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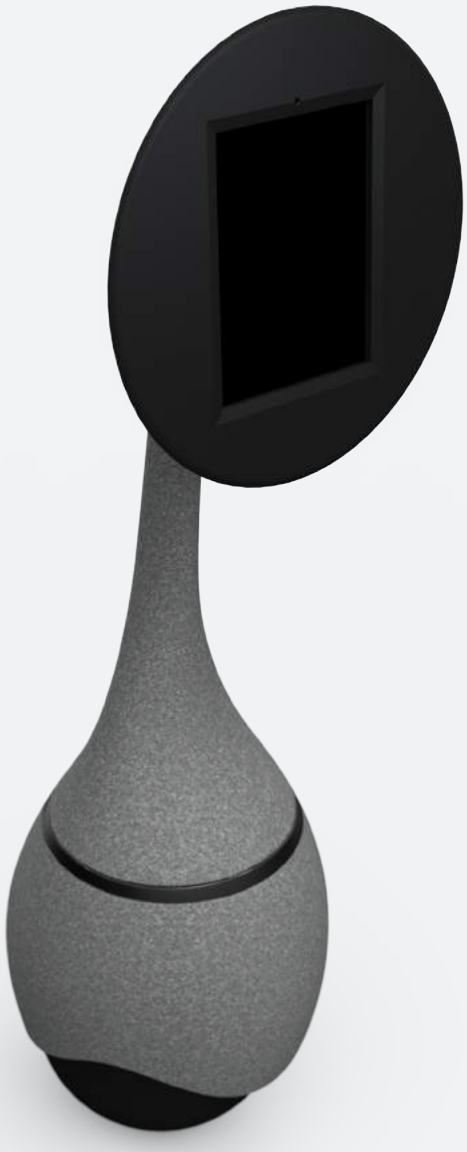

MASTERS THESIS PROJECT - MA04-ID10 - JUNE 2016 - PRODUCT REPORT

NICOLAI ODDE DAM & MARIA SLOT JACOBSEN

PROJECT INTRODUCTION

This report is the product report showing the result of a Masters Thesis project by students at Architecture and Design with specialty in Industrial Design. In collection with the product report, a process report elaborating the progression, tests and decisions made in the process. To dive down into the process, and the argumentation for the product, see the associated process report.
The thesis deals with a holistic approach to the development of a social service robot for a commercial audience.
The project has been developed in close relation with Karl Damkjær Hansen, an expert within the robotic field.

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Nicolai Odde Dam

Maria Slot Jacobsen

PRODUCT INTRODUCTION

Flexbot is an agile social service robot, which alters the use of service robots on various levels. Pleasing design and a software platform allows it to potentially open the market of service robots amongst humans to a whole new point.
The vision for the robot is that it can be altered on basis of the software in different application located on the tablet, which works as the screen of the robot. Through this, any application made specifically for the robot, should be able to change its behavior.
This project has focused the specific behavior on a hotel lounge. Here the robot should be functioning lounge-roaming-order-taker robot, creating additional atmosphere and interest at the hotel.

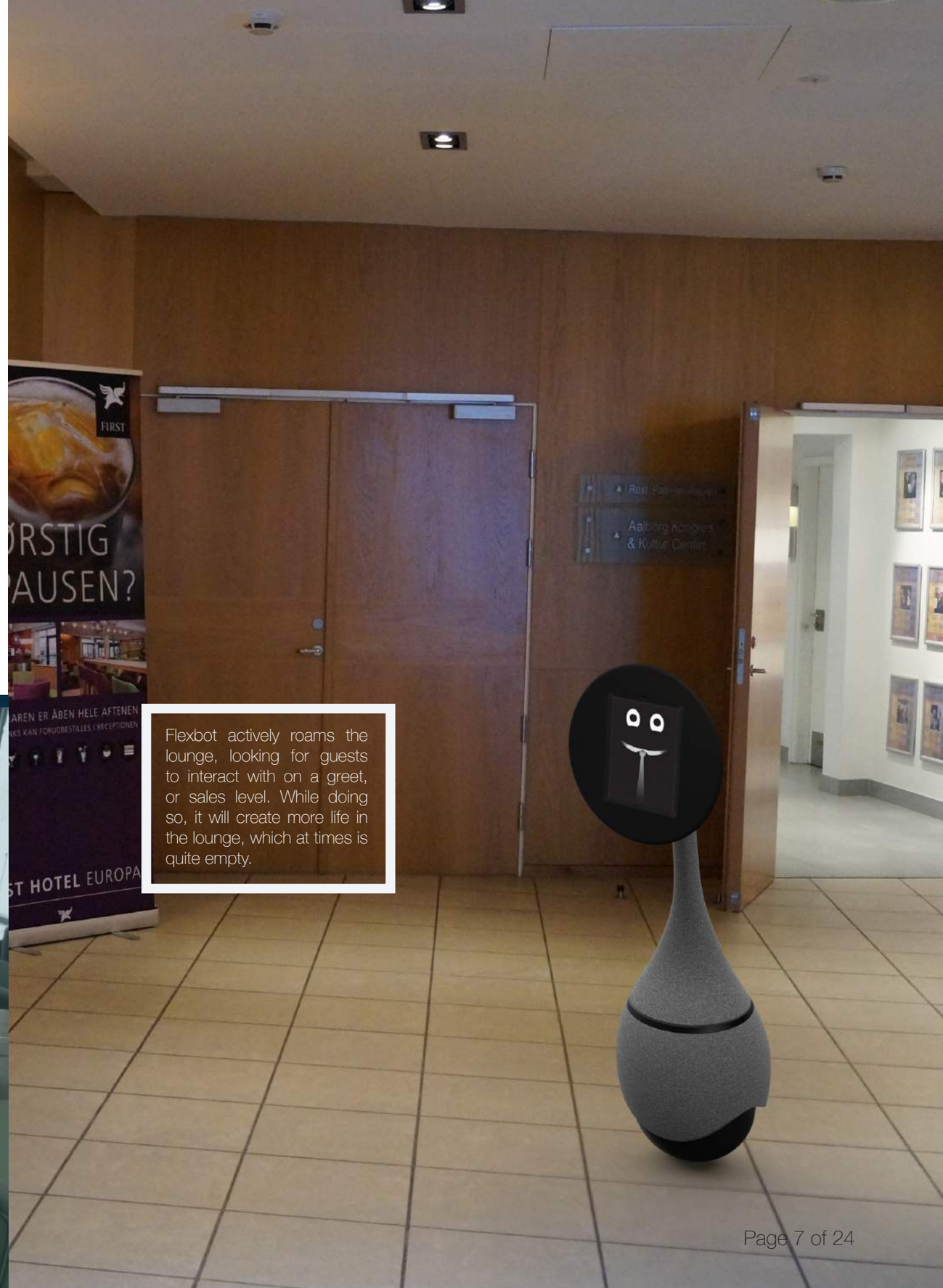
FLEXBOT IN A CONTEXT

Flexbot is a social service robot, ready to work amongst people. The preliminary competences of the Flexbot is mainly interaction and tablet functionalities. With the right software from an application, the robot would be able to do most kinds of interaction at a simple level.
The background illustrates Flexbot about to approach a guest at a hotel. In this context, the main purpose of the robot is to take orders from the guests, and additionally be a personality in the room, creating atmosphere.

FLEXBOT IN ACTION

While Flexbot is creating an atmosphere roaming in the lounge, it keeps an eye out for guests to greet, but most importantly, to approach and offer beverages and snacks.
A camera allows Flexbot to use facial recognition on people, so it has data to behave according to. The data from this technology will be stored encrypted for about a day before it gets permanently deleted. This allows the robot to know whether to approach or not, because it can store rejections, previous interactions with specific people, and many other interesting features. This makes Flexbot able to actively approach guests periodically to increase the sales of inventory from the bar.

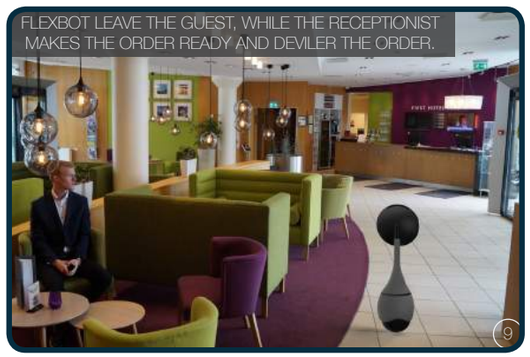
Flexbot can navigate multiple persons taking by recognizing the dominant speaker. This is done with a combination of microphones and software, allowing specific data to be gathered for each person talking. This creates a value, which when highest makes that person the dominant speaker. This makes Flexbot able to orient eyes and body towards the person that come of a the dominant speaker.
In connection with dominant speaker, Flexbot will automatically adjust its height to be lower than the persons eye sight if possible, to avoid dominant behavior or intimidation of the robot.



Flexbot actively roams the lounge, looking for guests to interact with on a greet, or sales level. While doing so, it will create more life in the lounge, which at times is quite empty.

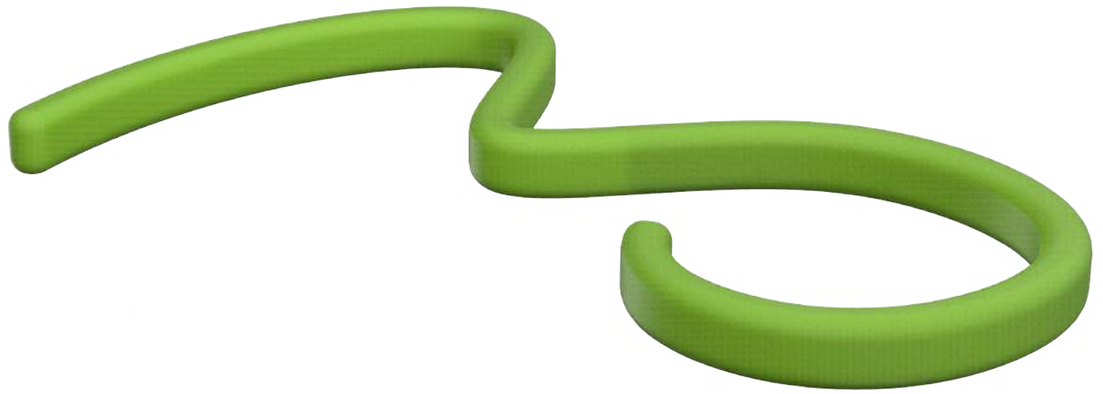
INTERACTION WITH FLEXBOT

Flexbot will interact with the guests with simple two way communication. This means that Flexbot controls the conversation, and with the use of voice recognition on basis of interpretation and recognition technology, leading the guest to answer with limited answers. Then Flexbot analyses a stated word, or words, from the guest to identify a matching word, resulting in a premature level of conversation.
The conversation is limited to the intention of the Flexbot, making conversations about off topics impossible.



FLEXBOT CHARGE

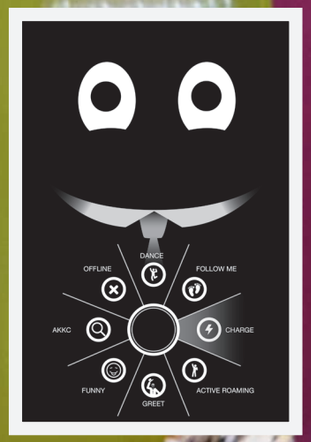
Flexbot has charging incorporated in the behavior, making it able to identify and time charging cycles on basis of previous experiences. The dock will in this case be placed as a part of the roaming area, as the charging behavior is integrated with the other behavior, making Flexbot able to go to sleep in the lounge, for peoples amusement.
The dock uses wireless technology to power Flexbot, making plug-in of cables unnecessary.
Flexbot can hold power for around 10 hours, depending on the activities it is doing. It will take 2-3 hours to charge Flexbot from 0 to 100%, but it is possible to program Flexbot to go charge in a the same time-slot every day, for instance during the night. It could be in the night where there is not many people in the lounge.



BEHIND THE SERVICE OF FLEXBOT

The orders Flexbot receives will be sent to the receptionists by Wifi, making them receive the order on a tablet in the reception. Information gathered by Flexbot makes the receptionist able to handle payment and deliver the order. Flexbot shows the guest that the order is retrieved and sent.

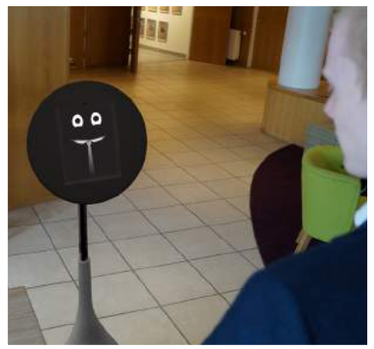
The receptionists are able to demand the robot to do specific commands. This is done by holding a finger on the screen for 3 seconds, forcing a pop-up menu where a slide to a given direction activates a certain command.



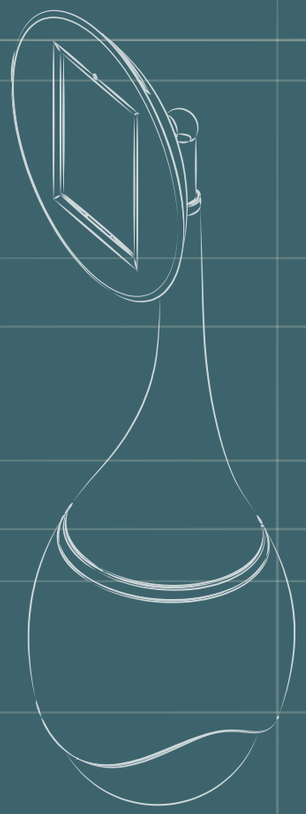
BEHAVIOR OF FLEXBOT

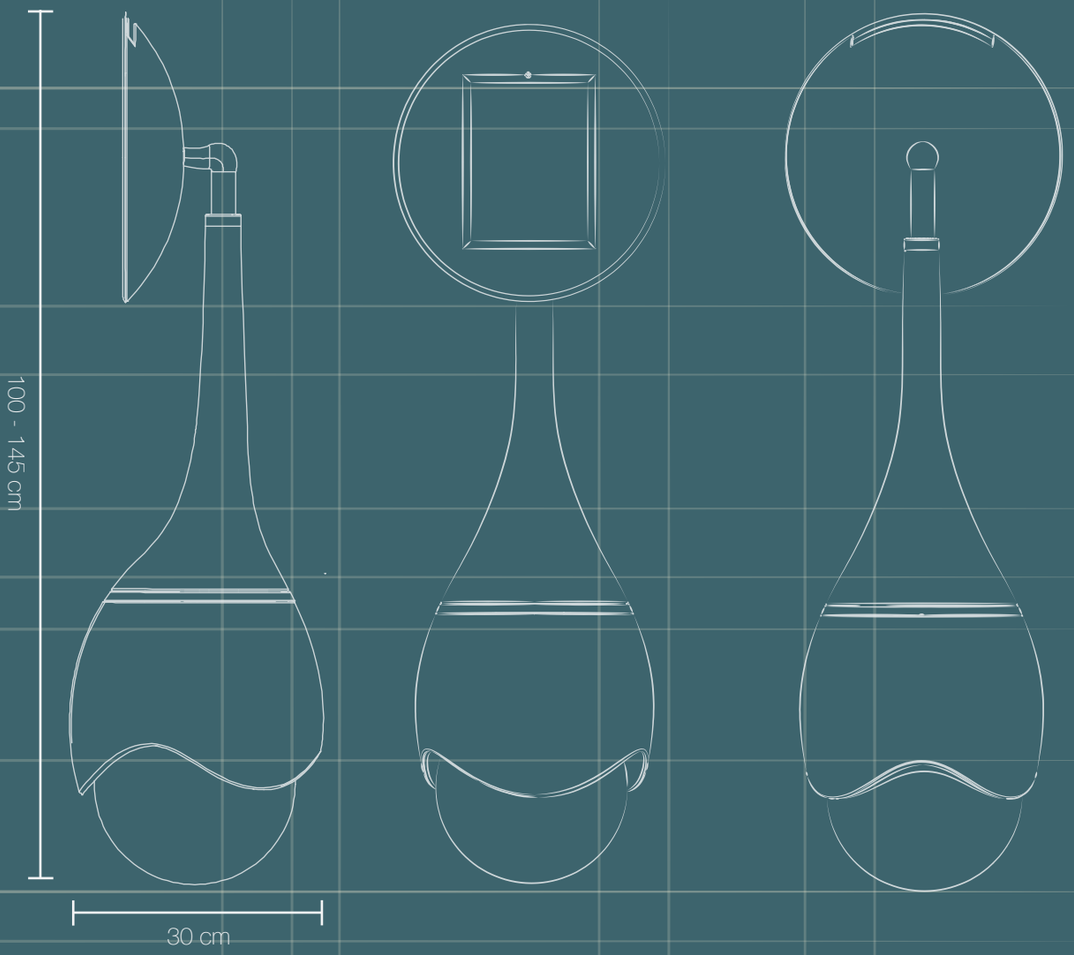
Flexbot has pre-programmed movement behaviors, and programming for another application can use those basic movement behaviors to work upon, making the movement of Flexbot as fluent and elegant as possible. The principle of this movement is as seen on the illustration, that the motions are melted together, avoiding step by step robotic movements.

Flexbot fit to different scenarios, to help with that, the previous mentioned height adjustment contributes. Flexbot uses images to measure an approximate height to adjust to for optimal interaction.
Here there are illustrated scenarios where a guest is standing or sitting in a high back sofa when ordering.



TECHNICAL SPECIFICATIONS





DIMENSIONS
Flexbot has adjustable height depending on the activity of the robot. The height can be from 100 cm to 145 cm.
The width of Flexbot is 30 cm

COLORS
Flexbot will be made in green, grey and white as a starting point, expanding to other materials and colors depending on project path. Possibility for logo on shell will also be available at some point.

MATERIALS
The initial material chosen for the shell is felt, giving a commonly industrial product a more soft and aesthetic feel both visually and physically.

SPEED
Flexbot will be able to drive up to 5 km/h, making it able to follow or show people around at an optimal pace.

MOBILITY PRINCIPLE
Flexbot use the ballbot mobility principle, that creates the possibility to move 360°.

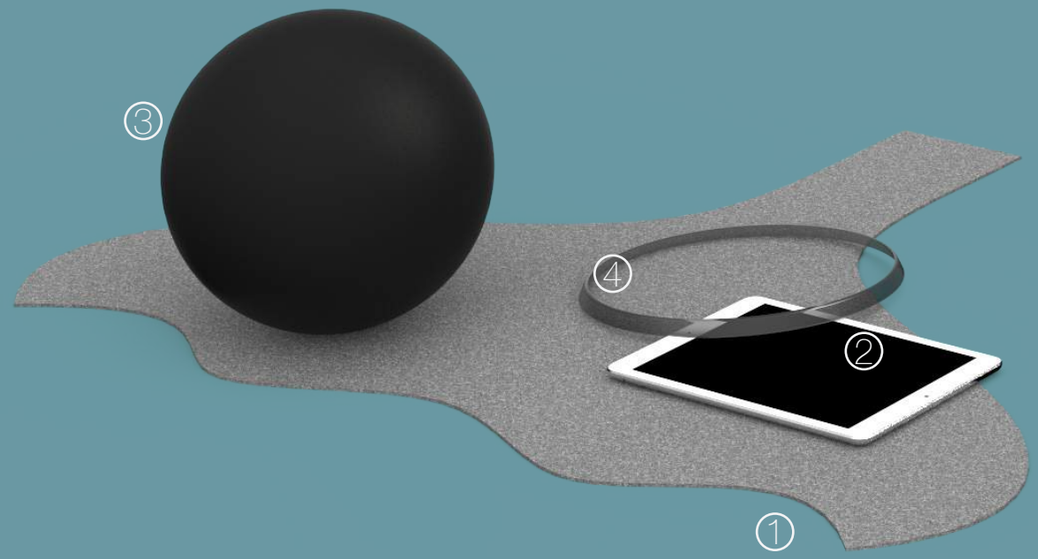
BATTERY
The time of the battery is at least 10 hours of use, and charges with wireless technology.

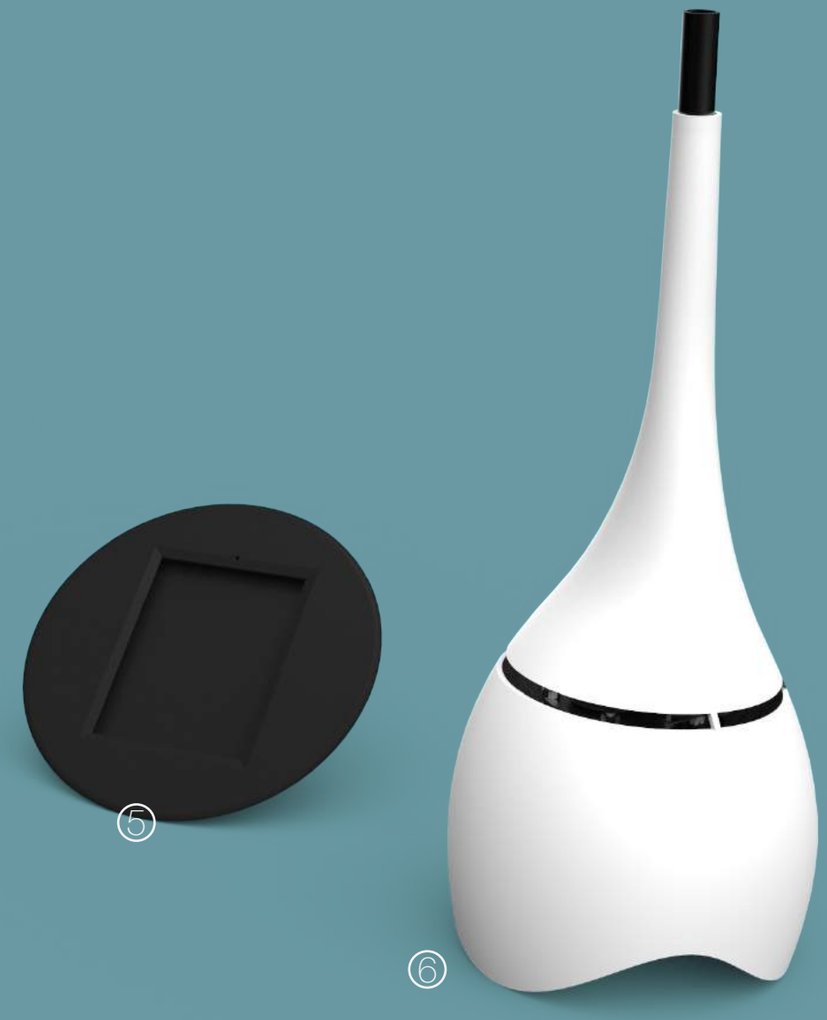
TABLET
Flexbot is compatibly to tablets with a 9,7" screen.

SENSORS
LiDAR sensor
Infrared sensor
Bumper sensor with micro-switches

WHAT IS FLEXBOT

Flexbot is one the first robots of its category, making it new and intriguing. Flexbot uses the ballbot mobility principle, meaning that it balances on top of a ball by rotating three so called omni-wheels, allowing movement in any direction.





1 FLEXBOT COVER
Flexbot cover is possible to change to fit the specific context.
As a starting point, three different colors, green, grey and white, has been chosen for Flexbot.

2 TABLET
To use Flexbot, you need to have a top of the line iPad or Samung tablet.
The tablet allows different possibilities for your Flexbot, as different applications mean different behaviors. This makes Flexbot quite agile and makes tablet functionalities possible as well.

3 FLEXBOT BALL
Flexbot ball is the piece of the robot creating the mobility principle. It makes Flexbot able to turn around on itself on the same spot, and the flexibility with no limit in the driving directions.

4 SENSOR WINDOW
Flexbot has a sensor window, making the sensors able to look out from the inside of the construction. The sensor window is made in dark transparent plastic, and is attached on Flexbot's body.

5 FLEXBOT HEAD
Flexbot has a neck joint, allowing vertical rotation of with the head. This makes Flexbot able to adapt the head angle to angles in movement and interaction, creating a more dynamic and deep possibility for behavior.

6 FLEXBOT BODY
Flexbot has a main body in plastic that covers the components inside the robot. It creates an easily swappable exterior, which in itself is most of the exterior identity.
The body is shaped in a way that the height adjustment doesn't affect the overall impression too much.

FLEXBOT IN OTHER CONTEXTS

By changing Flexbot's cover and software app, Flexbot will be able to fit into a lot of other contexts where the mobility, behavior and tablet functionalities are used. This makes application developers able to design solutions where Flexbot is a key component in the execution of the application.

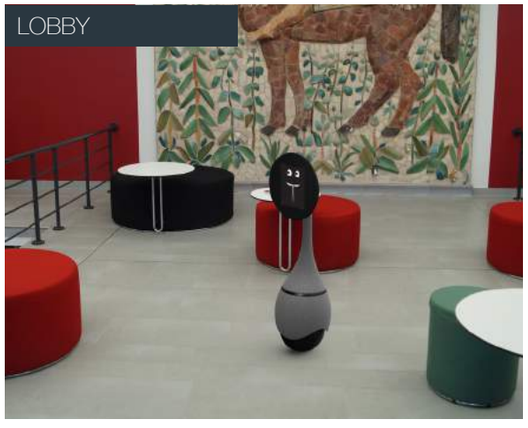
ENTERTAINING KIDS

Beneath are potential implementation places shown. Flexbot is capable of being used in most interactive scenarios, where the attention factor can be used actively. Some contexts use the tablet functionality, while others do not.

RESTAURANT ESCORT

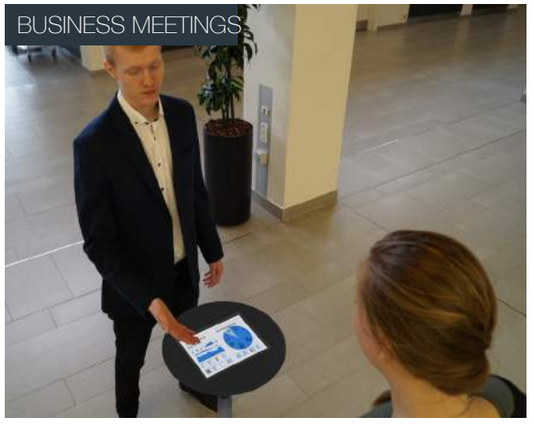
EXHIBITION ATTRACT

LOBBY

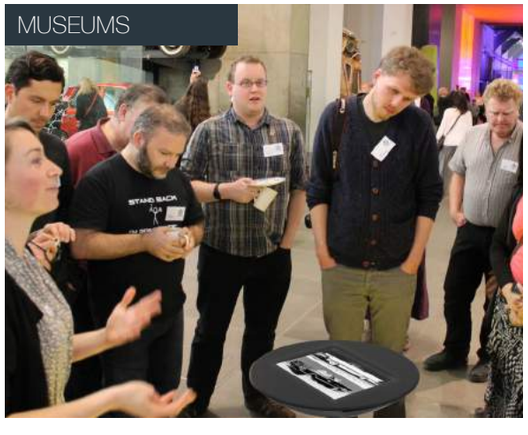


VISUAL SALES

BUSINESS MEETINGS



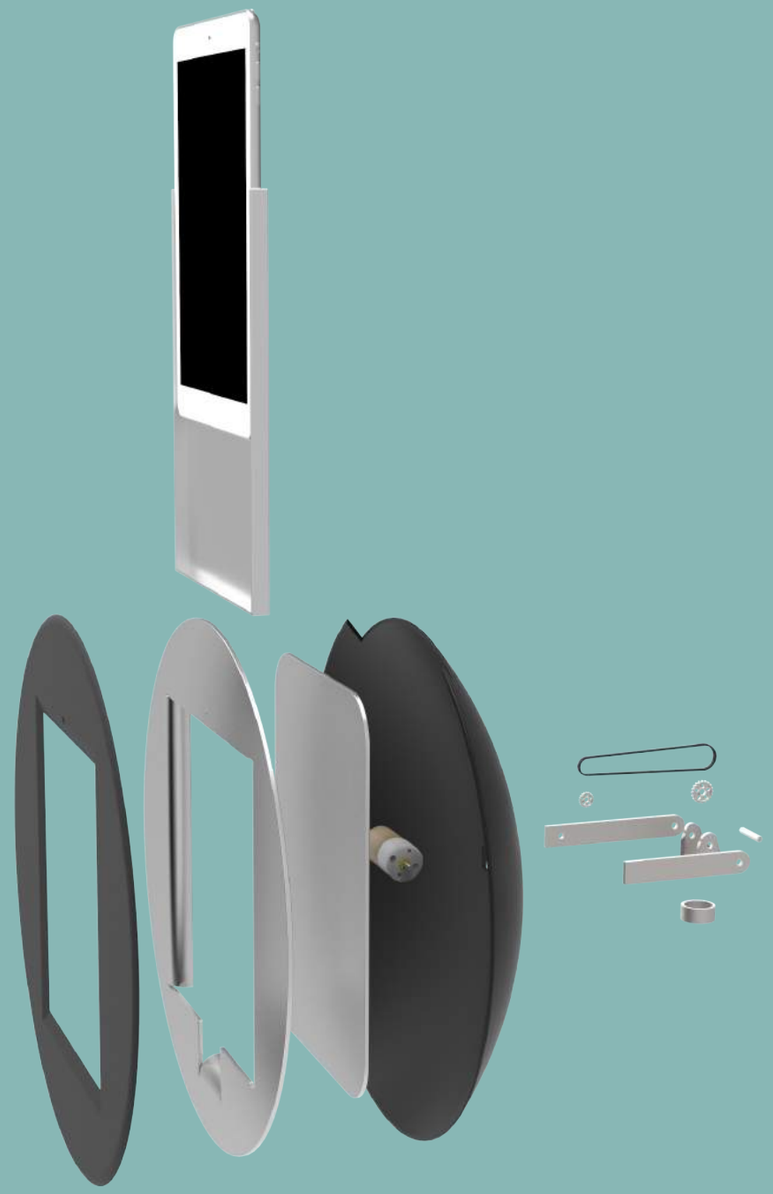
MUSEUMS



CONSTRUCTION OF FLEXBOT

Flexbot head consist of a layer construction with a neck joint attached to it. The neck joint is powered by a motor located inside the shell of the head.
The screen is as previously mentioned a tablet, and it is an add-on product the user add to Flexbot to make it function. It is easy to take out the tablet again, if the use is only short, and the tablet has another use in the context.

The design of the head features the possibility to use the underlying tablet features. A hidden user interface is placed on the front of the head, allowing use of the tablet buttons. This allows physical tablet use, beside the screen, only if you know Flexbot. This will maintain the use possibility, whilst keeping others from accessing the tablet functionalities.



The Flexbot construction is balancing on the ball where the omni-wheels are the only connection with the ball. The wheels are placed on the top-most third part of the ball to be in the best position for efficiency. To keep the construction together with the ball, it is to this point the intention that magnetism should hold those together.
The laser sensor is placed just above the Infrared sensors, which see through the sensor window. On top of that a space plate i located with integrated micro switches to create a bumper sensor. The shell will be put directly down on top of this construction, touching the space plate and the outer height adjustment tube.

IMPLEMENTATION PLAN FOR FLEXBOT

The implementation plan for Flexbot will focus on defining elements from Business Model Canvas. (Osterwalder and Pigneur, 2010) This is a model which is divided into nine different parameters that needs to be considered from a business aspect when you create a business plan.

VALUE PROPOSITION
Create physical presence for an application with the use of Flexbot. Allowing use of all its complexity depending on specific use.

CUSTOMER SEGMENT
At this time the customer segment will be quite limited, and customer segment will mostly depend on a collaboration with an optimal context, possibly another than Hotels.

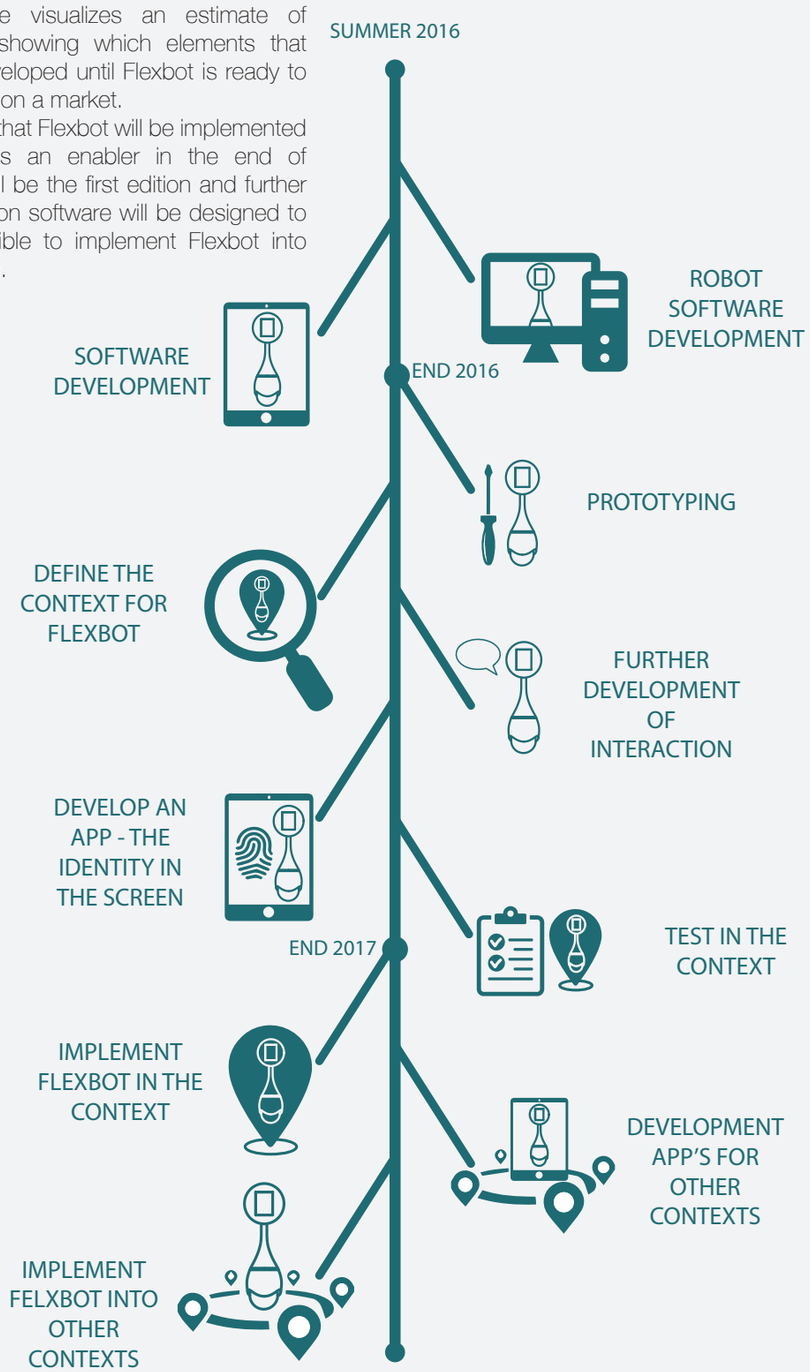
To reach out to other customer segments, a strategy could be to make a rental service, where it is possible to rent the Flexbot to special events, making it commonly known.
This could be an initial move towards making people and companies aware that Flexbot is an opportunity.
This implementation strategy has been seen within the car industry. The first cars were so expensive that the customers were renting the car, later the price for a car got cheaper, and more people could afford buying a car.

KEY PARTNERS
At this time the team need to build up a partnership to fulfill the project. DEVit sees two different ways of doing it.
One is to find investors, whom wants to invest in a project to develop Flexbot for a given context.
The other model is possibly more slow, which includes that the university brands the project, and they will get credit for it, by using student projects to further development of the robot.

The key factor here is that the physical form of the robot is very far in comparison to the non existing software.

REVENUE STREAMS
It is expected that the production price for Flexbot is about 10.000 DKK so the sales price will be about 20.000 DKK.
At this time Flexbot is a gadget that the customer can use as advertisement for the company. The team expects that some companies are willing to pay for that. If the price can or should be higher than 20.000 DKK has to be detailed at a later stage of the development, as the physical in itself cannot be the basis of it. The problem with this area is that Flexbot can't be compared with other products per say. This is because it creates a new market, proposing a new value for our mostly used technology platforms Google Play and App Store.

The time line visualizes an estimate of progression, showing which elements that has to be developed until Flexbot is ready to be implement on a market.
It is expected that Flexbot will be implemented and works as an enabler in the end of 2017. This will be the first edition and further development on software will be designed to make it possible to implement Flexbot into other contexts.



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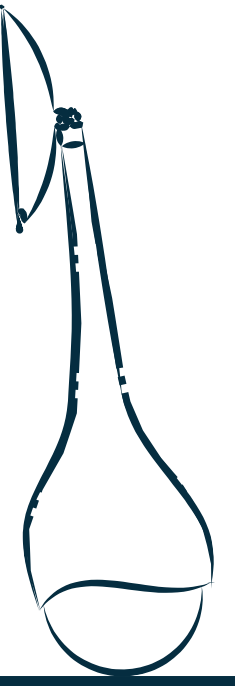
SOCIAL SERVICE ROBOT UNDER CONSTRUCTION

FLEXBOT



MASTERS THESIS PROJECT - MA04-ID10 - JUNE 2016 - PROCESS REPORT

NICOLAI ODDE DAM & MARIA SLOT JACOBSEN

TITLE SHEET

ARCHITECTURE AND DESIGN - INDUSTRIAL DESIGN
MSc04 - SPRING 2016

PROJECT TITLE
Flexbot - Social service robot

PROJECT TEAM
DEVit - MScID 04 - team 10

PROJECT MEMBERS
Maria Slot Jacobsen & Nicolai Odde Dam

PROJECT PERIOD
February 1st 2016 - May 25nd 2016

MAIN SUPERVISOR
Kaare Eriksen

TECHNICAL SUPERVISOR
Jørgen Asbøl Kepler

ISSUES
7

PAGES
117

USB STICKS
4

ARKITEKTUR & DESIGN

0.0 PRE PHASE

0.1 SYNOPSIS

This master thesis project is dealing with the rise of robots as an object working in harmony with humans. The development on social robots is still very limited, and the area exudes that other professions aren't digging into this world, so the development is based on robot engineers alone. This is where DEVit sees a potential to work within unclaimed territory, being Industrial Designer that approach the area in a whole different way. The project will have little research to work upon, as the key focus areas of design and interaction within this area is undefined.

The developed product is Flexbot, and it is what would be defined as a ballbot. The solution has redefined what a robot should look like when operating amongst people, and along with it are demands to key aspects of making the software ideal. Additionally is the solution based on a business case that enables it to be various and flexible in a way that lowers the entry barrier of dealing with robots. To realize these elements, the construction of the solution has been thoroughly designed to be usable in unique settings.

0.2 ACKNOWLEDGMENTS

A grateful thanks to Kaare Eriksen and Jørgen A. Kepler for 'on point' and usable supervision in a fairly special project, and of course a special thanks to Karl Damkjær Hansen for unique area expertise that has helped the team to navigate the jungle of robotics.

The team also wants to thank Kuno BeckerRasmussen, president of First Hotel Europe, for the interest and concrete business needs. Also a thank the employees at the hotel for letting the team investigate and observe their workplace.

Nicolai Odde Dam

Maria Slot Jacobsen

TABLE OF CONTENT

0.3 READING GUIDE

The process report is structured according to the three main phases Research, Envisioning and Detailing, with a summary to round off the process. The phases have several sub phases covering the areas the team has worked with throughout the project. The report is a walk-through of the essentials of the work that has been done to reach the final result. Just as the process report underlies the final solution, the process report has underlying work sheets located in the appendix both physically and digitally, which will be referred to throughout the report.

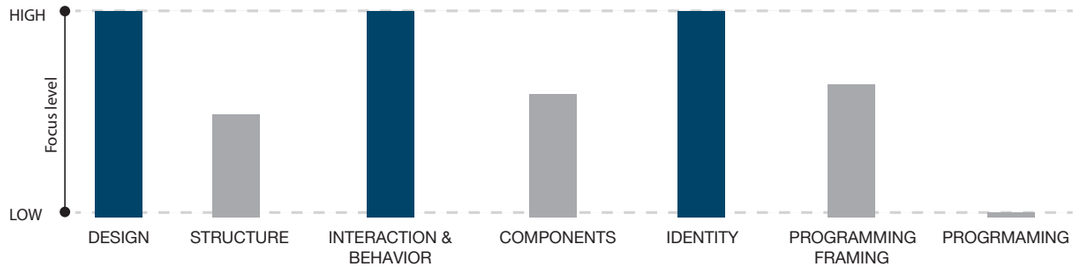
In addition to this process report, the team has made a product report presenting the final solution, a usb holding digital versions and videos and technical drawings of final solution.

Each chapter will have potential realizations and demands pointed out at the end, to capture the impact moving forward, see examples.

- Here realizations or demands will be stated.

0.4 INTRODUCTION

The robotic era is sneaking into peoples lives in various ways, the next step is taking robots to a social level from a service level. This is where the team as Industrial Designer can use the competences to help merge great design and interaction with a cold, but increasingly functional robotic world, see illustration 1 for intended focus. The area is still in the absolute starting phase, and there is very little to build upon when it comes to social robots. The origin of the project itself will be explained in the next chapter, as the team joined another newly started project.



Illu. 1 - A mapping of the intended focus in the project.

0.5 PROJECT BASIS AND COLLABORATION

DEVit has collaborated with Karl Damkjær Hansen Ph.d, postdoc employee at institute for electric system at Aalborg University. He has his own project that has been granted money for three years, from start 2015 to the end of 2017. This project is quite open, but basically it involves the development of a social robot.
DEVit has been granted the opportunity to tag along to this project, to create a design proposal that should show what a social robot could be on a physical level, and on an interaction level.
The team has been given no demands from Karl, except that the main approach should be to push the technology into commercial use, as another student group should work on pushing it to public services.

Illu. 2 - Karl Damkjær Hansen.

1.0 RESEACRH

The upcoming chapter will go through various aspect of the robotic world, creating an understanding of the field, which for the team automatically has been underlying most actions and choices taken throughout the project.
This phase is divided into two chapters, where the first chapter is defining the topic robotics, and the next is defining the context the robot is going to be implemented into.

1.1 ROBOTIC

1.1.0 WHAT IS ROBOTS?

The word robot is derived from the czech word ‘robota’ which means servitude (Today I found it, 2016), which comes from ‘rabu’, meaning slave. This word came along in 1921, and already 16 years later, between 1937-1939, the Elektro robot was made, able to walk by voice command, blowing balloons, smoking cigarettes and talk about 700 words.

How is a robot defined?
The definition of a robot is not specifically specified, and a coffee machine is in technical terms a robot; yet it would never be recognized as one by the average human. As seen below, the definition of a robot is wide and can by some be applied to most products today.

Oxford Dictionaries:

“A machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer.” (Oxford Dictionaries, 2016)

Merriam-webster:

“A machine that looks like a human being and performs various complex acts (as walking or talking) of a human being; also : a similar but fictional machine whose lack of capacity for human emotions is often emphasized” (Marriam-Webster, 2016)

In the 1980’s, a machine needed 6 degrees of freedom (DOF) to be classified as a robot, which isn’t the case anymore. [Wikipedia, 2016, 1] Devices ranging from coffee machines to smartphones to a remote controlled car is by technical terms a robot.

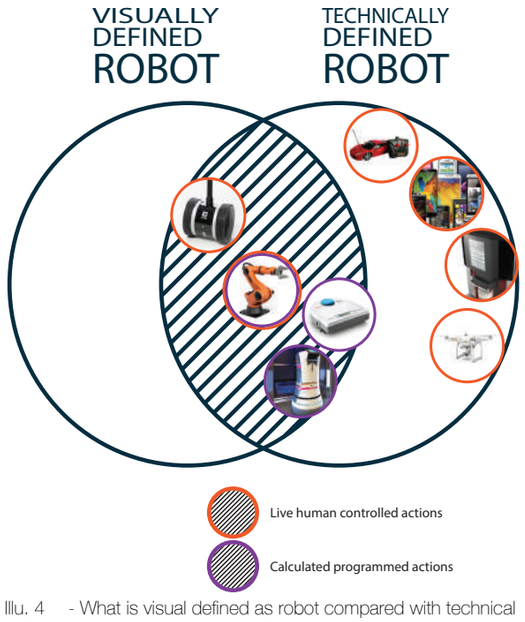
Wikipedia:

“A robot is a mechanical or virtual artificial agent, usually an electro-mechanical machine that is guided by a computer program or electronic circuitry” [Wikipedia, 2016, 2]

As mentioned earlier, some of these statements fit most technological devices used in this point in history, but robots ought to be seen at the most human of our machines.
Robotics is a broad term that houses a lot of different directions of use, but the principle is mostly to assist or perform tasks that humans can’t or shouldn’t do.

At this point in robot history, the greatest progression is on humanoid or android robots, which are those whom resemble and mimic real human behavior. It is especially here progress in compact technology and programming has improved movements and interaction, and also the path towards artificial intelligence (AI).

- Robotics is a blurry undefined area indicating its freshness and complexity.



Illu. 4 - What is visual defined as robot compared with technical defined as robot. (Pinterest, 2016)

1.1.1 INDUSTRIAL ROBOTS TO SERVICE ROBOTS

Technological progress in three domains is pushing the industrial robots towards service robots. These domains are defined as (Baya, Wood, 2015):

Cognition
This is the robots ability to perceive, understand, plan and navigate among people. Improving on this domain will make the robots able to work in diverse, dynamic and complex environments independently. Developments in this domain has for instance been the introduction of Microsofts Kinect sensor, making 3D sensoring accessible instead of 2D, and this information is used within simultaneous localization and mapping, also called ‘SLAM’, which results in real time mapping, so that the robot can actually plan its movement ahead.

Manipulation
Mainly the advances with the aspect of manipulation involves the robots ability to grip and hold an object through space without breaking it or harming the environment. In technical terms this area is about where the robot should hold, and with how much pressure to hold tight enough, but not too tight to break it.

Interaction
Advances within interaction will improve robots ability to collaborate with humans, both in verbal and non-verbal communication. Learning, observing and copying from human behavior will strengthen the interaction methods of robots to be more human-centric, working towards being true partners of humans.

In addition to these domains, two forces are expanding robotics and making them more mainstream. As seen on illustration 5, Autonomous learning and Modular platforms are the two forces, where autonomous learning is the three domains previously mentioned, that expands the variety and diversity of tasks that robots can do. Whereas modular platforms is dramatically lowering the barrier of development for robots and innovations linked to robots. These domains and forces will together possibly be the next big driver in enterprises, as CEO of Brain Corporation Eugene Izhikevich predicts: ”This opportunity with robots will be like combining the impact of electricity, communications, and the Internet”. (Baya, Wood, 2015)

Conclusion
Modular solution within robotics drastically lower the bar for entering robotics, and by this increase the development as more enter the area.

The autonomous learning increases both from within the robotics field and externally from creative new technology, pushing the possibilities within cognition, manipulation and interaction.

- Two paths are expanding robotics

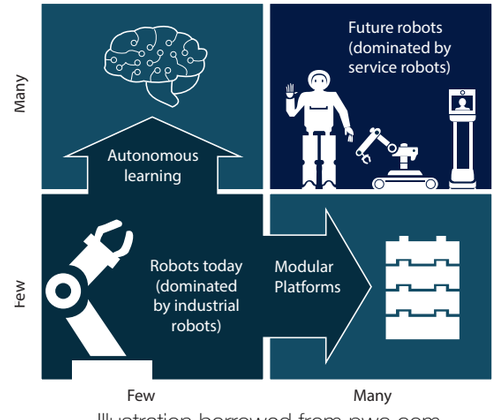


Illustration borrowed from pwc.com

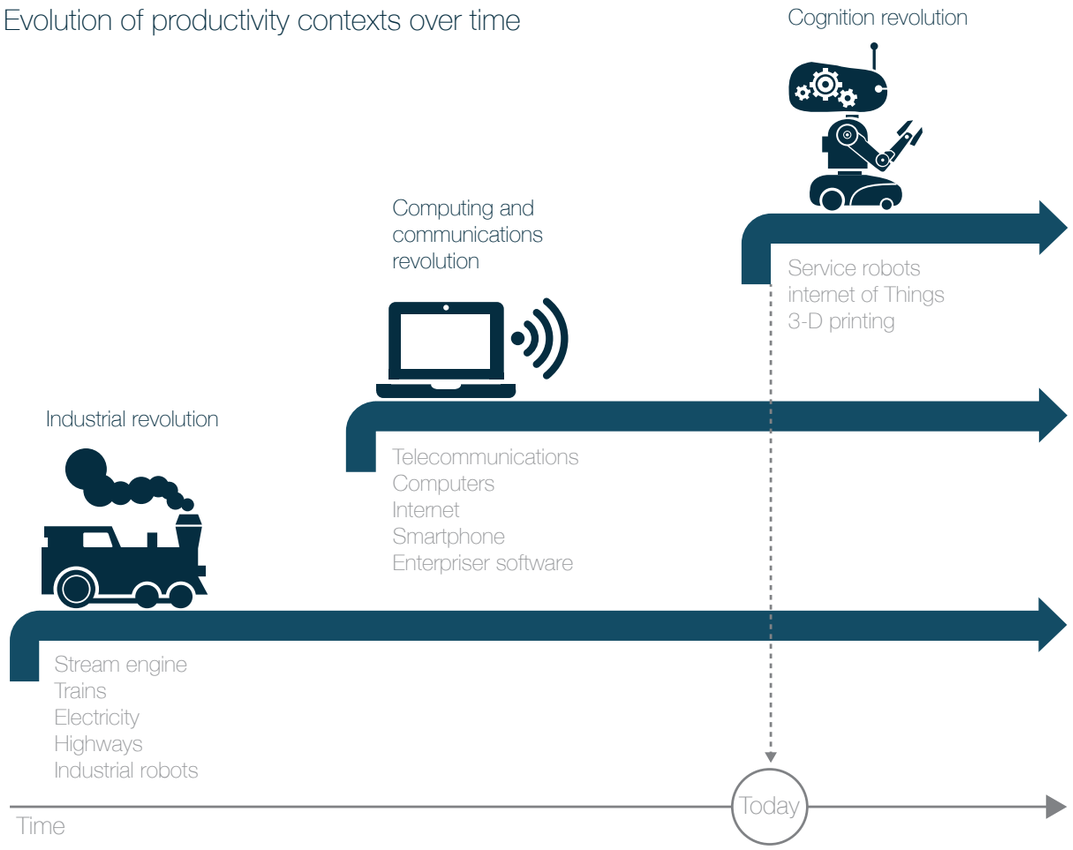
Illu. 5 - Show the definition of autonomous learning and modular platforms. [Baya, V., Wood, L,. 2015]

1.1.2 PRODUCTIVITY IMPACT

The growth of productivity has been increasing for a long time, and the last 120 years the annual growth of manufacturing, mining, farming and construction has been between 3-4% [Drucker, 1991], which overall makes it a 45 -fold expansion the last 120 years. This growth started in a physical context with the industrial revolution, which later transitioned into the computer and communication revolution in a digital context. And now we are entering the cognitive revolution, where the physical and the digital are merging together, setting the stage for products like service robots.

- The first world is at the beginning of a new revolution; Cognition revolution.

Evolution of productivity contexts over time



Illu. 6 - Evolution of productivity over time [Baya, V., Wood, L,. 2015]

1.1.3 FUTURE OF ROBOTS

In addition to the research the team has made as an initial step of diving into the robotics world, a discussion with Karl Damkjær Hansen dived into the aspect of paths for new technology. The discussion generated a view upon spreading of new technology as being at first; targeting simple areas to generate specific functioning solutions until most areas are covered, where the 'merging' phase initiates to out compete the static solutions.

The mere principle of development

Taking basis in 'The age of spiritual machines' where Ray Kurzweil [Kurzweil, 1999] explains his believes that evolution provides evidence that human will create machines with great intelligence. He grounds these theories in facts, algorithms and other theories about the exponential growth of computing. The point in this is linked with a theory he mentions called chaos theory, which ties amount of chaos and speed together. This theory states that when chaos is low; speed is high and vice versa, and robotics and computing in general is still 'simple' meaning low in chaos; resulting in high speed of growth. The current simplicity of service robots for example shows very much in which state the area of robotics are. Moore's law states that the amount of transistors in computer chips will double every second year, and it has held correct for 60 years and as for the complexity of robotics in general, it is highly likely that such a 'rule' will immerse as well for robotic actuators, as the 'Law of acceleration' will apply.

Chaos theory -> less chaos = higher speed -> more chaos = less speed

Path of robotic development

Exemplifying in the illustration 7; the current path of overall robotics within various fields is pointing towards increasing cooperation between humans and robots, making interaction, on a more social level, the more increasing topic of interest. Connecting this with the speed of which the development has, but given we're at the starting point of socializing robots with humans, the interaction is still very simple. Another thing is how simple it should be at this point in time, as for not breaking the comfort zones within different cultures. So developing the interaction should follow an evolutionary acceleration, meaning that it shouldn't leap; it should gradually build up, as the human habituation ability tolerates it. As for determining the speed of this habituation ability regarding robots, it's hard to say before wide implementation starts and a few steps are taken to evaluate upon.

The development in the Danish society

The society is always in develop and Rolf Jensen in his book Fremtidsmagerne – inspiration til nutiden fra 2030 gives an idea of how the society is in 2030 [Jensen, 2005]. The main thoughts are that the motive power is experience economy, and that everything is an experience that we want to be a part of, instead of being observers to our own life and the development in the society. The Danish people distinguish from the rest of the world by designing to the hearts and the feelings, and thereby share emotions and be diverse in the society. The learning of 2030 is play, experience and participation, and could be an inspiration of guidelines for future design of a robot.

Conclusion:

In the further where will be integrated robots other places that in the industry, the phenomenon service robots will be used in daily life.

The development of robots will be exponential and the there must be focus of future-proof the product.

- High speed development at exponential rate should be integrated in the line of thinking for the project.

Illu. 7 - The development from industrial robots to service robot and to social robots. (Pinterest, 2016)

1.1.4 MISCONCEPTION

After getting an insight into the pace that the development has, it is time to clear out the misconception that leading robotic project have created worldwide by showing off the max output of their robots in controlled environments. The result of watching top examples of todays robotic possibilities on a wide spectrum of areas, creates a heightened bar of expectation to what a robot should be able to do, both seen from a users perspective, and a developers perceptive.

Taking basis in the examples in illustration 8-10, it is exemplified how far certain areas are, and how great results they have shown in controlled environments. But when you take results from controlled environments, and expect them to work close to stable level in uncontrolled environments, then you learn otherwise. The point being that when people see these great achievements in controlled environments, they don't get to see all the aspect that do not work, and thereby assume proper functioning at that level, whereas in reality it is far lower.

To see more about the robots see the USB.

Illu. 8

Leo the robot, which can learn how to react to things by interaction. [TED, 2010]

Illu. 9

PKD android whome resemble a science fiction writer; Philip K. Dick. Database creating knowledge base so you can interview him, where he creates his own sentences. [TED, 2009]

Illu. 10

Big hero 6 is a movie, where the character Baymax is a health care robot, actually constructed seemingly realistic, even though it isn't. [Big-Hero-6, 2014]

- Robotics is an area known for its front runners, which set the standards.
- Ensure that the robot do not indicate competences it doesn't accommodate
- To be ready for production in the end, simplicity has to be key.

1.1.5 HUMAN PERCEPTION ON ROBOTS

In continuation of the misconception of robots, a mis-perception is also currently happening. A recent survey indicates, on basis of participants from the staff of a disability service organization, that they do not see robots as human-like social actors. Instead they see them as a technical application, just like a coffee machine or a vacuum cleaner. [Wolbring and Yumakulov, 2014]

In addition to this, a study based on a secondary analysis of Eurobarometer 382 “Public attitudes towards robots”, which is based on EU citizens aged 15 and over, from 27 countries in 2012 [Taipale, de Luca, Sarrica, Fortunati, 2015], indicates that the European people on some specific areas are non-supportive of robots. As seen on illustration 11, military and security, space exploration, search and rescue and manufacturing are the most accepted domains of implementation. Widely seen, these domains are primarily male dominated areas and a part of production, which in contrast to reproduction areas such as domestic work, education, child/elderly/disable care, are more prone to acceptance of robotics implementation by the Europeans. Acceptance of robots is seemingly linked with social class, being the higher socially placed, the easier you are to accept robots in health care. Pensioners are the most willing group of people to accept robots in health care, and this might indicate that people more naturally linked with the area are more acceptable of adopting robots to it. Hereby it is meant that pensioners are closer by age to be more interlocked with the health care system, having thoughts about their need for independence while somewhat disabled.

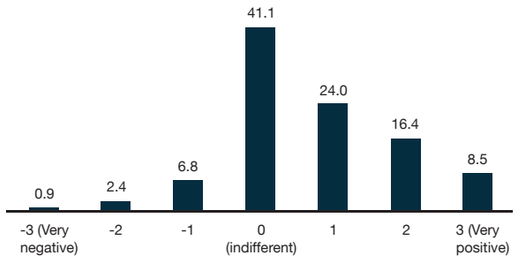
Overall the study states that 90% of the respondents were between neutral and very positive of robots, making only 10% negative towards robots. These numbers are based on the respondents mostly choosing more places for robots to be used instead of banned, which were the basic choices for the areas.

The basis of this study is questionable though, as the introduction to what robots are before the interview were only two pictures, which alone do not create an appropriate foundation for developing an opinion on this subject.

Life domain	n	%
Space exploration	13,895	51.9
Manufacturing	12,282	49.7
Search and rescure	11,016	41.2
Military and sercurity	10,937	50.9
Health care	6,007	22.5
Domestic activity	3,574	13.4
Transportation	2,962	11.1
Agriculture	2,813	10.5
Child/elderly/disabled care	947	3.5
Education	694	2.6
Leisure	670	2.5

Note Domains of social reproduction are in bold

Illu. 11 - Where Europeans are ready to implement service robots [Taipale, de Luca, Sarrica, Fortunati, 2015]



Illu. 13 - Response on test. [Taipale, de Luca, Sarrica, Fortunati, 2015]

- People in Europe have strong opinions of where robots are tolerated.

1.1.6 HUMAN ROBOT INTERACTION (HRI)

Human robot interaction is a huge topic and have used, in many years, to define the robots behavior from how humans react.
Isaac Asimow (Clarke, 1994) did in 1941 state three laws to clarify where robots are in the hierarchy between humans and robots.

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey any orders given to it by human beings, except where such orders would conflict with the first law.
3. A robot must protect its own existence as long as such protection does not conflict with the first or second law.

These laws were stated to have a safety interaction with robots. It is now many years ago and the development of robotics have been changed a lot since, but it is still something that is in mind when developing service robots and humanoid robots.

In the research of Human Robot Interaction is a broad approach to the actual interaction between humans and robots, but the results of the research can be difficult to use for other cases, because it is specified for the exact case. Therefore, this project, will not take any underlying basis on previous research on human robot interaction, but the team will make their own observations in connection to the context and the complexity of the designed robot.

- The team will test by themselves the vision of the interaction between user and the robot.

1.1.7 SMARTPHONES VS. ROBOTS

In 2016 a majority of the population has smartphones, tablets and other gadgets. Institutions have screens, tablets and apps for information, so what can a service robot deliver that these other products cannot?

A robot has its own physical mobility, the ability to escort and physically show, whereas a smartphone or tablet is restricted to digital navigation with close to no connection to the surroundings, for now. One of the biggest advantages robots have, is the possibility to perform physical interaction with users, which for the users always will be more natural and intuitive than digital interaction. At the moment service robots and apps are still linked together, as developing an independent OS for a robot is time consuming, and the result is unwanted by users. As for service robots the user will be served the information instead of actively searching for it.

Compared with humans a robot is doing a homogeneous job every time and thereby not vary in the service level from time to time, as undoubtedly human work will do.

Conclusion:
So to design a robot that cannot be replaced by an app alone, where the robot is an extension of an app that maybe in practical use has too little or short use for the users to want it. Focus has to be on communication with the user, and define the needs of the tasks that the robot needs to do. The focus is to use the mobility of a robot and the modularity of doing different things with a clear intention of it doing it right every time.

Repeatability

Accuracy

Own physical mobility

Physical interaction

Creating atmosphere

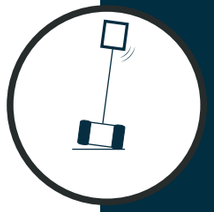
- Robotics have specific advantages that has to be in focus to ensure outcompeting ‘apps’.

1.1.8 STARTING POINT

The starting point and the technology push of this project is a robot technology of navigating on the floor. There is a robot named Double, that Karl is inspired of in his development of a robot. The Double mobility will be the basis for the driving technology used in the project. The Double robot is now a telepresence robot for communication, creating a physical presence. The telepresence person is navigating the robot via a computer, hereby the person can be at a conference another place in the world, without having to take the trip. The robot can raise op and down, so you can stand up and talk with people, and get the illusion of sitting down while being at a conference.
Karl is developing upon the Double, giving it the ability to navigate without a user, by implement a computer and navigational sensors like LIDAR system mapping. The development of the functionalities that the robot should be able to perform will be a collaboration between the team and Karl, hereby meant that the team will set the demands for the navigation and programmable functionalities for Karl to perform. These demands will be defined throughout the project in collaboration with Karl, creating a validation about the possible validity of the programming. and thereby the limitation to the project is not much, and something coming in the process.

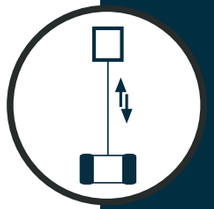
Illu. 14 - The Double robot [Bano, 2016]

Navigation using arrow keys



Stability of the robot is missing in the sides Lateral Stability Control

Tilting back and forth when stop driving



Make adjustment in the high

Tilts slightly back and forth to imitate the body language of a person.

In further definition of the starting point, the team has performed tests on the Double, to clarify the properties and identify possible pitfalls regarding this project.

This initial testing phase focused on mapping mobility regarding possible interaction and maneuvering scenarios. Testings here were:

- Speed on straight path (min. and max. height),
- Speed on rotation on spot,
- Stability on push
- Attention factor.

The team found that the technology in the Double makes it fairly slow overall, which would make rapid movements for interaction very hard. In addition the team confirmed that a robot in the year 2016 has a very high attention factor, as a simple drive-around at CREATE AAU resulted in people filming, taking pictures and generally stopping what ever the were doing when discovering it. [Worksheet 17]
This information will be a reference point to the timeframe and possibility of interaction movements later in the process.
Based on the tests done at the group rooms, the team concluded that the mobility base works well and stable enough to be used as a foundation, which again also is the opinion of Karl. The speed of it might not be enough, but upgrades are possible and the further definition of the interaction will determine whether there should be demands for higher movement speed for efficient interaction.

At this point the screen of the Double, an iPad, is thought to be integrated in the product as well, as the basic idea is to use its competences in terms of computer power, software modules, touch screen, camera etc. to fulfill navigational and interactive aspects of the product. At this early point, no reason to derail the use of it has been identified.

Speed on spot rotation
14 sec (laminate floor)

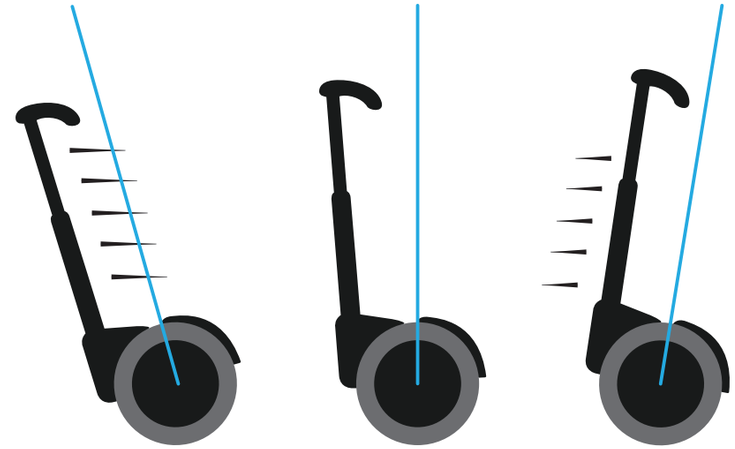
Speed on straight path
42 sec (high)
21 sec (low)

Stability on push
Very hard push required
3-4 meters to stabilize

Attention factor
3 people video recorded

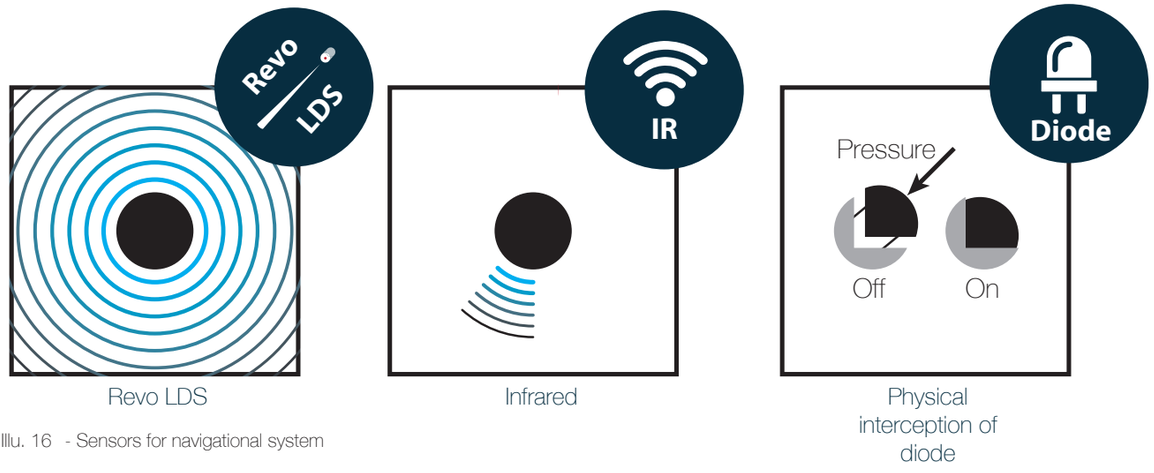
- Need of better lateral stability
- Need of navigation system
- Use tablet and mobility principle
- Need of higher speed for reactive movement.

As the team decided that the mobility base would be what the project builds upon, a brief walk-through of the principle will be presented. The segway technology is based on the principle of balance, activating upon imbalance made by a person. The principle uses a sensor to measure lateral angle, and the motor gets activated depending on the given angle of imbalance, so the higher an imbalance angle, the higher the speed to counteract the falling motion initiated by the user.



Illu. 15 - Segway principle

The missing link from a mobility system to a robot, is the navigation. The way of navigation will in this project, decided with Karl, be based upon the same principle that common robotic vacuum cleaners use. The illustration 16 shows how a combination of Revo LDS, infrared and light diodes create a great navigational system with three stages of sensors to observe objects, so there always will be a way of sensing objects. The aim is to create a selfdriving robot, these sensor are key essentials for it to do so.



Illu. 16 - Sensors for navigational system

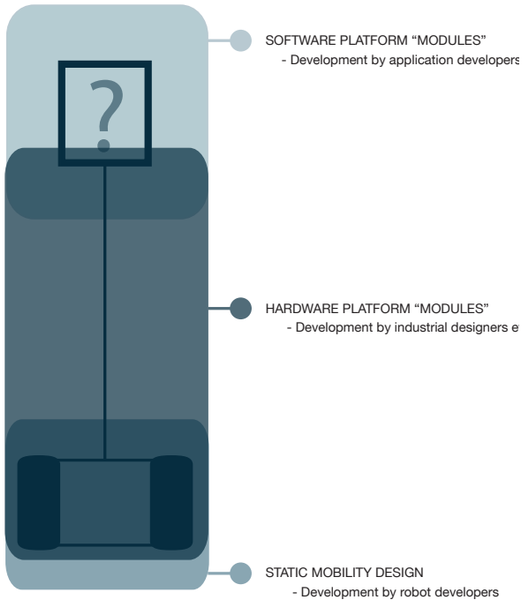
1.1.9 KARL's VISION WITH THE PROJECT

Karls vision for his funded project is to develop a social robot, and through the first meeting with him, the team initiated the idea of creating a robot that aims to fulfill tasks in various contexts, with the same base.

At this point, the 8th of March, Karls vision is to make an application based robot, that has access to software modules, maybe through iOS, that creates possibility to execute various tasks. This software module principle can also be combined with hardware modules, to create two modularities on top of a mobility base unit. This is the vision from his point of view now, where this will help the robotics community expand social robots faster as this vision strives to lower the entry barrier to the field.

Karls vision of using tablet technology together with a robot is being validated by Baya. "The large base of mobile app developers will be in a position to use their skills to develop mew behaviors for the robots." [Baya, Wood, 2015]
The way these two projects intersect is that DEVit is developing on an enabling functionality to build the robot around, working mainly with design and interaction. Through this entry point, the longer development of a platform system will arise, but it will not be a focus of DEVit, merely a thing to be aware of in the design process.

Other that DEVit's project path, another project is working on implementation of a social robot in rehabilitation centers, and Karl himself is looking into placing it on construction sites for architects etc.
These three contexts will at project end, late May 2016, set some requirements for how to be able to target all contexts with same robot.



- Using tablet gets emphasized.
- Ensure that the robotic exterior design can fit multiple contexts.

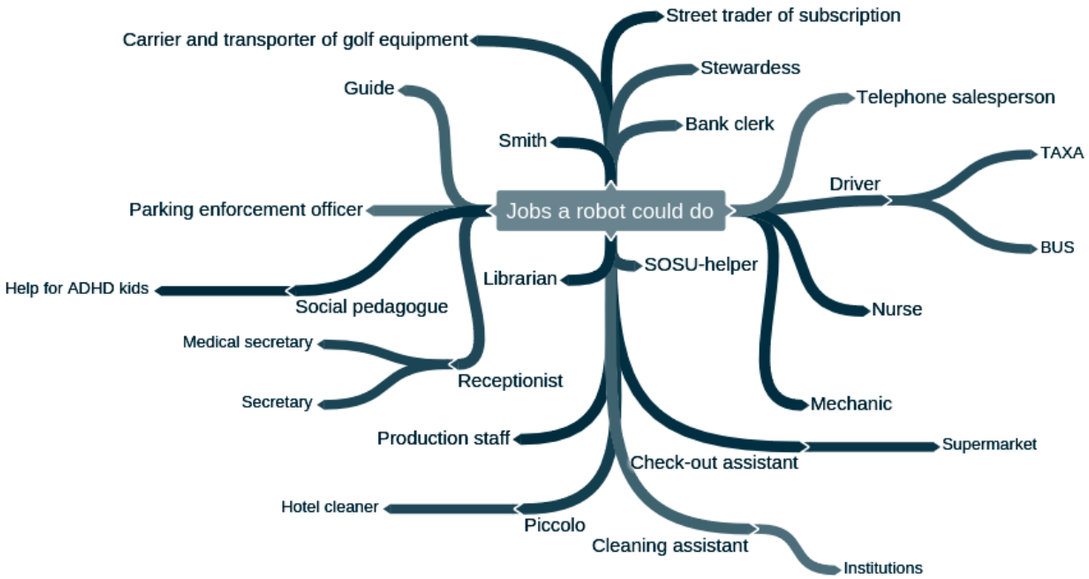
Illu. 17 - Initial understanding of project path

1.1.10 EXTERNAL ANALYSIS

The team wanted to analyze the development of the world to identify any opportunities or threats for this project to have in consideration when developing. The analysis' objective was for the team to open the task and find new aspects for the direction, so there would be a clear path for implementation. The analysis is subjective and there can be some aspects not represented in the analysis.

One way to analyze the current flow and trends in the world, is by making a DEPESTe analysis, here used to identify insights in parts of the developmental domains in the outside world. [To see the whole analysis see Worksheet 02]

This analysis lead to creating a mind-map of which jobs would be most appropriate to target for service robots, the team mind-map on possible positions that robotics could fulfill with the current simple state of robotics. The objective here was to widen the view upon the context of which service robots would actually apply to. In addition to that, it also would give a view upon what the team expected would be covered by robots in the near future, on basis of the initial research and knowledge gathered. This mapping created an overview over the potential jobs the robot could do, and thereby different places to implement the service robot.
The different environments have been worked with additionally to find the best path of the project.



Illu. 18 - The mind-map over different jobs the robot can do

1.1.11 PROJECT PATH

After collecting initial knowledge about robotics in various aspects, a path for the project had to be chosen. The process of selecting path for this project may seem rather detailed as the team could've just selected a path without any argumentation as it is a 'studying' project and any path within robotics at the moment is appropriate. The team agreed early on, that looking at the project as business development and with entrepreneurial approach, would be most beneficial for developing a solution best suited to hit the marked. This is why business foundation, future security and adoption of context has been quite crucial for the selection.

To pick the most appropriate environment for the project, four qualified environments were picked out, and brief concepts were brainstormed about implementation of a service robot. Different parameters were set up to evaluate the environments on many levels and different perspectives.

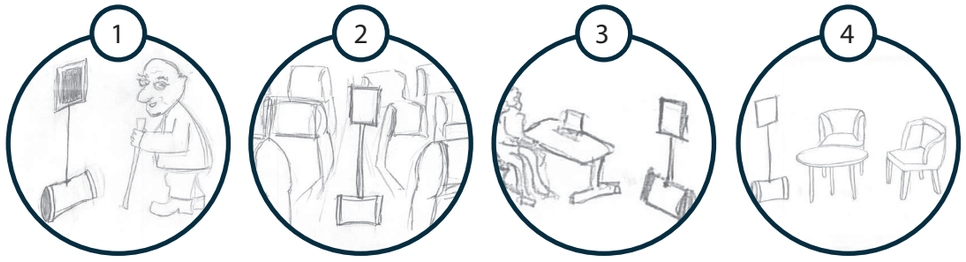
CONCEPTS:

Environment I - Elderly homes
Activation of elderly at elderly homes. It is a project already initiated, with research and some test already made. The focus with this predefined project would be a lot of interaction design, aesthetics and entertainment ideation.

Environment II - Robot as a stewardess
Implementing a service robot on an airplane to replace some of the stewardesses was a result of locating jobs which 'easily' could be automated. The idea is to create a delivery solution that is not in the way as the stewardesses often are.

Environment III - Robot in an office
The main value and function discussed with offices would be using cameras to detect body movement and positions to evaluate ergonomics on employees and through that enhance workers health etc. for a more effective work place.

Environment IV - Robot at a hotel
Hotels have many simple tasks with transport and delivery that a service robots could perform quite easily, and for this context a discussion about multiple functions occured, that seeded the idea of a project working towards a modular platform product.



Illu. 19 - The four concepts of placing the robot in a context.

1.1.12 PARAMETERS

To evaluate which path to take the project, a benchmarking was made, the parameters were as follow:

Is it going to be a service or social robot?
- There are lot of different kinds of robots and the focus on this robot is a service robot, and thereby offer the costumer, or the user a service and not need to activate like a social robot.

Does modularity of the robot makes sense?
- In the context it should give the possibility of having a modular robot with skills and tasks in the daily life.

Collaboration with Karl Damkjær Hansen
- This project is taking basis in Karls robot, and the team wants to collaborate with him for various reasons, which limits the team to social robots where his project is limited to.

Robot vs. smartphone/tablet for the need
- Smartphones and tablets are far ahead of robots, and they are great at covering some needs. Keeping in mind where the robot can differentiate itself is key, as an app shouldn't be able to compete with the robot; because the robot probably will lose.

Ethic
- Ethics is often slow to catch up with technological development, [Kilde: Robot Ethics, the ethical and social implications of robotics, by Patrick Lin, Keith Abney and George A. Bekey] thereby the ethic is a huge part of designing a robot and find the skills for the robot particularly when surveillance of the human behavior.

Robot competition in the field
- Are there already implemented robots in the context, or is it a completely new area. A place where the robots already is in the field can give an idea of the need of a robot and that they are ready for the invention of a robot in the workplace but it also gives competition consisting of robots filling out the needs.

Business foundation
- Can the team see a business potential for the context?

Team interest
- It should be a project where interest and motivation is present.

Is it possible to implement the robot within 2 years?
- The robot technology is in rapid development and to make sure that the robot and its components aren't getting outdated before it is launched. We have a value of two years of development for latest implementation of the robot.

The evaluation of the benchmark is from a scale of 1 to 10 where 1 is low/deficient and 10 is high/very good. The team made the benchmarking on qualitative subjective ratings of the described areas.

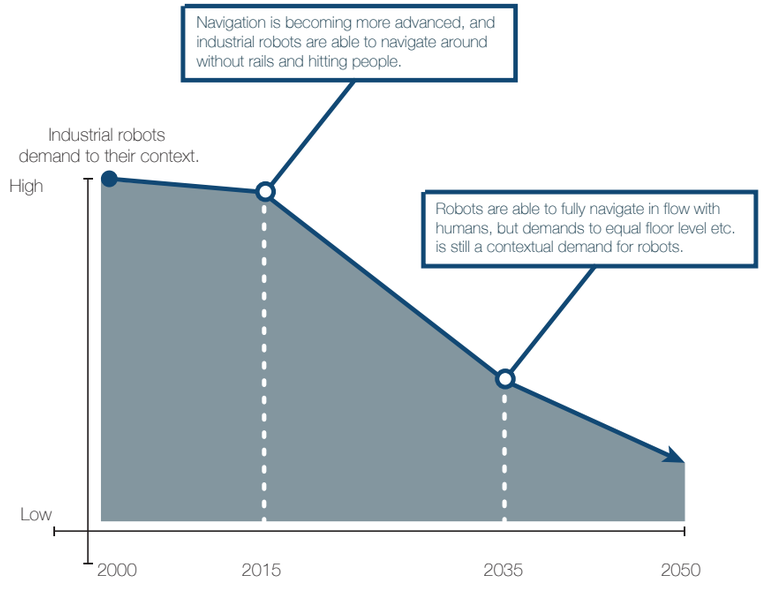
	Elderly	Airplane	Office	Hotel
Service robot	4	6	5	7
Modulation of the robot	3	3	6	7
Collaboration with Karl	8	1	7	8
Robot vs Smartphone/table	9	7	4	9
Ethic encounter	4	2	2	8
Robot competitors	4	2	3	5
Implemention within 2 years	8	2	3	6
Business foundation	7	5	5	8
Team interest	3	4	4	7
Context accessibility	8	2	4	6
Attention in context	4	7	4	8
Total	62	41	47	79

Illu. 20 The benchmark where it is the hotel context have the best score.

Taking basis in the benchmarking, the selection of hotel seems most beneficial, as the others contain areas that increases the difficulty of the project unnecessarily, like much ethical work and accessibility to context. Furthermore, the hotels seem to have more directions within itself of which the team can direct the project. The only 'downside' of choosing the hotel as context would be the competition, as service robots have been developed for this market, but they are still limited to three hotels in Silicon Valley and this robot should be implemented on the Danish market.

1.1.13 IMPLEMENTATION OF ROBOTS IN A CONTEXT

To implement a robot in a context the context need to be ready for the robot and the tasks that the robot have to do.
With industrial robots the context, often factories, are designed for the robot. The robots started being in cages, but technology makes industrial robots more competent as to be amongst the workers. It is the same for a service robot in a context. It is not really convenient to place the service robot in a cage until technology catches up and people are comfortable with them.
The point being that the context should be ready for the robot, and it is not unlikely that a solution will demand contextual changes. Robots are in many areas not ready to be incorporated into contexts without additional demands and this knowledge can possibly be used in the development.



Illu. 21 - A graph over easy it is to implement a robot in a context over time only visual, no underlying research.

- Hotels will be the context.
- Context should be willing to adapt to having a robot.

1.2 HOTEL

1.2.0 INTRODUCTION

As the team has targeted hotels as the audience for implementation, research has to be made to identify possibilities within the hotel industry. This chapter will go through the teams approach on determining the most convenient functionality for development of this robot.

1.2.1 SCREENING

The first step the team took was to make a screening of the nearby hotels in Aalborg. [Worksheet 07] This screening contained brief observations of structure with bar/lobby, hallways and obvious mobility obstructions, semi structured interviews at three of four places. The objective was to identify initial problematics and opportunities, possibly resulting in identifying path to dig deeper into.

The screening contained visits at First Hotel Aalborg, CabInn Hotel, Radisson Hotel and an arranged meeting with First Hotel Europa [Worksheet 06]. The team talked with a manager at First Hotel Aalborg, a vice president at Radisson. The meeting with the manager at Europa was in collaboration with Karl, but in all four cases the reception and lobby was observed.

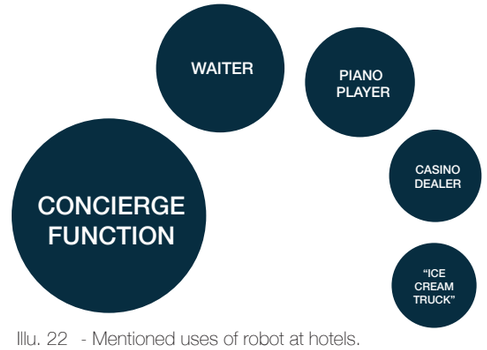
At First Hotel Aalborg the manager had trouble identifying the positive aspects of the implementation of a robot in any aspect. This resulted in the constructive realization that framing and communication when talking about this topic is crucial.

The visit at Radisson was quite another experience as we got a meeting with the vice president by mere coincidence, resulting in a 45 min meeting discussing future of his hotel, and how robots could be implemented. He mentioned some of the basic principles of what hotels are experiencing about worker contracts in Denmark versus Asia and Germany*, and how this puts pressure on Danish hotels to innovate to keep service up.

CabInn Hotel was very brief visit, basically just to see mobility possibilities, to compare with the other hotels.

The meeting with First Hotel Europa and Karl [Worksheet 03] was an introduction, and ideation on possibilities together with the manager and reception. The objective was to open the solution space, creating a path for the project.

Illustration 22 illustrates very abstract by size how much some ideas were mentioned through this screening, indicating the direction of focus for hotels



Illu. 22 - Mentioned uses of robot at hotels.

- Service and entertainment combined with more sales is key motivator for hotels.
- Cheap service over time is needed from the hotels more and more.

1.2.2 HISTORY OF HOTELS

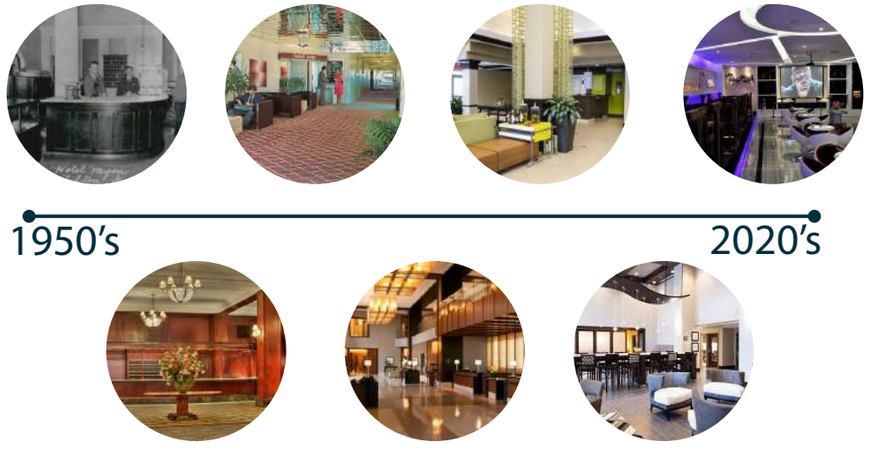
To understand the world of hotels, the team made desk research on where the hotel world evolved from, and where it is going.

The phenomenon of hotels has existed since the mid-17'century and the service haven't change a lot since the start, it is still part of renting out rooms to guests visiting a town with various agendas. Since the beginning many jobs such as butlers, piccolos, housekeeping, concierges and receptionists have existed through hundreds of years, but the business for hotels last 50 years have forced butlers, piccolos and concierges to only belong to the finest hotels, as contracts demand too high salaries for their profession. Nowadays the costs of the financial crisis have been hard for the hotel business and the hotels need to have fewer employs per room and per guest [Kilde: Hotelerhvervets struktur af Horesta]. The hotels do still need to offer a high service with less employees, and here a gap has emerged that robots potentially can fulfill, to close the gap between the services the hotels want to offer and what they can afford.
The Fast Future Research [International meetings review, 2016] have in 2010 launched lines for the hotels in 2020 by creating a survey, and apart of the focus is on where hotel will put their focus:

1. Guests' will be able to tailor every aspect of their hotel experience
2. The hotel of the future will be more personal, connected and responsive
3. Horizon scanning, anticipation and rapid implementation will become some of the hallmarks of successful hotel groups.

The essence of this research is that the hotels need to optimize their experiences for the guests, and reduce the time of checking in/out. They want to have a personal experience, and be connected to the hotel and the employees offering the services.

- Hotels are continuing to lower cost, while trying to keep up service, may be fit for a robot.

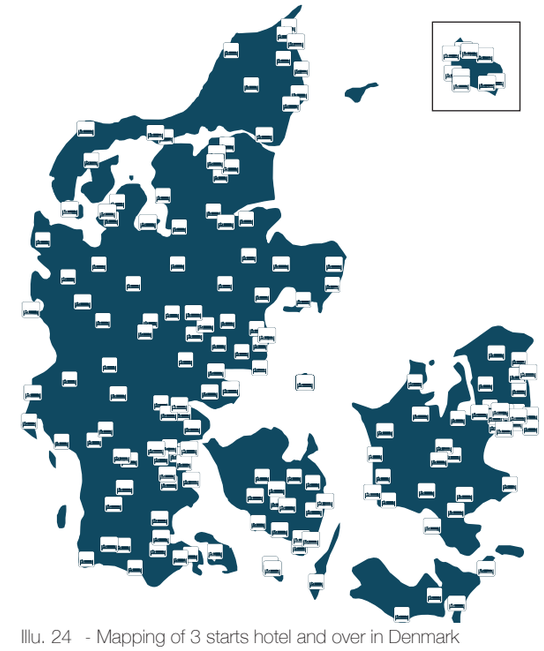


Illu. 23 - A time line over hotel lounges in the world [Pinterest, 2016]

1.2.3 TARGET GROUP - BUSINESS FOUNDATION

To establish an idea for the team about quantity of hotels with a certain level of service, the team researched on industry demands for stars. To be a hotel, you need to have at least six letting bedrooms and three of them need private bathroom facilities [Business Dictionary, 2016]. There are different evaluations of the standards for a hotel. 16 European countries have created a union for defining the standard a hotel has in general comparison. [Hotelstars, 2016] The evaluation is determined by a range of stars. [for full definition of the range can be seen in worksheet 11].
As the frontstage of hotels generally is the reception and lobby area the team chose to frame the project towards hotels that has this as a requirement, which is three starred hotels and up. Should the team go with a functionality backstage such as cleaning, another framing would be required as one starred hotels are required daily room cleaning as well.
To define the limit of the hotels there are, focus was on the hotels with 3 stars and over, because that requires the hotel to have a open reception 14 hours every day, and a lounge with a bar.

In January 2016 there were 471 hotels and holiday resort in Denmark where 63 of them is in North of Denmark [Dansk Statistik, 2016]. 283 of the hotels are members of the organization Horesta giving the hotels stars and evaluate their quality after a standard. (Hotel stars, 2016). 259 of the 283 hotels have three or more stars, meaning that 259 hotels at minimum have a lounge area with a bar, and can be potential market for the solution.



Illu. 24 - Mapping of 3 starts hotel and over in Denmark

- 3+ stared hotels often have higher interior standard, which sets a requirement for the aesthetics of the solution.

1.2.4 'COMPETITION'

Even though China has cheaper workforce than the western world, hotels are already testing robots as a dynamic part of hotels [Main Online, 2016], to reduce resources on employees. This trend makes it a growing area where robotic solutions are already appearing. A hotel in China have implemented a robot for bringing drinks, where the guests order from a tablet and the robot is delivering the order to them.

A hotel in Japan [The guardian, 2016] has gone a step further, by completing a hotel only with robots serving the guests. The vision for this hotel is to have a low-cost hotel where the guest do not need to pay for the employees at the hotel.

The hotels receptionist is seen on illustration 26, the way the guests interact with the robot is by having four different buttons to push to make the input for the robot, keeping it so simple that it works.

The robot on illustration 29 is the piccolo taking the luggage from the lobby up to the room for the guests. There is placed a screen on the robot where the guests enter the room number, and follow the robot to the room.

The robot on illustration 27 is places in the luggage room and ordering the luggage for the guests. It has the same function and navigation as an industrial robot but offering a service, and through that becoming kind of a service robot.

A hotel in California has a butler robot [Star wood hotels, 2016], Illustration 28 A.L.O. Botlr, to deliver the guests room service. The guests order in the reception, the robot gets packed, and the robot is then driving with the elevator to the floor, to the right door. The guest opens the door and take the order, and the robot goes back to the reception.

The implementation of robots in human contexts has begun, but it is still rare as the prices are so high The robots needs to fulfill different tasks to be valuable enough to implement, but as of now, that is too much to expect from them.

Illu. 25 - Robot serving drinks [Main Online, 2016,]

Illu. 26 - Receptionist robot in China [The guardian, 2016]

Illu. 27 - Luggage robot in China [The guardian, 2016]

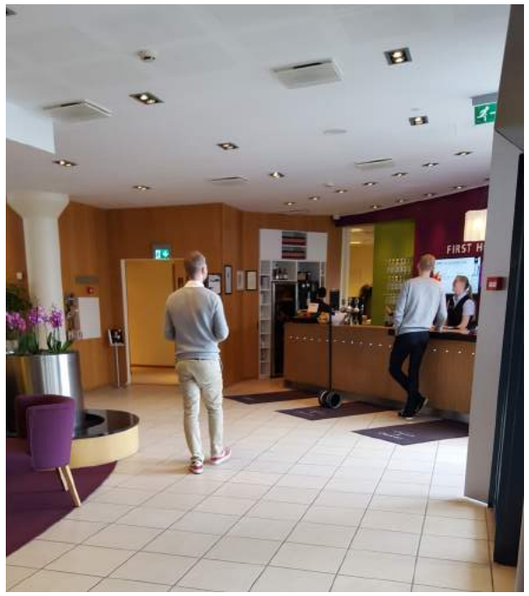
Illu. 29 - Piccolo robot in China [The guardian, 2016]

Illu. 28 - Aloft Botlr robot from California [Star wood hotels, 2016,]

- The robot should adapt to the context.

1.2.5 CONTEXTUAL OBSERVATIONS

To investigate further where the robot potentially could be integrated, the team wanted to observe front- and backstage at First Hotel Europa. The hotel is a three star hotel with a lounge and a bar. The hotel is from 2002 and has 168 rooms, it is mostly a business hotel, meaning that a lot of guests are on business trips in weekdays. The weekends are to the contrary mostly tourists.
The hotel has connection with Aalborg Conference and Culture Center, and restaurant Papegøjehaven. This means that the hotel often has guests connected with the venue. The hotel does not have their own restaurant, only a kitchen offering breakfast and sandwiches. At each room there is a bathroom and the housekeeper coming with new towels every day. [Firsthotels, 2016]
The reception is open 24 hours with staff, and it gives flexibility of checking-in and out for the guests.
The guests at the hotel are 80% business people and 20% tourist. This means that the lounge is mainly used by the business travelers.



Illu. 30 - Pictures of First Hotel Europa

- Business people will be the consumer if front stage is becoming the target.

BACKSTAGE

The objective with observing the backstage of the hotel, here being housekeeping, was to find opportunity for the implementation of a robot, or to dismiss the possibility of it.

The observation of housekeeping was of two stages, first being observation of a housekeeper for an hour, and then following their manager for two and a half hours.

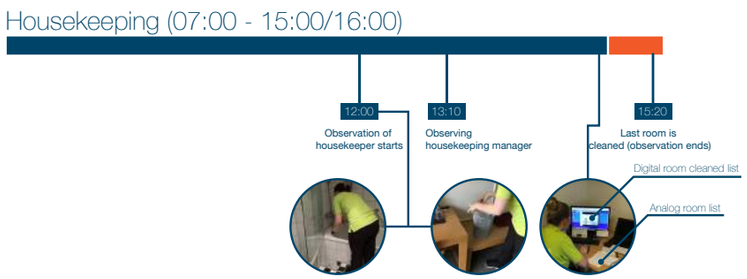
As seen on the illustration 31, two types of executions on hotel rooms were performed by the housekeeper, where the main principle of actions seen with robotic terms were manipulation, which as previously stated is very complex, but overall there were a high state of repeatability. The only notable opportunity was to optimize the housekeepers by assisting them, as they ran a lot between their wagon in the hallway and the room.

When following the manager the repeatability wasn't there anymore, as she functioned as an agile all around connector between the cleaning service and the reception. Some of the tasks she performed were stated in the illustration as well, and the principle of her tasks were as well as the housekeepers manipulative, but also much interaction, both physical and digital, and running from floor to floor, back and forth.
A more detailed description of the observations can be found in worksheet 13.

Conclusion:
Starting with the housekeeper, where as mentioned optimization would be the only logic implementation possibility, the idea of a following tool assistant were generated, creating a possibility backstage.

The complex composition of the managers work flow made it impossible to see how a robot at current technology stage would be able to support her work, as the mobility mainly is obstructing the ability to follow her.

There were possibilities for improvement on a structural level, meaning the way they communicate ready (cleaned) rooms to the reception, but a robotic solution is in no way convenient.



Illu. 31 - Backstage mapping of observations

FRONTSTAGE

The objective for observing frontstage, here being the lounge/bar, were to note the flow of the receptionists and all the different guests and people walking in the lobby throughout the day. The wanted result for the observations were to find tasks that a robot efficiently could fulfill, or in other ways add value for the guests. The observation were spread over several days, because the tasks and the activity in the lounge is fluctuate.

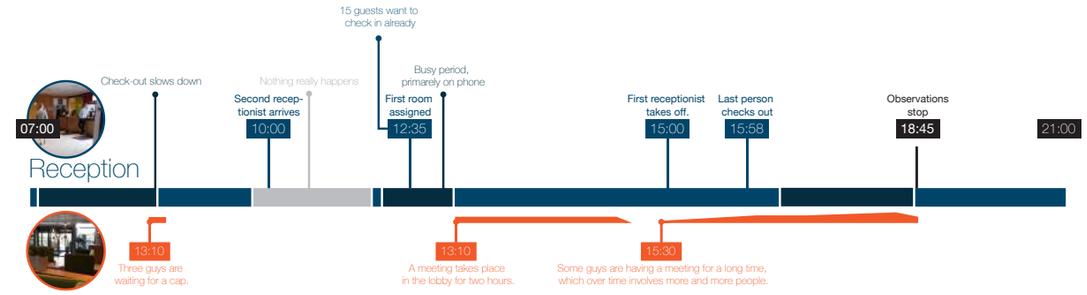
The observation was performed by sitting in the lobby from 7.05 pm until 6:30 am, and again a week later at 4.30 am to 9.30 am to observe everything happening in the lounge, to see a pattern in the daily work and flow of people stay in the lounge.

Receptionists do a lot of different tasks, and lot of them are services for the guests, checking in and out, and guiding them to their room etc. A big part of the tasks were out-house orders for the guests like taxi or pizza. Much time throughout the day is spend by ordering taxis, and finding the guests that ordered it upon arrival of the taxi.
A part of being a receptionist is to be able to serve the guests in the lounge. The receptionists are taking orders in the reception that is combined with the bar area. It came to the teams attention that the receptionists acts as waiters, but they seem uncomfortable doing so. The receptionists being uncomfortable obstruct the creation of more sales, as they don't posses the training to feel comfortable doing it. This results in the hotel not having the more sales that they could have.

A more detailed description, see [Worksheet 12 +15]
.

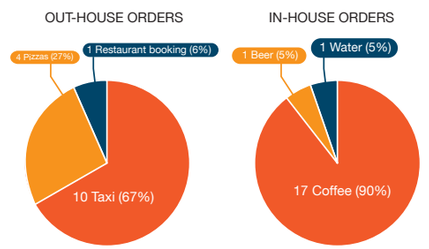
Conclusion:
Many of the tasks that the receptionists have, are as interaction link for the guests, like ordering pizza and that will be difficult for at robot to fulfill. This fulfillment is hard because it is difficult for a program to make conversation, first to the guest and then the pizza restaurant. Karl believes it is possible, but it would require a lot of time for a function that creates no revenue for the hotel, and the functionality has to be a place it makes sense to implement a robot compared with a tablet or smartphone, which it in this case doesn't.
A place to focus is where the guests are ordering something in the bar, so the hotel make the guests be aware that there is a bar in the lounge.

To see illustration 32 in larger format, see worksheet 12.



Illu. 32 - Frontstage mapping of observations

- Should be able to withhold power from 15:00-23:00, plus some time here and there during the morning.
- The robot could make it more comfortable for the receptionists to create more sales.



1.2.6 CLARIFICATION MEETING AT EUROPA HOTEL

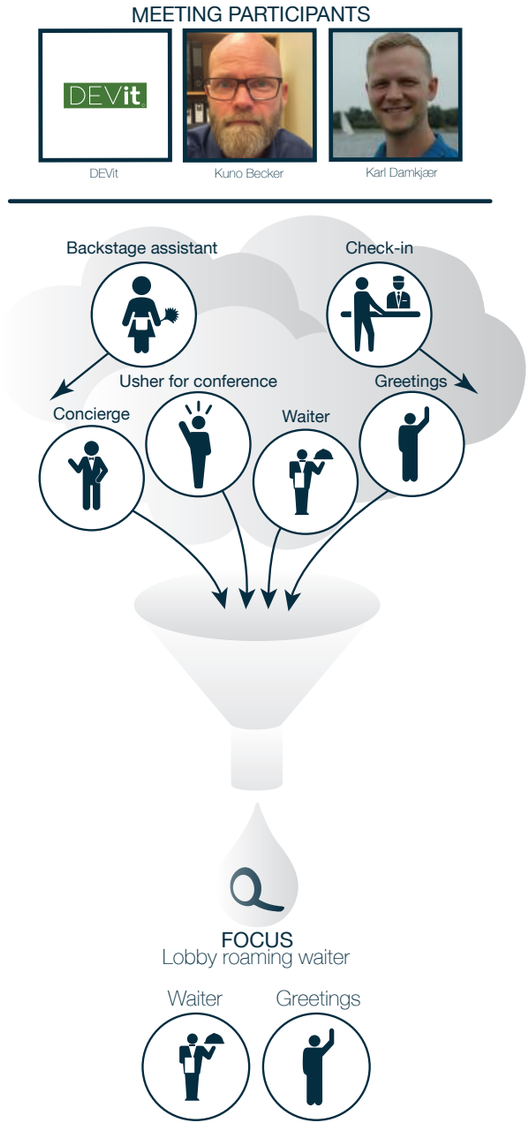
After using twelve hours a First Hotel Europa the team felt that there were no real possible foundation to frame the project towards. The reason for this was mainly that the interesting problematics were out of reach for the current standing point of robotics, and additionally the lobby wasn't as busy as initially stated by the hotel manager, so assistance there seemed useless.

At this point the team assessed that our findings had to be layed out to the hotel president and the collaborating partner Karl, so a meeting was setup to hopefully clear up potentially possibilities, and frame it towards one specific path for the project. This meeting took place two workdays later at Europa hotel with Kuno the hotel president and Karl. The objective being for all parties to determine a specific path for the project. Detailed notes on relevant points and ideas are collected in worksheet 14.

The main points the team brought to the meeting was that it only seemed to be assistance backstage that was observed to have a real opportunity. The team was at this point actually prepared for potential context change if necessary, as the plan was to find a specific path and if not, try to open up for the possibility of developing for the future hotel, and if not then change context entirely.

THE MEETING

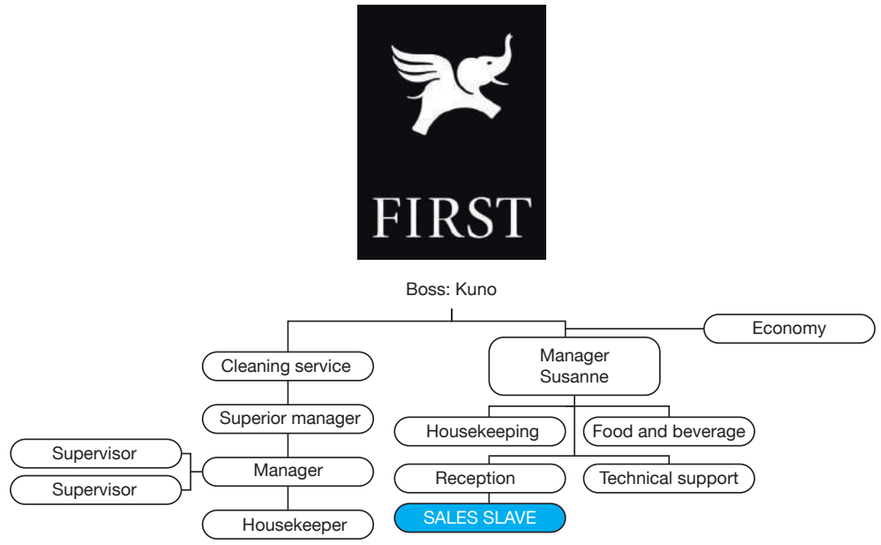
The meeting went better than expected, as the teams findings as mentioned indicated that foundation for implementation was lacking behind. The meeting composition was great as Karl had the total realistic view on robotics, Kuno had the business approach, and the team were trying to put the puzzle pieces together to frame the foundation for the project. As the meeting progressed, the converging narrowed the solution space towards bartender/lobby roamer, taking cost benefit into consideration for converging, as time frame etc. require the solution to be possible in reality within 2-3 years. Finishing off the meeting, we all seemed to have a common vision for the functionality, whereas 'the ball' was delivered to the team.



Illu. 33 - Progression of meeting [Kanal Frederikshavn, 2016]

- Lounge-roaming order taker robot as specific path.

First Hotel Europa has a fairly simple hierarchy, the thing to note here, is that the hotel rents the cleaning, hence their independent tree. The reason that hierarchy is important for the project, is the knowledge of where the robot will be placed within it, determining whom will be related to it, and whose 'slave' it's actually is going to be, which is related to control and maintenance of it. In this context the reception will be the boss of it, and their technical support will most likely be maintaining it.



Illu. 35 - Hierarchy of the hotel.

1.2.7 LAST VALIDATION

The team visited the hotel a last time for observation purposes to verify the business aspect, meaning that the team hadn't observed what Kuno stated about how busy the lounge was with customers year around. The result of this observation was that many people are there in the evenings, in contrary to the amount the team observed during the day and early night, validating the stated from Kuno.

- Team is aiming for a sales slave.

1.2.8 STAKEHOLDERS


DEVit:
Educational:
Create a well established concept including behavior, interaction, design, programming framing, components and product structure, based on research, systematic approach and design thinking.

Personal:
How is it possible to transform a robot from a distant object to a closer accepted and integrated object in human lives.

Karl, collaboration partner:
Wants to create an interesting and great robot that can fulfill a specific purpose, as an enabler to establish a robotic software platform that essentially lowers the entry barrier of using robots in various contexts.

Hotel stakeholders:
Kuno, President at First Hotel Europa:
Wants a product that makes him utilize the amount of people in his lounge year around. He would also like something to differentiate the hotel from other hotels.

User (reception):
Wants a thing that make it possible for them not to go out from the reception to take orders from the guests at the hotel.

Consumer (guests):
Wants to have the possibility to order things from the bar without leaving the chair.

Illu. 36 - Stakeholders in project. [Kanal Frederikshavn, 2016]

DESIGN BRIEF

INTRODUCTION

This project takes basis in pushing service robots into the Danish market, and the hotel is chosen as context for this project. Research on robotics current limits, their future and how they are perceived has created the framework for identifying and analyzing the opportunities and problematics. Observations have been made backstage and frontstage at First Hotel Europa to determine problematic and possibilities for implementation, and on basis on previously mentioned research the team has been able to, in collaboration with Karl Damkjær (robotic partner) and Kuno (hotel president), narrow the solution space down to a Lobby roaming bartender robot.

TARGET

The target for this project will initially be hotels wanting to increase sales in their lobby, by implementing a robot that has no problem with approaching guests in the lobby, leaving no stone unturned regarding to more sales.

AUDIENCE

The audience will be the reception personal and the guests in the lobby area. The guests in the lobby will from this projects perspective be the business people, as they represent 80% of visitors yearly.

STAKEHOLDERS

The stakeholders in this project is on the development side DEVit, which is this project team, and Karl Damkjær Hansen whom the team is collaborating with. Furthermore the implementation stakeholder and frame for the context being First Hotel Europa, represented by Kuno Becker.

WISHES

- Obtain payment on the spot from the customer
- Approach without interrupting
- Leave interaction without ‘offending’ the person that is being interacted with.

VISION

Short-term: The team strives to design a robotic solution that acts as a greetings service for hotels, and additionally creates more sales in the lobby/bar by approaching guests.

Long-term: The team strives to develop a platform for open source use, that makes the robotics field easier to enter, and the product able to spread towards various contexts on same principle.

DEMANDS

DEVit

- Use the robot’s specific advantages to ensure that it cannot be placed by an app [page 18 in report]
- Ensure that the robot do not indicate competences
- it doesn’t accommodate [page 15]
- Tablet to ensure software platform [Demand from
- Karl page 20]
- The exterior of the robot must not exude of belonging to a hotel. [page 26]
- The target of hotels with three or more stars, which have Interior design with certain values, set a demand of matching the values in the exterior design of the robot. [page 28-29]
- The robot should adapt to the context [page 31]
- Lounge roaming order taker robot [page 34]

Karl

- No lateral stability problems [taken from the double robot]
- Own navigation system [taken from the double robot]
- Three step security
- Higher speed than the Double Robot

Context

- Wifi (internet of some sort)
- Bar
- Lounge/lobby
- No stairs
- Light so the camera can identify the guest.

1.2.9 ADDITIONAL LIMITATIONS AND FOCUS

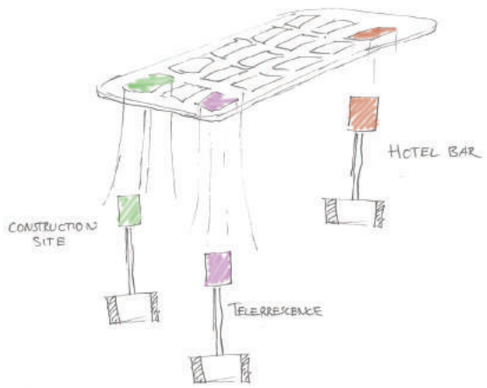
The team has made further limitations to a few areas in addition to the design brief, these areas are...

- Focus within autonomous learning
- Reality perspective
- Business foundation

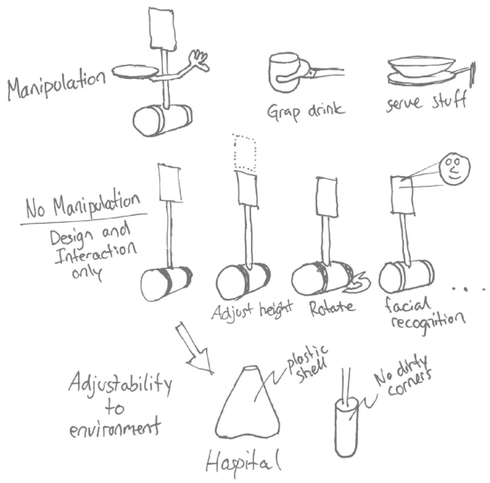
Autonomous learning was mentioned in 'robots as service robots' in the beginning of the report. Autonomous learning within the robotic field contains three areas, which are interaction, manipulation and cognition. The team wants to clarify that the main purpose of this project is to work within interaction, and the team does not intent to integrate manipulative components to the robots at this point, as realism is a key factor as well. Neither does the team integrate thoughts or work with cognition which for instance handles areas like artificial intelligence.
As mentioned before, the team intents to keep the solution realistic, only looking a year ahead in terms of technology.
The business foundation is a key driver for the path of the project, as it adds another layer to what this robot should be, or rather could be. The solution should be widely applicable, meaning that the hotel context in essence doesn't lock the project more than being a setting for the development.

The strategy is as seen on illustration 37, that the team will work towards a solution on basis of the hotel context, but with the strategy in mind about the solution should be able to go into a whole new context if the software is changed.

The point of departure for the essence of this path is to develop a solution that can fulfill current demands and be applicable in various contexts. As seen on illustration 38, the team is focusing on the area described in this chapter, and on basis of that can solutions with manipulative components be integrated in the future when that is becoming more evolved. The point here is that there are tons of possibilities and directions, but the team is sticking to the hardcore essentials, because gathering too many things will most likely lower the realism and quality of the final solution.



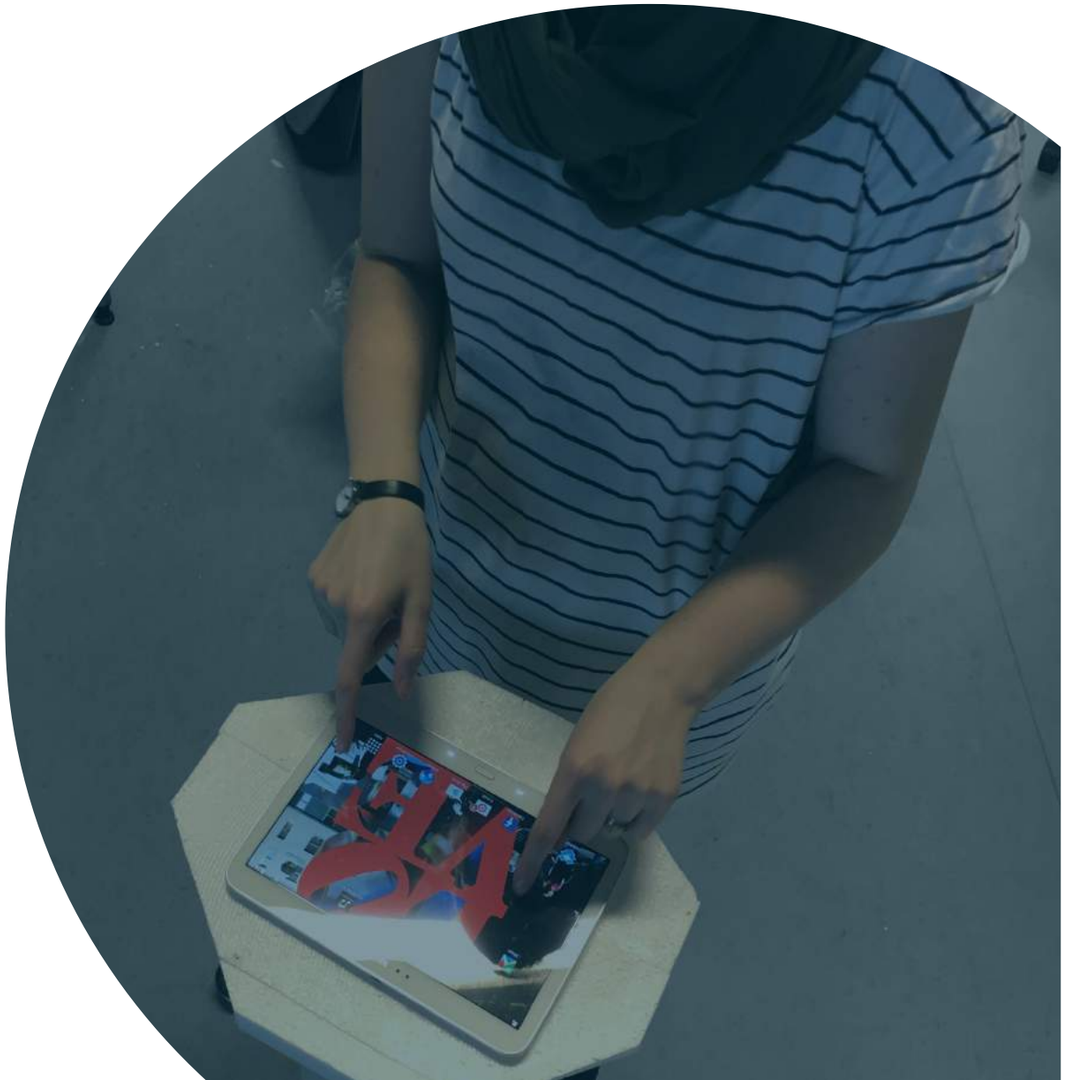
Illu. 37 - Apps allow use in other contexts.



Illu. 38 - Focus of project, and future path on basis of current.

2.0 ENVISIONING

This phase is to clarify demands for the developing of the robot, by testing, research and mock-ups. The focus will be on defining the behavior and the interaction for the robot compared with the physical dimensions for the robot.



2.0 INTRODUCTION

After the team had converged the solution space down to a tangible area, the path was set to gather further knowledge on this specific area, which would set demands for the conceptualization.
The team wants to clarify that what is under development isn't a waiter robot, a part of it's functionality is merely to offer beverages and snacks to guests in the area.

2.1 INITIAL TESTING

The team initiated some tests on personal sphere and reaction on robotic movement, basically because the team saw these as relevant for interaction in the lobby environment. Starting with the personal sphere, which was merely a screening, the team tested three persons willingness to let the Double come close, with different pictures on the screen illustration of robot, celebrity or live imaging, see [Worksheet 18]. Interesting enough the test persons allowed the celebrity picture to come most close, and the robot illustration the least. It was only the celebrity pictures that were allowed close enough for physical interaction, meaning they could touch the screen, This made the team aware that people are still skeptical towards robots, which to be all fair, is understandable. The distance found here will be used as an estimate on wanted distance in continuation of the project.

The team wanted to get some data on how people would react to a robots sudden movements, whilst being in close range of it. After several attempts where the robot was just ignored, merely because it was too slow to create an impactful enough movement to get attention, the team decided to set the test aside, with opposite results than expected, as it was simple ignored.

At this point the team felt that there wasn't a clear enough direction or objective of the tests that was made, so no further test were made at this point. Instead a decision was made to narrow the focus down even further, so that the main focus would be how the robot should interact whilst creating more sales, creating a more easily approachable scenario to specifically test for.

Illu. 39 - Testing distance to robot

- Too broad testing in an undefined area as robotics can consume a lot of time, forcing the team to focus the research additionally.

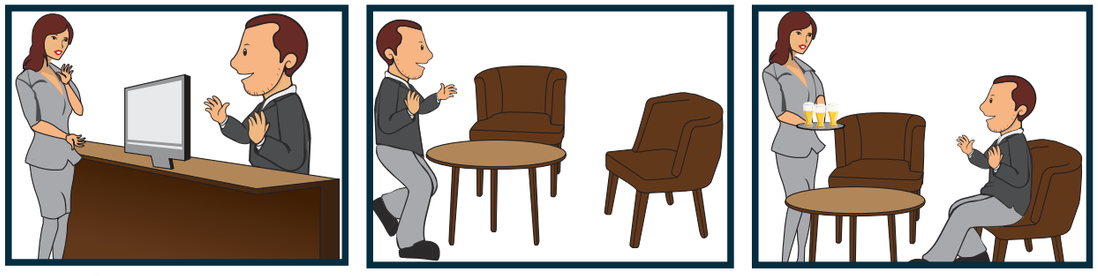
2.2 CURRENT SITUATION

The observations at the hotel showed two scenarios of which ordering happens. 'Scenario I': either the guest is going to the reception to order, and bring the refreshment back to the table himself. 'Scenario II': he leaves the reception without the refreshment and the receptionist will bring it to the table.

Scenario I

Illu. 40 - Guest brings own beverage to table

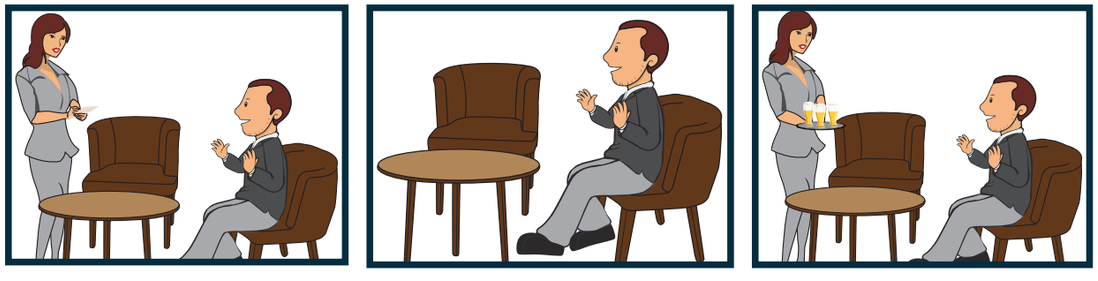
Scenario II



Illu. 41 - Guest gets beverage served by receptionist.

The management would like to see the receptionists putting themselves out there to create more sales, creating a scenario as showed on illustration 42.

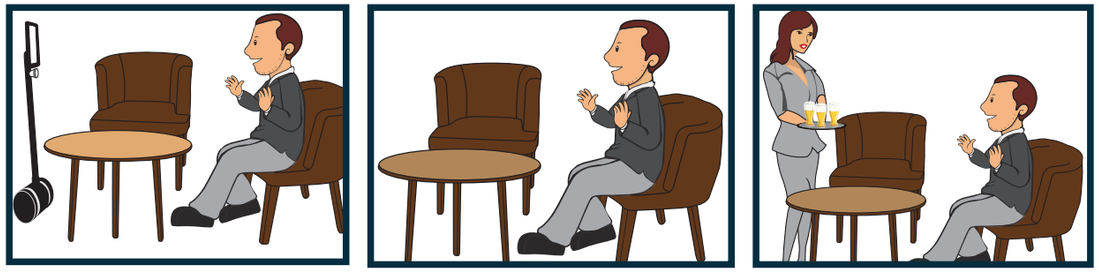
Management dream scenario



Illu. 42 - Receptionist comes to take order, and delivers it.

The team wants to do what the receptionists seemingly have a hard time doing. It is of course possible to teach the receptionists to do this, but using this case as a setting for the robot development is great, because it is so simple.

The vision for the robot



Illu. 43 - Robot takes order from guest, and receptionist delivers.

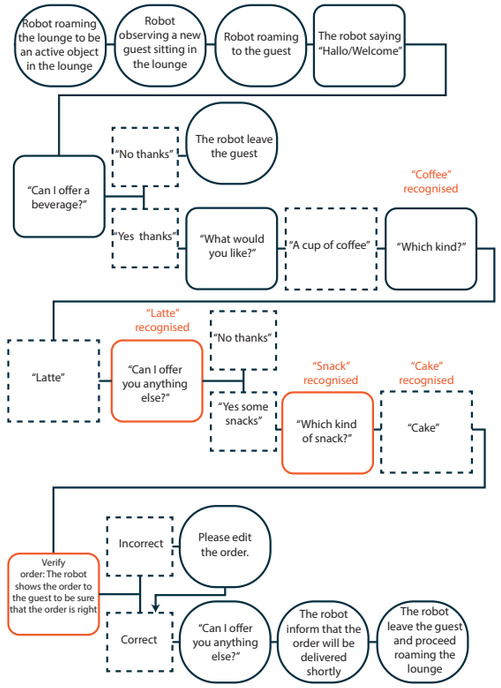
There are two solutions of retrieving payment from the consumer in the scenarios. It is possible to put it on the room or pay when ordering. [Worksheet 15]

The current solution creates the issues that it is the guests themselves that actively needs to order something, and through the lack of trying to sell more actively the hotel is missing many extra sales throughout a year, at least that is the hypothesis.
The management wants the receptionist to create more sells in the bar by leaving the reception and direct them to the consumer. The receptionists does not feel comfortable directing themselves to the consumer, instead they stay passive. [Worksheet 15]
This is a gab between management and employees, and a robot could be a solution to make both parties happy. Additionally it is relevant to point out that the receptionists in busy bar hours won't have time to be very active in roaming the lounge to establish more sales.

- Identified gap that the robot can fulfill with physical movement and interaction.
- Demand: Retrieve payment from consumer will be the same scenario as today.

2.3 ACT IT OUT

In continuation of the testings made on personal sphere, the robot was taken to First Hotel Europa. Here the team went through some act it out scenarios, where the objective was to determine the most appropriate type of interaction for the various parts of the interaction flow. [Worksheet 20]
One group member acted as guest whereas the other controlled the robot and acted out the simple verbal queues to fulfill the scenario. The full flowchart of the interaction steps the team is aiming for can be seen on illustration 44. A short and a little more simple version was used for the act it out.

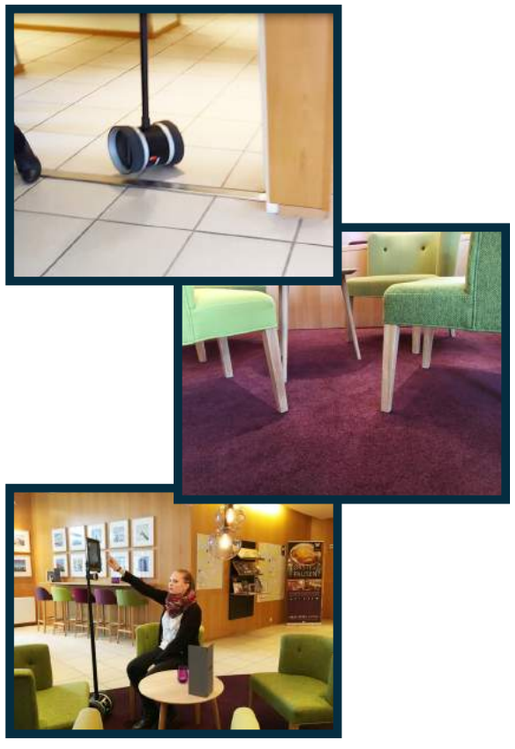


Illu. 44 - Flow chart of wanted interaction scenario.

The act it out and additional improvised testing lead the team to identify mobility problems, peoples reaction to instability and the inaccessibility for the robot to reach physical interaction range of all seating spots as currently arranged in the lounge.

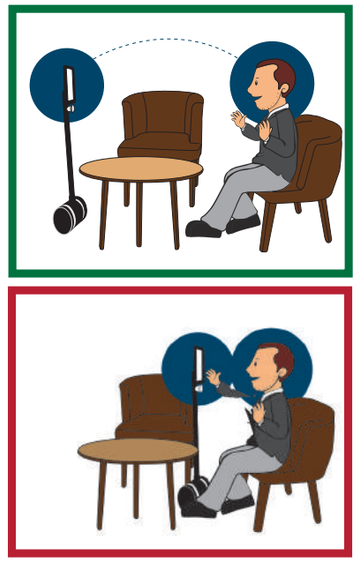
- The team has chosen to use verbal interaction as the main way of communicating with the robot and physical interaction as a back-up (technical support)

Starting with the mobility problems, the only short term relevant was lateral stability while driving around on the tiles as seen on illustration 45. In addition to that, as seen on the same illustration, when the mobility system has to drive over something approximately 5 mm. higher than current level, and the system approaches non orthogonal the system in worst case falls to the ground. [Worksheet 19]
Such increases in floor level isn't encountered within the framing area of the project, and will, because of that, not be dealt with at this point. In addition to the chapter of starting point earlier in the report, where the mobility system was determined to be taken as is, the team sees no reason to open up for development on the base, both in terms of time consumption and the fact that lateral stability has already been upgraded in Double 2.0, so increasing performance is possible.



Illu. 45 - Problems located in the lounge.

Determining that verbal interaction is the projects solution for facilitating the interaction has a few other aspects in addition to getting close enough etc. The team sees verbal interaction as a more interesting and futuristic approach, which is definitely a parameter of this project, as the intention is to create something noticeable and physical interaction with a tablet is not exactly what you would call futuristic now a days.
The establishment on verbal interaction also creates more opportunities in regard to attracting the robots attention in different scenarios, for instance if you want to order. At a later stage when, and not if the robots gets more advanced, it can be asked about activities in Aalborg etc.



Illu. 46 - Choosing verbal speech as main interaction.

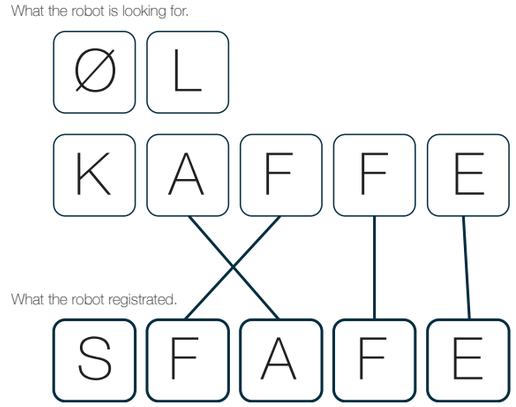
- To define what verbal interaction the team to investigate more about the technology and what it is capable of.

2.4 VERBAL INTERACTION

In continuation of choosing verbal interaction as the main way of communicating with the robot, it has to be clarified how and to what extent this verbal interaction is supposed to stretch. [Worksheet 16] If one imagines that 'SIRI' from osx (Speech Interpretation and recognition interface) is the current level within verbal interaction, which is based on interpretation and recognition at a fairly sophisticated level. As most have experienced, SIRI tend to misinterpret what the user is saying, resulting in a quite frustrating process where the wanted result rarely is reached.
Based on this experience the team wants the interaction to be based on a more simple way of interpretation and recognition. The robot will determine the conversation, and the consumer will answer 'simple' questions with a limited number of replies, making the robot able to easily identify what answer is stated, but eliminating the need for physical interaction.

The working principle of this should be as seen on illustration 47, where the robot have asked something that results in the need of one of two inputs, one being beer and the other coffee (in Danish). The consumer then says "kaffe", but the software records it as being "sfafe", but that should be okay, as the software then should be able to identify how well the stated word compares with one of the anticipated words. In the example "sfafe" compares approximately 55% with "kaffe" and 3% to 0% with beer, resulting in a clear choice.

This is of course a solution that works now, and as the years pass by, the technology and software will become greater and greater and eventually a full conversation will be possible.



Illu. 47 -Comparison of two words.

- It is possible to use verbal interaction in the extent that the robot knows the range of possible answers the consumer can reply.

2.5 RECOGNITION

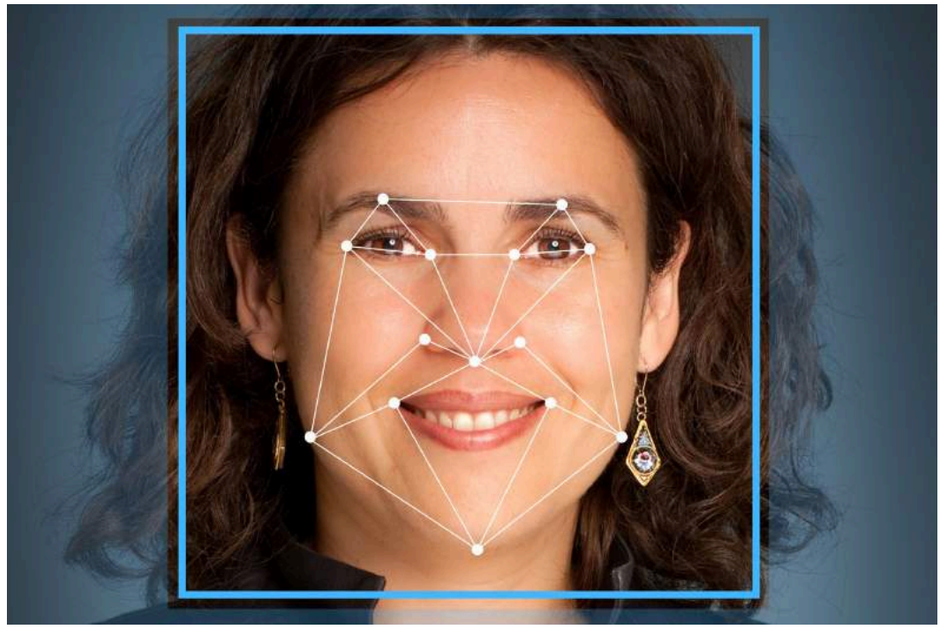
To be able to identify people in the lounge, the team chose, in collaboration with Karl, to use facial recognition. This technology also would make the robot able to avoid approaching the same individual many times.

The intention is that the robot should be able to recognize people based on facial recognition. This basically works as seen on illustration 48, where software defines the location of specific facial features and map the alignment of these. This mapping will then be individual from person to person, and the uniqueness of the mappings will of course depend on the detail of the pictures.

Ethical thoughts
The team is aware that making recognition that is basically surveillance can be an issues, especially if people know it stores peoples 'identities'. The team believes that you can program your way around most of these issues, as it should only be temporary storage of people for greetings and possibly different behaviors depending on the relation between the robot and the person. If in principle you store the mapping of the person only, and no pictures, there would be no correlation between a mapping and a person, and if there indeed is, it may be possible to encrypt the mapping.

Importance of the technology
As previously mentioned, there are possibilities in this technology, as you can establish deeper connections with the persons of interaction.
There is going to be a cost-benefit that has to be thought through depending on whether ethics is going to be a problem or not. The personal relations possible with this technology, as a foundation, is just hard to establish in other ways.

- The recognition of a person should be based on facial recognition.



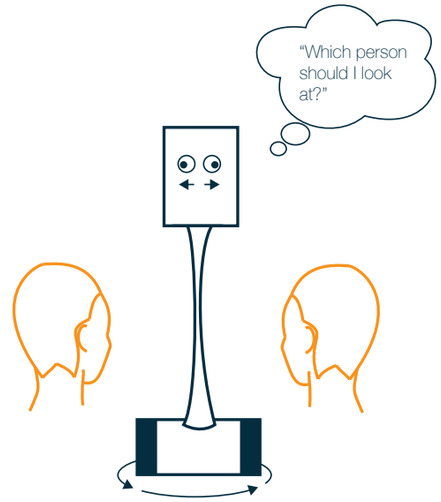
Illu. 48 - Example of the principle of facial recognition.
[Static1 squarespace, 2016]

2.6 CONNECTION WITH THE CONSUMER

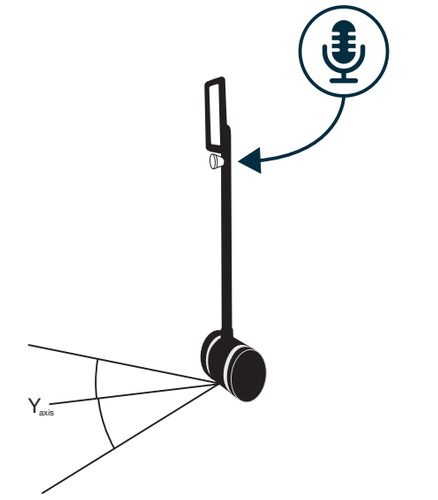
In principle the interaction is framed in a possible way at this point, but should the robot be able to orient towards the person it is interacting with, and how would that work?

The team see great value in the possibility of establishing a connection with the consumer, and the team sees this being done through 'eye contact', as a robot 'starring' into the thin air seems careless. To find out how this would be possible, the topic was brought up on one of the meetings with Karl. [Worksheet 33] He said that there actually was people at the university in another department that was working on something that could make this work.
The thing they are working on is called 'dominant speaker' and the principle in it is that you have multiple microphones, to be able to determine direction, and by software the words spoken will be identified to specific individuals, resulting in a value for each person. For instance individually standing words/ expressions like mmh, yes, right etc. would give a low value, lets say three for the sake of the example, and nine words in a sentence would give a way higher value, lets say twenty five. These values then will have a relation to a timespan to keep relevance in the mix, and the one with the highest value will be the dominant speaker. One can then of course determine whether a person is dominant speaker instantly or after x number of seconds or percentage difference etc.

This would allow the robot to know whom to orient towards if it calculates the angle from the talking person to its own, in this case y axis, then it can rotate to align with the incoming speech. Instead of rotating the entire robot, it would also be possible to make the virtual eyes orient towards a given angle, possibly covering faster changes in dominant speaker, as physical change in orientation in robots isn't as fast as seen on humans as of now.



Illu. 49 - Choosing verbal speech as main interaction.



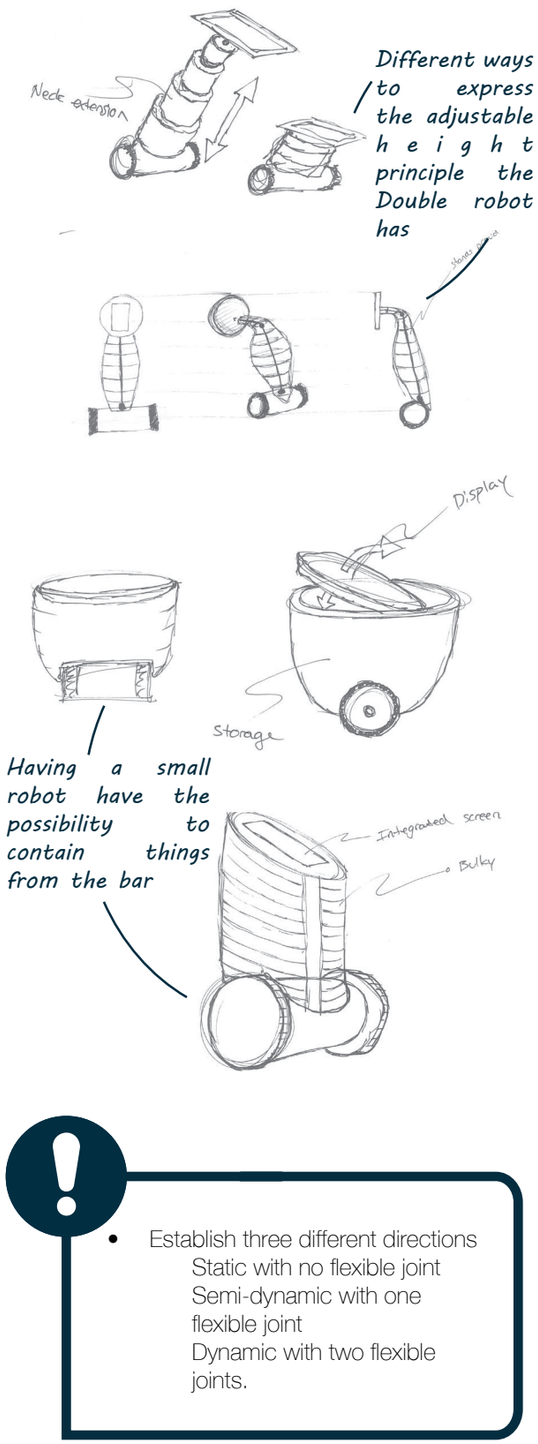
Illu. 50 - Choosing verbal speech as main interaction.

- The robot can orient towards the dominant speaker in interaction scenarios.
- In further development it need to be looked deeper into, because what if two consumers have a conversation about what they want to order, what would that do?

2.7 SKETCHING ROUND I

At this point the team realized that it probably would be wise to stop, and diverge briefly to see what it could lead to, as further testings would just converge even further and possibly lock the creativity too much. So the team decided to make an initial sketching round without any specific objective, just to do it and see what it leads to. [Worksheet 21]
The framing of the sketching round was merely that the mobility principle should be that of the Double, except that, the sketching was limitless.

When the team went through the sketches, it became clear that a specification of movement possibilities should be established. This would rapidly slim down the design possibilities and lock the freedom of which interaction can be created. The team saw three concept paths to try out as seen on illustration 51.



- Establish three different directions
  Static with no flexible joint
  Semi-dynamic with one flexible joint
  Dynamic with two flexible joints.

2.8 THE THREE PATHS

The three paths are on the illustration applied on the Double to communicate the principle appliance for each path. [Worksheet 22]

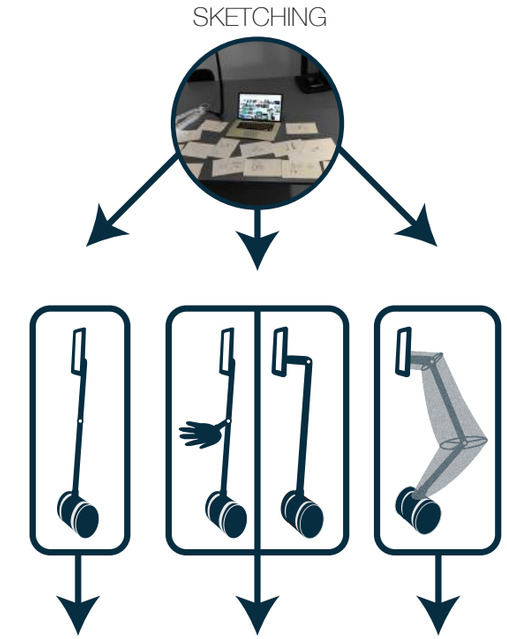
- Path one should be static with no flexible joint
- Path two should be semi-dynamic with one flexible joint
- Path three should be dynamic with two flexible joints.

Starting with path one; the behavioral and interactive possibilities here are quite limited, as it only will be the segway principle, and the tablet that will be able to establish the behavior, just like the Double itself.

Path two; adding a joint can change the space between tablet and mobility principle, or add a stiff hand to increase behavior communication. The great downside of adding things like a hand or more complex parts, is that it will be very hard not to make the robot exude that it can manipulate with things.
Being able to change the space between tablet and mobility principle, or move the tablet as a neck joint can create more obvious behavioral movements that doesn't automatically intrigue people to overestimate its competences.

Path three; adding two joints creates another dimension to only having one, as you then can play with sequences, where for instance neck movement is connected with hip movement, creating complex movement behavior. The question here is whether the complexity of these movement sequences are usable in the context and with the long-term vision in mind.

As of now the team has three paths that will determine some distinctive demands for the design, depending on the amount of flexibility the final product is concluded to have. The team is expecting that more joints will create more behavioral and interactive possibilities, but the question is whether the value of these will be worth the cost of making them possible, as simplicity still is a keyword for the success of this project. But as a start the team wanted to determine which possibilities that could be created from the three paths. To initiate this determination the team quickly started a bodystorming session.



Illu. 51 - The three paths.

- The team need to define which path of structure is the most convenient for the demands of the project.
- The team need to determine the paths by the possibilities of them.

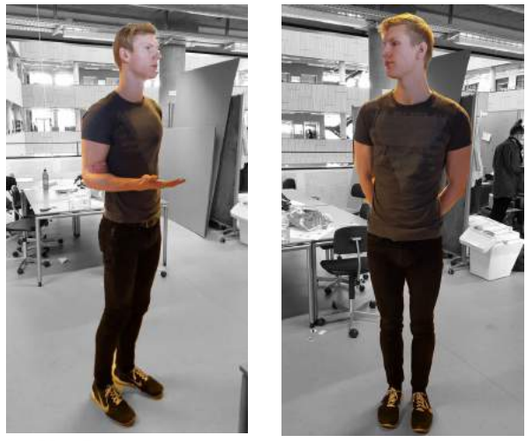
2.9 BODYSTORMING

The approach for investigating the different paths was first by bodystorming the motions that are possible with the human body given the amount of flexible joints for each path. [Worksheet 24] Doing this gave the team an idea of how flexible versus how stiff the robot would be in broad terms. The results for the team indicated that having no other flexibility than that of the mobility base wasn't going to be enough for what the team intended be able to work with in terms of behavior. There wasn't much to conclude else than this, as the difference between one or two joints wasn't investigated deeply enough to differentiate them and draw conclusions.

Static path

Illu. 52 - Adjusting height

Semi dynamic path



Illu. 53 - Rotating on spot

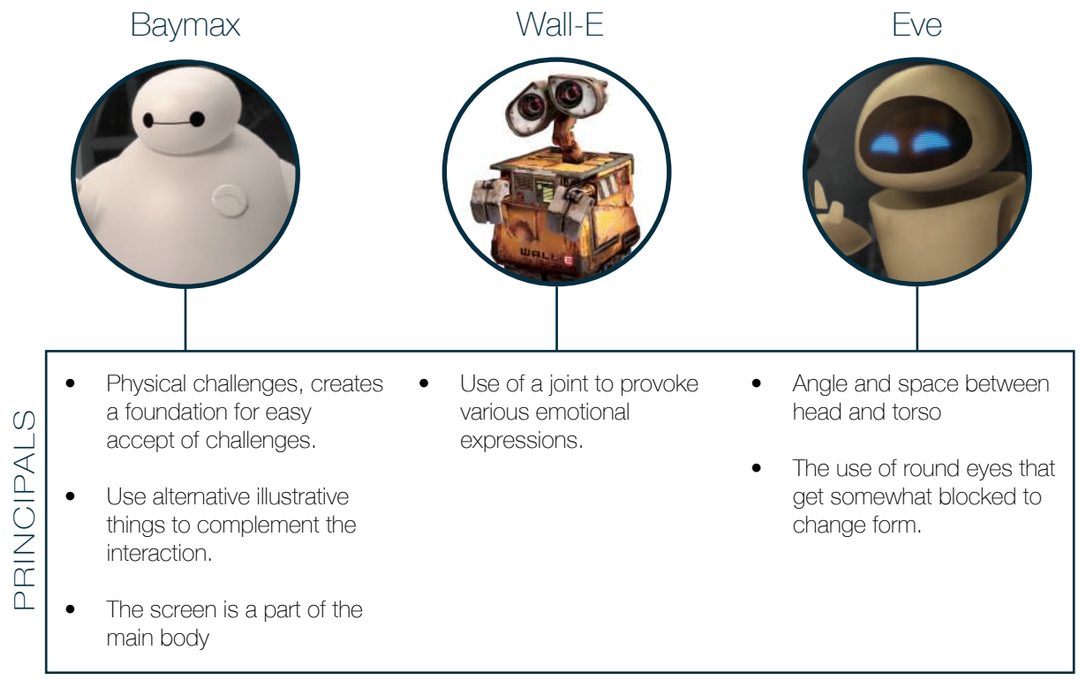
Dynamic path

Illu. 54 - Bending torso and knees.

- The static path will be to limit in term of the possibilities of behavior of the robot.
- The paths are affected by the intention of behavior for the robot.

2.10 ANIMATION MOVIE ANALYSIS

In continuation of the bodystorming the team wanted focus on the behavior of the robot. To analyze the behavior the team have been looking at animation movies where robots are in focus. This is to get inspiration, and to define principals of how to communicate interaction, behavior and feelings for something that need to be programmed, and has limited movement. [See worksheet 29 for the table, and worksheet 35 for the analysis of animation movies robots] [See clip from the movies on the USB
The three robots from animation movies are:
Baymax from Big Hero 6
Wall-E from Wall-E
Eve from Wall-E



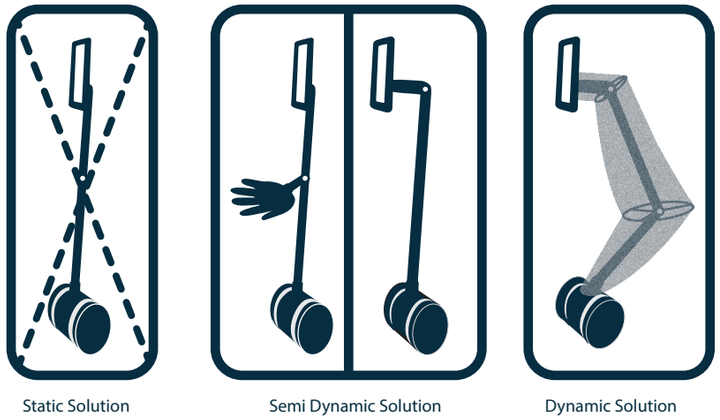
Illu. 55 - Principles found from the animation analysis. [Big-Hero-6, 2014] [Wall E, 2008]

To have the robot indicate feelings, behavior and interaction gives better possibilities if the robot is not static.
The eyes of the robots are indicating a lot about the feelings of the robot, in cooperation with tilt of the head in different angels. This is the main principle of the behavior of the animation robots.

- Creation of emotions and behavior is made with movements and typically it is at least two entities of the "body" being used.
- The eyes of the robots is giving them personality, and can easily indicate emotions.

2.11 CHOOSING TO ABANDON STATIC PATH

The behavior that has been observed, has shown that it will give value to the robot with flexible joints, as joints probably will make translation of animated principles easier. In addition, the increased flexibility will create more human like motions, that can help them relate to the robot. The team had seen evidence enough on limitation of the static approach, and chose to discard it on basis of that.



Illu. 56 - The three paths.

- Static was chosen to be too static for the projects intentions.
- The project is missing a framing of the behavioral intentions.

2.12 BEHAVIOR IDENTITY

The team has earlier experienced trouble with measuring the potential of findings regarding behavior, which lead to the objective of establishing a specific identity that can be aimed for. To do this, the team analyzed Charlie Chaplin movies, as the team saw that character as something interesting to this matter. This interest was based on his ability to be funny about his own clumsiness and a general witty approach to most interactions, which the team saw potential in using for the robots inevitable ability to fail sometimes. More about this can be read in worksheet 52.

Illu. 58 - Charlie Chaplin behavior. [We heart it, 2016]

- Witty
- Clumsy
- Random
- Apply humor to its own failures, point them out. Apologize to objects it hits etc.
- Make it look like it is not very observing, “living in its own bubble”.

In addition to the behavior extracted from Charlie Chaplins behavior, the team used knowledge gathered from the analysis of Big Hero 6, where Baymax performed some behavior the team saw great potential in. One of these were how he uses a projecting mechanism in collaboration with his head to elaborate what he is trying to communicate, illustration 57.

Illu. 57 - Baymax is showing Hero where he will experience additional hair growth in puberty. Big-Hero-6, 2014

- Communicate message in interaction with screen illustrations
- Clearly indicate that it is cautious if maneuvering tight spaces (eye(s) looking down on mobility unit)

These information should set the scene for what the team is aiming for with behavior and interaction principles.

While the focus is on the identity of the robot behavior, it is important to clarify that the behavior that is being framed in the project, is only intended for in-app use for the given context at First Europe Hotel. This means that the exterior design of the robot should have no connection with this, as that should be usable for many different functionalities, each with independent behavior defined by that ‘context designer’.

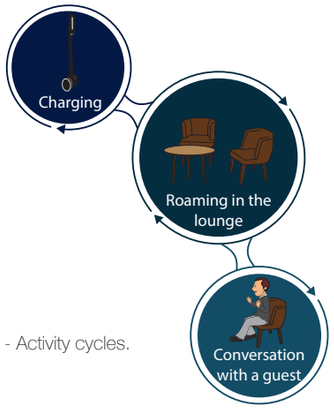
This chapter will be elaborated later in the report.

Illu. 60 - Identity in software.

- A rather abstract, but specific aim has been set for the behavioral intentions of the robot.
- The identity has to fit to the context in which is functions.

2.13 DECONSTRUCT ROBOT ACTIVITIES

To define the activities of the robot, they were mapped, see illustration 61.
The robot have three functionality zones it have to do, roaming in the lounge, conversation with a guest and charging.
The three functionality zones was then divided into phases, dividing activities in pre-phase, main-phase and post-phase. This made it possible to map specific tasks as seen on illustration 62. [Worksheet 32]
This is still in the early phase, and it is made for the team to understand the activities the robot has to perform.



Illu. 61 - Activity cycles.

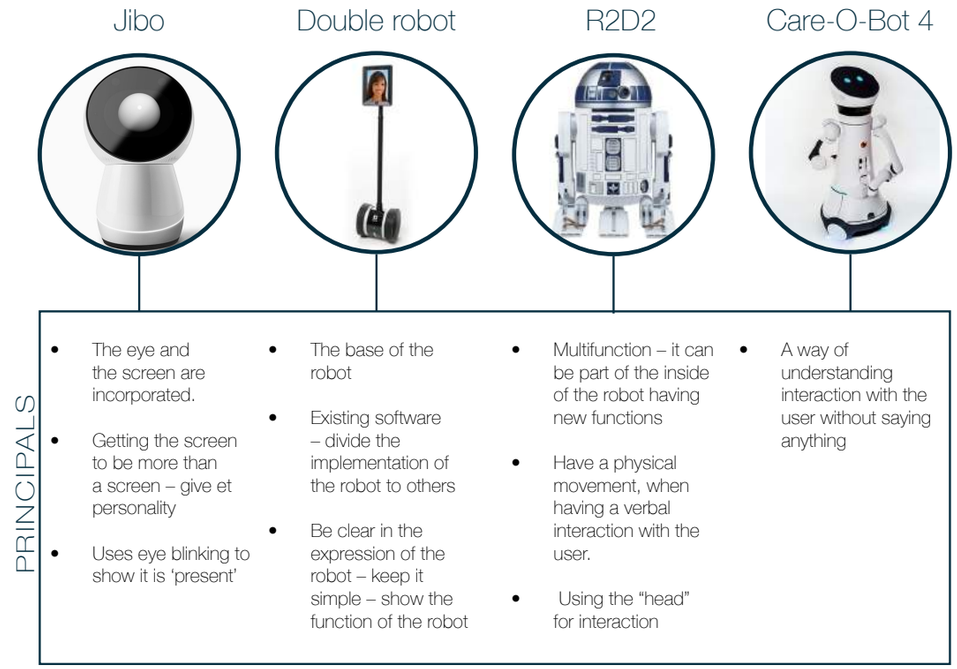
	Pre-phase	Main-phase	Post-phase
 Roaming in the lounge		How to find the guest: • Creating good atmosphere • Identify guests • Say “hello” to the guests - people passing by	
 Conversation with a guest	How to establish connection: • Robot identify a guest • Robot driving to the guest • Robot contact the guest	How to establish connection: • Robot identify a guest • Robot driving to the guest • Robot contact the guest	Robot leaving the guest: • Deliver order to receptionist • Leave the guest • Start roaming
 Charging	• Need charging	• Charging	• Finish charging

Illu. 62 - Activities in the phases.

- Realization: The product will have three behavior cycles that can contain various behaviors, which can be worked with.

2.14 WHAT HAS BEEN DONE SO FAR?

At this point the team has defined how a robot can have behavior, so the team wanted to analyze how the few other robot developing companies have solved the interaction and behavior. Four robots were analyzed, these were chosen because Karl had presented them as being interesting robots regarding interaction with people, and the robots own behavior. [To see the whole analysis see Worksheet 32 + 36]
Illustration 63 show which things the team found to be interesting for further involvement in the project.



Illu. 63 - Principles of behavior in current robots. [Pinterest, 2016]

- Jibo and Care-O-Bot 4 use the screen to give the robot personality - That is something that the team want to test for maybe use the principle.
- Most of the robot are using the screen as face, the team thing that it works and want to implement in he robot.

2.15 ANALYSIS OF HUMAN BEHAVIOR

The team has looked upon other robots, and robots in animated movies at this point, so to understand what humans do in interactions and how the robot can become acceptable, the team analyzed human behavior. [Worksheet 30 + 37]

The team found an interest in investigating basic human behavior in terms of interaction, to find principles that can be converted into the behavior of the robot. This could possibly establish a behavior humans can relate to. This investigation was done by research in the book “Menneskers adfærd” [D. Morris 1977] where the author investigates and identifies patterns in human behavior. This research lead to general principles of movements and gestures which is seen on illustration 64. The behavior lead to a principle which the team then discussed how could be applied to the robot.
Some of these appliances will, if wanted, set a specific demand for the overall flexibility of the robot, here meaning an extra joint etc. But the results from the task was in general more related to other topics of developing this robot, as they either were too complex to be communicated with one or two extra joints, or appliance to the software in the tablet. The only physical possible movement was head shake and nodding.

		BEHAVIOR		APPLIANCE
1		• People are always moving during conversation.	• Different movements for the robot when having a conversation	• Look like a natural movement • Incremental movement, not radical.
2		• Expansion of the pupil receives more attraction from others.	• More attraction with bigger pupils.	• Have a more toned down eye at roamed mode, but expose the pupil more with direct interaction. • Use pupil size to show that the robot likes what it sees when it identifies a human.
3		• The white in the eyes indicate where the eyes are looking.	• The possibility to orient eyesight without moving the head.	• This makes it possible to eliminate the need for neck movement, as the eyes are able to orient towards an object with physical movement.
4		• City dwellers are particularly prone to affect his own head.	• Touching head to show state of mind	• Use the screen to illustrate a hand to the face that shows that it is thinking.
5		• How you say hello, depends on how well you know the person	• Relation determines personal sphere	• Use programming to determine how far the robot can approach, maybe a different angles.
6		• Synchronization of movements between friends in conversation.	• Copy body position to show that you are alike	• The robot could ensure that it is same height as the person that is being interacted with
7		• Long distance hello by waving indicates friendliness.	• Gesture from a distance	• The robot could upon recognition of a person, animate a quick hand-wave to
8		• Head shaking and nodding is the most well-known way of saying yes and no.	• Heads hake and nodding is globally understandable	• The robot could physically nod the head as a way of signaling that it understands what is being said/done.

Illu. 64 - Analysis with principles and appliance. [Panero, Julius and Martin Zelnik, 1979]

- Many ways of interaction requires hand/arms
- Simple movements can establish relation
- Shouldn’t be intimidating
  Don’t stand complete still
  Mimic human replying mechanisms

2.16 DEMANDS

DEMANDS

- Use the robot's specific advantages to ensure that it cannot be placed by an app [page 18 in report]
- Ensure that the robot do not indicate competences it doesn't accommodate [page 15]
- Tablet to ensure software platform [Demand from Karl page 20]
- Ensure that the robot fit to different contexts (demand from Karl page 20)
- The exterior of the robot must not exude of belonging to a hotel. [page 26]
- The target of hotels with three or more stars, which have Interior design with certain values, set a demand of matching the values in the exterior design of the robot. [page 28-29]
- The robot should adapt to the context [page 31]
- Lounge roaming order taker robot [page 34]
- Should be able to take orders from consumer.
- The robot need minimum one joint (page 54)

DEMANDS TO KARL

- No lateral stability problems [taken from the double robot]
- Own navigation system [taken from the double robot]
- - Three step security
- Higher speed than the Double Robot
- Verbal interaction with ordering with physical as backup [page 47]
- Should be able to identify and "remember" persons in the lounge/lobby.
- Face recognition (page 48)
- Orientation in relation with the person interacting with [page 49]
- Shouldn't be intimidating [page 59]
- - Don't stand complete still (page 59)
- - Mimic human replying mechanisms (page 59)
- Should be able to contain power for 12 hours. (page 33)

BEHAVIOR AND INTERACTION DEMANDS

- Verbal interaction with ordering with physical as backup [page 47]
- Apply humor to its own failures [page 55]

WISHES

- Obtain payment on the spot from the customer (page 44)
- Approach without interrupting
- Leave interaction without 'offending' the person that is being interacted with.
- Approach without interrupting
- Stop interaction without 'offending' anyone.
- Be able to create an atmosphere.
- Deliver the order to the consumer
- Fit into other environments
- Approach to people in the lounge - face recognition.
- Guide the consumer in the menu card
- Guide in all the different questions the receptionist is getting.

WISHES TO KARL

- Program detection of dominant speaker
- Connect eye movement with location of dominant speaker
- Should be able to define optimal charging moments based on patterns.

DEMANDS TO CONTEXT

- Wifi (internet of some sort)
- Bar
- Lounge/lobby
- No stairs
- Light so the camera can identify the guest.

2.17 BALLBOT

Until this point the working mobility principle has been the segway, as this was the starting point, but possibly a stepping stone. The team chose, in collaboration with Karl, to switch to a ballbot principle.

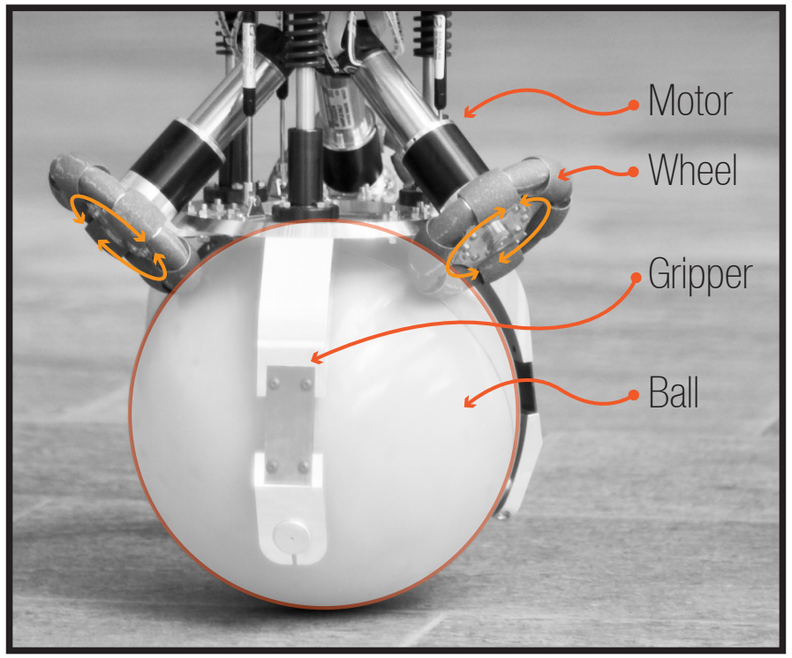
The team had solely thought about this early in the process, but chose to leave it be, as it was assumed to be too expensive.

<u>So how does a ballbot work?</u>

A ballbot, hence the name, is a technology where you balance upon a ball, you do this with three wheels 120 degrees apart seen from above and angled 45 degrees onto the ball, see illustration 66. Combining the movements of these three wheels with programming results in the possibility for moving the ball in any wanted direction.

Just like the segway principle this principle leans forward to counter the force of the movement, and in theory the angle should be the same for the two principles, according to Karl.

Illu. 65 - Principle structure of omni wheel placement..

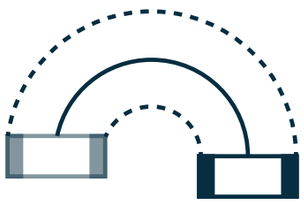
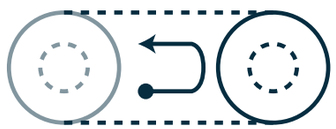


Illu. 66 - Parts included in the ballbot principle. [Wikipedia, 2016]

Illustration 67 compares essential parameters in the mobility base, and shows that the programming and pricing basically is the only downside to switching. On the contrary the new principle has better:

Mobility: consumes less space on rotation and turns and doesn't have lateral stability problems.
Behavior: The ballbot principle adds a standard rotation of the body, as it can turn on the ball without physically changing direction.
Technology: Ballbots are still fresh and fairly unknown to the average Joe, and is through that expected to be even more interesting.

- Ballbot is more convenient for the project

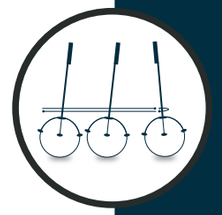
PARAMETERS	SEGWAY	BALLBOT
• Movement directions in mobility principle.		
• Difficulty in programming the bases	**100%**	**110%**
• Time span in programming the bases	**100%**	**110%**
• Lateral stability	**Problem**	**Not a problem**
• Leaning angle	**Identical**	**Identical**
• Age of technology	**16 years old**	**6 years old**
• Footprint when rotating on spot for each principle.	**Physically turning direction** 	**Rotates on the ball** 
• Turnrate in movement	**Has to make a real U-turn** 	**Rotates on the ball Stays on same path** 
• Price	**100%**	**140%**

Illu. 67 - Comparison of the two principles.

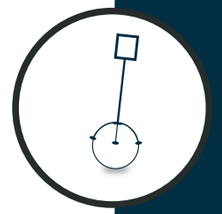
With ballbot as the new building block, the team had to evaluate which type of ballbot would be most convenient for the project. There are currently three ways of building ballbots, these are illustrated on illustration 68 and they have individual advantages and disadvantages.
The team focused mainly on pricing and design restriction, as key factors for choosing which type to proceed with.

The team thought about this, compared and asked Karl for advice, and resulted in choosing to continue with the magnetic solution, as it seemingly can be done with a plastic coded metal ball, with magnets placed in the robot frame to keep them connected. This is a slight alteration of the illustrated principle beneath, which with that design would have been the most expensive.

- Magnetic binding between ball and robot frame should be used.

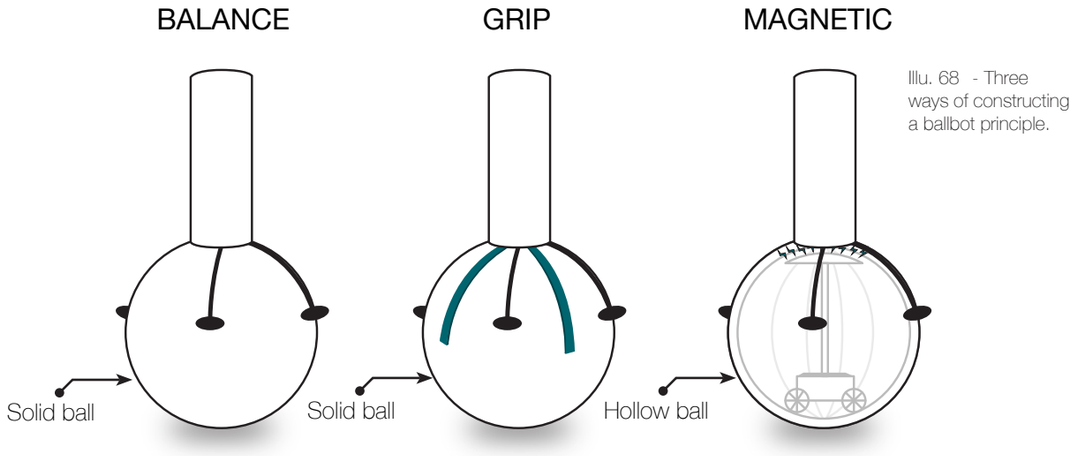


Tilting back and forth when stop driving



Better lateral stability

Tilts slightly back and forth to imitate the body language of a person.



Illu. 68 - Three ways of constructing a ballbot principle.

2.18 DEMAND REVIEW

The team has reviewed the demands for the product as a result of changing mobility principle. The only demand affected by this change is the demand of no lateral instabilities, which came from the segway principle, and therefore isn't current anymore.

DEMANDS

- Use the robot's specific advantages to ensure that it cannot be placed by an app [page 18 in report]
- Ensure that the robot do not indicate competences
- it doesn't accommodate [page 15]
- Tablet to ensure software platform [Demand from Karl page 20]
- Ensure that the robot fit to different contexts (demand from Karl page 20)
- The exterior of the robot must not exude of belonging to a hotel. [page 26]
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- The robot should adapt to the context [page 31]
- Lounge roaming order taker robot [page 34]
- Should be able to take orders from consumer.
- The robot need minimum one joint (page 54)
- The robot use the mobility principle of ballbot principle (page 63)

BEHAVIOR AND INTERACTION DEMANDS

- Verbal interaction with ordering with physical as backup [page 47]
- Apply humor to its own failures [page 55]

DEMANDS TO CONTEXT

- Context
- Wifi (internet of some sort)
- Bar
- Lounge/lobby
- No stairs
- Light so the camera can identify the guest.

WISHES

- Obtain payment on the spot from the customer (page 44)
- Approach without interrupting
- Leave interaction without 'offending' the person that is being interacted with.
- Approach without interrupting
- Stop interaction without 'offending' anyone.
- Be able to create an atmosphere.
- Deliver the order to the consumer
- Fit into other environments
- Approach to people in the lounge - face recognition.
- Guide the consumer in the menu card
- Guide in all the different questions the receptionist is getting.

DEMANDS TO KARL

- Own navigation system [taken from the double robot]
- - Three step security
- Higher speed than the Double Robot
- Verbal interaction with ordering with physical as backup [page 47]
- Should be able to identify and "remember" persons in the lounge/lobby.
- Face recognition (page 48)
- Orientation in relation with the person interacting with [page 49]
- Shouldn't be intimidating [page 59]
- - Don't stand complete still (page 59)
- - Mimic human replying mechanisms (page 59)
- Should be able to contain power for 12 hours. (page 33)

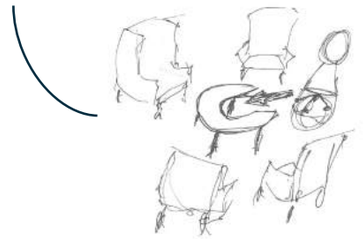
WISHES TO KARL

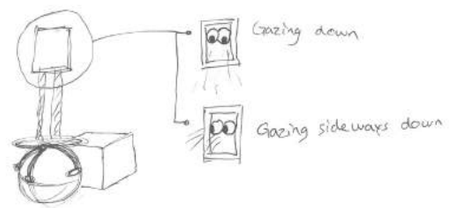
- Program detection of dominant speaker
- Connect eye movement with location of dominant speaker
- Should be able to define optimal charging moments based on patterns.

2.19 SKETCH ON PRINCIPLES

The team initiated a sketching phase on basis of the earlier defined principles. To see the whole sketch phase see worksheet 35-37.

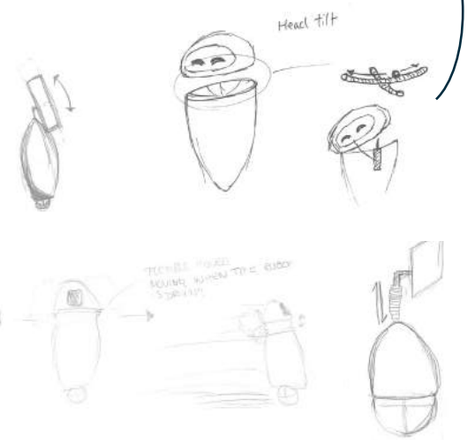
1 The environment adapts to the robot

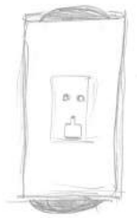




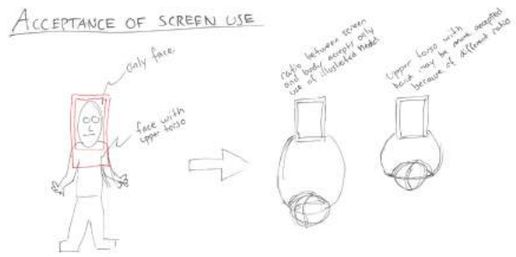
3 Use of the eyes to indicate emotions and where the robot is looking - who the robot has conversation with.

2 Use the screen as a head on the robot - movements of the head can indicate the behavior of the robot



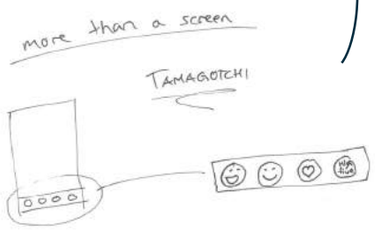


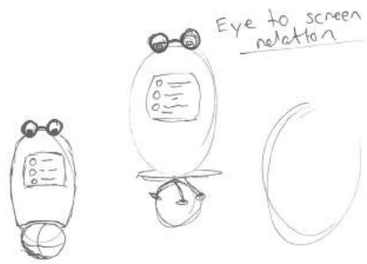
4 The screen as a part of the main-body



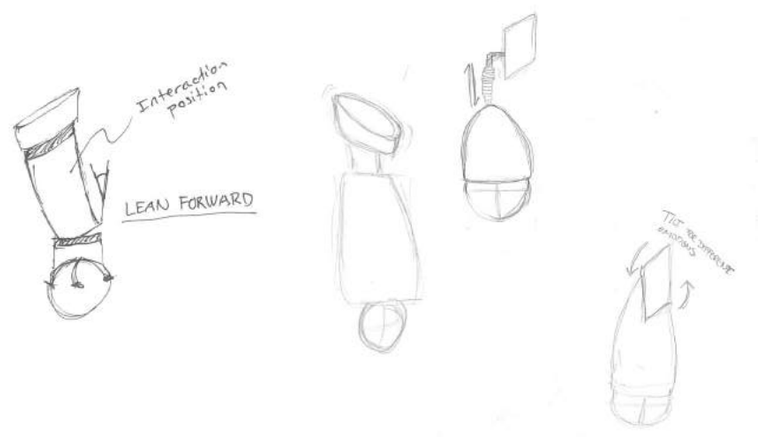
5 Multi functionality to fit different contexts.

7 Have more than one screen, a tablet and a dedicated screen for instance





6 Adjustable joints to get different angles of the screen.



- The team lacks specific volume to work on basis of.

Conclusion:
The sketches are changing in the height-width dimensions of the robot, which makes it difficult to see if the principles can be used for the robot. This realization made the team aware that a specific ratio for height-width had to be found.

2.20 DISTANCE FROM THE ROBOT TO THE CONSUMER

To define the distance between the consumer and the robot different test was made throughout the project. First it was tested with the Double robot, where the variable parameter was the a picture on the screen. This was also the test mentioned on page 41. [Worksheet 18]

To define the height of the robot the distance is a factor in need of consideration, the two variables have been tested together because of that. [Worksheet 55 + 60] It have been tested on distance 70 cm, 100 cm and 120 cm.
In this test a pair of Baymax looking animated eyes were used to indicate a face. The distance of which a conversation was most convenient was at 70 cm.


Illu. 69 - Testing of distance.


Illu. 70 - Testing distance with height.

The estimated distance for most convenient interaction is around 70 cm. But there are still factor regarding this subject that has to be tested more. This is intended to be done while prototyping, so behavior and shape can be a part of the definition. In addition it should be tested in context with other people, the point being that a too great distance can remove to connection between robot and consumer.
In addition to this, it is relevant to test whether the robot approach angle creates problems. It may also be a problem if the robot comes too close to other people in the lounge zone while interaction with another person.

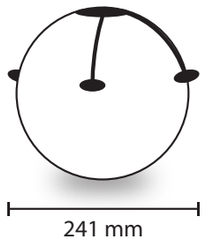
- There is a lot of detailing regarding the specific movements within arrangement of furnitures like the one in the lounge of First Hotel Europa.

2.21 DEFINING OVERALL DIMENSIONS

In the definition of the overall dimensions, there are three dimensions in focus, which needs to be defined. They are:

- The size of the ball
- The weight/ circumference of the robot
- The height of the robot

The ball has been chosen to be a basket ball size 7, as a starting point, with a perimeter of 749-760 mm, which will give a diameter of 241,9 mm for the ball.

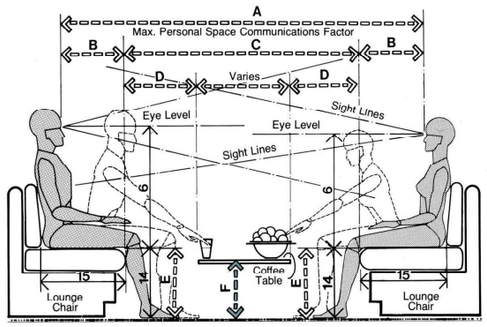


Illu. 71 - Measurement of ball.

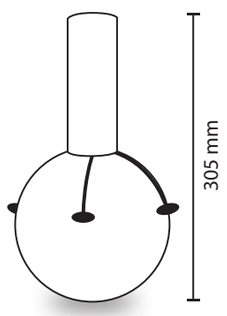
The width of the robot needs to be as small as possible to reach all places in the lounge. [See worksheet 40]. This makes the circumference of the robot limited to be as narrow as possible on top of the ball of 241 mm. in diameter. In the comparison with the environment the smallest place that the robot needs to drive is 400 mm. wide which will be fulfilled by having it as small as the ball.

Illu. 72 - Measured minimum distance of chairs in lounge.

To define the height of the robot, the team has made desk research in “Human Dimensions & Interior space, A book of design reference standards by Julius Panero and Martion Zelnik.” (Panero, Zelnik, 1979) That is to define what the human dimensions are suited for. [See worksheet 39] Illustration 73 shows measurements for humans sitting in a lounge chair, showing reach and eye level.
The team took basis in the stated reach to 305 mm. in height, because the backup of the system still should be physical. To test the minimum height out, the team made a mock-up, starting at 305 mm.
Having convenient interaction height for standing persons wasn’t in focus at this point, which made the team investigate how you feel with low robots.



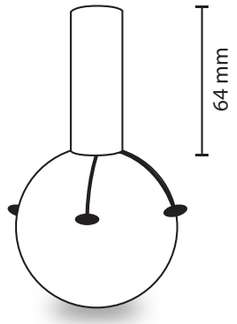
Illu. 73 - Human dimensions on coffee table measurements. [Panero, Julius and Martin Zelnik, 1979]



Illu. 74 - Height defined upon reach to coffee table.

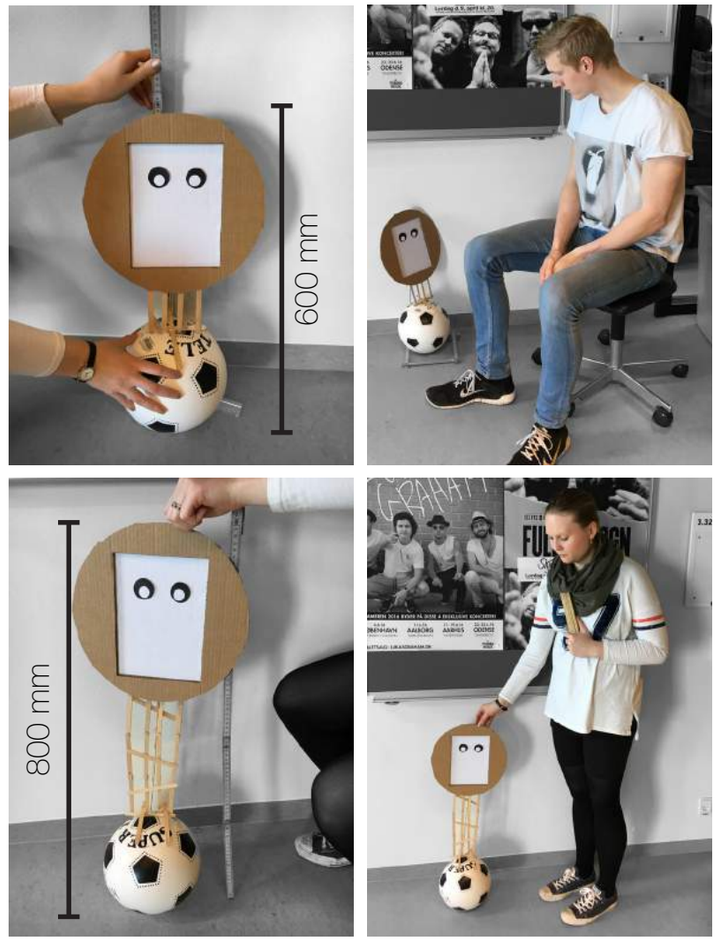
- The ball size is 241 mm diameter
- The width of the robot should not be much more than 241 mm

This quite low height can be difficult to construct because of the size of the ball, which automatically adds height.



Illu. 75 - Left over space for components.

This would only leave 64 mm. for components and tablet. To define how high the robot should be a mock-up was made with different heights to see how it would be to interact with while sitting. [To see the whole testing see worksheet 44]
The focus of the mock-ups were to have the ball principle and the tablet, here represented by an iPad with 170x240 mm. i dimensions. A circle was added to indicate a head shape that would connect to the rest of the robot.



Illu. 76 - Mock-ups of small ballbot.

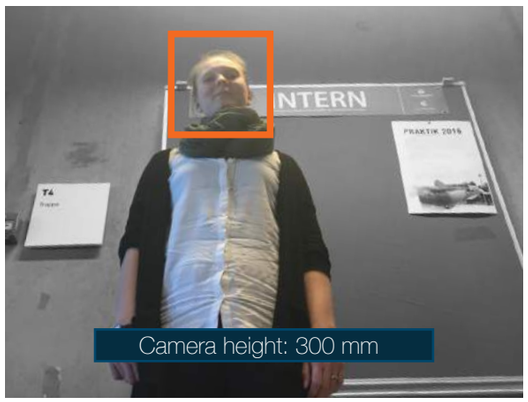
While doing the tests, a lot of different questions came up about the placement of the components. Most important was the realization that the demand for facial recognition would require a significant higher placement of a camera than the current structure could provide. To get answers to some of our questions the team arranged a meeting with Karl. [See worksheet 45]

It is difficult to define exactly how much space the components will consume in the robot, but the team found that it wouldn't be close to the amount of Rezero , which is seen on illustration 79. One of the reason why it has such a volume is the because it is a studying platform, which isn't the intention of this projects. It will be easy to fit all components in the shape of the robot, and the team should not be limited by this.

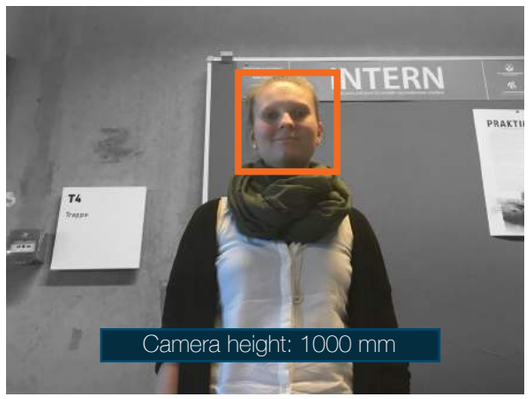
Illu. 79 - Rezero ballbot construction. [Wikipedia, 2016]

A quick test made with Karl made the team realize the importance of angle for facial recognition. [Worksheet 46]

The test showed that around a minimum of 1000 mm. would be most optimal for the camera, setting a new minimum height for the robot.



Illu. 78 - Camera height 300 mm.



Illu. 77 - Camera height 1000 mm.

The team started becoming more aware of the fundamental fact that standing people also should be able to interact with the robot.
This realization made the team investigate in the human dimensions book once again, seeking an optimal height for the robot.

By looking in the book Human Dimensions & Interior Space (Panero, Zelnik, 1979, page 215), the eye sight height can be defined for a person sitting and standing [See worksheet 49]

Woman sitting eye height:
Min: 107,3 cm
Max: 123,8 cm

Man sitting eye height:
Min: 116,8 cm
Max: 134,3 cm

Woman standing:
Min: 140,4 cm
Max: 160,6 cm

Man standing:
Min: 155,7 cm
Max: 176,5 cm

The team hit a problem with the span of optimal heights increasing. This made the team realize that the solution probably should have height adjustment integrated in the construction, as users would either view it as too low or intimidating high.

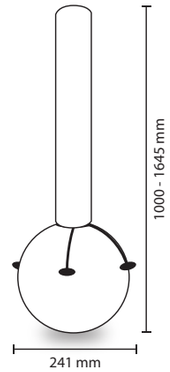
The adjustable height is then:
- Minimum height: 107,3 cm
- Maximum height: 176,5 cm

To give the most appropriate interaction between the user/consumer and the robot.
With adjustable height it is still possible for the robot to be at same height as the person it is interacting with. To secure that people should never be or feel lower than the robot, the team made an intimidation factor on 12 cm, so the robot adjust the height to be 12 cm under the approximate height of the person interacted with. This is something that needs to be incorporated in the programming.

The demand for the adjustable height will be as follows.

- Minimum height: 107,3 cm = 107,3 cm
- Maximum height: 176,5 cm - 12 cm = 164,5 cm

Compared with the minimum height for the camera of 100 cm, it indicate that the robot have the dimensions:

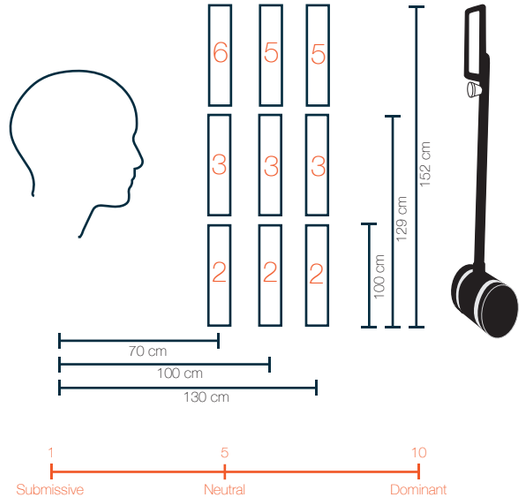


Illu. 80 - Wanted adjustable height.

- Height adjust ability should be integrated
  1000 - 1650 mm. height span

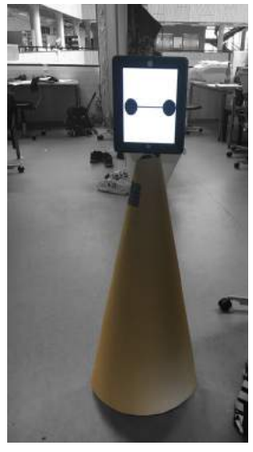
To see what the theoretical finding means in practical, the dimensions were tested. The objective was to find out which dimensions made a construction dominating and possibly find out what aesthetically can be done to prevent it.
The experiment was made in different levels, just as illustrated in illustration 82, where three heights and three distances make up the nine testings. [Worksheet 55]
First it was with a mock-up of the robot, and afterwards with the double robot to include the swinging mobility principle to see which impact that would make. [Worksheet 60]

The tests showed that the mock-up was more dominating than the double robot. This can be caused by the thin structure of the Double robot, as it is possible to look beneath the screen, which remove the impression of being forced to look at it.



Illu. 82 - Setup of the testings made.

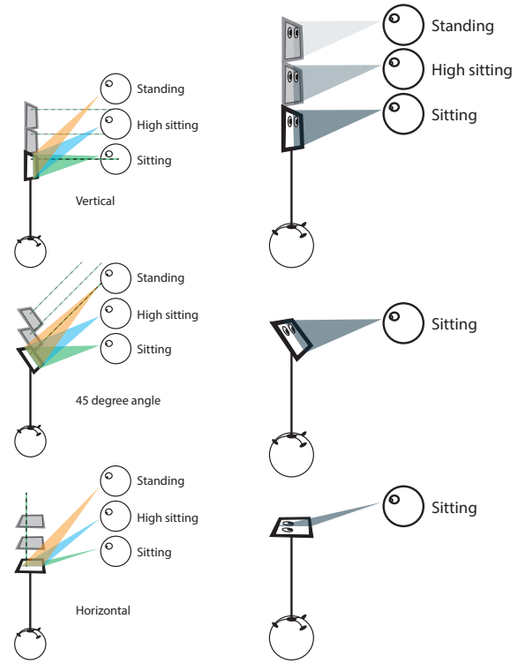



Illu. 81 - Testing volume of the robot.

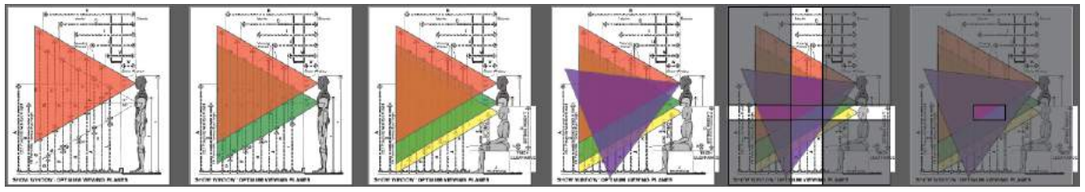
- Thin construction towards the head lower the possibility of the robot coming on as dominating.

2.22 SCREEN ANGLE

In continuation of finding the most convenient dimensions of the robot, the team wanted to further analyze how to create the best interaction scenario for anyone between sitting and standing height. To do this the team continued the use of human dimensions (Panero, Zelnik, 1979) to establish framing to find out where sitting and standing have view angles. The result of this work lead to determining that the height concluded previously works for all the heights if the standing persons look 22° degrees down, which isn't enough to cause overload on the neck.
With the realization that height adjustability would be most convenient, the team now had an interest in finding out how the screen should be oriented, horizontal, vertical or something in-between.
Vertical would obviously work the best for sitting people, horizontal only for group view, but angled would probably be most optimal for others than sitting people, as they automatically will create an angle towards the screen, see illustration 83.
In addition to this, the orientation of the screen will be locked towards a specific distance and height, shown with dashed line on the illustrations. The result of this would be that the eye(s) on the screen will be the only indication of orientation while interacting, which can be problematic.



Illu. 83 - Screen angles with different heights, and eye orientation depending on screen angle.


Illu. 84 - This line of view angle shows how the variety of heights can see a tablet screen at 1320 mm. max. height [Panero, Julius and Martin Zelnik, 1979]

This can be problematic because the relation of orientation and eye orientation often indicates underlying thoughts or emotions, at least in human interaction. As seen on illustration 83, the expression changes when simple eyes are looking towards something with various angles, and it probably has something to do with hierarchy, as the more it has to look up or down with eyeball in relation to the tablet orientation, the more it sets itself in a submissive and humble position (slave).
The height adjustability has of course, as seen in upper right corner of illustration 83, changed this, as it should be possible to adjust height to each interaction.

This analysis ended with the team being aware that a neck joint would be great in combination with the height adjustment, creating a combination able to orient towards most people.
With defined use of adjustable height and a neck joint the team worked with adding an extra joint but could not see the potential value of adding an extra joint. [Worksheet 31]

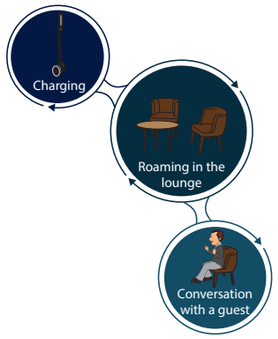
2.23 SETTING A DEMAND FOR SCREEN TYPE

The team wants the screen with face and interface to be viewable from as much angles as possible, as failing to be able to see the face from certain angles may change how it is perceived.
There are currently many display types, and types that are viewable from 179° or close to, is already common in high-end tablets, which is why the team, depending on further development, wants to point out that any high-end tablet performs to the intentions of the other demands. In the teams perspective, tablets with FTF LCD displays aren't good enough, as they have a maximum view angle of 140°. See worksheet 50.
The use of a dedicated screen instead of a tablet will not reduce the cost on that area, and it will contradict the purpose of the business foundation.

- Neck joint should be integrated to adjust angle of screen.
- The tablet chosen is required to be 9,7" high end tablet.

2.24 SPECIFIC BEHAVIOR

The team has, after performing various analysis and sketch phases, constructed an idea about which behaviors that should be implemented in the software. The idea is still at a principle level, and should be seen as something to integrate through work with it, as it is not a given that should just be put in.
The activities of the robot is split into three phases, and the team believes that the behavior of the robot should be divided as well. This is because the behavior should fit the task that the robot is doing. The analysis of the behavior is then divided into the same three phases of activities. This chapter is an elaboration of the previous chapter "Behavior identity", and repetition will occur.



Illu. 85 - Charlie Chaplin behavior. [Police, 1916]

ROAMING

The team approached this task by first and foremost talk about what type of characters that were interesting in behavior, but most of the characters that arised were based on animals, which the team found misleading. Just like the team analyzed animation movies on basis of their robotic origin, something like that was wanted to aim for, but the team also wanted a character that was well known, at least in characteristics, like mickey mouse, Donald duck etc.
Somehow the conversation ended up bringing Charlie Chaplin up, as mere fun, but was realized to be an interesting way to go. The initial thoughts were that movies from that time, and his style, was over exaggeration of behavior. Movies still had a touch of simplicity as they weren't far developed, no sound and only about 16 fps, making fast movements blurred.

The team then actively analyzed Charlie Chaplin movies to establish ground for an identity to aim for. The result of this was some key words and scenarios that establish an idea of behavior for the roaming part of the activities.

- Witty.
- Cocky.
- Clumsy.
- Walks around random and provoking/fun towards other people.
- The humor does not come from the Tramp bumping into a tree, but from his lifting his hat to the tree in apology.

The team only found the cocky behavior as not usable.

CONVERSATION WITH A GUEST

PRE PHASE

To figure out how a robot most conveniently establishes connection and keeps it with people from a distance in a lounge, or another place, while approaching. The team tested it [Worksheet 65] several times, both by using the robot and by acting it out.

The tests showed that robots need a clear and obvious behavior when driving to the user, so the consumer doesn't get surprised when the robot is standing in front of the person.

With act-it-out the team had a person walking in the same route as the robot, but actively using the eye ball to have eye contact with the person, and that was intimidating and creepy for the consumer.

The behavior in this phase should not be over-played, and the design and use of eyes should be done carefully with clear boundaries, as taking an eye ball to far to the side makes the consumer be creeped out, see illustration 87.

Further testing of where the limit is in specific scenarios hasn't been tested, but it is intended that this should be tested, and adjusted during a prototyping phase, mainly because final design of face is thought to have high impact.

It has also been tested at which angle towards a person, that people fell the eye-contact is lost. [Worksheet 64] The result was that the robot may not diverge with more than 3 degrees before the person feels that the eye contact is lost. This should be taken into consideration for the programming.

MAIN PHASE

In addition to parallels drawn from Charlie Chaplin, the team see potential in using some of the principles found in Baymax during the analysis of animated movies, specifically how he uses illustrative technology to elaborate on his poor speaking ability. This will be used in form of the verbal interaction indicating elements on the screen at the same time. Tests show that it is more difficult to understand what another is saying when it is not possible to read of the lips [Worksheet 56]. Hereby it is possible to show the conversation on screen to secure every step of interaction, just like in a messaging conversation.

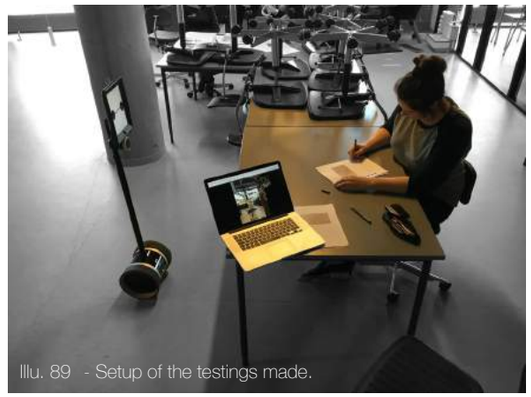
Illu. 86 - Testing the approach of the robot with eye contact.

Illu. 87 - Looking out the corner of the eye.

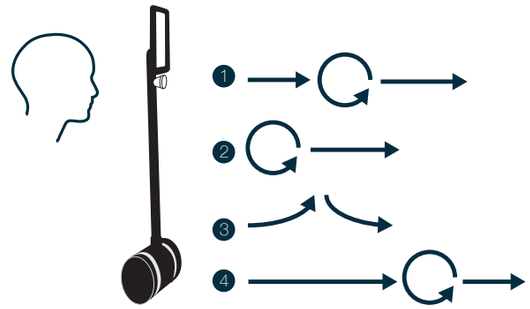
Illu. 88 - Baymax using illustrative technology. [Big-Hero-6, 2014]

POST PHASE

There are many different ways of leaving the consumer after the conversation is done. Four of the ways were tested to define how to physically move away [Worksheet 67]. The test was made on multiple people showing that it was behavior number three that was the best way amongst these to leaving the guest. This movement was the only fluent compared with the rest, and had a movement implying that it would do something for you, according to the test persons. Another key thing here is the reappearing thing about too intensive eye contact. The test was made with animation of Baymax eyes as previously, and scenario number four backed away so slowly that most test persons were crept out by this. This underlines that use of eyes creates a great responsibility for using them carefully.



Illu. 89 - Setup of the testings made.



Illu. 90 - Different movements in the test.

CHARGING

The team has throughout the project suppressed the behavior involving charging, as there have been so much other stuff to investigate. A small brainstorm was made by looking at how humans are using body language to tell they are tired. This resulted in the idea of making the robot lean as if it was tired when it charges, making that the main approach to this subject forward in the project.

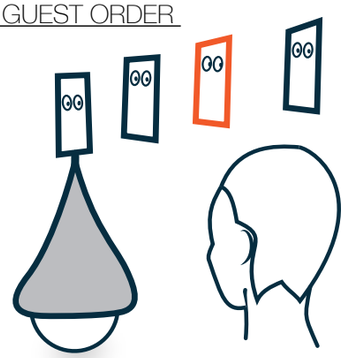
Illu. 91 - Ideation on charging scenario.

The behavior should then be:

ROAMING

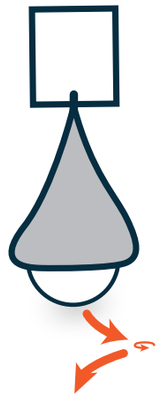
Illu. 92 - Be aware and funny about mistakes.

A GUEST ORDER



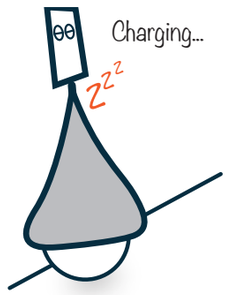
Illu. 93 - Keep eye contact.

Illu. 94 - Use eyes in combination withillustrations.



Illu. 95 - Use fluent motions.

CHARGING



Illu. 96 - Lean on wall while charging.

The determined principles is on this page illustrated, showing how they in principle will be used in the robot.

- The team has established principles for implementation regarding behavior.

2.25 DEMAND REVIEW

The team has reviewed the demands for the product as a result of changing mobility principle. The only demand affected by this change is the demand of no lateral instabilities, which came from the segway principle, and therefore isn't current anymore.

DEMANDS

- Use the robot's specific advantages to ensure that it cannot be placed by an app [page 18 in report]
- Ensure that the robot do not indicate competences it doesn't accommodate [page 15]
- Tablet to ensure software platform [Demand from Karl page 20]
- Ensure that the robot can fit to different contexts (demand from Karl page 20)
- The exterior of the robot must not exude of belonging to a hotel. [page 26]
- The target of hotels with three or more stars, which have Interior design with certain values, set a demand of matching the values in the exterior design of the robot. [page 28-29]
- The robot should adapt to the context [page 31]
- Lounge roaming order taker robot [page 34]
- Should be able to take orders from consumer.
- The robot need minimum one joint (page 54)
- The robot use the mobility principle of ballbot principle (page 63)
- The robot need a distance from the consumer between 700-1000 cm (page 67)
- Ball size of 241 mm (page 68)
- The widht of the robot may not be much more than the ball size (page 68)
- Adjustable height ability of 1000-1650 mm (page 71)
- Neck joint should be integrated to adjust angle of screen (page 74)
- The robot require a 9,7" high tablet.
- The robot behavior should take basis in defined principles on page 78

DEMANDS TO CONTEXT

- Context
- Wifi (internet of some sort)
- Bar
- Lounge/lobby
- No stairs
- Light so the camera can identify the guest.

WISHES

- Obtain payment on the spot from the customer (page 44)
- Approach without interrupting
- Leave interaction without 'offending' the person that is being interacted with.
- Approach without interrupting
- Stop interaction without 'offending' anyone.
- Be able to create an atmosphere.
- Deliver the order to the consumer
- Fit into other environments
- Approach to people in the lounge - face recognition.
- Guide the consumer in the menu card
- Guide in all the different questions the receptionist
- is getting.

DEMANDS TO KARL

- Own navigation system [taken from the double robot]
- Three step security
- Higher speed than the Double Robot
- Verbal interaction with ordering with physical as backup [page 47]
- Should be able to identify and "remember" persons in the lounge/lobby.
- Face recognition (page 48)
- Orientation in relation with the person interacting with [page 49]
- Shouldn't be intimidating [page 59]
- - Don't stand complete still (page 59)
- - Mimic human replying mechanisms (page 59)
- Should be able to contain power for 12 hours. (page 33)
- The robot need a distance from the consumer between 70-100 cm (page 67)
- The tablet require a 9,7" high tablet.
- The robot may not diverge with more than 3 degrees from the consumers face (page 76)

WISHES TO KARL

- Program detection of dominant speaker
- Connect eye movement with location of dominant speaker
- Should be able to define optimal charging moments based on patterns.

BEHAVIOR AND INTERACTION DEMANDS

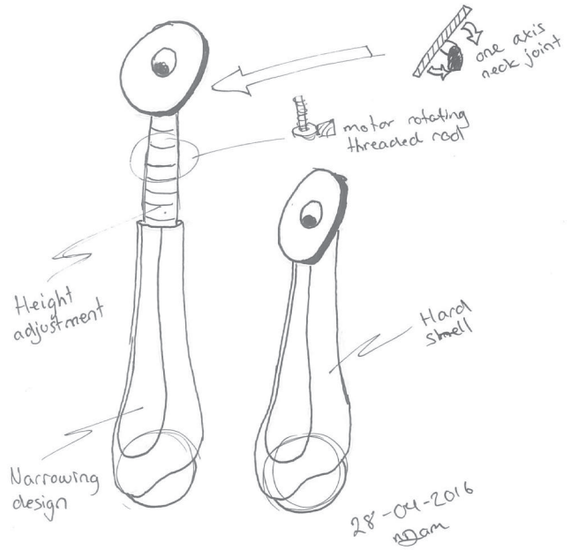
- Verbal interaction with ordering with physical as
- backup [page 47]
- Apply humor to its own failures [page 55]

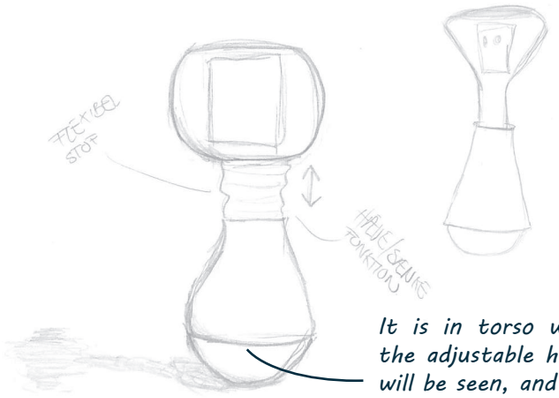
2.26 BODY SHAPE DEVELOPMENT

With more specific demands to base the design on, the team was now ready to develop the robot. The idea generation was divided into three parts:

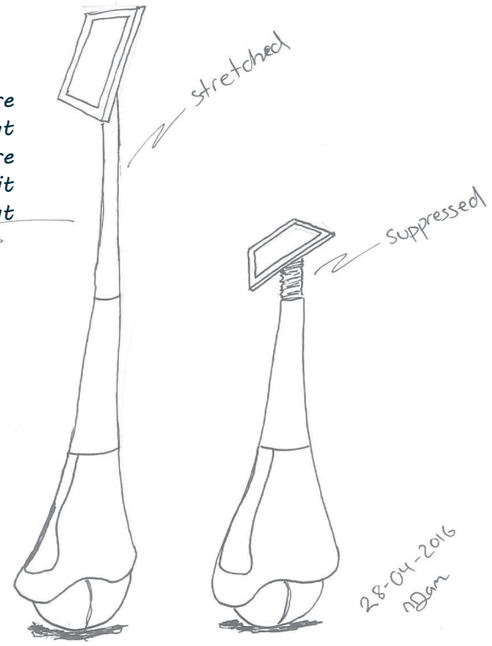
- The body shape,
- Hiding the omni-wheels
- Development of the head.

Here there will be focus on developing the body shape.
As adjustable height is a demand, the design should be able to perform in different heights, which was the first that was sketched on. [See all sketches in worksheet 54]

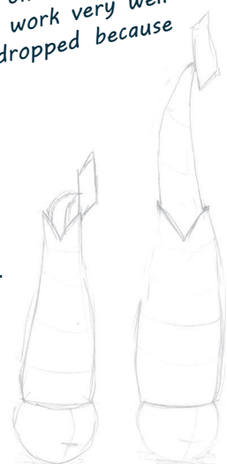




It is in torso where the adjustable height will be seen, and here it is tried to make it as a long neck that the robot gets



Here it is tested how it will work if the screen is "popping" out of the main body on the robot. It doesn't work very well and was dropped because of that

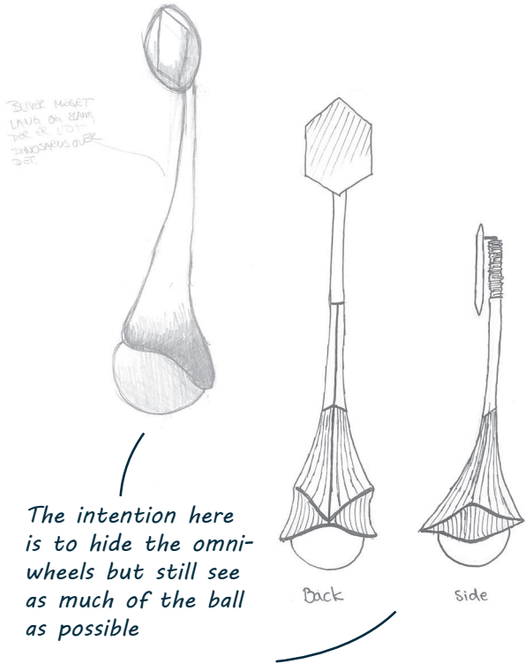


Here it is flexible fabric being stretch when the robot change levels of height

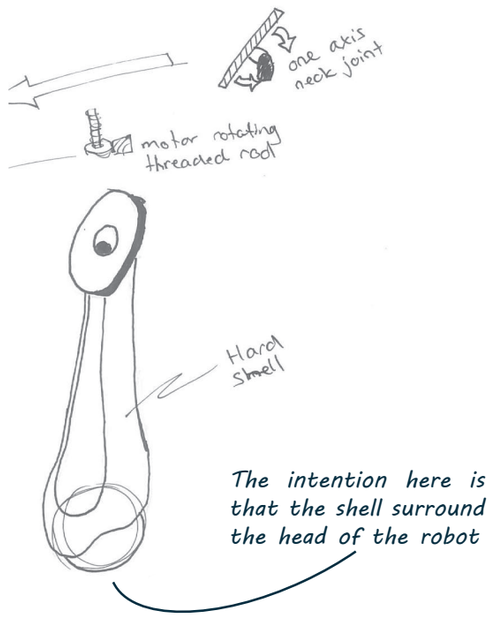
To define if the shell should follow the head up when adjusting the height, a test was made with a mock-up. The test showed that the structure of the robot gets warped in a strange manner if the shell is being pulled with the screen.
The team decided that the head should move upwards alone because of this. [See worksheet 54]

Illu. 97 - Testing placement of the shell.

The result of these sketches and mock-ups is that the robot will get two different expressions depending on the height of the robot.
The shape of the robot will be clear when the robot is down and small, and then there will be a pole raising the head of the robot. It will create a break in the shape if the body isn't surrounding towards the height adjustment principle.



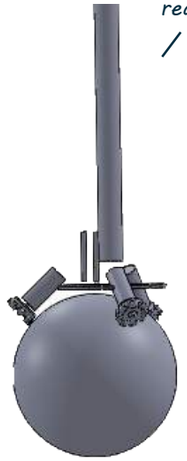
The intention here is to hide the omni-wheels but still see as much of the ball as possible



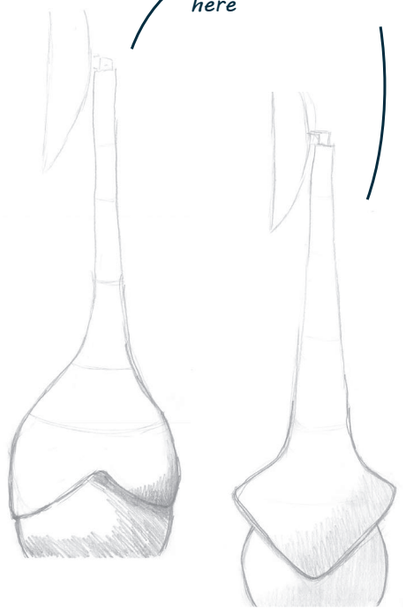
The intention here is that the shell surround the head of the robot

Afterwards the sketch topic was to have the main body, so it could be shaped in 3D. [To see all sketches see worksheet 62]

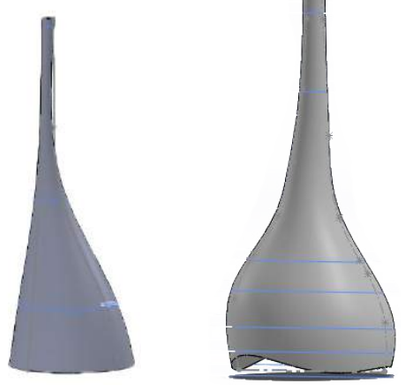
A proportionate 3D model was build to sketch upon to have realistic proportions



Previous research showed that the robot would be less dominating if it is possible to look under the screen, this is sketched on here



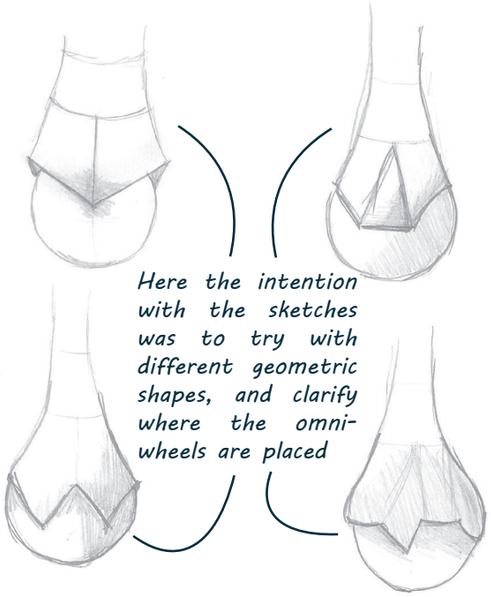
Finding the best 3D form based on sketches was the next step, making the last thing the buttom cut



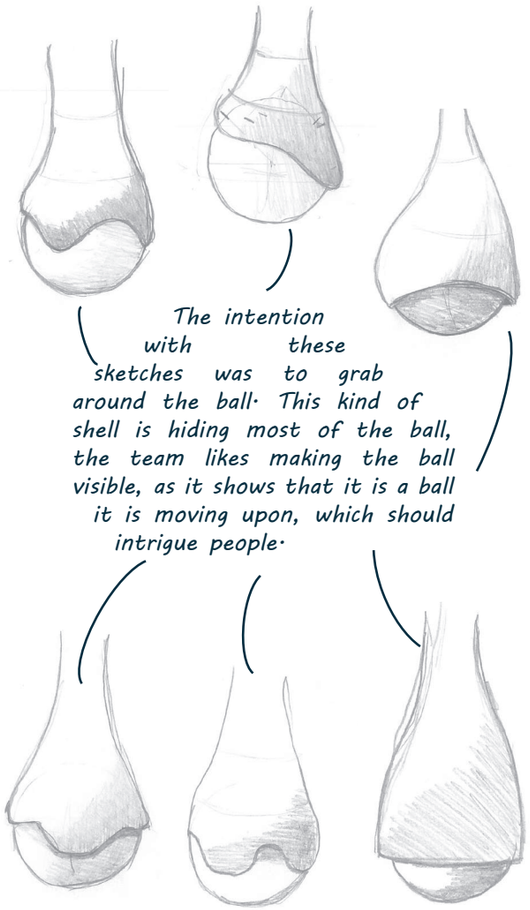
The principle underlying the final 3D drawing of the shell was a sleek line narrowing in to the height adjustment diameter. With this defined, was the missing thing the bottom cut of the shell, basically creating the transition between shell and ball.

2.27 HIDING OMNI-WHILE DEVELOPMENT

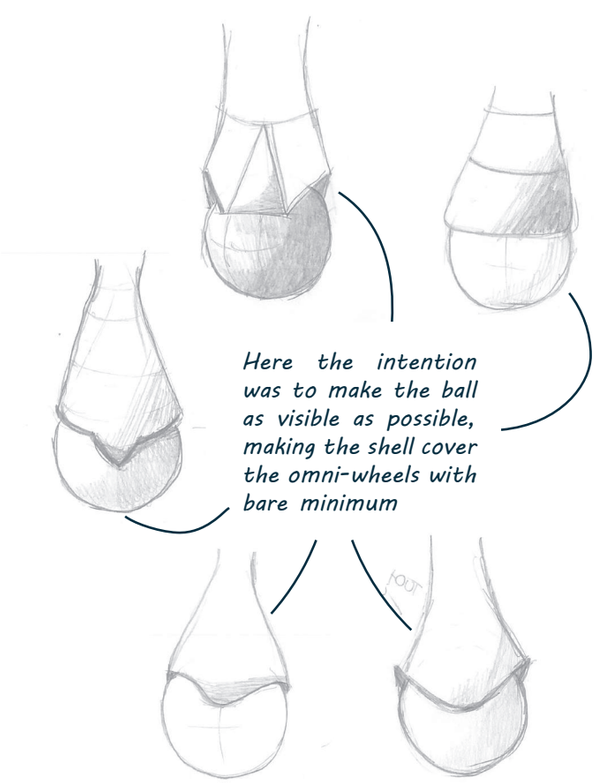
The demands for the transition from the ball to the shell of the robot, is to cover the technical parts and that is mainly the omni-wheels placed with 45° onto the ball., 120° apart. [To see the whole sketch phase see worksheet 59]



Here the intention with the sketches was to try with different geometric shapes, and clarify where the omni-wheels are placed

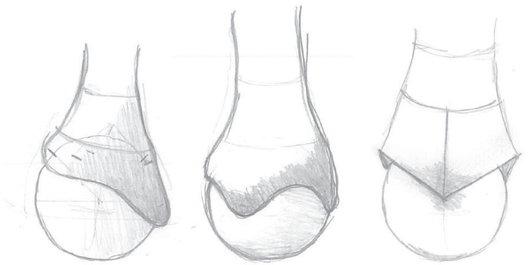


The intention with these sketches was to grab around the ball. This kind of shell is hiding most of the ball, the team likes making the ball visible, as it shows that it is a ball it is moving upon, which should intrigue people.



Here the intention was to make the ball as visible as possible, making the shell cover the omni-wheels with bare minimum

The team pick three different shapes trying to work further with in 3D modeling.



Illu. 99 - Three designs for shell bottom.

Illustration 98 shows the final form, unveiling that a soft curve cut was chosen for the shell, as it created a pleasant transition from the shell to the ball.

Illu. 98 - Final form

The thought behind the final hard shell form is that it should be covered with material like felt and leather, making it able to change aesthetic expression.

The reasoning for automatically going in the direction of these materials, is rooted in conversation with Karl and working with moodboards early in the process. The team choose rather early on, that the aim for the design expression should be in line with Danish design and something with soft materials. This would create an expression far away from the average robotic expression. [Worksheet 41 + 42]

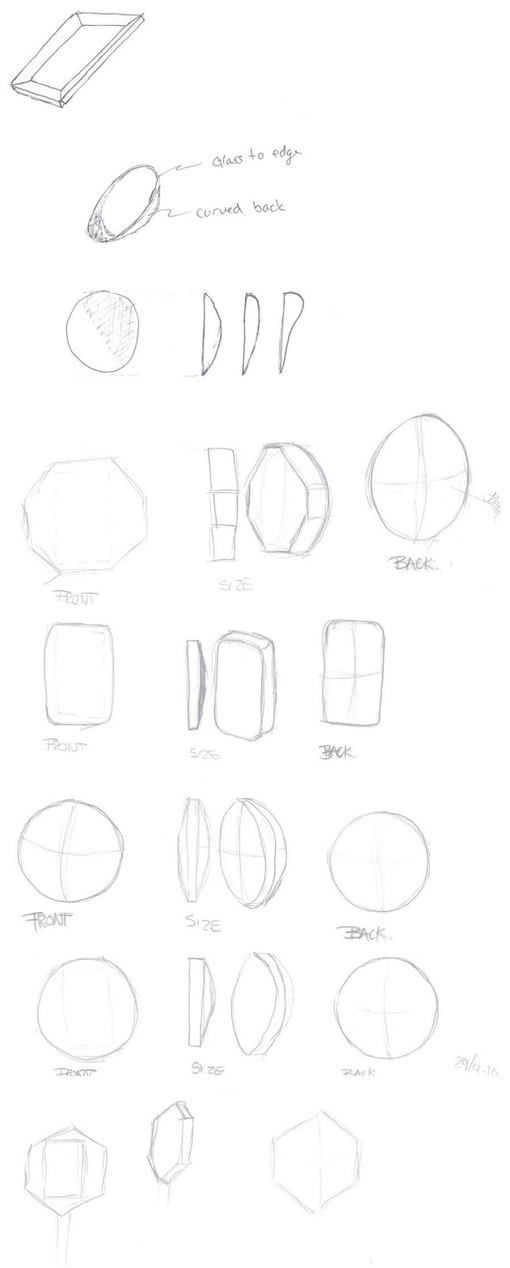
Illu. 100 - Moodboards of Danish Design, Futuristic and Soft shell. [Pinterest, 2016]

Integrating flexibility in expression is wanted because the team observed how hotels have various interior design, and the team see potential in the ability to adjust the robot design.

- The shell should have additional material applied to change expression.
- Danish design with soft materials is the aim.

2.28 DEVELOPMENT OF THE HEAD

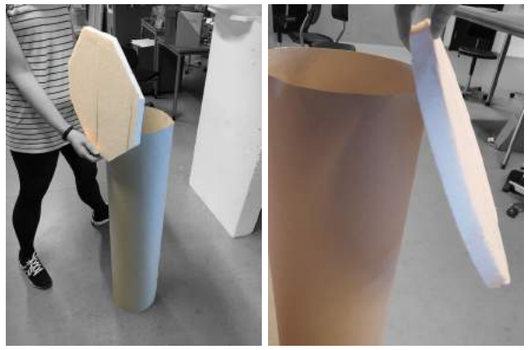
The development of the head started with sketch on different shapes. [Worksheet 57]



To see how the shapes were fitting to the robot mock-ups were created.

Illu. 101 - Testing shapes of head.

The head shapes were also tested with different angles

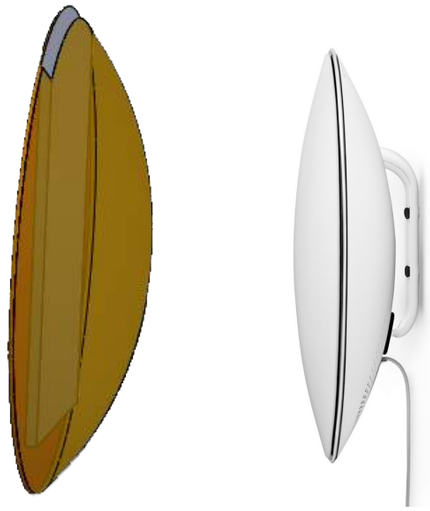


Illu. 102 - Testing placement of head in relation with body.

By a coincidence the head model was placed on the top of the body mock-up, and that sparked the idea of having the possibility of laying the head and screen down on the robot, making it possible to have a new kind of interaction with the robot.

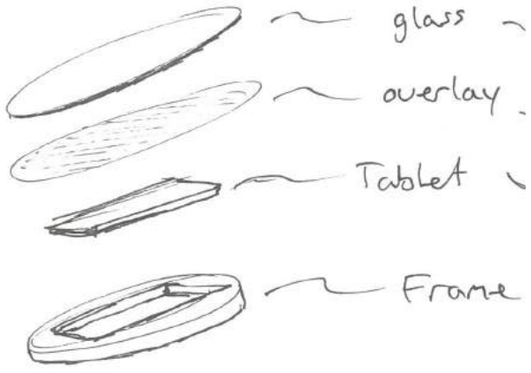
Illu. 103 - Discovering new interaction scenarios.

The team quickly found that a round shape for the head was the wanted path, initially taking basis in the shape from Beoplay A9, just with a flat front.



Illu. 104 - Beoplay A9 shape used for head. [Shoplr, 2016]

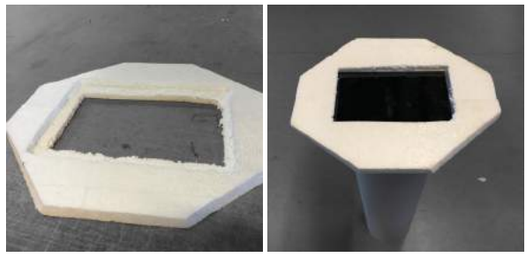
After defining the shape of the head, the tablet needs to be integrated.
It is a wish that it is not possible to see that the screen is a tablet.
The first ideas was to have the tablet hidden so the user couldn't see that it was a tablet, making the only visual a circular glass front, with no visual transitions.



Illu. 105 - Initial construction example for head.

The initial idea was found not to work after making a mock-up. The mock-up quickly identified that the tablet functionalities would be lost if the structure was done as initially proposed. This would happen because the glass surface would cover the whole interaction surface with the tablet.

Another mock-up was made, putting a tablet into a head shape, reveling that access to tablet buttons also should be possible.



Illu. 106 - Testing tablet integrated in head.

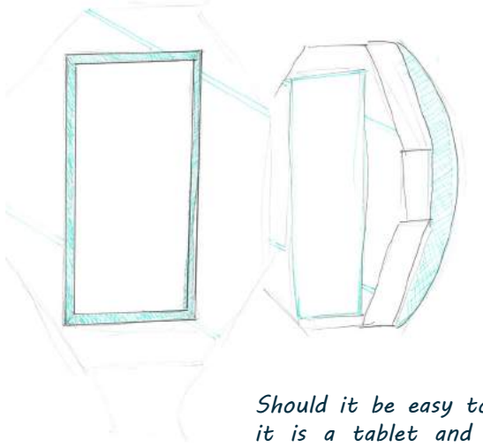
When the tablet was placed in the mock-up it was not possible to switch the tablet on, and use the bottoms outside from the screen.

Illu. 107 - This tablet has buttons on the long side.

- Has to be direct access to tablet screen
- There has to be access to tablet buttons.

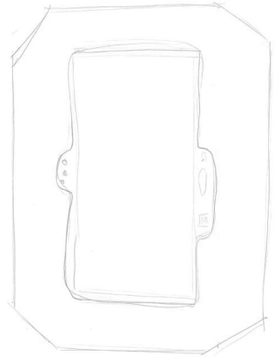
New sketches and ideas needed to be created to define where the tablet need to be.

Should the tablet be hiding so it is not possible to see it?



Should it be easy to see it is a tablet and take it out of the robot for other use?

Should the buttons for the tablet be exposed, how will that work if it is possible to use different tablets, where buttons are placed different places on the tablets



For use in the lounge at hotels it will be better if the consumer do not have the possibility to use buttons that can create errors in the robots programming.
A mock-up indicating the screen in a cover.

Illu. 108 - Mock-up of unicase for tablet in the head.

The intention for the concept is then that the back pieces on the mock-up is rubber where it is possible to use the buttons through, so it is possible to use the buttons but only if you know that they are there.

2.29 FINAL CONCEPT

With a clear intention for the different part of the robot, the team now had to bind them together, forming one concept.

The screen is a tablet, and the tablet is closed around the shell with rubber so it is possible to use the buttons on the tablet.

In the head there is a crack to place the tablet into.

The shape on the bodyshell is narrowing in, making it less likely to become dominating.

The head joint can rotate vertical, which can be used for behavior and contextual use.

It should be possible to change the exterior to align better with other contexts.

The shape on the bottom part of the body shell is formed to hide the omni-wheels with a aesthetic transition to the ball.

Illu. 109 - Final design proposal.

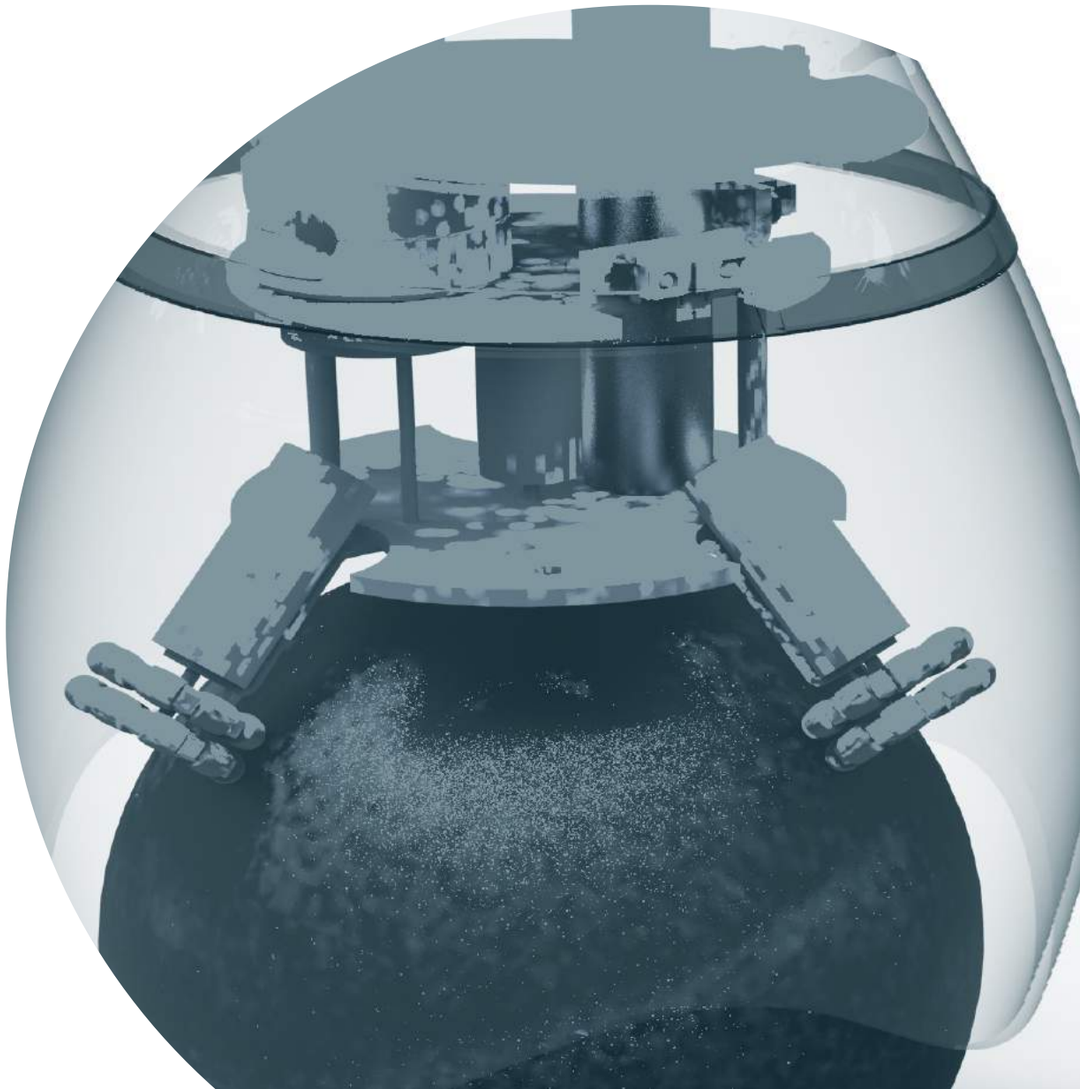
2.30 PRESENTING THE CONCEPT

This concept was presented at a meeting with Karl and Kuno, president of First Hotel Europa [Worksheet 63]
Both of them had good response on the concept, and the feedback on the possibility of changing the exterior was definitely a good feature, as the hotel quite often changes interior, making it possible to match the rest of the lounge.
Kuno was very pleased with the design, as he had been worried that the solution would be quite industrial looking.

- The final concept was approved, making it ready for detailing.

3.0 DETAILING

The upcoming chapter will sum up on the project by having a conclusion and a reflection. The last part will include references and list of illustrations.



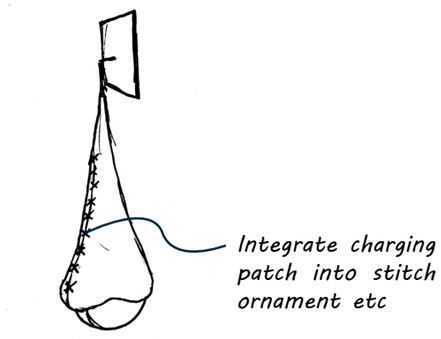
3.1 TECHNICAL FEEDBACK

The presentation of the concept continued as a meeting with Karl alone, changing the focus to technical feedback on robotic aspects, and ping-pong ideas for further development. The main topics of this session were...

- Expectations to result
- Charging technology
- Location of motor to neck joint
- Location of omni wheels
- Business possibilities
- Practical and other stuff (see full worksheet 63)

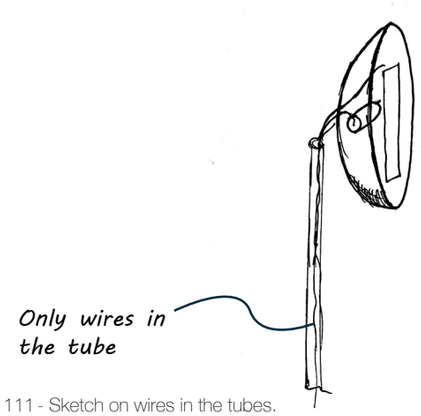
Karl stated at the meeting that he was interested in the team taking the design proposal as far as possible in terms of construction and production, so he could use the elements. This statement alongside the teams own intentions is the reason why the detailing phase will focus mostly on construction and production, making the final design ready for hand over.

One of the topics were how to charge the robot, and a few ideas came up of how to do that, which included wireless charging which seemed to be 200% charging time compared with cable. Another idea was to integrate charging connectors into some ornament in the design, keeping the effectivity of physical charging without compromising the design.



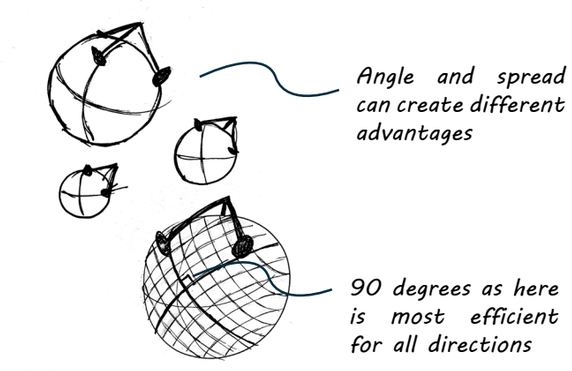
Illu. 110 - Sketch on integration of charging.

Another topic was how to make the neck joint move as wanted, and it was quickly clear that having it in the back of the head shell would be most convenient. This was because it wouldn't take height, and the only thing that needed to go through the tubes would then be cables to the motor, and tablet.



Illu. 111 - Sketch on wires in the tubes.

The team also learned through the meeting that the position of the omni wheels can be done basically as you want, as long as the rotation axis applied to the spheres own grid, isn't parallel to each other. Playing with these angles can create for instance greater thrust forward if wanted, or any other direction.



Illu. 112 - Sketch on omni wheel placement on ball.

In addition to the technical aspect, the team talked with Karl about initial production number, and business possibilities in the fact that the hotel has just been bought by Scandia.

These technical aspects will be further detailed later in the report, where they will be specifically elaborated.

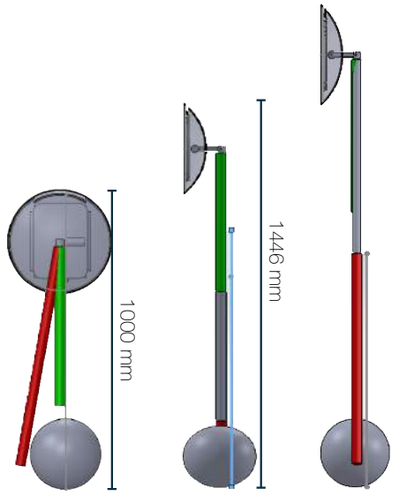
3.2 DETAIL ADJUSTABLE HEIGHT

The requirement for the height was set from 1000 mm. to 1640 mm. so the team started looking at the possibility of fulfilling it. At this point the construction was made so the tubes created the adjustable height of 440 mm and that is not enough.
The team was searching for alternative solutions to the height adjustment because of that. The team found that It was possible to move the tubes to the side of the ball.
To understand the principle and see which kind of challenges the principle would bring, the team build a mock-up to test it out. [Worksheet 68] It showed that the pole can not go too far down on the ball, because when adjusting the height, the robot finds a new center of gravity, which makes the tube come closer to the floor.

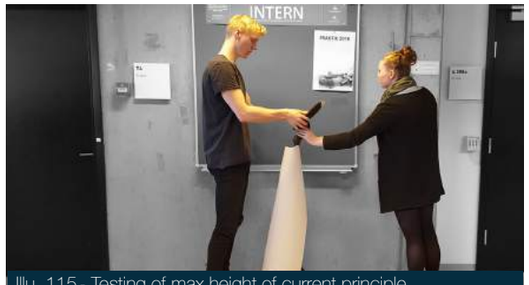
To test it more theoretically, the principles was calculated upon, in the search of finding a comparable hight difference. [Worksheet 70] The result was that if the robot had principle two (red tube) the height can be 1741 mm and if it is principle one (green tube) the height can be 1446. This constructional adjustment would make the team fulfill the wanted demand.
Now it will be needed to see which kind of challenges that will give if the tube is moved to the side of the ball and change other parts of the requirements.

The decision of the requirement of the adjustable height from 1000 mm 1640 mm was decided before the team defined the need for a neck joint, that makes it possible to angle the screen. To test how the angle possibilities roughly changes the demand, the team set up interaction where the screen was lowered, but angled. The test can be seen in [Worksheet 69]. On illustration 115, it can be seen that it is tested with a height of 1400 mm with an angle making the screen look directly towards the user.
The response of the test was good, and the new height was actually preferred in some cases, making the 1400 max height acceptable. This means that both principles can be fulfill the demand for the construction.

Illu. 113 - Mock-up testing of new height adjustment principle.



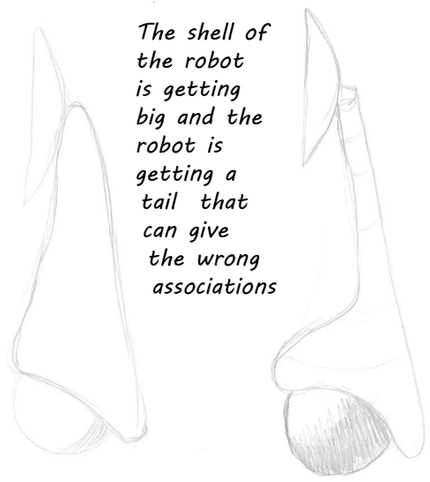
Illu. 114 - Height comparison.



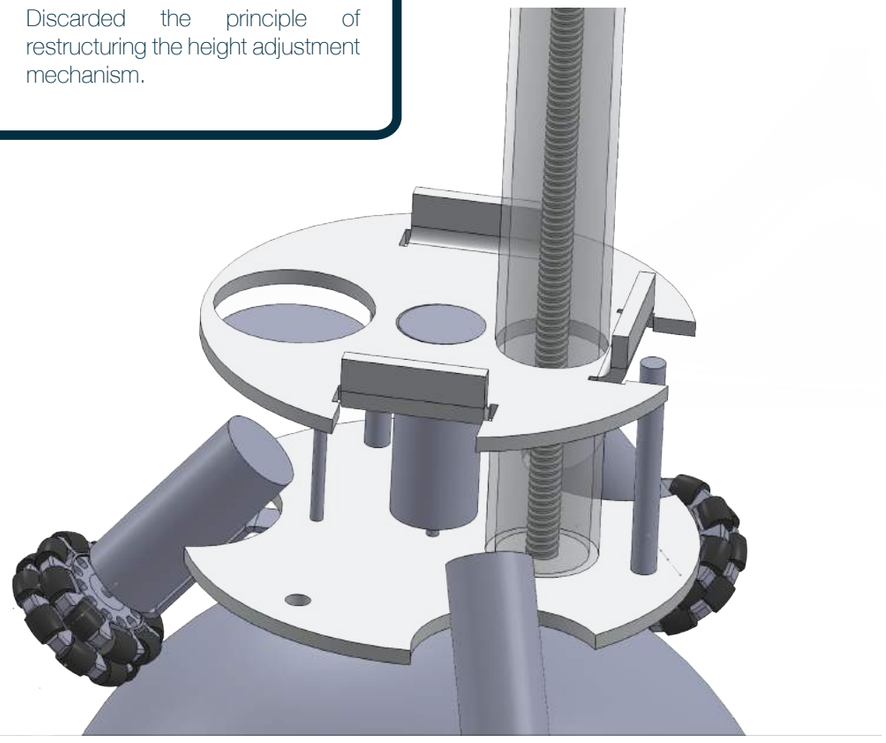
Illu. 115 - Testing of max height of current principle.

- The maximum height demand was changed from 1640 mm. to 1400 mm.

To help decide whether tilting the height adjustment is the solution, the team wanted to ideate, by sketching on that structuring of the robot. This would help determine whether there would be any aesthetic loss in switching. [Worksheet 71]
The results of the sketching revealed that it was not easy to see the same flow in the shape of the robot, as it was hard not to create a “tail” in the back of the robot, and the design will automatically be tilted in a way that makes it more forward leaning in the expression.
The results regarding the design aspect in addition to the factual change of demand in height wasn’t enough for the team to switch structure.
The path of switching structure was because of that discarded, and the initial structure was again the path for further development.



- Discarded the principle of restructuring the height adjustment mechanism.



Illu. 116 - Straight height adjustment principle in 3D.

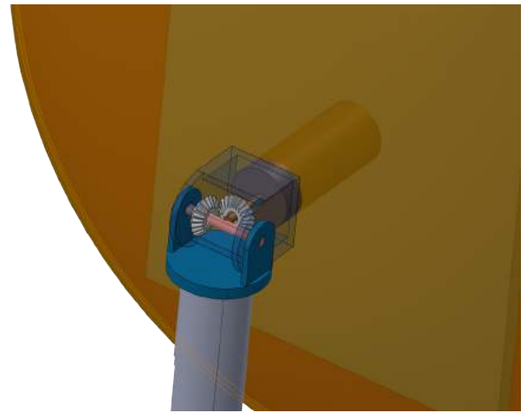
3.3 NECK DEVELOPMENT

At this time the team was ready to detail the neck joint, which should create one axis rotation for the head, and as stated through the meeting with Karl, the intention was to locate the motor in the head shell. Based on this an initial propose for a construction was created. [Worksheet 73]

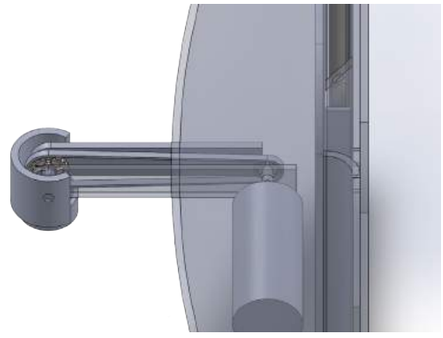
This first attempt, seen on illustration 117, had the motor orthogonally to the face of the head, making it stick out of the back and through that becomes a part of the coupling between tube and head.
The problem with this construction was that bever gears are more costly than regular gearings. In addition to that, it might not be very smart to have the head be supported on by the motor, as that obviously isn’t the intention and function of that part. As a result of various downsides the team chose to give it another try where the motor is parallel to the face of the head.

The second try as seen on illustration 118 uses regular gears with a toothed belt. This try also has gearing integrated, so the motor will rotate slower with greater moment. Additionally the toothed belt is surrounded with two plates of aluminum, which should connect to the motor so it locks with the mechanism. These also works as supporters for the head, and should just be covered with a tube or a plastic part.

- A functional mechanism for the neck joint has been made.



Illu. 117 - Initial neck joint construction.



Illu. 118 - Second and final neck joint construction.

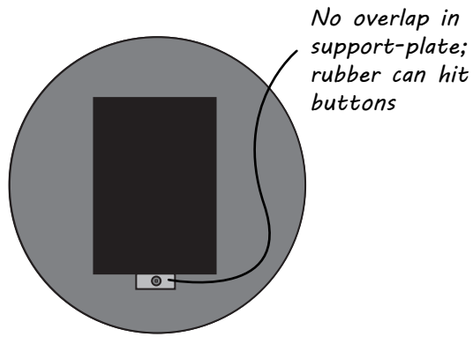
3.4 HEAD DEVELOPMENT

The concept for the head of the robot had to be broken down into layers to establish the functionality of being able to use the tablet functions without making them visible.

SECURING TABLET FUNCTIONALITIES
The main idea is to use a rubber front to make interaction with the tablet buttons possible, so the construction has to fulfill that purpose.
To do this the, main initial construction idea was to make the full front in rubber, while having a thin plate behind to support it in all places except where the rubber should be able to be pushed towards a button.
The thing with this construction was that it would only work with an iPad, as it only has a physical button, but Samsung has touch buttons as well, which requires it to be able to activate those as well. The solution, as seen on Illustration 119, was to implement a material, as used on stylus', on the back of the rubber on the interaction points, that would allow the back of the rubber to activate touch buttons without the touch of a physical finger. see Worksheet 74 for whole development.

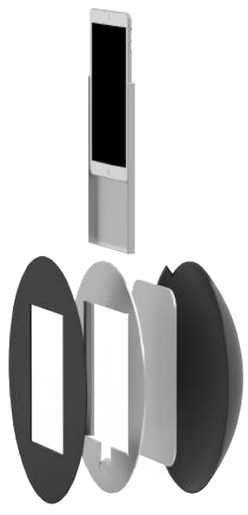
SLIDE-IN FOR TABLET
Behind the front there has to be a slide-in for the tablet, so it can be taken in and out, and in the first mock-up in 3D, it was build into a solid shell of the back part. But as a decision later concluded that the back part should be vacuum molded, another construction had to be created for the case of the tablet to slide into the head, see illustration 121.
The solution for this was to change the supporting plate between the rubber and the back shell, making it sheet metal with inner bends that then creates the frame for the slide-in drawer to the tablet case. Adding a back plate then finishes it, and the tablet case can be slided in, see illustration 122.

FITTING BOTH SAMSUNG AND APPLE TABLETS
This previously mentioned unicase for the tablet is supposed to be just a margin bigger than the average size of 9,7" tablets, so that the newest Samsung and Apple tablets can fit the same case, as they're just few milimeters different in size. To cope with this tiny difference the team see potential in just putting foam on the inside of the case, so it can fit both tablets.



Illu. 119 - Overlap in construction of head.

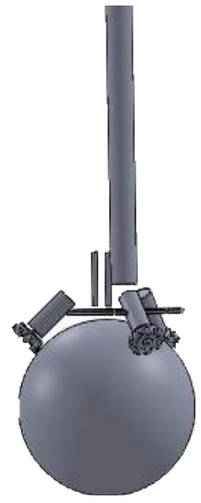

Illu. 120 - Solid shell slide in.


Illu. 121 - Final construction of head.

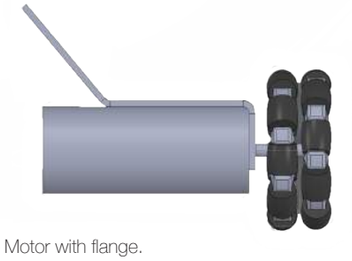

Illu. 122 - Final construction of middle plate in sheet metal.

3.5 DEVELOPING SKELETON

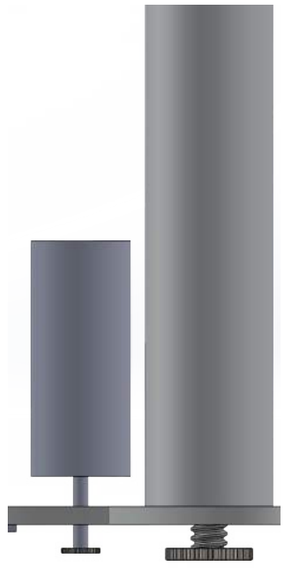
With the top of the robot mostly functional, a more detailed construction of the skeleton was the objective, as this would set the minimum for the size and shape for the final body shell. [Worksheet 76]
Illustration 123 shows how the skeleton of which the initial design suggestions was created, and it is this which has to be further detailed.
The intention from the start, which should be somewhat possible to see, was to have two plates on which the inner components should be placed, making it possible to develop further, as they would act as platforms for whatever components wanted.


Illu. 123 - First mock-up in 3D of skeleton.

The first step was to attach the motors and wheels to the bottom plate, which then establishes the foundation for the skeleton on top of the ball. The team chose to do this with bended pieces of metal that grabs the motor and attaches to the bottom side of the bottom plate, making it cheap and simple.


Illu. 124 - Motor with flange.

With the foundation constructed it was time to incorporate the tubes, threaded rod, motor, gears and toothed belt for the height adjustment. To reduce the consumption of space in the height, the team chose to use gearing to be able to place the motor alongside the tube, see illustration 125. The gearing here should of course be defined on basis of the wanted heightening speed, which the team hasn't focused on achieving.


Illu. 125 - Motor with gearing to height adjustment tubes.

Illu. 126 - Combined construction of current parts.

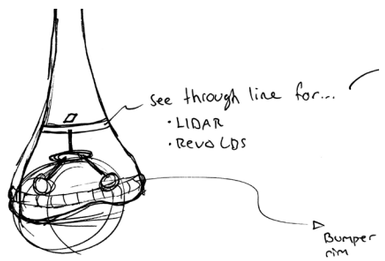
3.6 INTEGRATE SENSORS TO THE DESIGN

As mentioned very early in the report, the team would take basis in the setup of sensors in robotic vacuum cleaners, see page 21. The specific sensors the team intent to use are:

- LIDAR
- IR SENSOR
- MICRO SWITCHES

Illu. 127 - LIDAR, Infrared and micro switch sensor.

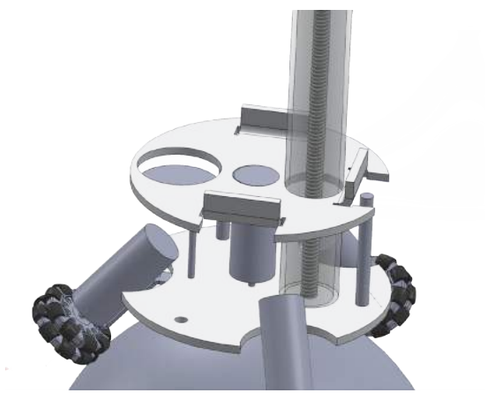
These combined should establish a good foundation of navigation for the robot.
The objective at this point was for the team to integrate these sensors in the most optimal way in terms of navigation, with the least impact on the design.



Illu. 128 - Sketch on integration of sensors.

As seen on illustration 128, the initial idea was to integrate a line in the shell so the rotating laser (LiDAR) can see through it. In addition the team thought that you could use the same line for the IR sensors as they also would need see through material to be usefull. The plan was then to locate the two types of sensor in such a way that the LiDAR can rotate with maximum free view, with the IR sensors beneath with as little distance as possible, to use the same line in the shell.

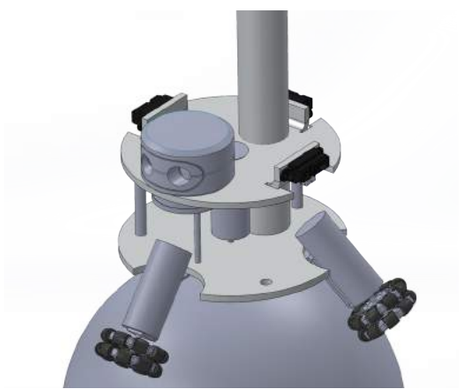
The first step of defining this structure was to build a platform for these sensors on the skeleton. As illustration 129 shows, the platform is around the height adjustment tubes and elevated with pillars from the bottom platform.



Illu. 129 - Plate for LIDAR and IR sensor.

Throughout the detailing of this the specific sensor shape and size were found, which called for many small adjustments. In contrary to the current plate on the illustration, the plate was flat in the beginning, but the shape of the IR sensors made the team realize that it would be smart to bend the metal plate to integrate attaching plates for them, instead of additional parts to save money in production and time in assembly.

The integration of the micro switches will come at a later stage as is it dependent on the final shape of the body shell.



Illu. 130 - Construction with LIDAR and IR sensor.

3.7 BODY SHELL DEVELOPMENT

The volume of the skeleton was at this point detailed enough to begin working with the final form of the body shell. [Worksheet 78]
Finding the ideal line from a side view was the first step, making sure that it wouldn't hit any components, while being aesthetically pleasing. With a good line as basis, the team made a three dimensional shell.

Illu. 131 - Side view lines for final shell.

With the overall shape in place, the team wanted to work with the cut of the shell, which defines how it aesthetically connects with the ball. As seen on Illustration 132, the team tried different cuts, ranging in height and curvyness.

Illu. 132 - Development of body shell cut.

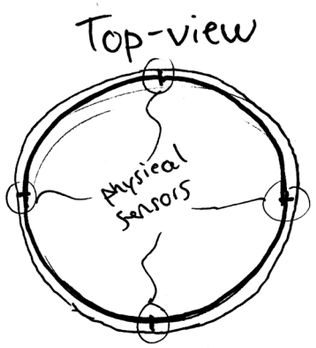
This process stopped when the team made the cut seen on illustration 133, where it is compared with the shell on the initial design proposal. The comparison clearly shows how the skeleton has demanded another shape, especially in the front, where it wasn't allowed to reach as far down as initially drawn.

Illu. 133 - Comparison of initial shell and final shell.

After the form finalization, a cut for sensors to look through, had to be integrated. This cut was decided to be integrated as a line, making in as small visually as possible. Curves for the cut was considered, but would require too much space in height, and capture additional attention on something that is thought to be somewhat hidden.

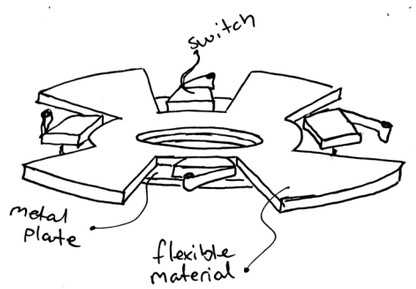
3.8 INTEGRATING MICRO SWITCHES

This solution has already captured two thirds of the sensor types, leaving the micro switch for physical hits. The initial idea here, as seen on illustration 134 and illustration 128 on page 98, was to integrate a bumper sensor between the inner bodyshell and the applied material, on the broadest place of the shell. This construction would make impact on the applied material push the rim, that would push the physical switches and activate them depending on direction of impact.



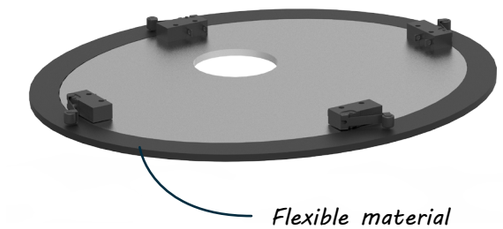
Illu. 134 - Top-view of bumper rim sensor sketch.

At the point where this principle should be integrated in the 3D model, the team had been wondering how to lock the body shell centered according to the skeleton. As a result of thinking on this topic, the team created the idea of taking the bumper rim on the inside and additionally use it as a spacer on the inside. The constructional principle of this mechanism is seen on illustration 135, where a smaller radius metal plate has switches located on it, with a flexible material layed down from top in the in-between spaces, making a spring mechanism that only allows the shell to be pushed to the switches with a specific minimum of force, as the switches themselves gets activated rather easily.



Illu. 135 - Sketch on inner bumper spacer mechanism.

While building the mechanism in 3D, the structure changed, as it seemed more smart to make the structure in one plate, instead of having two layers. The mechanism isn't very far developed, and it is merely the principle of it that should be view upon.



Illu. 136 - Final construction of inner bumper spacer mechanism.

3.9 DEVELOPMENT OF A FACE

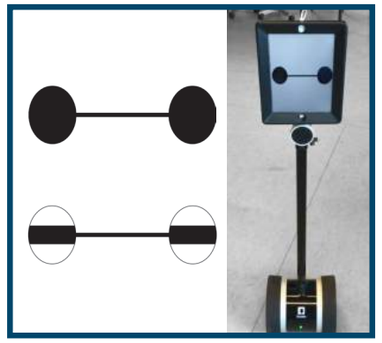
The face of the robot should be the screen, and because of that a software design that can be changed in association with the context. The limits to the face are because of that close to limitless.
The identity is based on software, and it should define whether the robot is a he or a she. Eyes were found to be enough for people to understand that i has an identity. [Worksheet 61]
Because the robot has human activities at the hotel, the team has chosen to go on a somewhat human design path
To test the use of eyes, four eyes were made and animated. These were then put on the Double to see what they created in combination.
The four animation can be found on the usb stick, showing the eyes opening and closing, or just moving an eye ball around.[See animations on USB]

<u>Eye design 1:</u>
This was inspired by Baymax from the movie Big-hero 6, which earlier inspirited the team in the development of the robot. The interesting thing about these eyes were that if people knew the movie, they say his eyes, if they didn't they say for instance a iconized weight lifting bar.

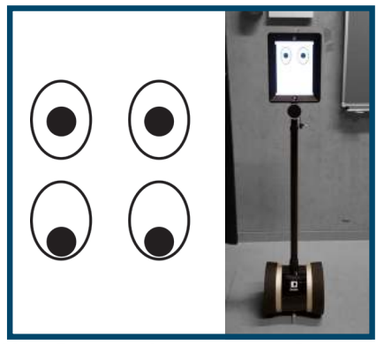
<u>Eye design 2:</u>
Typical cartoon simple in structure. Here it is the eye ball moving, indicating in which direction the eyes are looking.

<u>Eye design 3:</u>
Is a whole face to see how that was perceived contra just the eye.

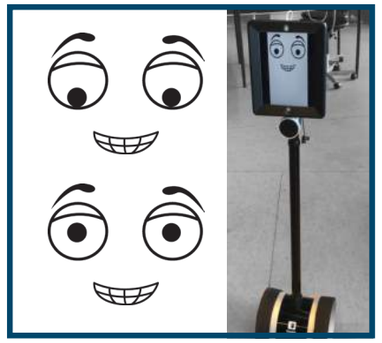
<u>Eye design 4:</u>
This was inspired by the robot Jibo, using a 3D ball to indicate the eye of the robot.



Illu. 137 - Eye design 1: Baymax eyes on Double.



Illu. 139 - Eye design 2: Simple eyes on Double.



Illu. 138 - Eye design 3: Eyes with mouth on Double.

Illu. 140 - Eye design 4: Jibo eye on Double.

The team didn't make a dedicated testing of the eyes, but gathered feedback of them through other tests and conversations with fellow students. This has lead to some comments on the design, making up an idea obout the design path.
The comments were as follows:

Eye design 1:
- The robot is cute, because Beymax in the movie is cute
- I have seen the movie and Beymax was harmless so it is okay that the robot is getting close to me.
- Which kind of eyes is that, it looks like a beam.

Eye design 2:
- It looks like the robot is giving me the elevator eyes and that is creepy.
- It stare at me when the eyes do not close, and the eye contact is getting intense.
- It tells that the robot can look other ways than just straight ahead.

Eye design 3:
- It is creepy, and it is a dirty look the robot is sending, - "go away" (saying to the robot and wave with the hand)
- Ew go away - it is too much.

Eye design 4:
- Is that an eye
- It looks like someone is pressing a huge acne
- That is not something that I can identify with.

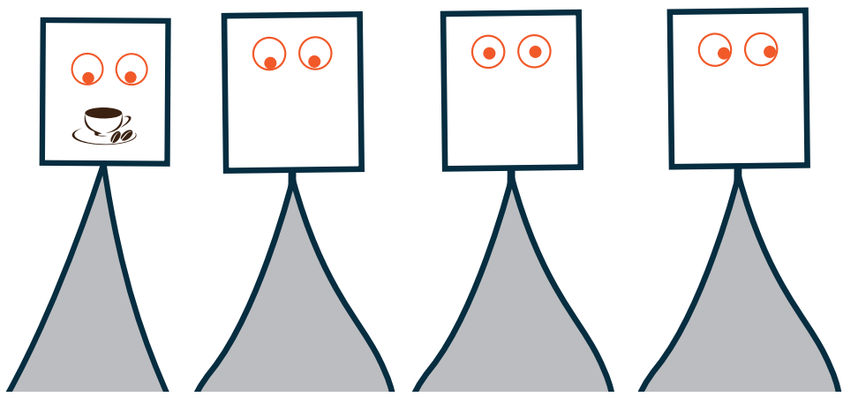
From earlier analysis the robots activities and behaviors were mapped. This has established an idea of which features the face should be able to perform. Some of the defined features are listed below.

The eyes should in some way communicate being:

- Funny
- Clumsy
- Ordered item
- Tired (low energy)
- Sleeping
- Energized

These behaviors need to be considered in the development of the design proposal for the eyes/face. In addition it is important to note that overplaying the features can create unwanted emotional responses from the users.

The conclusion from the work regarding use of eyes, it was chosen to keep it very simple, and play it safe. It is always possible to build on top, and the team doesn't want to create too complex structure that can be decoded wrongly.
Essentially the team just wants a circular outline of the eye with a moving eyeball inside. When it has an interaction, like ordering, the screen should use the left over space to illustrate components in the conversation, like coffee, snacks or for instance being extra happy.



Illu. 141 - Result of how the eyes should be.

3.10 FINAL DESIGN AT PROCESS END

3.11 ROBOT IN PRODUCTION

The robot construction will be based on many standard components, and these will mainly be the electronics, motors and gears. Aside from the standard components, the team has worked on using cheap and simple production methods throughout the detailing phase. As an example the use of later cut and bended metal plates are consistent, using as little material as possible, and utilizing the possibilities of every given element.
Many of the elements will be standard size tubes and rods that has to be cut to specific length, which also is a cheap way of doing things.
The 'special' produced elements in the construction are going to be the body shell and head shell, as their organic and round shape makes metal constructions inconvenient.

Vacuum molding has been a starting production principle for the team, as it was known to be cheap and easy.

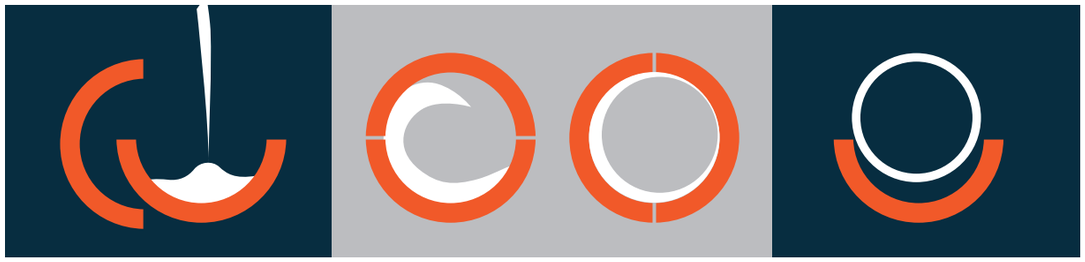
Body Shell
The problem here with vacuum molding, as a general production method, was that the shell would have to be divided into two or three pieces. These pieces would then have to be put together again, which in itself isn't a problem as the shell should be covered in by an additional material.

During a supervisor meeting, the team changed the method to 3D printing, as it is a viable way at least as a beginning, but the team knew that it could be very costly, and because of that, another change was highly probable. A quick use of the fellow students made the team aware of rotational molding as a very good method of use, it is cheap and has the properties the team is seeking to the body shell.

- Correct outer surface
- 'Cheap'
- Elements size is normal

The uneven surface on the inside of rotation molded parts shouldn't be a problem in this case, as there is much waste space on the inside, and there is no real use for a complete even finish on the inside.
Putting the additional material on the body shell has been thought to be either glued on to the plastic part or zipped on i some way, that would allow customers to change the material themselves.
The team has chosen to start with the production principle of gluing it on, to ensure best finish, and based on the price of the inner shell, i may also be the most economical viable way.

Head Shell
Vacuum molding for the head shell is still a viable solution, as it is simple in shape, and can be done in one mold with some additional work afterwards to finish the part.



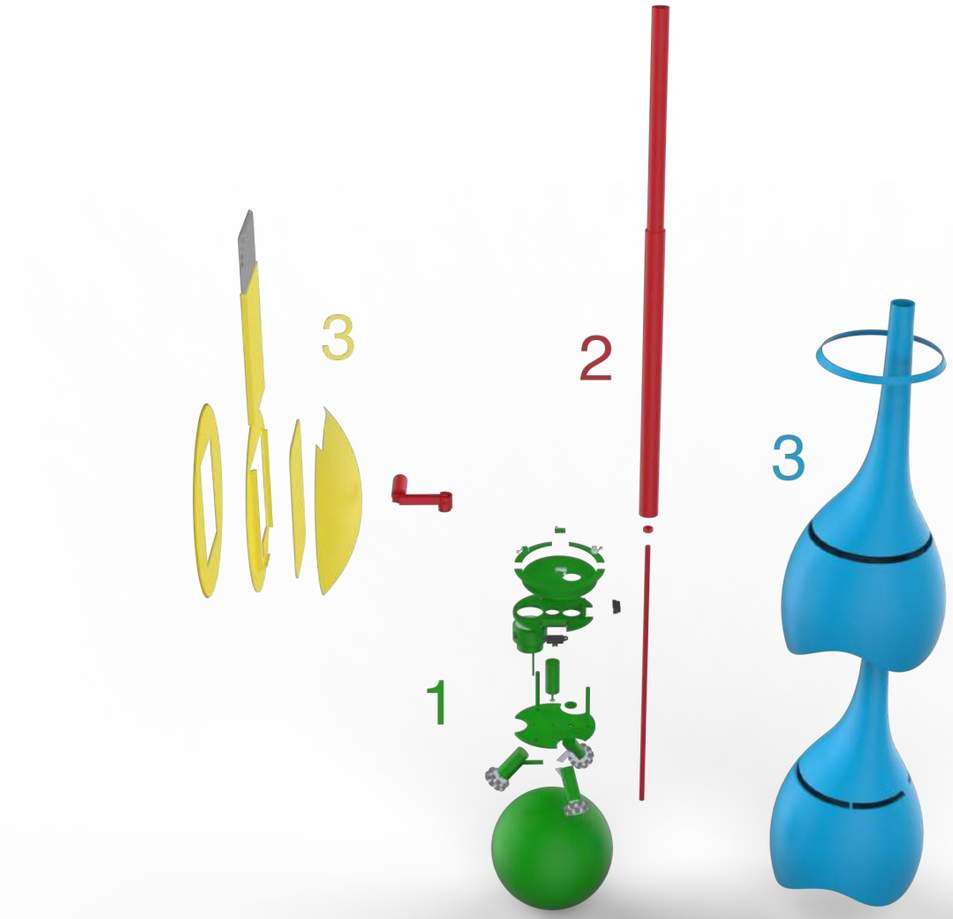
Illu. 142 - Rotational molding principle.

3.12 ASSEMBLY OF THE ROBOT

Throughout the construction of the robot, the team has been aware of how the components are connected, and how you should be able to assemble the product in the end for production purposes.
The result of having this in mind is a construction mainly based in the principle of layers, both in the skeleton and the head construction. Constructing in layers makes assembly rather easy as you start from the bottom and work your way 'up'.
The overall intention of assembly can be seen on illustration 143, where it is possible to see that the skeleton should be assembled first.

The idea then is that the neck joint should be assembled with the tubes and raised to be parallel, so it is possible to lower the body shell down over the skeleton. Afterwards the assembly of the head can be done on top of the neck joint, as it has to go into the head.

For deeper understanding of assembly and construction, see attached working drawings.



Illu. 143 - Exploded view of assembly.

3.13 FURTHER FINISH

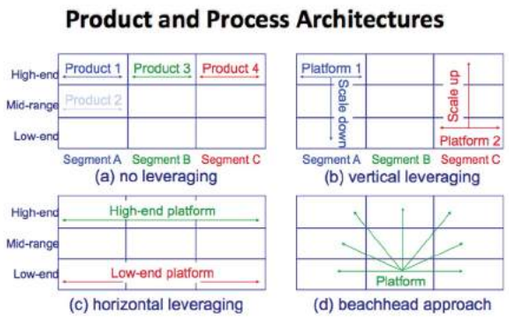
At the reached point of construction the robot overall has most of the components needed. The mechanical constructions are set up in a possible way, but needs final detailing in the sense of attachment to solid elements, bolts, optimizing in dimensioning, dot weldings etc.
Many of the above mentioned things are probably something you would wait with until making full detailing, as prototyping most likely will reveal many things that has to be changed.
Point being that even though elements in the design aren't fastened properly at this point, doesn't mean that they are not intended to be so, it is merely beyond the point where detailing makes sense for the team to use time on.

3.14 BUSINESS ASPECT

As starting point the business aspect will be defined by elements from Business Model Canvas. (Osterwalder and Pigneur, 2010) This is a model which is divided into nine different parameters that needs to be considered from a business aspect when you create a business plan.
The team only found two factor relevant for the current point of the project;

Value Proposition
Create physical presence for an application by placing a tablet in a robot.

Key Partners
Is the Scandic Hotel where the first robot will be tested and implemented as an enabler for value proposition of the project.



Illu. 144 - Product platforms. [Kyvsgaard, 2014]

The business strategy is output from the theory by Marc H. Meyer about product platforms (Meyer, 1997) He divides every product into four different strategies, these being:

(A) No leveraging
"A Niche-Specific Platforms with Little Sharing of Subsystems/Manufacturing Processes" - as a strategy where the product platforms sharing too little technology.

(B) Vertical leveraging
"A strategy is Vertical Scaling of Key Platform Subsystems" - either it is scaling the platform down to a lower price/performance match the market segment or the other way around by scaling up by adding new technology.

(C) Horizontal leveraging
"A platform Horizontal Leverage of Key Subsystems/ Manufacturing Processes" - downgrade high-end products to low-end product by changing a component and leverage the price.

(D) Beachhead approach
"The last strategy The Beach Strategy" - the companies develop a low-cost effective platform to a low-end user, then the platform is being scaled up in performance with new features and then reach other segments.

The solution as is has the ability to leverage horizontally, making no changes in the physical product aspect, furthermore the team acknowledges that a down scaling or upscaling of the current solution can open access to new markets on basis of the same product architecture, make that approach vertical leveraging instead.

SCANDIC HOTEL

Scandic hotel is a hotel chain with 230 hotels allocated in seven European nations where 22 hotels are in. (Scandic hotels group, 2016)
Europa Hotel Scandic should be an enabler for finalization of the robot, and possibly a buyer to initiate production.

PRICE ESTIMATE

The team has made a quick assessment of price for components, resulting in a notion of collected cost of making the product. Karl had earlier in the process stated that 2600 DKK would be an estimate on production cost for the robot, the problem being that too few elements were included in the calculation. Even though it was used to conclude selling price to the potential buyer Kuno. The team challenged this estimate and found that it will most likely cost close to three times what he initially estimated, see worksheet 77 for excel spreadsheet.
Kuno was delighted when the price of 2600 DKK was stated for him, resulting in buying price of 10.000 DKK, but he has earlier in the process stated that he would like to use about 20.000 DKK on the robot if it fulfills the needs. So the teams estimate shouldn't eliminate Kuno as a potential customer. The difference in price estimates is something Karl needs to be aware of when talking to potential buyers.

PARTNERING UP WITH CODING FIRM

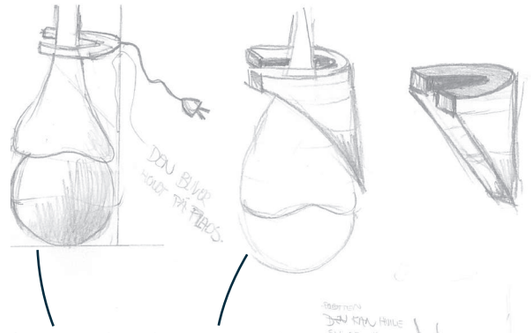
The team has thought about how you can make it more accessible to establish your own app to use the robot. To do that the next step could be to team up with a programming firm that can facilitate the development of software for potential customers, so they just can spend money and get the product, instead of finding software developers by themselves to be able to use the product.

3.15 DOCKING STATION DEVELOPMENT

[Worksheet 72] The robot of course needs to charge at some point, so the team made a brief concept sketch on what that could look like on basis of a set of requirements:

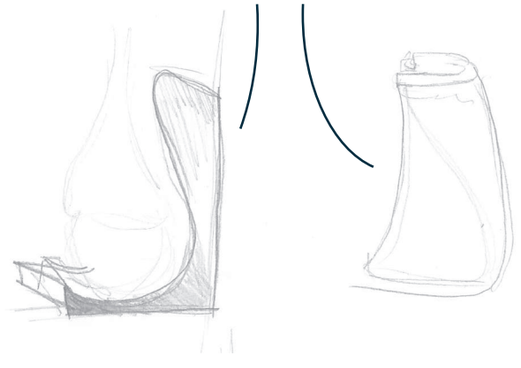
- The charging unit shouldn't be hidden, therefor be in the lounge - making the robot able to charge without the staffs attention.
- Wireless charging is the chosen technology.
- The robot should use the least power possible during charging.
- The dock and the robot should create a united expression when they are together.
- The dock shouldn't exude of missing something while the robot is elsewhere.
- The charging of the robot is located on the body of the robot.

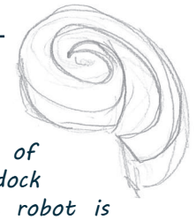
A sketching session was initiated on basis of these requirements.



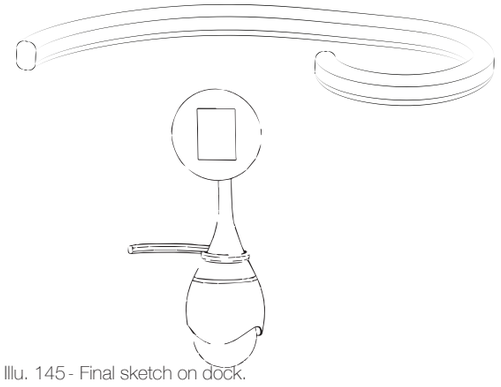
Here it has been tested how the dock can hang on the wall
The dock doesn't contain many components and can because of that be quite small

These sketches are inspired from a typical docking station for a robot vacuum cleaner, this is not the expression we want, as the location of the charging technology will be placed quite high





To reduce power consumption during charging the team looked into ways of holding the robot with the dock
The idea here is that the robot is driving into a whorl, which makes the dock grip the robot and thereby holds its balance
To get in and out of the dock, the robot has to rotate on spot, making the shape of the body shell whorl in and out

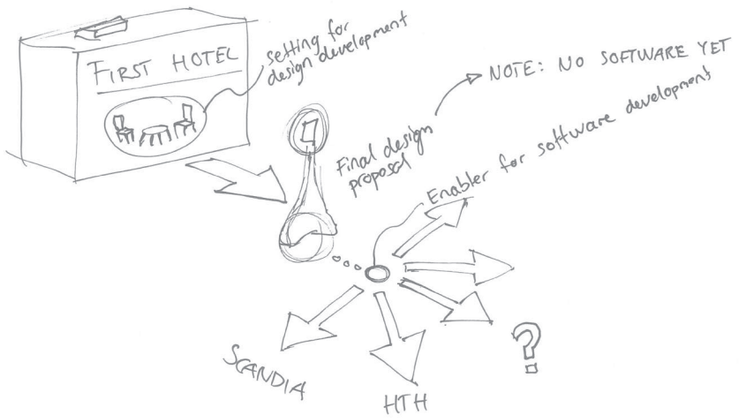


Illu. 145 - Final sketch on dock.

3.16 POSSIBILITIES OF THE PRODUCT

The converging the team has made to result in the given robotic solution, makes the team want to show where it is believed that the solution can be altered to fit. During the span of the project a few contexts have been mentioned, for instance as assistance for salesmen, using the tablet functionality in the position as seen on illustration 146, showing it targeted to 'Svane køkken'. The important part for potential contexts is of course that the interaction and tablet functionality can be used actively, as it otherwise is a complete gimmick, which for some people and contexts might be enough.

The sketch shows how the team at point of hand in, has a design for a robot with software platform possibilities, with no developed software. This means that a specific path for further development actually is quite open, and may call for a incorporated partner that is willing to participate financially to push the software and further detailing to goal for the given context, this could for instance be Scandic.



Illu. 146 - SOMETHING

4.0 SUMMARY

The upcoming chapter will round off the project, with a conclusion and a reflection, digging into various aspects of the project. References and illustration list will be the last part of this chapter.

4.1 CONCLUSION & REFLECTION

CONCLUSION

The project was framed to be based on using a robot to take orders in a lounge environment, at First Hotel Europa in Aalborg. The project has changed the way robots are aesthetically perceived, by integrating the mindset of Danish design to the construction. The project has additionally researched and defined essential aspects of interaction with a robot amongst people, creating knowledge for the upcoming software design. The outcome of the project is FlexBot, a robot based on software platform, great design and physical movement to establish behavior.

PROJECT FRAMING

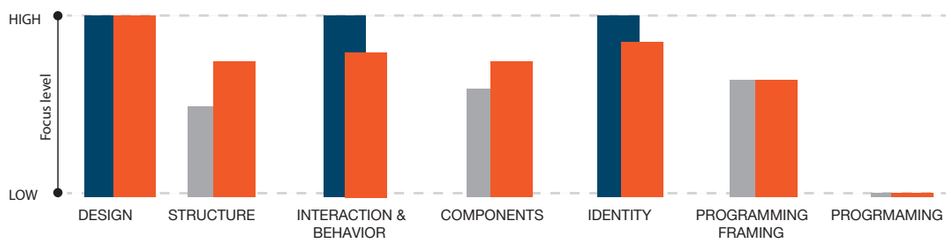
The subject for this master thesis has been large and challenging, as it is a new topic, where most people have no prior experience to begin with. The definition of what a robot is, and where the development of robots is going, is difficult to figure out, but an essential knowledge for the team to understand what the right direction is. On top of that, there is a major misconception of the topic, as the topic is ways has unfolded from sci-fi, books and imagination, and the reality is trying to reach that level of expectation.
One of the aspects the team has been hit in the head with continuously is why the robot isn't performing any manipulative actions, like serving a beer. This is an aspect that on the surface seems rather easy, but in reality is complex tasks beyond comparison if you want to do it like humans. For instance, how do you make sure it holds an object too tight depending on material? Point being that knowledge about the field is crucial to be able to understand the accomplishments that are made within robots today. The team found that this area is hard in the beginning also because people have not foundation to relate to the implementation of a robot, which the team experienced early in the process, where hotels were approached. The area requires you to have something quite specific and tangible, along with time, to make people understand the intentions. Whereas other product categories require way less initial material to create an understandable foundation.

PROJECT MANAGEMENT

The management of the project was structured by co- management, making the members equal at all times. This was done because of motivation for both members to keep the overview of the project. The management was structured mostly on Trello, which is an online representing the methodology of SCRUM, to organize the tasks, it helped well in the early phases of the project, where many tasks were individually, and the team worked apart two of the five weekdays.
The team has used a lot of energy throughout the project to keep track of direction and the current position in the main picture, which will be further elaborated in the collaboration section.
There is a lot of aspect that can be tested in such an undefined area as robotics, but the great possibilities have made it hard for the team to navigate in terms of relevance. The team could've tested from project start to project end, but the specific correlation between direction and tests were in many cases hard to keep track of.
Worksheets have been used throughout the project to keep track of the work done, and the conclusions and reflections of it.

COLLABORATION

The team has collaborated with Karl, and it is his project and vision that the team has worked along with. The essential vision for the overall project wasn't clear in the beginning, and was from the perspective of the team, developed alongside the work of the team. This puzzling alignment took a long time to fall into place, as a mutual understanding first was reached half way into the project. A reason for this is most likely that Karl still was in the alignment phase for the overall project, which also reflects on why mobility principle was changed twice during the time DEVit was working along.
Initially the team had expected that Karl would begin working alongside the team to actively create demands for the project. This was possibly a misunderstanding, and the result of this has been that the team has taken the project further in terms of defining components that initially expected. The team started the project by framing the focus around design and interaction, which evolved during the progression of the project. As seen on illustration 147, the intention is compared with the real output, showing that structure and components have been in higher focus than expected.



Illu. 147 - Indication of intention chart.

The collaboration has been a huge help for the team to work actively towards a possible solution within a rather complex area for outsiders. The supervision provided from the collaboration has been helpful to a degree that couldn't have been reached elsewhere, which of course is appreciated.

FURTHER WORK

There are many small detail, and some bigger things that are missing before the project has reached the full extent.
Further work would include a prototype of the robot where the ball-bot principle can be observed. The specific movements of this principle are still to some extinct unknown for the team. This would make the team able to define the last elements of the behavior for the robot, like how do people react with a robot amongst them at work etc. There are a lot of real context testings that have to be made in collaboration with the context.
Additionally the development of the voice recognition should be detailed, so that the consumer can get information about different kinds of coffee, as a part of the software. The whole realization of the software aspect hasn't been opened yet, and will need specific work and detailing for a proper solution to work.

The team has worked with the humane way of doing the aspect the robots is supposed to do within various areas. This has of course led the team to wonder what the main principles are in the interaction a waiter establishes. Even though this was an objective from quite early in the process, did the team manage to avoid investigating the area for possible findings for the behavior. This wasn't done because there always seemed to be more fundamental issues at hand, as the project has so little preexisting research foundation.

It was initially stated that another group from the study was working with the robot as well, giving the team something to compare with at project end. This was sadly not possible, as the other team glided away from using the robot in their context, as it was hard to establish grounds for use.

The team is aware that the initial focus on hotels has faded during the envisioning, making the solution more versatile, and less specific to the target. It should be able to used in a positive way, as previously stated, making potential investor search potentially easier, but also potentially harder, as there is no specific target.

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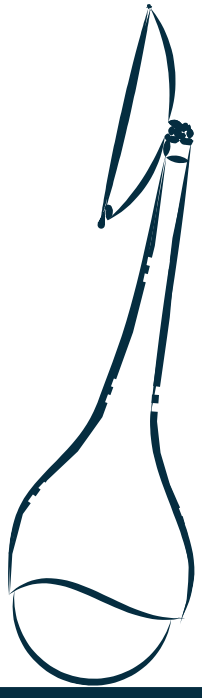
4.3 ILLUSTRATION LIST



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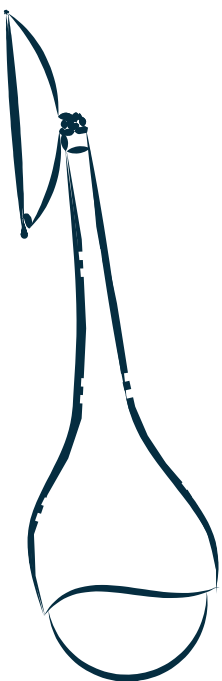
APPENDIX



MASTERS THESIS PROJECT - MA04-ID10 - JUNE 2016 - APPENDIX

NICOLAI ODDE DAM & MARIA SLOT JACOBSEN

READING GUIDE

The appendix, which mostly including work sheets, is meant to show the raw work done that underlies the presented process in the process report.

It is not at all expected that the worksheets should be read as a whole, as every worksheet made, is placed in here, to show close to all directions included in the project.

TABLE OF CONTENT

WORKSHEET 1.0

Activity: Skype meeting with Karl Hansen

Worksheet no.: 01 Date: 04-02-2016 Responsible: NOD

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Objective:

Meeting with Karl Hansen about project alignment, and possible paths for the project based on initial research done by the team.

Experiment/Data:

Here you put in a sketch, storyboard, diagrams, photo of mock-up or experiment, rendering of 3D model, interview, etc,
including own explanatory comments, analysis and perhaps evaluation

Keypoints of conversation:

- Keep it simple, stupid!
    - Things that appear simple, may be very complicated as every actuator multiplies itself with eachother and creates exponential complexity.
- Technology on a level where one application at a time is key.
    - The one application should be bound physically, as it should compete with apps.
- Ergonomics surveillance was thought to be hard in the ethical aspect.
- Designing for the future is inevitable with this field, as project span easily becomes long in term of the technology development
    - Technologies such as batteries are in great development and will make alot of prog ress, which directly changes the performance output for a robot.
    - Open source programming within robotics movement, facial recognition etc. be comes much better.
- Work on contexts where simple actions should be preferred.
    - Opportunity with areas with more than one simple working context... eks. hotels; room service, conference etc.
    - Karl has connections at two hotels in Aalborg.

Evaluation:

Reflection:

Activity: DEPESTe

Worksheet no.: 02 Date: 11-02-2016 Responsible: MJ

DEVit©

Objective:

The DEPESTe analysis is created as a part of the external analysis to find an environment to integrate the robot. The DEPESTe analysis should here be seen as a tool to get an insight in parts of the developmental domains in the outside world, it can help to map where there is a gap or a potential market for a robot. The focus on this DEPESTe is the development in Denmark, because it is here the robot is going to be implemented.

Experiment/Data:

Demographic development

- There are lot of singles in Denmark, it gives that the supermarkets are developing packaging to one person and creates the accept of being single. (Dansk Statisik 2015, Rekort storts antal enlige)
- Few born children affect the job market in the future and thereby there will be lot of jobs not filled out. (Europa parlamentet, Europas demografiske udfordring)
- Lot of people in the 50'es or older suffer physical with weak knees, backs and other parts of the body.
- E- sports is the new thing in the whole world (Alstrup, K., Rasmussen D., 2016, Elektronisk sport stormer fremad, online http://esport.mediajungle.dk/baggrundshistorie-1/ d. 11/02/16
- People in Denmark are afraid because of growing violence in Denmark.
- How to implement the fugitive coming to Denmark and what will the fugitive affect Denmark and the society?
- Global warming and green energy. How to save the world?
- Healthy lifestyle
- Men in females' jobs (FIU ligestilling, 2010, Mænd i "kvindefag" online http://fiu-ligestilling.dk/tools_materials/maend-i-kvindefag/ d. 11/02/16)

Economic development

- Fugitive, the government are using lot of money on implement the government.
- Budget cutback in day care centre
- Budget cutback in the health care sector
- People in the 40'es are wealthy (Juul J.S., 2011 Hvem er den rigeste procent i Danmark?, arbejderbevægelsens erhvervsråd)

Experiment/Data:

Political development

- Green energy, how do we save the world?
- Fugitive, to implement them in the society.
- Money
- Surveillance in the society.

Ecological development

- STOP waste of food
- Focus on eating food with low production of CO2
- Urban farming in the big cities (Madsen T.N., 2012, Trend: Urban Farming, online http://penge.dk/investering/trend-urban-farming d. 11/02/16)
- Developing of batteries e.g. electrical cars

Socio-cultural development

- There are lot of singles in Denmark, and it is acceptable to be single.
- Board games – developing of board games café and events.
- Collecting of data about everything in the internet and research

Technological development

- NFC (Near Field Communication) (Devantier N., 2014, Sådan virker trådløs NFC-betaling i Danmark, online http://www.computerworld.dk/art/231665/saadan-virker-traadloes-nfc-betaling-i-danmark d. 11/02/16)
- Batteries the development is huge and is in a strong position that give the flexibility of placement and transportation.
- Technology to structure the daily life at workplaces. Digitisation of profiles in health care and communication tools of telepresence in offices.
- 3D-print development
- Autonomous motorised vehicle like google car and city car with the safety of autonomous brake.

Evaluation:

The DEPEST analysis gives an assumption of the development in Denmark, seen from the team members view and knowledge and thereby the analysis is not framing all parts of the development in the society. The analysis is used to open op for opportunities and potential environments to implement the robot in the future.

Reflection:

The DESEPST analysis have given some potential environments to implement the robot, and the next step is to research about some of the topics to see if there are more about it than first assumption. In some of the topics it could be with a mindmap.

Activity: Meeting with Karl and Susanne (worker at First Hotel Europa)

Worksheet no.:03 Date: 17-02-2016 Responsible: MJ

DEVit©

Objective:

Interview with Karl and Susanne at the First Hotel Europa

Experiment/Data:

Notes from the interview:
First hotel Europa is a business hotel and there are lot of visitors coming for conferences at Kultur and Kongrescenteret next door.

- There is a passage through the hotel to the centre and lot of visitors are using it. A focus could be to focus on extra sales in the breaks of the concerts and entertainment next door.

Every robot in the industry can 1 thing and that's all, but a robot to the homes need to do more than once, to cover the price versus the value the robot gives the homes.
Where do the hotel experience having busy time:

- In the summer families with young children are visiting the hotel and the city, and typical in the morning there are giving lot of different information about activities in the area, the weather and so on.
- The communication between the housekeeping and the information about cleaning the room and if they are finish cleaning them.
- Bartender robot – in the lobby with the reception lot of the customers are sitting there and get a bear but in the reception there are lot of different things to do and thereby there is not always time for being a bartender. The could need a robot taking order and being bartender.
- Something for cleaning the floor in the lobby, it is a wish that the floor is being cleaning more than once in the day, but now the time is not for it and is only being cleaning every morning.
- Waiting time with and in the elevator maybe some information about the weather or activities (it can probably be solved with a screen and not necessary need a robot for it)
- A snackbar driving in the hall of each floor and offering snacks in the afternoon.

The principle is from a Hjemis-bil. Now they have the minibar in each room, but they are not earning any money on it and want to replace it in parts of the rooms. The minibars are in this moment using around 60.000 DKr in power.

- An information stand in the lobby.

Continue on the next page

The robot could be a part of a bigger connection – e.g. their payment system or booking system.
It has to be a robot there are visible for the customers and thereby something that the customers are interact with. The hotel wants the robot to be a brand and entertainment for the customers.
The focus of the robot should be narrowed down to either the customers or the staff of the hotel. Where do the robot create most value for the hotel?
Synergy – how precise is the movements of the robot and how huge deviation can work in the context. The more precise the movement is the more expensive/difficult is the robot to create
Maybe a robot there are personal – something you can identify you with.
Observe how perceive human contact versus contact with a robot, do a want to order more if it is a robot or a human.
How interact a waiter – map it if a robot should fill out the role of a waiter.
Find a simple click system of how to add features in the form of hardware to the robot.
How do we make secure that the robot is fitting in visual at a hotel, which kind of materials can we use?
method of payment – cash card automat - face recognition

Evaluation:

The interview gave a good insight into where to place a robot at a hotel, and how they were understanding a robot, about they wanted it to be for the customers to helping and entertainment, while the first ideas were to helping the staff with their jobs and not for entertainment.

Reflection:

The next step is to see if there are the same needs for a robot at other hotels to create a marked not just for one hotel but for many.
It is also to understand what the robot can and not can and how to get it simple of its competences instead of a complex robot.

Activity: Context research at Aalborg hotels

Worksheet no.: 07 Date: 18-02-2016 Responsible: NOD

DEVit

Objective:

Talk to receptions and others at hotels to get insight and intel of possibilities for functionalities for the service robot and differences in hotel context that the robots will have to adapt to.

Experiment/Data:

Visited hotels: First Slotshotel Aalborg - CabInn Hotel - Radisson blu Limfjord

First Slotshotel Aalborg: (observation and conversation) 6 min conversation

- Talked with supposed manager about implimentation possibilites of a service robot. She saw no need for replace or support current staff with a robot on front stage tasks, as these contained values which were too key. She seemed more interested in a robot to work behind the scenes, making cleaning of rooms easier.
- The structure of this hotel had more deviding beteween reception and lobby area than FIrst Europa Hotel has, but the would be no mobilty problems other than lists in the hotel, and the upper floor where 4 rooms only has access by stairs.
- Own kitchen
- Lots of information, folders and screen with commercial
- High focus on customer contact, afraid of losing it with implementation of robot.
- Business customers in the weekdays and vacation customers in the weekends fx. nowegians

CabInn (only observation)

- One of the cheaper hotel, furniture lower standard and lobby pretty cold
- A robot in this environment seem to be measured on pure savings and varm values wouldn't be taken into consideration.

Radisson blu Limfjord (observations and conversation) 45 min conversation

- Talked with assistant director of the hotel
- He has a lot of different ideas and basic problematics of which solutions could arise.
- He was most interested in a concierge that could answer and guide guests to info instead of the reception. talk all languages, get summoned.
- Making a speed table in the casino
- Having a robot playing the piano
- Hotel rule in Denmark: 3 rooms = 1 employee .. asia 1 room = 3 employees.
- 65000 årlige gæster

Evaluation:

It was obvious that some are more open for change than other, and it semt like it had to do with lack on background knowledge on the subject and just basing opinion on prejudice.
Mostly the first visit at first slothotel indicated that an approach should clearly communicate the possibilites to get them on board.
She thought it was exciting, but just saw no use initially, but the team sees this reaction pretty normal when you're not looking further into the future.

The hotels were all different in many ways, making an obvious general implementation functioning very unclear.

Though it was clear that many hotels are connected to something else, like a casino, meeting fascility etc.

Reflection:

The team had used 15 min on preperation before going out to observative and talk with hotels, just to align the objective behind doing it. As mentioned in the evaluation, a better way of communicating our vision and the possibilities might have changed

Activity: Frontstage versus backstage analysis

Worksheet no.: 08 Date: 18-02-2016 Responsible: MJ

DEVit©

Objective:

There are to different places that a robot can be placed in at a hotel is frontstage and backstage. Is the robot for the customers or is it going to be used of the staff and which kind of value can the robot add to the hotel.

Experiment/Data:

Frontstage

Pros

It is visual for the customers and have the possibility of giving a wow-factor to the customers
It can be an entertainment for the customers and thereby create more value without having adding technical solutions.
It can be a brand for the hotels, something that the customers will remember them fore.
It can release space for the employs by taking part of their jobs
It is a new thing for many people and thereby the interaction can be an experience that they will remember.

Cons

It can be a disruption inter the lobby and thereby be another element in the new area relate to.
It can be difficult to interact with the robot.
People in Denmark are still not familiar with interacting with a robot and can find it intimidating that it is something you have to interact with.
It can be noise and the customers do not know how to interact with the robot

Backstage

Pros

It is the staffs tasks the robot should help with and replace part of the staff.
It will be the function that will be the main part of the robot, and it is only the staff who need to interact with it.
It can be a part of something bigger in their booking system or cleaning system.
It can carry things for the staff or bring the things that the housekeeper needs.

Cons

It will give a secondary value for the customers, they will not know that it is a robot that doing the job.
It can be complex jobs and difficult to develop the robot.
If it is going to clean, it is going to be a complex system because there are lot of unpredictable factors, by this time of development of robotics is not developed for this kind of tasks and it will be expensive to develop.

Reflection:

By placing the robot in frontstage environment it can create value for both the staff and the customers. A robot in a hotel environment is still new and at this time it can still create a wow-factor as a part of being a customer at the hotel. it can here be a robot helping the staff and thereby narrow down the peak time for the staff and the hotel gets staff with energy to helping the customers and do their jobs.

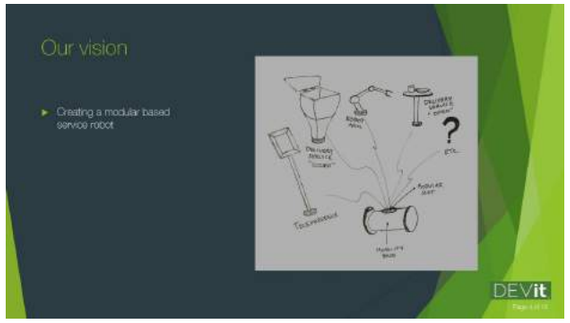
Activity: Milestone presentation I

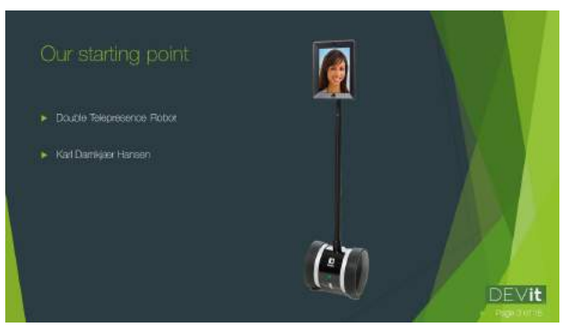
Worksheet no.: 09 Date: 01-03-2016 Responsible: NOD

Objective:

Present the project at its current state at get feedback on framing and conceptual path

Experiment/Data:





Reflection:

The presentation had too much focus on the robotic field in generel, with lack of our framing on context, robots them selves and our concepts.

Activity: Milestone presentation I evaluation

Worksheet no.: 10 Date: 02-03-2016 Responsible: NOD

Objective:

Try to answers the feedback received at the milestone to identify possible gaps and to further specify our framing.

Experiment/Data:

What is our aim to contribute to robotics and our relation to them?

- We want to contribute with lowering the entry barrier for robotics development
- We want to contribute with robotic interaction on a 'low' service level.

What do we actually want to achieve?

- We're one week short of being able to specificly specify what we want to achieve, as it at the moment is too broad. The thought at this point in time, is that we want to create a robot for one dedicated task, with some kind of general modularity in mind.

What is the purpose of putting a robot into a new context?

Problematikker indenfor hotel verdenen

- AirBNB
- High saleries (1 employee per 3 rooms vs. 3 employees per 1 room = 9 times more)
- Fewer peresonale for each guest, as seen above.
- Define the hierarchy

- Pushing boundaries?

- Hvor nemt det er at skabe en service robot, (entry barrier) = det skal være nemmere at skabe en service robot til mange forskellige kontekste.
- Creating the foundation for robots possibility to become common property.

- Question relationship between man and robot?

- How do you get Danes to interact with robots, as we are a more introvert people than Americans etc.

- Supporting existing structures with a servant's servant

- We will be able to define this with the choice of dealing with front- or backstage.

Do we want to change the perception of robots?

- It should be okay to get help from robots, it's not better just because it's done by humans.

What is the value we are creating?

- Customer experience
- Staff unburdening (stress relief)

We should state that we don't intend to have a robot with arms etc. In regard to interaction. blue ocean canvas

Find a key exemplified dive. What tasks can be outsourced?

Interaction

- Could be how it should position itself when people come into the hotel, how does it signal that it is there for you, that you should got to it and not the reception.. etc.

Technical

- Could be the modular connection point etc.

Lastly some statements from the feedback that are relevant to further thoughts and framing.

- Robot being the servant's servant -> the objective and hierarchy goes into the identity of the product you're designing.
- Defining the product as a robot will not give any indication of its relation, hierarchy, interaction etc.
- Narrow down to key functionalities.
- Servants servant's gives a mental picture of reframing.

Evaluation:

This was done just before supervision and created a good analysis and insight of our feedback, developing understanding about current needs within framing. An alignment of value creation, purpose and focus has resulted in better general understanding of what we're trying to achieve.

Activity: The evaluation of Hotels defining by stars

Worksheet no.: 11 Date: 03-03-2016 Responsible: MSJ

Objective:

Research

Experiment/Data:

The different countries have different definition of the starts evaluating the hotels standard, and thereby it can be difficult to define the standards. Spies Rejser defines and evaluate by them selves the rang of the hotels they are using [http://politiken.dk/rejser/hoteller/ECE2501507/nu-skal-det-vaere-slut-med-forvirring-om-hotelstjerner/ d. 3/3 2016] to make sure that the hotels they offer have the standard they want them to have. 16 European countries have created a union of standards for hotels value them to the rang of stars. [http://www.hotelstars.eu/ d. 3/3 2016]

The criteria are:

1 star

- 100 % of the rooms with shower/WC or bath tub/WC
- Daily room cleaning
- 100 % of the rooms with TV together with remote control
- Table and chair
- Soap or body wash at the wash basin
- Bath towels
- Reception service
- Publicly available telephone for guests
- Extended breakfast
- Beverage offer in the hotel
- Deposit possibility

2 stars

- Breakfast buffet
- Reading light next to the bed
- Internet access in the room or in the public area
- Payment via card
- Body wash or shower gel at the shower/bath tub
- Linen shelves
- Offer of sanitary products (e.g. toothbrush, toothpaste, shaving kit)

3 starts

- Reception opened 14 hours, accessible by phone 24 hours from inside and outside, bilingual staff
- Lounge suite at the reception, luggage service on demand
- Beverage offer in the room
- Telephone in the room
- Hair-dryer, cleansing tissue
- Dressing mirror, adequate place or rack to put the luggage/suitcase
- Sewing kit, shoe polish utensils, laundry and ironing service
- Additional pillow and additional blanket on demand
- Systematic complaint management system

4 stars

- Reception opened 16 hours, accessible by phone 24 hours from inside and outside
- Lobby with seats and beverage service, hotelbar
- Breakfast buffet or breakfast menu card via room service
- Minibar or 16 hours beverages via room service
- Upholstered chair/couch with side table
- Bath robe and slippers on demand
- Cosmetic products (e.g. shower cap, nail file, cotton swabs), vanity mirror, tray of a large scale in the bathroom, heating facility in the bathroom

5 stars

- Reception opened 24 hours, multilingual staff
- Valet parking service
- Concierge, page boy
- Spacious reception hall with several seats and beverage service
- Personalized greeting for each guest with flowers or a present in the room
- Minibar and food and beverage offer via room service during 24 hours
- Personal care products in flacons
- Internet-PC in the room on demand
- Safe in the room
- Ironing service (return within 1 h), shoe polish service
- Turndown service in the evening
- Mystery guesting

Evaluation:

The creteria of the stars give an indicater of where the level of hotels are and the definition for hotels. To reach out for hotels to implement robots it will be hotels with a standard of 3 stars and over.

Activity: Observation at First Hotel Europa frontstage

Worksheet no.: 12 Date: 03-03-2016 Responsible: MSJ

Objective:

Observations at First Hotel Europa in the lobby from 7:00 - 18:30
The observations to find out where they have problems and opportunities for implementing a robot.

Experiment/Data:



Time: 7:00 – 8:00

- A bit over 7 two guests have checked out
- There is being vacuumed and a cleaning lady is cleaning the lobby and the toilets
- The receptionist is either behind the desk focusing on the computer or walking from the backroom and to the desk
- Few people are coming and go, most smokers
- It can be difficult to find the way out when there are entrances in both sides.
- There is only one receptionist
- More than two guests are checking out and there are waiting time
- The lobby are used to guests waiting for being picked op, off taxis or business arrangement
- There is a flow in people checking out and what the receptionist can do.
- A man wanted to go through the lobby to the Aalborg Kultur og Kongrescenter, but the door was closed.
- The door to AKKC is open at 7:53

Time 8:00 – 9:00

- People coming from the parking place to AKKC through the lobby – there are any doubt which way they have to go. – There are any signs of where AKKC is, so it can be difficult to find the way though
- The receptionist is calling the housekeeper to tell that a room has to be clean for leaning instead of staying.
- A guest outside is in doubt of the place and walking in and out a few times and finally sitting down in the lobby – after time she is waiting at some friends.
- There are not many checking out – the baggage is being stored in a room in the

lobby.

- 8:43 there are quiet

Time 9:00 – 10:00

- There is a long séance with a guest that need help booking a plane, in the same time the phone is calling and disturb the conversation but the receptionist is helping the guest finish before she is answering the phone.
- There are few checking out around 5 people.
- Two window cleaners are cleaning the windows in the lobby

Time 10:00 – 11:00

- An extra receptionist has arrived and there is the opportunity for a break.
- The receptionist is doing wake-up calls.
- The receptionists are using lot of time calling a taxa and they can be send in hold.
- They are doing little paperwork
- The different workers are starting around the hotel but otherwise there are quiet at 10:30
- Plane staff are staying at the hotel.

Time 11:00 – 12:00

- There is quiet in the lobby and the staff are in the backroom
- Different small things are happening behind the desk and supplies is arriving to the bar area
- The staff having breaks when nothing happing

Time 12:00 – 13:00

- Plane staff are checking in are arriving with taxa
- There coming a lot of people from AKKC and though the lobby about 12 – maybe a conference is finish
- People are coming and checking in
- There are most phone conversations from outside
- They had to show the direction to a supermarket (the question were where can I buy toothpaste?) they were showing him to Kennedy Akaden
- There are arrived Germany guests, the conversation is switch between English and German because none of them were good at the langue. (maybe some translate robot could be useful there, or something that give the possibility to check-in or booking)
- More guests are arriving and checking in about 15 guests from 12:00-12:35 it is possible already to get the room.
- There are two in the reception the hole hour – they are standing with the computer and working

Time 13:00 – 14:00

- Checking the housekeeper manager about the room if they are ready
- There has been an order for 3 cups of coffee – there are time for making the order – the guest contacted the receptionist for ordering – the receptionist making them – she serve the coffee without tray so she need to work twice. They are not paying before they are living

the lobby. – they are sitting in the lobby for some time and it gives life to the lobby. There do not need many people in the lobby to fill out the lobby

- It is in the reception everybody is contacting if they have any questions (taxa driver contacted the reception because he could not find the passage)
- 3 more guests are checking in – it can take some time because there is different paperwork to do.
- They are supplement each other in the reception and helping each other when following op at bookings.
- The next bar order is coming on coffee while they are checking in – it is a coffee to go
- Two arrive though AKKC to check in.
- It is possible to borrow a kettle to the room when you are staying a couple of days.
- Another order of coffee – pay immediately
- The lobby are most used for waiting for a taxa or each other.
- The receptionists are getting lot of questions “How do I navigate in the city and find different things”

Time 14:00 – 15:00

- It if first possible to check in from 14 a clock but they have already checked a lot in before
- The receptionists have to explain a lot where the different places are in Aalborg and what they have to see – maybe it will be good if it could be after interests.
- There are a few sitting in the lobby and drinking coffee by themselves – maybe some entertainment
- A group of plane staff settle down in the lobby
- The receptionist is cleaning up after the first 3 having drinking coffee and left the lobby
- There do not happing anything in the reception
- The receptionists are counting the money in the box
- Another taxa booking
- The one of the receptionists are lighting new light at the tables
- There are total silent in the lobby (14:43)
- Goods delivering need to be guided to the right place to deliver the goods. The receptionist has to sign up for getting the goods.
- Changing of the guard about 15:00
- Few people walking through the lobby from AKKC

Time: 15:00 – 16:00

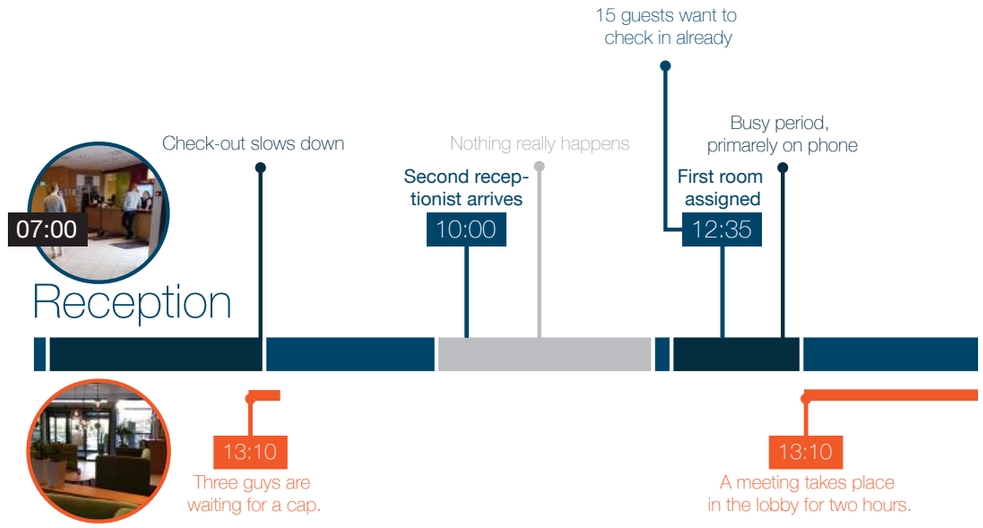
- There is a business meeting in the lobby, they ordered coffee and this time the receptionist was using a tray to deliver it – the payment where writing on the room.
- At this time there are always two people in the reception.
- The first meted receptionist is leaving for today

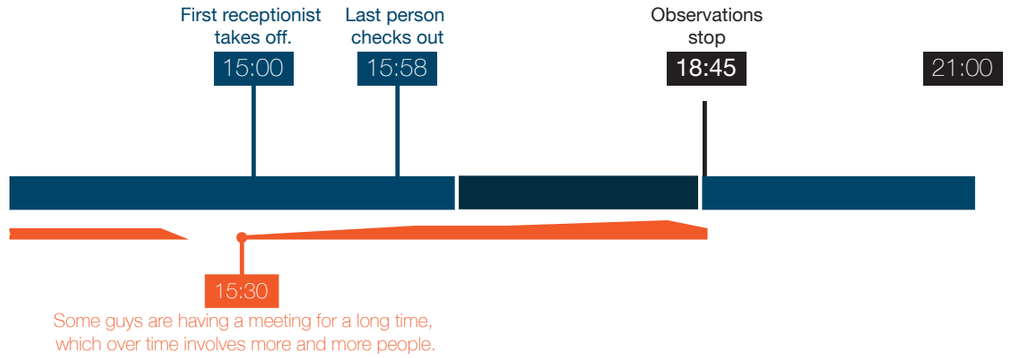
- A group of 6 are checking in it is plane staff. They are just to be here it looks like, so it do not take long time checking in.
- There are very quiet in the reception and the lobby
- A receptionist is booking taxa for tomorrow morning.
- They are talking in phone to clear orders for next week and new bookings.
- The receptionists are walking between the backroom and the reception
- There is a few walking through the lobby to or from AKKC
- Another one order a cup of coffee.

Time: 16:00 – 17:00
- One check out
- Some coming for picking up their baggage from the storing room.
- Better indication of where the taxa is parks. There have been different drives coming to the reception because the guests not are coming to them.
- There is relatively quiet
- An elderly lady asking for direction to AKKC
- There do not happening anything in the reception
- There is a tendency that lot of the cards for the rooms do not work. About 10 guests have been complaining.
- The receptionist is ordering a pizza for at guest
- There are arriving 4-5 guests to check in. It takes longer time when it is not Dane checking in, because they need to use passport number.
- Everybody have left the lobby 16:52

Time 17:00 – 18:00
- One is checking in
- A small group of people are sitting in the lobby and having fun but most to waiting and the leave again.
- The receptionist is ordering another pizza
- There are coming a few once in a while and checking in
- One is ordering a beer and drinking it in the lobby.
- Some are ordering coffee to drink in the room
- There is a small business meeting before they are going out for dinner.
- Two are checking in while two are waiting to order coffee

Time 18:00 – 18:30
- New people are checking in and people are coming down to the lobby
- The receptionist is ordering more pizza's
- No one is sitting in the reception
- 8 people are sitting in the lobby not all together
- The receptionist have to call to a restaurant to book a table for some guests.





Evaluation:

The receptionists are using the most time of checking guest's in and out of the hotel, thereby they get different questions about the city and services they offer by order foot or book a table at a restaurant. At the day they are calling a taxa company a lot, and there is almost a taxa waiting outside. It will this part of the job it will be possible to add a robot. There were lot of time where the receptionists did not have anything to do, so the robot will have the possibility of replacing one of the receptionists.

Activity: Observation at First Hotel Europa backstage

Worksheet no.: 13 Date: 03-03-2016 Responsible: NOD

Objective:

Observations at First Hotel Europa cleaning crew from 12:00 - 15:30
The observations should reveal possible opportunities for implementing a robot and creating argumentation for an area and against others.

Experiment/Data:

Generel stuff:

- 4 rooms cleaned per hour.
- 07:00/08:00 - 15:00
- Primarily five housekeepers, sometimes six.
- Aprrox. 168 rooms
- 1st and 2nd floor are short with fewer rooms
- 6th floor has four suites and rooms with special duvet and pillow, requirering more time
- 3rd and 6th floor has coffee machines that needs cleaning

12:00 - 13:10 Following a housekeeper

- Moving around with a 'clean' wagon and a linnen wagon for dirty linnen.
- There is a lot of physical manipulation whilst cleaning the rooms...

These are for rooms that are checked out.

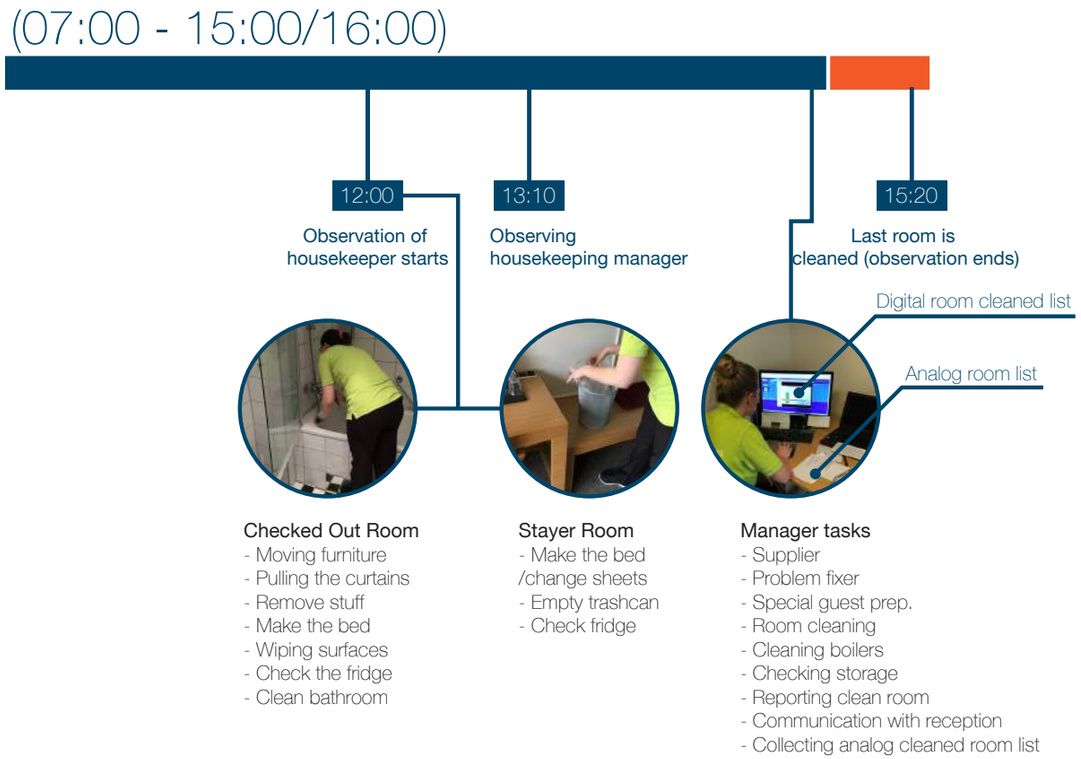
- Moving furniture
- Pulling the curtains
- Remove stuff (sometimes from hard to reach places like under sleeping sofa)
- Make the bed
- Wiping surfaces
- Check the fridge
- Clean bathroom

- Rooms that are occupied
  - Make the bed/change sheets
  - Empty trashcan
  - Check fridge

- Restocking of the clean wagon is on 4th floor by the elevator
- If something is missing, call Nanna (Housekeeping manager)
- The housekeepers always knock 3 times, wait 3 sec. knock 3 times, go in and say "Housekeeping"
- She goes for the storage 1-2 times per day to restock something, where one each day is refill of Lime soap water.
- Depending on current floor, she uses minitowels instead of rags when running dry.

13:10 - 15:30 Following Housekeeping manager (Nanna)

- She is the fleksible link between storage and the working housekeepers
- Cleans rooms just like the housekeepers
- Prepares rooms for black members
- Deal with people not checking out, or in other way.
- Collects physical numbers of rooms cleaned by housekeepers and report to reception through computer system on stationary computer in their office/cantina/storage.
- She has a manager phone to bed linked with the reception
- The housekeepers to not have phones, have to be reached physically, but they can reach her through room phones (I suppose)
- If a room has been specially edited, like added baby bed, the room is declared dirty and the reception is called to let them know that room xxx is clean with the addition.
  - Making sure it will not be rented out to a regular by mistake.
- The hierarchy is Housekeeper<Manager<Superior Manager<Owner (manager has to supervisors, able to take the manager position)
  - the housekeeping division is a part of another company, not First Hotel, so their hierarchy is within the hierarchy of First Hotel.
    MAPPING WILL BE MADE



Evaluation:

This three and a half hour long close observation of housekeeper and manager gave an insight on which type of work there is done backstage with the housekeeping. The work is heavily rooted in what would be defined as manipulative work within the robotics world, as moving stuff and in other ways manipulating physical stuff is estimatly 80%. The last 20% would then be mobility, for grapping cleaning equipment and new sheets and so on. Manipulation for robots is fairly complex, and atleast the tasks the housekeepers are doing, would be very hard to do for a robot. The possibility the teams sees for backstage would be assistance with equipment, as they use fairly much time on running back and forth between the wagon in the hallway and the rooms + to the depot when something is needed from there. The work of the manager is rooted also in manipulation, but also much in interaction with reception and mobility on a level that robots really would struggle to compete with, especially based on the mobility concept the team is currently using as starting point. The managers work partically and all together creates a bundle that both will be nearly impossible to replace, and even as hard to assist.

Activity: Meeting with Karl and Kuno

Worksheet no.: 14 Date: 10-03-2016 Responsible: NOD

Objective:

The objective was to present our findigs for Karl and Kuno, and to have our first meeting with Kuno, hopefully resulting in determination of a specific path for the project.

Experiment/Data:

Kuno:

- Check-in will be a supplement (fast lane)
- The guests have a focus when they get in to the hotel, they see the reception and want their room card.
- Kuno sees the possibility of a gimmick after dinner time, when people are killing time in the lobby, this is where he wants to 'get them'. This is where they are approachable, they are in the lobby for a reason, since they could just be in their room
- The call the lobby a LobbyBar
- Huge differentiation in use of lobby.
- Kuno recognises that the reception has a psychological barrier to overcome around approaching people to create more sales. Which makes this an opportunity they don't exploit.
- 55-58.000 guests per year
- Recognition as a feature is very interesting
- We need to put it to use at something it can actually do.
- Asks where we would like to see a robot within this context with the eyes of a user.

  Nicolai: I'd like to see it as a concierge, a greetings function with something additional

  Kuno: that is interesting as I immediately would've said something about more sales, because we need to make some money, that's why we are here. The idea about a concierge is good, because it is something that belongs to a five-star hotel, in Denmark we have an agreement that makes concierges very costly and there not really more than 2-3 and they're only in Copenhagen. So here we could create something unique; greeting-recognition which in itself becomes a gimmick.
- Getting some rate of commission on pizza not taxi.
- If you could remove less productive tasks such as ordering pizza and taxi, that would be interesting as well, so the employee could focus on more valuable things.
- Following guests to the room could be a good service

  Karl: I would be able to follow with a person up there, but unable to come down again with current elevator technology in the hotel.

  Maria: is there any problem with finding the rooms?

  Kuno: Not really, but because some experience the hotel as a new place the first time, some people tend to be unable to see the elevator.

Maria states: how is the interaction between reception and guests, and how would the robot sweep in and smoothly overtake?

Karl: use case here might be quite limited, but it might be quite relevant in other hotels where the lobby and main floor is way bigger.

Nicolai: this could also be done through tasks execution that the reception executes though tablet with 1-X buttons where the robots then on button 1 just drives to the elevator and says: “here you go, have a nice day” and drives back.

- He is quite persistent on the more sales aspect of the project as a key driver.
- We have a lot of regulars, and there is an expectation about being recognized.

Karl: Exactly, in some cases you might think its awkward to be recognized, but here at the hotel you’d think its good service. And this recognition could be just as cookies on the web, something you had to accept at first interaction with the robot.

So in this aspect neither Karl nor Kuno believes that any ethical problem will arise.

- Maria: Do the reception have time to deliver the beverages?

Kuno: Yes, this is also how it’s done in bars, you come in and a waiter asks for your order, which he will deliver after some time, where the order in this case gets taken by a robot.

Karl: You could make the robots able to deliver the beverage as well, but that a hardware step further.

Kuno: Just taking the order is fine, as it has done its job which is create more sales.

Karl:

- Karl expects the team to come up with a solution different than the Double, or maybe it is builds upon the Double, who knows?
- Do like Apple and Google, let others access the platform and innovate things for it (division of labour)
- Main flow should be the focus, just like a cash machine has a set of main steps, these are the ones to first create, while afterwards all the what if’s can be identified and developed.
- This is how the most software is being made at this point in time.
- Use case no 1 -> slice no.1 – use case 2 -> slice no. 2 small increments with feedback

This way there is a priority in what we’re doing and we can create value as fast as possible, this will drive the development until you reach a full system.

- There is a lot of great ideas, but they are rooted 10 years into the future, what we want to do is something doable within 2-3 years max.
- Use cases

Rolling minibar

Usher for conferences

Bartender

- Cost-benefit between making something that is really good, but it takes three years to develop versus something that is decent, but takes two months to develop.
- Recognition of people with be fairly easy. Easy to see it is a face, but whose face it is, is more difficult.

Then you could try to identify if it is a new guest, currently staying or recently staying etc. -> welcoming guests is recognized as ‘new’ THIS could be basics -> with more to add. “Perceived intelligence” it has no interaction, it creates one-way communication

In addition, the same hardware might be able to detect whether someone is sitting in the lobby, and through this approach, and if it doesn’t detect a person in the first place, it will see him next time, its just an error, not a fatal error and if you walk into it, you’d take the blame and put it up again.

It would also be possible to detect whether it is a new person sitting there.

- Rolling minibar would be hard to create the same value as the ‘bartender’
- Usher for conferences would have mobility problems based on our starting point, as there are many many stairs in this conference centre.
- Check-in functionality for robot, ‘easy’ depending on hotels current IT-system

Kuno: It should be for those whom just needs to receive their card, as they’ve already payed (fast lane)

Karl: Hardware modules, you could maybe make a module that creates the cards for room and delivers them to returning customer based on some kind of recognition. (module because this would obviously not be used for brain damaged people on centres)

Click on hardware is actually pretty interesting

Kuno: this might be hard to do, but it is very interesting.

Karl: People might ask here why it is a robot doing this and not just an info desk.

- Many are afraid of robots taking over their jobs, and then there is me who think its rubbish because we place he robots many of the places where we don’t have people to do anything in advance and tasks people gladly want to give up, as example the thing about more sales where many have this hold back towards it, which makes it a win win for a robot to take over these tasks.
- We’ve talked about payment, where you can use the room number, and here we could use the facial recognition to approve someone who has already been approved once, but this is not ‘fool’ proof as I can put a picture of you (Kuno) up in front of it.

Kuno: There is also boundaries for how creative you can get, as the reception has an overview of the lobby. Another way of doing it could be that you enter your room number on the robot when ordering, and then deliver this number with the order so the reception can verify what person lives in that room upon delivery.

Karl: In addition to this, the robot could take a picture of the person ordering. It might be with the order.

Kuno: yes, super!

- I think this area is interesting as many aspects within robotics are getting touched, such as navigation, recognition, interaction and how to not interrupt a ‘conversation’, which is something else, but something we can work on, maybe something about it first talking when people are facing it etc.

Kuno: it could be very cool if you could add such finesse also, so it seems more sophisticated.

Karl: and this are these extra slices I was talking about.

- Both bartending and greeting function are based on the same hardware, so we can work with more functionalities and not just be like everyone else, that makes a 'one trick pony' that can do one thing, that's not what we want.
- We have to make some reality check; this might be through role playing with the double.
- It is a range of stuff we want to create, but somewhere we need an enabler, which in this case will be the bartender roamer.

Evaluation:

The meeting went better than expected, as our findings indicated that foundation for implementation was lacking behind. The meeting composition was great as Karl had the total realistic view on robotics, Kuno had the economical drive to earn money most of all and we were trying to put the puzzle pieces together to frame the foundation for the project. As the meeting progressed, the converging norrowed the solution space towards bartender/lobby roamer, taking cost benefit into consideration for choosing, as timeframe etc. require the solution to be possible in reality within 2-3 years. Finishing off the meeting, we all semt to have a common vision for the functionality, whereas 'the ball' was delivered to the team.

Activity: Observation hotel evening

Worksheet no.: 15 Date: 10-03-2016 Responsible: NOD and MSJ

DEVit©

Objective:

The objective was to see the front stage at a more busy hour, and to observe the lobby with many people.

Experiment/Data:

16:30

- A conference just finished in the AKKC and there is mange people in the looby and at the parking place.
- A group of 10-12 is sitting at the high table with beers and coffe with great mood.
- They order another round of four special beers, the guests are bringing it to the table themselves
- The receptionist is filling a few baskets of chips and bring them to the table
- Some extra order on something they cannot deliver.
- 16:47 another 3 beers
- 17:15 one leaves the table and goes to room
- 17:29 The women leave the 'party', and there are now five men left talking, two women are coming back and now they are seven
- 17:31 another woman join the company, and two minutes later she leaves again.
- 17:50 It is breaking up and the arrange to meet 19:30 to go eat.
- 17:54 a receptionist brings a tray and starts cleaning the table, and the other receptionist comes as well
- There are three other groups present
- a three man group - don't think they have ordered anything - left 16:35 table 5
- a two man group - don't think they have ordered anything - left 16:49 table 2
- a two man group drinks water and coffee, one leaves 16:40 while another has arrived and there is conversation - 16:44 they break up, the coffee stays (its in a paper cup)
- There are two in the reception, when a order is being places.
- One table has not been cleaned (table 3) this is where im sitting
- Three are coming from AKKC and goes to their rooms
- There are frequently coming people through the lobby from AKKC
- the receptionist is ordering pizza
- 16:35: one has arrived, whom sits and waits, she goes out to smoke, 16:41: she has a taxi ordered and goes out to wait. 1712: she comes in again as the taxi hasn't arrived. The receptionist is calling to push for a taxi and she gets picked up at 17:14
- Supplies arrives to the bar
- Nothing happens in the receotion, so the receptionists leave the front to go to the back.
- There is alot of noise in the lobby, and is it hard to hear anything.
- Walkthrough all the time from AKKC to the parkingplace

- 16:42 two are sitting on the bench by the toilettes and talk
- Two beers are getting served in the reception while one is waiting for service, the one waiting wants baggage to the baggageroom
- Two new places themselves at the tall sofas and start conversation, it is them whose bought two beers table 5
- a new company places themselves at table 1, thay are three and two of the order and receive beer. 17:20 they break up and go to the reception.
- a man sits a table 6 and is occupied with his phone, while he is waiting and when he arrives they leave together.
- 16:48 check in is happening
- Two arrives and have a conversation with a man at table 5, 16:53 the conversation stops and table 5 continue their conversation, while the other go to ask for AKKC
- One comes a ask the reception for AKKC
- It is nearly impossible to keep a phone conversation and people leave the building to make calls.
- 16:54 one checks in at the reception and needs guidance for something unknown, while another waits in the meanwhile as his roomcard doesn't work. at end it is 16:57
-
- 17:00
- Nothing really happens in the reception and the receptionists are walking back and forth.
- 17:03 the receptionists try to look like they are doing something by standing at the computer (why doesn't she clean the tables and offer people refills etc.?)
- 17:06 one of the receptionists takes a rollingcart and goes to the basement, she return at 17:12
- Groups of 2-4 people still arrives from the AKKC and goes through the lobby
- One comes that has to go out to run, he gets a card so he can navigate.
- A man connects the company at table , but doesn't stay long before going to his room
- 17:15 the reception orders pizza
- one comes to the reception to check in
- the receptionists begin to clean table 1 at 17:22, but this is the only table where there is cleaned.
- 17:26 one comes and orders two beerse, she takes the beers and places herself at table 1, while another gets let into the baggageroom
- the second woman arrives at table 1, 17:33 a third woman arrives to the table but has not ordered anything.
- one adresses himself at the reception for a bag for valuables while he is running, and he needs guidance for a running route.
- 17:31 coffee beans are being filled in the coffee machine
- 17:22 two more has connected with the conversation at table 5, 17:33 one leaves the company
- Two arrives at the reception and asks for when there is reserved a table
- 17:34 the bell in the lobby is ringing as three ladies needs check in
- the pizzaman comes with the first round of pizzas
- another checks in at 17:37
- 17:38 the receptionist calls to the room that has ordered pizza, and he collects it at 17:44
- There is still in the reception for a moment, so they can clean a little at the desk.

- 17:40 - 17:45 the two receptionists are waddeling around out back
- 17:45 two men comes in from the back and sits at table 2, they order beer and water, they are known at the hotel as the go out back to get stuff, they bought food that they eat ion the lobby 17:53, another man comes a joins.
- One comes to order a beer, which is payed on room number. he sits at table 4, but return to the reception for some snacks. He shifts to table 6 maybe because table 4 hasn't been cleaned.
- The receptionist is cleaning the high table, while she is doing this one comes to check in, so one receptionist helps the guests while the other cleans, there is a problem at check in.
- one comes to sit by him at table 6, buy he needs a beer first.
- There are still missing bottles which has been moved on trays, which are hasn't been removed by the receptionist. two have gone out back to clean a little, the talk about whos going to take the rest. 17:59 the rest is being removed.
-
- 18:00
- 18:01 table 3 and 4 is now being cleaned.
- one joins table 2 and orders a soda, 18:04 another one joins and there is nearly not enough space for them all. They are waiting on the pizza they've ordered. another one joins 18:05 and 18:07 the pizzas arrives.
- There are three at the reception orderingthree beers, they join table 6
- 18:03 one has left table 1 while the other two are still there. 18:05 the last two leave the table and leave towards AKKC
- talbe 2, 5 and 6 are booket and im at talbe 3 myself.
- another one joins table 6 at 18:07
- They have not changed the lights on the tables as they have gone out.
- 18:09 there is a line at the reception, one has to order pizza, one has to go to the baggageroom og one needs a beer
- the reception orders a taxi
- one is standing by table 4, maybe he is waiting for a taxi
- a man is sitting at the high table and orders a beer
- the company at table 5 just left the table at 18:13 he orders red and white wine for 10 people.
- one is checking in while another is waiting to get her last wallet back, which the reception has out back
- a man is ordering a beer and joins table 6
- 18:17 a man joins table 2
- another orders a bottle of beer and joins table 6
- one of the guys from table 6 orders another beer
- a man adresses the reception regarding her who had mess with her reservation where they couldn't find her in the system. The lady went away without getting it solved, and there is registred 6, but booket 7 rooms and they solved it. The receptionist tries to blame the guest by her failing to give the right name og someone she knows in the hotel.
- 18:26 one leaves at table 2 and a new arrives.
- him at at high table is waiting on some guests whome are coming from the outside
- There have been ordered two beers and the sit at table 5, again where there hasn't been

cleaned and they place to empty beer glasses on the center pillar, another on has joined them.
- The receptionist goes to collect the lights on the tables that are not occupied
- 18:30 three gentlemen are checking in
- 18:35 the last arrive for the guy at the high table, a beer for that table is ordered
- 18:37 another leaves the company at table 2 while another is ordering a cola in the reception
- 18:41 two are standing by the reception and order beers, they sit at table 1 afterwards.
- 18:44 4 joins table 5 and talk, only 2 stay while the rest continues, the social minister is sitting at the table and many are joining to greet. Another minister arrives
- Three elder genetlemen stand by the reception/opening to the elevator and watches over the lobby
- A drink is being ordered for a young lade whom joins table 5, they are now 6 people at the table
- There is a bit crowded and there are many small talking in the opening between the hallway and the lobby (I heard something about a party at 19:30)(it is a big conference where many are attending, including Frank Jensen)
- 18:49 the people whom are sitting at the table begin to move towards AKKC
- Hernings mayor is also present.
- 18:55 the company at table 1 leaves to go to AKKC
- one arrives to the reception whom need check in, it goes much faster when it is a Dane, as no passport number is needed
- Another one arrives and there is need for the bell to contact the receptionist, this is also a check in
- Table 2 clean up and leave. they bring everything for the reception and clean after themselves.
- Now there is company at table 5,6 and the high table
- one adresses the reception and asks where Papegøjehaven is.
-
- 19:00
- One arrives a sits at table 2
- Two beers are getting ordered in the reception by the company at table 6
- The company at the high table begins to be ready to go, 19:04 they left.
- A man is standing in the reception whom are taking both the receptionists attention, a long explenation about some complaining ends with him buying a water and a sandwich and joins table 2
- There is company at table 2,5 and 6
- one arrives from the outside and orders a draft beer and sits alone at table 1
- 19:08 the high table is being cleaned, the tables are not being cleaned between the different companies.
- Maybe it is the financial minister whom also sits at table 5
- There is a dishwasher out back that all glasses gets put in
- 19:11 one has sat at the table I'm at, but only for two minutes
- a man join the table 2, it gets decided that they need something to drink, a beer and a coke is ordered, 19:17 another joins the table, more and more arrive and now they are 8 in the conversation.

- Table 6 has had some replacement and now they are 5 men having two conversations
- Three men stand and talk in the reception, the check in.
- 19:21 one waits to adress the reception, she orders a bottle of white wine for table 5
- 19:23 the old company from the high table hangs out and waits on eachother
- It is KL's topmeeting these days
- The company at the hightable move towards AKKC
- Anders Samuelsen is also here
- 19:30 status: one is sitting by table 1, five at table 2, five at table 5 and five at table 6
- 19:31 the company at table 6 move towards AKKC
- Table 2 comes with orders and order a glass of white wine and a little draft beer
- 19:35 a man is sitting at table 6 and talk on the phone, he goes a little around and then leaves.
- Nobody is standing in the reception, both out back
- 19:38 the reception clean table 6
- 19:42 two leave the company at table 5, now there are 4 left
- 19:48 status: there are company at table 2 and 5 and one person at both 1 and 6. The guy from table 1 goes outside
- One more has arrived at table 6, they are now two
- 19:52 table 5 breakes up
- the receptionist collects some glasses and the last lights
- the men at table 6 leave the lobby and go to the nightlife
- 19:55 one uses the computer
- there is a lot of traffic from the rooms to AKKC
- 19:57 the company at table 2 leaves.
- The guy from the computer is now at the reception, because there is something wrong with the printer. they print it in the reception instead.
- The one receptionist begins to clean table 5
- Two guys from table 5 are stading at the reception because they forgot to get the receipt
-
- 20:00
- Total silence in the lobby
- the receptions is collecting the last glasses at the tables
- 20:19 the phone rings, it is one whos checking up on a reservation.
- 20:24 a man comes a buys cigarettes and a match box
- 20:40 the phone rings, booking of room
- 20:46 a man orders a small draft beer, pays directly and takes 'børsen-avis' and sits at table 1
-
- 21:00
- 21:08 one of the receptionists are going home
- the receptionist begins to clean a little to make time pass
- 21:17 one arrives to check in
- another one arrives to check in, wrong hotel though
- 21:24 a woman approaches the reception, she buys a sandwich as thats what left.
- a group of three very young sits at table 5
- Observations end 21:30

Evaluation:

There were lot of guests in the lounge when arriving and gave the illusion of it were busy in the reception, but lot of them were sitting for longer time, and they went to the reception when ordering. So for having the lounge full does not mean that the reception having lot to do. The groups of guests sitting in the lounge were there for an hour or more enjoying a beer or two. The things the receptionists were doing were to taking the order in the reception/bar and giving them. The guests were waiting in the reception to pick it up, so the receptionists did not need to deliver it to the table. When a group of guests were leaving the lounge it could take time before the receptionists were cleaning up after them. It is not easy to see from the reception if there is something to clean up, and the receptionists were not leaving the reception area to go round in the lounge just for looking if they could do something, even not when they did not know what to do.
A robot could maybe help cleaning up or encourage the guests helping cleaning up, so the glasses not do it impropriate to sit whit the table.

Activity: Bodystorming interaction between lobby roaming waiter and guest

DEVit©

Worksheet no.: 16 Date: 15-03-2016 Responsible: NOD

Objective:

The objective was to reveal some aspects of the interaction that the team hadn't realized, to have it in mind for real testings with Karls robot two days later.

Experiment/Data:

The experiment was set up in a closed meeting room where one group member acted as guest, and the other as the robot. This was done three times with both trying each side. Behind from where the picture was taken was the door, which was played out as being the entry to the hotel and the reception. For physical interaction, a piece of paper with a simple menu drawed upon was used.

Time used: 35 min.

Findings:

- Set the intetaction up to one-way communication
    - What are the possibilities for verbal recognision if you know which words to look for? the team asked Karl The answer was that it would require some work, but that it was much easier than real conversation on level with siri etc. As seen on the picture, the principle would be to compare the heard word to expected heard words and choose the most compatible.

- There seems to be a boundary between funny and irritating that determines some limits of the interaction
- It will be hard for the robot to reach physical interaction with people sitting on the inside of the tables.
- How is the visual barrier for the robot, will it check it lobby with a set frequency, whom will it sell to; the ones that have been there more than 5 min? etc.
- Where should the robot be positioned, when is it in the way of guests?
    - Maybe avoid being in the way and say "excuse me" when it happens.
- How does it decide which person to interact with when there are more than one person whom equally seems to want to interact with it visually.
    - Maybe orientation towards sound may help deciding.

- Compare all these things with what a real waiter does

Evaluation:

The objective was fulfilled, as the team revealed aspect not realized yet, and made a dive deeper into many of the aspect of the interaction the team is working towards. The method gave high value in quite short time, which is always great.

Reflection:

This experiment was good a an initial test, but as the team gets further, testing in real lobbies would be required.

Activity: Entertainment in the robot

Worksheet no.: 17 Date: 16-03-2016 Responsible: MSJ

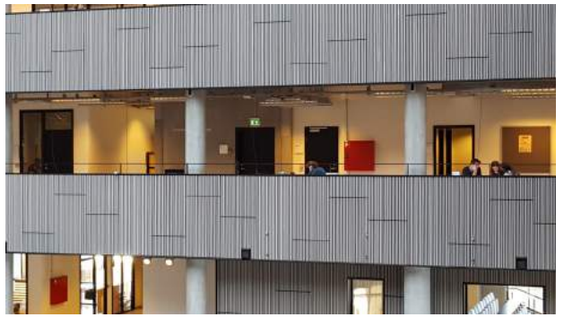
DEVit©

Objective:

Robots are still a new thing and it is not something you see every day. To observe if the people gives the robot attention, we will drive around at the floor to see if any people looks at the robot.
The robot to test it with is the double and there is a camera on to see if people looks at the robot without the team is following the robot.

Experiment/Data:

This experiment is a quick doing experiment and to find out if the robot get the attention that the hotel manager want it to do.
Driving at the 3th floor at Aalborg University city campus Create, the groups sitting at tables where all being interrupted by their work, to see the robot. Some of the people were taking pictures of the robot, and other will here more about the robot and were interesting in the functions of what the robot can do.



Evaluation:

The robot is a new thing and thereby it creates attention, but when the robot is not a new thing any longer, there will be more focus on the skills that the robot have and not just that the robot is driving. It is important that the robot is developing skills so it is useful and not just entertainment because it will fade out with the time.

Reflection:

Next step will be to test the attention at the hotel and in the context to find out if the robot have the same attention as in the this experience.
A positive thing with the context of hotels for guests giving the robot attention is that there are lot of change in guests and allways new guests visit the hotel. The new guests haven't seen a robot like this before and then give it attention.

Activity: Persons sphere test with double robot

Worksheet no.: 18 Date: 16-03-2016 Responsible: NOD

Objective:

To get a basic understanding of how people tend to respond to robots coming very close for physical interaction in head hight while sitting on a chair

Experiment/Data:

This initial test was performed with the test person sitting on a chair in a 'hallway' where to the robot would be driven closer and closer until the test person said stop. This was done with three different heads on the screen, but variating between the genders.

These three heads were:
1) Static picture of Brad Pitt or Angelina Jolie
2) Static picture of robot head drawing
3) Live webcam footage of either Maria or Nicolai

The gender of the persons on the screen were always opposite of the test persons gender.

Test person 1 (Anne)
1) When the picture of Brad Pitt was on the screen the robot was allowed to come nearly as close as possible without going between the legs.
2) When the picture was the illustration of a robot, it had to be further away, what semt like a half foot length.
3) With Nicolai on the screen the robot wasn't allowed close at all (out of physical interaction length)

It didn't seem like it was allowed to go between her legs to come closer.
The wheels on the office chair made the robot elevate with one wheel and would in some cases make it tilt and fall
Test person 2 (Mathias)


1) The picture of Angelina Jolie could come up close
2) The picture of the robot had to be held a straight leg length
3) Maria on the display had to be held near straight leg length
as well, but it was allowed closer if the angle of Maria was
changed to more straight on instead of from down and up on her face.

Mathias allowed the robot to come closer than Anne, as he had his legs spread as men often has, and it was okay for it to be there.


Test person 3 (Nicoline)
1) With Brad Pitt on the screen the robot could come up very close, but this semt to be mostly because of her enjoyment with Brad
2) The illustration of a robot had to keep distance, way out of interaction reach.
3) With Nicolai on the display distance had to be kept as well, just about at max interaction range.

On the last test person the team tried to see what would happen if there were just an interface on the screen.

4) The interface could come as close as possible from front (with closed legs), but from side it had to keep some distance.





Evaluation:

In all three cases the static picture of a opposite gender person they knew was allowed most close. It was actually the unknown robot illustration that was least preferred, and this creates a very rough indication on whether a human mimicked identity of this robot is the way to go. The most noticeable thing about the test was that it was only the pictures of celebrities that was allowed close enough for physical interaction with the screen.

Reflection:

This experiment had a lot of errors, but as it was merely a screening it doesn't matter that much. A test like this will most likely be obligatory later in the process, but this screening was necessary to find a direction to point with this identity aspect, as it is essential that people can tolerate it being close enough to manipulate on the screen.

Activity: Findings of the double robot by testing at hotel

Worksheet no.: 19 Date: 18-03-2016 Responsible: MSJ

Objective:

The team was testing the double robot, to get an understanding of the competences in the context of a hotel. By testing the robot/play with it, the team found out that there was some complications by implement the double robot as it is now. These complications are pointing requirements for the programming and the design for the robot.

Experiment/Data:

The findings are:

The floor at the hotel is making the robot unsure at driving especially when the robot is in speed. The robot is laterally unstable and it looks like the robot is almost topple. It is especially when the robot is driving over a skirting board, and if the robot is coming from the side of the skirting board and not in the right.

The arrangements of the lounge area is placed that the robot not have the capacity of getting into the last chairs and the last person sitting there. That gives that the robot should go in from the back, or the design of the robot should be smaller so it can navigate.

The robot is not using the whole part of the wheel as first assume and that challenge the stability of the robot

Evaluation:

These tests are created by driving in the lounge at the hotel, and it is not all the errors there here have been testing, it where the once we found when testing the robot for other things in the context.

Reflection:

The robot using for testing where the double robot 1.0 and some of the errors in this edition is being eddied for the new edition they just came out with for a couple of months ago. Thereby the results and the errors from the findings are already being fixed. The result of this test should be hold against the new edition.

Activity: Bodystorming interaction between guest and robot in the context

Worksheet no.: 20 Date: 18-03-2016 Responsible: MSJ

Objective:

Here the team were bodystorming different scenarios with the robot and the guest ordering. The objective for this test were to find out if there were any physical demands for the robot compared with the context. The test were recorded and the photos are still pictures form the video.
The lounge at First Hotel Europa have three different arrangements of couches. Each arrangement were recorded twice, one with physical interaction and one with verbal interaction.

Experiment/Data:

Couch arrangement I

Is four chairs standing together with a table in the middle. The robot can just go all thorugh between the chairs.

Physical interaction

Verbal interaction

Evaluation:

The space between the chairs is not much and it can be difficult to have physical interaction with the robot for the person sitting in the back.

Couch arrangement II

Is two tall couches to fill you having a private conversation. There are two tables in the middle.
Physical interaction

Verbal interaction



Evaluation:

If there are two persons sitting in the same couch it if difficult for them both to order if it is physical interaction.

Couch arrangement III

This arrangement is a tall table with tall chairs. To see the interface of the robot, the robot need to raise the interface. When the robot is high the driving going slow. In these tests the robot is low when driving and raise in high being at the table, and lower when going again.

Physical interaction




Verbal interaction




Evaluation:

It takes time to raise the robot, and it could be something that it was doing on the way to the table so the guest not need to wait for the robot to do it before ordering.
This table give the possibility for the robot to drive and come close to each person at the table from the back and that give the possibility of having different orders and not the whole order at the same.

Reflection:

Both the physical and the verbal interaction have different complications, a combination of them both could be a solution. That it is a verbal interaction by ordering and then the interface of the robot showing the order and where in the process the order is, so if the guest want to delete anything it will be by physical interaction at the screen.
Next test will be a combination of the interaction.

Activity: The first idea generation phase

Worksheet no.: 21 Date: 27-03-2016 Responsible: NOD

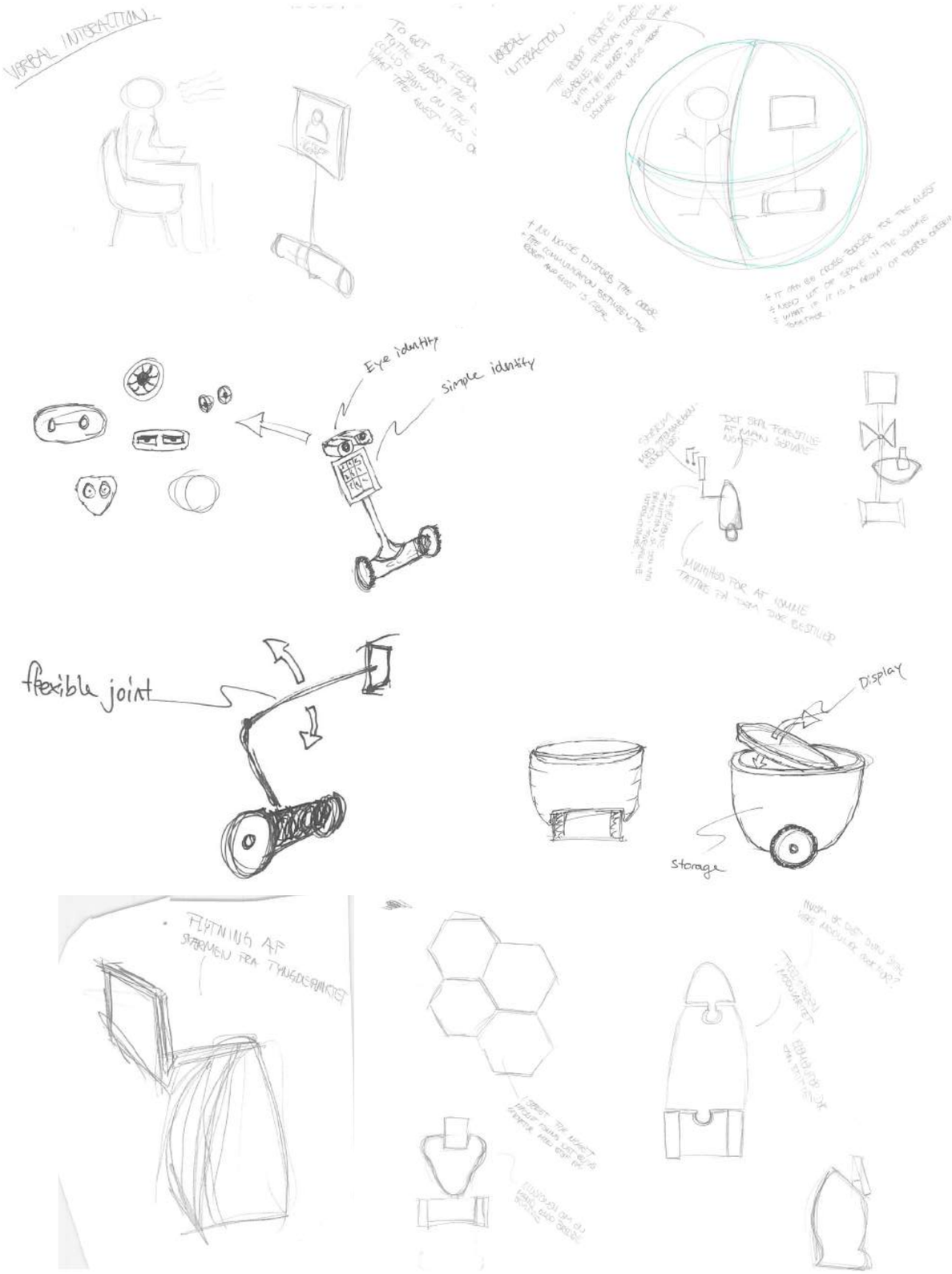
DEVit

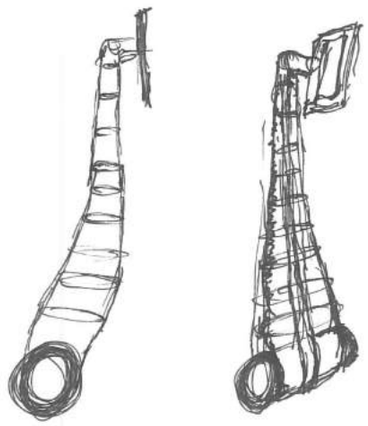
Objective:

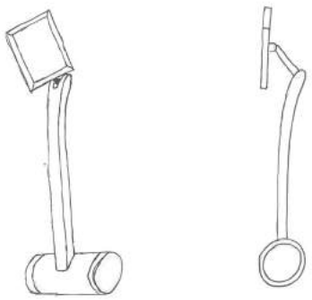
This first idea generation round had no real purpose. The team wanted to clear the mind before narrowing deeper into specifications based on tests, so this step was merely a;" lets do it and see what comes from it". There were no limitations expect the mobility principle and facts.

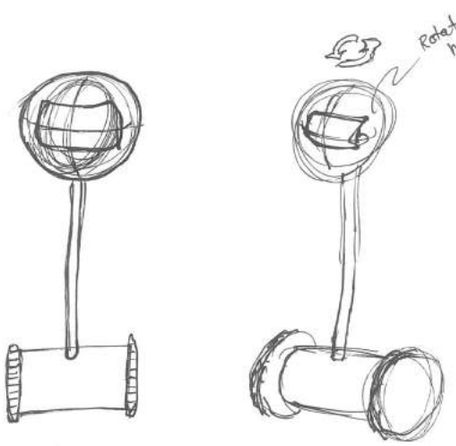
Experiment/Data:

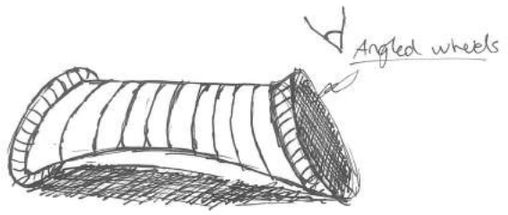
What the team did was to initiate a sketching round before individual working days + week-end, to let ideas be generated over some time. This was an indirect tasks over one working day and two off days. The team made sketches on a5 pieces of paper and went through them one by one, to understand the angle the sketch had on the product. Maria approached the task mostly on an interaction level, where Nicolai more worked on overall shape and personality.

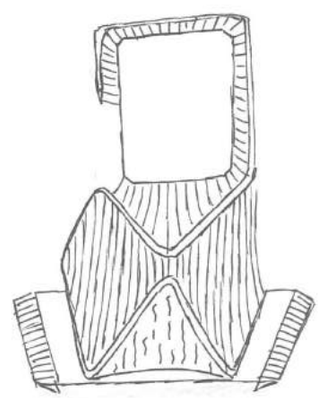

VERBAL INTERACTION
Eye identity
Simple identity
flexible joint
Display
Storage

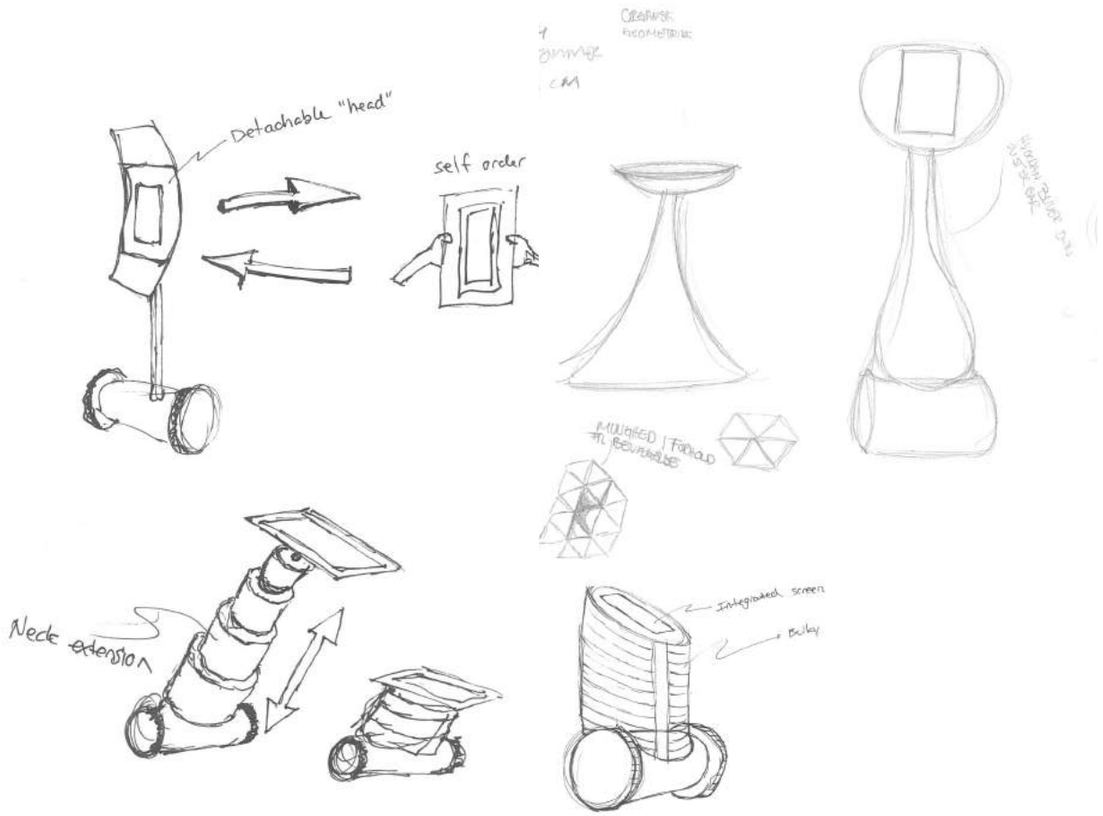

Unibody with base

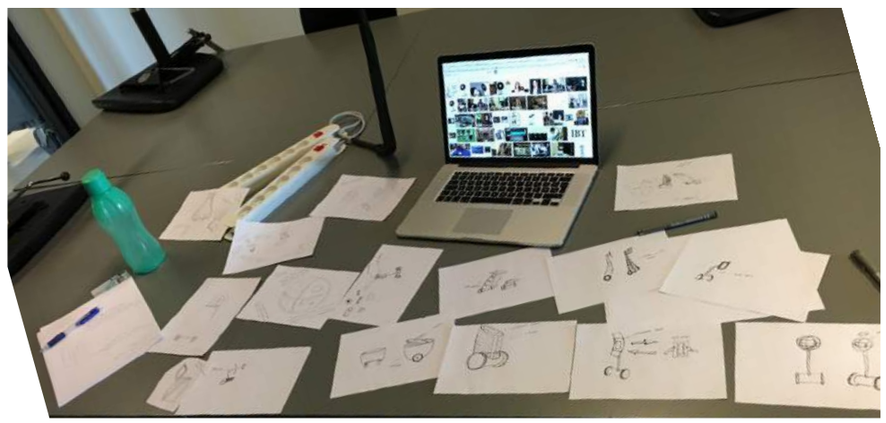



Rotatable head


Angled wheels







Evaluation:

The idea generation ended up giving the team three different paths to go with on a conceptual level, taking basis in degrees of freedom of the robot, and the possibilities that bring.

Reflection:

It is hard to reflect on a task when there were no clear objective, and the result was something that wasn't the intention to achieve.

Activity: How to define the three directions

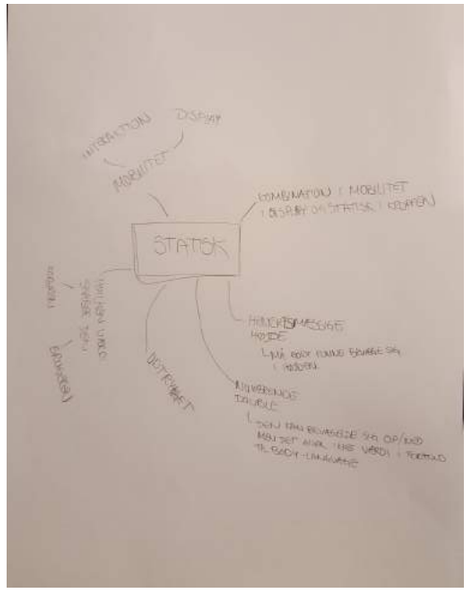
Worksheet no.: 22 Date: 26-03-2016 Responsible: MSJ

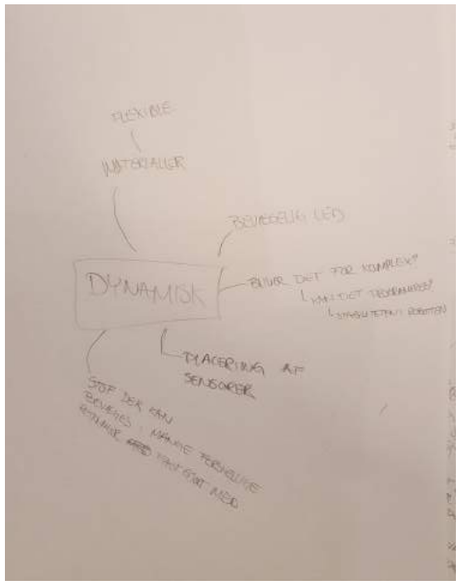
DEVit

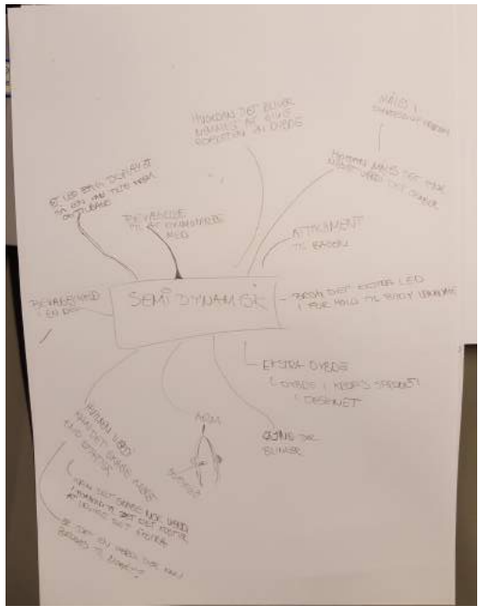
Objective:

By having sketched on solutions for the robot, the result were 3 different directions. A static solution were the robot do not have any flexible angles, a semi static solution were the robot had one flexible angle and a dynamic solution were the robot is flexible overall.
To define and understand the different directions, a brainstorm on the solutions were made.

Experiment/Data:







Evaluation:

This exercise was created to have the team a clear understanding of what the directions mean, and what the intention is to have different directions to design from.

Activity: Presentation for another group

Worksheet no.: 23 Date: 21-03-2016 Responsible: NOD

Objective:

The objective for this presentation, in contrast to the other group, were to establish a discussion about the project, weaknesses and things to be aware of etc. (the other group aimed more on communicating it better). The team had chosen to make a very short presentation, to see what is possible to leave out when talking about robots.

Experiment/Data:

- They want some elaboration on how the hotel context was chosen
  - Can't see the relevance as it was a vaguely supported choice.
- Clear visualization of what the teams wants the robot to do.
  - Clear boundaries as well
  - The main and sub focus of the lounge-roaming robot
  - The focus is actually HRI, as Guilia stated
- What are our considerations on interaction with people from different cultures, do we isolate from it or is it also something that we're including?
- How do we know that the translating from the framed interaction to programming is possible? -> the team evaluates with Karl, but we need to tell this to the reader
- The teams focus is interaction and physical appearance.
- What about interaction with kids?
  - Maybe the team should limit the project to the business part of the hotel. (add this to the framing)
- What is the value-gap between interaction with humans and robots?
  - Is it an addition or a substitute
- How does the operation around the lounge at Europa hotel compare to other hotels.
- The thing about sales anxiety should be a part of the problem description.
- Which hotels are we targeting?
- Which type of robot are we trying to develop visually, just show service robots
- The teams needs to describe why we take basis in the Double base.
- The team has to visualize the navigational system.
- The team should take into consideration that the robot could be in a crowded space, this being relevant to stability etc.
- How is the robot going to attract attention in a crowded space, maybe after some time when people are getting more used to it, and it is not that interesting.
- More info on the specific hotel: Types of guests, how many of each etc.
  - It should be here the team limits towards the business guests.
- What kind of three star hotels are we talking about? in Denmark, Egypt.. at the beach or in the forest?
- How is the team going to test the final product? meaning towards reaction
- How will the team work with the environment being quite loud in terms of verbal communication?
- Maybe make an illustration showing the hotel transparent, to show which part the robot should be navigating in, as limitation.
- Maybe tell that the team has focused on finding the easiest and quickest value point at the hotel to create a kickstart for the long-term development.
- How will the team show that the product creates the value that is claimed.
- Tell how the team intents to play on the attention/entertainment factor, as functionality still is in its beginning.
- What service should be established around it, like whom should take care of it, clean wheels, repair etc.
- How will the team make the robot stay inside the hotel doors?
- What are the teams thoughts on arrangement of the furniture in the hotel, should the hotel adapt to the robot or should the robot aim to fit in?
- I think the team needs to limit itself from much of the navigation, because that is an area deep enough for a project itself, and it is not really relevant as it is Karls domain.
- Maybe focus on the word transparency for the scenario.
- Will it be able to "speak" multiple languages?
  - Maybe a preset of languages will determine based on the first words, whether this is English, Danish or etc.
- How will the robot determine whether a person is 18 or not?

Evaluation:

The presentation itself wasn't clear enough, the audience semt to be missing some vital information about robotics, how we got to our path, and limitations + framing. Overall the team got the feedback type we wanted, as things were mentioned that would be good to be aware of. It became clear that some people believe some information to be crucial, because they lag insight to the area, which ofcourse cant be taken into full consideration when having short time for a presentation, but the point is that the area is complex and people often miss complete understanding.

Reflection:

Seen in retrospect, the team should maybe have used the opportunity to present just like the status seminars, to reherse the full understanding. This wasn't possible to do the way the team used the opportinuty.

Activity: Bodystorming on the three directions

Worksheet no.: 24 Date: 22-03-2016 Responsible: MSJ

Objective:

The objective with this exercise were to test out the robot skills in the three directions, static, semi static and dynamic.

Experiment/Data:

Static


Semi dynamic



Dynamic



Evaluation:

This exercise gave an indication of what a robot could do in the different directions and what is possible to do.
In static there were trying to add a hand to the robot, to see if it where creating more value. It created the wrong value of the robot can do more than the robot actual can do.

Reflection:

A human body do not have the same skills and there are different limits from the robot and the possibilities that a robot have. The exercise were to have an understanding of the three directions and what is possible in the directions, and to understand if the direction create more value to the robot.

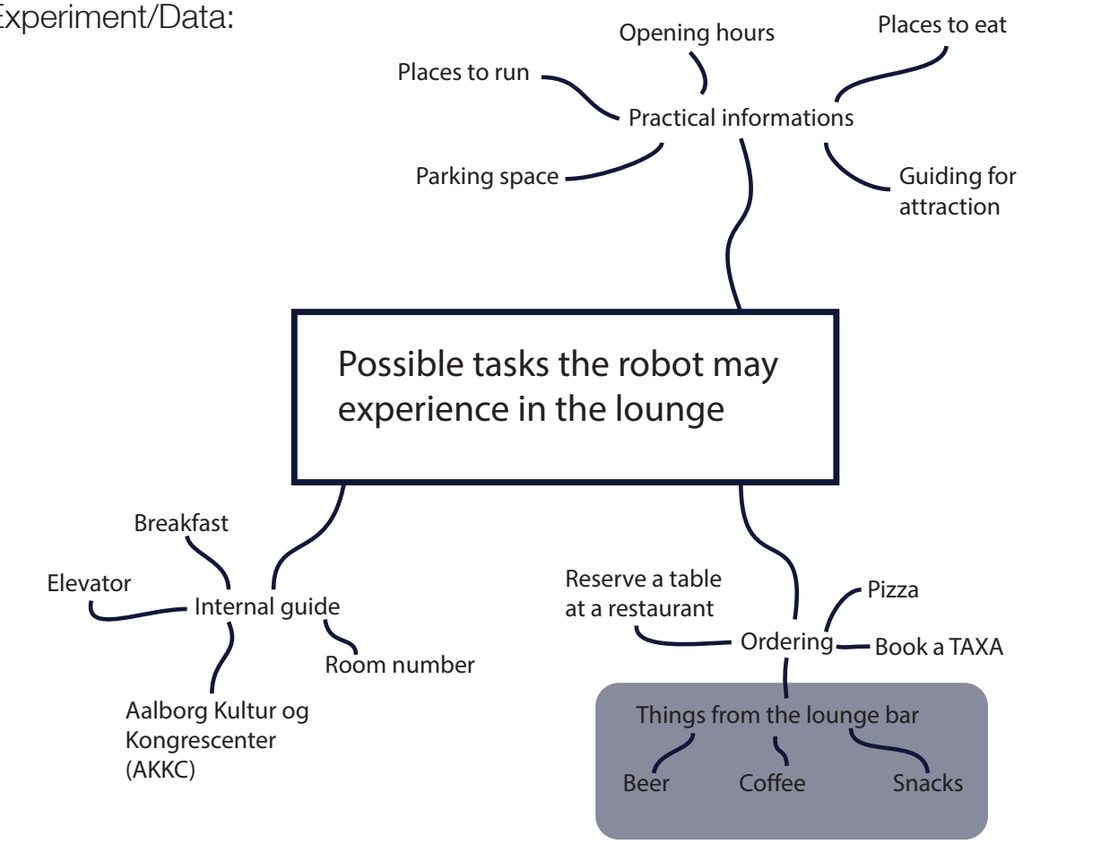
Activity: What a robot can be asked about

Worksheet no.: 25 Date: 26-03-2016 Responsible: MSJ

Objective:

There are lot of different questions that a robot can be asked, and to be sure that the programming of the robot is possible, it have to be narrowed down what the questions from the guests to the robot is. Thereby a brainstorm of possible questions for the robot is made. The brainstorm build on the observations from the hotel, in which questions the receptionists where questioned about.

Experiment/Data:



Evaluation:

There are lot of different questions that the robot can be questioned about. The questions are divided into three categories. There where lot of different questions and to narrow it down the focus will be on the ordering in the house , form the lounge bar.

Reflection:

It is not much that the robot have one function, but when the robot is programming for the first part, it is easier to develop and programming for the next task, and then you will bring the brainstorm into consider again, and then take a categories of potential questions that the robot could be asked about of the guests.

Activity: Verbal and physical interaction

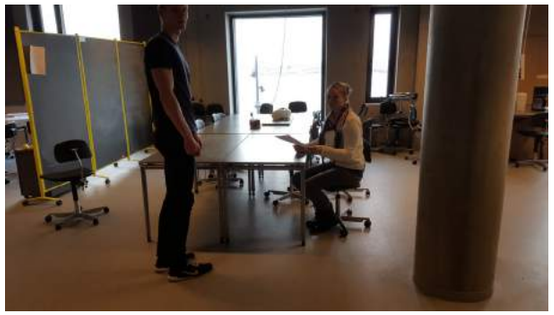
Worksheet no.: 26 Date: 30-03-2016 Responsible: MSJ

Objective:

This exercise is to see how it will be if the robot gives the consumer a tablet to order from and thereby not having any verbal interaction with the consumer. This have been tested out by act-it-out with the team members.

Experiment/Data:



Evaluation:

It can be difficult for the consumer to understand they need to take the tablet to order something, and what kind of extra value will that give the interaction that it is a robot coming with the tablet, instead of just being a tablet on each table in the lounge.
Or it should be the robot giving the consumer the tablet, but then the robot need an extra joint and that can difficult to programme and make from a technical point of view.

Activity: Additional Sales - research

Worksheet no.: 27 Date: 30-03-2016 Responsible: MSJ

Objective:

Disk-research at additional sales to understand the hotel, and if there are things that can be added to the robot. This is notes from different readings on-line.

Experiment/Data:

Additional sales
Additional sales are to sale more to a customer than the customer where searching after original. [Kilde: http://www.amino.dk/wikis/erhverv/hvad-er-mersalg.aspx d. 29/03 2016]

3 things that will do you richer: [Kilde: http://www.amino.dk/blogs/leonbirdi/archive/2012/09/06/mersalg-kan-redde-din-butik.aspx d. 29/03 2016]

1. Boost your service
2. You have to structure your additional sales
3. You have to collect new customers and restrain old customers

Possibilities – efforts – results
Wrapping of the service

A list over ideas creating additional sales [Kilde: http://www.amino.dk/blogs/leonbirdi/archive/2016/02/09/25-ting-du-kan-g-248-re-hver-dag-for-at-yde-den-bedste-service-eller-for-at-s-230-lge-mere.aspx d. 29/03 2016]

A) Get up immediately
B) Smile and seek eye contact
C) Bid customer to you with a friendly gesture
D) Go customer in meeting
E) Give hand
F) Help with outerwear
G) Offer to google information for him
H) Loans your phone out
I) Keep the door
J) Provide additional information as the customer does not know he will need
K) Praise the customer's choice - genuine
L) Follow him completely out
M) Say " thank you"
N) Throw everything else there is no client-side when the client is entering
O) Inform on alternatives once you've sold out
P) Touch customer
Q) Listen
R) Tell if the customer is buying something wrong
S) Offer coffee
T) Introduce the customer to your colleague when you give him / her further
U) Be generous - give a little extra
V) Find a chair - offer a newspaper when there is latency
W) Provide follow-up after the deal
X) Ask until the customer's knowledge so you can dispense your information well
Y) Be humble and show that the customer is king

Evaluation:

Part of the research gives an overview over some elements that can help giving additional sales, but it is not all that can be implemented to a robot, because lot of them are the interaction between the customer and the employ by opening the door and so on, and that can the robot not do. A expansion to the robot could be offering things in a link to the order from the guest, like if a guest ordering coffee the robot could ask if he want cake to the coffee. That kind of sales will help the hotel to additional sales, but it will huge demand for the programming of the robot, and will not be seen in the first edition of the robot, but a part of a expansion.

Activity: What can you order in the lounge bar at First Hotel Europa

Worksheet no.: 28 Date: 31-03-2016 Responsible: MSJ

Objective:

This task is for creating an overview over what is possible to order in the bar at First Hotel Europa by looking at their menu-card.

Experiment/Data:

The overview is here a mind-map that also indicate what is most ordered from the menu-card to find out what is the first that the robot should be programmed to order.

Evaluation:

There are lo of different things that are possible to order in the lounge bar at First Hotel Europa. The menu cart will still after the robot is implemented at the hotel, and thereby gives the consumer the a way to see what to order.

Reflection:

For programming the robot and have voice recognition it will be advanced when there are so many different things to order, but typically they will start with the things that most people are ordering, as coffee and beers, and after that develop it as requests for it.

Activity: Analyse interaction of robots in cartoons

Worksheet no.: 29 Date: 04-04-2016 Responsible: NOD

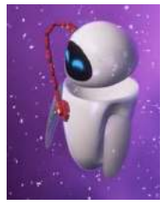
Objective:

The objective is to identify simple movements that can add value to interaction of the robot.

Experiment/Data:

- Wall-E and Big Hero 6 look through for this information.
- R2-D2 desk research for information.

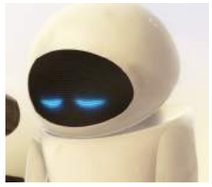
Eva from Wall-E
She uses mainly distance from head to torso combined with eye shape to present emotion. In some cases the arms are used to specify the emotion, and in others it's creating it.


Amused

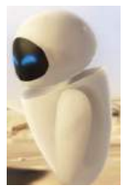

Angry


Anticipating

- Doesn't work without arms
- Only works in sequence
- Relevant to project

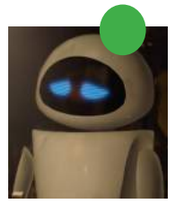

Defeated


Greeting

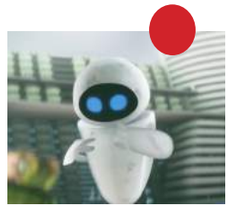

Happy relief


Flattered

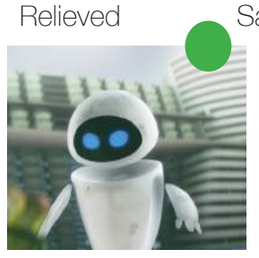

Overly excited

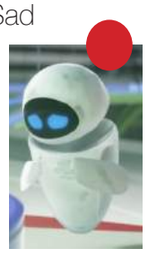

Relieved


Sad


Surprised


Thrilled

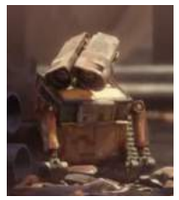

Anxious Waiting

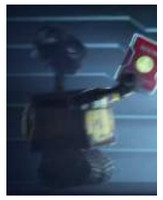

Worried

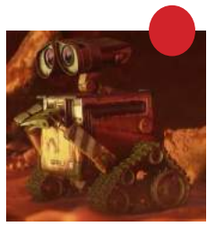
Wall E from Wall E
He mainly uses his eyes/head to orient towards and away from things to create emotional states, again using head to torso, and arms are used to specify or create the wanted emotion. Furthermore Wall-E uses the ability to tilt to use balance as well to communicate.


Amused


Distancing


Sad

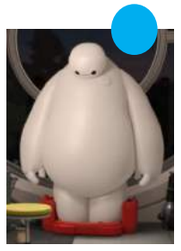

Shocked

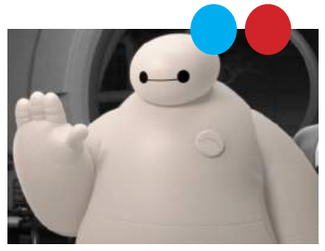

Shy

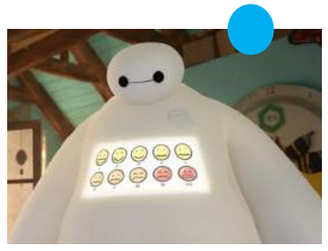
- Doesn't work without arms
- Only works in sequence
- Relevant to project

Betamax from Big Hero 6
He uses a lot of verbal language combined with projector on his stomach to communicate what he says better than just words. The movement is stiff, and it is mostly head tilts that indicate his focus, it is rarely possible to see emotions in the bodylanguage. The arms are used to indicate an idea, greet or physically manipulate things. The verbal interaction is very action based, meaning a statement of his is said, and an answer of the person is required.

The interaction remind a lot of what can be expected today, with everything seeming calculated instead of being thought, so it is not smooth in interaction.


Awareness


Greeting


Projection

R2D2 Star Wars
He has rotation of the head as orientation and physical interaction, with beeping sounds as verbal interaction, often creating an answer in tones. The most complex verbal communication he transmits is "wuuuu" or "wiiii" in scenes of the movies, showing thrill and fun. He mostly is used in play with others where the very simple communication can create fun or establish a more lovable feeling towards himself.

While researching R2D2, the team came across an interview "http://www.npr.org/2014/05/25/315703259/what-makes-r2-d2-the-most-beloved-robot-in-the-galaxy" where one is asked about why R2D2 is so lovable in comparison to C3P0, whereas the answers is basically "the uncanny valley theory" that states that robots are cool and interesting until a certain point, where familiarity decreases.

- Design elements should match in human realism.
- Reducing conflict and uncertainty by matching appearance, behavior, and ability.
- Human facial proportions and photo-realistic texture should only be used together.

Evaluation:

Looking at the found gestures and interaction movements from the four robots, it's only a few that has interest for the quite narrow interaction the project looks upon. The problem with three out of four of these is that arms play a distinctive role in performing the gesture. It is only Betamax that performs a movements indicating awareness of place that seem relevant for the project at this given time. All the other gestures and emotions aren't within the project framing, as they are mostly sad, shocked, amused etc. making it relevant at a later stage only. If the project standing point is taken into consideration, Betamax would be the most directly reference of these four robots. The reason for this is that Betamax performs actions and expects responds in a non-smooth and quite realistic way compared to real time technology and programming level, in addition to that he uses very simple physical interaction and very little of it, and combines it with simple speech and the ability to illustrate with projections on his chest.

Furthermore the finding of the uncanny valley theory provides some understanding of what to be aware of in regard of the design of robots

Activity: Human interaction - research

Worksheet no.: 30 Date: 05-04-2016 Responsible: MSJ

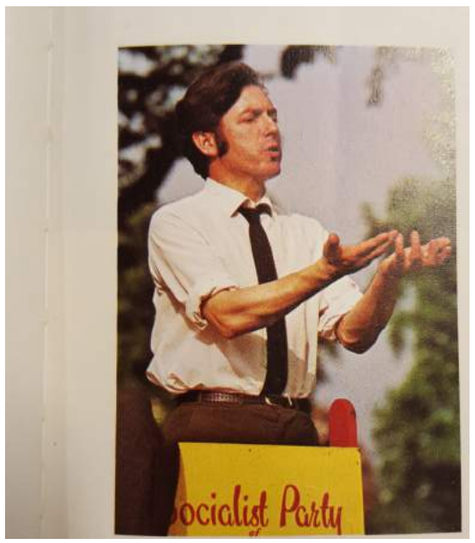
Objective:

This worksheet is for having an understanding and perception of body language between humans. The background for the research is Desmond Morris “Menneskers adfærd” 1977 giving a perspective of human behavior.
The is done to see if there are something useful that is possible to implement to the robot, and if there are something that need to be considered in the interaction between a human and the robot.

Experiment/Data:

The body language of a human is saying a lot, and there is some examples of how to understand it.

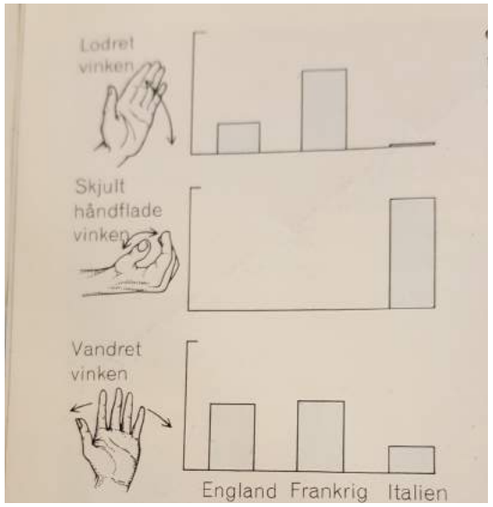
Saying hallo from distance can be in different ways, and can be as the picture indicating with both hands and arms, but also a subdued hallo with the hand.
It is the body language indicating in which way they want to communicate with the other man. This could be a part of the robot, should the robot have an expression of wanting to say hallo from a distance, without speak but from the body language of the robot.

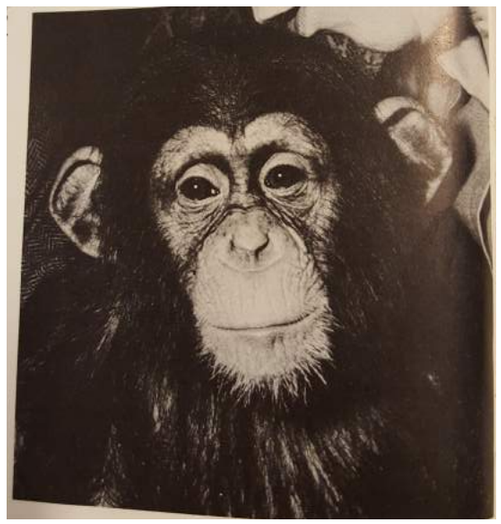


This picture indicate that a speaker is humble and will to convince to audience that it is right what he is saying.
The way he is holding the hands is for begging and he want something back.
That is a language that the robot do not need to have, because the robot do not need to beg from the guest, but they want by them selves order something with the robot.

Head nod and headshake are two signs indicating “yes” and “no” and could be a part of the robots interaction with the guest, by indicating that the order is right, or the guest indicating by nodding if they want to order something or not.

There are parts of the human behavior that are culture stated, as the picture here, where it is ware with the hand that are different in different countries.





Human have the white part of the eyes that can help indicating the direction that the human are looking without moving the rest of the body, and is a clear indicating of the attention in a conversation. That is a part of the eye that other animals do not have developed, and give human a special aspect in the conversation to other.
This aspect is interesting in the analysis of the robot need to have eyes, what kind of personification of the robot are we giving the robot in the way of which kind of eyes the robot is getting, and what more can a couple of eyes else indicate in an conversation.

A part of the research is about posture and how people can copy the posture depending on the situation.
When friends having a conversation they synchronize their movements while they are talking and thereby are like one. Uniformize movements are typically indicate that it is the same status in the friendship and that can be used by superior people to go down in level to have a conversation with other people by copying and using their body language.

Evaluation:

This is just a part of all the different analysis that can come out of an analysis the human behavior. Part of the behavior is complex and lot of different part of the body act a part of the behavior, and it will be too complex in implementing in the robot.
The parts of how the eyes can tell a whole conversation could be something to look deeper into, so make it clear when the robot is trying to get the attention to the guest and when the guest and the robot are finish interacting and the robot will leave the area.
It can be part of the robot body indicating when it is closed and when it is open and ready to a conversation, and something that indicate when the robot is speaking with a guest and then can not be interrupt by other guests and the robot have 100 % focus at something. - This kind of analyzing body language will be the next part in developing.

Activity: Karls inspiration for having this project

Worksheet no.: 31 Date: 07-04-2016 Responsible: MSJ

DEVit©

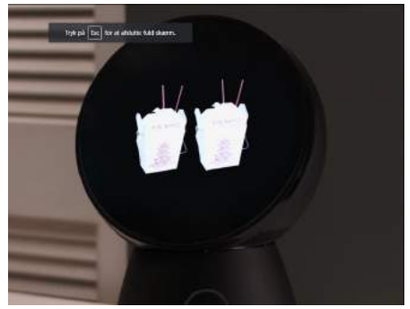
Objective:

The inspiration that Karl have for doing this project comes from four different robot, and this worksheet gives an analysis of the four robots to find out if there are parts of the robots we can use in developing of our robot.
The four robots are Jibo, Double, R2-D2 and Care-o-bot 4

Experiment/Data:

Jibo

Jibo is a social service robot, that is friendly, helpful and intelligent. It is the intention that the robot is in the homes, but can not drive in the home, but the user can move the robot from room to room for the functions. The robot can sense and respond on the users and can be used for telepresence. One of the examples there are used to introduce is that it can take pictures, and be used as a camera you don't have to hold for taking good pictures.
The body is flexible and con move around with the user, and the face of the robot have the possibility of giving the robot personality of by changing the eye of the robot, and show parts of the communication.



The robot is still a concept and you can not buy it yet, so it is difficult right to understand if the robot is realisable. If the technical solution is there yet.
The parts that Karl find inspiration in is the multirole that the robot have - so the robot create more value for the user and thereby can replace other products in the house.
Sleek - the robot can stand on a table
Likable -
Affordable -

Double

The Double robot is a telepresence robot, there you navigate the robot from the computer as the one being telepresenced.
The elements that Karl find interesting are:
Mobile - the navigation
Sleek -
Affordable - it is possible for companies to buy the robot and have it placed at conferences.

R2-D2

R2-D2 is a fiction robot from the movie Star Wars. (See the description of the robot in worksheet XX)
The elements that Karl find interesting are:
Multirole - the robot can do lot of different tings, and save the day a lot of time by using different tools R2-D2 have inside the cabinet.
Tool -

Care-o-bot 4

The product vision of the robot is a mobile robot assistant to actively support humans in their daily life. The robot can be in different environments in the homes it can help with delivering food and drinks, assist with cooking or cleaning. The robot can also support patients and personnel health care institutions. The developers define it that the robot have 24 degrees of freedom and can thereby do lot of different movements and is flexible in the movements.
The elements that Karl find interesting are:
Multirole -
Likable -

Evaluation:

There are few elements from this robots there can be used in the project. But the exercise was most to understand what Karl is seeing in the robots and that gives that the interface and interaction between the robot and the human where the robot have a personality and trying to analysis the humans mood and interact so it fit to the mood of the humans.

Reflection:

The elements needs now to be created as principals so they can be used in ideation and sketch.

Activity: The robots activities - Behavioral Expression

Worksheet no.: 32 Date: 08-04-2016 Responsible: MSJ

Objective:

The behavior of the robot, is narrowed down to 4 phases of behavior. The phases indicate different actions the robot have in the lounge. This exercise is a part of analyzing the behavior of the robot, and thereby not completed by it self. The should be seen as a generation of ideas of the behavior for the robot, but there are other possibilities there will be focused on later in the process.

Experiment/Data:

Roaming in the lounge:

1. Create a good feeling in the lounge
2. Identify guests
3. Greet guests - people passing by

Possible solutions:

1. Create a good feeling in the lounge
    - Dancing
    - Playing music
    - Sings
    - Greet guests

2. Identify guests
    - Movements in proportion to placing the camera on the robot

3. Greet guests - people passing by
    - Saying “Hallo”
    - Nod
    - Blink with one eye
    - Create a bigger smile
    - Create bigger eyes

Initialization - Pre-phase

1. Robot identify a guest
2. Robot driving to the guest
3. Robot contact the guest

Possible solutions:

1. Robot identify a guest
    - Technology solution:
    - The eyes indicate something (the eyes can go round in the head - like humans)
    - Head nodding

2. Robot driving to the guest
    - The eyes are locked at the guest when the robot driving to the guest
    - The head are locked at the guest when the robot driving to the guest
    - The robot is dancing to the guest
    - The robot entertains on his way to the guest
    - The robot whistle on his way to the guest

3. Robot contact the guest
    - “Hallo” - verbal interaction
    - Wink with the eyes

Main-phase - Interaction with the guest

1. Robot contact the guest
2. Reaction on “Yes”
3. Reaction on “No” (rejection)
4. Reaction on order

Possible solutions:

1. Robot contact the guest
    - Verbal - “Hallo”
    - Happy face
    - Tilt the head/the screen
    - Raise/lower the high of the robot

2. Reaction on “Yes”
    - Happy face
    - Happy eyes
    - Dancing
    - Cheer
    - Lean the body of the robot back

3. Reaction on “No” (rejection)
    - Looking sad - face
    - Never mind - face
    - Neutral face

4. Reaction on order
    - Hmm (verbal)
    - Nodding
    - Thumps up (icon)

Post-phase - robot leaving the guest

1. Deliver the order
2. Leave the guest
3. Start roaming

Possible solutions:

1. Deliver the order
    - Software part
    - Mail -icon
    - “Order delivered” - verbal

2. Leave the guest
    - Raise/lower the high of the robot
    - Reverse away
    - Turn around and drive away

3. Start roaming - see Roaming - phase

Evaluation:

This exercise indicate different solutions to the behavior. The behavior need to have a more detailed brainstorm. This are the first thoughts of the behavior. The next step is to see if parts of it can be used by test it how it will be intercept by people need to interact with the robot. The consumer of the robot is human, and they intercept behavior from humans without thinking about it. Thereby there need to be more analysis’s of the human behavior to implement at the robot in the way that it make sense, so they understand what the robot is doing by their unconscious and without thinking about it.

Activity: Meeting with Karl

Worksheet no.:33 Date: 08-04-2016 Responsible: NOD

Objective:

The objective of this meeting was clarify the amount of joints most optimal for Karl, so that the team can start using the specific movement ability to construct behavior and emotions. Furthermore there were an underlying need for alignment, as is still was clear that perfect alignment of aim hadn't been reached.

Experiment/Data:

The robot can adapt to changes in the center of mass, but a focus on how the adaptation changes the structure needs to be applied.

- if this becomes a problem, weights can solve it probably.

It would be possible to add two joints, but it would be tough practically to add for testing, no mentioning about programming complexity
Something about trade-offs you have to do under development, cost-benefit,

We have do to obsticle avoidance in 3D

- Intel has launched some new cameras with structured light (not for sale yet)
- What you do here is you would have an array of pixel, and instead of a color it is a distance, and if some of the pixels get to low a value because they come too close, then we stop. this 3D imaging will possibly be too tough for the small computer that will be on the robot as it will be on battery. What you could do would be to select a specific line of pixels to navigate after the way earlier descriped, and just the the rest of the array be screening for object breaching a certain proximeter to avoid impact.
- The placement of the 3D camera can francly be anywhere from around mid to bottom, but the middle uses the spectrum of the array more effecient than the bottom for example would.

Camera wouldn't be wanted both in front and in back

Infrared sensoring could be used to check backwards for impact.
The highten and lowering function of the Double in the same of some elevation table, meaning a threaded rod and a bolt, pushing or pulling someting.

Assumption to question: People want to be served by small in heigth things.

- why dont a waiter get on their knees while serving? wouldn't that be more comfortable for guest?

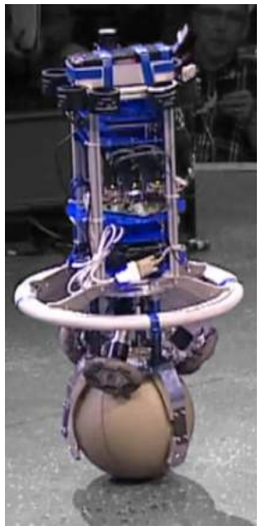
Is the current base enough in general?

- it is simple, there are two motors and that is it.
- But is it flashy enough? it is a 15 years old technology and segways a widely known.
- Hotels most likely dont have effeciency in main focus, in contrast to aesthetics and flashyness

So what about using a ballbot principle?

it has several advantages

- Possibility for
- More flashyness in terms of how it moves
- Sideways movement
- More soft movements, doesn't have the stiff movement of the Double.



Some initial disadvantages

- Not possible to directly test the principle
-

From Karls perspective, is the ballbot principle just around the same difficulty as the segway.
The ballbot we have on our board is made from good students, but on bachelor level.

Karl vision:
Karl wants the robot to be an attachment to an app.

- Maybe for instance someone develop an app for making the robot able to follow you and take pictures or film in a proffessional way.

Develop a software development kit for app developers, so that they can make apps that utilize the competences of a robot, making it possible for great app developers to incorporate robots without being robot experts. This is what he wants to offer.

He then wants this to be open source, so that other robot manufacturers like Double can open their Bluetooth and use the software development kit. As long as everyone uses the same interface, just like bluetooth headsets where they are all based on the same driver (bluetooth profile). This will increase competition, but it will increase the overall marked revenue, just like Tesla did with releasing patents, because making 10% of a 1 billion dollar marked is much better than 40% of a 50 million dollar marked.

So as I see it now, Karl wants to develop this great robot for various contexts, and whilst developing this he will create the software development kit, so that the robot he builds will be usable for app developers world wide. He then wants to give out this software development kit for free to all other robot developers, first of he will own the foundation of the link between robot developers and app developers (normal people), and this move should boost the overall marked to become bigger, as the accessability becomes way greater.

The common denominator is this case is the software interface "software developers kit" that enables the use of the sensors on the robot or on the tablet as pleased. This again should adapt to which robot you ofcourse persess, whether it is a cheap chinese robot or the high end.

People should be able to use subsets of the robots capabilities and on the other hand also use supersets where things are added to the orignal.

As the robot will surely have a tablet in it a question about whether it should be sold with or not was raised...

- Karl says he doesn't want to sell tablets at all, he will just say that the robot is compatible with this, this and this tablet.
- This will also lower the overall cost as a tablet should be calculated in, and people might already have a tablet for it.
- In our case an integrated tablet would make sense, but it probably wouldn't at have.

Construction site thougths

- Decision maker is the ones whom facilitated the project.
- If the current problem at hand is over the whole office space etc. it is not possible to explain like that, and the construction worker and the architect speak different languages, so now you can, just like with the Double, show where the problem is.
- This is just not enough to have a robot
- Value would be less time consumption on commute.
- Given that there are more use cases within the field, it is believed that the Double in many aspect, like mobility and flexibility, is lagging the required hardware to fulfill the tasks. In addition to this is it not rigid enough, function > aesthetics.
- It is not anticipated that the same hardware platform will work in both construction site as well as hotel. But that is a part of the concept, as if you try to hit both these contexts you won't hit any of them.
-

At what level are we talking modularity?

- is it at a production level, user level or developer level?
- Modules for the user is still believed by Karl to be a good idea, but it might be hard to "click clock" (sound of added module) you all the way from hotel to construction site

Would we like to get to a higher level of concept with the project?

- maybe we should consider dropping some of the realism perspective as just clearly state in the report that we want to result with a more conceptualized interesting
product because we will be bound to realism after this project anyways.

Karl as a customer:

- Make a robot for the hotel business based on the ballbot principle
- Give it a modern design that makes it beautiful and exciting to look at and surprising.
- The surprise will arise from the ball.
- I like a sleek form that mounts up to a screen, maybe it should curve.
- I'm still in love with making some of it in oak wood.
- I believe that is something that a guy like Kuno would be interested in. They would be somewhat careless about the software platform part, but super happy that we have developed the hotel part through. Maybe just tweak the software modularity to something about the hotel not being reliant on some guys from the university, as they can get an app made themselves if they'd like.

Karl mentions that we should just do what we're good at 'hopefully' which is to make robots, but we need the whole platform with as well. This is where I just realized that in long term strategy with this, some kind of interface designer would be pretty crucial.

Thought: As we're developing a robot for horizontal leveraging, we need to design a generally good looking mid-high end robot that isn't bound in identity, so the identity should be incorporated in the app.

The Double is a stepping stone for the development to get to where it gets.

How do we create a design that is simple, but doesn't become boring, just like many of B&O products?

The Double base on consists of a print-board, two motors and a battery.

The size of ball used on the ballbot is basketball size.
There are two methods of gripping upon the ball -> down and around and on-top
Either you have something in the ball with magnetism or you balance on top

- Balance on top means we can have a cheap ball
-

Identity faces at acceptable zone in the lobby
Check if information in the database restricts me from approaching (maybe they just said no)
Approach table and position myself in front of it, I recognize x persons, create session for table x with x persons at xx:xx o'clock, first time of interaction.
Can i offer you anything?

Karl dont see any trouble with letting everyone order at the same time.
we can calculate angle for eyes with angle from facial recognition
Maybe we can use dominant user detection to determine whom is the the robot to look at and orient towards. -> not sure if this is done with facial recognition as well.
This will create the possibility for two redundant movements, where one is virtual. With fast movement on eyes and slow with "body"

Project oriented programming can be used to store information about individual persons face, seen places and such, so even if they move from one place to another, the robot will still know whether or not to approach. This can also be used to keep track of people coming to

the hotel for the greeting part.

The thing about the eyes might be easy to test at the hotel, where we could manually control the whole thing and act as if the robot can look at you whilst interacting.

Should the robot make a mmh noise while going around not to shock anyone?

There is alot of possibility about animation around the eyes.
- Maybe the should transform to a beer when one is ordered etc.
- Maybe it should look down upon the receipt being written as an animation.
- Should it be flashy or elegant?

What happens when the eyes are transformed or removed for a short period?

Evaluation:

The meeting went very well seen isolated from the initial objective, as the team failed to get a concrete answer to how complex the amount of joints would make his part. Other than that the team was very happy with the meeting, which took nearly two hours and contained topics ranging from component understanding to interaction discussion. This meeting actually resulted in the team changing mobility principle once again, as there were minimal downside to doing it in contrast to the upsides.

Reflection:

Looking back upon the task of the meeting, i could've been smart to prepare more structure what the team had on their minds, and through this keep track of whether the objective of each topic or question had been answered.

Activity: Project milestone - robot

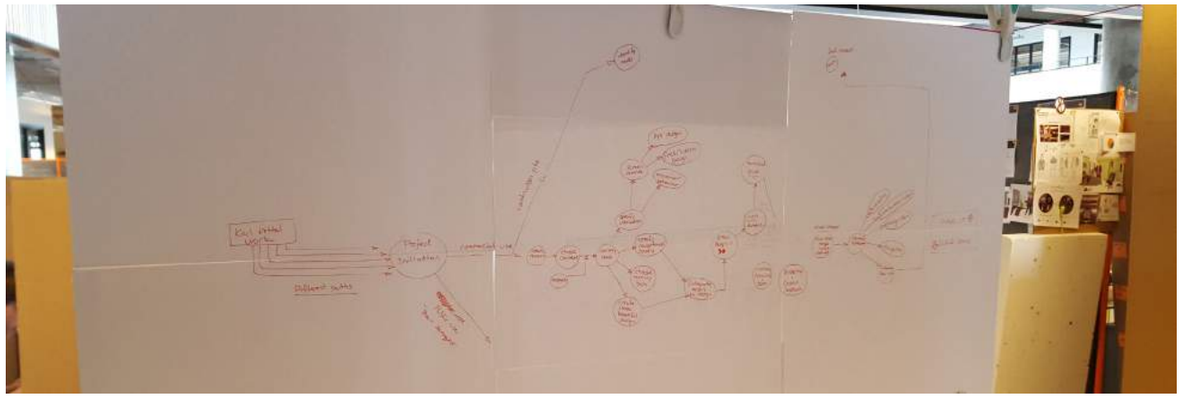
Worksheet no.: 34 Date: 13-04-2016 Responsible: NOD

DEVit

Objective:

The team wanted to create an overview of the overall project, so that limitations would be fairly clear to make in regard to areas and phases.

Experiment/Data:



The picture illustrates what the team made in efford of structuring what has to be done through out the project, variating in detail. Briefly it shows how the initial project start of Karl has lead to three paths, two paths of which groups from MSc04 ID is working on implementing robot technology in commercial use and public use. In addition to that Karl himself is working with a path of using it at construction sites. From here the team has identified a possibility and between here and doing the programming, is where the team is performing the work to create a robotic solution in regard of design, interaction, behavior, structure, components etc.

Evaluation:

The team managed to get an overview, and is continuously plotting more areas on, to fulfill the aspects of the project. The intention is that this should help illustrate the boundaries of what we're trying to do with the project within the time frame that we have, as it contains so many aspects that we cannot cover them all.

Reflection:

The task has created a good overall view of the project, allowing continuous mapping of the work we are doing, and intent to do, making it quite valuable.

Activity: Analysis and sketch by cartoons principles

Worksheet no.: 35 Date: 11-04-2016 Responsible: MSJ

DEVit©

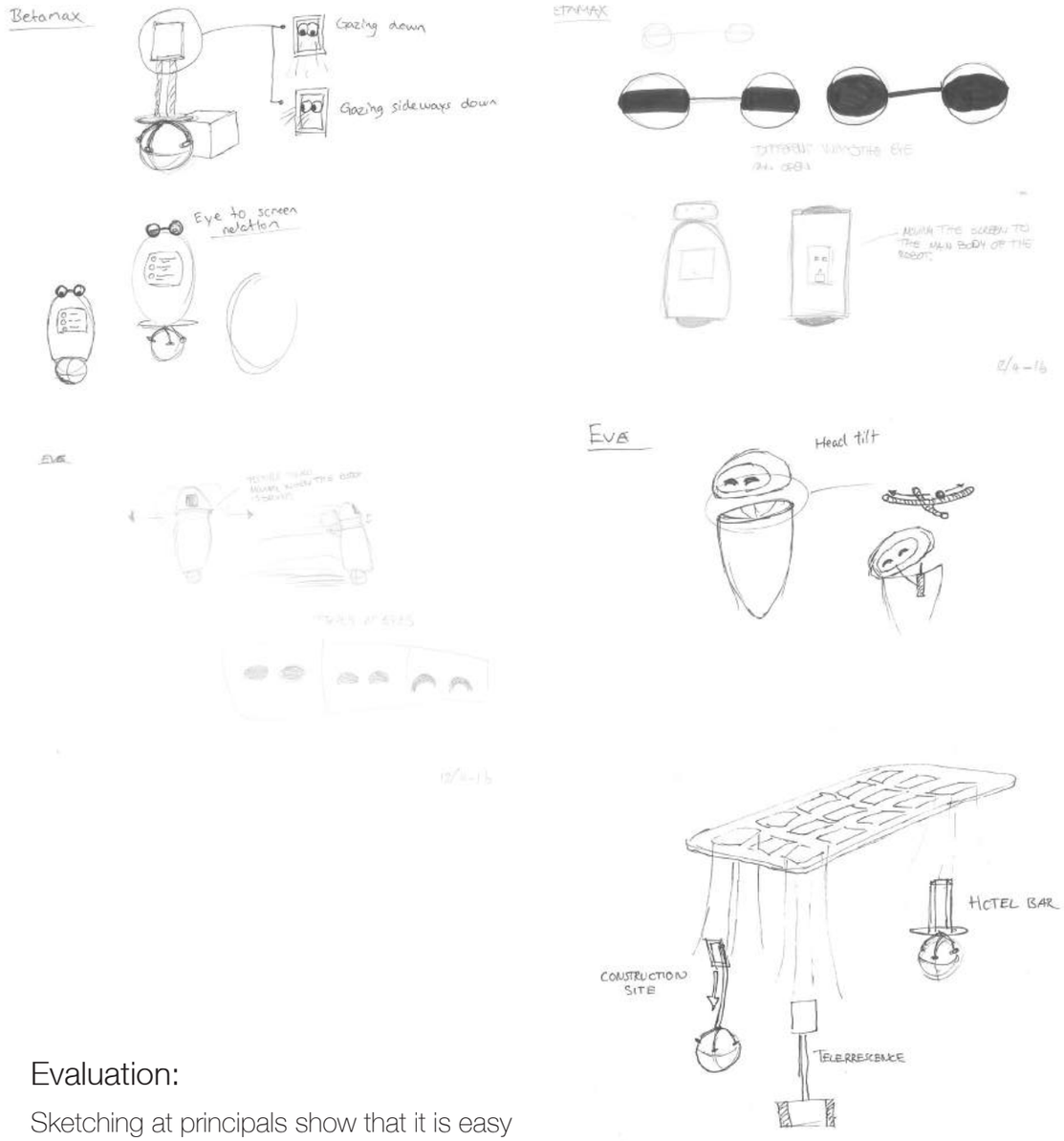
Objective:

The cartoons robots have been analyzed and here the exercise is to find the principles and after sketch to see if there are any of the principles that can be used in the developing of the robot.

Experiment/Data:

To organize the analysis there is created a table and after defining the principles there is time for sketching by the principles.

Existing robot	What we find attractive	Which kind of principles can be extracted
Beymax - Big Hero 6 	- How neck movement and stiff facial expression still can create something you love. (Betamax is like that mentally challenged bigger brother who's awkwardly too big) - Uses neck to show that he is looking at his footprint to navigate. - Uses his chest as projection point for illustrative information to add in interaction scenarios - How his verbal interaction is limited to the ask-get an answer level we're at in 2016.	- It is obvious that he has challenges, and that creates a foundation for easy accept of his challenges, it then becomes something you love him for. - Use alternative illustrative things to complement the interaction.
Eva - Wall-E 	- Relation between facial area/eyes and the torso, so the space between and how it is used to mimic an invisible neck. - Simple eyes - Simple facial limit	- Angle and space between head and torso - The use of round eyes that get somewhat blocked to change form.
Wall-E - Wall-E 	- How he uses his eyes and neck to shrug into the torso to provoke various emotional expressions.	



Evaluation:

Sketching at principals show that it is easy to indicate feelings by having a joint moving the head so there is physical behavior in the head and not just with the eyes. The eyes can show lot of different motions and indicate that the robot is in a specific mood. The cartoons have different looks using the eyes, and that can be a huge part of giving the robot identity by the software and thereby can change it for the different contexts.

Activity: Analysis and sketch of existing robots

Worksheet no.: 36 Date: 11-04-2016 Responsible: MSJ

Objective:

Karl have four robots that he have found interesting in the developing of this project and here is an analysis of what he is finding interesting and that the team is finding useful for the project and the development of the robot. This is also to understand what Karl have in mind and find interesting with robots, so the design and develop of the robot can be in collaboration and filling his requirements.

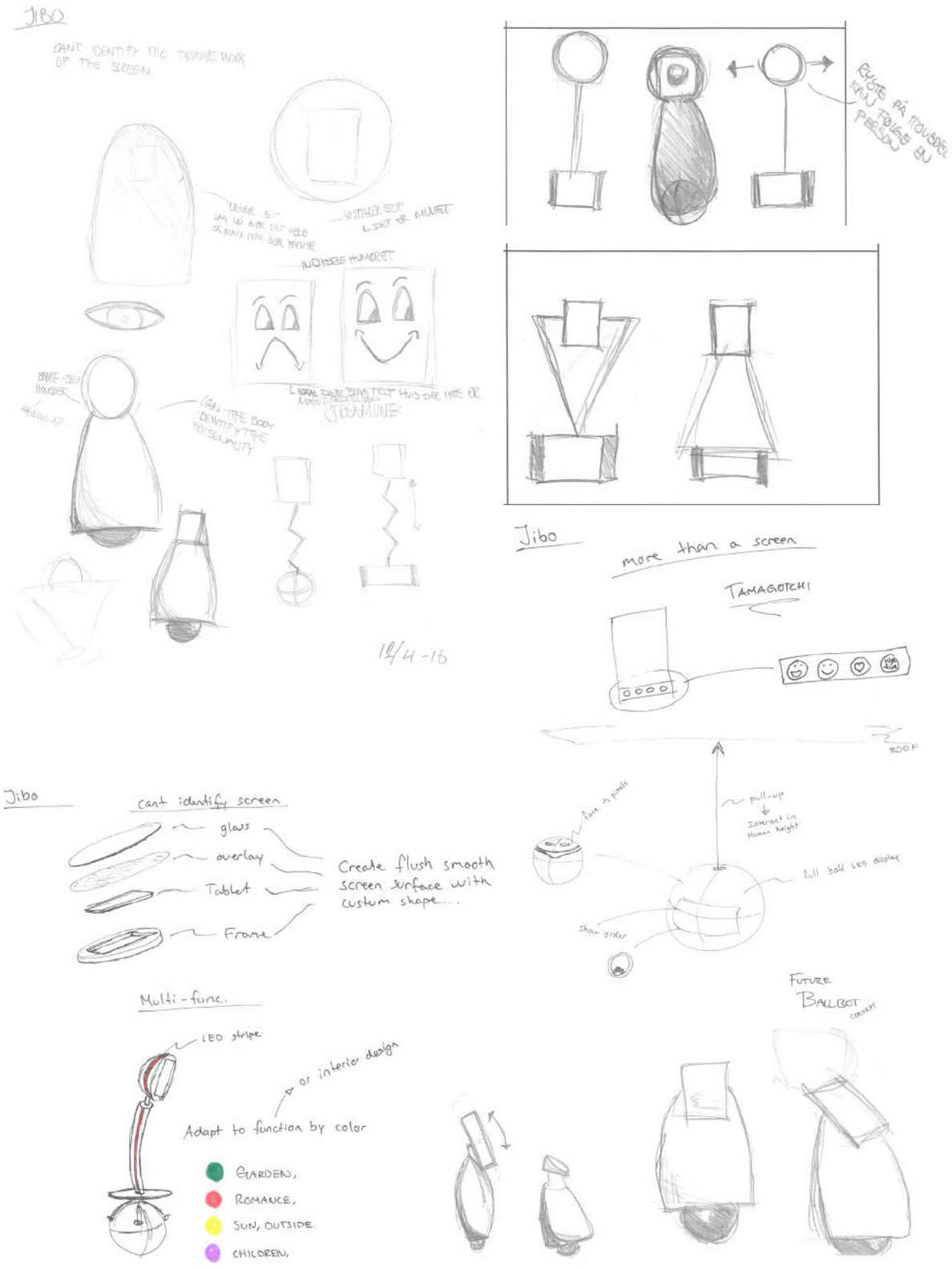
Experiment/Data:

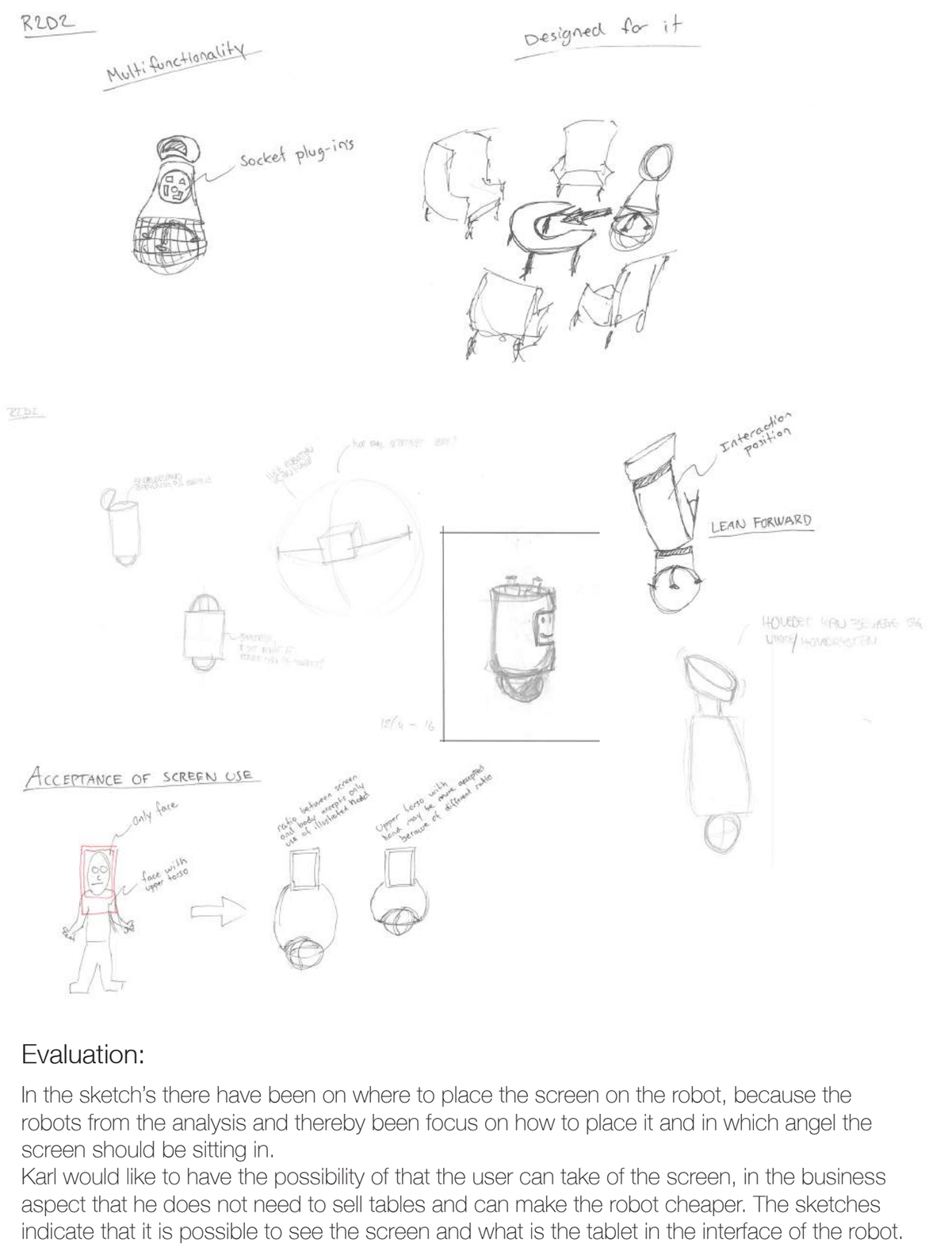
To organize the analysis there is created a table and after defining the principles there is time for sketching by the principles.

Existing robot	What Karl find attractive	What we find attractive	Which kind of principles can be extracted
Jobi 	- Sleek - Likable - Affordable	- Multifunction – can be used in different scenarios/environments by different users - The easy verbal interaction - The way that the eye indicates the mood - Show the interaction/ part of interaction at the screen - Integrated screen – do not look like a screen when it does not use the function	- Can't identify the framework of a screen. - Getting the screen to be more than a screen – give it personality - Software multifunctionality in harmony with design
Double Robot 	- Mobile - Sleek - Affordable	- Mobility - Lateral - Using existing software – easy to implement to another use - Simple construction – the design tells the function and nothing more	- Be clear in the expression of the robot – keep it simple – show the function of the robot - Design that doesn't become boring.

Existing robot	What Karl find attractive	What we find attractive	Which kind of principles can be extracted
R2D2 	- Multirole - Tool	- Multifunction – have the possibility to solve lot of problems - Rotate the head to indicate focus in interaction – physical movement	- Multifunction – it can be part of the inside of the robot having new functions - Using the "head" for interaction - Environment designed to make R2D2 great
Care-o-Bot 4 	- Multirole - Likable	- The feedback that the eyes indicate (create emotions) - Showing emotions – at the screen and physical driving	- A way of understanding interaction with the user without saying anything

After analyzing the principles of the existing robots, there have been sketch on the principles.





Evaluation:

In the sketch's there have been on where to place the screen on the robot, because the robots from the analysis and thereby been focus on how to place it and in which angel the screen should be sitting in.
Karl would like to have the possibility of that the user can take of the screen, in the business aspect that he does not need to sell tables and can make the robot cheaper. The sketches indicate that it is possible to see the screen and what is the tablet in the interface of the robot.

Activity: Analysis of human behavior

Worksheet no.: 37 Date: 11-04-2016 Responsible: MSJ

Objective:

To use the research from human behavior, the behaviors have been analyzed and found principles in the behavior. These behaviors is mapped here and it gives here examples of hos to use the principles in the robot.

Experiment/Data:

Human behavior by Desmond Morris

The behavior	The principle	Examples of how to use the principle
Movements – when people having a conversation they cannot stand still and start moving the body	- Different movements for the robot when having a conversation	- Look like a natural movement - Incremental movement, not radical.
Eyes – Expansion of the pupil receives more attraction, and the person with the expansion will receive more attraction from others.	- Change the size of the pupils when having a conversation to establish greater interest.	- Have a more toned down eye at roamed mode, but exposes the pupil more with direct interaction. - Use pupil size to show that the robot likes what it sees when it identifies a human.
Facial - City dwellers are particularly prone to affect his own head. 	- Touching head to show state of mind	- Use the screen to illustrate a hand to the face that shows that it is thinking.
Headshaking and nodding is the most well-known way of saying yes and no.	- Headshake and nodding is globally understandable	- The robot could physically nod the head as a way of signaling that it understands what is being said/done.

The behavior	The principle	Examples of how to use the principle
Greetings - The way you say hello, depends on how well you know the person 	- Relation determines personal sphere	- Use programming to determine how far the robot can approach, maybe a different angles.
When friends have a conversation they synchronize their movements while they are talking, and hereby they are like one. Synchronized movements are typically indicating that they have the same status in the friendship, and that can be used by superior people to go down in level to have a conversation with other people by copying and using their body language.	- Copy body position to show that you are alike 	- The robot could ensure that it is same height as the person that is being interacted with
Saying hello from distance can be in different ways, and can be as the picture indicating with both hands and arms, but also a subdued hello with the hand. This action show friendliness or a lack of hostility.	- Gesture from a distance 	- The robot could upon recognition of a person, animate a quick hand-wave to

The behavior	The principle	Examples of how to use the principle
Hand movements indicate what you want to have – like drinking something without having anything in the hand.	- You can mimic having a physical object with really having it	- The robot could illustrate bowing etc.




Evaluation:

There are lot of different principles in the human behavior, and it is easy to identify them all, but here there have been focus on behavior there people are trying to interact with each other. It can be principles that can be used by the robot in the communication with the consumer and user.
One of the principles taken thought is that people are not standing still so the robot must not be static in movements.
The robot is still a new thing and people are still not comfortable with it, and it can be difficult for the consumer to analysis the movements and thereby predict the next movement. That will be something that the team will test to see if the behavior have the affect as expected.
Lot of human behavior is by using the body and all the joints that the body has, and that can not be copied over to a robot, not having the same flexible joints, and the behavior can possible not be used as the intension with the analysis.

Activity: Ideation on behavior analysis

Worksheet no.: 38 Date: 12-04-2016 Responsible: NOD

Objective:

After have been doing behavior analysis on various levels, the team was ready to convert principles found into something tangible that the product could contain.

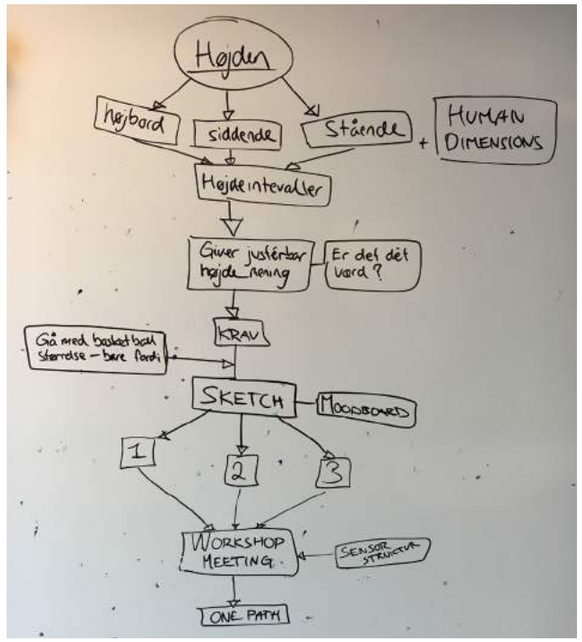
Experiment/Data:

The approach was to take schemes made with analysis, talk about the principles and convert them into something tangible, like a sketch that can later be added to the concept.

SHOW SCHEMES HERE

The result of the work was then sketches and ideas to how these principles could work on a robot and in our project.

These ideas were then grouped according to the part on the robot where they would belong. At this point we asked our selves what we would attach the ideas to, as we had no defined concept to place them on. This lead the team to make a structured plan to get to a defined solution space in terms of height and width, so a overall design could be reached before defining which ideas that can be integrated in the solution.



Evaluation:

Seen from the projects angle, the team managed to get to a good result, but if you see it with a concept view, the team came no closer to a concept, as the results were unable to be combined.

Activity: Analysis of the height of the robot - defining it from research part I

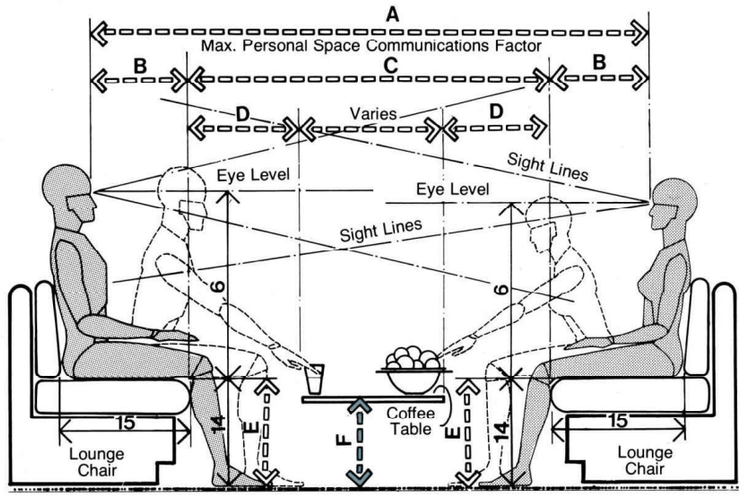
Worksheet no.: 39 Date: 13-04-2016 Responsible: MSJ

Objective:

To define the minimum high of the robot there have been doing desk research from the book Human dimension & interior space, A source book of design reference standards by Julius Panero and Martin Zelnik.

Experiment/Data:

As the point of departure here is page 277 from the book, indicating dimensions for seating in lounge chairs.



LOUNGE SEATING / CLEARANCES

	in	cm
A	84–112	213.4–284.5
B	13–16	33.0–40.6
C	58–80	147.3–203.2
D	16–18	40.6–45.7
E	14–17	35.6–43.2
F	12–18	30.5–45.7
G	30–36	76.2–91.4
H	12–16	30.5–40.6
I	60–68	152.4–172.7
J	54–62	137.2–157.5

Evaluation:

The conclusion is that if people can reach something at a coffee table that are 305 mm high they will also have the possibility of reach out and interact with a robot in that high. This will then be the lowest that the high of the robot could be.

Reflection:

By defining the robot so low, the next the team will find out is if it is possible to interact with the robot, how will it physical feels like if the robot is so low. The consumer and user have also the possibility of interact with the robot as standing people, how would it feel like.

Activity: Measurement of the interior at the First Hotel Europa

Worksheet no.: 40 Date: 13-04-2016 Responsible: NOD/MSJ

Objective:

To define some of the dimensions of the robot, there have been measured elements of the interior at the First Hotel Europa. This is both to define the height ad the possible weight of robot, to see where there are limits for the robot compeered to the environment.

Experiment/Data:


The height is 780 mm


The height is 1000 mm


The height is 1100 mm


The weight is 1140 mm


The weight is 1050 mm


The weight is 300 mm


The weight is 400 mm

Evaluation:

The height of the objects in the lounge at the hotel is 1100 mm and the robot need to be higher than that to roame in the lounge and to get an overview of the lounge.
The weight of the robot have the limit of 400 mm in comparison with the environment.

Reflection:

In the roaming of the robot, and in the identifying of the guests it have to be a consideration that there can be people standing in the lounge that the robot can not see over and behind, but the consideration will be in the defining of the sensors and a backup system.
This test gives the limit in the environment and now it need to be defined by components for the robot.

Activity: Moodboards for defining three concepts

Worksheet no.: 41 Date: 13-04-2016 Responsible: MSJ

Objective:

To have something to sketch from and a direction to the design three different mood-boards is made.
The themes for the moodboards are:
Soft Shell
Danish Design
Futuristic Design

Experiment/Data:

It was easy to see in the first sketches that the futuristic design will give too much a futuristic look, and it will not give anything good for the hotels, and it will not fit into the still of the hotels. It can be difficult to identify with something there is futuristic and people can be afraid of the robot instead of interact with it.
After that observation, the futuristic design moodboard was taking down and it were not the two other moodboards that created the design of the sketch to the robot.

The intention of the moodboard were also to have a design and a direction of design to discuss with Karl.

Evaluation:

To use the sketches for anything there need to be more dimensions on the robot and that is why the sketches from this is not so useful.
There need to work a lot with the demands before creating a design to the robot.

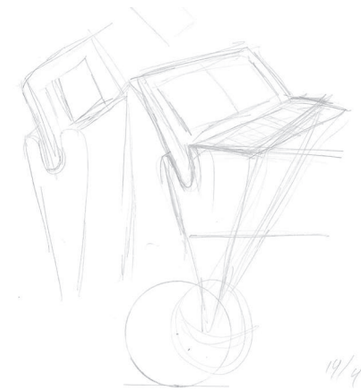
Activity: Sketching to fine 3 different concepts

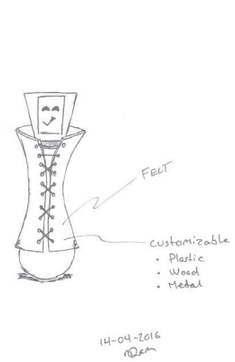
Worksheet no.: 42 Date: 14-04-2016 Responsible: MSJ

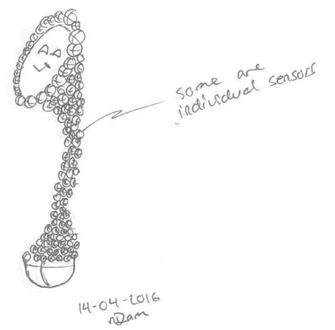
Objective:

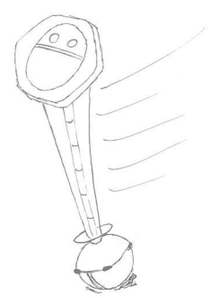
The intension with the exercise is to sketch from the 3 different moodborads, to find a design for the robot.

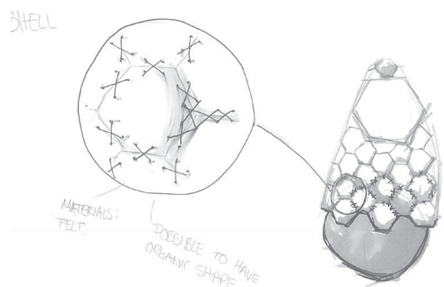
Experiment/Data:

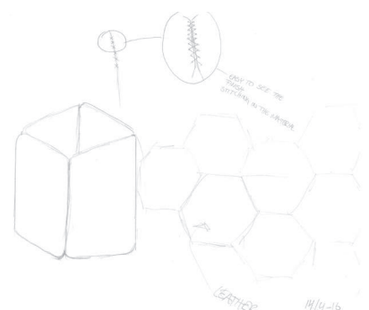


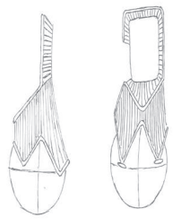


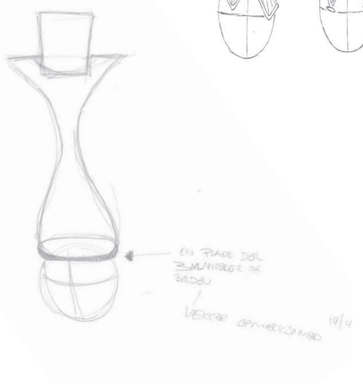


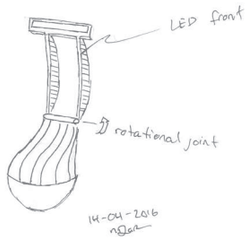


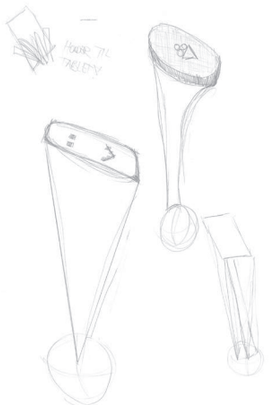


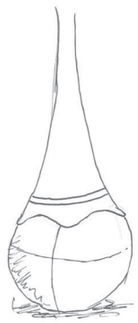


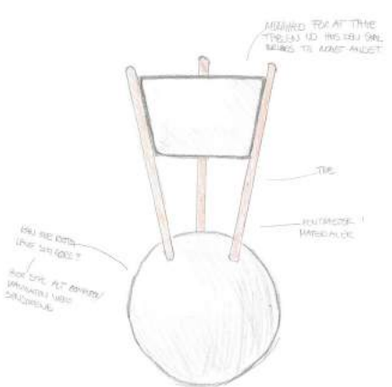


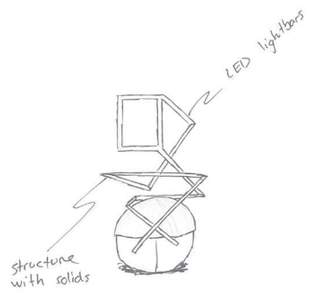


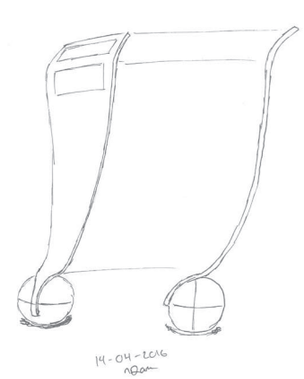


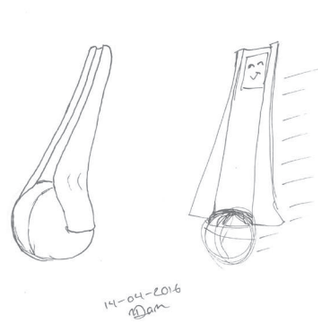












Evaluation:

When sketching it was getting clear that the dimensions for the robot should be decided first, because the expression of the robots change when having the right dimensions to sketch from.
This will then be the next before decide the shape of the robot and the design of it.

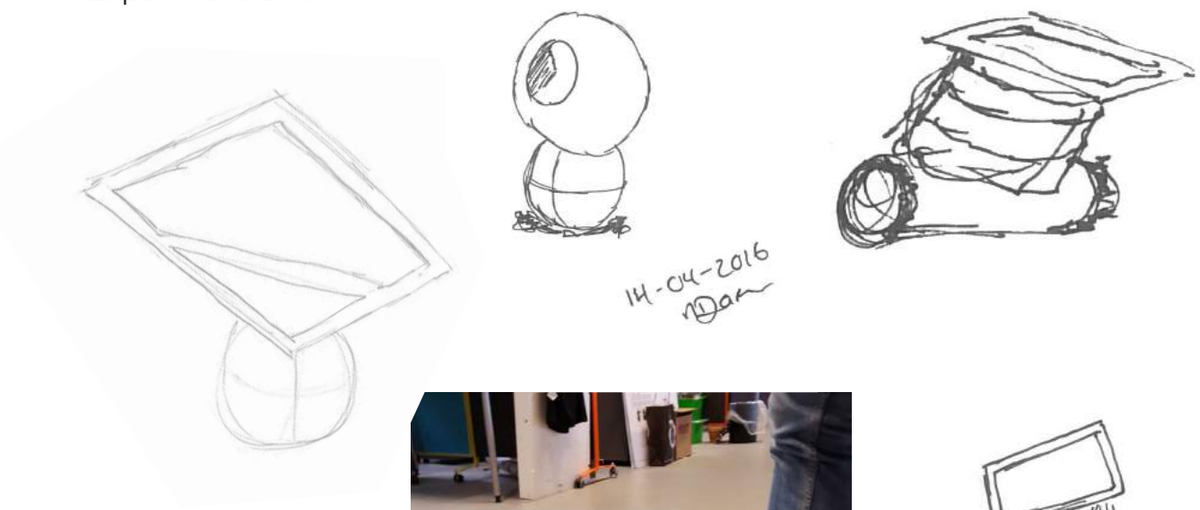
Activity: How small can the robot be - mock-op - sketch

Worksheet no.: 43 Date: 14-04-2016 Responsible: MSJ

Objective:

The height for the robot is not defined yet and thereby the generation of ideas gives ideas of small robots like a robot vacuum cleaner. This principle is being sketched on and tested by mock-up to see if you want to have a conversation/interaction with a robot at that height.

Experiment/Data:



Evaluation:

The sketches and the mock-ups is small, and the questions about it is possible to have all the components in the robot was asked, and the concepts need to be evaluated together with Karl.
The interaction with the robot when it is so small can be difficult, and it need to be tested more if it is this direction the team is going, how it will feel and so on.

Activity: Height of the robot - Mock-up test and table

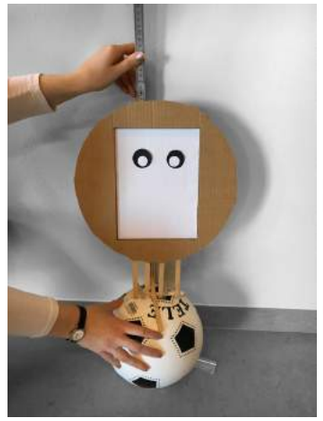
Worksheet no.: 44 Date: 14-04-2016 Responsible: MSJ

Objective:

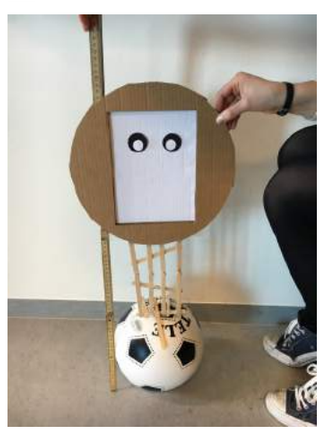
The intention for this activity was to make a mock-up of the robot, to see how the height of the robot is feeling like physical and not just on paper.

Experiment/Data:

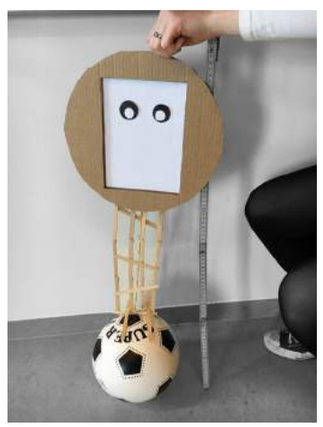
The robot with a total height of 600 mm



The robot with a total height of 700 mm



The robot with a total height of 800 mm



Evaluation:

As shown in the pictures, it is possible with the height of 600 mm when sitting but standing it can be difficult to have the right ergonomic posture and it is not good to design a product encourage for not posture right. It is the same with the two other heights, but 800 mm could go it will be like talking with a child so the identity of the robot could be a child, but is it what we want it to have?
To define the height of the robot, a pros and cons table where made, to see where the best possibilities where.

Pros:	Cons:
- Intimidating factor - if the robot is small, the robot is not so frightening	- The robot can not map all the element in the lounge
- The guests slave - there are a clear hierarchy	- Complications with interaction with high tables and standing people.
	- It have the possibility of not seeing the robot

Evaluation:

When doing these tests and the table there where lot of questions that where difficult to answer because it is for the technical point of view. How much does the components and technical devices fill? Is there any demands for the sensors or camera that need to be in a specific height to work.

Reflection:

To move forward in this direction a meeting with Karl is being organized.

Activity: Meeting with Karl

Worksheet no.: 45 Date: 14-04-2016 Responsible: MSJ

Objective:

This is notes from a recorded meeting with Karl.

Experiment/Data:

Place of all the components in the robot:
Power supply: the mechanics in the robot takes a lot of power, it is possible that the robot can contain power for 24 hours.
It is possible to split the printed circuit board until three parts and place them exactly where we want in the robot.
The motors is placed where they are now, and is about a handful in size, there is a motor pr each omni-wheel.
There are different ways to use omni-wheels but it is best if you place two omni-wheels together to have most efficiency. In a series production we possibly will produce our own omni-wheel but not now.
There are different opportunities for placing of gear box together with motors, but then we need to define motor power - That is something that Karl will work further on.
The electronic devices is not something that the team need to focus on, when designing the robot, because they are just something that fit in somewhere.
3 omni-wheels it the magic number of wheels, to many wheels is just make the robot more complex and expensive.

Where to place the omni-wheels on the ball:
The wheels need to be orthogonal with each other.
They can be placed on 45° on the ball to obtain the best orthogonal relationship.
What is the robot is tilting is the robot takes the ball with or falls down? - If the ball is heavy and the robot is lightweight Karl could dissemble that the robot lift the ball with and get it under the robot to stabilize the construction again.

The ball:
A ball of steel with a rubber coating will be a good choice, or a plastic ball with a steel ball inside to make the robot heavy.
Is it good/bad with a soft ball? it is possible with a soft ball, that will give a better flow in the movements of the robot, because of the different floors the robot can drive on and it will be easy for the robot to absorb roughness's in the floor. - Karl do not know how much it will do with a soft ball compared with a rubber coated ball.
The size of the ball depend on the wanted footprint of the robot, but Karl thing a basketball size is a good size as the team have delimited it to be.

Patent:
Karl have found a patent that maybe can be a problem for developing a robot with the ballbot principle, but it is not clear if the new robot is getting onder this patent or not.

Charging:
How is the charging possible, because it can not be a dock on the floor, because it is not possible to charge thought the ball?
The dock could be as the Double robot, where a person physical is on plucking the robot to charge. Now the Double robot is activating the legs when it needs power.
Karl thing it can be funny if robot can show/indicate when it needs power, e.g. by lean to a wall or something indicating that.
The team want the robot to drive by it selfs to the dock, so it not need to be a worker to do it.
If the robot should lean up against something the robot need a 3D camera to registrate that it is an object the robot can lean up against.
Karl wants that the robot haves different behavior, because it will make the robot more interesting - Part of it will be software but parts will also be hardware. - It could be that the software part is “relax mood” and then the robot is programmed for lean up against a wall. Thereby it is both a hardware and a software solution.

Practical for the rest of the project:
How far is Karl when we are finish with the project: not so far, because the ballbot principle is a difficult platform to get to work and get something to balance.
Karl has a vision that he want to have a 8. semester project in programming this robot to drive, but that will be in next spring and not something that we can use right now.
One of Karls students has programmed a ballbot robot, and he will find out if it is possible for us to use it for the exam.
The team will preferably have a function model of the ballbot principle to the exam so it not just be something working on principle level. It will be difficult for Karl to have a 100 % working model ready to the exam.

Price of the robot:
The Double robot have the price of aobut 50.000 DKK - Karl thinks that it is too much
The team thinks about 20.000 DKK
Karl says: if it is about 10.000 DKK the companies are buying without blink.

App-development
The team can give an estimate of how the interface of the robot should be, but they do not have the competences to have a clear interface. The team think that Karl should have someone else looking at that.
Karl think it is better to wait until he has a model working so it is possible for them to test the software.

The team shows sketches and moodboards:
The team shows the different concepts they have developed.
The main idea is to change the shell of the robot so it can fit into different contexts without it gets a huge investment for Karl. - Karl loves the idea.
Colorc-odes: Karl want to use color-codes to tell the user how the robot works and to indicate in which direction the robot is driving, so people can navigate arround the robot. Karl says that Red- light and green - light is known in Europe and can be used without misunderstanding, as the team is afraid of by using color lights.
Karl likes that the robot is organic in the expression and don’t look like lots of the other robots.
The team want to go away from the high-tech look a like and make them fit into the context they should be implemented into.
The robot need to be warm in the expression.

Programming:
Is there any front/back on the robot - yes because you need to define which motor is the front motor when programme.
There is not any physical on the ballbot principle that indicate that there is a front/back.

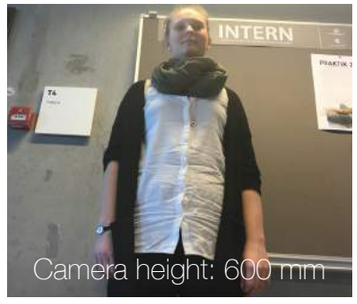
Activity: Bodystorming with Karl - Camera angle

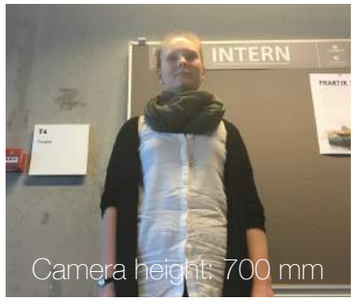
Worksheet no.: 46 Date: 14-04-2016 Responsible: MSJ

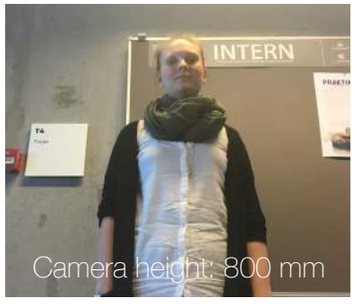
Objective:

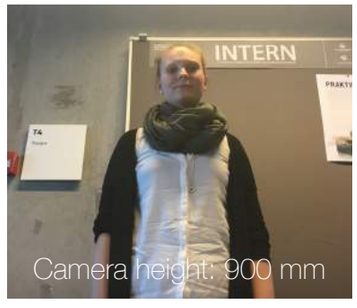
The intention is to understand the camera angle of the camera that define and recognize people. This experiment is made in collaboration with Karl, and the result will be a part of the demand fore the height of the robot. - The camera taking the pictures are angeled so it is possible to see the face at all heights.

Experiment/Data:









As higher up the camera is coming as more of the picture is the head, that is the part that the robot is going to identify. Thereby it will be a benefit for the robot if the camera is sitting height on the robot.

Evaluation:

The result gives that how more straight the camera is on the person it maps as better recognition it is a and that gives a better result for the robot. So to interact with a person sitting the camera should be sitting in 100 cm.
Thereby the placement of the camera should be as height as possible on the robot.

Activity: Milestone presentation II

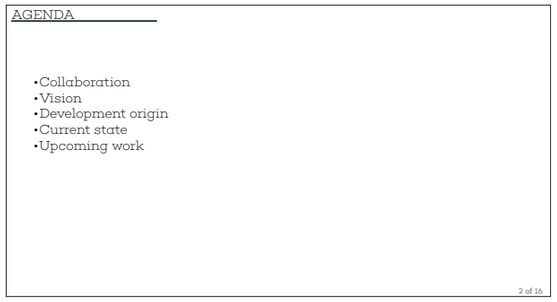
Worksheet no.: 47 Date: 18-04-2016 Responsible: NOD

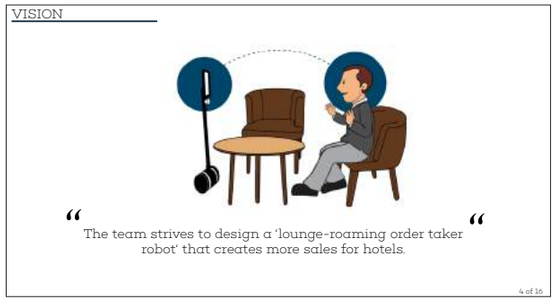
Objective:

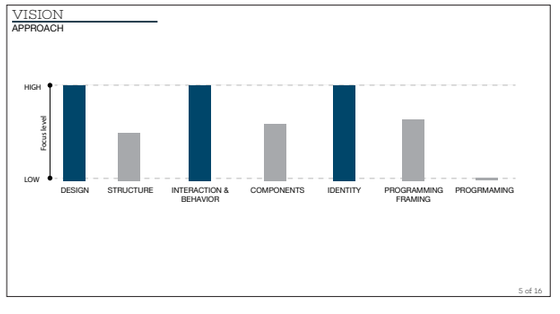
The objective was to present our project to get feedback.

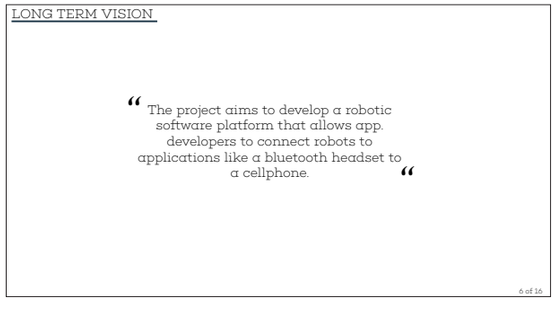
Experiment/Data:

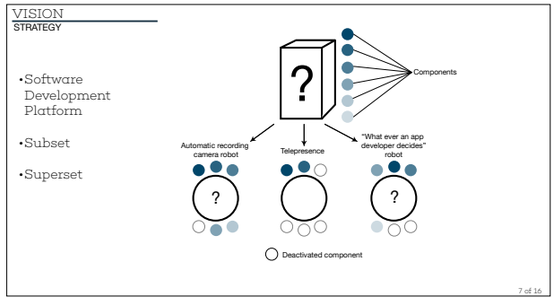
Presentation file “Status II.pdf”

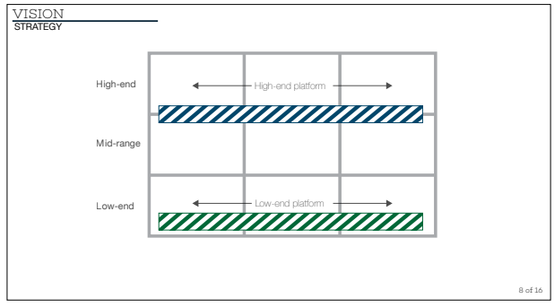


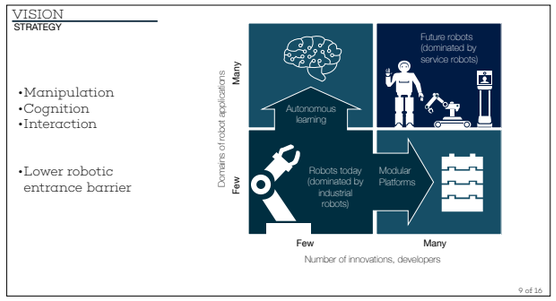


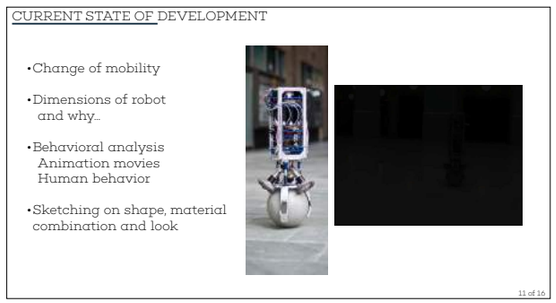


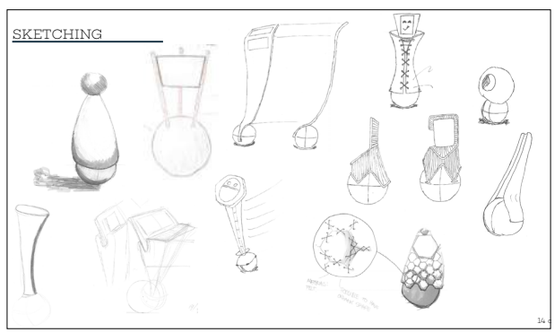












UPCOMING DEVELOPMENT

- Behavior
- Tests of interaction connection with tablet 'eye' - at hotel
- Work with overall Design
- Integrate navigational system in design

Feedback notes:

- Hard to understand what we're adding to the lounge area…
- Understand what it means to be a traveler, why not just a vending machine?
  I think we should tell a better story of what we intend the robot to be.
- We need criteria, what is the robot supposed to do on paper?
- Systematically trying to investigate
- We are looking for a skeleton to build upon
- It seems to be an overkill using a robot for this
  They keep wanting it to bring stuff or in other ways do more than what is possible.
- Align business, user and consumer perspective.

Evaluation:

The presentation didn't communicate our project properly. The supervisors had a very hard time understanding what we're trying to create and why. In addition to that we came across as missing the systematically approach to the project.

Reflection:

When reviewing the feedback it seems clear for the team that we have to be more clear in how we communicate this project, as it is quite complex in various aspects and works with an area that for many is unknown. Beside this there were some "truth" to some of the feedback, as we are lacking clear demands for the project, seen both various perspectives. This seems to be the essential element that disconnects the team efford in sketching and general detailing, as there are no clear demands to hold possibilities up towards

Activity: Testing centre of gravity at the double robot

Worksheet no.: 48 Date: 19-04-2016 Responsible: MSJ

Objective:

The intention with the test is to see how much weight it is possible to add to the robot for the robot to define a new centre of gravity. The test can also give an indication of how the robot is programmed to define the centre of gravity.

Experiment/Data:

The weight is being added in the front with the screen and wight is here ½ liters of bottles with water = ½ kg.

Evaluation:

The test shows that by adding weight to the robot it was not possible for the robot to find a new centre of gravity, by the robot could not stand still, and start moving. This indicate that the robot is programmed to have a fixed centre of gravity, and it can not be changed by adding weight.
This way of programming, is not the way we want to have for the robot, because it will limit our possibilities of use the robot for different things. It must be that the robot define a centre of gravity in collaboration with the added weight on the robot.

Activity: Defining the height by research part II

Worksheet no.: 49 Date: 26-04-2016 Responsible: MSJ

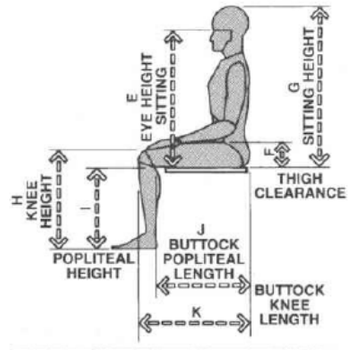
Objective:

The intention of this worksheet is to define the height of the robot from the side of the interaction with people sitting and standing. The measurement here is coming from the book Human Dimensions & Interior space, A book of design reference standards by Julius Panero and Martion Zelnik, page 215
There will be taken point of reference in the table that 5 indicate the minimum interval because it is 5 % of people having this height or lower and 95 tells that it is 95 % of all people having this height or lower.

Experiment/Data:

First it will be defined the height of the robot when having a conversation with a person sitting.

All the measurement is taking from the persons eye.
Eye height sitting



Woman:

Min: 69,5 cm + 37,8 cm = 107,3 cm
Max: 79,8 cm + 44,2 cm = 123,8 cm

Man:

Min: 76,4 cm + 40,4 cm = 116,8 cm
Max: 86,5 cm + 47,8 cm = 134,3 cm

Here is the maximum and minimum height of the robot looking in a persons eye when interacting with a person sitting in a chair.

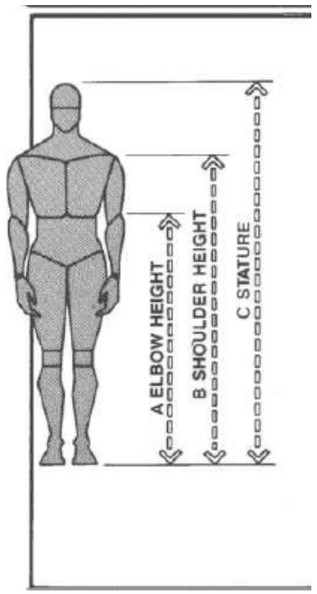
Adult Male and Female Projected 1985 Body Dimensions in Inches and Centimeters by Sex and Selected Percentiles

		Weight		A		B		C		D		E		F		G	
		lb	kg	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm
95	MEN	215.4	97.7	47.6	120.9	61.3	155.7	74.3	188.6	34.4	87.4	34.1	86.5	7.5	19.1	39.0	99.0
	WOMEN	165.1	74.9	42.8*	108.7	55.7	141.4	68.0	172.8	31.7	80.6	31.3	79.6	5.9	14.9	36.0	91.5
5	MEN	143.7	65.2	41.5	105.5	53.7	136.5	66.2	168.2	29.3	74.3	30.1	76.4	5.7	14.5	34.8	88.5
	WOMEN	104.5	47.4	38.0*	96.5	48.4	122.9	60.0	152.3	26.7	67.7	27.4	69.5	4.1	10.4	32.0	81.2

		H		I		J		K		L		M		N		O	
		in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm
95	MEN	23.7	60.3	18.8	47.8	21.7	55.1	25.7	65.4	20.8	52.9	11.7	29.7	27.4	69.6	16.6	42.2
	WOMEN	21.4*	54.3	17.4	44.2	20.7	52.7	24.4	62.0	18.4	46.8	10.7	27.1	24.8	63.1	16.4	41.6
5	MEN	20.5	52.1	15.9	40.4	18.3	46.4	22.2	56.4	17.5	44.4	8.3	21.0	23.9	60.6	13.5	34.4
	WOMEN	18.4*	46.7	14.9	37.8	17.2	43.7	21.0	53.3	15.2	38.6	7.6	19.2	21.3	54.2	13.9	35.4

Here the height of a person standing will be calculated to find the height of the eyes.

Eye height standing
The measurement in the table is for the height of the whole person, so first we need to calculate the differential from the height from the human and to the eye height.



Woman:

G - E = the size from the eyes to the top of the head.
Min: 91,5 cm - 79,6 cm = 11,9 cm
Max: 81,2 cm - 69,5 cm = 11,7 cm
Average: (11,9 cm + 11,7 cm) /2 = 11,8 cm

Man:

Min: 99,0 cm - 86, 5 cm = 12,5 cm
Max: 88,5 cm - 76,4 cm = 12,1 cm
Average: (12,5 cm + 12,1 cm) /2 = 12,3 cm

This can now be subtract from the standing height in the table C

Woman:

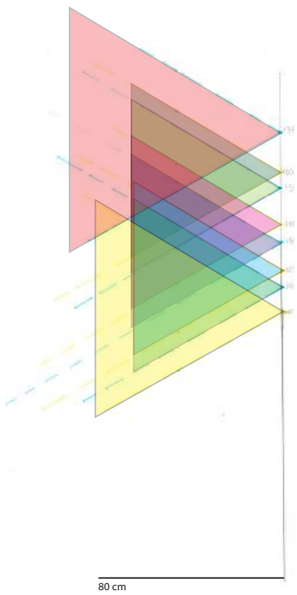
Min: 152,3 cm - 11,9 cm = 140,4 cm
Max: 172,3 cm - 11,7 cm = 160,6 cm

Man:

Min: 168,2 cm - 12,5 cm = 155,7 cm
Max: 188,6 cm - 12,1 cm = 176,5 cm

Here is the maximum and minimum height of the robot looking in a persons eye when interacting with a person standing.

The next step is to see the point of view for the sitting and standing person as the minimum height and the maximum height, to see if the there is any height as the robot can be, to full fit the different demands.
A humans point of view is 60 degrees and shown here. There will be an overlap with 80 cm away from the person, but then the robot is still 140 cm and that will be to intimidating. So to have interaction both with people standing and sitting the robot need to be adjustment in the height.



So to define the adjustment height there are these intervals

Sitting:
Woman:

Min: 69,5 cm + 37,8 cm = 107,3 cm
Max: 79,8 cm + 44,2 cm = 123,8 cm

Man:

Min: 76,4 cm + 40,4 cm = 116,8 cm
Max: 86,5 cm + 47,8 cm = 134,3 cm

Standing:
Woman:

Min: 152,3 cm - 11,9 cm = 140,4 cm
Max: 172,3 cm - 11,7 cm = 160,6 cm

Man:

Min: 168,2 cm - 12,5 cm = 155,7 cm
Max: 188,6 cm - 12,1 cm = 176,5 cm

That will give that the height of the robot in focus of the human dimensions is:

Minimum height: 107,3 cm
Maximum height: 176,5 cm

That will still indicate that the robot can be intimidating for the user, and thereby the team have defined a intimidating factor of 12 cm so the robot approximate is a head smallere than the person it is interacting with.
Then the dimensions will be:

Minimum height: 107,3 cm - 12 cm = 95,3 cm
Maximum height: 176,5 cm - 12 cm = 164,5 cm

Activity: Setting demand for screen quality for tablet

Worksheet no.: 50 Date:26-04-2016 Responsible: NOD

Objective:

The objective is to create awareness that if integrated tablet is for instance chosen, the team has set a demand for the quality of the specifications that the project has to fulfill.

Experiment/Data:

In this case the team has specific demand for the screen technology of the tablet, as some have problem with view angle, especially if you get into the lower end of the tablets produced.

Screen technology:

	Viewing angle
Retina:	• 179°
IPS:	• 169-179°
TFT LCD:	• 100-140°
AMOLED:	• 179°
TFT TN	• 55-95°

In most cases Retina or AMOLED (SUPER AMOLED) is used in high-end tablets, making it as optimal as it gets at this point with viewing angles.

Evaluation:

Most tablets fit the criteria the team has set.

Activity: Evaluation of an extra joint

Worksheet no.: 51 Date: 26-04-2016 Responsible: MSJ

Objective:

The discussion of adding an extra joint is here been evaluated.

Experiment/Data:

The team has at this point concluded that height adjustment and vertical rotation of head is most convenient. In continuation of having a fairly concrete structure of the product in terms of mechanisms, the team wanted to push the foundation of possibilities if reason for it could be identified. To do this the team took an extra joint into consideration, in the belief that the more flexible possibilities, the better. This extra joint was thought to be an independent mechanism, most likely what the team calls a torso joint, which allows torso like flexibility in one axis. The joint could also be an arm or other human like manipulation mechanisms, but the team have been very straight forward as to discard these type of mechanisms, as they are both complex, unsafe and creates an idea about extended possibilities from the users, which it cannot fulfill. The team had earlier worked with this, which made the team clear about which implication this extra joint could have, both mechanical, in terms of volume needed and the designs ability to adjust to the extra flexibility. With a combination of a lot of negative implications and few to no ideas on how to use the additional value in a way that could justify the constructional issues, the team discarded the idea and chose to keep it simple and ‘limited’.

Evaluation:

The team have now decided that an extra joint is not something that the robot need, because it is not create more value to the robot, and maybe create an understanding of that the robot can do more than it actual is capable of.

Activity: Finding identity

Worksheet no.: 52 Date: 26-04-2016 Responsible: NOD

Objective:

The team wanted to find and describe an identity that should be the aim for the project, so that objectives linked to the identity can be measured by holding it against what we're trying to create.

Experiment/Data:

The team had some expectations to the identity:

- Commonly known
- Able to create an atmosphere
- Fun about his/her movements
- Likable

The team approached this task by first and foremost talk about what type of characters that were interesting in behavior, but most of the characters that arised were based on animals, which the team found misleading. Just like the team analyzed animation movies on basis of their robotic origin, we wanted something like that to aim for, but the team also wanted a character that was well known, at least in characteristics, like mickey mouse, Donald duck etc. Somehow the conversation ended up bringing Charlie Chaplin up in mere fun, but a team member didn't see the fun, and realized that it actually would be an interesting way to go. The initial thoughts were that movies from that time and hes style was over exaggeration of behavior, and movies still had a touch of simplicity as it wasn't far developed, no sound and only about 16 fps, making fast movements "invisible". The team then chose to analyze Charlie Chaplin movies further to establish ground for an identity we wanted.

Two movies were analyzed (Police 1916 and The knockout 1914).

Movies from the early 20th century

- They are in a slow pace with over exaggerated behavior and mimics.
- Commonly recorded with 16 fps (min. of 24 fps is optimal)
- One that one person in the picture, there are only one movement when the other look at him.

Charlie Chaplin

- Whitty
- Cocky
- Clumsy
- Walks around random and provoking towards other people
- "the humour does not come from the Tramp bumping into a tree, but from his lifting his hat to the tree in apology" https://en.wikipedia.org/wiki/Charlie_Chaplin

Robot

- So it might be something about taking the Charlie Chaplin behavior to when the robot is "clumsy" (drives into stuff or people, or gets stuck)
- Trying to apply humour into the inevitable flaws of the robot and make that something that creates an identity and atmosphere.
- Try to make itself aware of the flaws, acting upon doing them.

- Hvis den kun skal gøre én ting af gangen, ville den i roaming delen skulle køre lidt - stop op roame - køre igen. Dette ville måske gå ind og påvirker menneskernes adfærd i lob-byen, og måske gøre den dummere i navigationen end egentlig er muligt programmering-smæssigt.

Definiton of identity

- Whitty
- Clumsy
- Random
- Apply humour to its own failures, point them out. Apologize to objects it hits etc.
- Make it look like it is not very observing, "living in its own buble".

Evaluation:

The team came a lot closer to something specific, resulting in a more clear vision and approach of the other angles in the project.

Reflection:

This should've been done way earlier, re-sulting in a more clear path and need for the things that has been tested.

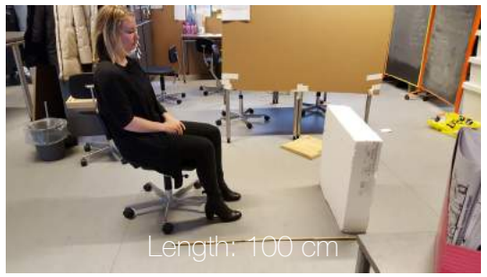
Activity: Distance from the robot to the consumer

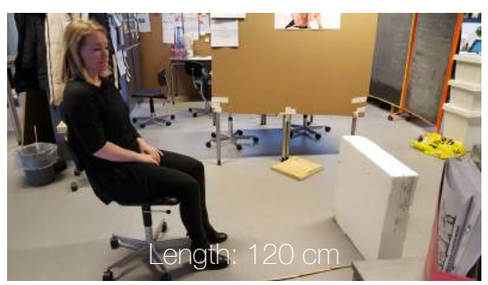
Worksheet no.: 53 Date: 27-04-2016 Responsible: MSJ

Objective:

The intention is to test out how close the robot should come to the consumer when interacting. This test is only accomplished fact and how it looks like how close the robot is coming to the consumer.

Experiment/Data:





Evaluation:

The test can be difficult to be valid on the result, because it is massive block using as robot, and that could be a wall and that gives a factor that an be difficult to interpret on. This test can only be valued from the picture and how it will looks like to interact with the robot. Here it will be between 60-80 cm that will be the best distance from the robot to the consumer, but it will be something that need to be tested with the real robot, and evaluate on the consumers feelings on the distance between them.

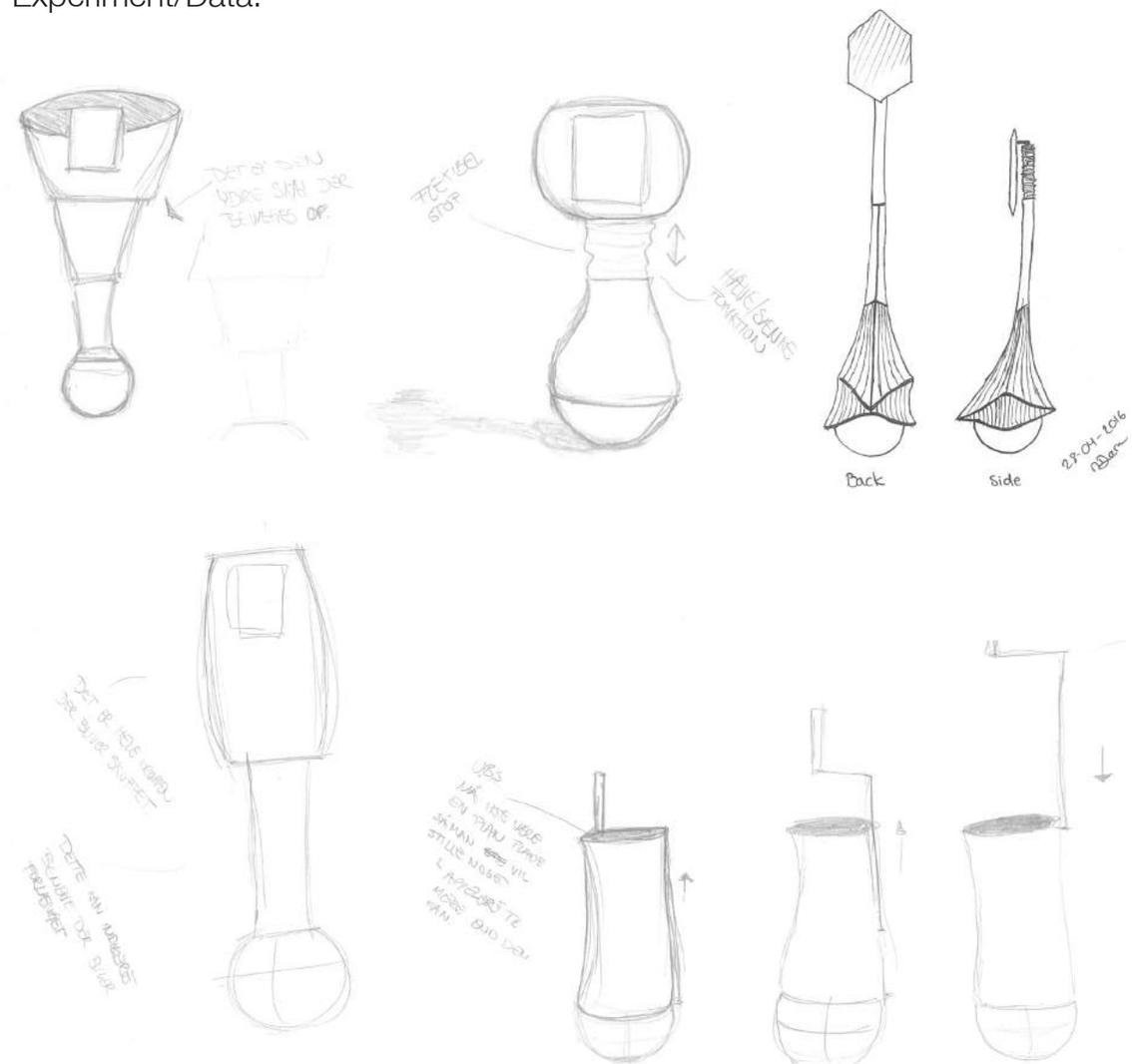
Activity: Height adjustment principle for the robot - sketch

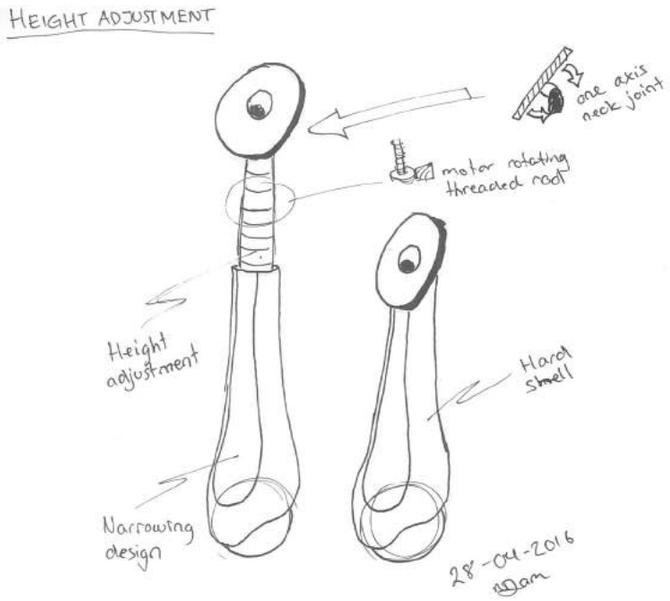
Worksheet no.: 54 Date: 28-04-2016 Responsible: MSJ

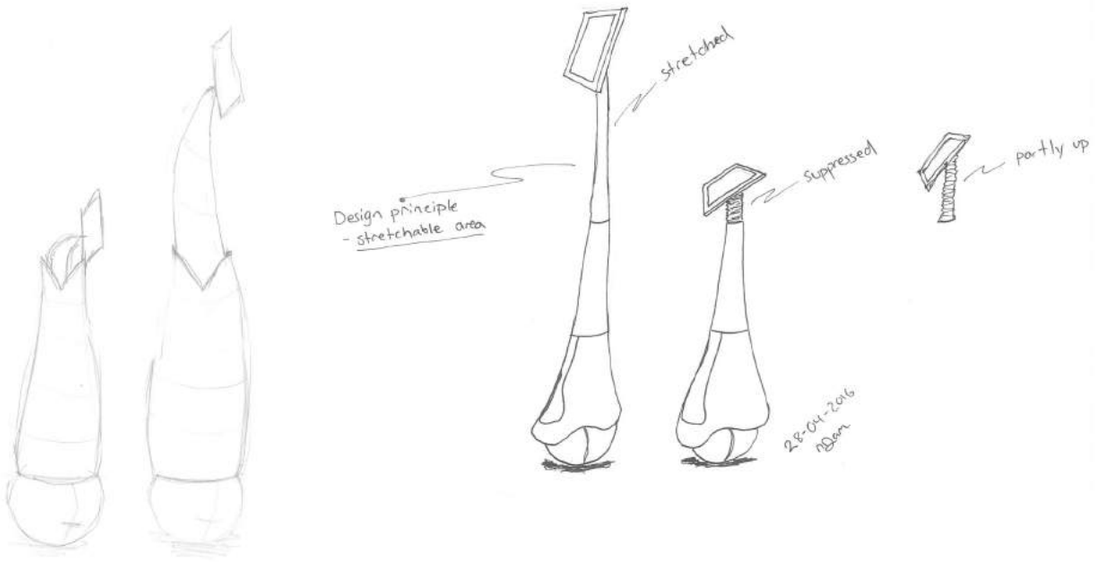
Objective:

The intention were to divide the sketches into categories, to be clear in the intention if the sketch phase. There it is the look and expression of the robot when changing levels of height.

Experiment/Data:







Different shapes are also been tested out in mock-ups to see how much of the shape it change when adjust the height.

The variation of the shapes gives different expressions, and the ideas about it, how the shape shall follow the adjustment and blot the bottom of the robot or shape staying under the adjustment and then blot or change the design under for adjusting op.
Part of the ideas for the materials is to cover part of the cover in flexible materials like fabrics and then stretch it for the height of the robot.

Evaluation:

There were lot of the solutions where the shape is slim in the top of the body shape to indicate the neck, and it is difficult to create a shape that works both as the low robot and the height robot.

Reflection:

To conclude which kind of shape the robot need in height adjustment principle different shapes need to be tested out i physical to see that it gives to the dominance of the robot.

Activity: Mock-up height of the robot compared with feelings.

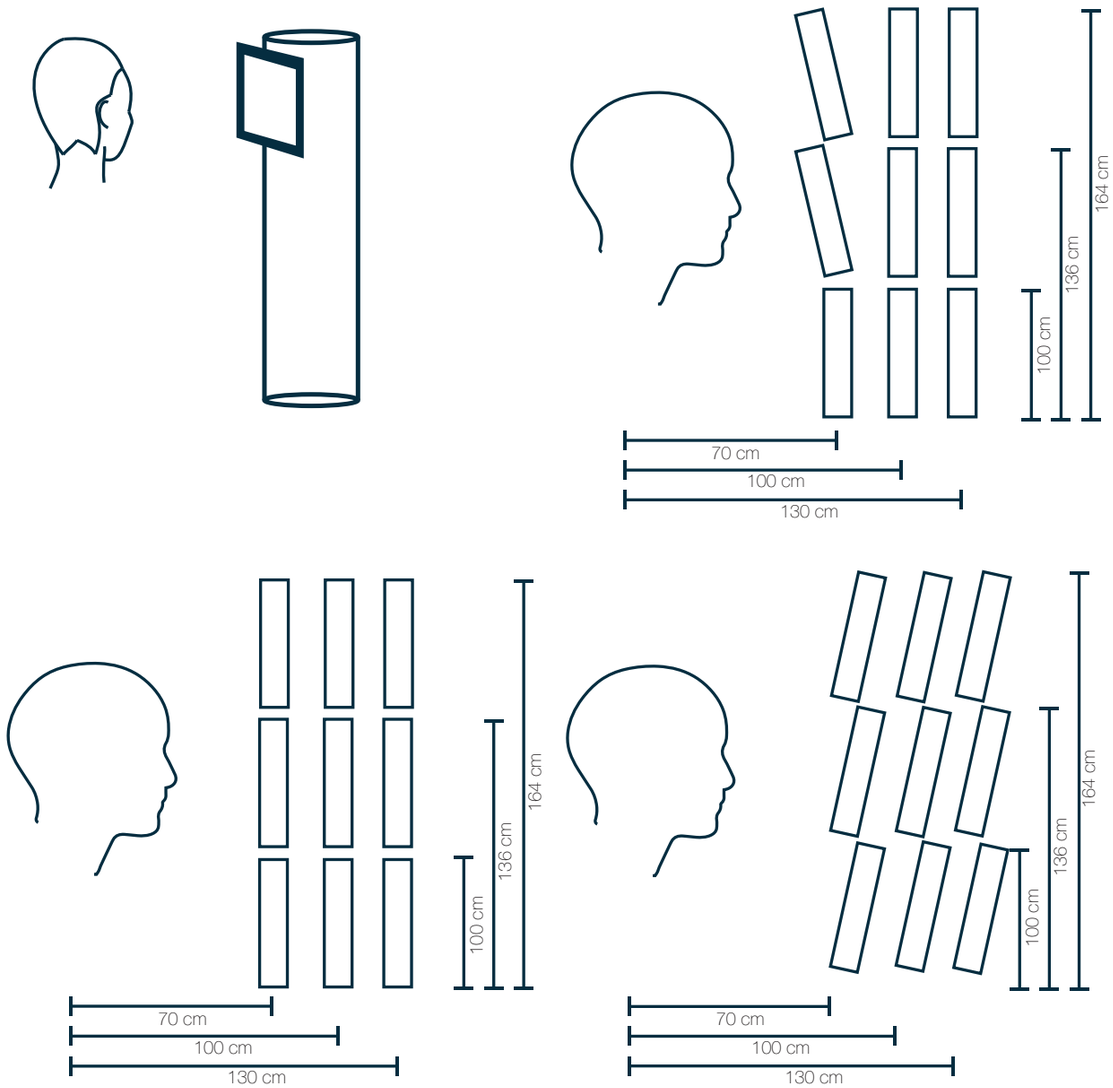
Worksheet no.: 55 Date: 29-04-2016 Responsible: MSJ

Objective:

The intention is to find define where the robot is to dominating and humble compared with changing the height of the robot. The robot world is still new for many people and thereby it is necessary to define where it is dominating, because it will not work if the consumer is afraid of the robot.

Experiment/Data:

The experiment is configured with these variants:



This height works, because the robot is lower than the person interact with, and thereby the robot is not dominating.

When the robot starting being higher than the person interact with, the robot starting being dominating. It can be because the robot fulfill the consumers point of view.

This angel of the screen is not working, because you are not use to tilt the screen that way. It feels like the text in the bottom of the screen is much far away than the top text. It have the tendency to flex the neck to see the screen and it is being under to robot, so it is possible to look up on the screen.

This height is dominating and the consumer need to look up at the robot, and change the angel of the head, so that height will not be appropriate for the consumers neck, and not something that we will design for.

By tilting the body of the robot, it is possible to get the screen in another angel, but the robot is being intimidating, and coming closer to the consumer than the measured distance.



Reflection:

The mock-op of the robot is a cylinder, and not the right shape of the robot, because the shape is first decided after this tests but it is the dimensions from the part of defining dimensions.
The mock-up is static and was standing still under the testing and thereby it is easy to understand the behavior of the robot, because it could not move.
The next phase of this test is to use the robot to see if it gives other results if the robot do not standing still and have motions.

Activity: Distance in verbal interaction when it is not possible to read off when talking.

Worksheet no.: 56 Date: 29-04-2016 Responsible: MSJ

Objective:

The distance was different when the robot was talking from not talking because it is more difficult to understand the verbal interaction when you do not have the possibility of read off the lips when talking, as humans do.

Experiment/Data:


Evaluation:

The test shows that it can be difficult to have the interaction with the robot, is the consumer not use the see sense when it is still a new phenomenon to interact with a robot. Thereby the team will work further with show part of the interaction on the screen, like the things that the consumer order.

Activity: Head principles for the robot - sketch + muck-ups

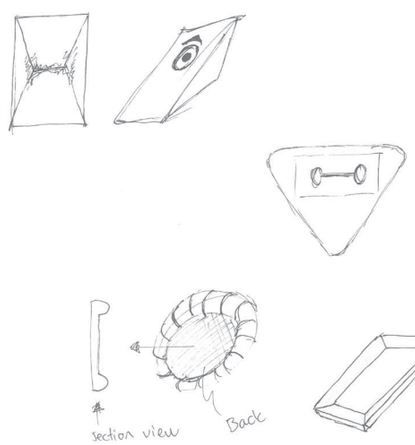
Worksheet no.: 57 Date: 02-05-2016 Responsible: MSJ

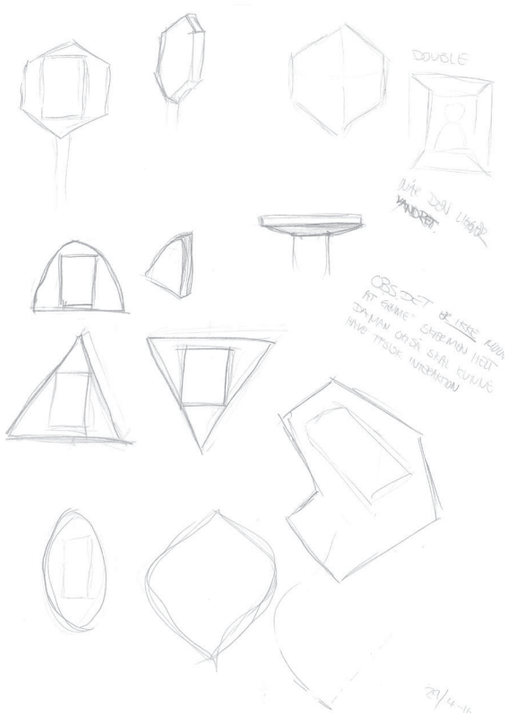
DEVit

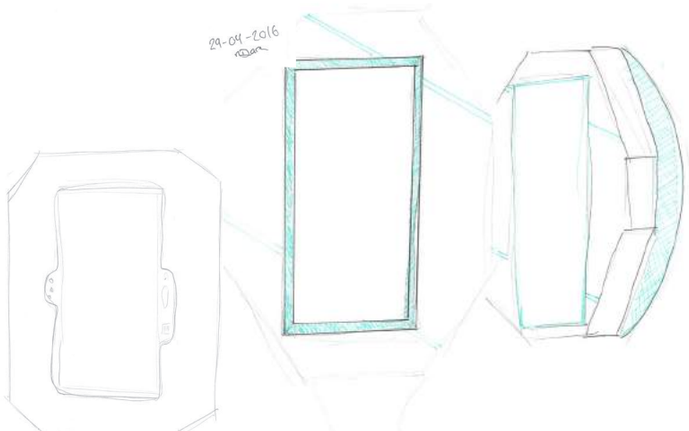
Objective:

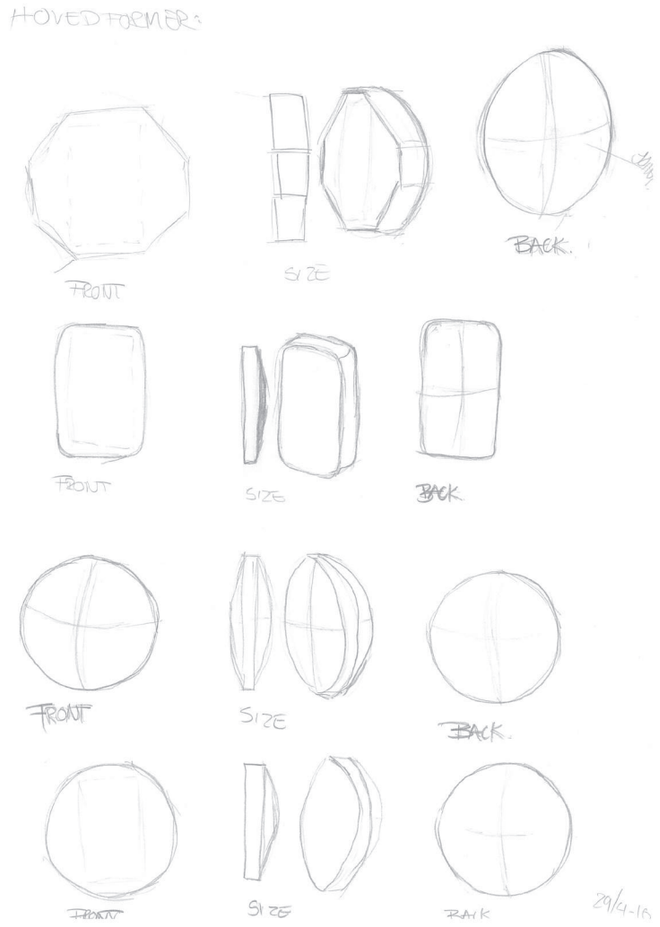
The intention is to sketch on the head, and which kind of shapes the head can be, after the sketching there have been created different models of shapes to test on the double to see how it can look like.

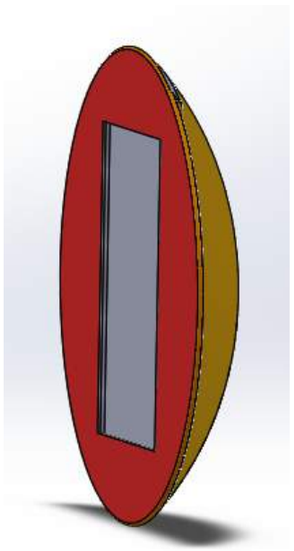
Experiment/Data:

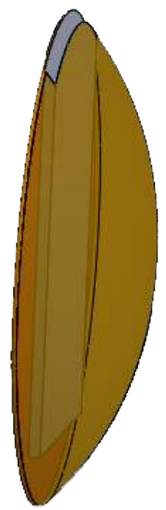












Evaluation:

Lot of the shapes can be used as placing the tab in, but it will be natural when the interface of the robot should be a head, to make it round, because when it fit to other places as well.
It will have a circular curve back where the neck joint is placed, then it will indicate the back of a head for a human and gives associations as the robot have a front and back.

Activity: How can the head also be used - joint's possibilities - mock-up

Worksheet no.: 58 Date: 02-05-2016 Responsible: MSJ

Objective:

By having a shape in cardboard and different shapes on the head, it was easy to play with different combinations of where the head should be placed, and what can be possible when having a neck joint.

Experiment/Data:

Evaluation:

This exercise gave that it is possible to lay down the screen and then it is possible to interact with the robot as more than one person and give a good position for physical interaction as standing.

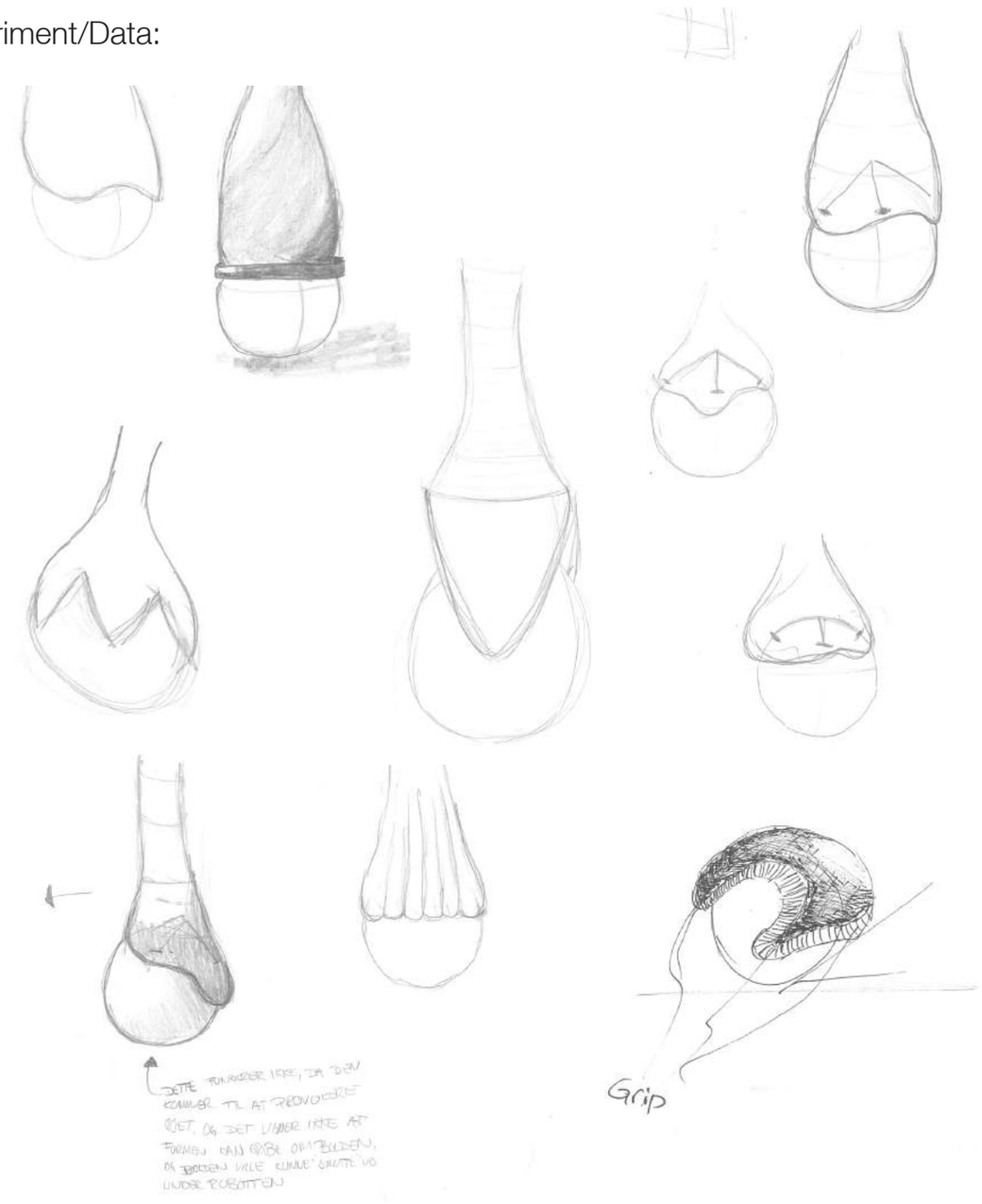
Activity: Ball - hiding omni-wheel principles for the robot - sketch

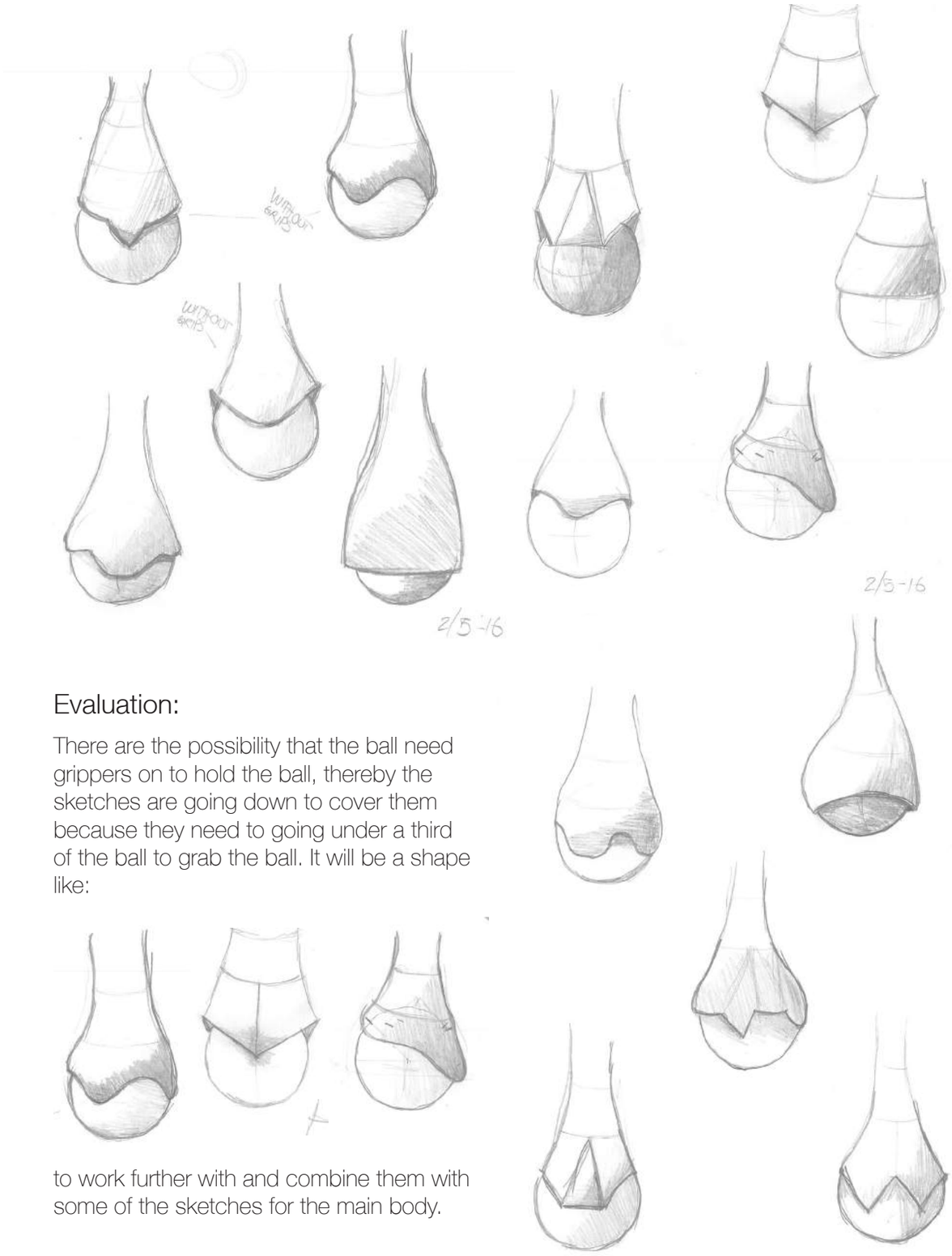
Worksheet no.: 59 Date: 02-05-2016 Responsible: MSJ

Objective:

Here the team have sketched on the principles of hiding the omni-wheels but still have the possibility to see the ball.

Experiment/Data:





Evaluation:

There are the possibility that the ball need grippers on to hold the ball, thereby the sketches are going down to cover them because they need to going under a third of the ball to grab the ball. It will be a shape like:

to work further with and combine them with some of the sketches for the main body.

Activity: Height of the robot dominating with the double robot - test

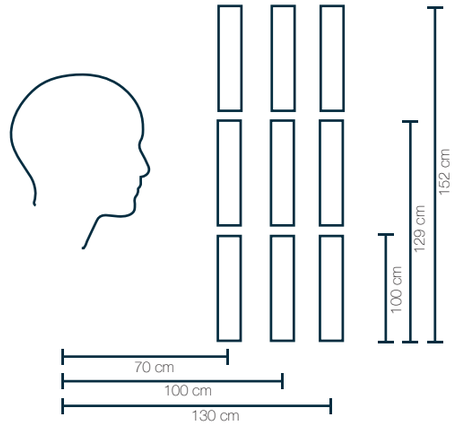
Worksheet no.: 60 Date: 02-05-2016 Responsible: MSJ

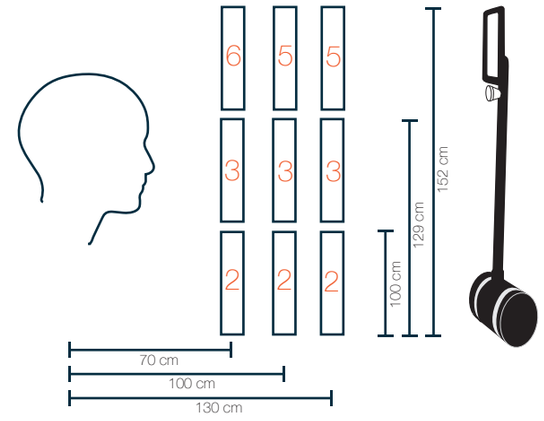
DEVit

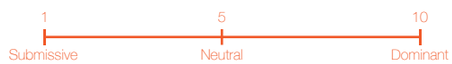
Objective:

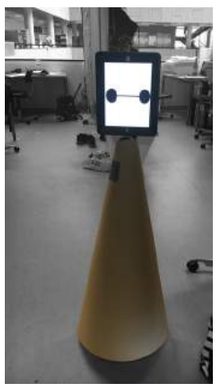
The intention with this test is to define where the robot is dominating with using the double robot, so we can implement the behavior of the robot, of not standing still but moving a little bit. The test is second edition from test worksheet 55

Experiment/Data:









Evaluation:

The test were created a few times with different shells to see if the robot is more or let dominating compared with the shape of robot.
It showed that the double robot in it selves is not dominating because it is possible to look around the robot when interacting.
It is more difficult when different shells were placed on the robot, and that made them more dominating. This is a element that will be used in the design.
Another parameter that was observed was the thing that is shown on the screen, if the eyes are cute the robot is less dominating. The test persons were creating personality from the eyes and not from the shape of the robot. That indicate that it is easy to change the personality of the robot by changing what's on the screen

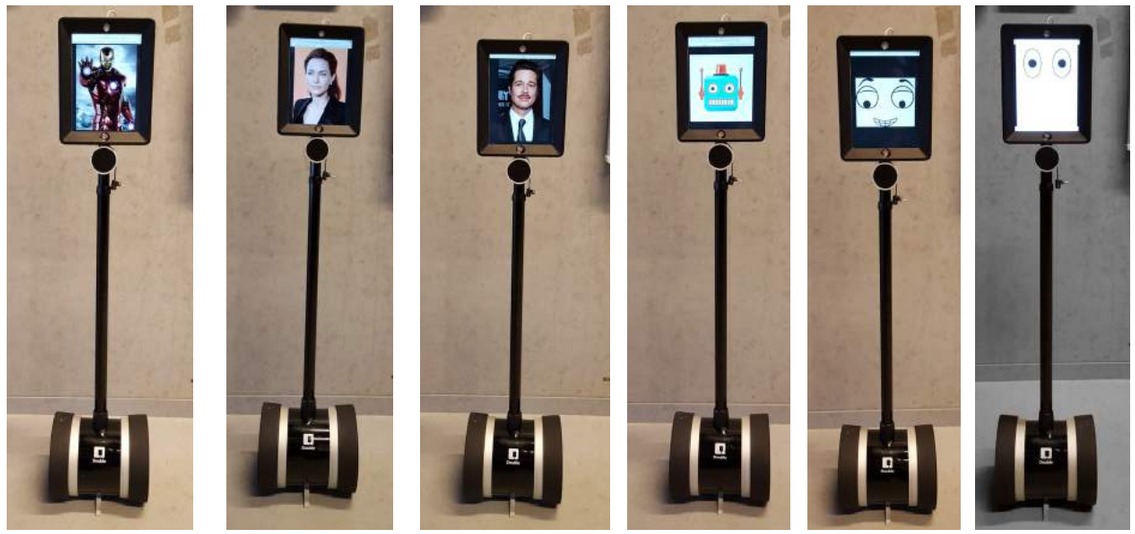
Activity: Testing of eye development in animation

Worksheet no.: 61 Date: 03-05-2016 Responsible: MSJ

Objective:

Here it been tested out which kind of identity the Double robot is getting when changing the picture of the screen. The intention with this test is to see how much there should be developed on the interface of the screen to create a identity and to change it, when implement the robot in other contexts.

Experiment/Data:



Evaluation:

The test shows that the robot gets an identity when it is an imaginary face showing on the screen. The test persons can not relate to the robot when it is a human being on the screen, because they do know that it is not the real person standing in front of them.
The tests showed that it was not necessary to have a whole face on the screen for the test persons to relate to the robot, but a couple of eyes is enough for the robot to have an identity and call it a he or she.
The team will now work further with design a imaginary couple of eyes to the robot to have create an identity.

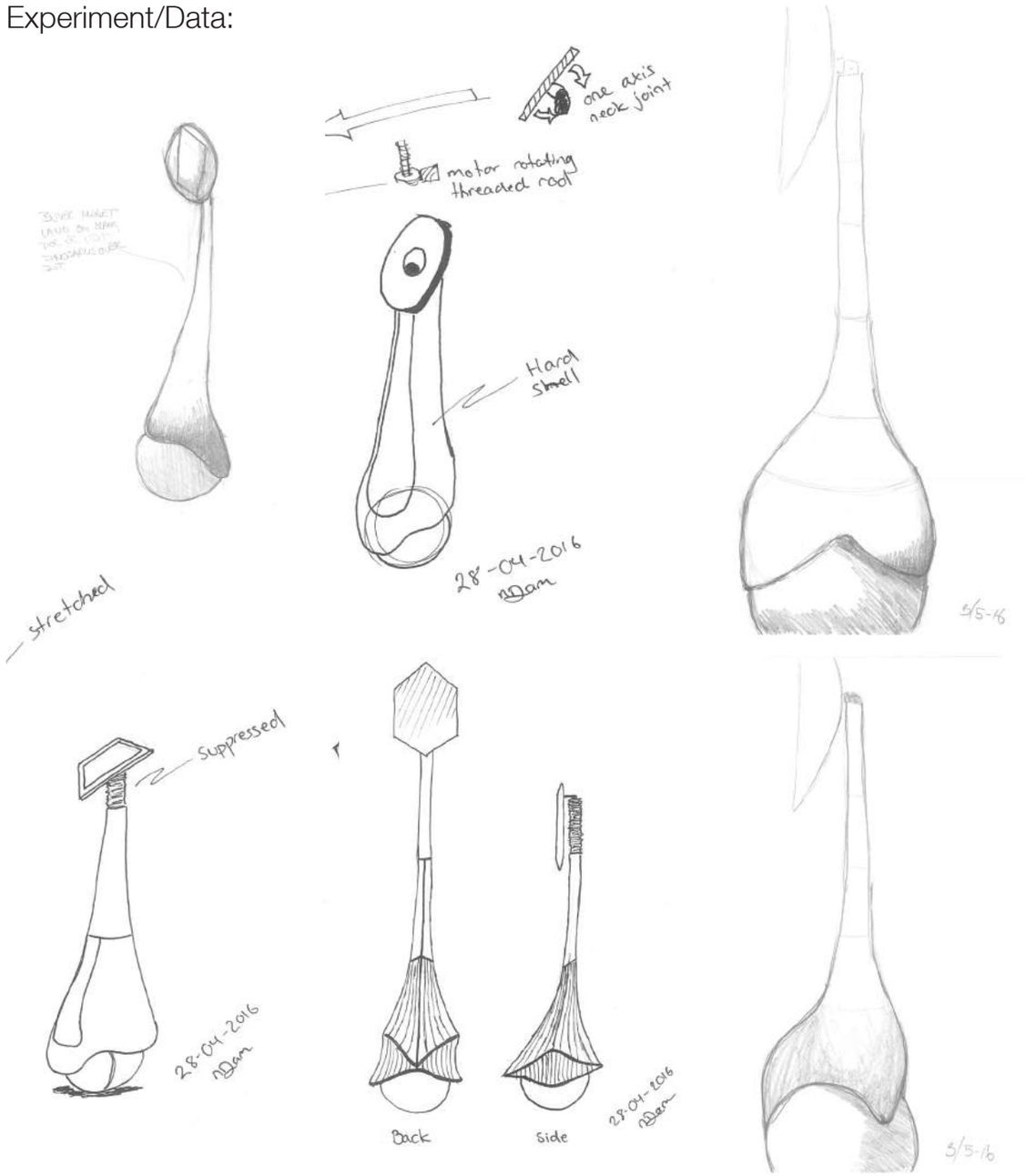
Activity: Body shape principles for the robot - sketch

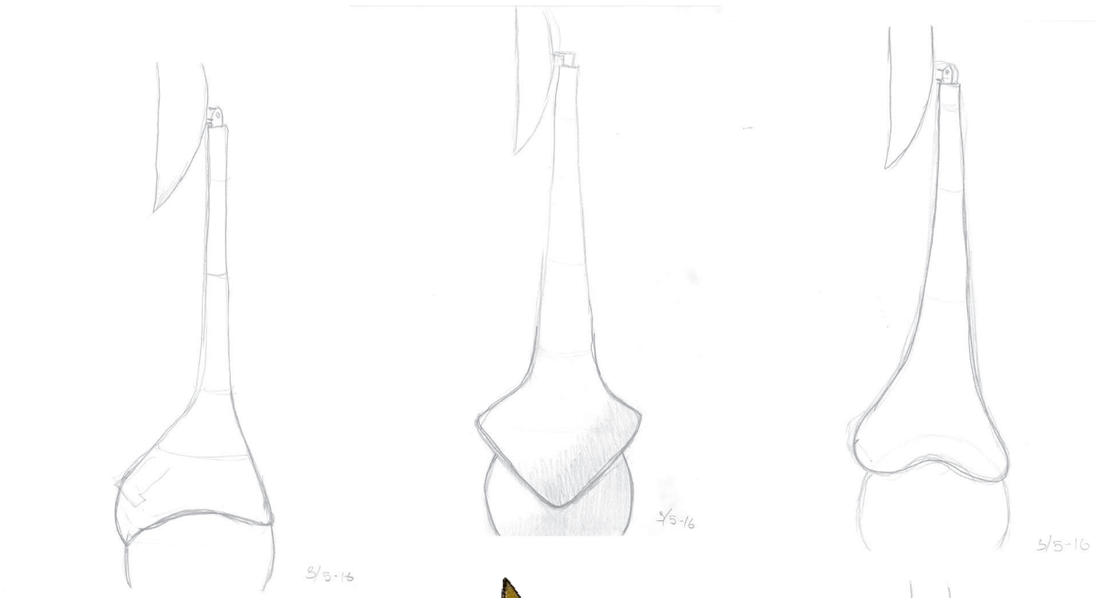
Worksheet no.: 62 Date: 03-05-2016 Responsible: MSJ

Objective:

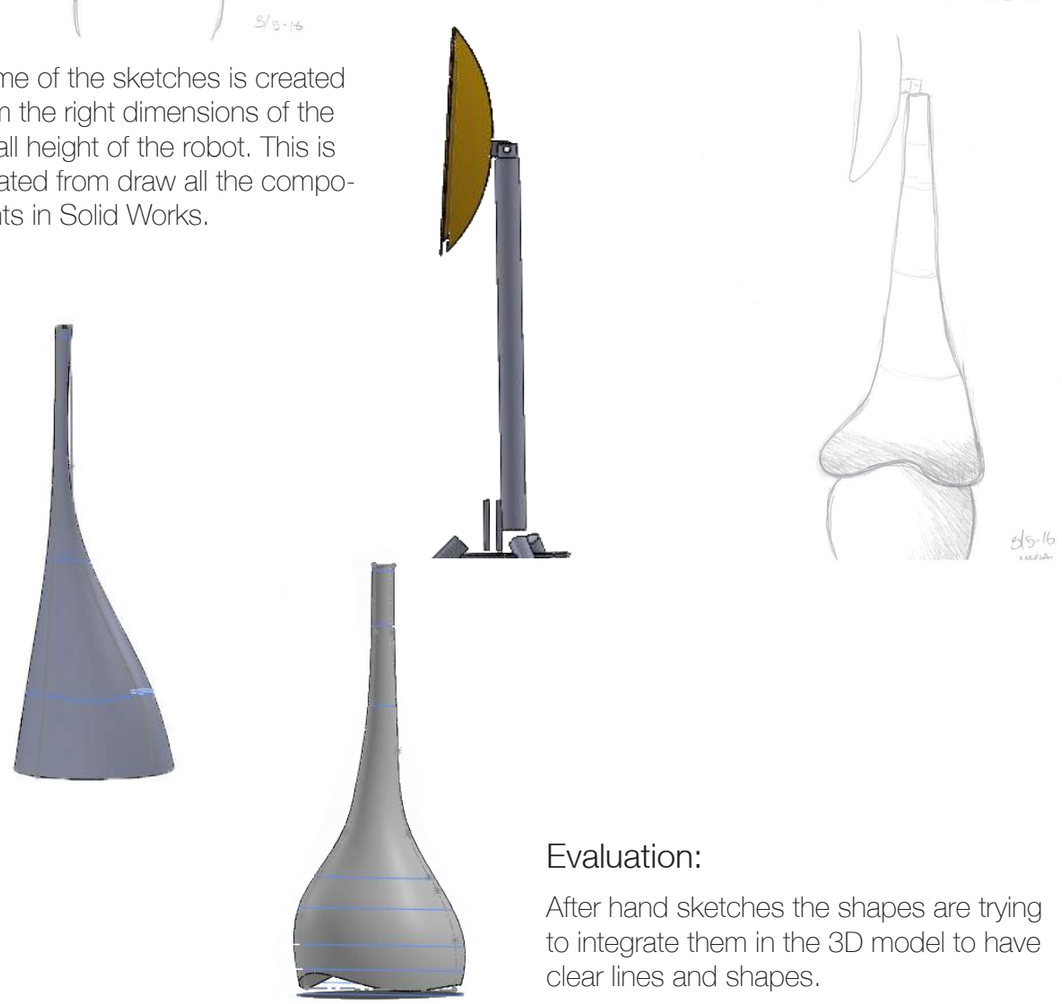
The intention for this worksheet is to show the development of body shapes for the robot. This will be sketch phase of the development.

Experiment/Data:





Some of the sketches is created from the right dimensions of the small height of the robot. This is created from draw all the components in Solid Works.



Evaluation:

After hand sketches the shapes are trying to integrate them in the 3D model to have clear lines and shapes.

Activity: Meeting with Karl and Kuno

Worksheet no.: 63 Date: 03-05-2016 Responsible: NOD

Objective:

The team arranged a meeting to present current position in the project. In relation to Kuno, the team wanted to get feedback on choices regardig to behavior, interaction and design, hopefully giving the team an idea on whether we're on the right track.

Experiment/Data:

- Both Karl and Kuno like the addition of having a possibility of making the screen horizontal for other purposes.
- The idea of having an invisible interaction surface through rubber etc on the face was thought to be interesting.
- Kuno believes that connection between robot and reception should be through a dedicated thing. Tablet etc.
- Kuno stresses that the view of the customer in this context is always the right one.
- Kuno is reliefed about the design, as he had expected that the deisgn maybe could've been to industrial or off in other ways.
- Kuno likes that there is a focus on making the tablet integrated enough so that it isn't decodable.
- Karl adds to this that in some cases, being able to identify that it is a tablet, can add value in the sense that people know about the modularity aspect
- Kuno response to the price around 10.000 was quite unspecific, as he wouldn't directly say yes, as the final application and value for the robot isn't fully defined yet.
- The hotel has been sold to Scandic
- Kuno is hinting towards having material so that when Scandic asks about what stuff is going on, he can put this on the table in some manner.
- Karl would like to establish a firm when a prototype has been made, and adds that if we haven't found a super interesting job at that point, there would be something there.
- Given that the project ends out where it seems to be heading currently, Kuno can see potential in spreading to more hotels than just this one.
- Kuno sees more and more ideas for every meeting we have.
- It is important for Kuno that the things around the main function also works and is thought to end, how to act around other people etc.
- Kuno says that robots are being integrated in the school, his wife is working at Frederikshavn municipality, making them learn about robots from scratch, which will make them more used to them.
- There is always going to be an outdated generation, this time it is just going to be robots instead of computers.

- KUNO LEAVES THE MEETING

- The placement of the omni wheels are pretty free, but some rules has to apply for the principle to work, for instance may two wheels not have parallel force appliance to the ball.

- It is possible to arrange the omni wheels in such a way that more force can be applied for forward acceleration, than for backwards.
- Karl said he expects to work on developing it during autumn.
- Karl would like to have as thought through elements on the shell and head.
- Its best to place the motor for the neck joint in the head, so it is only wires that has to be in the tubes.
- It is probably not even worth thinking about using a dedicated display if it doesn't have a very specific and demanding purpose.
- He says that app developers know that creating for companies is where you make steady money, and not through micro payments
- Charging could be done with wireless in dynamic integration, but for development would cable be best because of downtime, **maybe other contexts would require longer up-time, so that wireless charging isn't fast enough.**
- It would be fun just to place a beer on top and make it able to balance it.
- Should it be able to park for the horizontal interaction or?
- A resistance mode is possible, there just has to be a good balance as to how much it will resist, because when the pressure stops, it'll just move fast.
- Maybe charging should be on the back, so that it would always lean its back on the charger/wall for charging.
- Maybe the charging could be integrated in some kind of ornament, button, stitches etc. and use these integrated in the design to break the, in some cases, quite big evenly colored material.
- Using Scandic as an enabler for the project, getting them as an investor in a way.
- Karl uses example of Denmark buying 30 air jets, where as the US. buys 2500
- Museum robots are already used, so it seems to be a viable path as well.
- Karl also sees the project trying to reach people in need, but later in the process, as they aren't economically strong enough to support the start of the product, but can receive the positive effects of them being more and more common.
- We're still in the very beginning of doing robots, for instance if you look at cars, there are many many types.
- It is not impossible to run into some patent stuff
- Suspensions of the wheels to the skeleton could be a technical dive.
- Maybe use thrust bearings on the omni wheels to take hits from the ball to the skeleton.
- Rezero uses suspensions in the skeleton, don't know why, probably a reason for it. (Double doesn't use it so?)

Evaluation:

The meeting went great in regard of validation of current path from Kuno and Karl, and the result was merely to keep working and take it as far as possible before project finish. The team discussed various technical aspects after the essential part of the meeting with Kuno, resulting in an alignment with him and some ideas on how to realize some of the aspects. All in all the team wound up being beyond satisfied with the overall opinions about the project.

Activity: When do you have eye contact consumer - robot - Test

Worksheet no.: 64 Date: 03-05-2016 Responsible: MSJ

Objective:

The intention with this test is to define in which angel it is possible for the consumer to feel that he/she have eye contact with the robot.

Experiment/Data:

The set up for the test:
The robot is placed 70 cm from the test-person and then the robot is rotated 2° for each evaluation of having the illusion of having eye contact with the robot.

Result:
Test person 1:
To the left side of the person the robot could rotate 3° before she felt that there was not eye contact with the robot.
To the right side is was 5°

Test person 2:	Test person 3:	Test person 4:
Left side: 5°	Left side: 3°	Left side: 4°
Right side: 7°	Right side: 5°	Right side: 8°

Evaluation:

The test show that the robot need to place very precise in front of the person the robot interact with for the consumer gets the feeling that they have a conversation.
There is a variation in the angel from left side to right side, that can be caused by the reflection in the screen from the window in the background.
The robot should not diverge from the front of the person with more than 3° - that is a requirement to Karl and the programming of the robot.

Activity: Pre-phase of interaction with the robot - test with double

Worksheet no.: 65 Date: 03-05-2016 Responsible: MSJ

Objective:

The intention with these test is to see how the pre-phase of interaction can be. The enter of the robot and how the robot indicate that he has seen you and is driving over to you.

Experiment/Data:

The set up for the test:

Step 1
The robot is roaming in the lounge.

Step 2
The robot observe that there is a person, and start driving to the person. It is the intention that the robot and the person should have eye contact - so that the person know that the robot have seen him.
In the this test there are 3 meters angeled from the person.

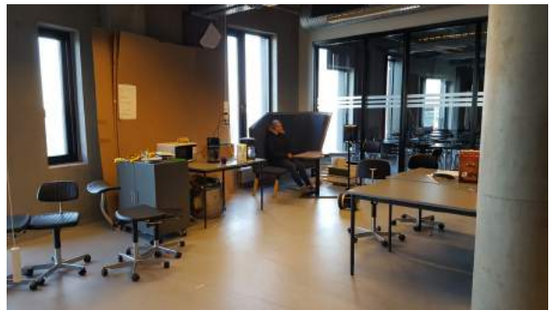
Step 3
The robot start driving to the consumer.

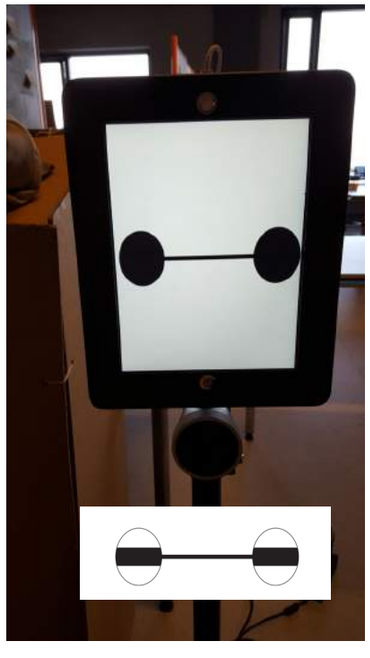
Step 4
The robot drive, but it is not possible for the robot to take a direct way from observe the consumer to be with the consumer ready to take an order.

Step 5
When the robot is out for the consumer the robot is turning the body and head so it is in front of the user.

Step 6
The robot is now placing in the right position for the conversation.

Pictures from the tests:





This was the interface on the robot. It is an animation of Bey-max from Big-Hero-6 movie's eyes that is recreate to give the robot a personality.

Results:
Test person 1:
“I did not feel that I had eye contact all the time”
“At step 3-5 it felt like the robot had forgot me”

Test person 2:
“The robot broke of for the contact when starting driving.”
“Direct physical orientation to the user maintain the contact between the robot and user.”

Test person 3:
“There was not any contact before the robot was right in front of me.”
“It felt like the robot was on the way to be, but it was not clear.”
“No eye contact”

Test person 4:
“The eye contact was maintained”
“The robot was driving direct enough till I understood that the robot was on it’s way to me”

Evaluation:

The robot should look and indicate of eye contact with the consumer in step 2, if that is not happening it is not clear that the robot is on the way to the consumer and the robot have seen the consumer. It can fail if the consumer does not see the robot because of looking another way or it can happen if the robot is looking a little bit away from the consumer, and that not give the indication of eye contact.

The robot need to indicate contact with the consumer the whole time driving to the consumer, else the consumer can get the intention that the robot have forgot the consumer and drive by [Step 5] the consumer before getting to the consumer and rebuild the connection. - This need to be collaborated with the behavior of the robot, because it should either be like the robot is stares at the consumer in a creepy way or lose the contact between the robot and the consumer.

The eyes for testing got the responds that the robot was cute and that created a personality that it was okay that the robot did not dive the direct way to the person, and not having contact with the person the whole way. That tells that the eyes and interface on the screen are doing a lot for the behavior and what the consumer think is okay for the robot. Therefore it will be in the part of developing of the software to focus on the expression of the robot as person compared with what’s on the screen.

Activity: Pre-phase of interaction with the robot - act it out

Worksheet no.: 66 Date: 03-05-2016 Responsible: MSJ

DEVit©

Objective:

The intention with this test is to develop on the previous test, what if the robot having eye contact the whole time, where it is the head moving and the body have the same direction of movements as previous test. This is created as a act-it-out test just to get an overall perception what it will change if this kind of behavior is being used.

Experiment/Data:

Results:
Test person 1:
“It was clammy and creepy”

Test person 2:
“It feels like the robot is watching me the whole time, without indicate that it is me it is trying to interact with.”

Test person 3:
“Its getting creepy and not feeling warm and welcoming.”

Evaluation:

When the eye contact is getting overacting its getting creepy.
Lot of the robots behavior can easily be overacting and making it easier to read and understand as the consumer, but here is not one of the places. Lot of the creepiness is in the expression that the robot have in the software/ the eyes. That need to be tested more what different eyes are telling and what they are relate to, that give the whole robot an identity and personality.
That need to be tested in the different contexts that the robot in the first place should be integrated in.

Activity: Testing how to end interaction

Worksheet no.: 67 Date: 04-05-2016 Responsible: NOD

Objective:

The objective was to determine which way of physical movement is the most pleasing for people when the robot has to disconnect the interaction.

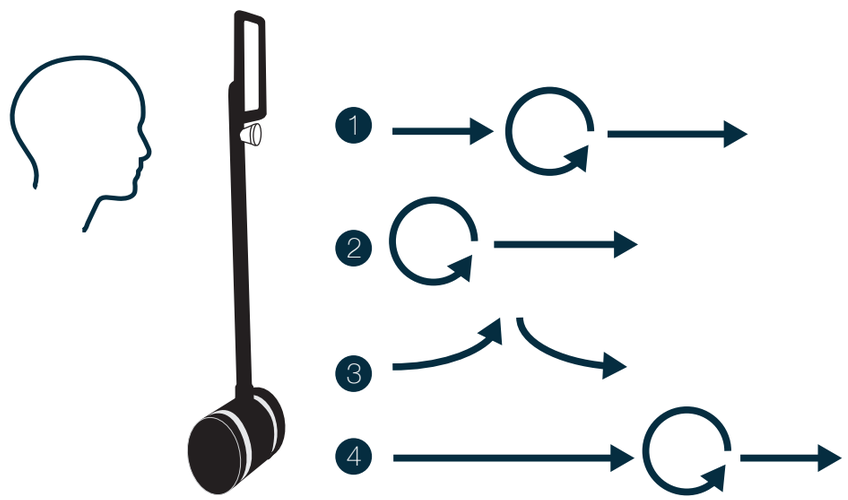
Experiment/Data:

For the experiment we used the Double as a representative of the final robot. In addition to the physical mobility we added an animation of Baymax eyes to add an illusion of a 'soul' that would have somewhat the values we're searching for in the facial area.

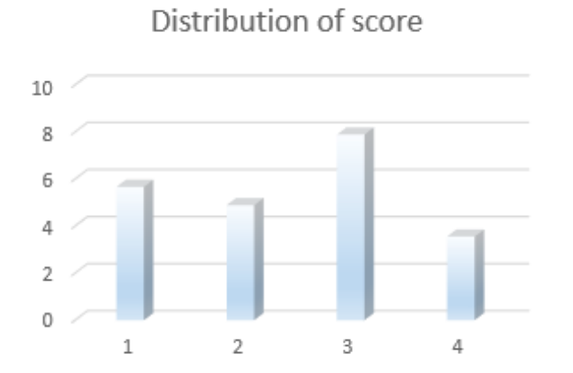
The illustration under shows the four different ways the end interaction could be, and it is them the team have been tested.The test persons then needed to fill out the form when test the four different scenarios. These four scenarios is roughly shown on the same picture, for instance showing how the first will back up a bit, then rotate 180 degrees and the go straight ahead.

The respondents were told to rate each one 1-10 (1 being bad and 10 good) individually or all at last, putting keywords and comments on the sheet if they wanted to.

The test was done with a table between because the team sees high possibility of some kind of furniture being between the robot and the person.



	1	2	3	4
Jane	5	2	7	3
Niels	6	3	9	1
Madelina	7	7	9	6
Anders	7	9	3	1
Nakita	6	5	9	4
Mathias	4	2	8	3
Mads P.	3	3	8	7
Nikolaj	7	4	9	3
Torben	6	9	9	4
	5,666667	4,888889	7,888889	3,555556



Person no.	Comments:
1	It is going very slow
2	4: starring a lot 1: long time before turn
3	Very slow
4	3: looks like its about to do something for you
5	1: slow 2: lacks space 3: wuhu stable 4: creepy because of speed.
6	1+4: creepy 4: slow 3: very robot like in the good way " yes, order taken, cu!"
7	1+2: Seems as if it is rejecting you 3: Has a better flow, seems more like a normal way of stopping an interaction 4: Seems a little creepy in the start, but gets better at distance.
8	3: Seems quite natural 4: Unnecessarily long
9	4: Unnatural - generally all too slow

The values that the test persons was giving the four different scenarios, is here places in a table, and the average is calculated.
The table under shows the distribution of the score on the scenarios. Here is shows that it is scenario 3 there have the best success.
The test persons were saying that it was most natural and dynamic in its motion.
Aside from getting a direction for the best way, the feedback on the other also indicated what could be a problem, things like too hard eye contact in ways that are considered creepy, or that if you turn too quickly it may seem as if it is rejecting the person it just interacted with.

The general commons to the test can be seen under in the table.

Evaluation:

The team received answers roughly as expected, but hadn't realized how high the speed factor actually had on the person, as it seemed to distort some motions because they became so lengthy.

Reflection:

The test has many flaws, that only makes it a help in choice of orientation of the direction for this movement, as final form and behavior and possible mimic, can change the view on this quite much.

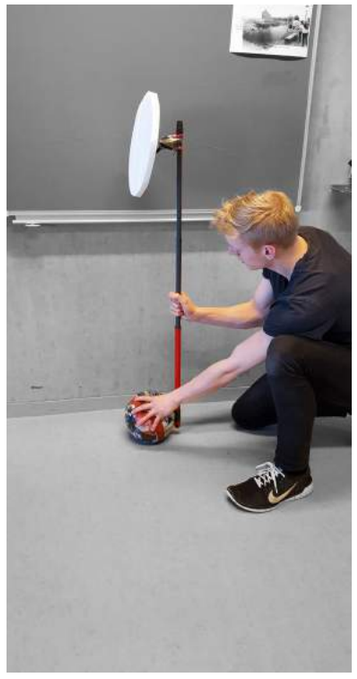
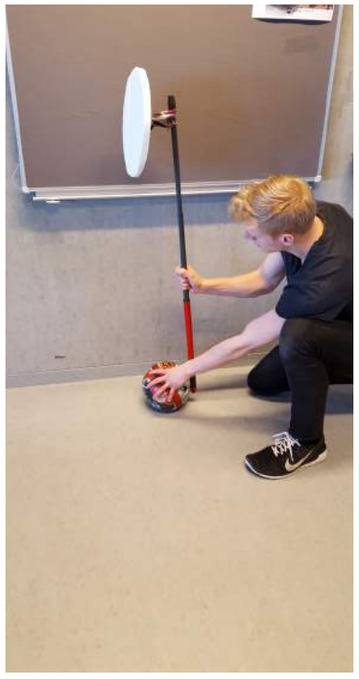
Activity: Position of the adjustable height pole - mock-up

Worksheet no.: 68 Date: 04-05-2016 Responsible: MSJ

Objective:

The intention here is to physical see how it will look like if the adjustable height pole is placed on the size of the ball. When placing the pole on the size of the ball, gives the possibility of raising the height as observed earlier in the process.

Experiment/Data:

Evaluation:

It is possible to place the pole on the side of the ball without doing anything. When the robot adjust the height it need to calculate a new gravity and lean back.

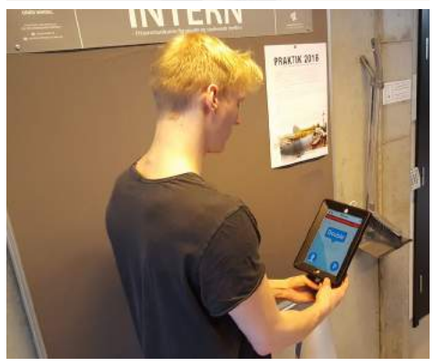
Activity: Robot height for a standing person - test

Worksheet no.: 69 Date: 04-05-2016 Responsible: MSJ

Objective:

By adding the components needed for the robot, the pole for the adjustable height can not be long enough as the requirements 100 cm to 164 cm. With the composition right now the height of the robot can max be 140 cm. After the height requirements it have been defined that the robot need a joint in the neck and that gives a flexibility of adjust the angel of the screen and that gives other possibilities of angels seeing the screen as for the consumer. Here the intention is to test if the height of 140 cm is acceptable for a standing person when it is possible to adjust the screen angel.

Experiment/Data:



Evaluation:

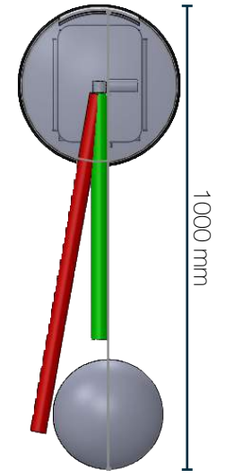
The possibility of adjust the angel of the screen, made it feeling okay to interact with the robot from a height of 140 cm.
There is a parameters showing on the pictures that it is not ergonomic right for the neck to stand like this, but in these pictures the robot is placed to close to the person compared with other tests showing that the robot should be 70 cm away from the person interacting with.
The construction can now be as the robot only need a adjustable height from 100 cm to 140 cm.

Activity: Measurement of the adjustment height pole

Worksheet no.: 70 Date: 04-05-2016 Responsible: MSJ

Objective:

The measurement of the which of the two possible ways to place the height is made by calculations to see the differences between the two principles.
The principles is the green tube places on the top of the ball with a threaded rod to adjust the height, the size of the green tube is 540 mm. The red tube is placed inclined on the side of the ball that can give extra height because the pole can be longer and thereby the threaded rod can be longer. The size of the red tube is 750 mm.
To have tolerances and possibility of assembly the constructions it will be calculated that the threaded rod can raise a height that is 50 mm smaller than the start tube.
The measurement is not completely precise but it indicate what the intention with it is, and which kind of possibilities there are with the different ways of having the adjustable heights.



Experiment/Data:

Head size: 353 mm
Ball size: 240 mm

First the team will calculate for the maximum height for the green tube.

The green tube size: 540 mm
The threaded rod size: 490 mm

The height for the, together is:
540 mm + 490 mm = 1030 mm

To have the whole height of the robot a half head is added and the height of the ball:
1030 mm + (353mm/2) + 240 mm = 1446 mm

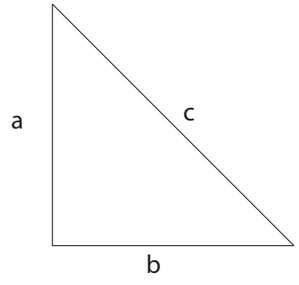
1446 mm is then the maximum height of the robot if it is the principle for the green tube being used.

Then the team calculate on the second principle with the red tube.

The red tube size: 750 mm
The threaded rod size: 700 mm

The height for the, together is:
750 mm + 700 mm = 1450 mm

This length is inclined and to have the maximum height on the robot we need to find the height of the 90^0 angel on the floor. Thereby we use Pythagoras theorem for right-angled triangle:
$a^2 + b^2 = c^2$



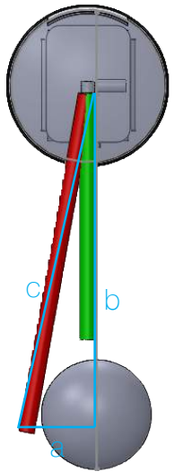
$a^2 + b^2 = c^2$

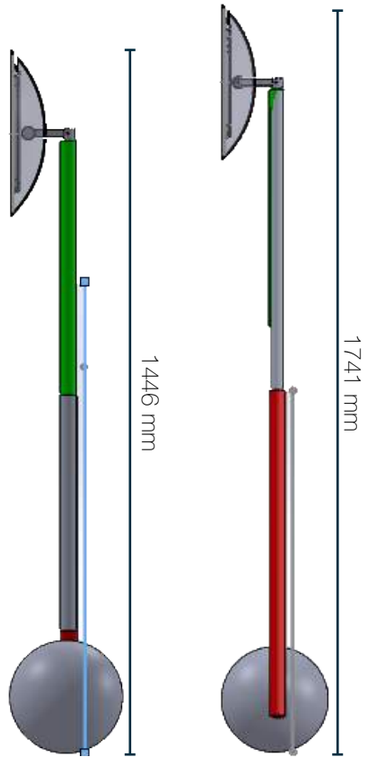
120^2 mm + b^2 = 1450^2 mm
14.000 mm +b^2 = 2.102.500 mm
b^2 = 2.102.500 mm + 14.000 mm
b^2 = 2.088.100 mm
b = 1445 mm

Then we have the height b, and to get the whole height of the robot a half height of the head is added and the half height of the ball:
1445 mm + 176 mm + 120 mm = 1741 mm

1741 mm is then the maximum height of the robot if it is the principle for the red tube being used.

The differences between the two principles is:
1741 mm - 1446 mm = 295 mm





Evaluation:

The requirements to the maximum height will be fulfilled if it is the principle two the team is going with. But then the team need to look at what the principle will work to the design and other requirements for the robot.

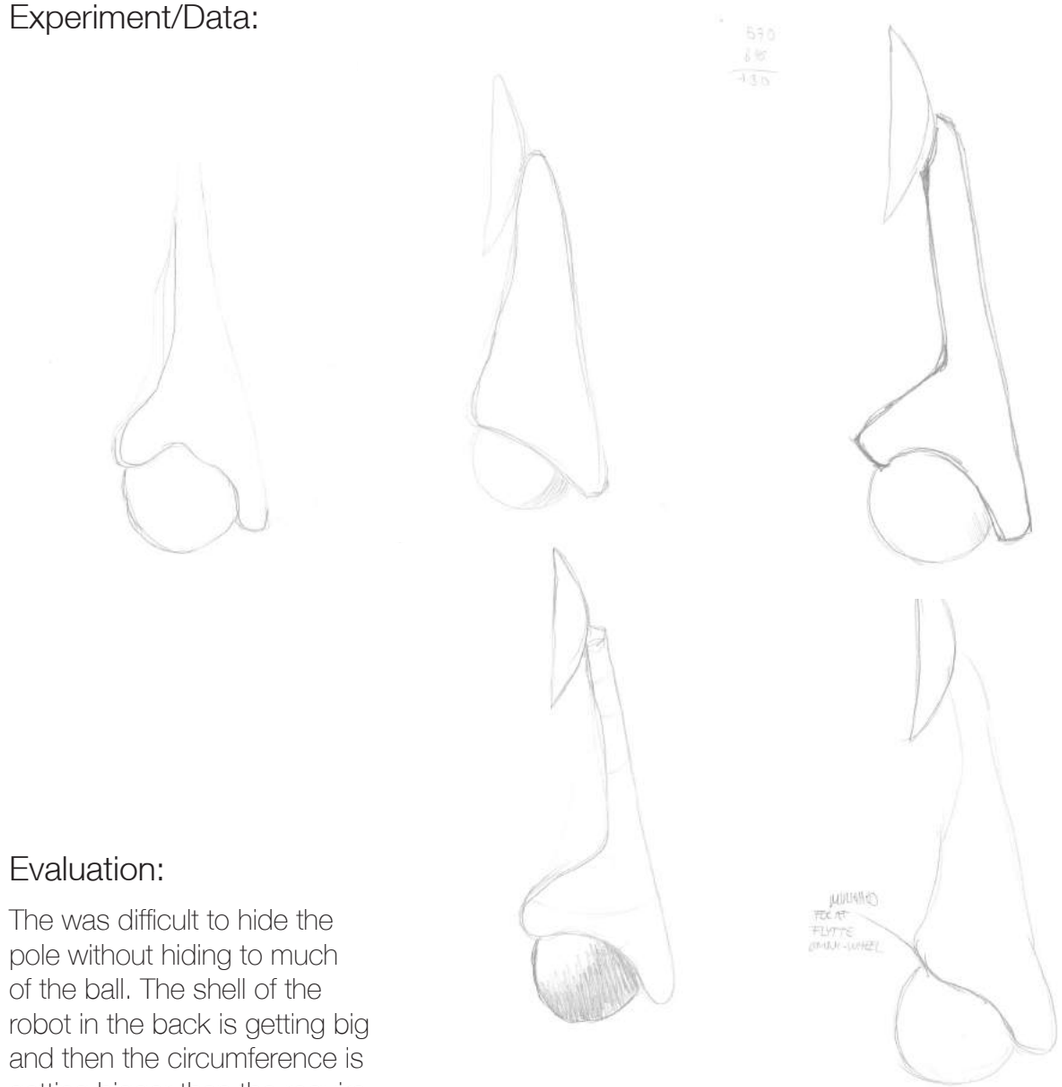
Activity: Shapes for adjustable height pole in the side of the ball - Sketches

Worksheet no.: 71 Date: 09-05-2016 Responsible: MSJ

Objective:

The intention is to see how the shape can be if the pole is placed on the side of the ball. Which kind of challenges are there in the design of the robot.

Experiment/Data:



Evaluation:

The was difficult to hide the pole without hiding to much of the ball. The shell of the robot in the back is getting big and then the circumference is getting bigger than the requirements, and that can give that it can be difficult for the robot to navigate between things in the lounge, and is getting bigger to get around as a person going around the robot.

Activity: Development of the dock to the robot

Worksheet no.: 72 Date: 09-05-2016 Responsible: MSJ

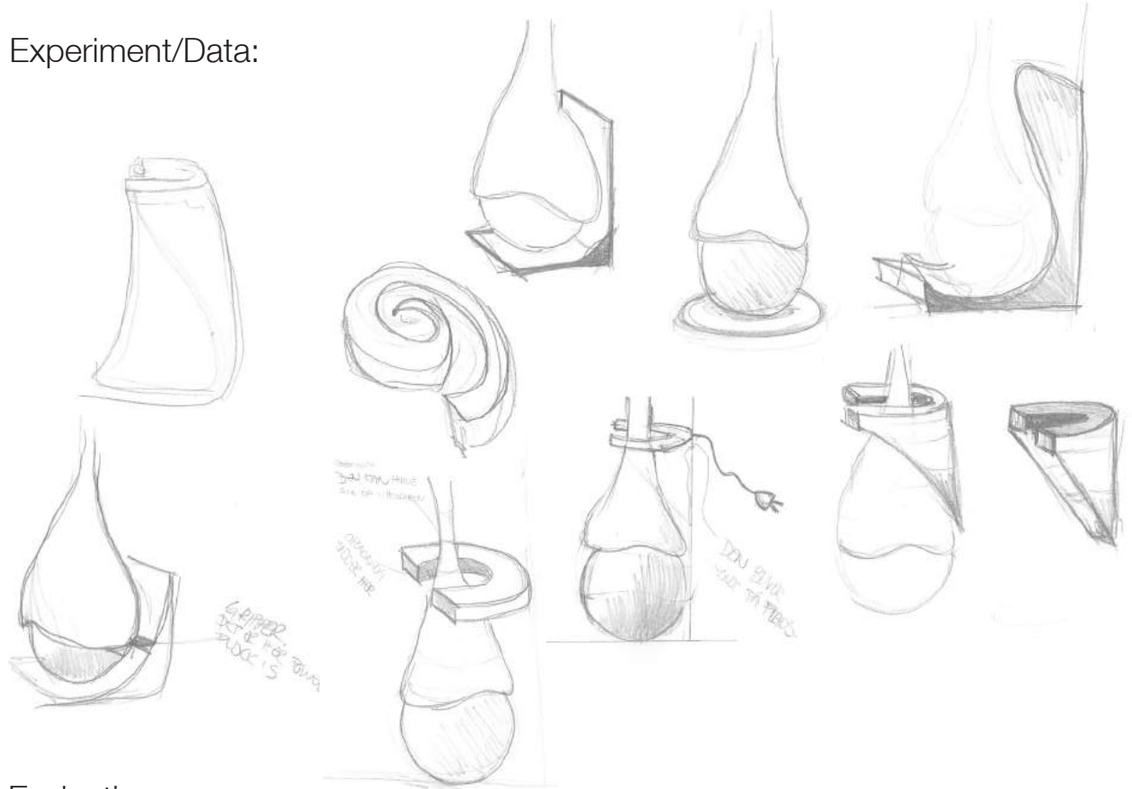
Objective:

The intention is here to develop the dock to the robot so the robot can be charging.
The is some requirements for the dock:

- The charging unit should be in the lounge - so the robot by it self can be charged without the staff need to do something active for it.
- The charging should be with wireless power
- The robot do not need to use power under the charging
- The dock and the robot need a united expression when they are together
- The dock may not look like something missing a part when the robot is not charging.

From these requirements there have been sketched on the concept of the dock.

Experiment/Data:



Evaluation:

From a evaluation, the dock do not need to be big, because the dock do not need to contain many components, so the shape of the dock is a spiral where the robot is driving in and then the robot is placed there and can not get out before charged and then accelerate out of the dock again.

Activity: Neck development

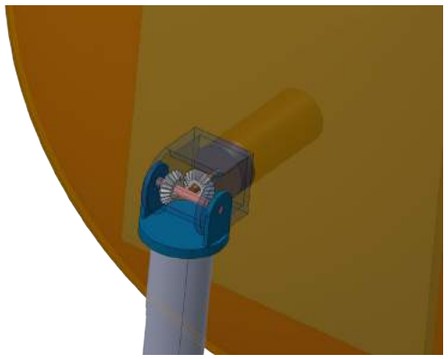
Worksheet no.: 73 Date: 09-05-2016 Responsible: NOD

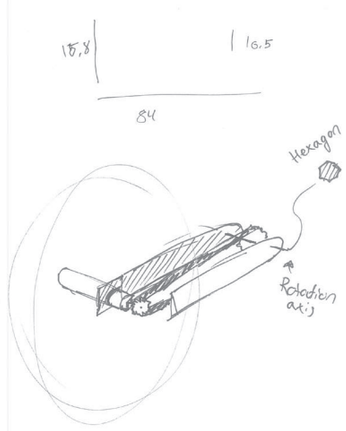
Objective:

The objective was to create a mechanical principle for the neck joint, keeping cost in mind along the way.

Experiment/Data:

The sketches here show how the initial principle has been converted into a functional principle. The idea in the beginning was merely to use a motor to rotate the heads orientation. The team decided in corporation with Karl, to place the motor in the head. The first construction used the motor size to make it directly connect with the rotation point, using bevel gears. This construction had various downsides, for instance the use of bevel gears, which are more expensive, and the thing that the motor itself has become the lever between the joint and head. Another construction was made because of that. The new construction took the motor into the head entirely, and by doing so, makes the motor unable to directly connect with the point of rotation. To come around this 'problem' the team implemented a toothed belt to connect the two. These two proposals were drawn in 3D, to see if constructing it virtually would highlight further problems.





Evaluation:

The objective was fulfilled with two proposals, and one was chosen to integrate in the final design.

Reflection:

The team could've worked with more construction principles, but the one chosen seemed to do the job.

Activity: Head development

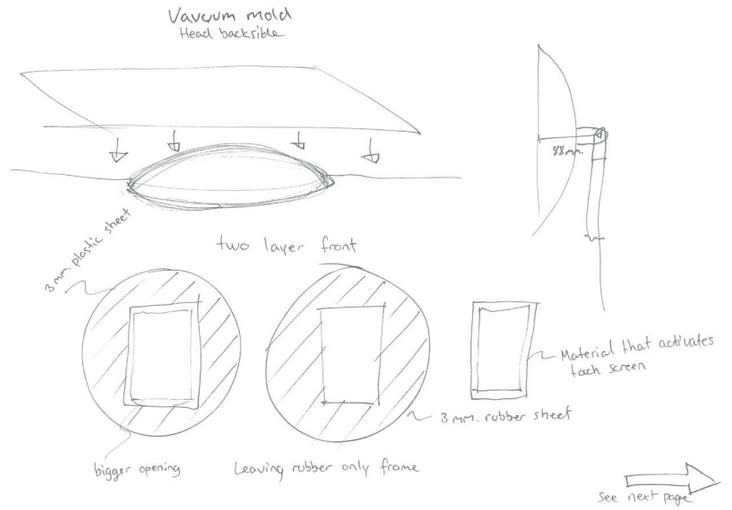
Worksheet no.: 74 Date: 09-05-2016 Responsible: NOD

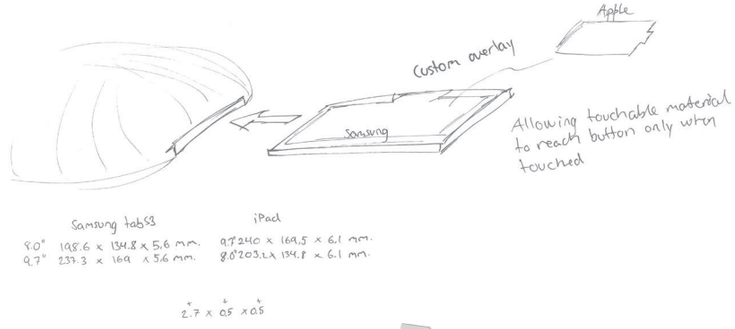
Objective:

Finalize the construction of the head, making the wanted functionalities possible.

Experiment/Data:

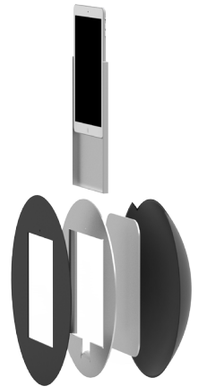
The starting point was that the design should use a rubber front to allow interaction with the tablet, while hiding that it in fact is a tablet. The work with the head focused mainly on creating a construction that allowed the functionalities to work, while using production methods chosen for the backplate as an example. While constructing this area, did the team find out that the new Samsung tablets are based on the same principle as iPads, as they have the buttons the same place. The team had until that point been working on how to allow both types to fit in the case and be able to interact with. As seen on the sketch, it was thought to be front of the case that would have swap able pieces, that would allow pushing as different places. The result is shown in the exploded view.





Reflection:

The final construction has its neat features, but focusing primarily on the front of the head, as thats where the team had a construction to create in line with some specifications. The back part of the head, where for instance a motor is going to be, hasn't been finalized per say, and will require additional work to be able to put components in.



Activity: Shell detailing 3D

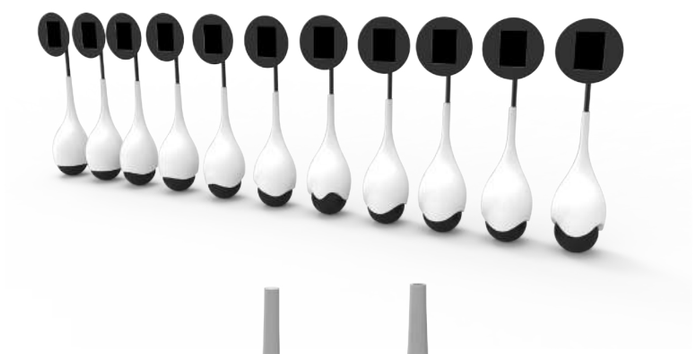
Worksheet no.: 75 Date: 09-05-2016 Responsible: NOD

Objective:

After the internal construction had been finalized to a volume defining point at least, the team had to alter the shell to become suitable.

Experiment/Data:

This was done by specifically altering according to the new measurements, trying to follow the already established form. After this was done, the team worked with the line of cut for the bottom connection with the ball. After the most aesthetically pleasing cut, the team had to integrate another cut. This cut should allow the navigational sensors to be able to see out from the skeleton.
This cut will be investigated in worksheet 78.



Evaluation:

The objective was reached, and a final shell form was found and created in 3D.

Reflection:

The team could've worked some more with the exact lines the shell follows, and worked with the creation of the perfect line. The line tweaking is just hard to see on this kind of form.

Activity: Skeleton development

Worksheet no.: 76 Date: 09-05-2016 Responsible: NOD

Objective:

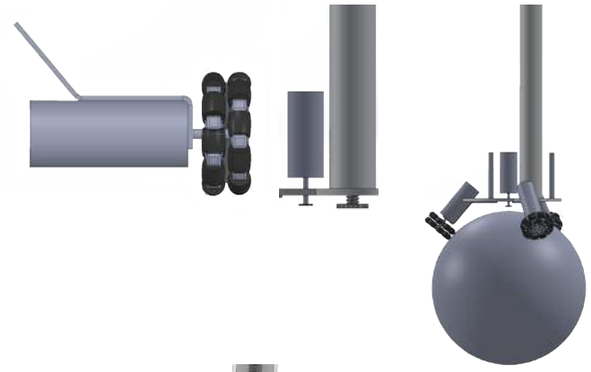
The skeleton of the robot has to be detailed, making the components fit the right places and utilize the every part used.

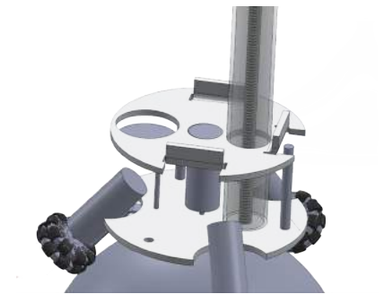
Experiment/Data:

The bottom part of the skeleton platform was made using the components shown to the right, this put together created the foundation for the robot. The bended piece of metal holding the motor-wheel construction allows simple connection to the metal plate.

On top of that there has to be another plate placed, which contains the sensors for the navigation. This is constructed by spacer bars with nuts, and the plate itself utilizes the material by bending it to become optimal for IR sensor placement.

The sensors are then placed.





Evaluation:

A more realistic construction was reached, utilizing the material instead of creating more parts than needed.

Reflection:

Further detailing can and will be done from this point to make holes, fillets etc. but this was about constructing the skeleton roughly in the most convenient way.

Activity: Making a price estimate on the robot

Worksheet no.: 77 Date: XX-XX-2016 Responsible: NOD

Objective:

The team wanted to challenge the pricing of the robot that Karl had stated at a meeting, as the team believe that it is way too optimistic an estimate.

Experiment/Data:

The team made an excel document, setting a price as close as possible for each component of the product. The team wants a precise estimate as possible, with the least amount of effort. Some components are probably very precise, and some are more of a guesstimate.

	A	B	C	D	E	F	G
1		Pris	Antal	Collected	Størrelse		
2							
3							
4	Sensors						
5	LIDAR	1600	1	1600			
6	IR	50	3	150			
7	Switch	15	4	60			
8				0			
9	Construction elements						
10	Aluminiumsplade	300	1,5	450	300x500x3		Mold price
11	Body shell	500	1	500			20.000
12	Head shell	50	1	50			1000
13	Tubes	75	1	75	2m		
14	Threaded rod	20	1	20	1m		
15	sbr rubber head front	100	1	100			
16	Gears	150	1	150			
17	aluminum distance rods	50	1	50	1m		
18	Toothed belt	50	1	50			
19							
20							
21	Mobility components						
22	Motors	230	5	1150			
23	Battery	100	1	100			
24	Wheels	31	6	186			
25	Motor controller	330	3	990			
26	gyrometer acc meter	131	1	131			
27	Arduione Zero	360	1	360			
28	Ball estimate	300	1	300			
29							
30	Assembly time estimate	125	4	500			
31	Bolts, nuts, wires etc.	300	1	300			
32							
33							
34	TOTAL			7272			

Evaluation:

The estimation of Karl was on 2.600 dkr without a tablet, just like this one, but the teams estimate is nearly three times what Karl estimated, making the assumption about incorrect pricing quite true.

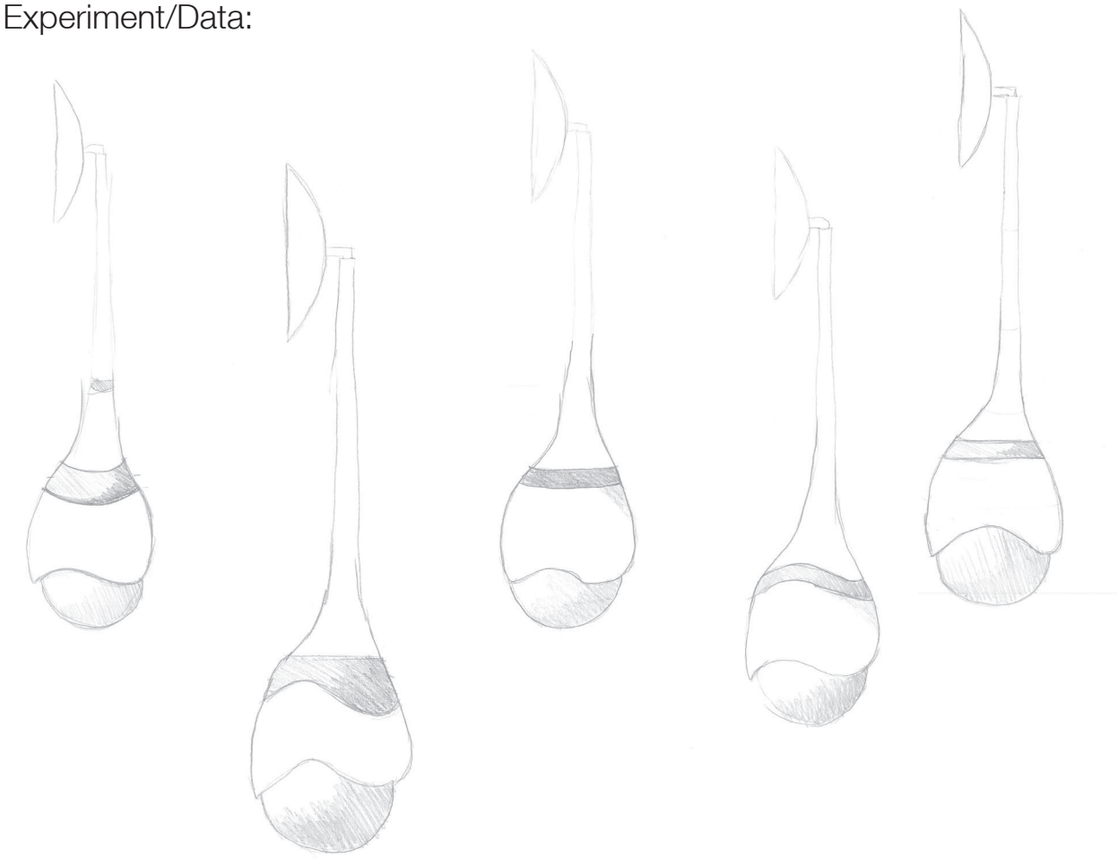
Activity: Shape of the robot with integrated sensors - sketches

Worksheet no.: 78 Date: 13-05-2016 Responsible: MSJ

Objective:

The intention is here to show the process of sketch on the shape of the robot with integrated sensors, and the demands for them.
There is placed a lidar sensor, that need to look out, and thereby there need a break in the shell to integrate it.

Experiment/Data:

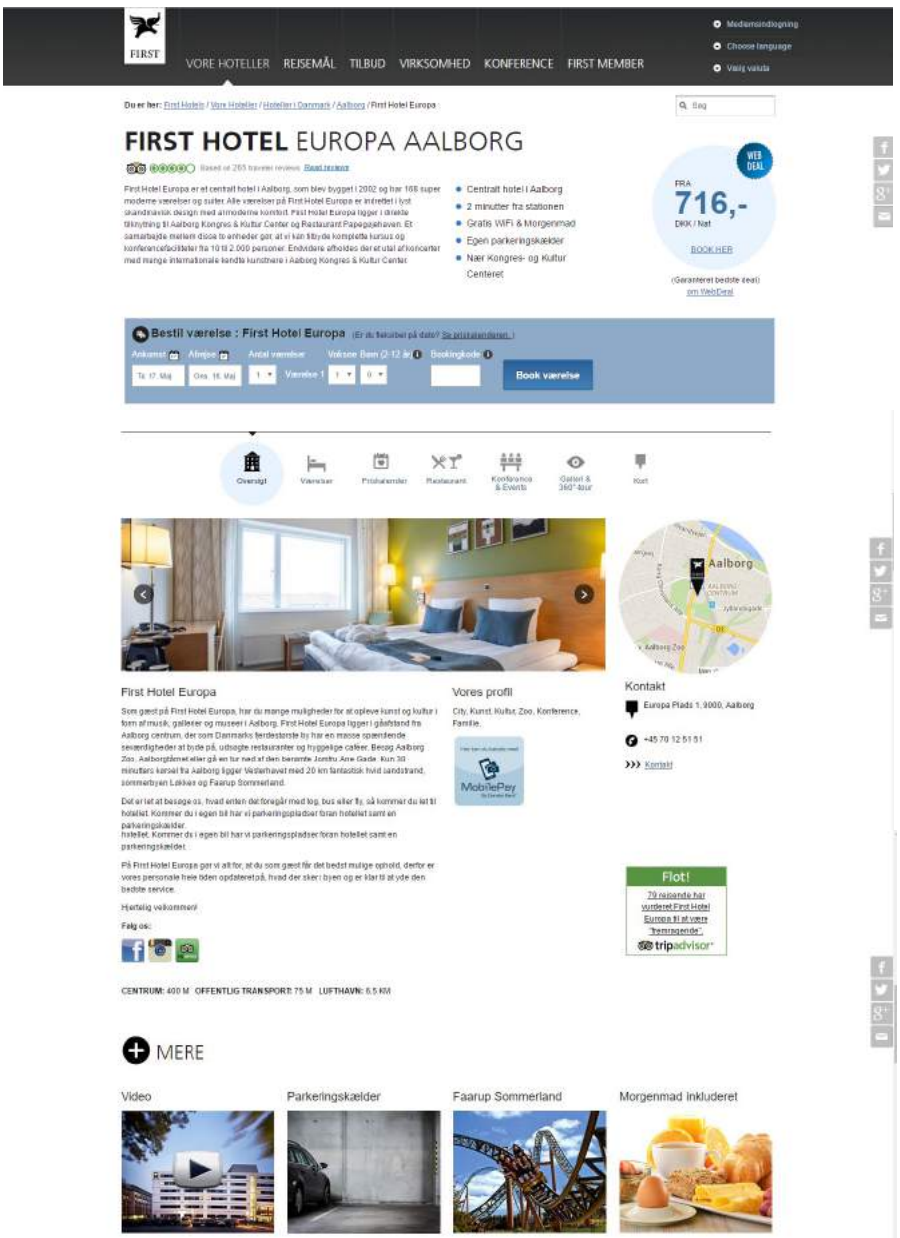


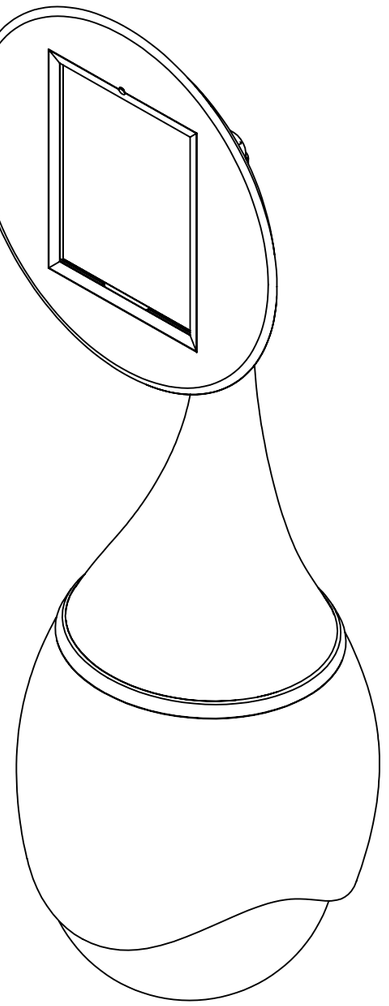
Evaluation:

If there is played with the shape of the stripe for the lidar sensor, it is going to be huge, and thereby the team decided to make it as small as possible.
The next thing is to draw it in 3D, to have it more detailed.

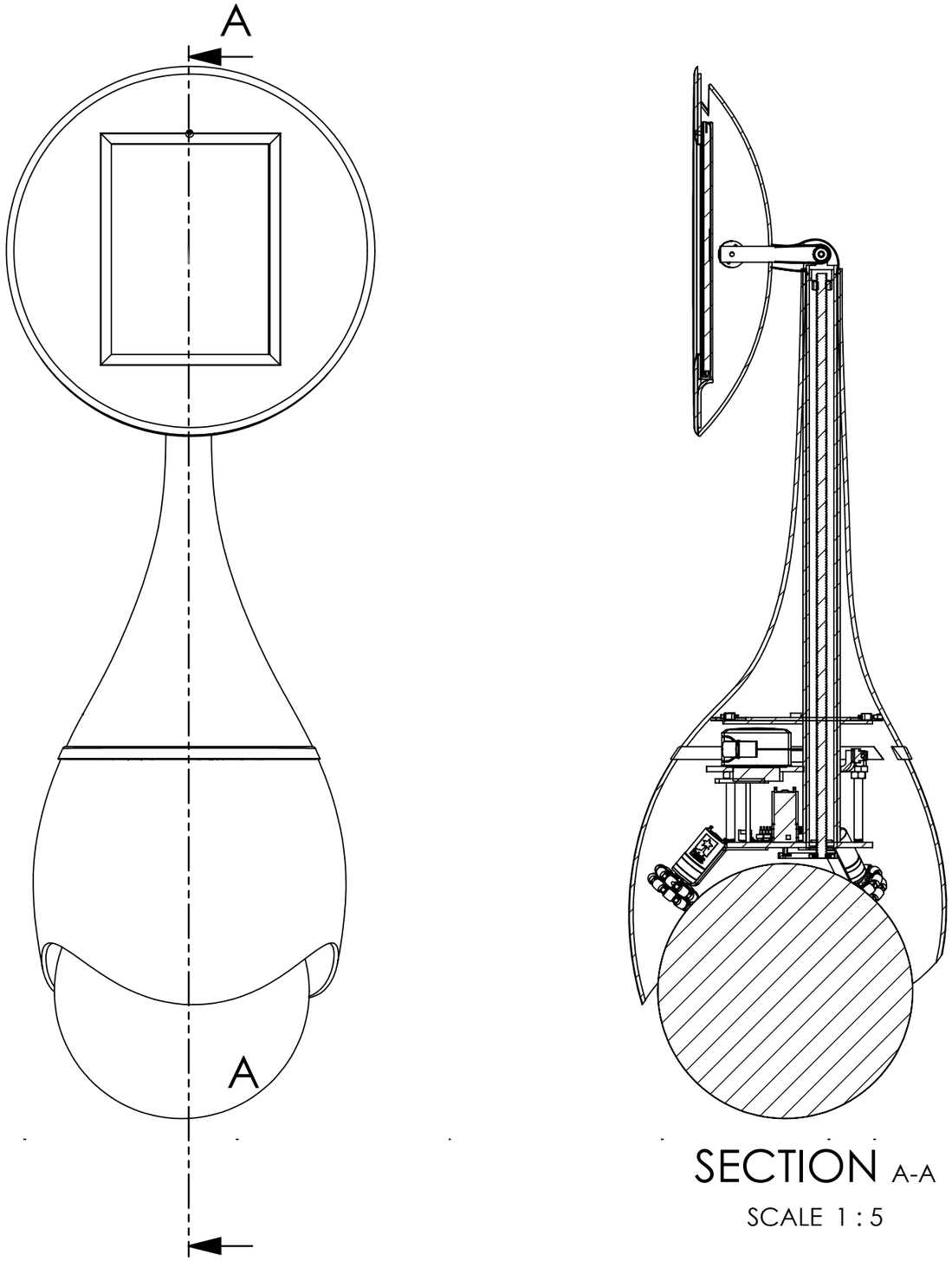
OTHER APPENDIX 2.0

Screenshot from http://www.firsthotels.dk/Vore-Hoteller/Hoteller-i-Danmark/Hoteller-i-Aalborg/First-Slotshotel-Aalborg/
d. 17/05 2016





DO NOT SCALE DRAWING	Date 23/05 2016 A3
MATERIAL:	
TITLE: Total object in perspective	
DWG NO. 1 of 5	DEVit
SCALE 1:5	SHEET 1 OF 1

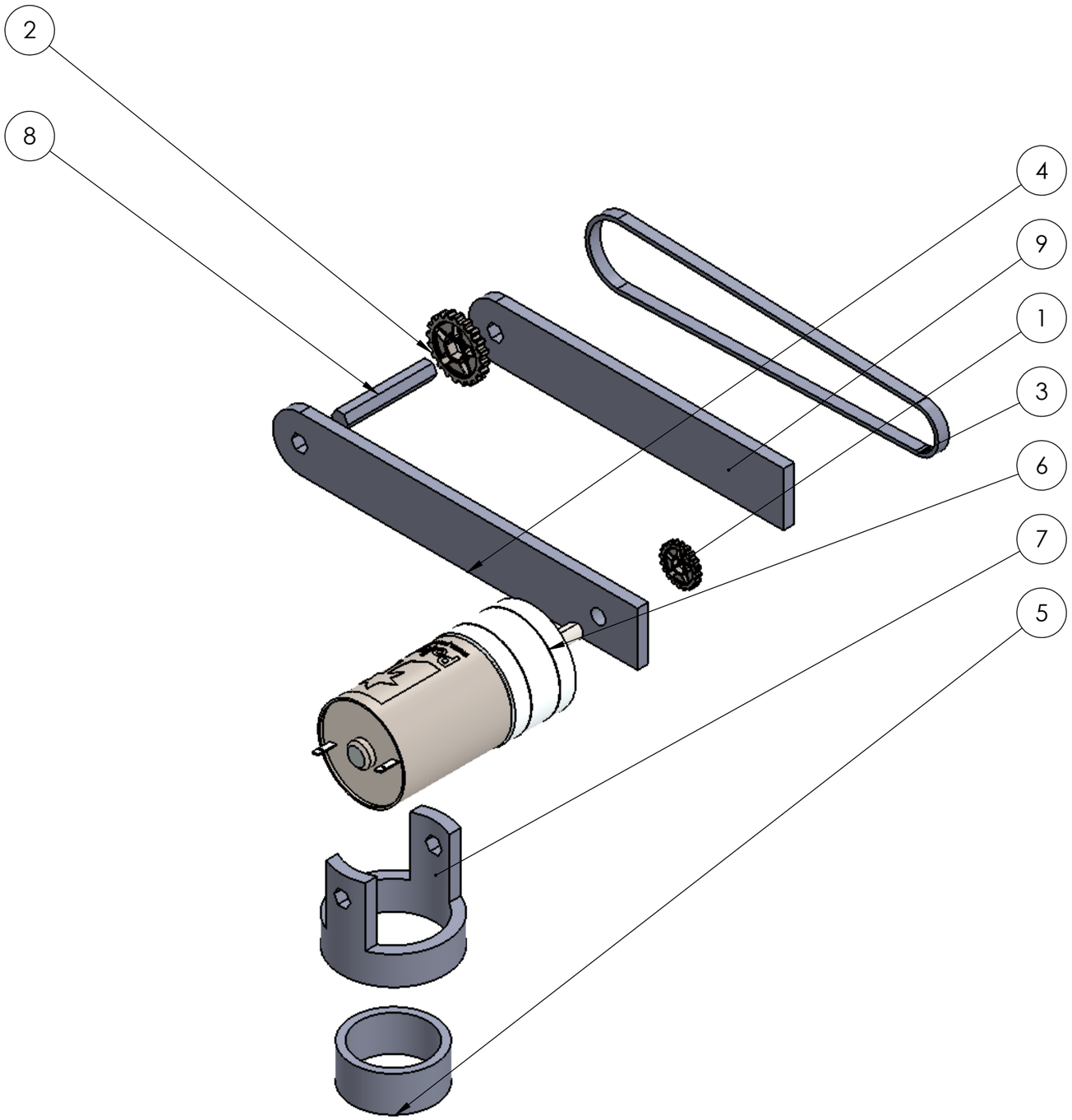


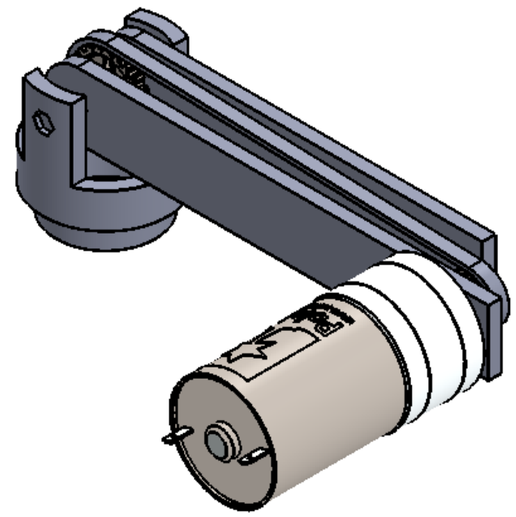
SECTION A-A

SCALE 1 : 5

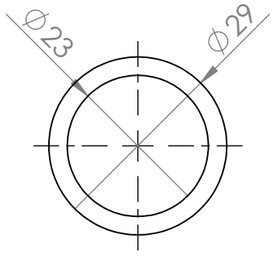
DO NOT SCALE DRAWING	Date 23/05 2016 A3
MATERIAL:	
TITLE: Section view of construction	
DWG NO. 2 of 5	DEVit
SCALE 1:5	SHEET 1 OF 1

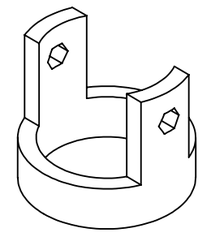
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	gear	Standard component	1
2	gear bigger	Standard component	1
3	gearing bond	Toothed belt for gear cobling clutch	1
4	Neck plate 1.1	3 mm. plate metal	1
5	inside part for neck 1.0	Ø23-Thickness 2 mm.	1
6	Pololu motor 25d	Standard component	1
7	Outside neck part 1.1	Ø29-Thickness 3 mm.	1
8	hexagon stick	4 mm. hexagon bar	1
9	Neck plate 1.0	3 mm. plate metal	1

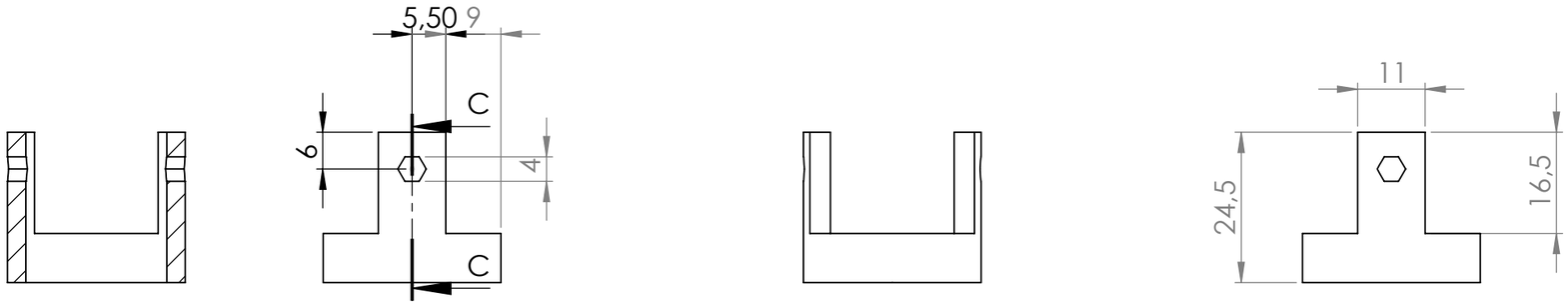




DO NOT SCALE DRAWING	Date 23/05 2016 A3
MATERIAL:	
TITLE: Assembly of the neck joint	
DWG NO. 3 of 5	DEVit
SCALE 1:1	SHEET 1 OF 1

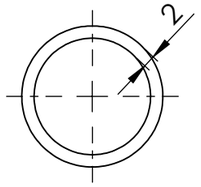


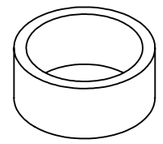


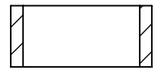


C-C (1 : 1)

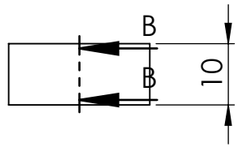
Tolerances: Unless otherwise specified: DS/ISO 2768-1 "c"	
DO NOT SCALE DRAWING	Date 23/05 2016 A3
MATERIAL: Steel pipe ø29-3mm.	
TITLE: Outside neck part	
DWG NO. 4 of 5	DEVit
SCALE 1:1	SHEET 1 OF 1

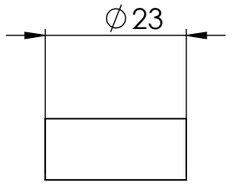






SECTION B-B
SCALE 1 : 1





Tolerances:
Unless otherwise specified: DS/ISO 2768-1 "c"

DO NOT SCALE DRAWING | Date 23/05 2016 | A3

MATERIAL:
Steel pipe ø23-2mm.

TITLE:
Inside neck part

DWG NO.
5 of 5

DEVit

SCALE 1:1 | SHEET 1 OF 1