Future Material Handling

How might we improve empty container handling in automation?

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2017

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Umeå Institute of Design
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Summary

Summary

N-9 is an innovative autonomous empty container handler for Kalmar Global. It stacks containers from the bottom up instead of the top down. This drastically increases the container throughput and time efficiency. It is built in an automated robotic twistlock system, allows for the stacking of up to 9 containers.

With this system empty container terminals gain up to 87% more space for 40ft containers. The autonomous system behind N-9 allows it to work with more efficienciency, precision and safety.


KALMAR
08
MAERSK
CONTAINER LEASING
45

Background

Intro

"We want to see a product which has never been seen before."

- Peter Söderberg, Vice President, R&D Mobile Equipment, Kalmar Global

This project was focused in and around the harbour environment. The main topic was to focus on future material handling and it's mobile equipment solutions. During this project a more theoratical approach was taken to identify potential product opportunities. It focused on a human centered design approach after the stanards from IDEO to identify opportunities. Combined with desktop research this was translated into future visions to create a believeable scenario. Our cooperation partner for this 10 week project was Kalmar Global a market leader in material handling solutions. They provide heavy machinery vehicles mostly for harbour handling. Kalmar Global is part of the Cargotec Group.
The outcome was a complete new product and which has not yet been seen before. Thereby it should be considered that it should generate value for the customer and ideally also for Kalmar Global. The outcoming result should also be integrated into a good product experience either for the end customer or for the user directly. During this project I wanted to start to work on my overall goals and wishes, which are stated at the end of this report, for my study period here at UID .
The following report covering the phases which are currently taken on and is giving a overview of the project. It summarizes the research and it gives a detailed overview on the user centered design approach. Also described is how we as a class worked together during the first stages and used our different backgrounds to complement each other.
At the end of the project report there is timetable which is a week-by-week schedule to visualize how the project was structured. The project will be supervised and mentored by programme director Thomas Degn and a guest tutoring by Johan Gustafsson, Industrial Designer and CEO at Struktur Design.

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CMA CGM
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CMA CGM

Background

Cargotec Group

Kalmar is part of the Finnish company Cargotec Oyj. Cargotec is a company that makes cargo-handling machinery for ships, ports, terminals and local distribution. Cargotec was formed in June 2005 when Kone Corporation was split up in two companies: Cargotec and new Kone. At the end of 2016, Cargotec had approximately 11.000 people working in over 100 countries and a revenue from EUR 3.5 billion.
Cargotec is split in three different business areas and all are working in different areas of material handling and engineering.

Hiab products, service and spare parts are used in on-road transport and delivery. The product portfolio includes loader cranes, demountable, forestry cranes, recycling cranes, truck mounted forklifts, and tail lifts.

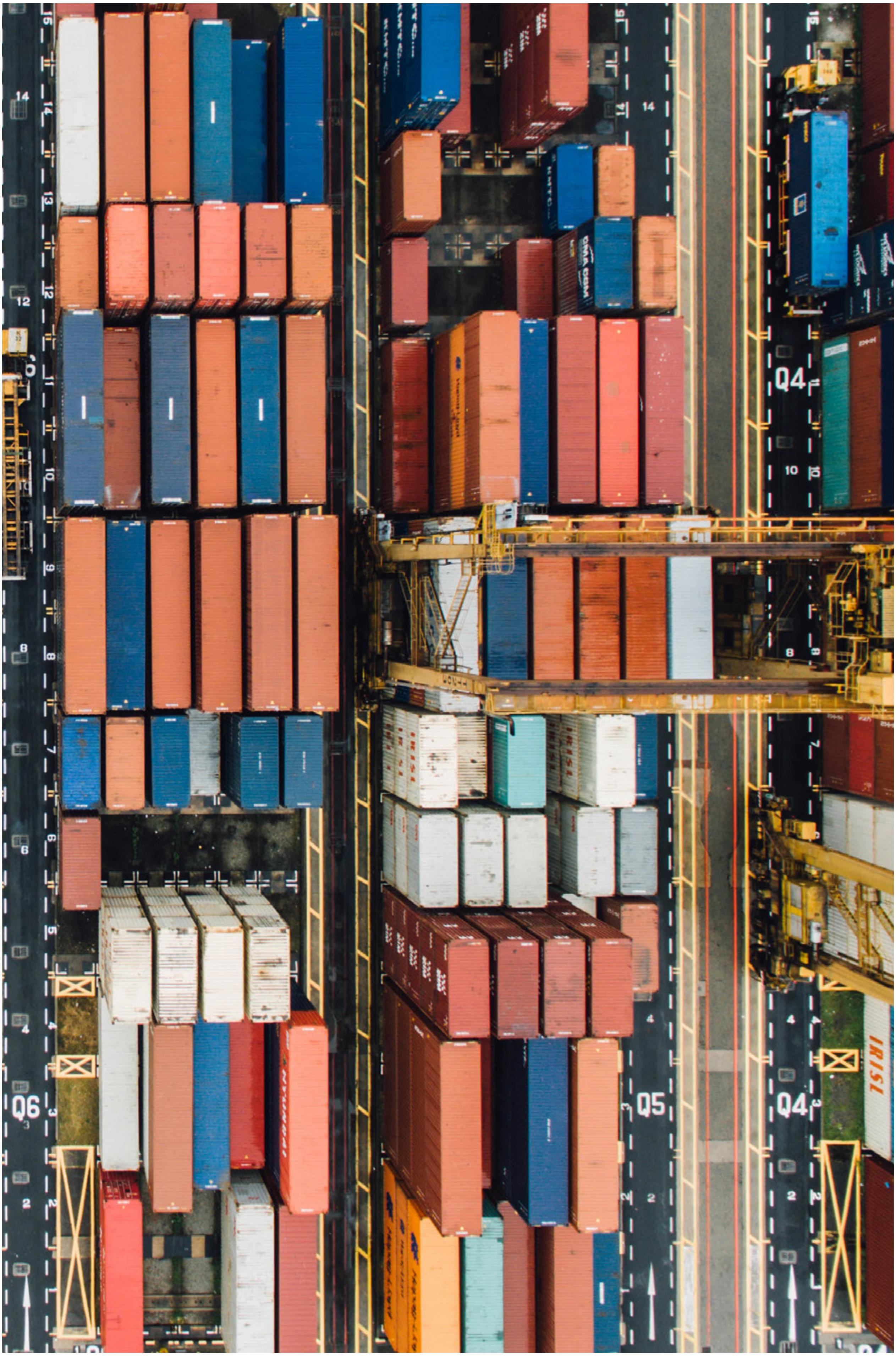
MacGregor focuses on engeneering solutions and services for handling marine cargos and offshore loads. macGregor products are used in maritime transportation, offshore and naval logistics markets, in ports and terminals as well as on board ships.

Kalmar products and services are used in ports, terminals, distribution centers and in the heavy industry. Kalmar products include forklifts, terminal tractors, quay cranes, yard cranes, ASCs (Automated stacking cranes), shuttle and straddle carriers, reachstackers and equipment for empty container handling. Lately Kalmar has investeed in terminal automation and in energy-efficient container handling. At the end of 2016, Kalmar had more than 5,700 employees in 30 countries, of which the largest were the United States, Malaysia, Sweden, China, Finland, Poland, Spain, India and the Netherlands.
Kalmar received EUR 1,721 million Orders, has an operating profit from 135.3, a sales revenue from EUR 1,7 million and EUR 900 million in orders.

The collaboration partner for this project is Kalmar with the focus onfuture material handling.

CARGOTEC

KALMAR HIAB MACGREGOR


Q4
Q6
Q5
Q4

- 1.02 - Method

Research

Fieldtrip

30.10.2017, Umeå, Sweden

12 Advanced Product Design Students and **programme director Thomas Degn** started their research trip in Umeå.

30.10.2017, Malmö, Sweden

First stop was Malmö we had time to quickly visit the city and have a look at the famous **"Turning Torso"** tower.

31.10.2017, Stargard, Poland

After a trip with the night ferry to Poland. We had a quick bus ride to our first visit. The **production facility of Kalmar Global** in Stargard, Poland. Their we met **Per-Erik Johansson**, Head of the Mobile Equipment, our main client contact, **Hans Zachau and Robert Bourghardt** from Lighthouse Design. We had our **Kickoff** with the company and visited their production facility. It was also possible to take a ride with some of their equipment on a test track. This was the **first contact** with Kalmar machines.

01.11.2017, Hamburg, Germany

In Hamburg we visited different companies so we could see a big broadspan of Kalmar equipment. We had **8 user interviews** and visited **4 different facilites**.
First we visited the **Hamburg Unikai** their we had **two interviews,** one with a logistics manager and one with the head mechanic of the terminal workshop. Unikai is a **multi purpose terminal** therefore it was a special scenario and it was a very interesting visit.
The second stop was the **HHLA Burchardkai** it is one of the **biggest terminals** in Hamburg and also one of the most advanced. Their we saw **partly autonomous** solutions and also how to unload megavessels. After our guided visit we visited **HCCR a empty container handling company**. There we had **two interviews**, one with the logistics manager and one with a heavy machinery driver.
The last stop in Hamburg was **Arcelor Mittal a steelmill**. Their we focused mainly on forklifts and the process of a smaller but faster logistics process. We had also **two user interviews**. One with a forklift driver and on the other hand we had the chance to talk to the head of logistics.

04.11.2017, Umeå, Sweden

Back in Umeå a smaller group of students visited **Brattby Sågverks AB a medium sized sawmill**. This was also completly different to what we saw in Hamburg and we had a more detialed look at forklifts of Kalmar. We had **two interviews** with the co-owner of the sawmill Mikael Bergstrand and one with a forklift driver.


KALMAR


KALMAR

Interviews

Patrick Albers
Logistics Manager, Unikai Hamburg

"I think in the future more machines can be operated by one driver."

"Containers are secured manually."

The Interview with Patrick Albers showed us how complex a multipurpose terminal is. He was also confident in autonomous truck solutions and in his opinion this will be clearly the future. He also explained to us the process of a how a multipurpose terminal and how to secure containers.

Tobias Zink
Head Mechanic, Unikai Hamburg

"The machines have three driving modes but they [drivers] are always using the power mode."

"I think we need more hybrid solutions."

Tobias Zink gave us insight how the current maintenance process of Kalmar machines is. He had great insights about how the trucks were handled by drivers and what parts are the most difficult ones to change.

Michél Ecks
Logistics Manager, HCCR Hamburg

"In 5-10 years empty container handling will be an automated process."

"Sky is the limit."

Talking to Michél was really interesting because he started as a driver and worked his way up to become a Logistics Manager. Therefore he gave us insights how the machines are from a drivers and a managers perspective. Michél also gave us insights in the future of empty container handling.

Mike Meyburg
Heavy Machinery Driver, HCCR Hamburg

"It is Lego for grown ups."

"You have to feel the weight of the containers, technology is sometimes restraining me."

Mike is now driving heavy machines for 15 years. For him empty container handling is like Lego for adults, this means his work is also about having fun. An other insight was, for him feeling the machine and the weight of the containers is really important so he needs a haptic feedback during his work.

Marc Schölermann
Logistics Manager, Arcelor Mittal

"The environment is too Human right now."

Marc Schöllermann gave as a tour of the steelmill and showed us the production process from raw iron to finished steel billets and wire coils. It was interesting to hear his perspective because he is in an managing position. This means during the interview we got a lot of insights regarding the whole process of logistics. Marc pointed out the bottle necks of their production line and showed us how to resolve them.

Heinz Giasi
Forklift Driver, Arcelor Mittal

"It is all about the feeling and the connection to the machine."

"I don't have any view to the back so my co-worker already hears the noise and knows that there is a danger."

Heinz is a forklift driver for 37 years therefore he has seen a lot. He appreciates warning systems and technology assisstents. He also pointed out ergonomic the cabin form the Kalmar forklifts is nowadays.

Mikael Bergstrand
Co-Owener, Brattby Sågverks AB

"Storage and time are the most important things."

"Wood is a living material so the driver needs to feel the load and an automated machine can not handle it."

Mikael Bergstrand gave us great insights on the logistics of the sawmill and how advanced their cargo tracking system is. The most interesting part was that they are using a RFID tag system for each different raw wood stack.

Mikael Eriksson
Forklift Driver, Brattby Sågverks AB

"Every forklift is almost the same but Kalmar's are the comfortable ones."

"It takes a day or two before you have learned all the functions."

Talking with Mikael Eriksson was espescially interesting because he had the opportunity to drive the new Kalmar Forklift for the first time. He gave us great insights on ergonomics and also what the difference is between a Svetruck and a Kalmar forklift.

Analysis

Gathering Data

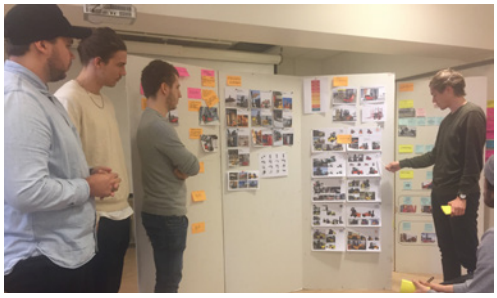
The first step after the field research was to meet as a group and analyse all the data we gathered. We were split up in three groups of four and each group got a different area to synthesize. The four main topics were Empty Container Handling with empty container handling machines, Multipurpose Terminals with reachstackers and terminal tractors and the last one analyzed the steel- and sawmill with focus on forklifts. Each group looked into the process of the area to find general broader opportunity areas. An other task was to summarize the interviews and find relevant quotes. Also we had to consider major trends in each category and point out why they are relevant to us. The task was purly analoug therefore we used a lot of print outouts, post-its notes and Sharpies.
After this we met as a group presented our findings.

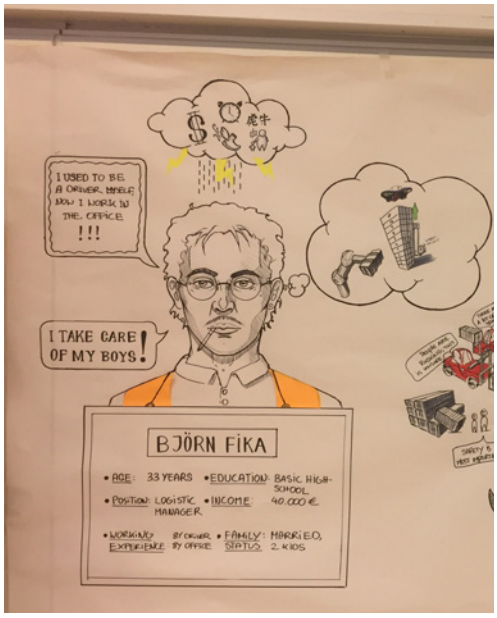
Visual Social Persona

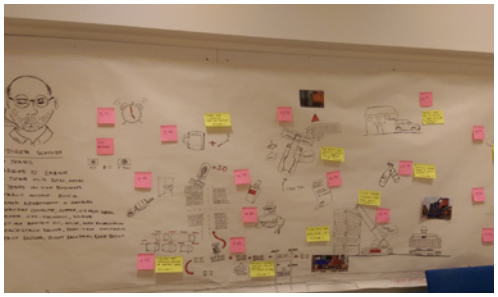
A visual social persona(VSP) was put together after our research analysis. This method was used to spark our creativity and prepare us for the upcoming brainstorming session. The intention behind this method is to give us a detailed overview of a workday in the life of a heavy machinery driver. The main goal was to make a “Action packed day” to frame it with Thomas Degn’s words. This means we should not only consider the work environment of our persona but also his personel aspects and how they could influence his workday. This task helped us to understand the workflow better and how the people are interacting with their work environment. It showed us new aspects and made the user more human.
At the end of this task we presented it to each other in a storytelling exercise.

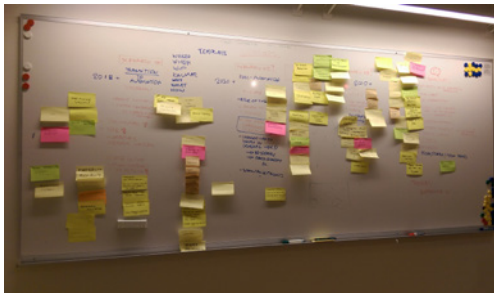
Brainstorm Ideation

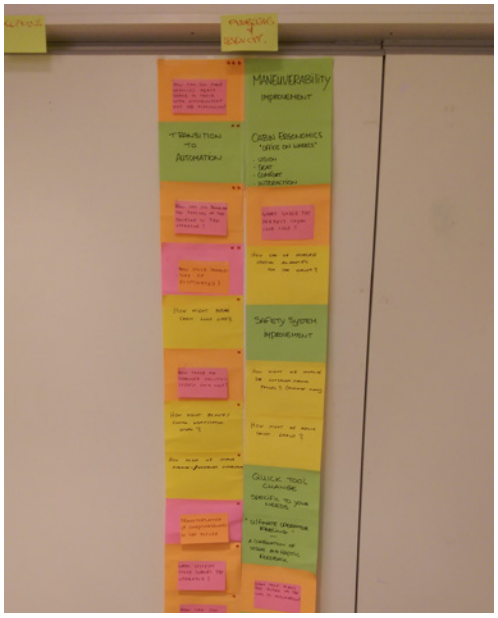
The last step in our 3 day workshop series was to use one day as an ideation brainstorm day. Therefore we were split up in random teams of four. The first steps were to create problem areas or “How might we“ questions. After this we met again as a whole group and voted over the most important ones. After the voting we split up and started to generate ideas on bigger post-it notes. First every group needed to generate 80 ideas in total, with this task done we needed to pick seven which seemed the most valuable ones. The main goal of this excersie was to generate as many ideas as possible in a short amount of time.




I USED TO BE A OWNER, WHILE NOW I WORK IN THE OFFICE !!!
I TAKE CARE OF MY BOYS!
BJÖRN FIKA
• AGE: 33 YEARS
• EDUCATION: BASIC HIGH-SCHOOL
• POSITION: LOGISTIC MANAGER
• INCOME: 40.000 €
• WORKING EXPERIENCE: 8Y OWNER 8Y OFFICE
• FAMILY STATUS: MARRIED, 2 KIDS

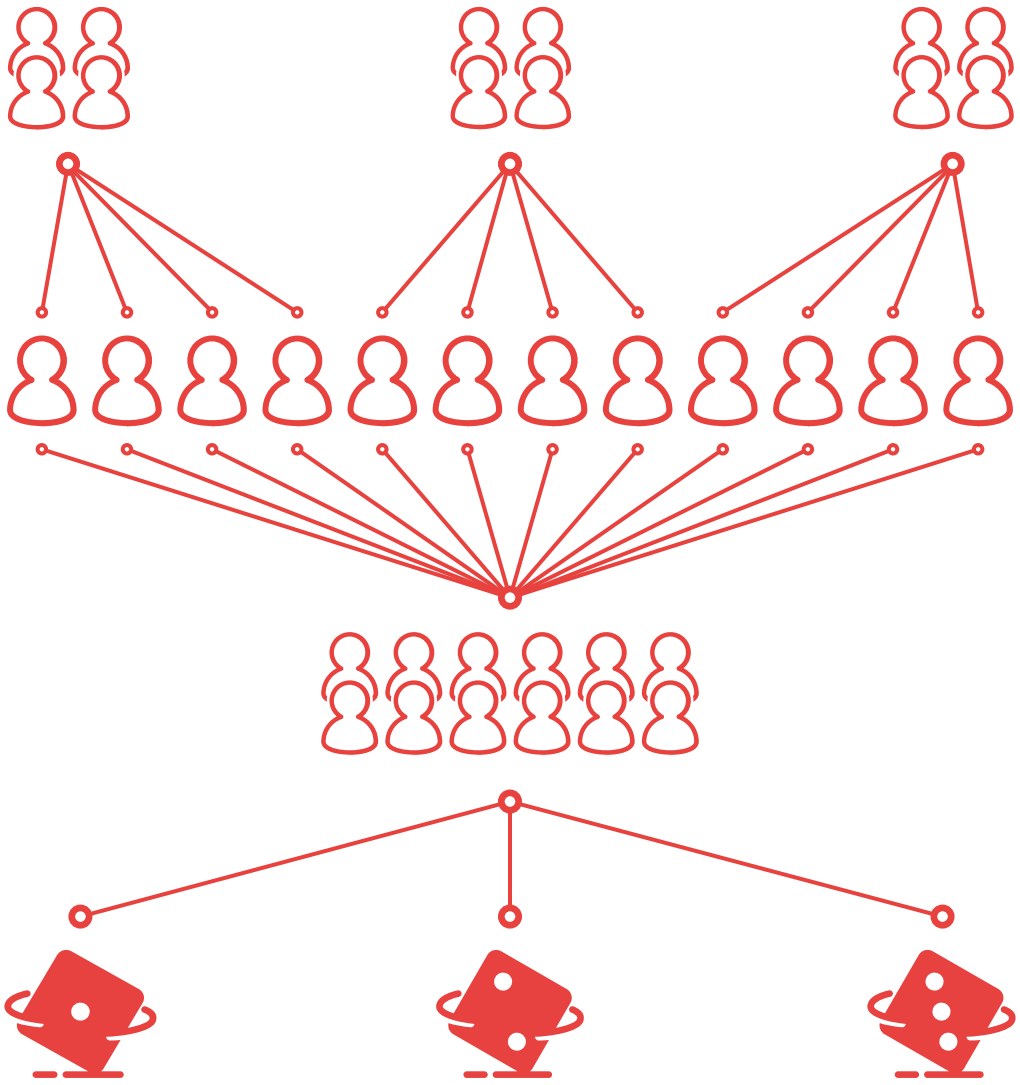





MANEUVERABILITY IMPROVEMENT
TRANSITION TO AUTOMATION
SAFETY SYSTEM IMPROVEMENT

Future Visions

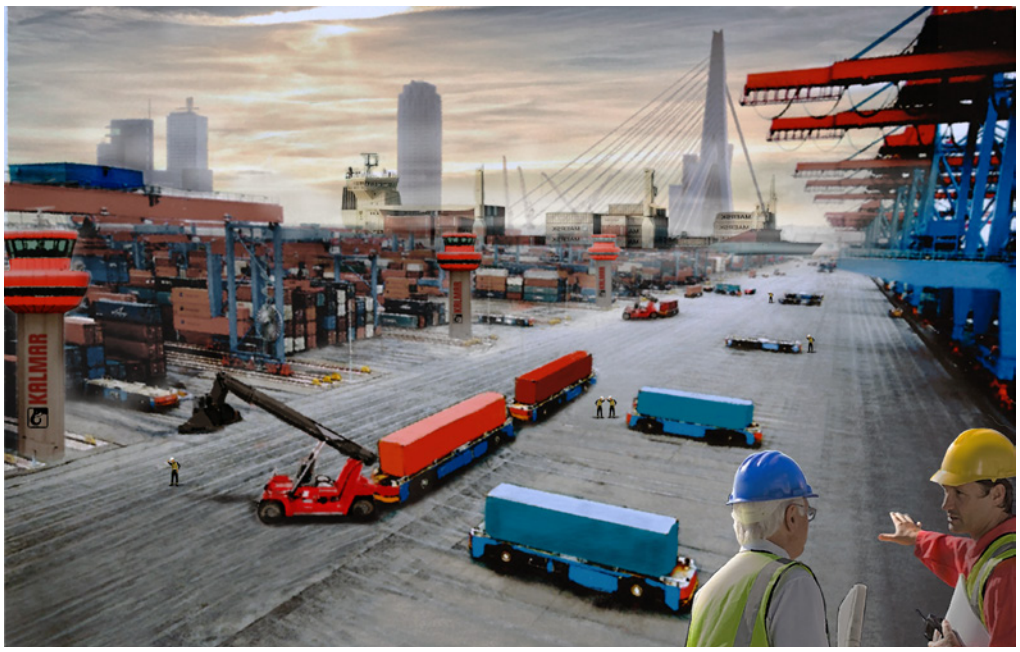
After our analysis we split up for a day and made indiviual desktop research. We used this moment to reflect on where to go with the project and to find our own fields of interests. This was nescessary to scope out who is going in what direction and if there are common interests which could be explored together.
During my desktop research I focsued on finding the human in the harbour process. Therefore I tried to analyze the complex system behind harbour logistics and where human labor is needed. I both looked into where physical and cognitive labour is needed to find possible opportunities.
With the desktop research finished we met again as a group and decided to make three different future scenarios to have a common ground as a group for our projects.
For each future scenario, we created a visualization which was printed as a poster. Next to the posters we created a story of how Kalmar could support a fictional company in this scenario.



2018+

Future Scenario 1

Transition to Automation



The first future scenario is reflecting the current status quo. In this scenario a change is already happening and is disrupting the industry. Newly built harbours and already existing harbours are in the transition to automation. Container ships are getting larger and certain harbours are not able to handle the load of containers anymore. Currently the operators of heavy machines are the most critical link in the chain. Container terminals try to incorporate different semi-automated solution to deal with the cascading effect. In this scenario Klarmar tries to help these terminals with, semi-automated systems, providing new technologies, consulting for full automation and offering platform based solutions. Kalmar tries to stay up to date with all the upcoming technologies therefore they invest a lot in research and development.

2030+

Future Vision 2

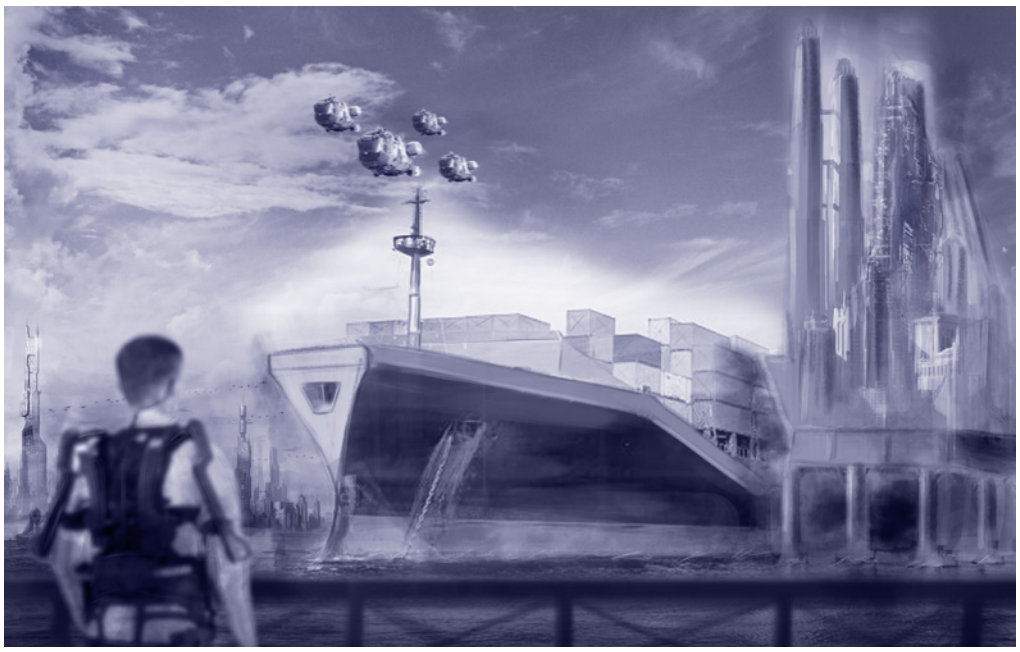
Full Automation

In 2030 full automation is completely implemented. Future container terminals are able to handle the massive amount of containers which come on a daily basis with mega vessels. They are able to stack container higher as ever before and automated solutions are helping out. People have switched from hands on work more to a cognitive work. They are the brain behind the machine and help them to gather information.
Kalmar is supporting the terminals with autonomous solutions that are able to handle not only repetitive mass-container-handling, but are also capable of adapting to flexible demands of smaller and mid-size ports. In the future they are also providing a service for flexible automated systems, that can not only be easily implemented but can also be updated regularly. Kalmar offers tools that will be able to adapt themselves to each task.

2060+

Future Vision 3

Beyond Automation



2060 is beyond automation and the world has changed. Environmental changes are showing their impact on the world. Big data has become more important and is now also a logistics good. Container terminals changed their layout. They are now switched to multi layer terminals and off shore unloading terminals. Due to this new terminals new shipping possibilites are popping up like deepsea shipping and stratosphere shipping.
Kalmar joined up with MacGregor and is providing a more offshore focused equipment. AI and machine learning is implemented in their products. Humans are focused on purely cognitive tasks. New transport technologies are provided like Elon Musk's Hyperloop, Kalmar is adapting to this. Since sustainability is one of Kalmar's key words it is focusing more on the new energy solutions and harvesting.

- 1.03 - Conclusion

Opportunity Synthesis

Areas of Interest

Automation

"In 5-10 years empty container handling will be an automated process."

- Michél Ecks

In the next years automation will take over in this business area. The research showed that there is clearly potential in this topic. Automation can also be implemented in new service applications not only products.

Safety

"The environment is too Human right now."

- Marc Schölermann

Safety is one big issue in the harbour. A lot of dangerous works are fullfilled by humans right now. Humans and machines are interacting with each other in a small environment. Thereby it could also be seen how to optimize a process with a semi automated machine.

Human Interaction

"I think in the future more machines can be operated by one driver."

- Patrick Albers

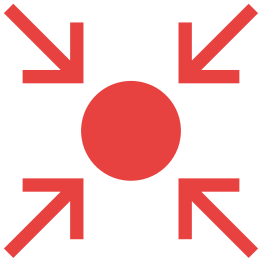
Due to the fact automation will take over in the near future, the question is coming up how will be the future human interaction be? Because also in the future there will be a human somewhere who takes over cognitive tasks.

Modularity

"Weight dictates the purpose."

- Mikael Bergstrand

The research and feedback from the company showed that there is a clear interest in a modular vehicle which can adapt to different kind of works and be more versatile. Modularity is also incorporating how the perfect platform could look like.

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07
STOP
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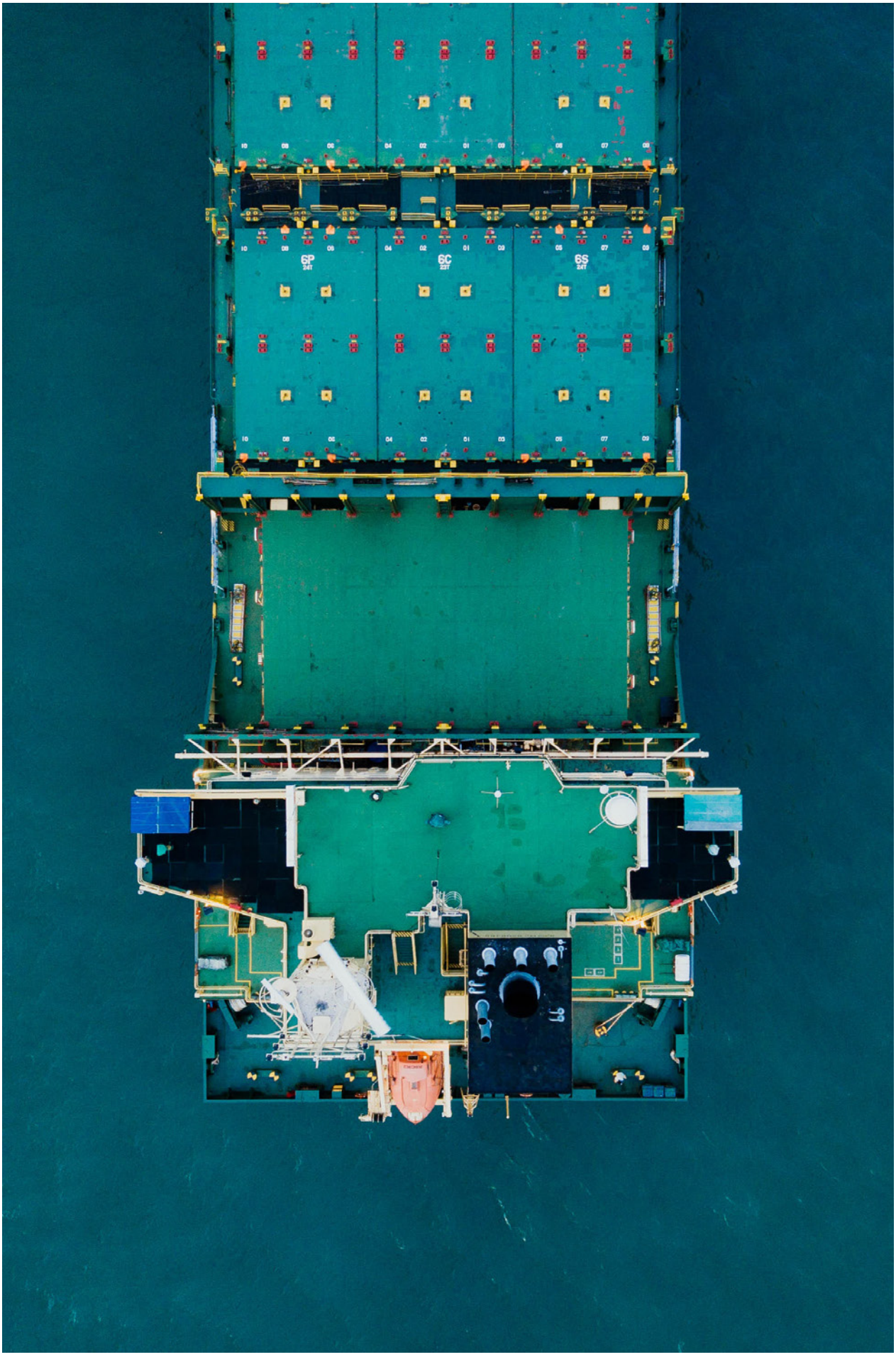
STOP

Direction

Design Opportunity

How might we improve empty container handling in automation?

The question was a result of the research and it was my chosen design opportunity. The research showed me that people need more space even though the distribution is getting faster. Currently important tasks were still done by people and some of them are combined with a direct danger to them. A major issue I found also during my research is the lashing and securing of containers on ships and ground. This task is currently done by hand. Some locks are already automated but they still need a human to be placed. This task involves climbing in high altitudes and being in the same environment as heavy machinery. In future scenarios containers will be stacked higher this means this topic is becoming more and more important. I think this is a great opportunity to provide customer value in helping to optimize this process without cutting out the human completly. In my project I want to focus on how to improve the safety and the work process of empty container handling in full automation.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"Sky is the Limit."

- Michél Ecks, Logistics Manager HCCR Hamburg

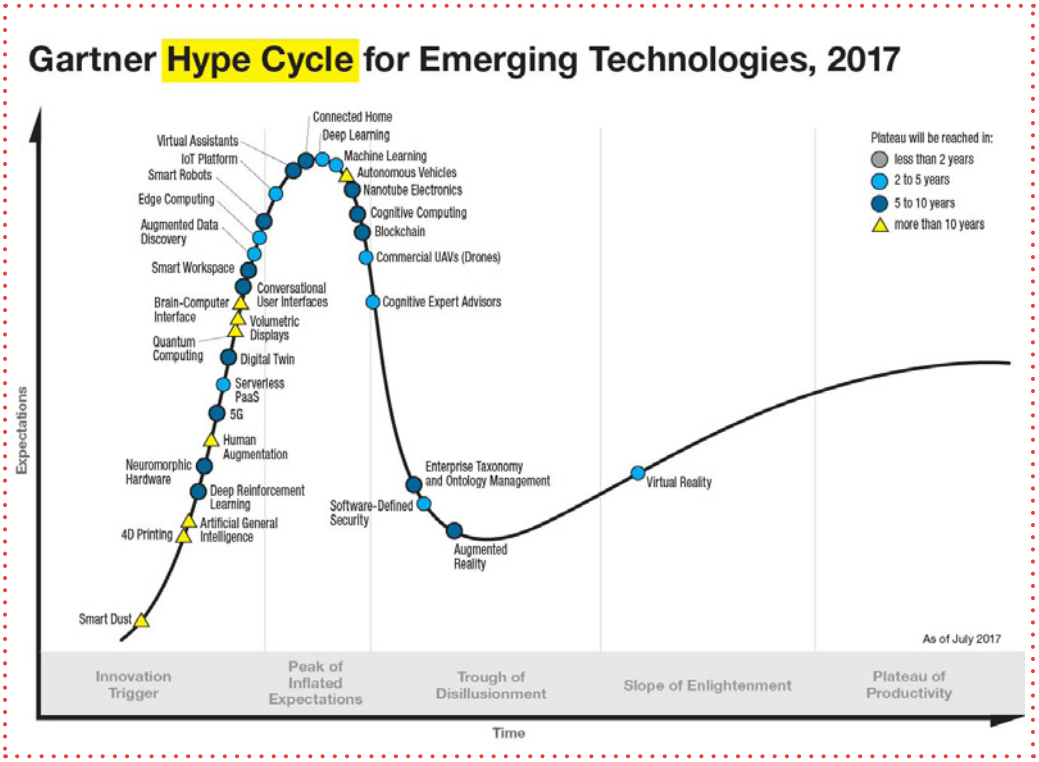
"Containers are manually secured."

- Patrick Albers, Logistics Manager Unikai Hamburg

"I think in the future more machines can be operated by one driver."

- Patrick Albers, Logistics Manager Unikai Hamburg

These quote were part of where my brief was built on. Future empty container terminals will start to stack higher to gain more space. Since they ran out of it already today. Patrick Albers explained us in more detail how the containers are lashed and what a dangerous job it is. This is my user insight which I wanted to translate in the future and build a concept around it.
Fruther I was looking more into emerging technologies. Gartner a research and advisory company is providing the "Hype Cyle of Emerging Technologies" which is pictured underneath. Their diagramm is split up in different year cycles and the main axes are peoples expectation and the other is time. This should be a foundation to look into what technologies could be implemented in this project.
The aim of my project was a future vision and should clearly be seen as one. At the same time it is important for me to build it on a grounded research so it is not only seen as a nice concept but could be more convicing and had a believeable character.

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Kalmar

Goals

The goals for Kalmar were based on what feedback we got from our kick-off meeting but also on where value is in the project. An important goal was to increase safety due to lashing the containers together. Also important was to optimize the process of empty container handling. Since in the future automation is obligatory an other aim was to create a fully autnomous system. Therefore it was important to keep the user in mind for maintenance.

increase safety

optimize process

fully automated system

keep the user in mind

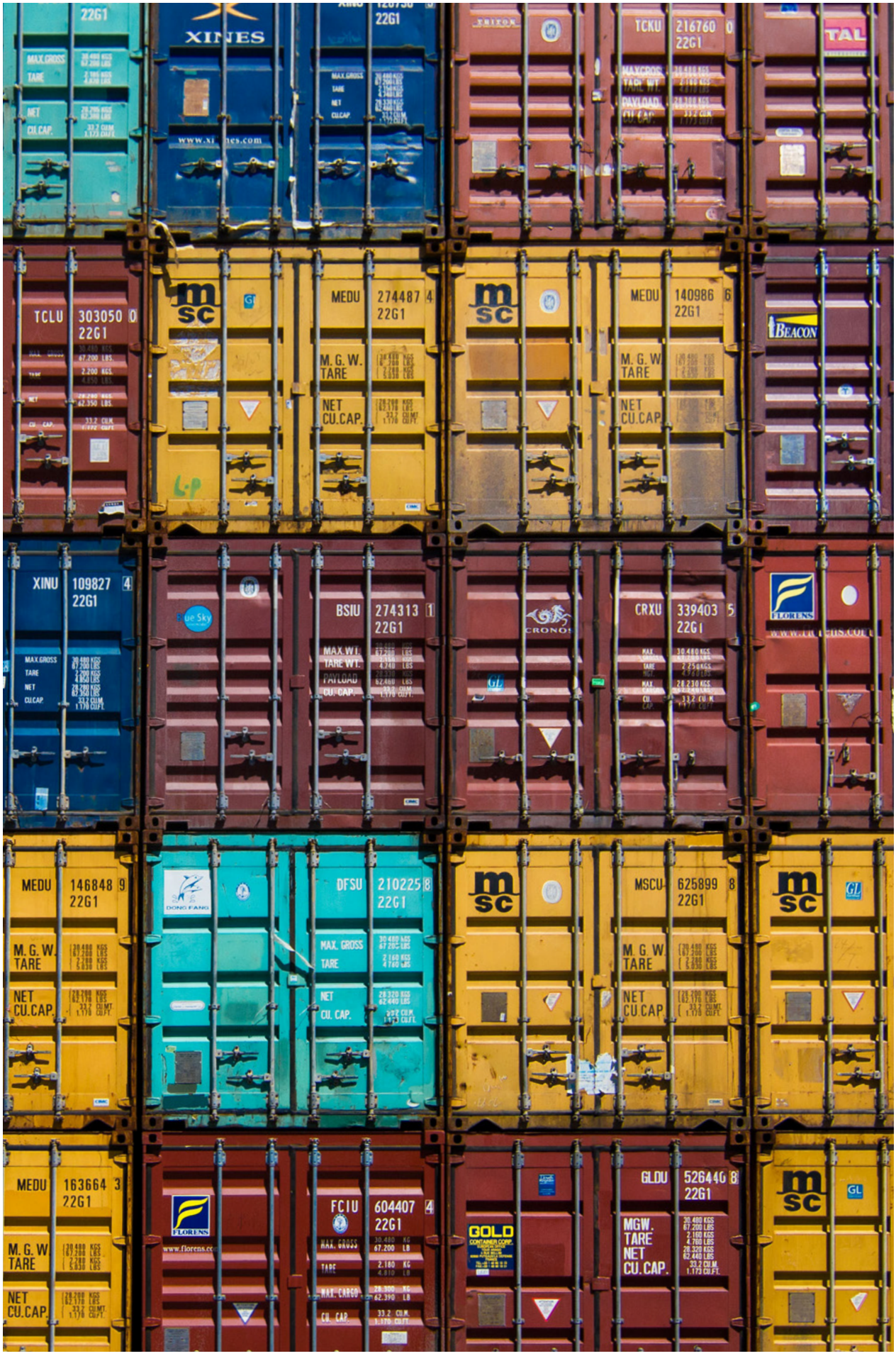
Wishes

A wish was to create a believable future concept. So it should show the future but also be somehow believable and not end up in the scifi area. An other wish was to create impact through design. This was really important for to gain the maximum out of this project for the company. The last wish was to stack higher, It was a tricky wish since currently we have restriction which prohibited higher stacking in Europe.

make a believable concept

make impact through design

stack higher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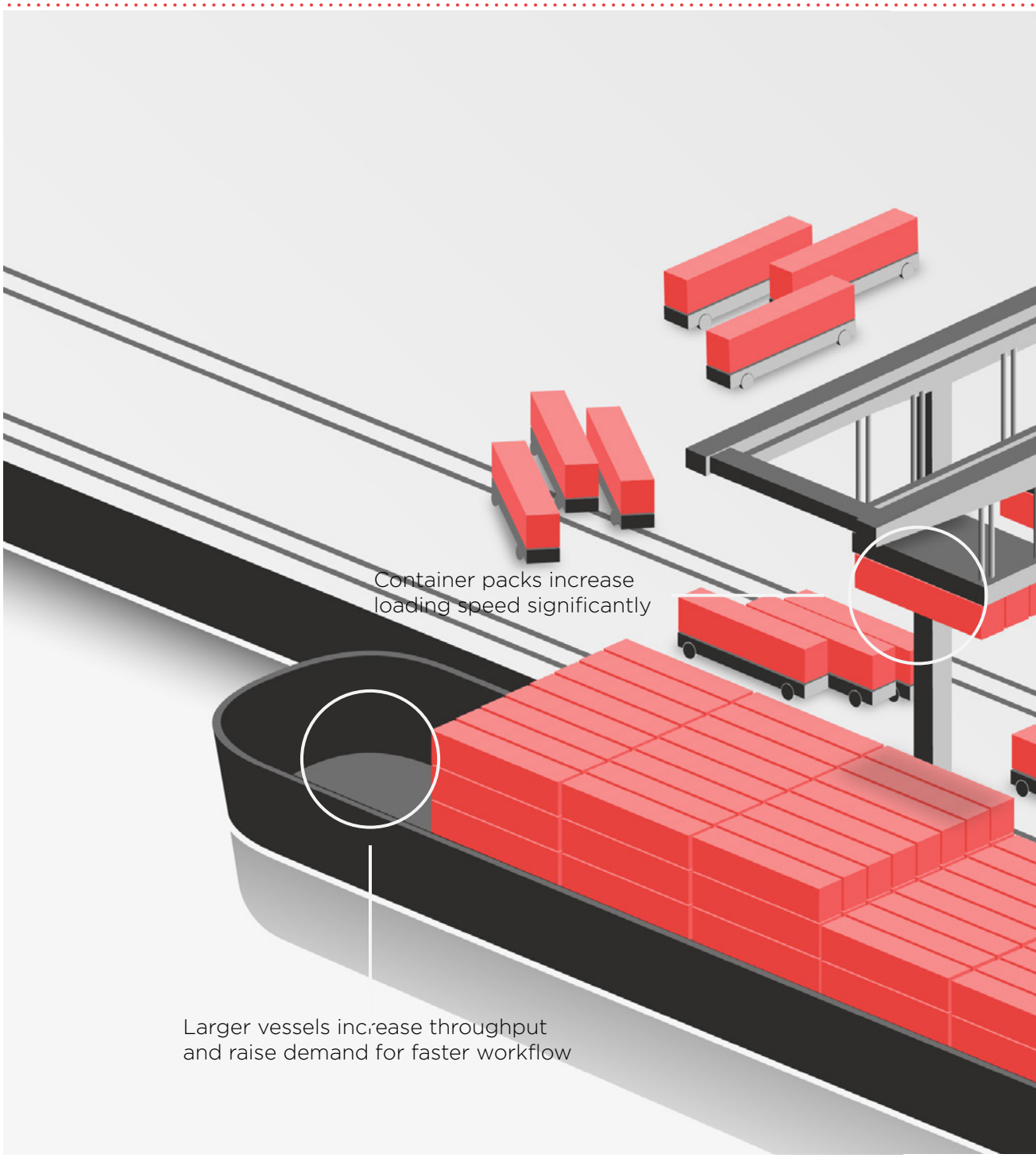
CRXU 339403 5
FLORENS
MEDU 146848 9
DFSU 210225 8
MSCU 625899 8
MEDU 163664 3
FCIU 604407 4
GLDU 526446 8
GOLD

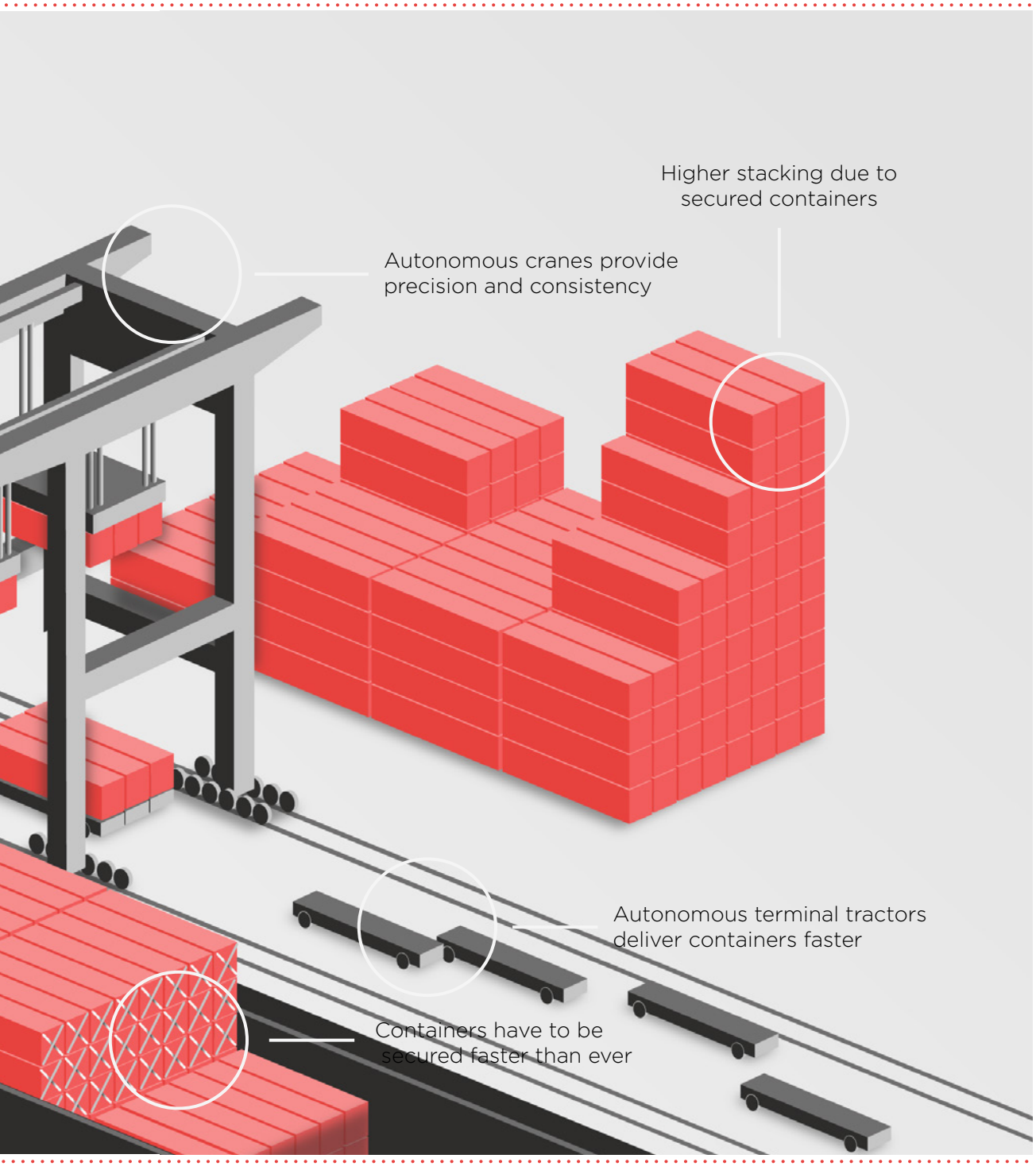
- 1.04 - Ideation

General

Scenario

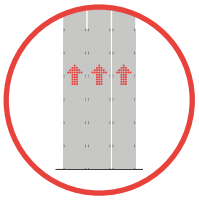
During the ideation it was nescessary to create a scenario which displays the environment in which the machine is set. Terminals started to stack higher due to secured containers. Also inside of the terminals, only autonomous vehicles are allowed. An improved container handling process is nescessary because mega vessels are increasing the throughput.




Higher stacking due to
secured containers
Autonomous cranes provide
precision and consistency
Autonomous terminal tractors
deliver containers faster
Containers have to be
secured faster than ever

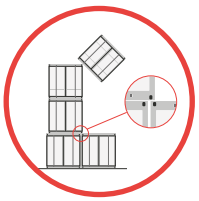
Narrowed

Opportunities



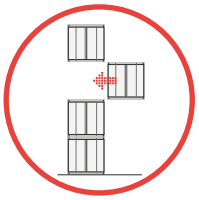
Efficiency

Improved efficiency due to higher stacking.



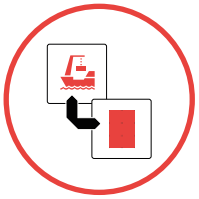
Safety

Improved safety due to eliminating overlapping containers by lashing them together.



Innovation

New stacking solution allows Kalmar to show their full potential in innovation.



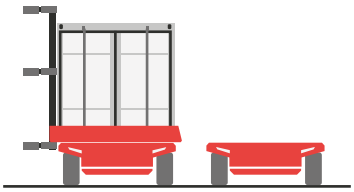
Automation

New automated solution which can be used in the harbour, but also on the ship.

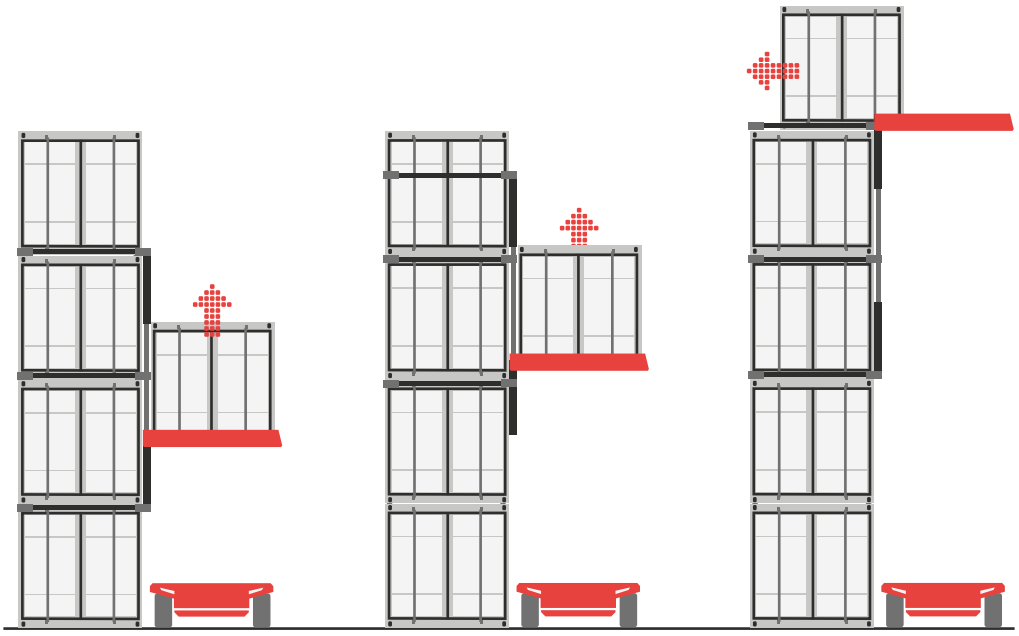
Narrowed

Core Idea

The core idea of the concept was to combine container lashing with empty container handling. Therefore, efficiency would be increased because empty container handling terminals could stack higher. This drastically increases the empty container handling business revenue.
The first concept in which the core idea was used was the “climbing“ platform. It is a symbiosis between an AGV and a platform which is climbing up the container stacks. The climbing platform would have an integrated Twist lock dispenser which is connecting the containers to one another. It is a common tool used on container ships. Currently there are manual, semi-automated and full-automated container locks available. So, if we scale this up in the next 15 years, big container terminals would only use fully automated twist locks.



Driving Mode



Lifiting Mode

- 1.05 - Concept

Final Direction

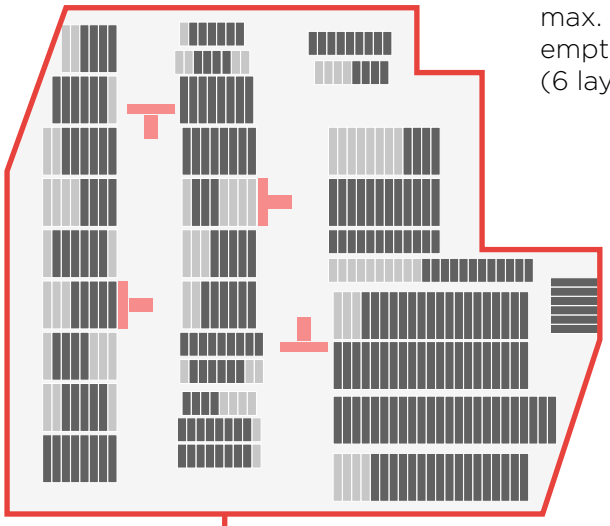
Strategy

After the ideation presentation, the feedback was to rethink our current concept and find a better solution than the climbing platform. Another main input was to make the concept believable, and show Kalmar Global how the concept would improve current situations in numbers.
The f irst step was to calculate how the harbour layout would change due to the provided concept. The calculation is based on the empty container terminal layout HCCR in Hamburg, Germany.

Calculation

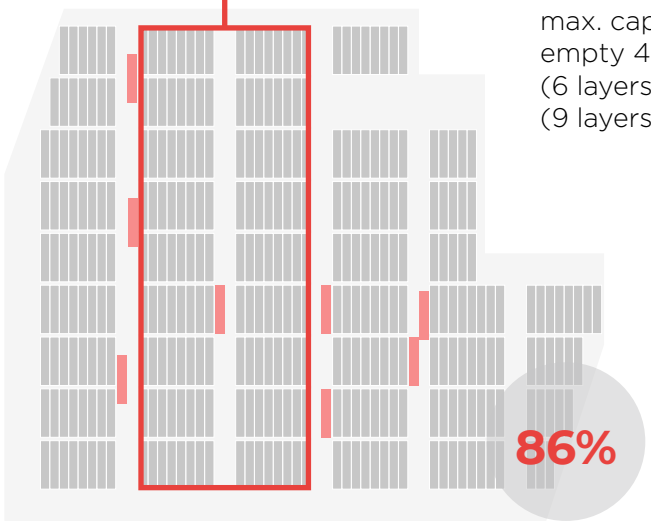
available space

in use or depicted



max. capacity
empty 40 ft. containers
(6 layers each stack): 1600 - 1700

same amount of containers

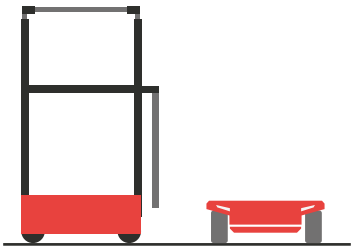


max. capacity
empty 40 ft. containers
(6 layers each stack): 2076 (+22%)
(9 layers each stack): 3114 (+86%)

Final Direction

Core Idea

For the final main idea, the “climbing“ platform was transformed into a more static solution. Instead of stacking top down, the machine stacks from the bottom up. The elevation of the container is minimized, and the throughput can be increased. To lift the containers, it hooks itself in the top row and pushes the container up with four pistons. It is also working in symbiosis with the AGV and a smart system. This increases timing drastically and allows better planning for empty container handling. For long distance traveling it can connect itself to the AGV, for short distance travelling it uses the built-in wheels. The machine is completely autonomous and can be controlled if necessary. It also still connects the containers with fully automated twistlocks which allow for higher stacking of up to nine containers. This means it can stack one more than current solutions.



Driving Mode

Lifiting Mode

Today vs. Concept

01.1

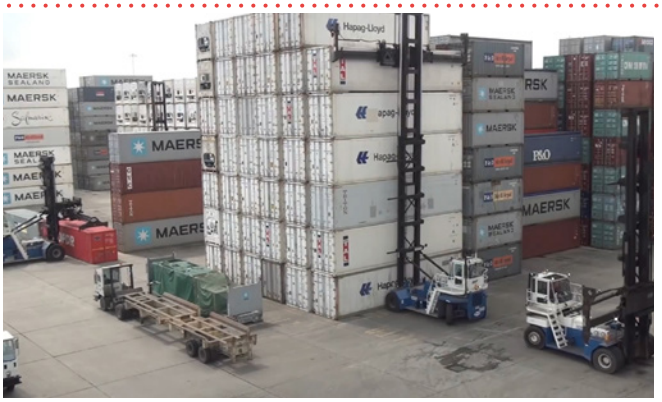
Empty container handler picks up container from terminal tractor. Space needed is almost three times as big as the container's width.

01.2

Empty container is picked up and ready for placement on the stack. Container handler is still in the middle of the passing lane.

01.3

EHC is lifting the container blocks. Therefore, half of the passing lane is blocked because it needs to wait for raising of the container.

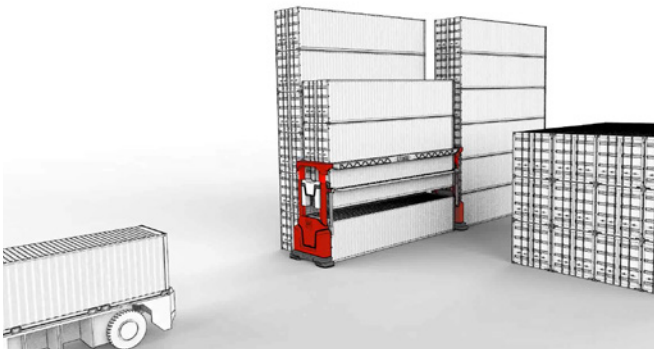


01.4

Container is placed on the stack. It is not possible for the driver to see whether it is placed in the correct position.

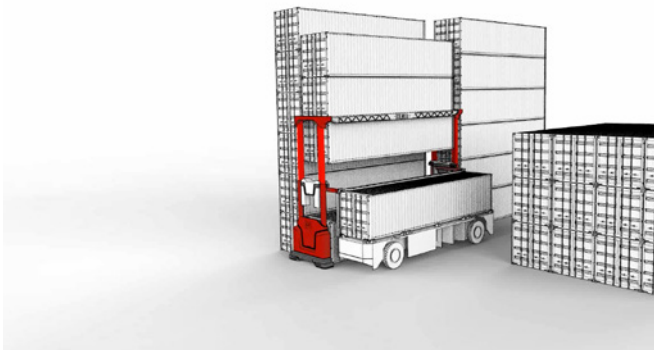
02.1

N-9 Starts lifting while AGV is arriving. The system coordinates the machine with it's surrounding to time the movement perfectly



02.21

AGV arrived container grabber starts picking up the container. Pistons pushed the other containers to the right height.

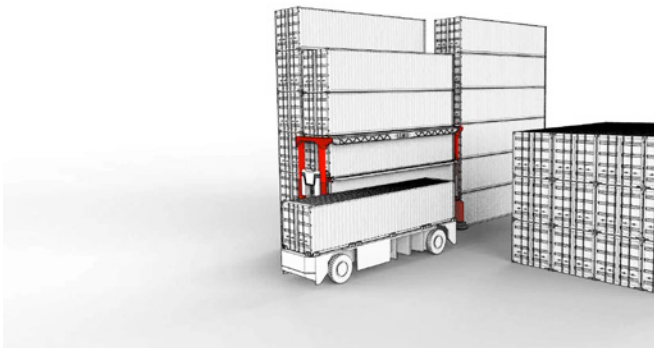


02.3

Empty container is lifted in place and container grabber returns to starting postion. Automated twistlocks are placed in the top container. Pistons place top containers perfectly on the bottom ones.

02.4

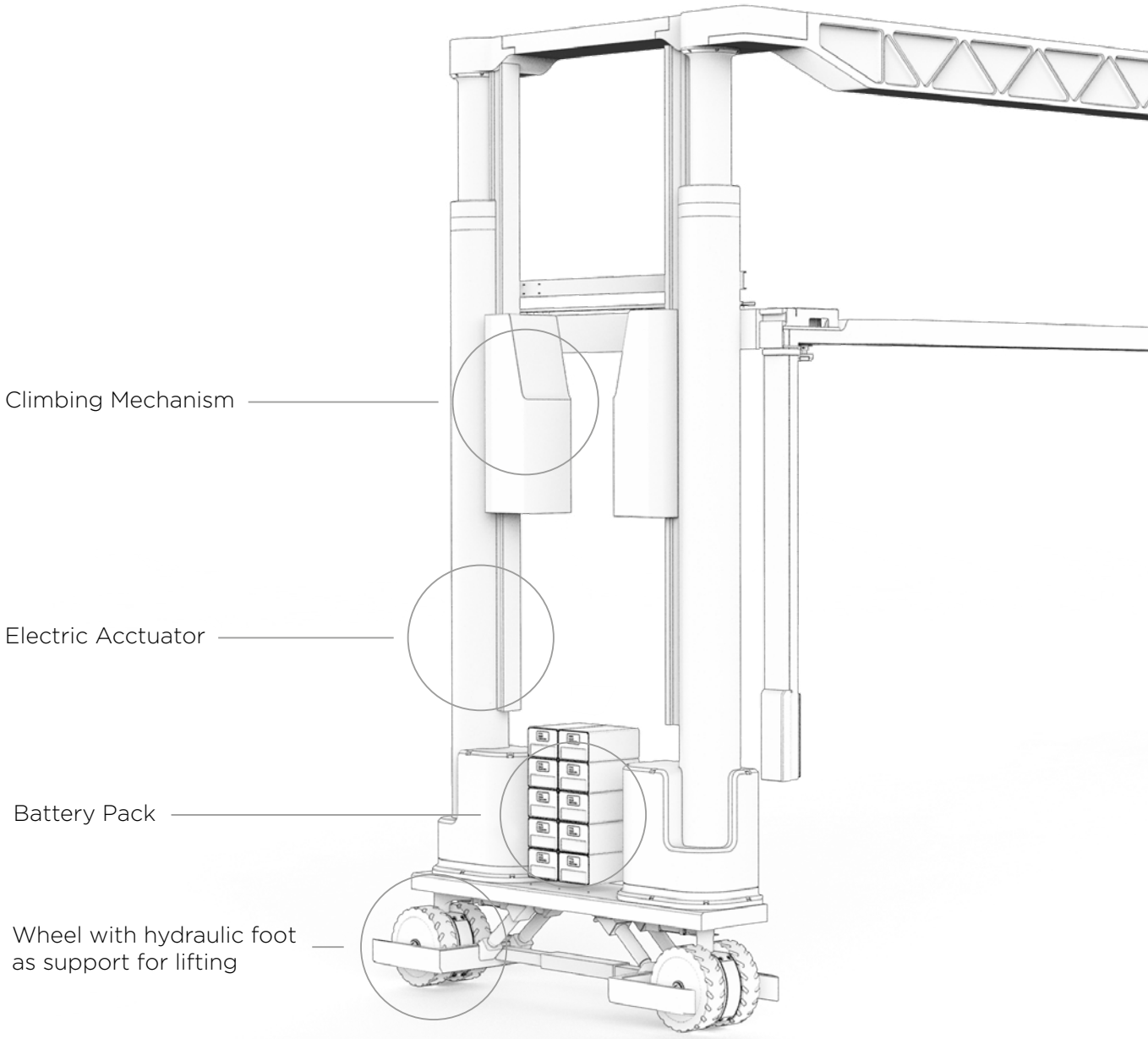
Containers placed pistons started to push again. AGV has already arrived to bring the next empty container. Process starts over until 9 containers are placed on each other.

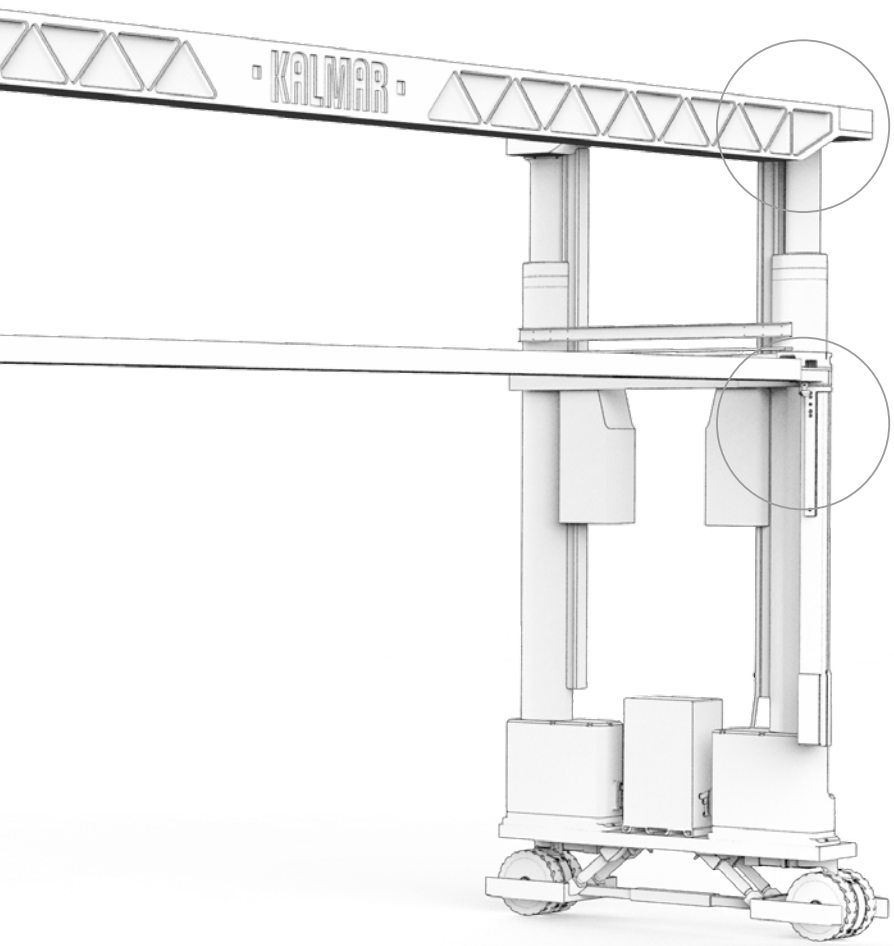


Final Direction

Inside out

Since there was no existing machine on which I could base my idea, it was necessary to first built a near complete mechanical structure. This also helped to make the concept believable and trustworthy. Later on, this was used as an underlay in the design phase to create its visual appearance.





Construction Boom

Container Grapper

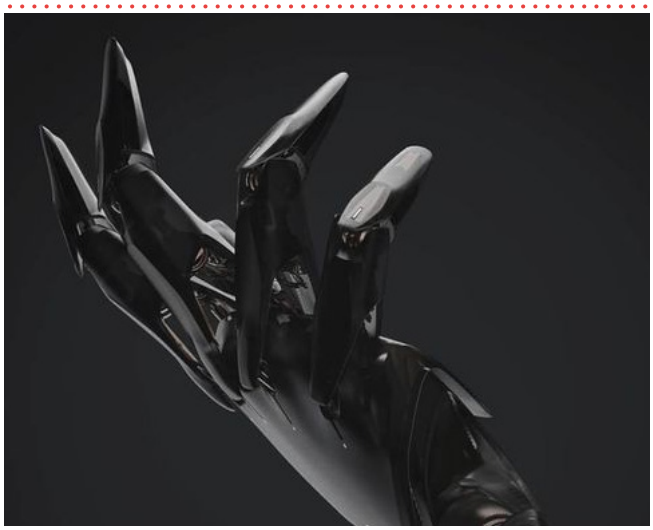
- 1.06 - Design

Final Design

Inspiration

01.1

- *Reliable*
- *Strong*



01.2

- *Trustworthy*
- *Symbiotic*

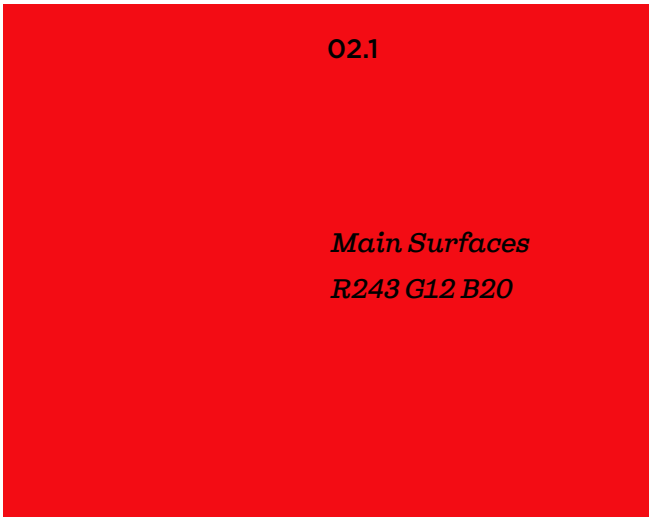
01.3

- *Iconic*
- *Precise*

02.1

Main Surfaces

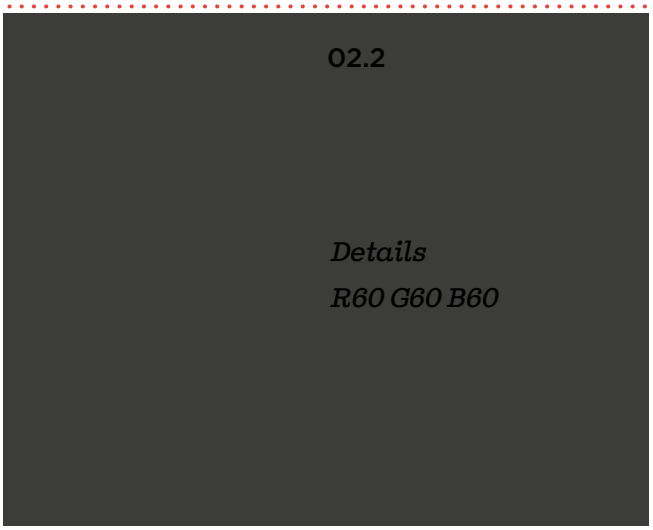
R243 G12 B20



02.2

Details

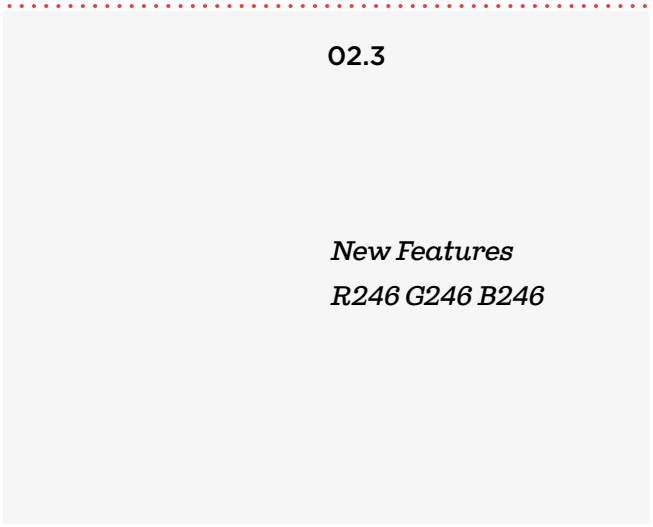
R60 G60 B60



02.3

New Features

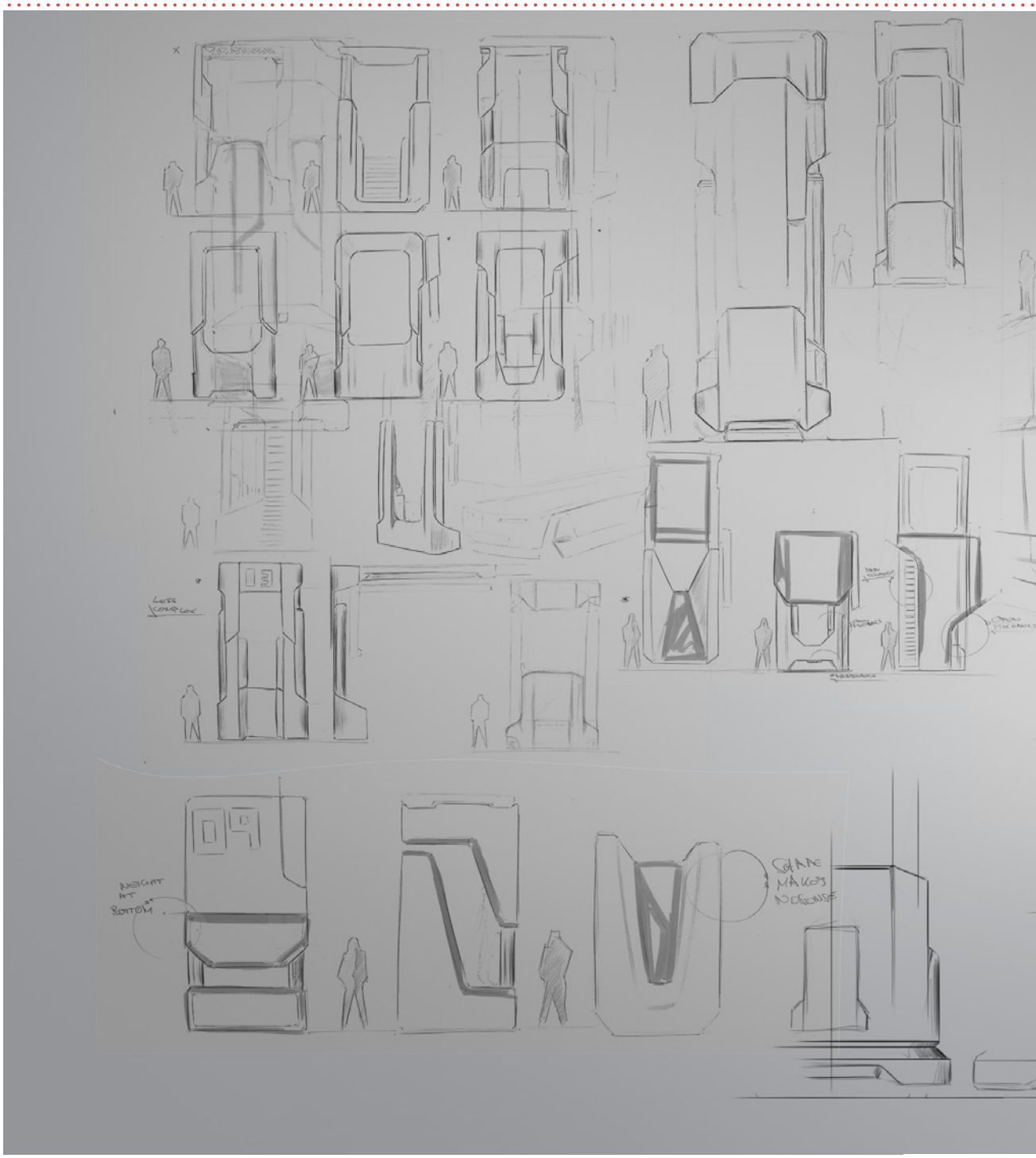
R246 G246 B246

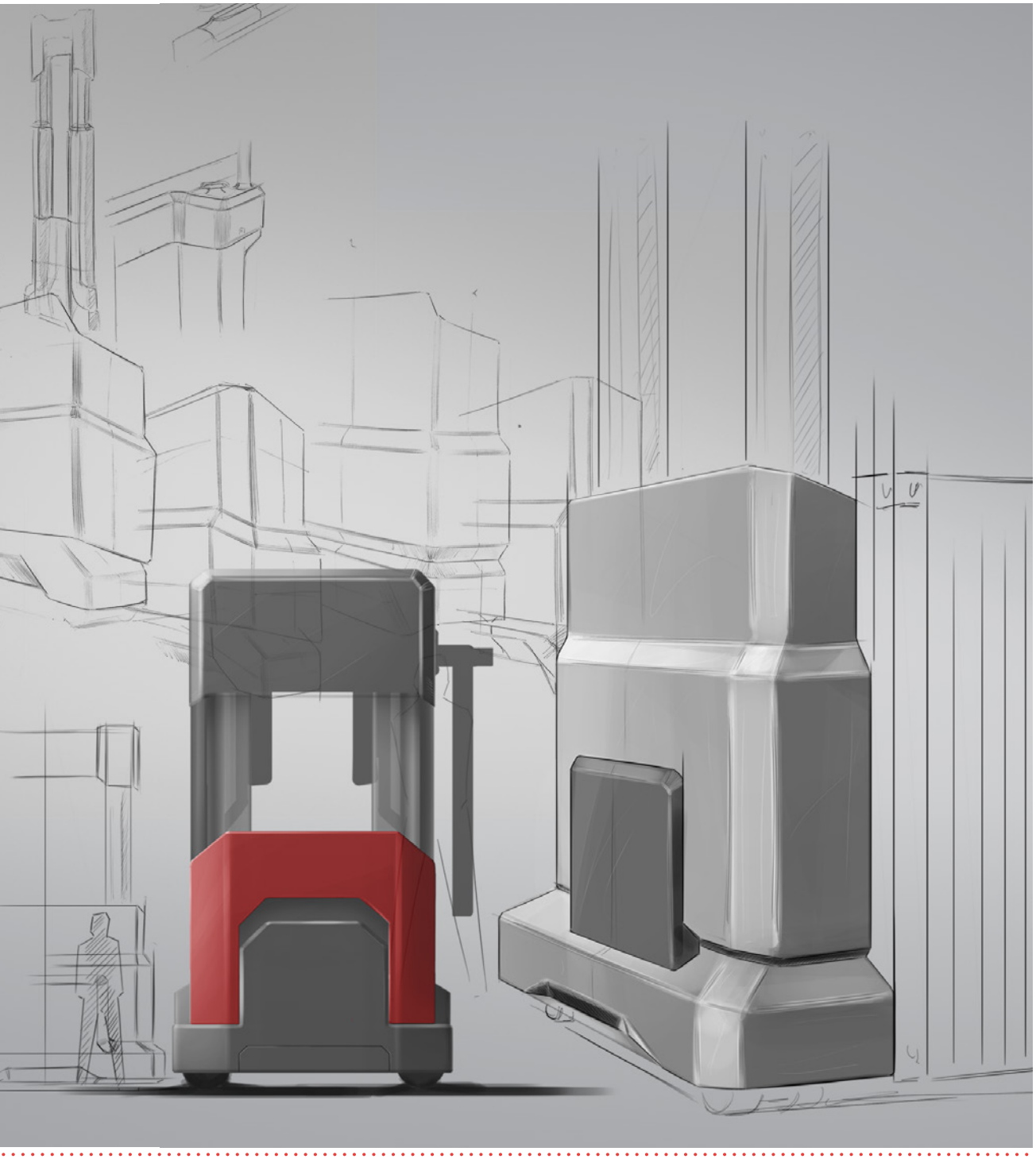


Final Design

Sketches

After setting the parameters of the machine with the inside-out strategy, it was time to start with form exploration. The most important keywords were trustworthy and reliability. The sketching phase began in an analog method with markers and ballpoint pens, and ended using Adobe Photoshop.

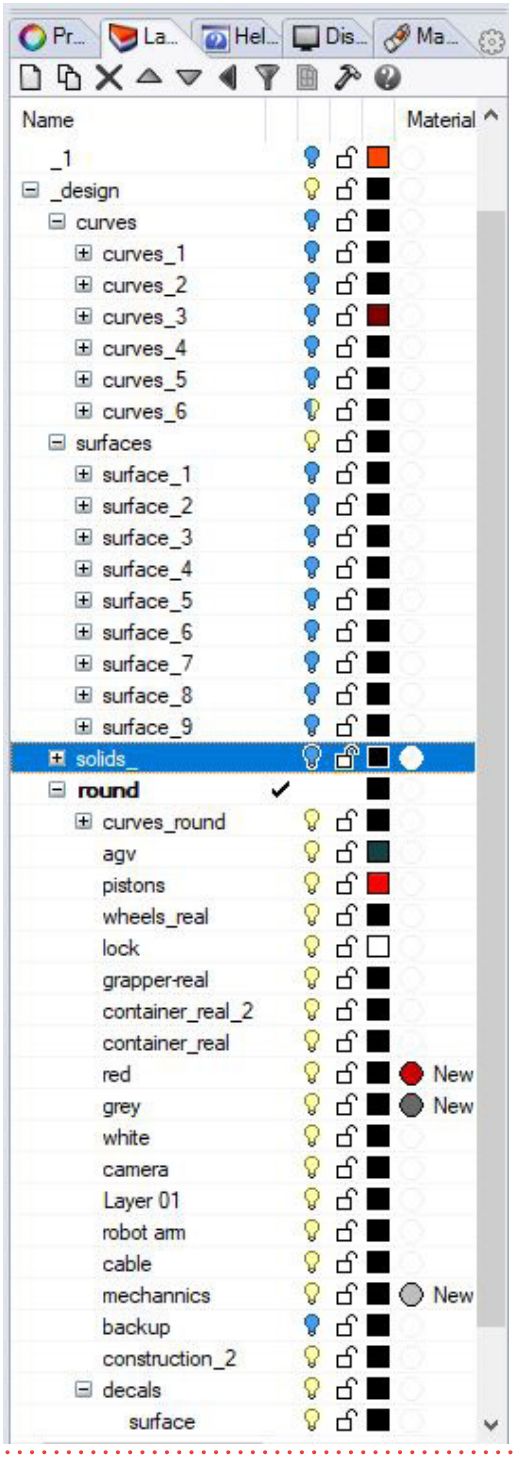


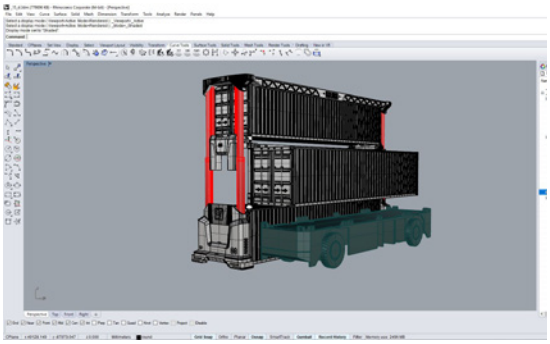
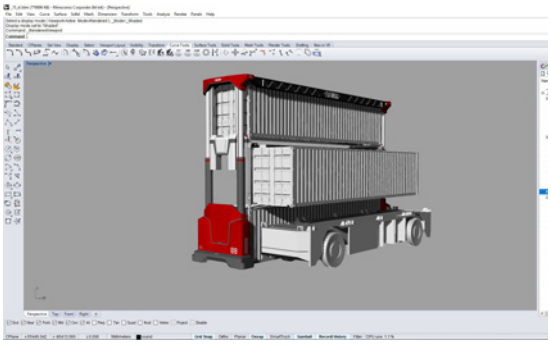
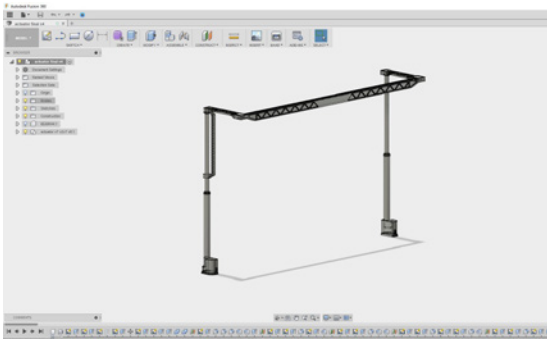
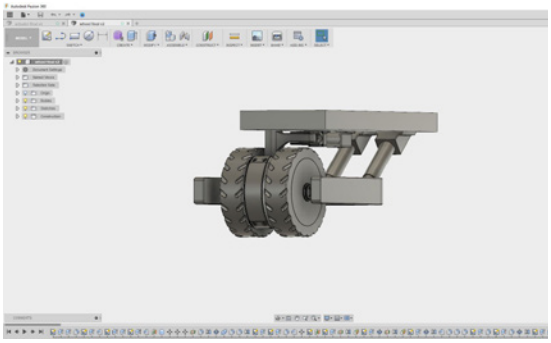
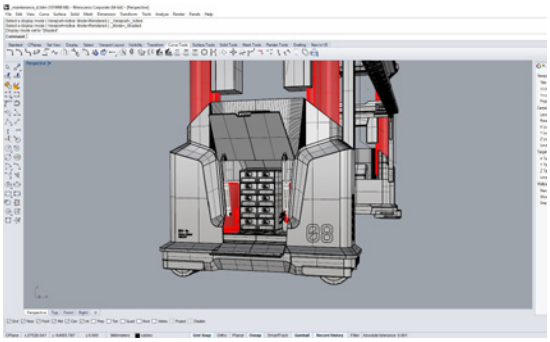
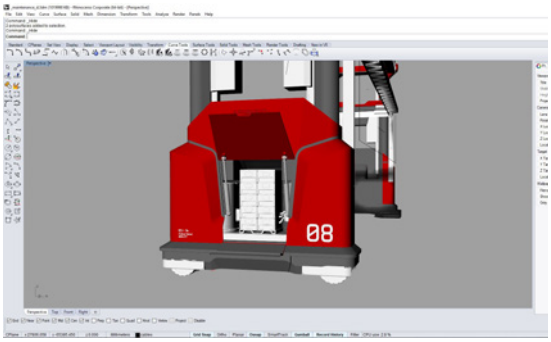
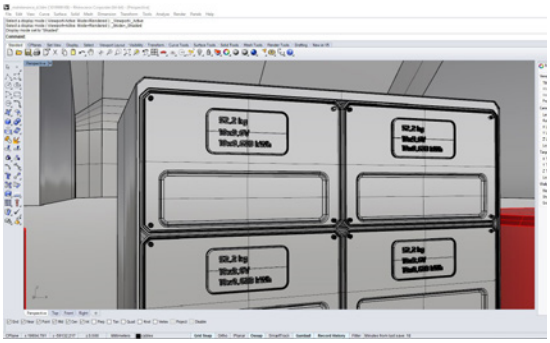
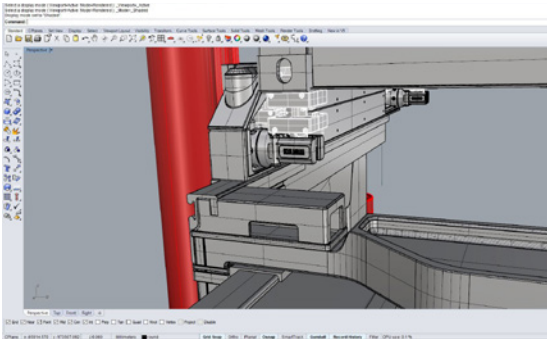


Final Design

CAD Modelling

For CAD modelling three different softwares were used. To build the mechanical structure, Fusion 360 has been used. Rhinoceros 5 was used for surfaces modelling. Solidworks has been used for filleting and chamfering complex parts. The first rough 3D Mockup has been built around November, therefore 100+ CAD hours can be calculated.

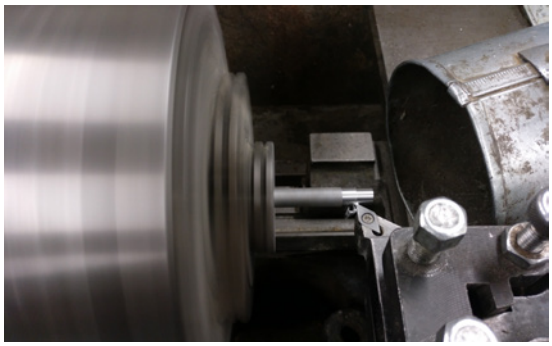


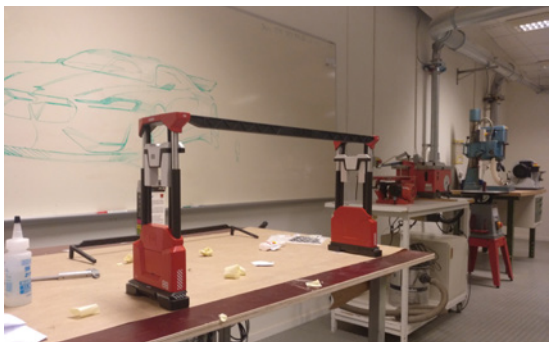
Model Making

Model making process started as soon as the final shape was determined. The model was mainly made out of PU-foam. The used materials for the pistons were aluminium and PVC. First, both materials were turned to the correct diameter and length. Later, the aluminium component was polished. Rubbon stickers were used for decals. The boom was laser cut and glued.







Final Design

N-9

The side view reveals the heavy bottom part where the technical parts are built. The chamfers coming from the left and right are an hommage to the design of the counterweight on the Kalmar empty container handler. The edges were evolved to be more rounded and smooth. The Kalmar logo is embossed on the main panel. Light grey was used for the new feature of the automatic lock mechanism.
The left side is fully closed, and the right side shows the maximum height.


08
08
NO STEP

The front view is kept slim to gain space between container rows. The Kalmar type logo is debossed in the main construction boom. In total, the Kalmer logo is used more in a more suble manner. Therefore, people connect the machine not only with the brand, but with innovation as well. The left side is fully closed and the right side shows the maximum height.


08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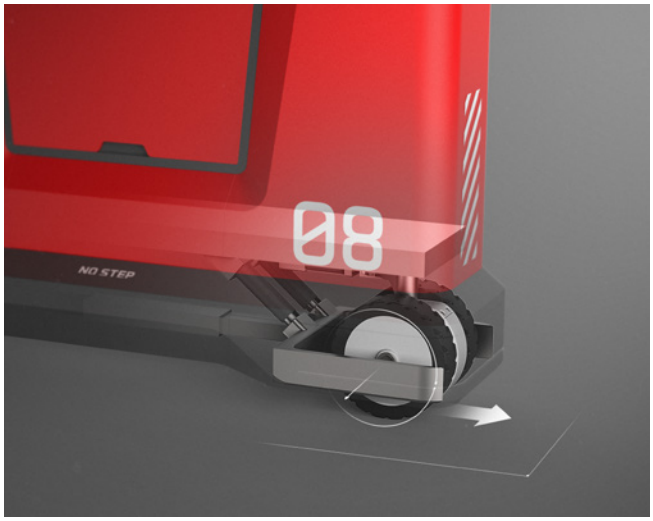
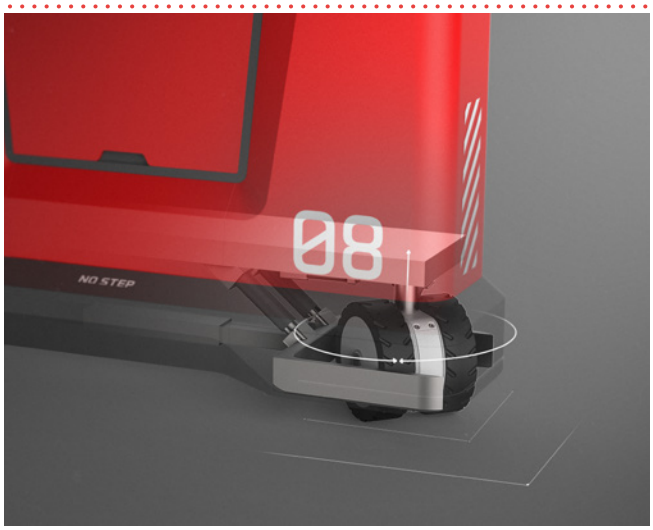
Mechanical Details



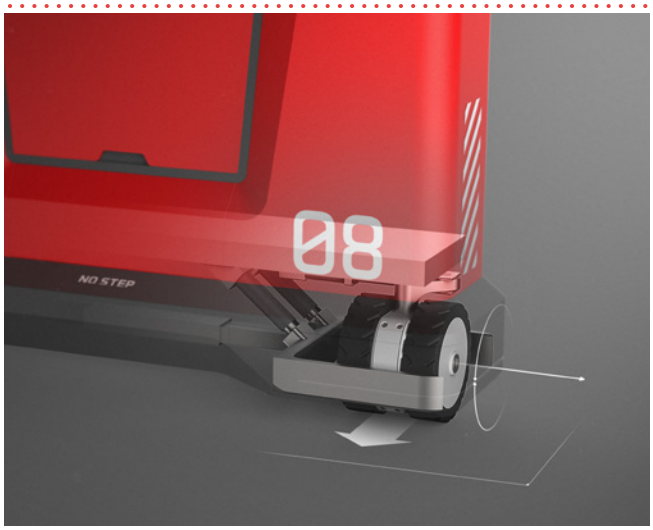
01.1

This is the position of the machine in which it can away from a container stack, and either connect to a AGV or drive to a nearby container stack.



01.2

This picture is showing the turning mechanism. The wheels can be turned 90.° Electric acctuators are pulling or pushing the axle of the wheels. This motion can also be used to drive curves.



01.3

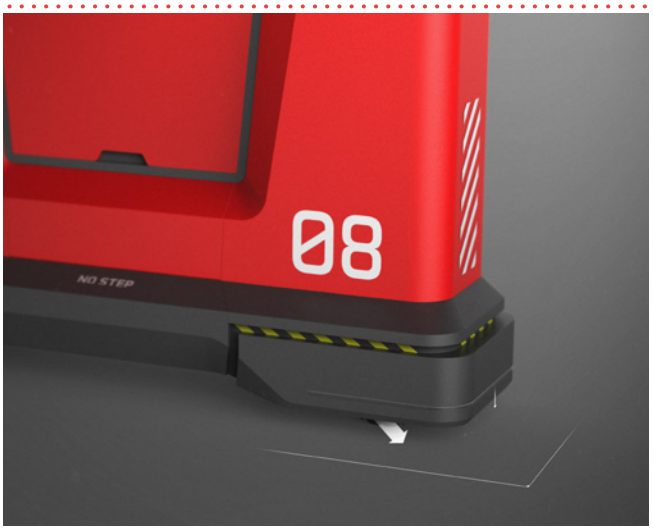
The other fixed position of the wheels is used to drive diagonal to a nearby container stack.

02.1

The first picture is showing the driving position of the feet. This is revealing the wheel underneath, and shows no yellow warning signs.

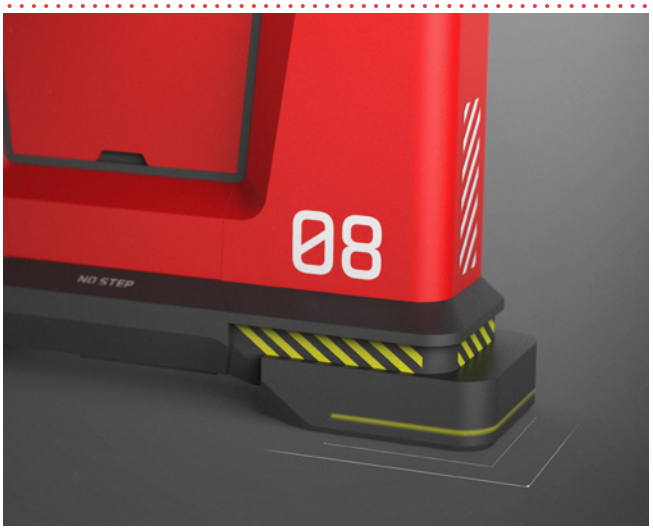
02.2

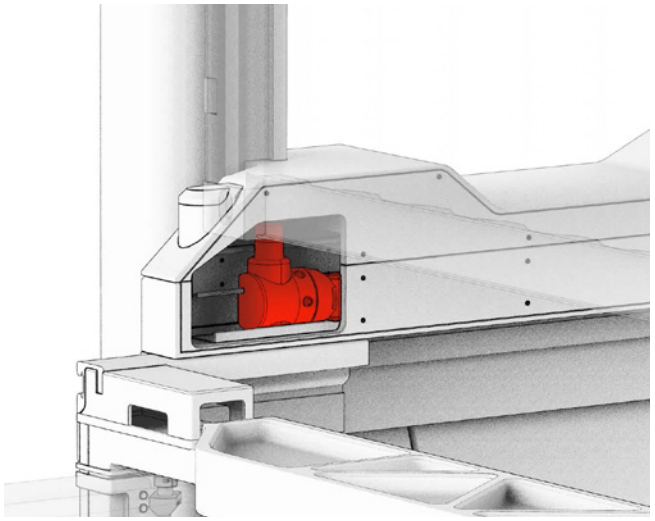
The picture to the right is showing the motion inbetween the two states of driving and lifting. On this frame the machine is currently changing state.



02.3

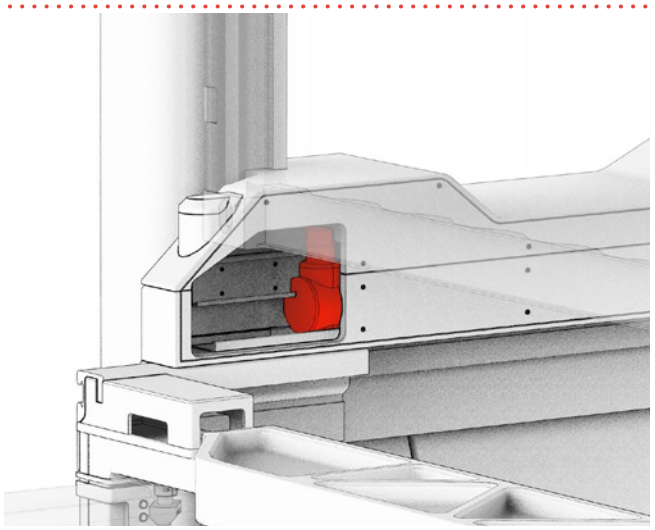
The standing postion is revealing yellow refelective warning stripes, and also iluminating the floor around the foot by activating a yellow LED stripe.





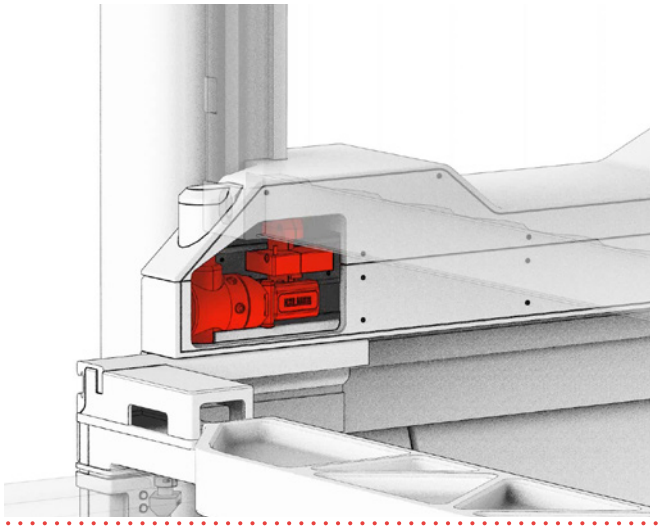
01.1

The robot arm is in starting postion to pick up locks from the magazine.



01.2

The robot arm moves inside of housing for locking when the container is in the right height.

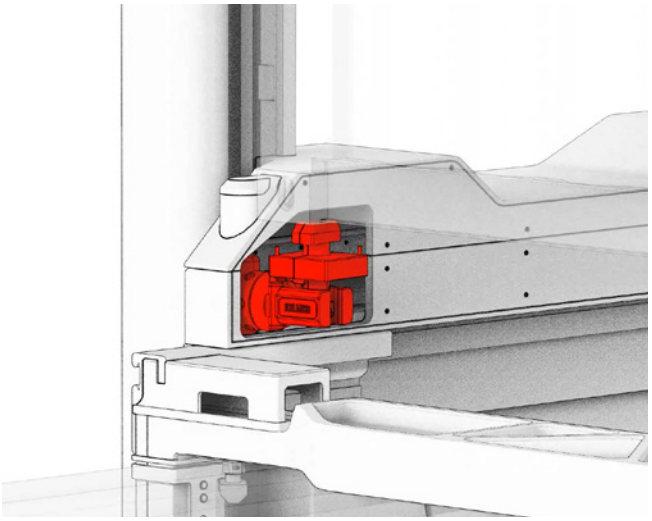


01.3

Moves all the way backwards to so it can turn for around 90° and put the locks in.

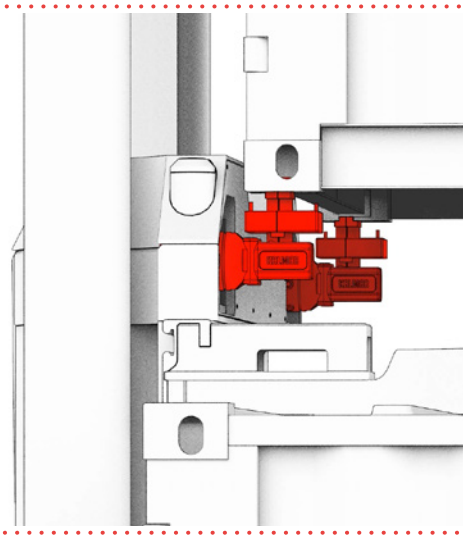
01.4

Locked postion to put locks into the container. and pick up new ones.



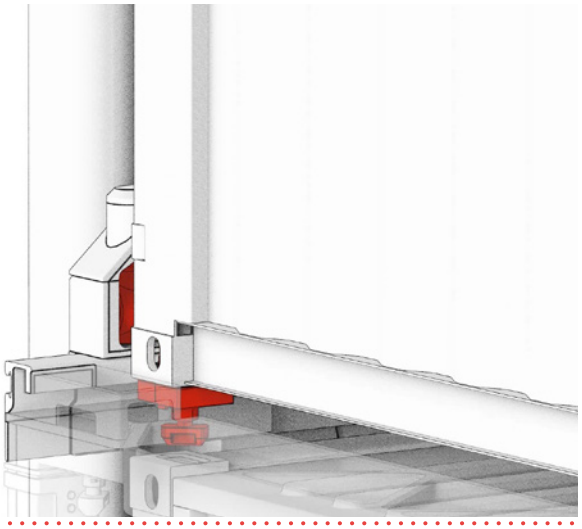
01.5

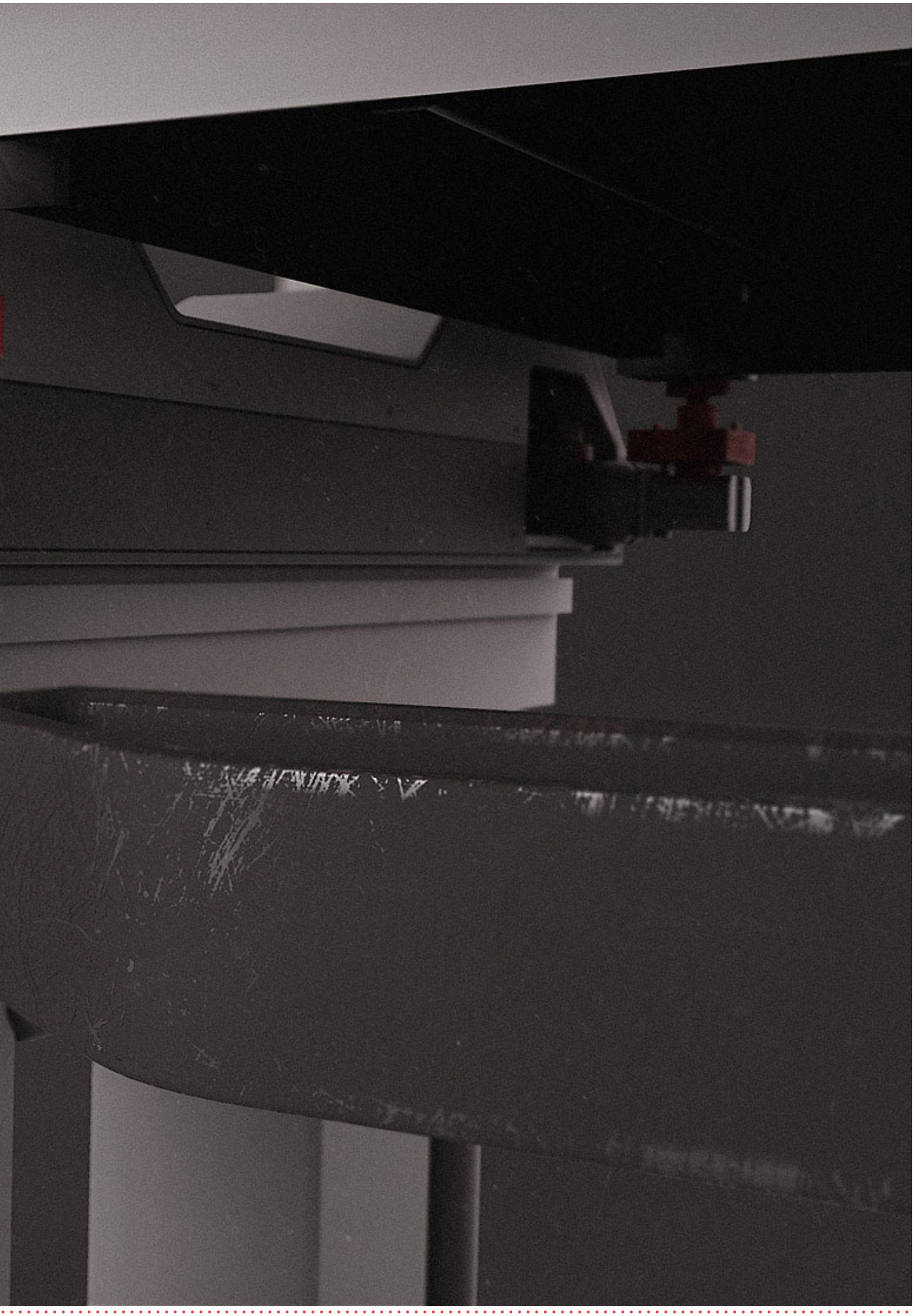
Pushes locks into container. Automatic twistlocks are getting activated and turn automatically.



01.6

Twistlocks are in place and container can be lowered to connect to the bottom one.






08
NO STEP


MAERSK
MAERSK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CONTAINER LEASING
45
45
CAI
CAI

- 1.07 - Conclusion

Feedback

Reflection

The overall project was really challenging for me. This was mostly due to the complex nature of the machine. The project grew continually during the various stages of the design as well. To optimize my performance I tried to combine different processes and methods. This meant I tried to use processes I have never used before e.g. the inside-out method for the mechanics. This was also one of the most complex models I have ever built so far, as it required a new level of foresight and planning to execute my vision.
In my opionion I achieved my over all goals and wishes. The main aim was to create impact through design, and challenge the company. I believe my concept, N-9, achieves this. It was also recognised by the company during the final presentation. The only goal which was not possible to achieve withhin the time frame of the project was a concept video that illustrates the machine's abilities through a user. Because it was not nesceassry to describe the concept through story telling, this method of visualization was cut during the final post production phase.

"The amount of detail and also the idea with the twist locks is spot on."

- Peter Söderberg, Vice President, R&D Mobile Equipment, Kalmar Global

"At first we weren't sure about the idea but you made it believeable."

- Per-Erik Johansson, Senior R&D Manager, R&D Mobile Equipment, Kalmar Global


KALMAR
THE WEB - W3/6
Brazil
Material Handling Equipment

- 1.08 - Appendix

Timetable

Week-by-Week

This is the timetable I framed for this project. I want to try to stick to it as much as possible so I can work in a more structured way and achieve my goals. Each red square represents a different phase in the project, and these squares are divided into work days to make clear how many days could be spent on each task. The deadlines are highlighted in the presentation section to make sure that the deliverables are ready on these dates.
The weekends are left blank as a buffer and to recover my mental and physical health due to stressful workdays.


Week 49
Week 50
Week 51
Week 52
Week 01
Week 02
Week 03

Reference List

If a picture is not listed it was either taken or produced by a study collague of mine or myself.

Page 3: Kalmar Global Image Picture, https://www.kalmarglobal.com/globalassets/newsroom/images/hires/cargotec_columbia10-12-127_print_49202.jpg, 16.11.2017

Page 4: Logo by Cargotech, https://www.cargotec.com/globalassets/images/logos/cargotec_ba_wide_rgb.jpg, 15.11.2017

Page 5: Photo by chuttersnap on Unsplash, https://unsplash.com/photos/Q4bmoSPJM18, 15.11.2017

Page 17: Photo by chuttersnap on Unsplash, https://unsplash.com/photos/9cCeS9Sg6nU, 15.11.2017

Page 18: How are Containers Loaded? | Cargo Operations on Container Ship, https://www.youtube.com/watch?v=kj7ixi2lqF4, 15.11.2017

Page 19: Photo by chuttersnap on Unsplash, https://unsplash.com/photos/5Rlrs3sKVJU, 15.11.2017

Page 20: Gartner hypecycle for emerging technologies, https://www.gartner.com/smarterwithgartner/top-trends-in-the-gartner-hype-cycle-for-emerging-technologies-2017/, 15.11.2017

Page 21: Photo by Samuel Zeller on Unsplash, https://unsplash.com/photos/-Bi_CXPZwqk, 15.11.2017

Page 23: Photo by Guillaume Bolduc on Unsplash, https://unsplash.com/photos/uBe2mknURG4, 15.11.2017

Page 30: Taylor TXEC-207/8 Empty Container Handler (1), https://www.youtube.com/watch?v=iTsKlNJvt-s, 15.11.2017

Page 34: Hankook Mirae Technology - Vitaly Bulgarov, https://lemanoosh.com/app/uploads/vitaly_bulgarov_3d_robot_design_08-388x587.jpg, 17.12.2017

Page 34: Sydney Hardy, https://www.instagram.com/p/BUVuqhTjpsU/?taken-by=syd_hardy, 17.12.2017

Page 34: Huge Moto, https://static1.squarespace.com/c/57bb6bb33e00be03ee971ee2/57d889615016e12407823eaf/57d8915be6f2e1210952fbe2/1475769156480/07_side_righthigh_c.jpg?format=2500w, 17.12.2017