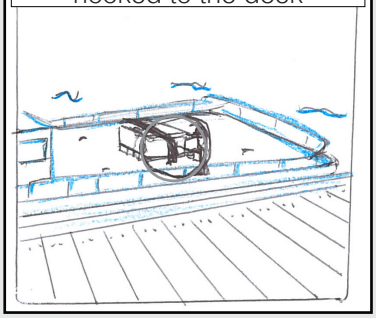
Land or on-board crane lifts cargoe off the ground

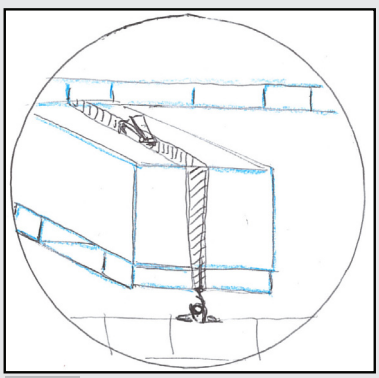


Guided by a worker the cargoe is placed on deck between 2 attatchments



The cargoe is lashed in place, using standard lashes hooked to the deck

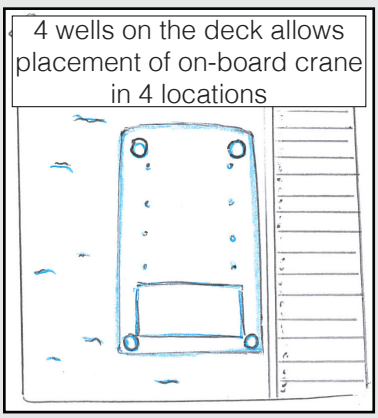




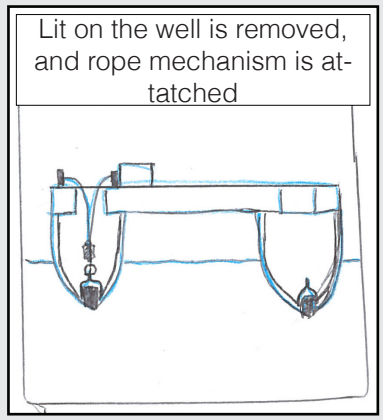
ill.35A

Mounting on-board crane

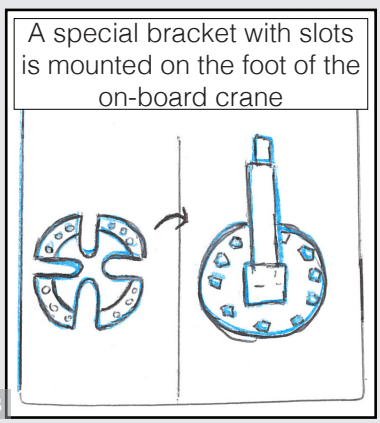
4 wells on the deck allows placement of on-board crane in 4 locations



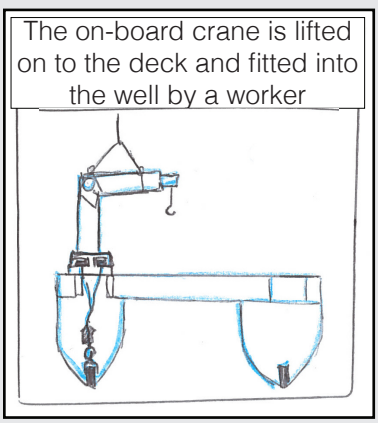
Lit on the well is removed, and rope mechanism is attatched



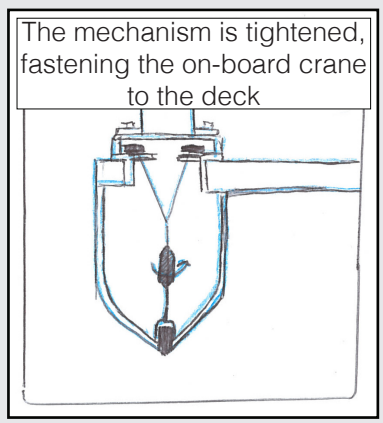
A special bracket with slots is mounted on the foot of the on-board crane



The on-board crane is lifted on to the deck and fitted into the well by a worker



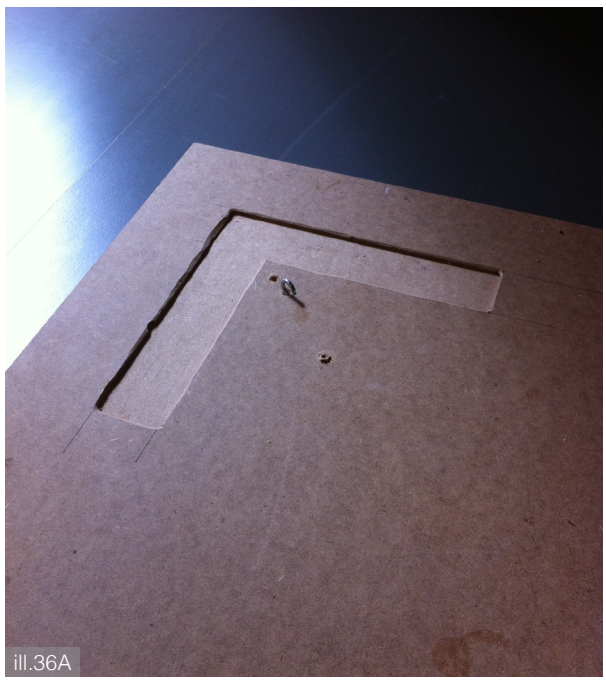
The mechanism is tightened, fastening the on-board crane to the deck



ill.35B

Functional prototype - Module

In order to validate the mechanism chosen for detailing, the use scenario will be converted into functional models. These models allow the use scenario to be acted out, and the system to be tested and optimized.

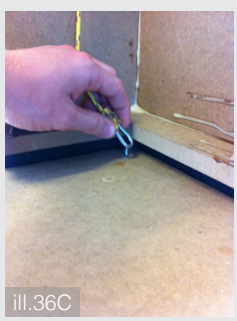
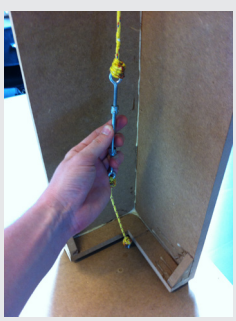


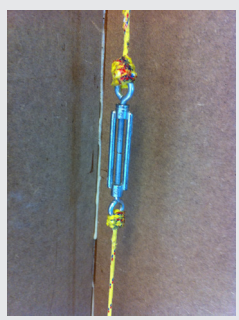
ill.36A

ill.36B








ill.36C

The model is a section illustrating the scenario of mounting a module to the platform. The module is placed on to the platform in predetermined positions. A hook on the module is attatched to the platform and the rope i tightened by turning the mechanism on the rope. When tightened the module is securely fastened to the platform.

The model highlights three interaction points. The interaction between module and platform, placement of the hook, and tightening of the mechanism. As tightening of the mechanism is crucial for the functionality of the mechanism, this is the primary interaction point. It raises the question if the mechanism should be visible, and if it should be shielded from unwanted interaction.

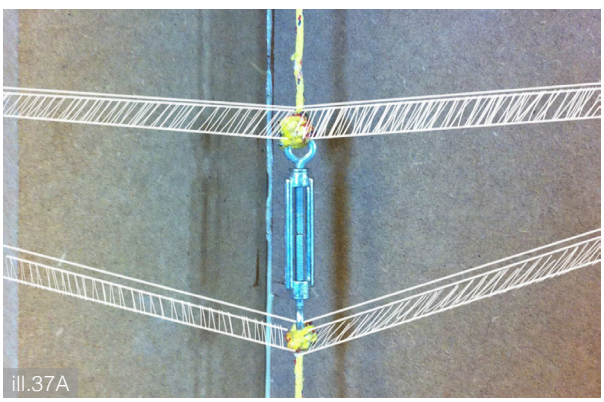
The platform attatchment slots for the modules work well keeping the module in position. The slots in the platform does not have to be very deep in order for the system to work as pressure is applied by the cable, pulling the module downwards. By maintaining a low depth of the slots, draining will be avoided in the construction.

The placement of the hook is done by hand from inside the module. An opening in the bottom of the module enables access to the eye on the deck in wich to mount the hook. The opening is not featured in this model and is a focus for further detailing.

The mechanism for tightening the wire relies on a left and right oriented thread pulled towards eachother by a buckle in the middle. This system works well for applying tention on the wire. How ever, the wire turns when turning the mechanism, so fastening of the two threads needed in order to fixate and eliminate rotation.

The mechanism applied on the middle of the wire creates vibrations. The fixation will also help eliminate unwanted vibration of the wires.

The eyes mounted on the platform, used to attatch wires from the modules also enables cargo to be strapped to the deck. This happens with standard lashings, hooked to these eyes.



ill.37A

Sumup

The mechanism is validated through the functional model. Two issues are found when acting out the scenario on the model.

The tightened wire enables fluctuations ass a heavier mass is placed in the center. This must be avoided by supporting the turnbuckle as shown in ill.37A

When rotating the turnbuckle the wire has a tendency to rotate with it. The final solution must eliminate this rotation.

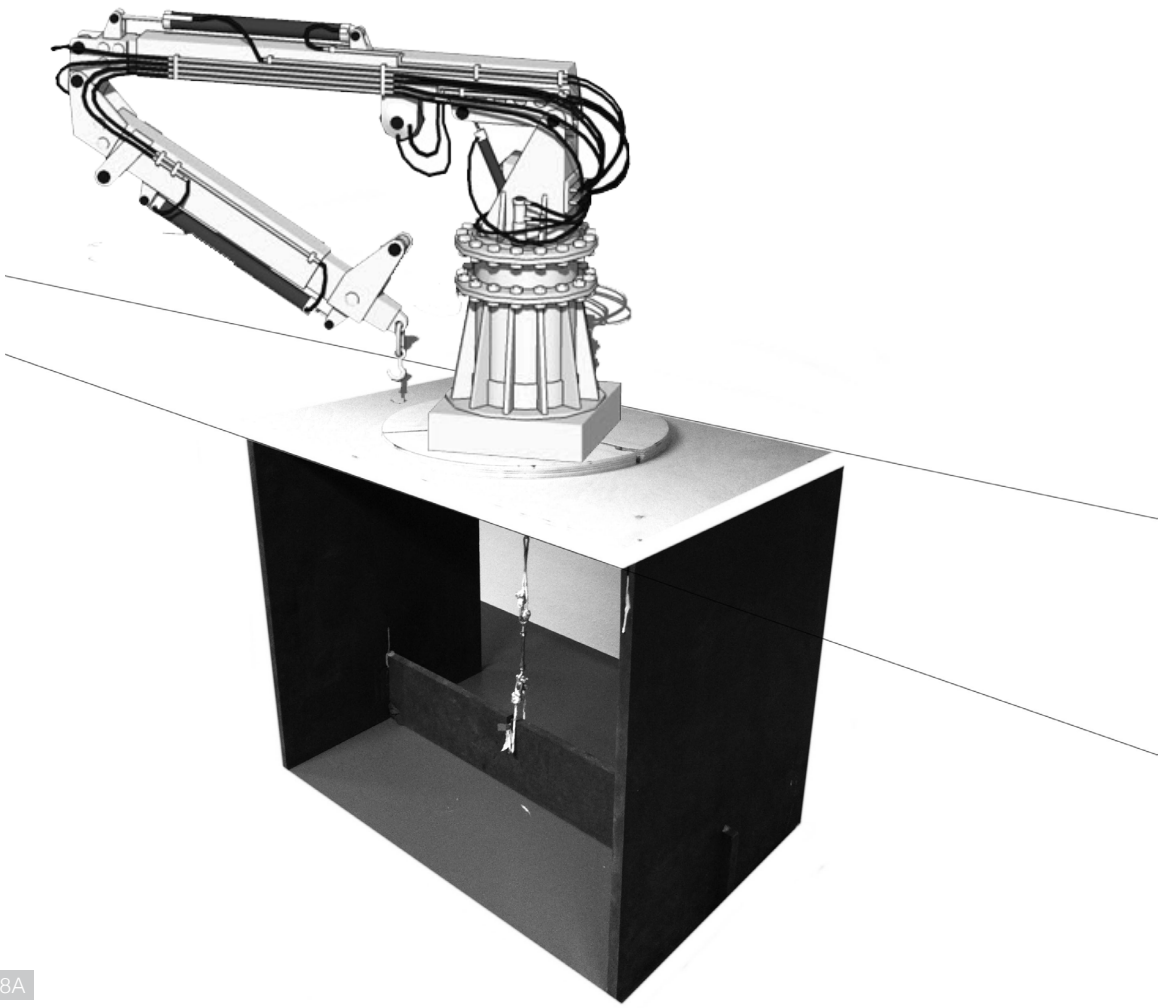
As tightening of the turnbuckle is crucial for the mechanism to work, design of the turnbuckle mechanism is chosen as the design dive.

The question of wether the mechanism should be visible and if it should be shielded requires an itersation of its own.

As cargo is mounted using standard lashes in the system already existing for mounting modules, a functional model for the cargo mount scenario will not be made.

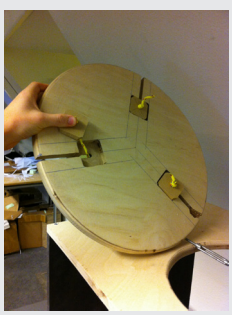
Functional prototype - Crane Mount

The design dive is chosen to be the tightening mechanism in the module. But in order to validate the mechanism transfered to mounting of an on-board crane and act out the use scenario, a functional model of the on-board crane mount has to be made.



ill.38A

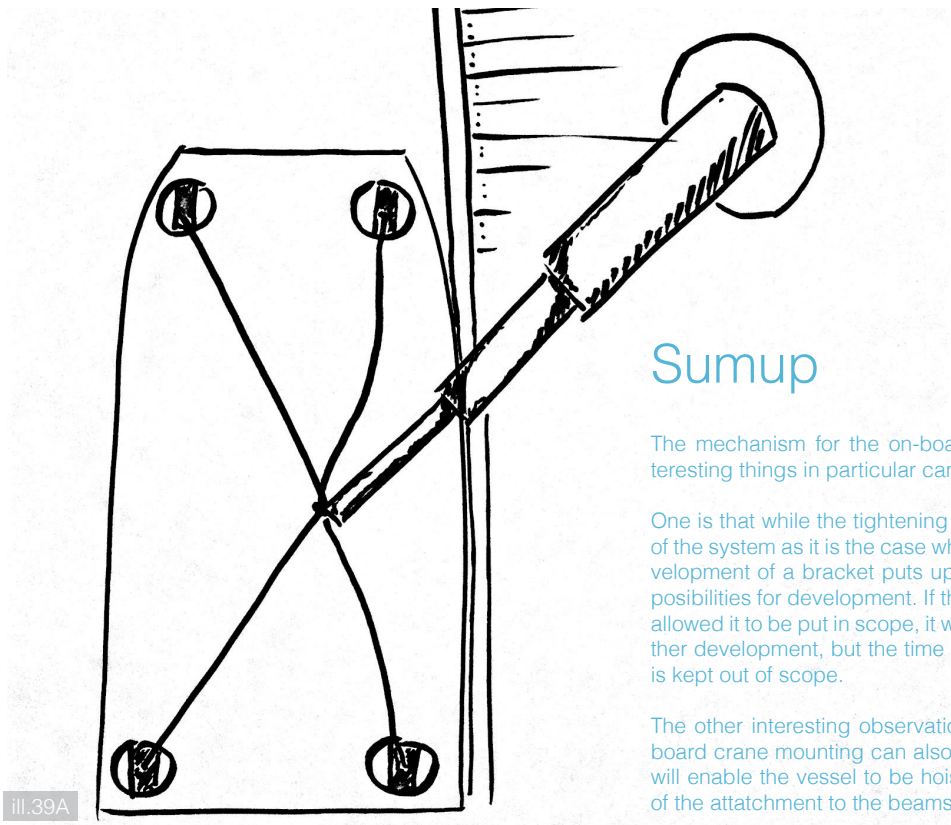
ill.38B



This model is made as a scale model close to a 1:1 scenario. It illustrates the scenario of a bracket mounted to the on-board crane. Bricks attatched to wires are then attatched to the bracket and while the on-board crane is held into position, tightening of the mechanism mounts the crane firmly on to the platform. This is able to be done in all 4 corners of the platform as crane wells not in use will be covered by a lid.

The model highlights 3 essential interaction points. Placement of bricks into the bracket, placement of the bracket in the well on the platform and tightening of the mechanism. Again tightening of the mechanism is crucial for the system to work, but placement of the bricks in the bracket puts up different interesting scenarios for how the use case should be.

In addition to the platform wells primary function of mounting an on-board crane, the wells able to surve a secondary purpose. Transport af hoist of vessels can prove a difficult task. But the attatchment through the wells to the solid beams of the ship, allow lifting in these points as well. By mounting a wire in each of the 4 corner wells, the ship will be able to be lifted by a crane.



ill.39A

Sumup

The mechanism for the on-board crane is validated. Two interesting things in particular came out of the model workshop.

One is that while the tightening mechanism is a crucial aspect of the system as it is the case when mounting a module, the development of a bracket puts up interesting use scenarios and posibilities for development. If the time span for the project had allowed it to be put in scope, it would have been included in further development, but the time span being as it is, the bracket is kept out of scope.

The other interesting observation is the fact that wells for on-board crane mounting can also add value to the platform as it will enable the vessel to be hoisted in these 4 points because of the attatchment to the beams of the hull.

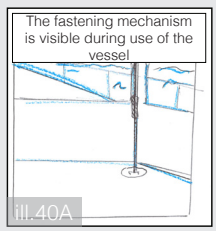
Visibility and shield

In acting out the module placement scenario on the functional model, the issue of visibility and shielding occured. 3 different scenarios are therfore stated, in order to determine the optimal visibility and shielding scenario for the mechanism.

1

When in use - Visible

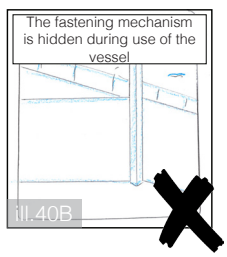
A scenario in which the mechanism is totally visible. This enables aesthetics of the mechanism to add to the aesthetics of the module, and serve both a mechanicle and design purpose. However by exposing the mechanism, all on board of the vessel have access to activating the mechanism and potentially cause the mechanism to fail by accident.



ill.40A

When in use - Hidden

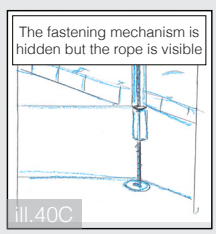
A scenario in which the entire mechanism is hidden. This eliminate the posibility of using mechanism asthetics actively, as it will only be visible when modules are being mounted. Design is in this case with the user alone in focus. Hiding the mechanism completely removes focus from the system and ensures that access to the mechanism is granted only to trained personel.



ill.40B

When in use - Semi hidden

A scenario where the inactive part of the mechanism is visible, being the wires, while the interactve mechanism component, being the turnbuckle, is hidden. This enable the mechanism to be an active part of the module aesthetics while granting only access to trained personel.



ill.40C

2

A combination of visible and semi hidden

A new scenario where the entire mechanism is visible. The inactive part of the mechanism apears without any shielding while the interactve mechanism component, being the turnbuckle, is shielded by a transparrent screen. This enable the mechanism to apear as an aesthetic feature while granting access only to trained personel.

Sumup

In order to enable mechanism aesthetics to be added to the aesthetics of the module, a combination of scenarios “visible” and “semi hidden” is chosen.

The wires will apear without any shielding, while the mechanism is shielded by a transparrent screen ensuring only trained personel will be able to access the mechanism.

Tensioning mechanism

The tentioning mechanism is required to consist of standard components as much as possible. The concept revolves arround utilizing a turnbuckle, but in order to ensure that this component is optimal for the system, a case on standard tentioning components is made.

ill.41A

Belt lashing

This is a standard tightening mechanism for lashings. This component relies on a manual system where a leaver tightens the inserted belt. This mechanism is not suited for tightening of wires as its construction is made to facilitate tightening of high tention belts.

The tightening mechanism move in steps as it uses a barb gear to uphold the tention, eliminating the posibility for acturat tightening as stepless tentioning can not be optained.

In size, the mechanism is the largest of the 3 cases.

ill.41B

Belt lashing

This standard component is a turnbuckle. Primarily used to apply tention to wires in different scales, applied in many different application scenarios. This mechanism is suited for tightening wires as it is constructed in a generic manner allowing it to grab onto any type of cable.

The tightening mechanism move steplessly as it relies on a buckle rotated arround two different orientated threads. This enables precision tightening.

In size, the mechanism is the smallest of the 3 cases.

ill.41C

Wire lashing

This is a standard component similar to the belt lashing. It relies on a manual system utilizing external tools in order to tighten wires.

Tightening with this mechanism is not able to be done steplessly as it also relies on a barb gear to uphold tention in the construction.

It is smaller than the belt lashing as it utilizes external tools for application, but still larger and more bulky than the turnbuckle.

Sumup

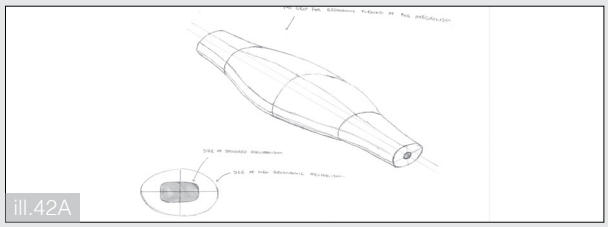
Out of the 3 standard tightening mechanisms the turnbuckle is chosen as the ideal solution. It is designed specificly for the scenario occuring in the concept, and it is able to be tightened steplessly for pressision.

Further more the simple symetric geometry makes it optimal to build arround enabling design of the interaction.

Turnbuckle scenario for handle V1.0

With a turnbuckle chosen as the standard component for the mechanism to build around, the use scenario of the turnbuckle has to be investigated as different scenarios are possible.

Rotated by hand

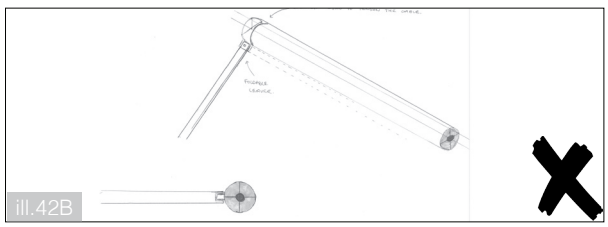


ill.42A

In this case the turnbuckle mechanism is rotated by hand without the use of external tools. The system rely on the handle geometry to allow sufficient momentum in order to adaquitely tention the wires.

This scenario has potential in allowing easy interaction when rotating the mechanism, as no tooling is required.

Rotated by attatched mechanism

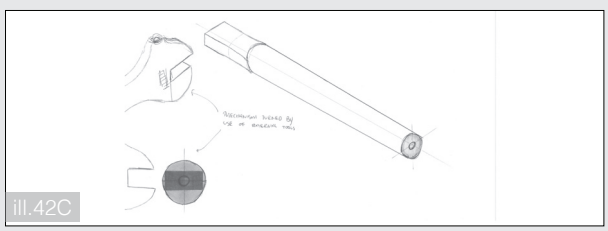


ill.42B

In this case the turnbuckle mechanism is rotated by an integrated mechanism in order to increase momentum.

This scenario is eliminated as an integrated mechanism require the handle to have a larger distance to surrounding walls in order for it to be able to rotate freely.

Rotated by external mechanism

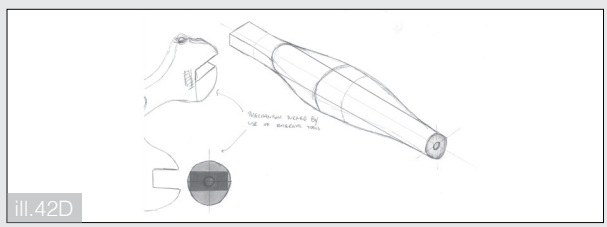


ill.42C

In this case the turnbuckle is rotated by use of external tool, able to attatch in pre determined interaction zones.

This scenario has potential, as it enable a simple mechanism. Also it does not add unwanted complications to the construction as it has to consist of standard components as much as possible.

Rotated by hand and external mechanism



ill.42D

In this case the turnbuckle mechanism is rotated by hand and by use of an external tool to increase momentum. This tool fits on to the mechanism in predetermined interaction zones.

This scenario is chosen as momentum needed for applying adaquite tention can be facilitated by external tools, while allowing the mechanism to be rotated by hand until increased momentum is required. As the tool used is external, it can change position during rotation, allowing the handle to be placed close to surroundings.

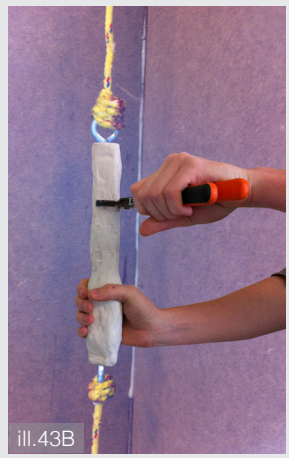
Sumup

Out of three scenarios, the optimal one is rotation of the mechanism by use of hand and external tool. This is chosen as it allow an adaquite amount of momentum applied, while keeping the handle close to the surroundings. By applying external momentum, the handle geometry can be kept to a slender dimension.

Turnbuckle use scenario for handle V1.0

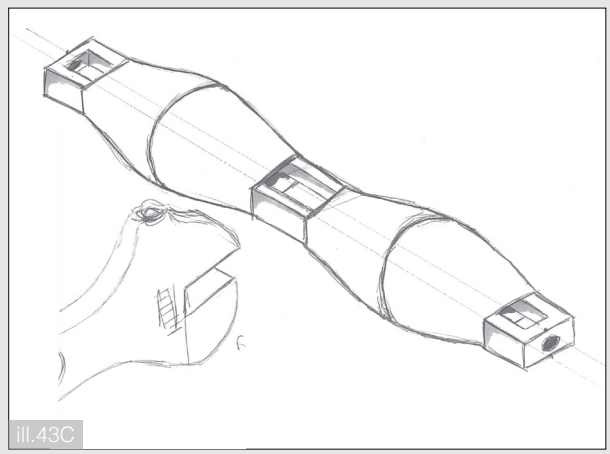
The chosen rotation scenario utilizes hand and external tool power in order to apply tention to the wires. A clay model is made in order to act out the scenario.


ill.43A


ill.43B

The scenario highlight two scenarios. One in wich interaction by hand occurs in the top while interaction with external tool occur in the bottom, and an other scenario in reverse.

As both left and right handed operators should find the mechanism intuitive, and as individual habbits and preferences is what determines the orientation of the mechanism, it is optimal to combine the two scenarios enabling hand interaction in two zones. One in the top and one in the bottom, while allowing tool interaction in the middle of the handle.


ill.43C

Sumup

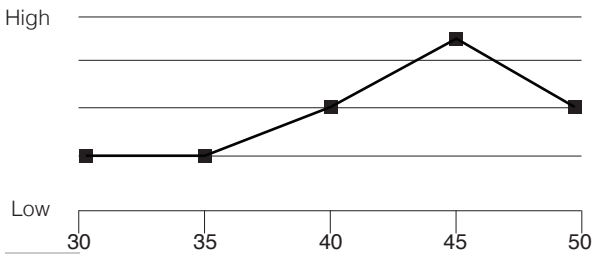
In order for the mechanism to suit both left and right handed operators, and in order to allow the mechanism to suit individual preferences, interaction zones for hand operation are decided to be located in the top and in the bottom, while tool interaction occurs in the middle of the handle.

Diameter of interaction zone for handle V1.0

In order to determine the size of the handle to optimize interaction, a user test is carried out. Clay models of various thicknesses are made and rated according to comfort of grip.

According to measure of man, the optimal diameter for a single hand grip, is between 32 and 38 mm. In order to test these dimentions, clay models are made, spanning from 25 to 50 mm in diameter.

Participants are introduced to the use scenario prior to testing, so they know the context in which the handle has to surround itself. By placing the span both above and below the standard measures, an optimal diameter can be found in relation to this specific context (Appendix C).



ill.44A

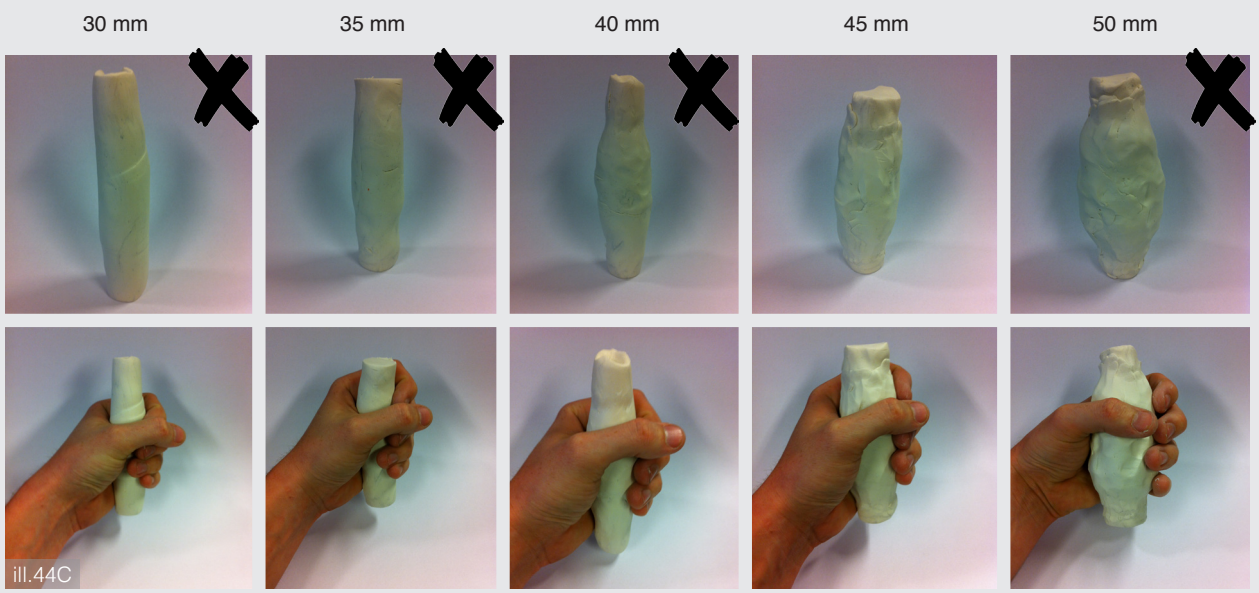
"Thickness, to allow the thumb to just cover the end of the index and middle fingers. For maximum power in an adult male, it should be 3 or 4 cm. in diameter"

According to surgeon Michael Patkin, the tested optimal grip is above the standard measures, but as shown in ill.44C the thumb just coveres the end of the index finger with 45 mm grip, where as with 50 mm, the contact is broken.

ill.44B

Sumup

As the graph indicate, a diameter of 45 mm is rated as the optimal size for the grip. This is 7 mm more than the standard measure and the size is argued by being a good size grip for a scenario where high amounts of force will be implemented.



ill.44C

Basic shape of handle V1.0

After discovering the optimal diameter of the handle, the shape is investigated in order to enhance the grip, and signify rotation.

Surgeon and ergonomics specialist Michael Patkin talks about handle ergonomics in a checklist.

Two of the checkpoint on that list are shape/size of the handle and the ability to signify function. As the size of the handle is determined by previous test, the shape will be utilized in order to signify the function of the handle.

Grip shapes exist in a lot of different variations. Three examples are investigated in relation to implementation in the handle.

ill.45A

ill.45B

ill.45C

Sumup

A handle with a dimple in the top, allowing overlap of thumb and index finger while maintaing a solid grip surface for the palm is chosen. The revolved continous geometry indicates rotation as the experience of interaction with the grip will be similar regardless of the rotational degree.

ill.45D

Uniform handle

A basic uniform shape of the handle. This allow the thumb to overlap the index finger and create a uniform surface to meet the palm of the hand.

ill.45E

Dimple for every finger

A handle with dimples for every finger. This reduces the active part of the handle, forcing the diameter to increase, as the diameter in the dimples must reach 45 mm in order for the same momentum to be achieved.

ill.45F

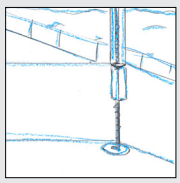
DImple in the top

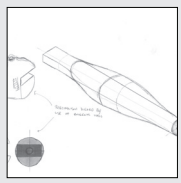
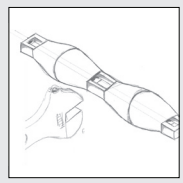
A dimple in the top allowing the thumb to overlap the index finger more significantly. Enhances controll of the handle.

This handle is optimal as it allows great support for the palm while enabling solid overlap between thumb and index finger.

Handle V1.0

The choises made along the detailing process are summed up to a styled design solution for the handle, incorporating all aspects of the process.

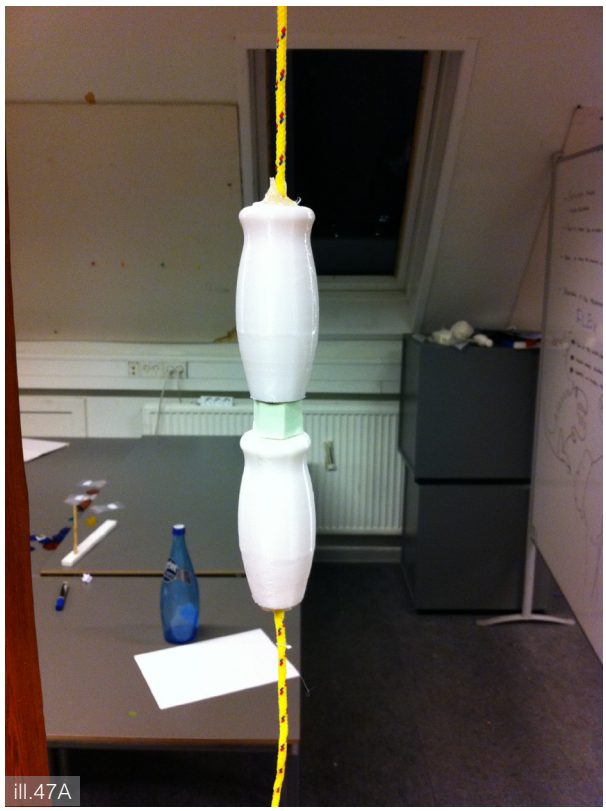


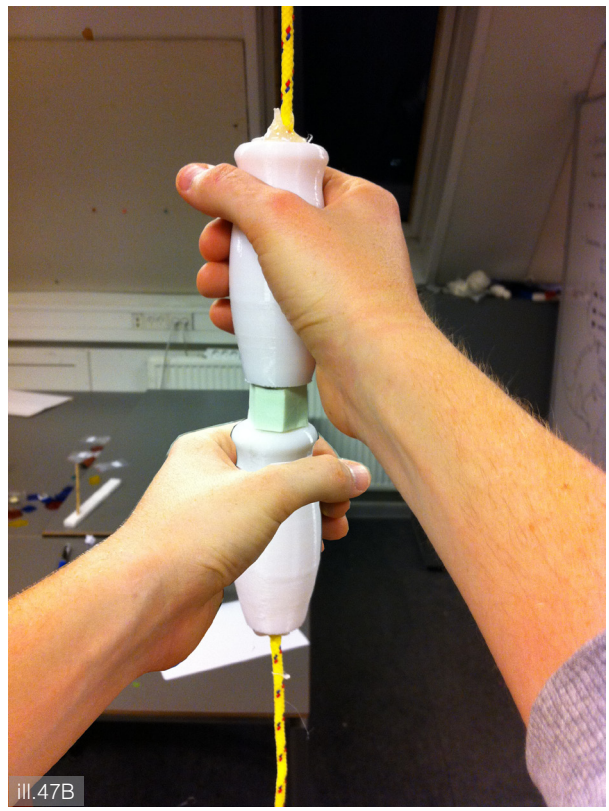



ill.46A

Physical model of handle V1.0

A physical model of handle V1.0 is 3D printed in order to implement the design in its functional context. This will enable the utilization scenario to be acted out and evaluate the handle design based on the functional context.


ill.47A


ill.47B

Through 3D print, the handle design V1.0 is build in a 1:1 scale. The scenario of tightening the mechanism is acted out, and two things are concluded.

The shape of the handle suits a one hand grasp very well, confirming previous observations. But the division of the overall structure with an upper and a lower handle encourages the user to twist the handle in opposite directions. With the use scenario as the pivot point of the development, this is contradicting.

The handle should not invite the user to turn each handle in opposite directions. On the contrary it should encourage a rotation of the entire handle in the same direction. The shape of the handle will therfore have to be changed in to a uniform geometry signifying corelation in rotation.

As the mechanism has to consist of standard components, estimations of the size of the turnbuckle needed are missing from the scope. This will need to be estimated prior to further handle development as dimentions may have to change.

Sumup

The two separate grips on the handle encourage the user to rotate the handles in opposite directions. This contradicts the scenario of rotation in the same direction. This require further development of the handle geometry, turning it into a uniform shape signifying corelation in rotation. Prior to further development, dimentions on an appropriate standard turnbuckle will have to be made, as this concideration may change dimentions of the handle.

Adding dimentions

The mechanism has to rely on a standard component solution. Dimentions of the turnbuckle component is therfore essential as it dictate the dimentions of the entire handle. An estimation of nescesarry turnbuckle size has to be made.

In order to determine the dimention of the standard turnbuckle implemented in the turnbuckle, the size of force added to the modules will have to be calculated.

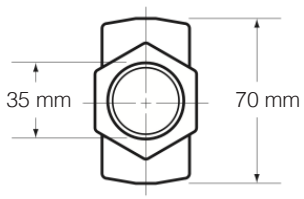
In order for these calculations to make sense, external forces effecting the module has to be known. As these external forces are undetermined, an estimation on forces effecting the turnbuckle is made.

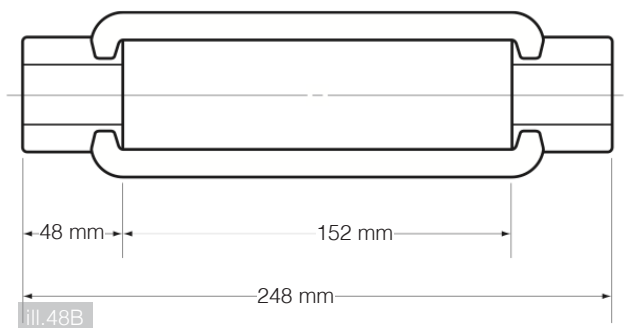
An estimation is made that modules attatched to the platform will not exceed a total weight of 5 tonnes. In order to keep the mechanism from failing in even the most extreme condition, it is determined that a single mechanism should be able to support twice the weight of the largest module, being 10 tonnes, in the catastrophic event that three out of four mechanisms should fail. The reason for the safety factor in every mechanism of 2:1 is to account for external forces still effecting the module during the catastrophe.

An american company called Wecall, manufacture and supply high tention turn buckles. A turnbuckle able to cope with 10 tonnes of tention is chosen, and dimentions are shown in ill.48B

This turnbuckle is used in development of handle V1.1

ill.48A





ill.48B

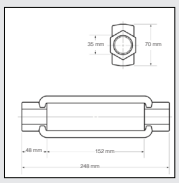
Sumup

The chosen turnbuckle is able to support 10 tonnes of pull, and has the dimentions highlighted in ill.48B

The turnbuckle dimentions are included in further design development.

Handle V1.1

After evaluating handle V1.0 with the conclusion that further development is needed, and after understanding the dimensions of the standard turnbuckle used in the mechanism, handle V1.1 is devleoped.

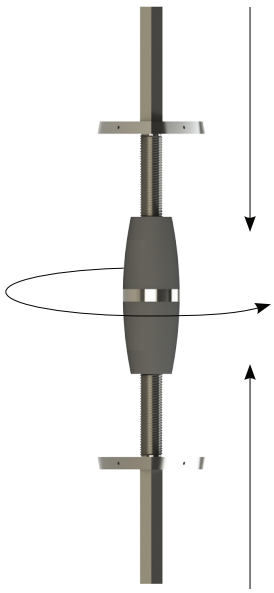


ill.49A

ill.49B

Mounting in cabin and fluctuation elimination

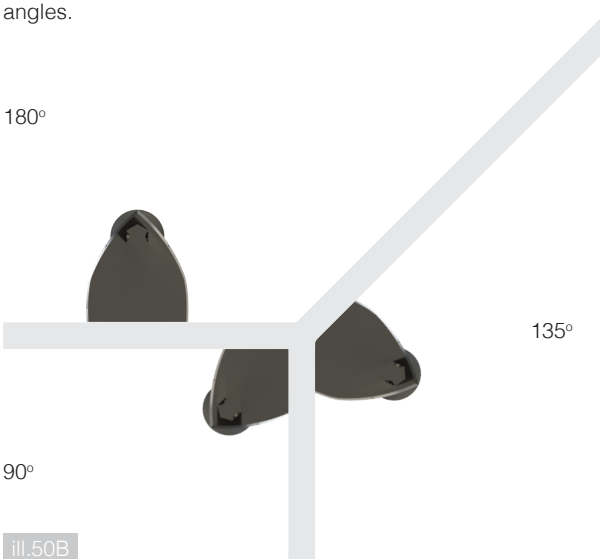
After detailing the handle, the moun of the mechanism has to be made. This mount will consist of 3 functions. First of all it mounts the mechanism to the module. Secondly it ensures that wires does not rotate with the handle when tightned. Thirdly it sampens fluctuation occuring in the wire during operation.



ill.50A

The mount consist of two brackets fastening the mechanism to the module. These brackets are designed in order to be able to adapt to any angle between 90 and 180 degrees as this span is what is able to occur in design of modules.

This adaption to angles happens by small changes to these two mechanism components. It is manufactured to adapt to 180 degree, and simple cuts will allow it to be possisioned in other angles.



ill.50B

Hexagonal beams pass through fitted openings in the brackets. Attatched to these beams are thread beams which are inserted in to the turnbuckle in each end of the handle.

These fitted hexagonal openings for the hexagonal beam are what keeps the wire from rotating when rotating the handle. By allowing the beams to move freely, it is able to tention the wires while the thread beams move closer towards eachother inside the handle.

This support is also what eliminate fluctuations in the wires, as the handle is held into position by the brackets.

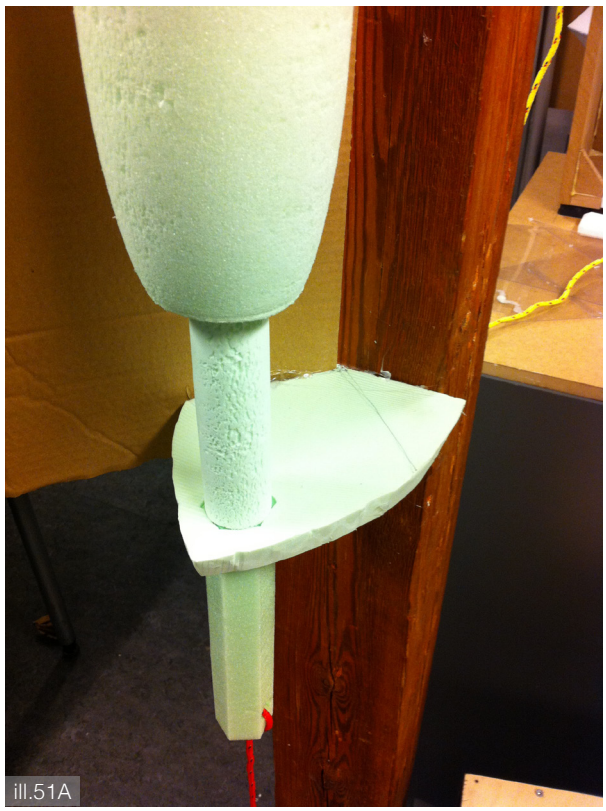
ill.50C

Sumup

Brackets mount the mechanism to the module. Hexagonal beams, mounted on the thread beams going in to the turnbuckle, pass through hexagonal openings in the brackets. This eliminate rotation of the wire while applying tention and prevents fluctuation in the wires during operation.

Physical model of handle V1.1

In order to understand poportions of the handle V1.1, a mock up model is made. This model will enable physical interaction with the handle, and visibly communicate the rotation and fluctuation elimination in the brackets.



ill.51A

ill.51B

The physical model of handle V1.1 reveals the vastness of the dimentions. The hight of the mechanism is 1 meter and the handle diameter is 90 mm, twice as thick as V1.0. When acting out the scenario, the dimention of the handle turn out to suit a two hand grip very well, enabling the operator to tighten the mechanism properly.

The concept for rotation elimination in the brackets apears to work as planed. Testing of this is not posible in this model as it is not functional.

However it becomes very clear that the brackets are able to dampen fluctuations occuring on the wire as notised in the first functional module model. This happens as the main mass of the wire, being the handle, is held firmly in to position.

Sumup

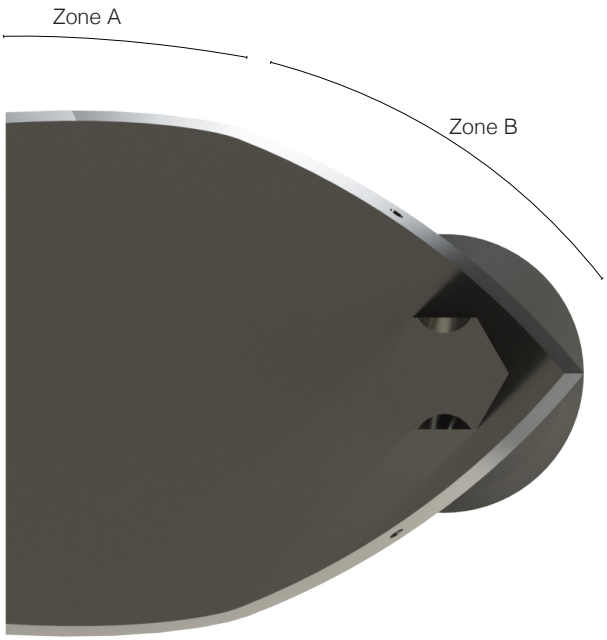
The thickness of the handle invites for a two hand grip, which is suitable as need for external tools is eliminated as it is assumed that sufficient rotational force can be achieved by hand as the diameter of the handle is increased.

Rotation and fluctuation elimination is achieved with the system in the mounting brackets.

Safety

In order to avoid unwanted rotation of the mechanism, a shielding is needed. It is chosen that the mechanism will be shielded by a transparrent shell as aesthetics of the entire mechanism will add to aesthetics of the module.

The bracket is divided in to two zones. Zone A is the the area of which cuts are made in order to position the bracket in angled corners. Zone B is the area of which the bracket remains the same in every situation.

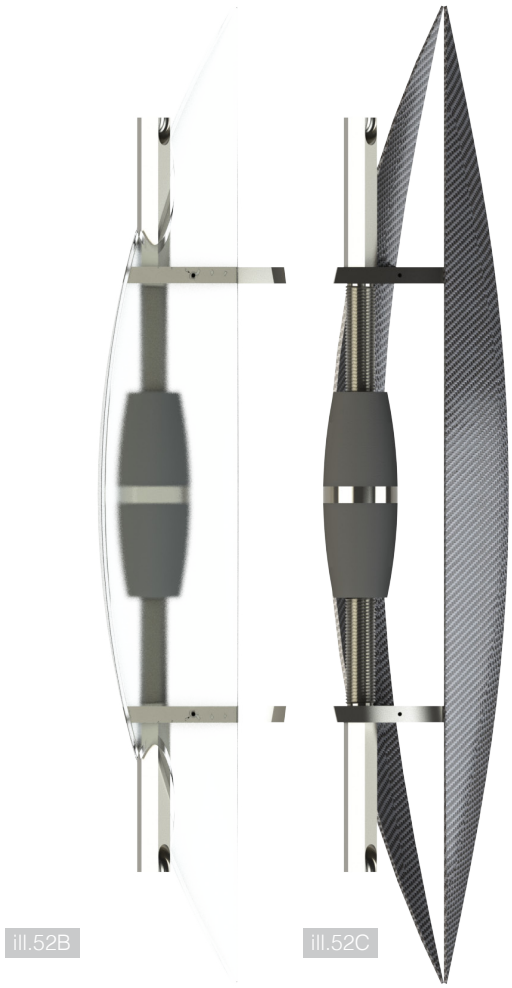


ill.52A

Having two different scenarios in which conditions differ, two different materials can be used, utilizing Tuco's strengths.

As Tuco has expert knowledge in composites, the flexible part of the shield in zone A can be manufactured in carbon fiber, allowing Tuco to rapidly manufacture shield panels for each case required. Added value will be the aesthetic reference drawn to Tucos profile.

Zone B never changes, and therfor invite for a material of a more solid nature. Using frosted glass, the shielding reveals the inside of the mechanism, while signifying a restricted mechanism.



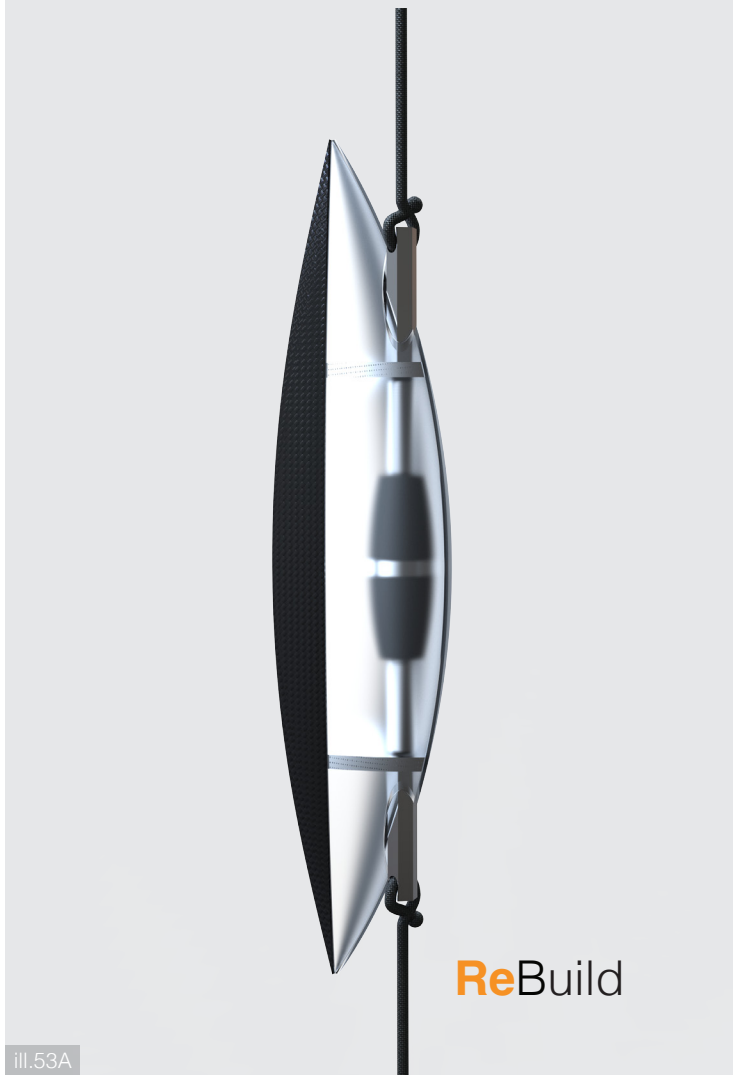
ill.52B ill.52C

Sumup

The mechanism shield consists of 2 parts. A transparrent shielding revealing the internal mechanism but shielding it from unwanted interaction. The second part is a shield in carbon fiber in the zone of degree variation. The carbon fiber draws reference to Tuco's main competence.

Final mechanism

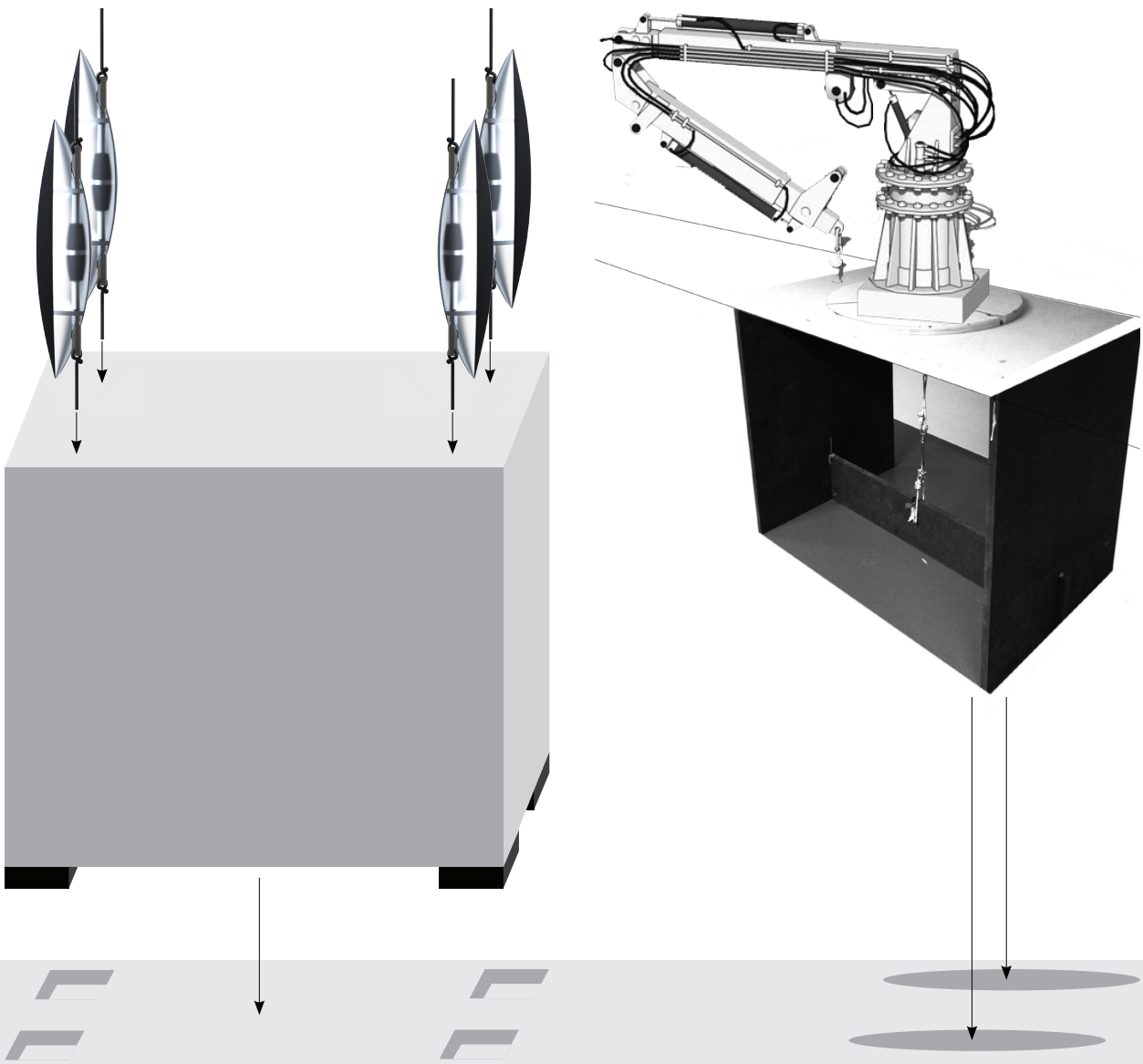
The design fase is stopped, and the final mechanism emmerge from the coises made in the design process. The presentation of the final mechanism will be followed by an implementation into the over all modular system.



ill.53A

Final modular system

The over all modular system consisting of modules containing ReBuild, on-board crane and a cargoe mount is presented in relation to the platform of the vessel.

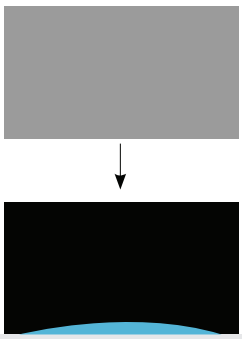


ill.54A

Technical conciderations

As mounted modules rely on friction to hold them in to position, conciderations on an alternative fastening scenatio are made. This will be in form of a reflection on the design and not as a new design iteration. Further more materials and production processes used in manufacturing of ReBuild investigated.

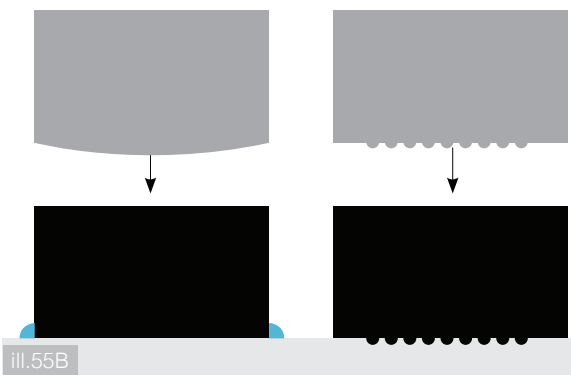
Fastening of the module



ill.55A

Fastening of the module on to the deck relies on friction between the rubber feet of the module and the platform. Relying on friction alone is riscy. Even though the friction coefficient between rubber and polymer on the platform surface can be high in dry conditions, wet scenarios may occur. When cleaning off the platform prior to placement of modules, small amounts of water can gather on the deck. If water is trapped between the rubber feet of the module when placed, the friction can be close to non existent. This would cause the entire system to fail.

Two suggestions are made to remedy this.

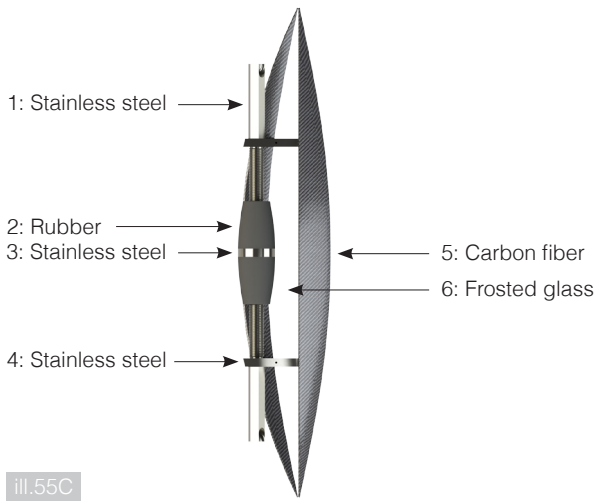


ill.55B

A rounding of the rubber foot attatched to the module will enable it to force water away during placement, avoiding gatherings of water, ensuring friction is obtained when the mechanism is tightened.

A pattern on the rubber foot of the module, matching recesses on the platform enables a mechanicle lock between the moudle and the platform, eliminating the need for obtaining friction.

Materials used on ReBuild



ill.55C

Production methods

Production method used in production of ReBuild are

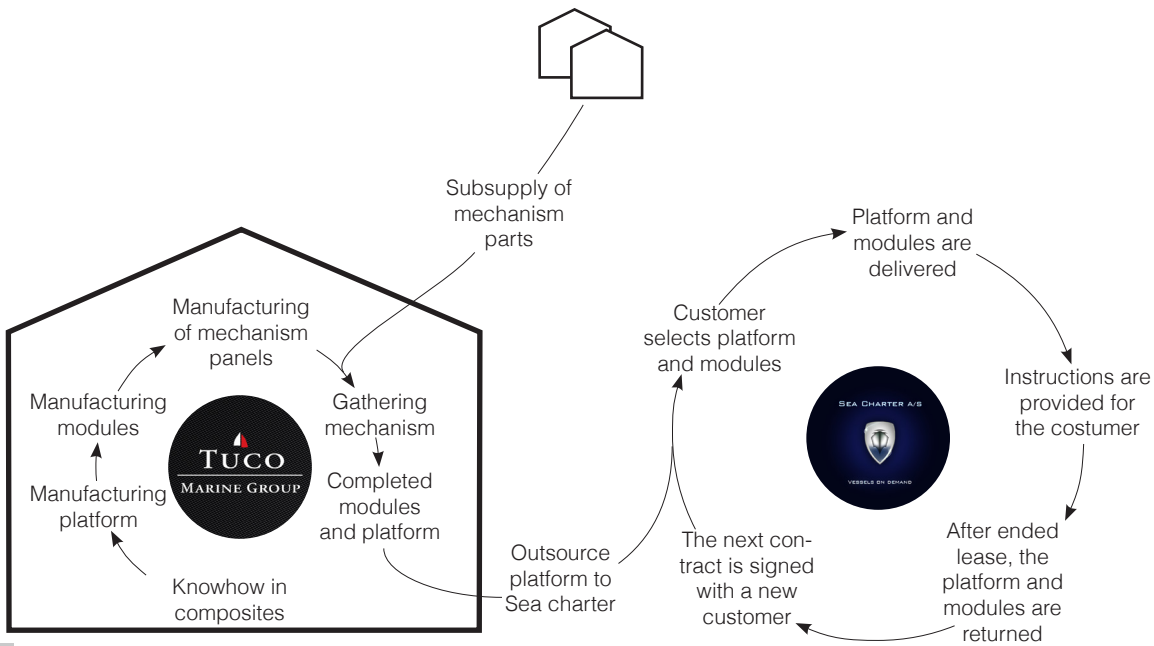
1: CNC lathing of threaded hexagonal bars
2: Injection moundling of rubber parts for the handle
3: Laser cutting of the stainless steel inlay in the handle
4: 3D laser cutting of the brackets
5: Vacuum infusion of carbon fiber panels
6: Termo shaping of frosted glass panels

Sumup

By applying patterns on to the rubber feet of the modules, matching patterns on the deck in the pre determined attatchment positions, the modules will rely on a mechanical lock rather than friction alone. Further more, theese patterns will eliminate the need for resesses on the platform. Materials and manufacturing processes involved in manufacturing of the mechanism have been investigated and chosen.

Business case

In order to understand the context in which the modular system is to be implemented in, an illustration shows the business case in relation to Tuco and their daughter company Sea Charter.



ill.56A

Being an expert in manufacturing in composities, Tuco manufacture first the platform in either 12, 15 or 17 meters. The appropriate modules are then manufactured. This all happens in house in Tuco's own manufacturing facility.

Composite panels for the mechanism are manufactured in house as well. The rest of the mechanism consist of steel and glass parts. These are delivered from subsuppliers and the entire mechanism is gatered in Tuco's facility and installed in the modules.

The ship is outsourced to the daughter companu Sea Charter, being a charter company aiming directly at commercial carter. The costumer select the wanted platform size, and determine demands for the functionality of the platform. Modules suiting the industrial purpose of the charter period are then attatched to the platform and the vessel is delivered. When the charter period ends the vessel is returned to Tuco.

A new costumer is now able to select the platform and a new industrial purpose determines the extend of platform re-assembly.

This charter circle enable Tuco to direct their platform at any given industrial purpose and inceases the flexibility of chartering as the costumer is able to determine functionalities of the platform as if the vessel was build for the specific scenario. This gives Tuco and their daughter company Sea Charter a competitive edge on a competitative market

A different scenario is selling the platform rather than chartering. In this case the platform is able to adapt to an industry in which very different scenarios can occur, and operators need the platform to be able to re-assemble to achieve optimal use.

Sumup

The re-assembly system for the platform is manufactured at Tuco's facilities and is aimed primarily at chartering through Tuco's daughter company Sea Charter.

Appart from suiting charter, the platform can also be sold to industries in which re-assembly is a wanted feature enabling flexibility in an industry where use scenarios differ.

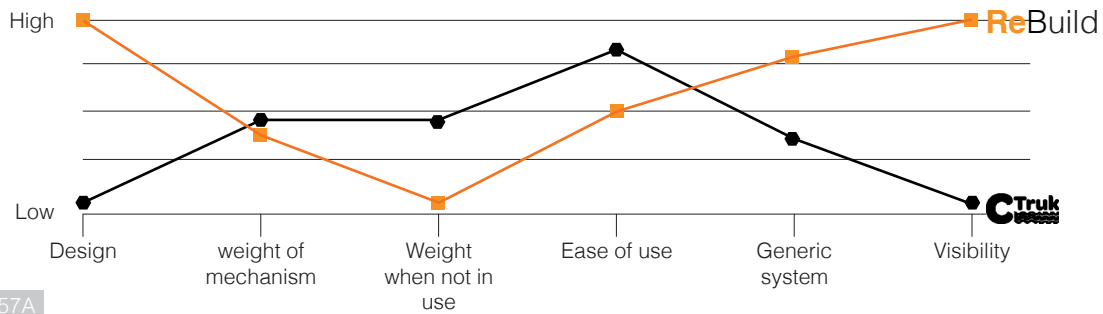
Benchmark

This modular system has only one close competitor, being C-Truck. In order to understand how the system differentiate itself from C-Truck and from traditional vessels, a benchmark is made.

Ill.57A shows how the modular system differentiate itself from C-Truck based on key parameters, being

- Design
- Weight of mechanism
- Ease of use
- Generic system
- Visibility

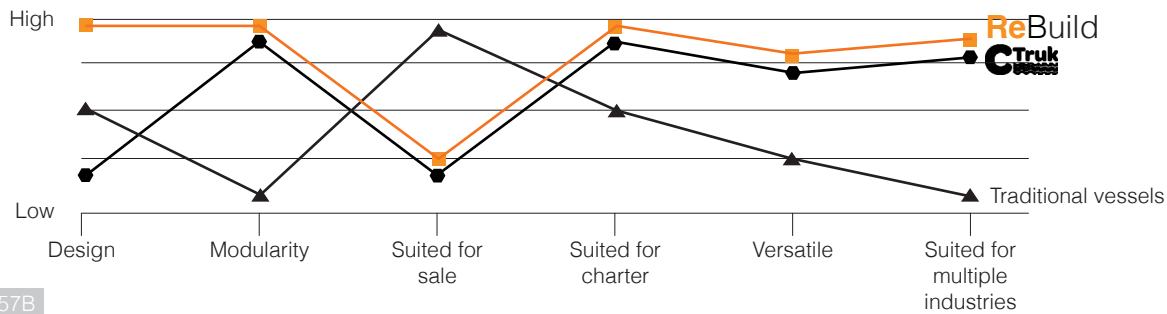
By differentiating itself from C-Truck, Tuco will be able to operate within a blue ocean market niech. Market differentiation through design has become a well astemed road to market growth, even within industrial purposes. This means that Tuco will be met with a product with the potential of a high market growth, and adventually with a high market share, as shown in ill.59A.



ill.57A

When rated in relation to traditional vessels, as shown in ill.57B the two re-assembly solutions have one key difference, being design. By differentiating through design, Tuco will be able to communicate their product more clearly, and every time the vessel is in use, the visibility of the mechanism will work as advertizing.

The key differences between the re-assembly vessels are that they are high on modularity, being able to duit different industries. And they are suited for charter rather than suited for sale.



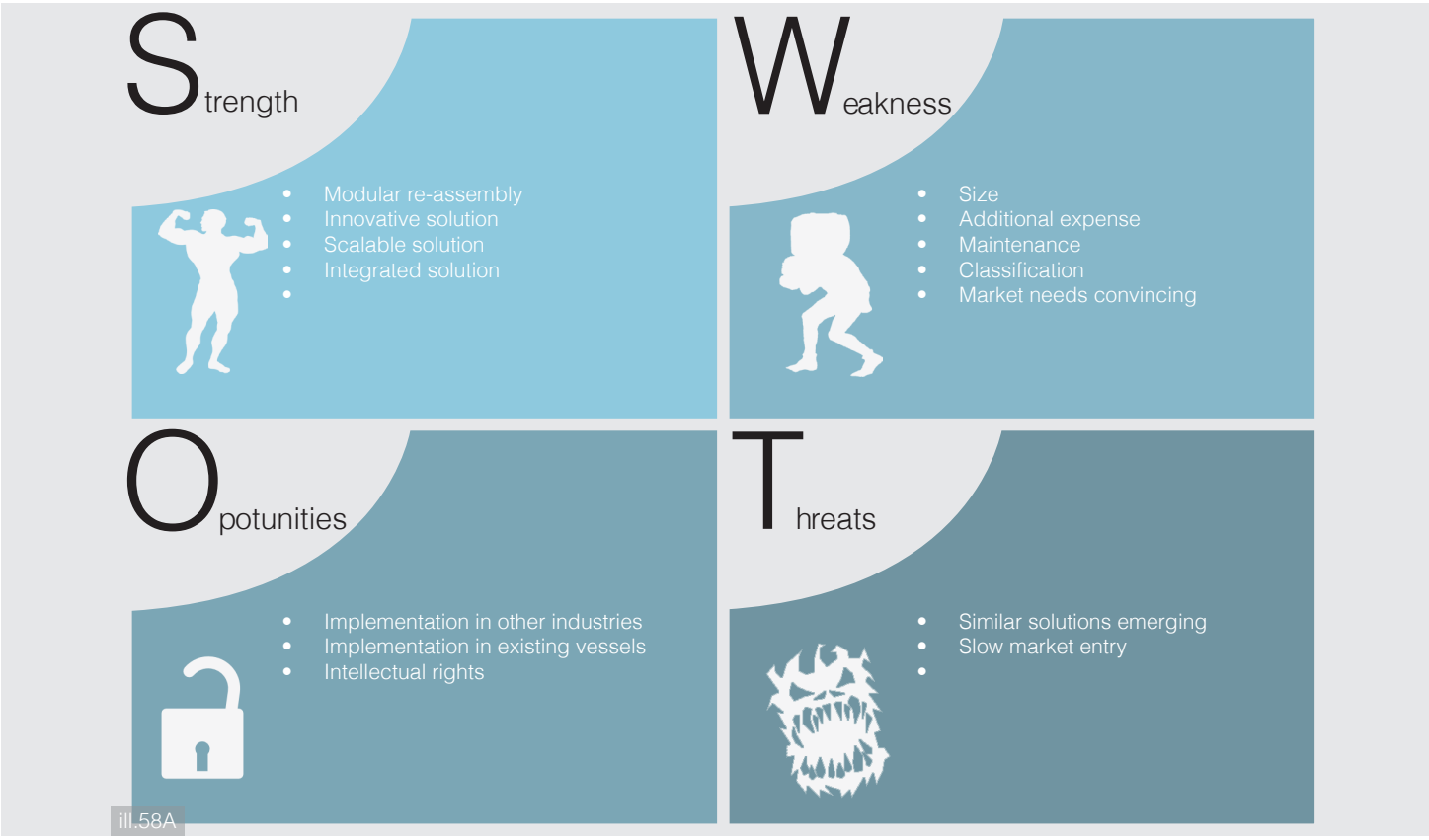
ill.57B

Sumup

Compared to C-Truck, the solution for Tuco rate high on design. This gives it a competitive edge as design can be used as a market differentiator. Compared to traditional vessels, it is the modularity and suitability for multiple industries that stand out, along with the fact that the re-assembly vessel is suited mostly for charter.

SWOT on the modular system

A SWOT analysis of the final mechanism is made, investigating internal strengths and weaknesses, and external oppotunities and threats.



ill.58A

Strengths

The strengths of the system are the modularity that exists through re-assembly. This is an innovative solution and gives Tuco an edge on a competitive market. The solution is scalable meaning it can be implanted in different scenarios on the vessels such as mounting of an onboard crane. The solution is developed on the base of integrated design, ensuring that aesthetics and function exist in the product in a coherent manner.

Weakness

The size of the mechanism takes up space within the modules. It is placed as a visual object rather than hidden away in order for the aesthetics to add to the aesthetics of the module. It is an additional expense driving up the price of the vessel. This means that demand for re-assembly is essential in order for the product to be valid. With the mechanism comes maintenance which has to be included in the business model. Also classification of the mechanism may stretch the time to market.
As it is a new innovative solution in a market with many players, the market will need convincing in order to welcome the new system.

Opportunities

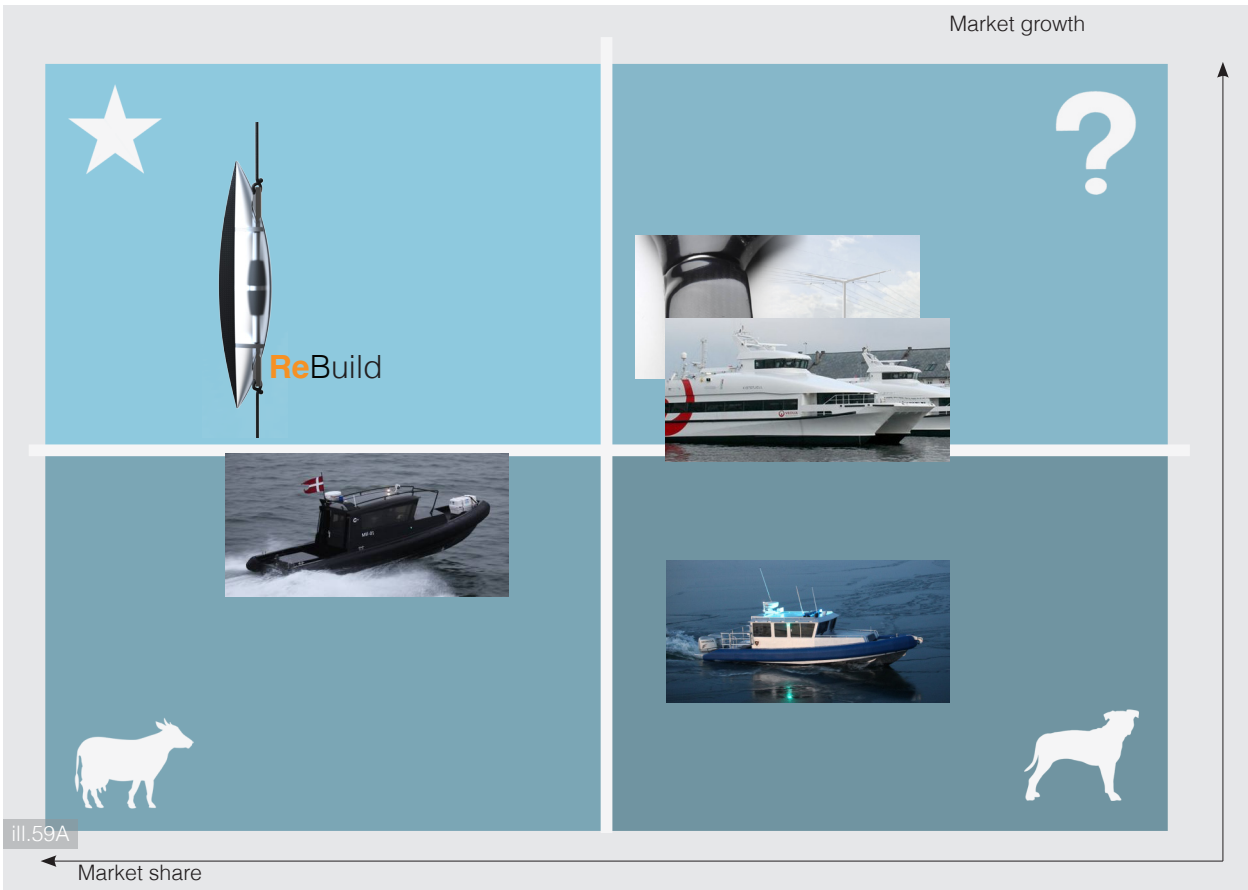
As the mechanism is scalable, it will be able to be implemented in other markets and in other use scenarios. This enables Tuco to enter an entirely new market with this mechanism. It will also be able to be implemented in to Tuco's already existing vessels. A solid market position will be able to be obtained through intellectual rights, protecting the system from being copied by competitors.

Threats

Should this system prove to be a popular choice within the maritime segment, the threat of similar products emerging will occur. This requires Tuco to build up a solid market share quickly in order to have a solid existence on the market prior to competitors emerging.

Modular system implemented at Tuco

Implementation of the modular system in relation to Tuco's existing products in a Boston Matrix, based on own evaluations.

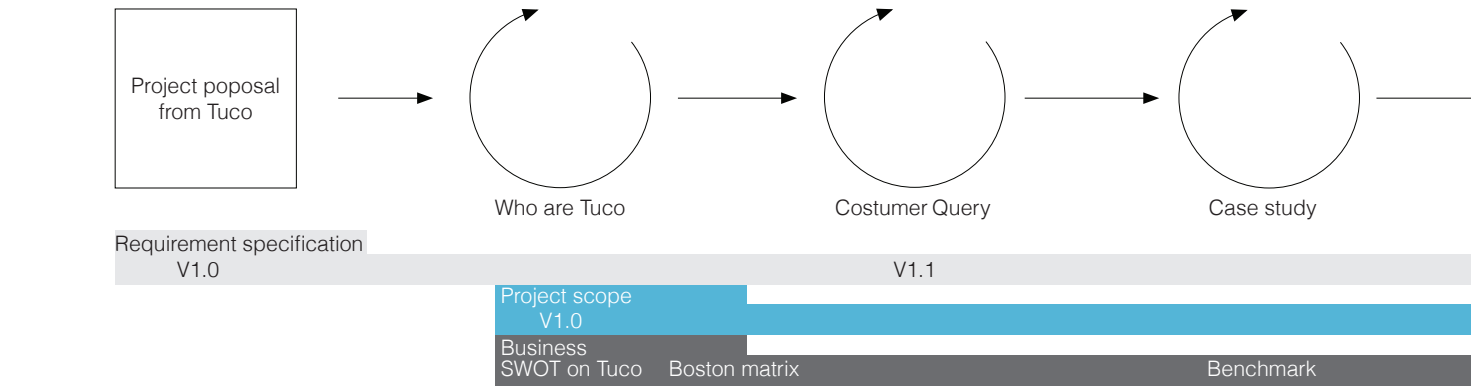


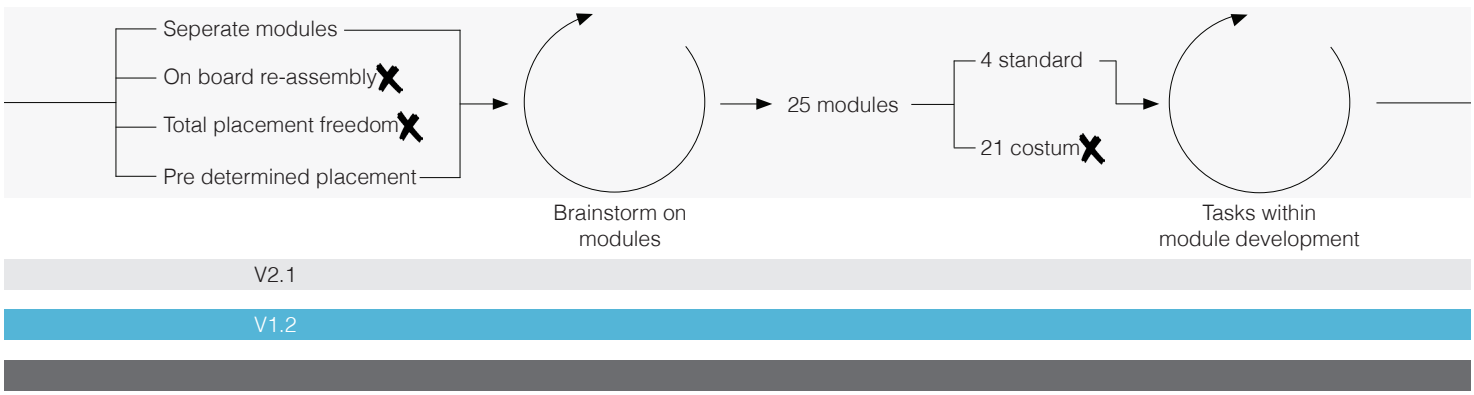
ill.59A

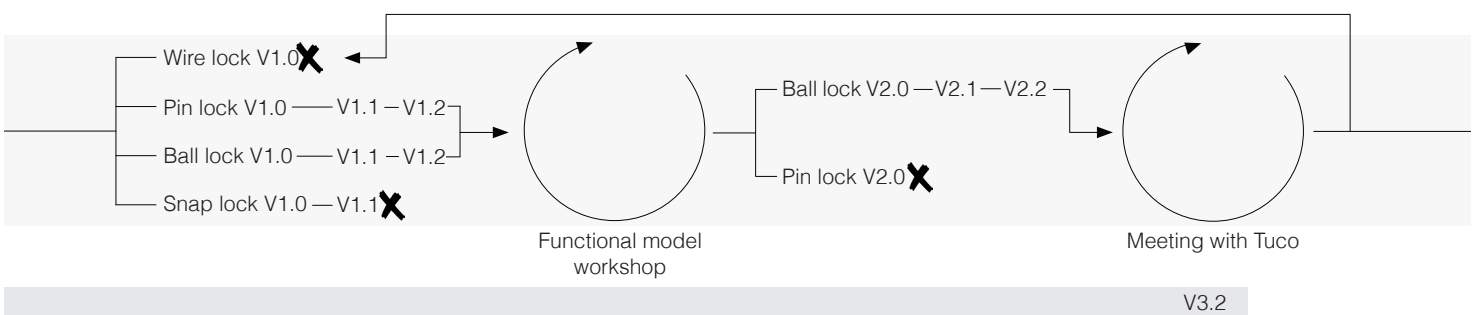
Being an inovative product in a niech market with only one direct competitor, ReBuild is able to obtain a high market share. As new solutions may take time being welcomed in to a market, the market growth may increase exponentially over time.

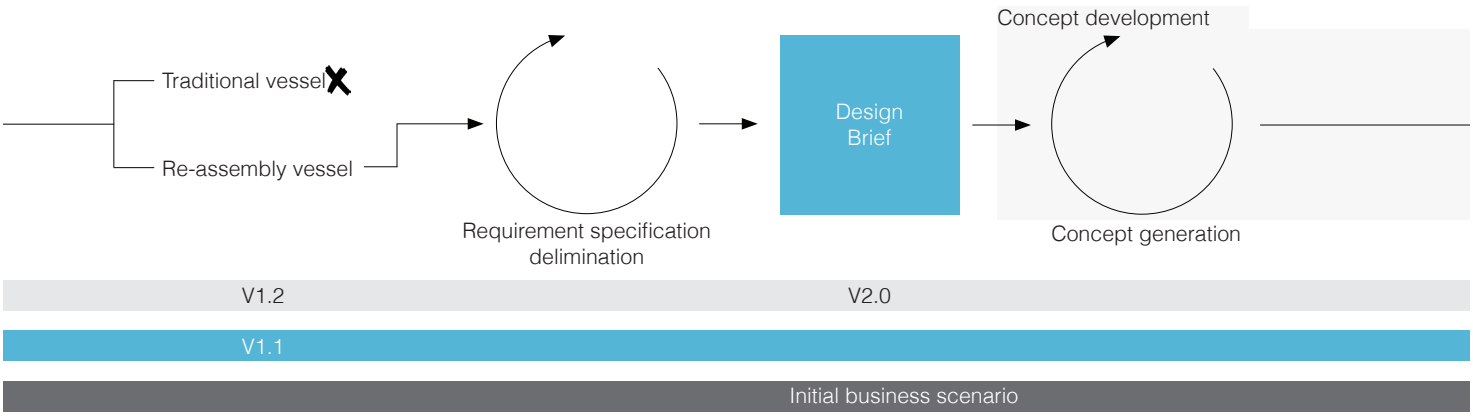
It is placed in the matrix rating high on both market growth and market share. This is an illustration of the imagined result after being introduced and accepted in to the market.

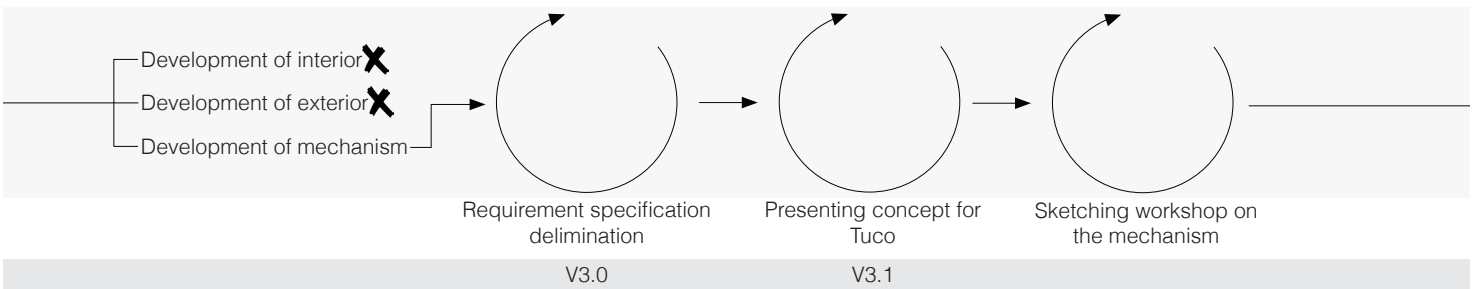
Process tracking

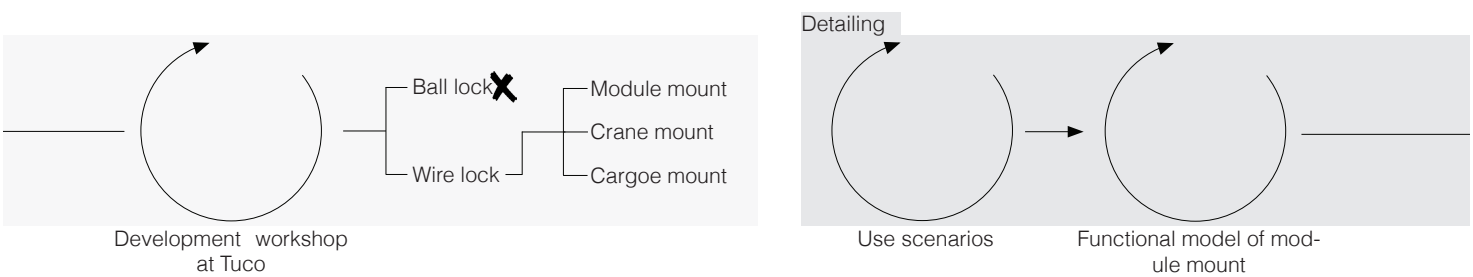


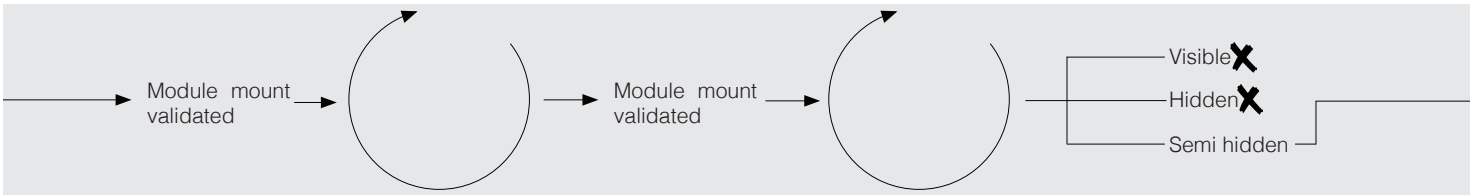


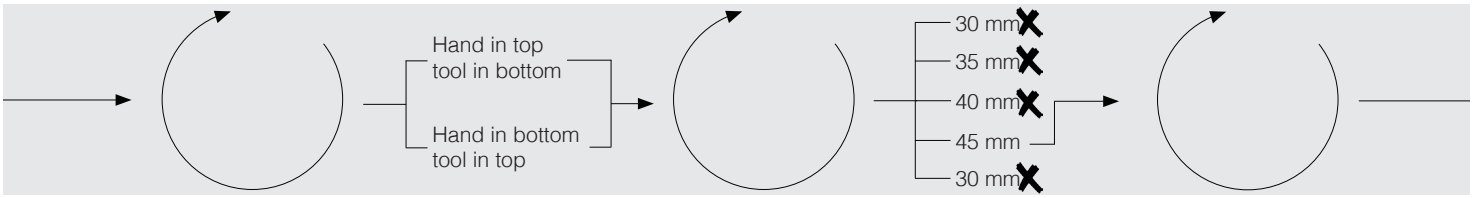


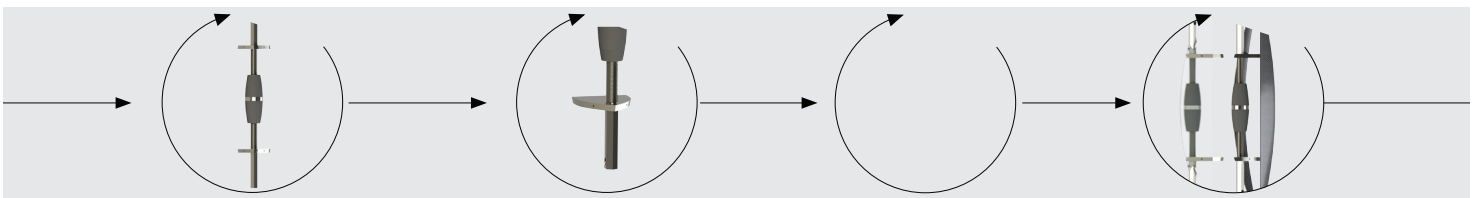

Traditional vessel
Re-assembly vessel
Requirement specification delimination
Design Brief
Concept development
Concept generation
V1.2
V2.0
V1.1
Initial business scenario

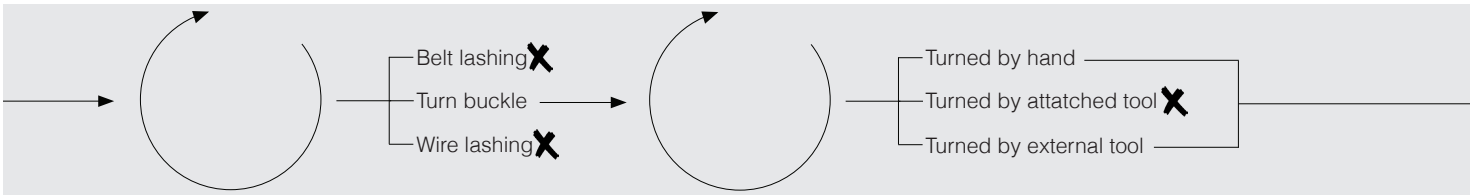

Development of interior
Development of exterior
Development of mechanism
Requirement specification delimination
Presenting concept for Tuco
Sketching workshop on the mechanism
V3.0
V3.1
V1.3

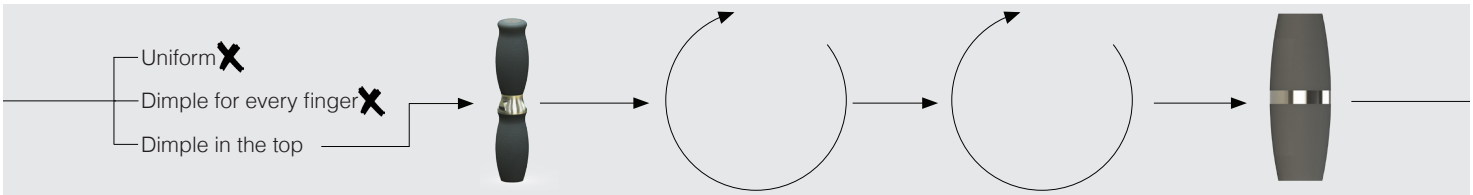

Development workshop at Tuco
Ball lock
Wire lock
Module mount
Crane mount
Cargoe mount
Detailing
Use scenarios
Functional model of module mount

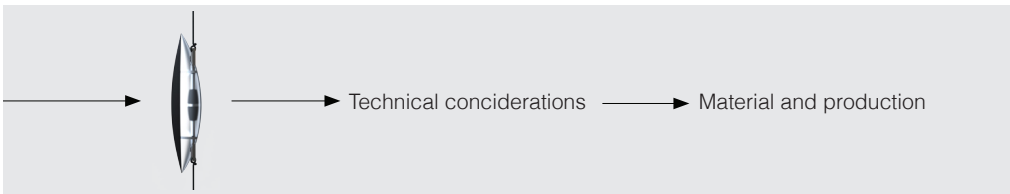

Module mount validated
Functional model of crane mount
Module mount validated
Aperance of mechanism
Visible
Hidden
Semi hidden


Scenario for operation
Hand in top tool in bottom
Hand in bottom tool in top
Diameter of inter-action zone
30 mm
35 mm
40 mm
45 mm
30 mm
Basic shape of handle


Mounting in cabin
Elimination of wire fluc-tuation and rotation
Physical model of handle V1.1
Safety







Business case Benchmark SWOT Implementation

Conclusion

ReBuild has been developed based on a continuously update of a requirement specification and It revolves around the use scenario of the system.

ReBuild is a simple mechanism enabling modular re-assembly of commercial vessels. It is installed in to functional modules and it attaches these individual modules to the vessel platform. ReBuild is an innovative product with only one competitor existing on the market. Change of scopes during the development process lead from design of a modular commercial catamaran, to design of a mechanism allowing re-assembly of the platform. This reinforces modularity and gives Tuco a competitive edge on a competitive market.

In general ReBuild has ended in a solution with a lot of potential, but in order to finally validate the use scenario, a functional prototype of the mechanism will have to be made.

Comments from Tuco during the development process:

"It is not how we expected the project to develop, but the concept is interesting and we look forward to seeing the final result."

"As re-assembly of the platform modules will not occur very often, the ability to implement mounting of cargo, onboard crane etc. adds significantly to the value of the system."

ill.64A

Reflection

Final product

The aim of the product was to develop a modular commercial catamaran for Tuco Marine Group. The project scope has changed through the development and has ended up in a mechanism for modular re-assembly. In this sense, only a part of the original design proposal has been fulfilled. This is due to the choice of creating a mechanism for re-assembly and making it the design dive in the project, eliminating development of the vessel itself. By doing so, this project acts as an inspiration to Tuco, as ReBuild invite them to step out of the traditional perception of vessel design.

The final product meets requirements stated throughout the project. It relies on standard components which have been allowed to determine dimensions based on tensile estimations. This has resulted in a very large mechanism. Based on the choices made in the process, the size of the handle is inevitable. This is due to the high safety factors chosen. A reduction of the safety factor would enable a downscaling of the physical size of the mechanism.

In order for the final concept to be validated in a suiting context, a functional prototype will have to be made. By acting out the scenario with potential clients and users, final feedback on the mechanism will be able to be obtained, while also validating the functional principles in a real life scenario.

Process

As the master thesis is the only project I have been involved in without being part of a group, this has influenced the process. It has been difficult managing deadlines, as the evaluation of phase has been based on experiences from group work.

Especially in the detailing face, where iterations inhaled rendering of illustrations and documentation with me as the sole generator. This has meant that the entire process would be held on pause if a part of the process stretched beyond its deadline. This has also effected phase of the detailing process. A late change of project scope meant less time for detailing iterations. Iterations in the detailing process have therefore not been as thorough as wanted. Also the level of detail in the final product could have been improved if further iterations had been allowed by the time span.

In retrospective, involving users and potential clients in concept and detail development would have been optimal as inputs could have benefitted the development, instead of relying on inputs from Tuco alone.

As the process tracking shows, the process has not been straight from A to B. The requirement specification and project scope has been used as a flexible tool throughout the project in order to show a transparent process. Not all requirements has been stated in the initial project proposal, and each iteration brings new knowledge, so by allowing this new information to influence the documentation as it occurs, the road through the design process becomes clear.

Project collaboration

The project collaboration with Tuco has been a successful experience. Communication has been based mostly on an informal foundation as the contact builds on an internship within the company.

The choice of collaborating with Tuco on the master thesis required me to be very conscious about decision making through the process. As it is my project, it has been important to let decision making be based on my tests and evaluations rather than let decisions be based on choices made by Tuco.

Tuco has been very good at giving feedback on presented concepts and ideas, in order for my project to progress in the direction I chose, rather than try and influence the direction of the project based on their original proposal.

List of references

Books

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Appendix

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