The Robot Facebook:
The field spotters guide of Robots

BSc Report by Eva Velt **(S1456563)**
Creative Technology
Supervisor: Edwin Dertien
Critical Observer: Robin Aly
31-01-2017

Abstract

Robots have a wide variation of possible applications, for example: health care, assisting, military, space and education. Designing robotics in such a way that they do not negatively influence robot users, is an important factor. When humans interact with each other they mostly focus on facial language, it is key in understanding one another. These same principles apply when humans communicate with a robot that has a face, therefore the main research focuses on robot faces.
In this graduation project an amount of 102 robots is collected in a database and analyzed. By using data visualization, design guidelines will be suggested with the goal to contribute in making future robots more understandable and accepted by the user. The method will be tested with the help of an actual robot project (R3D3) as a practice example.

Acknowledgement

I would like to thank the following people:

Marc Abbink, for his help with CSS and PHP.
Robin Aly, for his input and feedback during this graduation project.
Daphne Karreman, for sharing her opinion and knowledge on robots.
Kristina Zaga, for sharing her opinion and knowledge on robots.
Joris Bruggink, for helping me with certain Excel matters.
Justin Dijkhuis, for helping me with certain Tableau matters.
Edwin Dertien, for helping, meeting and guiding me throughout this graduation project.
Rico Nijhof, for helping me with structuring and spelling check this document.

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Hypothesis

By creating a large database, the goal is to find a large amount of design attributes which can be used to find a set of facial guidelines to improve future robots. It is possible that attribute trends in different robot genres will be found based on robot history.

1. Introduction

We deal with robots in daily life and they have already become indispensable. Robots have functions in for example: manufacturing, space-exploration and the military. Nowadays, robots are extending their tasks in entertainment, healthcare, education, social and domestic domains. Within the near future, we might even be able to buy a social companion robot that guards our house and controls our lights.

Robots come in all shapes, sizes and appearances. Even though there is a large collection of robots, there seems to be a lack of guidelines for facial characteristics that should be taken into consideration when designing a robot face. The face of a robot is an important feature; it’s the first place users will look at and communicate with. [1] If a face is unappealing, users might choose to mistrust or experience negative emotions towards the robot. While an appealing face could make a robot likeable and raise feelings of comfort.

In this project, a large amount of existing robotic faces will be collected, implemented in a database and analyzed through a specific set of attributes. These attributes describe all the main characteristics of robot faces. This data will be used in Tableau to create visualizations that can be used as a guidance for facial design specifications.
The goal is to provide a set of design requirements that can be used to improve a future robots facial appearance. It uses key facial attributes from existing robot faces. Equally as important is the creation of facial design suggestions for the robot receptionist called R3D3. [2]
Lastly, the database will be designed as a usable and visually appealing website and if possible, a mockup for a book.

1.1 Research questions

In order to create design requirements that contribute to future robot facial design, several questions have been composed to gain more insight about robotic facial appearance. The main question is based on the possibilities of improving future robot faces.
To answer this, the question has been divided into 4 sub-questions which relate to current robot facial appearance choices, cultural influences and robot tasks in relations with their facial form.

Main research question

- How to assist the design environment of robot facial design?

Sub-questions

- What research has been done regarding robot facial appearance?
- How to select existing robots and analyze them and their characteristics?
- How do attributes of a robot relate to its purpose?
- How to deduct guidelines for future robot design using the robot Facebook?

1.2 Structure of this document

The document starts with an exploration phase where similar projects and background research are discussed. Followed by researching current robot design methods. In section 2.2 and 2.4 of the exploration phase, project novelty and stakeholders are introduced. The section ends with a list of design requirements using the Moscow method. In the ideation phase, database and visualizations programs usable for the robot Facebook are discussed. This follows by a research in robot quantity, robot choice and analysis method will be explained.
The implementation phase explains website and analysis implementation. This is followed by data findings in which robot categories and robot purpose(s) are discussed in more detailed. The implementation phase ends with a detailed description of R3D3 design requirement suggestions.
In the testing phase, two tests are discussed. A validation of the robot analysis method is tested. The second test validates the user friendliness of the website. In the results phase, a more detailed and a concise design requirement suggestion list is presented, followed by the final website and data visualizations. This paper ends with the evaluation phase in which design requirements are evaluated, success of project rate by stakeholders is presented, answers to the research questions are given and finally, future work is being advised.

2. Exploration phase

This section describes all the exploration phases in the early stages of the project.
First, existing literature will be researched and a more in-depth reflection paper written by the author will be presented. Related work will be discussed by looking at a similar research project. The next section mentions popular related media and their use to the project, followed by discussing current robot design methods.
Secondly, the project novelty is clarified by looking at the previous sections of the exploration phase.
Thirdly, robots suitable for implementation are being searched. To restrict quantity but maintain the most complete selection, an idea about the selection method is formed. Following, potential stakeholders are identified and described. This section ends with the compilation of a list of project requirements using the Moscow method.

2.1 Related work

Literature Research

To gain insight in robot facial design, relevant scientific literature research has been studied.
To structure this research, one main question (How to improve future social robots by using key facial characteristics from existing robots?) and four sub-questions are being used as guidance throughout the research. To help find answers to these questions, an amount of ten papers have been studied. The full research report can be found in Appendix 1.
The following statements can be made about the research questions:

Sub-questions one and two:
When should a human realistic facial design be chosen?
When should an anthropomorphic facial design be chosen?
To understand these questions, one should understand the Uncanny Valley principle (Uncanny Valley Figure on page 11). Masahiro Mori first has this idea in 1970 [3]. He writes that robots with a human appearance remain cute/attractive until they've reached a certain point in which an eerie feeling arises and the robot tumbles into the Uncanny Valley. Robots that are human-looking but have aspects that are slightly off, create a sensation of discomfort, similar to a prosthetic hand. We believe the hand is real until we hold it and experience the cold, plastic feeling that can make us shiver.
On the lowest point of the Uncanny Valley we should imagine zombies and dead people.
Masahiro believes that if we continue developing human-realistic robots, another point will be reached in which the robot moves out of the Uncanny Valley and will be on the upper right side of the curve. Now the robot can't be distinguished from a human being. Mori suggests that this robot will be perceived as more ideal than human beings.

Research papers show a trend of robot designers either deliberately choosing to pursue the left side (anthropomorphic human robots) or the right side of the Uncanny Valley (creating human realistic

robots).
The choice selection between human looking and anthropomorphic robots still needs more research. Future research needs to include all effects and expectations that are experienced from a human looking appearance. The majority of robot users in multiple researches prefer a human looking face when robots perform social tasks. Although other research states that older adults prefer a human looking face, while younger adults prefer a mechanical looking robot [4].

Sub-question three:
Which cultural factors influence the appearance of a robot face?
Demographic background plays a significant role in robot acceptance [4,5,6,7]. Culture, religion, technical acceptance, preferred facial expression and age all influence robot acceptance. All these aspects are entwined with each other and result in different robot preferences throughout the world. More research is necessary on how demographic background influences robots facial acceptance. Aspects like education, robot age and differences in robot acceptance between sexes, could also play a role in robotic facial design, but aren't included in this literature research.

As mentioned, demographic data influences the user's behavior. But no easy statement can be made as cultural background is diverse and dependant on many factors [4,5,6,7]. For example: somebody has a positive attitude towards technology, but strictly follows a religion that has an anti-iconic doctrine. A human-looking robot might not be accepted by them as only "the creator "is allowed to create human-like objects [5].
It's important to take factors like this into account in future robot user-studies.

Sub-question four:
How does the facial appearance of a robot relate to its task?
The facial appearance of a robot could contribute to a positive experience of the robots tasks [5]. Data on robots operating in healthcare, education and as a companion show that there is a preference for a female human face. However, users also showed some signs of discomfort. Reason for this discomfort is that robots can be seen as a person who is taking over a human role. Less discomfort was experienced when robots performed domestic duties and activities. A male robot might be the best choice for decision-making or strength related tasks.

The perceived discomfort when communicating with a human looking robot, might argue the necessity for a human-like robot. Perhaps further research will show a more comfortable attitude towards anthropomorphic or cartoonish looking robots.

Additional literature research observations

An additional view has been discovered that might play a role in robot face acceptation.
Firstly, the demographic data of robot users causes a difference in preference of robot appearance. However, due to the time scale of this project, this complex demographic data can't be included. Perhaps robots from different origins might show novel insights when their characteristics are

compared. Future user test evaluations should include demographic questions. And demographic data will be suggested as future research criteria.

Another discovered remark is the variety in used research methods when researching a robot. In some research, pictures were displayed to the users. In others, users were presented a 3D animation. In other research, a test group interacted with the actual robot, while others were communicating with the robot offline. These different research approaches lead to a problem when comparing research outcomes. A research that used only pictures can't be connected to a research in which a test group communicated with the actual robot.

Reflection paper

A paper about the Uncanny Valley has been written to reflect on the validity of the Uncanny Valley as a guidance for developing nowadays robots. This goal of this paper is to question the usefulness of this principle (see Appendix 2).

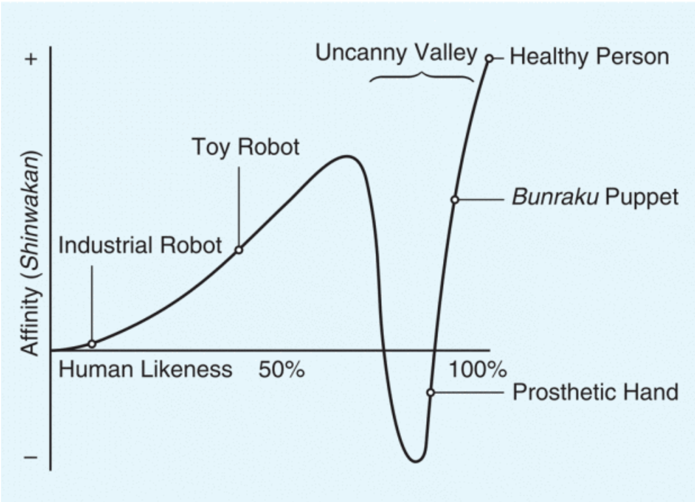

Figure 1. The Uncanny Valley (M. Mori, "The uncanny valley", *Energy*, vol. 7, no. 4, pp. 33-35, 1970.).

Even though the Uncanny Valley is a principle that many researchers take into consideration, it's worth mentioning that not everybody agrees with the way it's being interpreted.

Hanson tells "Mori put forth the Uncanny Valley as a speculation, not as true scientific theory [1]". Also A. Prakash et al. have their doubts. "Measures used in studies investigating the Uncanny Valley theory include: affect evoked such as fear and anxiety; attractiveness versus repulsiveness; familiarity; likeability; and perceived eeriness. Each of these measures informs about a particular constituent of perceptions; however they cannot independently provide a complete picture of perception formation." [4] Furthermore; several test results have already refuted the Uncanny Valley and showed different shapes and patterns. [1]

Sara Kiesler and Aaron Powers both remain uncertain about the Uncanny Valley. "There's some evidence that the valley exists, and some that it doesn't" [1]. Research already showed different outcomes and curves and some believe a 2D curve isn't enough anymore.

I agree, maybe every robot type needs a specific curve. Maybe the robot needs a multidimensional

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Figure 1. http://ieeexplore.ieee.org/document/6213238/

measuring space including appearance, movement, speed and voice. I don't think you can determine a robot solely on its appearance anymore, if we want to create them as social, autonomous situation [2]judging and self thinking creatures. That's why I believe it's important that future tests represent robots in a scientifically correct manner. Some test participants worked with real robots, others with 3D animations, some only with pictures and some without any supporting material at all. How can we combine all these results and filter a reliable conclusion?

Similar project:

All Robots Are Not Created Equal: The Design and Perception of Humanoid Robot Heads [8].

DiSalvo et al. wanted an understanding of how to design social goals for robots. The project also pursued more insight of when people are perceiving 'humanness' in robots. "If robots are going to be intelligent social products that assist us in our day-to-day needs, then our interaction with them should be enjoyable as well as efficient". [8]

As a start, they divided the robots into three categories: consumer products, fiction and research. They discovered fictional robots to be the most human-like and robots in the consumer products category the least.
This project analyzed 48 robots and conducted surveys to measure people's perception of a robots 'humanness'. The study planned to use the outcome to design a head for a new robot.

Unlike the robot Facebook project, DiSalvo et al. took different aspects into account.
The robot should keep an amount of 'robot-ness' so that the user doesn't develop false expectations. The robot should however have a considerable amount of 'humanness', this way the user will feel comfortable enough to socially engage with the robot. There was also need for the robot to carry an amount of 'product-ness' so that users would want to use them.

Another difference to the robot Facebook project is that the project was more focused on conducting two different types of surveys (showing head only or showing head and body) in which participants were asked to rate robots from a 1 to 5 scale (not very human to very human like). 20 participants were asked to answer only one of these surveys. They used a small amount of facial features: eyes, ears, nose, mouth, eyelids, eyebrows and a total number of different features present on the head. Secondly, they measured physical dimensions such as width of the head and bottom of lip to the chin.
They constructed two statistical models, performed a regression analysis and came to their findings. Their results showed the importance of facial features (especially eyelids, nose and mouth). The total number of features also contributes to creating a robots 'humanness'.
Their design suggestions are as follows:
1) Wide head, wide eyes.

[2]

2) Features that dominate the face (mouth, nose, eyelids).
3) Complexity and detail in the eyes.
4) Four or more features (especially nose, mouth and eyebrows).
5) Skin (to achieve a sense of finish).
6) Humanistic form language (head shape should be organic of form with complex curves in the forehead, back head and cheek areas).

This research was conducted by studying static images, isolated from any context.
This raises the question of how ‘human-like’ a robot can be perceived by its form alone. Form is not uniquely defining the ‘humanness’ of a robot. Interactions through expression, communication and behavior play a significant role in a robots ‘humanness’.
The importance of choosing a humanoid robot form is still an assumption that has to be proven.

Popular sources

Other related work was studied to find novelty of the robot Facebook project and the approaches other parties took in order to categorize robot faces. Different approaches in the collection, creation and arrangement of robot data. The most notable ones are discussed below.

Robots for Ipad App[3]
This application for the Ipad is created by IEEE spectrum (Advancing Technology for Humanity).
The application collects robots, presents them in a virtual environment and describes certain characteristics such as the creator, type and origin. The application invites users to rate the robot by choosing a grade between creepy and nice. An overall rating can be made using a maximum of 5 stars (1: not visually appealing, 5: most visually appealing). This approach could be considered one-sided, as the application will mostly be used by robot enthusiast. Also, the robot is solely rated by the feeling it provides to the user.

Mindtrans.narod.ru [4]
Mindtrans.narod.ru is a website with a collection of well known, but somewhat outdated robots. The owner of the website is unknown. The website is divided into the categories: robots, hands, walkers and heads. Every robot has a picture with the year of public introduction and some additional information. Mostly information about the dimensions and remarkable aspects. This website showed some useful insight about specific robots. A downside is the absence of movie robots and the somewhat outdated information. Other robots were completely outdated and no other online references were found.

Roboticstoday.com [5]

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[3] http://robotsapp.spectrum.ieee.org/
[4] http://mindtrans.narod.ru/robots/robots.htm
[5] http://www.roboticstoday.com/

Roboticstoday is a free promotion and news publishing platform created in the Netherlands. They offer a database of more than 1100 robots, which is considered the largest online robot database. Their aim is to create a clear overview of robot development. Besides robots they also present information about robot related devices, projects, institutions and developers. Robots can be categorized by alphabetical order, category, developer or country of origin.
Most robots have an image, description, highlighted features and several keywords. Their application category and developers are being mentioned and if possible; related robots.
A downside of the website for the robot Facebook project is the provided information being too superficial.

Wikipedia Humanoids [6]
The humanoid page of Wikipedia has a chronological overview of noteworthy humanoid robots. It provides a list of humanoid robots that caused the most impact over the years. This list was useful for selection of human-like robots relevant to this project. Most robots in the list have their own Wikipedia page, or a redirection to another source.
A downside of this page was the lack of pictures. When the reader is unfamiliar with the robot field, names can be confusing; pictures can help with identification.

Robots (Carlton books limited)[7]
Published by Carlton Books Ltd, 2008
ISBN 10: 1844420396/ISBN 13: 9781844420391
Written by Russel Porter, Selina Wood and Roger Bridman.
Description: "'Robots' vividly portrays and illustrates the complete spectrum of robotics, from the earliest design sketches and concepts by pioneers like Leonardo da Vinci through to the high-tech humanoid robots of today and beyond. It explains how robots work and uncovers the mysteries and wonders of robot technology used in industry, medicine, space and in the home". [9]

The robots book is a child-oriented encyclopedia of robots and their functions. They present the most famous robots such as Asimo. Its goal is to inform and stimulate children's interests in robots. This book was published in 2008, which makes it somewhat outdated. Because of its superficial information this book has little to no value for this project.

Robosapiens "Evolution of a new species"
Written by Peter Menzel and Faith D'Aluisio.
Publisher: The MIT Press; Reprint edition (October 1, 2001).
ISBN-10: 0262632454/ISBN-13: 978-0262632454
Description: "In Robo sapiens, Peter Menzel and Faith D'Aluisio present the next generation of intelligent robots and their makers. Accompanying brilliant photographs of more than one hundred

[6] https://en.wikipedia.org/wiki/Humanoid_robot
[7] https://www.amazon.com/Robots-Clive-Gifford/dp/1844420396

robots is an account of the little-known, yet vitally important scientific competition to build an autonomous robot. Containing extensive interviews with robotics pioneers, anecdotal "field notes" with behind-the-scenes information, and easy-to-understand technical data about the machines, Robosapiens is a field guide to our mechanical future.” [10]

Although this book was published in 2000, it has useful information for the robot Facebook Project. This book provides a long list of robots including their specifications and useful information given by sources closely related to the robot project. Some of the information provided by this book has been used in the robot Facebook project. A downside is that since the release in 2000, some robots have developed and their specifications have changed. Another downside was the lack of information on robotic faces (including anthropomorphic faces and animals).

Current robots design methods

Even though there aren’t true robot facial guidelines, a robot design process can be separated into three different categories.

Community-centered

The 21st century [8] robot and Poppy [9] are both community-centered robot projects. They have been designed with the help of a multidisciplinary community such as a group of students, researchers, artists, tech enthusiast and children. The tools for such projects are modular and easy to use. Because of their open source platform, these projects contribute to making future technologies more transparent.

Open source

An amount of robots are built as open source project. Depending on the project both the code and/or hardware design is published and free to modify. Examples of open source software projects are LeJOS and ROS. Hardware examples are Turtlebot and Sparki [10]. InMoov is the first fully open source 3D printable life-size robot [11].
The difference to community-centered projects is that these robots generally receive input from more specific in-depth target groups.

Companies

Hanson Robotics [12] and PAL Robotics [13] are both examples of companies that are commercially creating robots. Their developed hardware and software are licensed and restricted to be altered by users. They set their own design requirements. Most robots are found in this category.

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[8] http://www.21stcenturyrobot.com/
[9] https://www.poppy-project.org/en/
[10] https://opensource.com/life/16/4/open-source-robotics-projects
[11] http://inmoov.fr/project/
[12] http://www.hansonrobotics.com/
[13] https://pal-robotics.com/en/home/

2.2 Project novelty

Some mentioned sources showed a vaguely similar robot collection compared to the robot Facebook. But no other source included movie robots and no other website-database has an up to date collection of nowadays robots. Also, no other sources use a facial analysis method that could help in new robot designs. 'Robots for Ipad' was the a similar project that aimed to gain insights about a robots appearance. But the approach is significantly different from the robot Facebook as the users are asked to rate the robots. Users of this application are likely to be robot enthusiasts which could lead to a one sided opinion. Plus, the robot collection is of little quantity.

There is a variety of papers specifying one or multiple robots. These scientific papers are mostly focused on a specific characteristics such as facial shape. If the papers contain multiple robots, these robots are often similar to each other regarding their purpose and/or origin. Currently, there is no other database that offers comparison of facial characteristics of this many and diverse robots.
The database connects multiple attributes of multiple robots. This is a new approach, it could lead to new insights in robot facial design.

Research thus far showed that there isn't a true answer to "How to assist the design environment of robot facial design?" This project might lead to certain design suggestions, based on analyzing existing robots characteristics.

2.3 Robot quantity, information and analyzing

To get an idea of all the potential robots to be used in the robot Facebook, a small background study has been conducted. It gives a general idea of the possible robot amount and the variation in their characteristics. Depending on the diversity of the robot characteristics an analyzing method will be created to implement data into a spreadsheet.

As a start, an hour of Google image research was planned to collect as much robots as possible. On the side, it gave an idea on possibilities for future robot categorization. The used keywords were 'robot face', 'social robot' and 'robot'.
This research resulted in a total amount of 40 robots, of which 18 robots were eventually suitable to implement in the robot Facebook.

Quantity

To create design requirements for future robots, analyzing a large amount of existing robots is necessary to make sure the resulting suggestions are substantiated.
The project description states that >100 robots should be sufficient to create a reliable set of design requirements.

Robot choices

The robots suitable for the robot Facebook project should have a type of face. Too abstract looking industrial robots of which facial design isn't important, will not be included. A large number of robots are on the market. To attempt to prevent robot design failures, it is of importance to only include robots that are considered successful.

The project description states that a variety of robots should be analyzed, including fictional robots out of movies. This expands the results rather than limiting to analyzing robots with a scientific background. How to determine exactly which robots are suitable for the robot Facebook, remains an item for the ideation phase.

Analyzing method

To create design requirements using existing robots, a categorizing method is needed to describe every robot and eventually comparing their characteristics. To structure a database of >100 robots; clear categorization is needed. However, due to the variety of robot faces, an algorithm that analyzes faces can't be used. Another option could be the use of morphological charts, but the use of these would lack depth as they are applied only in the beginning of idea generation.

2.4 Stakeholders

The potential future user group of the robot Facebook can be divided into companies that build and/or design robots, independent robot designers and possibly robot hobbyists. Their general age will vary between 20 and 70 years. Stakeholders will likely have or be receiving a degree in a technical area. Robot designers are generally stakeholders with a technical background. They can be either male or female, they will have knowledge of the English language and their demographic data is diverse. The robot companies are similar but tend to be more commercial oriented.

The product-users of future robots designed using the robot Facebook would vary in demographic data, ages, gender and robot appearance preferences. Families, logistic companies, healthcare, education, space centers, children, lonely people and many more could be considered potential robot users.

2.5 Requirements

The following requirements have been taken into consideration. These requirements, used in a Moscow method manner, were gathered in consultation with various field experts and own project outlines.

- There **must** be at least 100 robots.
- Images **must** be included in the database.
- The chosen robots **should** have made an impact on the masses.

- If the chosen robots didn't make impact on the masses, it **should** be significantly researched.
- There **must** be a user friendly online database that equals the book draft development requirement.
- The database **could** be visually appealing.
- If information on attribute terms is unavailable, they **must** be ignored due to the timeframe.
- Design requirements **should** be made for the R3D3 robot receptionist project.
- The attributes **must** be exported into a spreadsheet.
- Exported data from the database **must** come in a suitable format
  for use in a visualization program.

3. Ideation Phase

This section explains the forming phase of ideas, software selection and analyzing choices that have been made to create the robot Facebook database and visualizations.
First, database software options are being introduced and a choice will be motivated. Secondly, the data visualization software options are being discussed. Finally the robot quantity, analysis method and attributes will be determined and discussed in more detail.

3.1 Software choices

To structurize characteristics of a large amount of collected robots, a database is needed. Also, this database needs to be able to export data in such a way that data visualizations can be created. An additional needed feature is the use of pictures for every robot and an additional video. To create data visualizations, spreadsheets are needed as intermediary. Excel compatibility will have priority when choosing the correct software for collecting and displaying data.
There are a couple of databases that could be an option for the robot Facebook project.

Potential databases

Wikia [14]

Wikipedia allows users to create their own sub-encyclopedia, called a Wikia. Every robot could have its own page with corresponding information and images. Users don't need HTML knowledge as Wikipedia is built in 'Wiki markup' language. This is a new syntax for communication and only applicable on Wikipedia. It is possible to export Wikia data into an Excel sheet. Wikia has its downside of limited freedom in web page styling.

Using folders on a computer

Another potential solution could be the use of maps, folders and documents, structured in the same manner as the 'File Explorer' on for example a Windows OS laptop. Creating an amount of folders and maps that contain images and spreadsheet data of robots. This establishes a clear hierarchy, but could also be confusing as comparing data becomes difficult. Creating a separate Excel sheet for every robot also leads to an unnecessary amount of files. Finally, maps and folders are hard to share.

MySQL

MySQL is a database management system accessible for everyone. SQL stands for "structured query language" and is considered to be the most common standardized language used to form databases. Data can be exported into a readable Excel file. However, saving images in MySQL is an uncommon practice. Images also need to be saved as a 'BLOB', which might lead to potential scaling issues. Displaying pictures is a prominent requirement for the database. The project timeframe of 8 weeks

[14] http://www.wikia.com/fandom

and the lack of SQL language knowledge could also lead to time issues.

Excel
Excel is complementary to any database but it isn't a database by itself. Because of the large amount of data that needs to be collected, mistakes can be easily made when filling rows and columns. Although, images can be inserted, it's not common practice. An Excel file can be easily shared, but when using a large amount of attributes, it's difficult to create a clear overview.

Wordpress
Wordpress is an open source online development tool that is coded in PHP and uses MySQL as its database management system. Wordpress is user friendly and doesn't require specific programming skills. Besides an easy to use database, the robot Facebook can also be made visually appealing. It supports images, videos and with an additional plug-in, data can be exported in an Excel file.

Database Choice

Wordpress, besides being user friendly and not requiring specific programming skills, offers a large variety of templates, plug-ins and external help forums. This results into a visually appealing and properly functioning product. In this case, past experience also benefits the project time frame by choosing Wordpress.

One of the side goals of this graduation project is to create a draft version for a book. As mentioned in the requirements, this option is of moderate importance due to the project time frame. Because Wordpress offers a platform for a visually appealing website, the book draft option has been replaced into the creation of an online robot Facebook library.

External options

To familiarize people with >100 robots, the robot Facebook needs to have an advanced search function that can filter multiple descriptions and show robots categorized by these filters. Another requirement is to export all the data into a usable Excel sheet.

Before finding any external plug-in that allows the requirements above, a Wordpress template is chosen as a starting point. The Template 'Aurum' is chosen as basic layout for the robot Facebook format. This Wordpress shopping template contains the basic pages and posts, but also product categories and product posts. These are suitable for custom attributes and additional information as it has multiple structured layers and navigation options.

With the use of Balsamiq (program), a mockup for making a website, several designs are made. The goal is to create a clean, user friendly and easy to navigate website that displays an overview of all the robots.
The mockup robot Facebook designs can be found in Appendix 3.
Robot implementation method

The first option was to use a traditional Wordpress post. In which all the specifications are displayed with the use of tables. An external Wordpress-plug-in created visually appealing tables. But all the information had to be inserted manually. No export-plug-in could identify the tables or export them into a readable Excel file.
This led to the choice of using attributes that can be implemented beforehand, these were easily accessible in every robot-post.

A plug-in called **WP All export** successfully detected and exported these attributes into an Excel file.

Another external plug-in was used: **WOOF-WooCommerce Products Filter.** This plug-in filters the entered custom attributes/labels and displays the robot that contains these labels. Multiple attributes can be selected for display.

Video
A robot is a moving object, it can be perceived in a virtual manner. Unlike a video, a static picture can't represent this. That's why a videos of the robots should be included. The main source for videos will be Youtube, as it the most commonly used channel. If a robot isn't presented on Youtube, Vimeo or any other source will be searched.

Additional information
Rather than solely specifying a robot, it will also be given a short description of its history, purpose, remarkable aspects and/or other noteworthy facts that give more identity to the robot.
Possible sources will be Wikipedia[15], Roboticstoday[16] and Mindtrans[17]. Some robots will likely be represented on an own website. Every source will be credited.

Data visualization methods

To give a visual representation of the robot Facebook, specific data visualization software is needed. Several options were considered.

RAW density design[18]
Raw density is an easy to use online data visualization program. It uses Excel spreadsheets to translate data into visualizations. There is a limited amount of 16 options to be chosen to display the data. The visualizations are aesthetically appealing but difficult to read. Users can download the data as .svg, .png or .json files. Additionally, you can copy the visualizations code into an HTML-based website for display. It's an easy to use tool, but it's not possible to save the data and it only displays one visualization at the time.

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[15] https://en.wikipedia.org/
[16] http://www.roboticstoday.com/
[17] http://mindtrans.narod.ru/robots/robots.htm
[18] http://raw.densitydesign.org/

Excel charts
Excel has a couple of built-in visualization tools such as a bar chart, line chart, area chart and scatter plot. The visualizations are basic and too limited considering the large amount of data that is going to be collected.

Plotly[19]
Plotly is another online visualization tool which is transforming into a program similar to Tableau. The free online version has a limited color palette, only .png and .jpeg exports are available and it only creates basic charts.

Tableau
Tableau is a quick and user friendly program that creates visualizations of many different kinds. It uses a drag and drop function for inserting data. The software is free to use for students and the visualizations are aesthetically more pleasing than the ones in Excel. Tableau data visualizations can be exported online and be used for presentation on websites.

To structure a large amount of data in an understandable manner, data visualizations have been chosen to display the results and find interesting insights regarding the robot Facebook.

Visualization choice
To visualize data, the choice for Tableau was made.

3.2 Robot structuring

In this section robot quantity, robot choice and analysis method will be explained.

Robot quantity
To create design requirements for future robots, an amount of >100 analyzed, existing robots is necessary to make sure the outcoming design requirements are substantiated. Considering the timeframe of this project, the amount of robots first had to be determined. The type of usable robots had to meet several requirements.

To understand the amount of work needed to implement one robot, a timeframe test was done for two types of robots. The chosen robots are Asimo and Ibn Sina.
The implementation of Asimo took 25 minutes as it is one of the most famous robots and all data was easily found. Ibn Sina was trickier to identify and multiple videos had to be consulted to spot certain characteristics. It took 40 minutes to complete.

To suit the project time frame, the robot implementation phase was given two weeks. This leads to a

[19] https://plot.ly/

maximum of 90 implemented robots, which is lower than the initial requirement. Because a larger amount is more desirable, an additional number of robots was implemented in spare time. Eventually, a total of 102 robots was reached.

Robot choice

It is important to only include robots that are considered a useful example to future design requirements. To determine this usefulness, the idea was formed that a robot has to meet at least one of the two below mentioned requirements.

Impact

Robots that created an impact on the masses should be included into the database. These could be existing famous robots like Asimo, fictional robots like R2D2 from Star Wars and popular robot toys like Furby. Also famous robot studies like Bigdog and Atlas should be included. These robots have a different background but share common ground considering impact. These robot designs are well known and might be fundamental for future robot appearance.

When is a robot considered making an impact?

-When an extensive amount of information can be found on Google and/or Youtube.
-Well known companies are using the robot as PR material.
-When in the list of most popular robot related movies according to IMDB[20], the biggest movie related database.
-Robots that are mentioned in popular media during the exploration phase (section 2.1).
-The first examples of robots, that were introduced in movies.

Some robots in this last requirement are excluded. For example Rosie, from the cartoon "the Jetsons", suffers from declining historical popularity (being forgotten) and therefore the impact becomes past.

Scientific research

If the robot had regular or little impact on the masses, the robot should be subject to some scientific research to still be suitable for implementation. These could be social studies like the ones done on Kismet, Icat and Ibn Sina.

[20] http://www.imdb.com/

Robot analysis method

To define a robot face, a specific analysis method needs to be created.
Robot faces are more diverse in shape and size than a human face. If a human analysis method exists, it could likely not be used without modification. A custom analysis system was made that could embody every robot.
This system is developed using a human face as starting point, it is the face-type with the most diverse features.

Figure 2. Keepon robot (Keepon, January 2017)

Using a custom analysis system that hasn't been tested could lead to unforeseen problems. These potential problems are listed below.

[21]**Objectiveness.** The goal is to analyze all attributes objectively. However, some choices have to be made intuitively. This could be considered to be subjective and disagreed by someone else.
For example, the Keepon robot has a speaker under its eyes. This could be perceived as an abstract nose where others might argue that it's a mouth.
A custom method, with overseen subjectivity could lead to one-sided results. To prevent this, user tests should clarify certain chosen attributes to be objectively picked.

Wrong picked attributes. There are many different types of attributes that describe a specific robot. However, these attributes might be wrongly picked or describe a feature in a too global or too deep manner. This might lead to disappointing, too general or insignificant confusing results.
To create the best suitable attribute descriptions, these possible issues should be kept in mind.

Main categories

Before specifying the attributes, the robots in this database will be divided into 6 categories: human-like, anthropomorphic human, placeholders, mobile vehicles, cartoonish and form defines function.
No robots of the category placeholders are implemented, for this reason it is left out. During the implementation, many robots turned out to have helmet-shaped heads. They were found distinctive enough to define a new category 'helmets'.
Mobile vehicles weren't a useful category as it turned out to better fit in the attribute 'frame composition'.

This leads to a final of 5 categories; human-like, anthropomorphic human, helmets, cartoonish and

Figure 2. www.keepon.com/

form defines function.

- **Human-like.** The robots in this category all have a face that can be described as human realistic. This includes human-realistic skin, eyes and most likely human realistic hair.

- **Anthropomorphic human.** Robots that are placed in this category have a human-like facial shape, but contain some anthropomorphic features. They tend to be perceived as humans, but aren't considered as convincing as human-like robots.

- **Cartoonish.** Robots in this category have a wide variety of forms and shapes. Their eyes are often big and prominent. Many have a funny and adorable looking appearance. They could be considered as anthropomorphic children, animals or movie characters.

- **Helmets.** Robots that are categorized in this group all have a helmet shaped head. Most helmets contain a screen that suggest they are hiding eyes. Others have a transparent screen with visible anthropomorphic eyes under it.

- **Function defines form.** This robot group varies greatly in form and shape. They are mostly abstract built, with a hint of human or animal features. Even though they don't look human-like, eyes can be identified. Most robots in this group have no type of skin coverage and show a large amount of visible technology.

Attribute list

All human characteristics were divided into 'attributes', which could be again divided into smaller 'terms' describing facial features. Resulting in the following:

- **Facial characteristics:**
  Facial shape, facial hair, eyebrows, eyelashes, eye specification, eye shape, eye size, eyelids, nose, cheeks, ears, lips, mouth, inner mouth, tongue, teeth and chin.

- **Additional characteristics:**
  Talking, mouth emotion, frame composition, degrees of freedom, height, weight, skin color, skin type, gender and head-neck-body ratio.

- **Background information:**
  Country, year of introduction, origin, purpose, created by, version and target group.

A number of robots didn't have lips, but did have a mouth. As a result, the attribute mouth was introduced. The mouth emotion in an offline stadium has also been taken into consideration as research shows that user test groups are more likely to pick a face that is stationary smiling [4].

The eyes are analyzed in great detail because “That’s always where the audience is looking” Gellar et al. [1]. The eye size will be measured relative to the human size. If the facial shape varies greatly, the eyes will be measured relative to the robot head.

Talking is part of the additional characteristic list as it seems to vary greatly between robots. Some robots talk like regular humans, others use blinking lights to communicate, whereas others talk without a form of mouth.

Background information will be collected with the goal of understanding certain design choices and perhaps discover remarkable aspects.

Even though the focus is aimed at a robot face, frame composition and head-neck-body ratio are also analyzed. These aspects could lead to a different attitude towards robots. A robot without a body could be perceived differently than a robot with a body.

Attribute terms list

Each attribute gets divided into a list of terms that refers to a specific characteristic of a robot.
A basic list was programmed into Wordpress, but flexibility towards future additional terms was taken into account and they could be easily added using either the robot editing page or the attribute menu list.

A complete list of all attributes can be found in Appendix 4.

Unknown attributes terms

As mentioned in the requirements, there is a possibility that information on certain attributes terms can’t be found. If 25% of the information on a specific attributes term can’t be found, the data will be marked as undefined.

4. Implementation

In this section the implementation phase will be discussed.
The analysis method implementation, the implementation of the Wordpress sheet into Excel and the spreadsheet conversion into Tableau will be discussed. Lastly the Tableau data findings are examined.

4.1 Website Implementation

The chosen Wordpress theme 'Aurum' is originally built as a shopping theme. It contains standardized functions which are unnecessary for the robot Facebook, some of them couldn't be switched off.

The next couple of functions had to be removed within the PHP/CSS code:

- Product ID on the robot pages.
- Basket icon.
- Search icon.
- Sorting list by price, recent products etc.

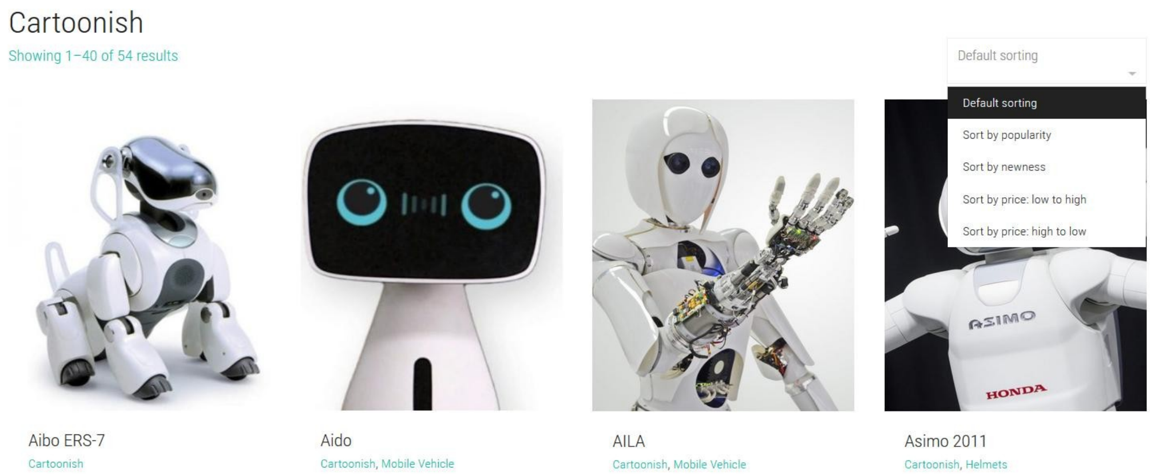

Figure 3: Default sorting list in the robot Facebook

To separate product categories and advanced search, the advanced search function was moved to the right side of the top menu bar and given a bold font to draw attention. The choice for this place is based on the general position of a search bar being on the top right of the page.
The footer menu on the bottom of the page was given a larger size and darker color to make it more visible.

The advanced search filter was eventually placed on the footer of the main page. But this proved inefficient and the advanced search filter got its own page where product attributes are separated into three columns.

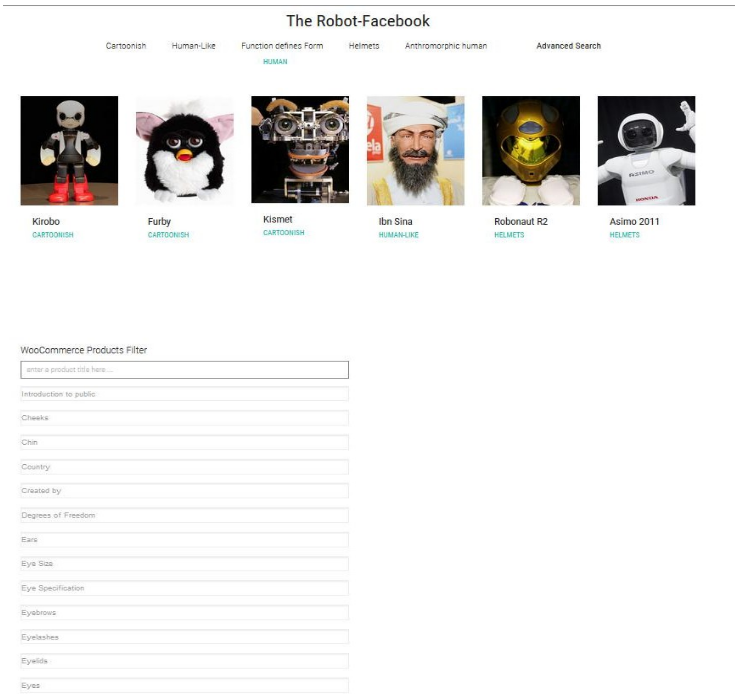

Figure 4. Advanced search filter in the footer of the robot Facebook homepage

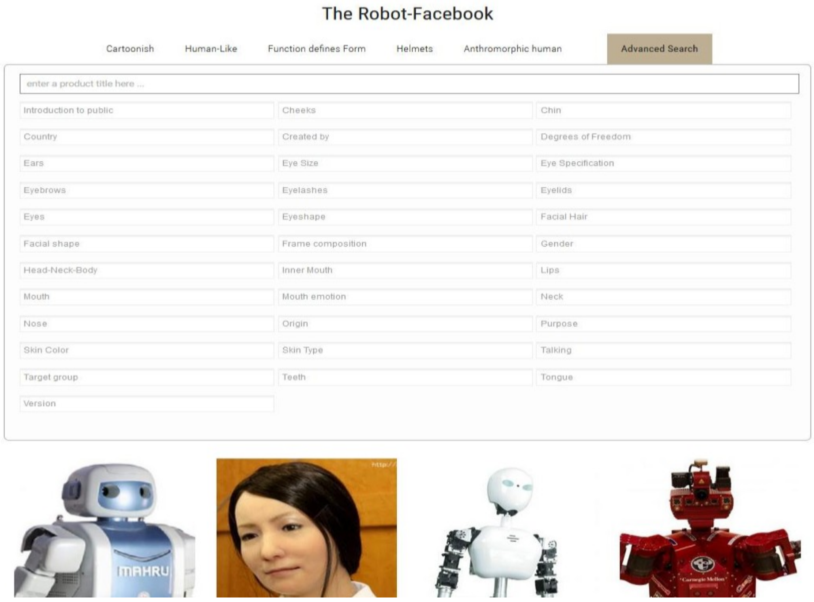

Figure 5. Advanced search filter having its own page

4.2 Data Implementation

Analyzing

During the identify process of robots, more attributes and terms were implemented to appoint new, recurring characteristics. This also led to rewriting some attributes.

Unfortunately, numerous attributes could not be specified, especially: weight, degrees of freedom, tongue, teeth and year of introduction. This led to a total of 319 attributes marked undefined.

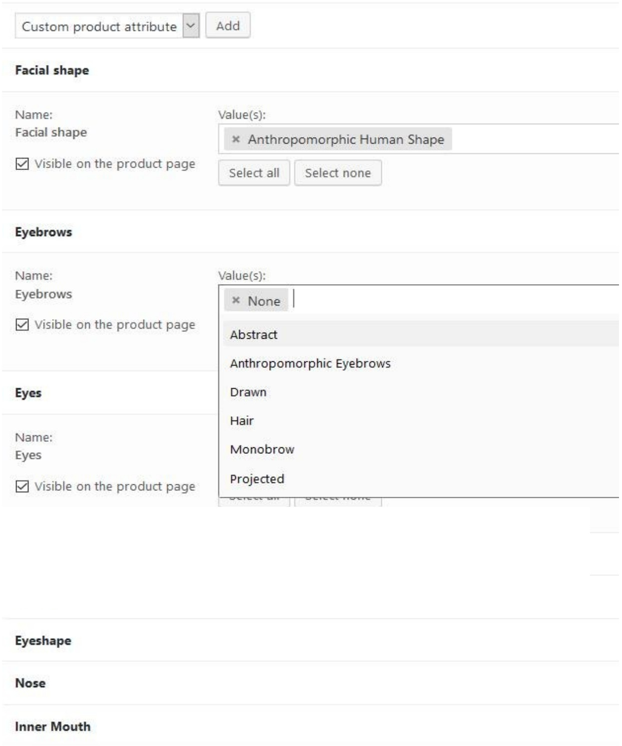

Figure 6. Inserting attribute terms in the robot Facebook

Considering a total of 3939 attributes this leads to a percentage of 8,1% undefined terms.

If 25% of the information on a specific attributes term can't be found, the data will be marked as incomplete. It might give an unreliable outcome of the robot Facebook.

The following attributes were therefore marked incomplete:
-Weight (33 unknown)
-Degrees of freedom (50)
-Gender (29)
-Height (27)
-Skin type (43)
-Version (36)

Excel

As mentioned in the ideation phase, a plug-in called **WP All export**[22] was installed to transfer the attribute data into a readable Excel file.

Exporting the data was successful. However, due to the conversion of multiple terms into one cell, the Excel sheet combined these cells containing multiple terms as a separate type.
For this reason the Excel sheet was manually modified to contain new rows for separating multiple terms.

Tableau

Tableau separates data into measures, dimensions and geographic roles. Some of the data was more suitable to be measured in Tableau, this data had to be altered as Tableau. The data had to be modified in Excel changing for example: yes as 1 and no as 0.

[22] http://www.wpallimport.com/export/

Unfortunately, Tableau is unable to compare data of different dimensions in one graph. Instead it layers dimensions which creates a hierarchy structure. For this reason many separate charts had to be made.

4.3 Data discoveries

In this section, the collected data will be described and potential discoveries will be mentioned.
In the first part, data will be analyzed using robot categories (human-like, anthropomorphic-human, helmet-like, function defines form and cartoonish robots). In the second section, the data will be analyzed again based on the most popular robot purposes.

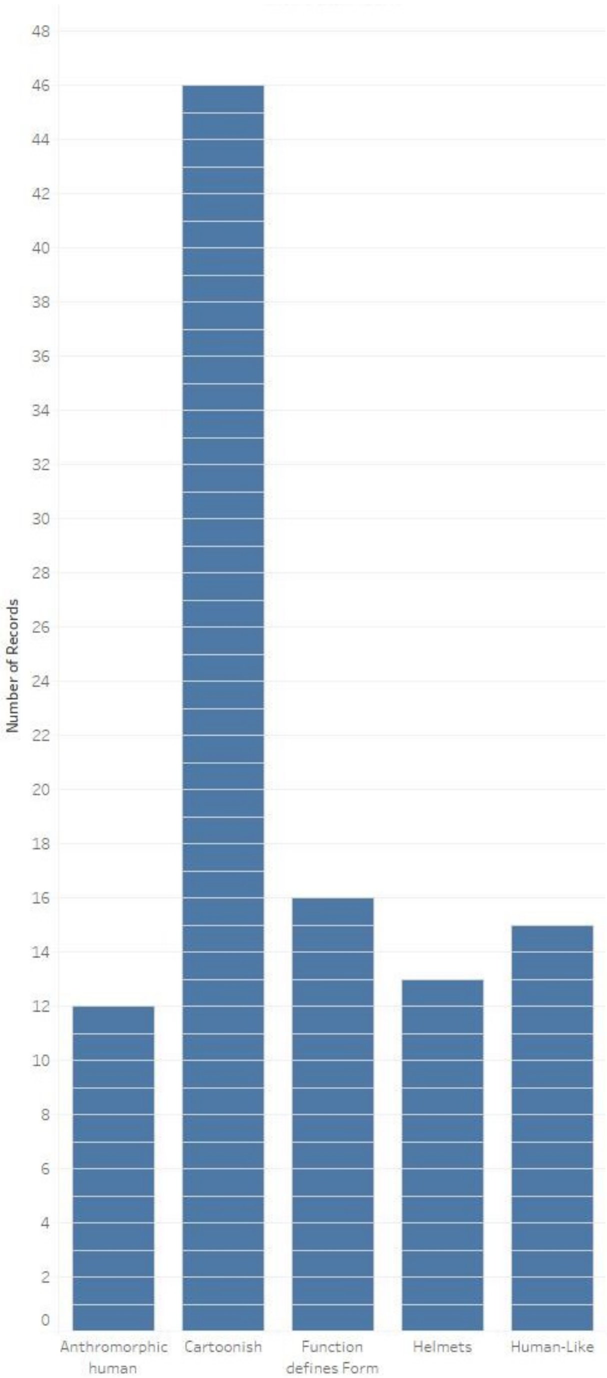

Figure 7. Amount or robots, divided into the 5 main categories in the robot Facebook

Due to the large amount of data, only interesting remarks are being highlighted. Data that has little importance will be ignored. Robot category data will be perceived using the categories as divisions.

The data starts with the background information attributes, followed by facial characteristics and additional characteristics (see section 3.2).

The database exists out of 46 cartoonish robots, 16 functions defines form robots, 13 helmet robots, 15 human-like robots and 12 anthropomorphic human robots. It shows that cartoonish robots are the most popular design choice, they make up 45,1% of the database.

Background Information

Country

37 robots from the database come from the United states. With 28 robots, Japan is the second runner up. Germany has 6 robots. A shared fourth place goes to South Korea and the Netherlands which both created 4 robots that are implemented in the database.

Country	Amount of robots	% Occurrence in total
United States	37	36,3%
Japan	28	27,5%
Germany	6	5,9%
South Korea	4	3,9%
The Netherlands	4	3,9%

Japan features the most human realistic robots (47,7%) and helmet-like robots (38,5%).
The number of cartoonish robots are equally divided between the United States and Japan (both 28,3%). Function defines form robots are highly represented by the United States with 81,3%.

Year of introduction

The oldest robot in this database is the 'Machine Man', it first appeared on the screen in 1927. Followed by 'Gort' in 1951 in 'The Day the Earth Stood Still'. All the databases robots that appeared before 1985 are featured in a movie.

Target group

A remarkable aspect here is the target group of the human-like robot category being undefined.

Category	Most popular target group	% occurrence within category	% total occurrence
Human-Like	Undefined	40%	20,6%
Cartoonish	All ages	39,1%	25,5%
Function defines form	Researchers and programmers	43,8%	17,7%
Anthropomorphic human	People in need of Psych/Physical help All ages	25% 25%	25,5% 7,84%
Helmet-Like	All Ages Movie-visitors Researchers and programmer	23,1% 23,1% 23,1%	30,4% 11,8% 17,7%

<u>Attributes that were left out</u>:

Robot version

Of the 102 robots, 37,3% remains undefined. 37,3% is considered finished and 25,5% is in ongoing development.

Created by

Robot company names are almost as diverse as the robot names, the numbers will have no added value to the project results.

Additional characteristics

Origin

A total of 38 robots have been built as a study. 22 robots have been created with the intention of developing a helping robot. 17 robots originated from a movie. 19 robots can be considered as a consumer item which includes subcategories as toys.
10 out of 102 robots in the database have their origin remain undefined (9,8%).

	Product Categories					
Origin	Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
Consumer item	8,33%	8,70%			6,67%	5,88%
Consumer item|Helper		8,70%	6,25%			4,90%
Consumer item|Study|Toy		2,17%				0,98%
Consumer item|Toy		2,17%				0,98%
Contest winner		2,17%	6,25%			1,96%
Helper		15,22%	12,50%	30,77%	6,67%	13,73%
Helper|Study	8,33%	4,35%				2,94%
Historical Figure					13,33%	1,96%
Movie	25,00%	15,22%	18,75%	15,38%	13,33%	16,67%
Study	58,33%	21,74%	37,50%	46,15%	33,33%	33,33%
Toy		10,87%		7,69%		5,88%
Transport			6,25%			0,98%
Undefined		8,70%	12,50%		26,67%	9,80%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Gender

A total of 39,2% of the robot database is considered male. 14,7% is considered female. 28,4% remains undefined.

Gender (group)	Product Categories Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
Can take both genders		8,70%			6,67%	4,90%
Female	33,33%	6,52%	6,25%		46,67%	14,71%
Male	41,67%	36,96%	43,75%	38,46%	40,00%	39,22%
Neuter	16,67%	19,57%		15,38%		12,75%
Undefined	8,33%	28,26%	50,00%	46,15%	6,67%	28,43%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Noteworthy is the relatively high amount of female robots in the categories anthropomorphic human and human-Like. Another noteworthy aspect is the 50% undefined gender of function defines form robots. A reason for this high amount could be a low gender-importance of this category.

Skin color

White is overall the most common color applied on robots. A total of 22,5% of robots are white colored and 27 robots are partially white, a total of 49% of robots can therefore be considered white of color. A total of 21 robots (20,6%) are black or partially black.
The third most common color is of metallic nature, applied to 12,7% of the robots.

Divided in categories the most popular skin color choices are mentioned below.

Category	Most popular color	% occurrence within category	% total occurrence
Human-Like	White human skin	86,67%	15,69%
Cartoonish	White	56,5%	49%
Function defines form	Metallic	37,5%	11,76%
Anthropomorphic human	White	50%	49%
Helmet-Like	White	53,9%	49%

Mouth emotion

Mouth Emotion (group)	Product Categories Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
Astonished	8,33%	4,35%	6,25%			3,92%
curious				15,38%		1,96%
Neutral	66,67%	23,91%	18,75%	7,69%	93,33%	36,27%
No mouth thus no emotion	16,67%	39,13%	75,00%	76,92%		41,18%
Smiling	8,33%	32,61%			6,67%	16,67%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Many robots don’t have a mouth or the mouth isn’t visible in offline or non-talking state.
It’s remarkable that many cartoonish robots have a mouth that smiles.

Talking

30,5% of the robots talk while opening and closing their mouth. This is the most represented category. A total of 30,4% robots doesn't talk at all. A total of 23,5% robots talk without displaying it.

Divided in categories, the most popular talking choices are mentioned below.

Category	Most popular talking method	% occurrence within category	% total occurrence
Human-Like	Human-Like	86,7%	28,4%
Cartoonish	Talking without displaying it	34,8%	23,5%
Function defines form	None	62,5%	30,39%
Anthropomorphic human	Human-Like	58,3%	28,4%
Helmet-Like	None	61,5%	30,4%

Facial hair

Most robots don't feature any facial hair (80,4%). The only remark is that the majority of robots in the human-like category feature facial hair (66,7%).

	Product Categories					
Facial Hair (group)	Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
Anthropomorphic hair	16,67%	6,52%				4,90%
Beard|head hair|Moustache & head hair	16,67%				66,67%	11,76%
Furr		6,52%				2,94%
None	66,67%	86,96%	100,00%	100,00%	33,33%	80,39%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Facial shape

The most common facial shape is human-like with a total of 20,6%. It comes forward that most cartoonish robots have an anthropomorphic human-shaped face.
Another remarkable aspect is the equally divided facial shape of anthropomorphic human robots. 50% have an anthropomorphic human facial shape and 50% have a human-like facial shape.

	Product Categories					
Facial Shape (group)	Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
Alien-Like		6,52%				2,94%
Animal-Like		21,74%	6,25%			10,78%
Anthropomorphic Human Shape	50,00%	26,09%	6,25%			18,63%
Helmet-Like		17,39%		92,31%		19,61%
Human-Like	50,00%				100,00%	20,59%
No specific form		4,35%	68,75%	7,69%		13,73%
Oval/Round		13,04%	6,25%			6,86%
Screen		10,87%	12,50%			6,86%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Frame composition

28,4% of 102 robots have a human-like frame composition. Most cartoonish and function defines form robots are mobile vehicles.

Divided in categories, the most common frame composition choices are mentioned below.

Category	**Most popular frame composition**	**% occurrence within category**	**% total occurrence**
Human-Like	human-like	86,7%	26,5%
Cartoonish	mobile vehicle	28,3%	22,6%
Function defines form	mobile vehicle	43,8%	21,6%
Anthropomorphic human	human-like	50%	49%
Helmet-Like	human-like	53,9%	27,5%

Head-neck-body

Even though this study focuses on the facial characteristics of the robot, the overall form of a robot was taken into consideration. This is relevant because it might play a role in robot perception.

	Product Categories					
Head-Neck-Body	Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
Fusion of Head-Neck-Body		10,87%	6,25%			5,88%
Head-Body		21,74%	6,25%			10,78%
Head-Neck		4,35%				1,96%
Head-Neck-Body	100,00%	63,04%	87,50%	100,00%	100,00%	81,37%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Generally most robots feature a structure of head-neck-body, but it's worth mentioning that 21,7% of the cartoonish robots only have a head-body.

Height

27,5% of all the robots remain undefined considering height, which makes the category potentially insignificant when finding robot requirements. However, the remaining data has been combined into 6 groups, which provides certain insights.

	Product Categories					
Height (group)	Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
< 50 cm		26,09%	6,25%		6,67%	13,73%
50 - 100 cm	16,67%	17,39%	6,25%			10,78%
100 - 150 cm	8,33%	23,91%	25,00%	30,77%	20,00%	22,55%
150 - 200 cm	33,33%	4,35%	12,50%	53,85%	40,00%	20,59%
> 200 cm		2,17%	12,50%	15,38%		4,90%
Undefined	41,67%	26,09%	37,50%		33,33%	27,45%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Excluding the undefined data, most robots in this database have a height between 100-150 cm.

Cartoonish robots can be generally considered as the smallest robots, followed by anthropomorphic humans and human-like. Function defines form are generally the tallest robots in the database.

Weight

32,4% of all the robots remain undefined considering weight. This makes the attribute weight potentially insignificant when finding robot requirements

Weight (group)	Product Categories Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
5 - 20 kg		15,22%		7,69%		7,84%
20 - 50kg	8,33%	19,57%	12,50%	23,08%	26,67%	18,63%
50 - 100kg	16,67%	6,52%		30,77%	26,67%	12,75%
< 5 kg	16,67%	26,09%	6,25%		6,67%	15,69%
>100kg	8,33%	6,52%	43,75%	15,38%		12,75%
Undefined	50,00%	26,09%	37,50%	23,08%	40,00%	32,35%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Excluding the undefined data, most robots weigh between 20-50kg. Cartoonish robots are among the lightest robots, function defines form robots are the heaviest. This corresponds with the height attribute in which cartoonish robots are the smallest and function defines form the tallest.

<u>Attributes that were left out</u>:

Due to the lack of data, the attributes skin type (43,1% undefined) and degrees of freedom (49% undefined) have been left out.

Facial characteristics

Eye size

A total of 47,1% of the robots from the database have big eyes compared to a human standard. 21,6% have slightly bigger eyes while just 2% have smaller eyes. This could conclude that big eyes are popular to implement.

Eye Size	Product Categories Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
Human-Like	33,33%				100,00%	18,63%
Out of proportion, big	25,00%	73,91%	43,75%	30,77%		47,06%
Out of proportion, slightly bigger	41,67%	21,74%	31,25%	15,38%		21,57%
Out of proportion, small			12,50%			1,96%
Undefined		4,35%	12,50%	53,85%		10,78%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Eye shape

Eyeshape (group)	Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
	Product Categories					
Abstract	8,33%	8,70%		7,69%		5,88%
Human-Like	75,00%	6,52%			100,00%	26,47%
None				46,15%		5,88%
Oval	8,33%	39,13%	6,25%	7,69%		20,59%
Round	8,33%	32,61%	87,50%	38,46%		34,31%
square		2,17%	6,25%			1,96%
Triangles		2,17%				0,98%
Various		8,70%				3,92%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Round eyes are with 34,3% the most common choice of eye shape. Human-like are the seconds most popular with 26,5%. Remarkable are the cartoonish robots, with a preferred shape of oval eyes (39,1%). Most helmet-like robots have no eyes at all (46,1%).

Eyes

There are a lot of eye type options. The most significant ones are displayed below.

Category	**Most popular eye attribute**	**% occurrence within category**	**% total occurrence**
Human-Like	Human-realistic	100%	18,6%
Cartoonish	One screen | Projected	17,4%	9,8%
Function defines form	Multiple eyes|camera lense	31,25%	5,9%
Anthropomorphic human	Human-realistic Anthropomorphic human eyes	25% 25%	18,6% 6,9%
Helmet-Like	One screen	46,2%	5,9%

Eye specification

This group has been divided into 2 subsections. One section explains the general eye specification and the other states robots with a camera as pupil.

General eye specification

Most robots in this database have eyes with eye white, iris and pupil (27,5%).
These types of eyes are the most popular in the group: anthropomorphic human and human-like. Most helmet-like robots have no visible eyes. The function defines form robot category contains

mostly robots with solely a pupil, while most cartoonish robots have an iris and pupil. Its interesting to conclude that there is an obvious eye-style trend for every robot category.

	Product Categories					
Eye Specification (group)	Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
Different eye styles		8,70%	12,50%			5,88%
Eye White only	8,33%	4,35%		7,69%		3,92%
Eye Whites and pupil	25,00%	21,74%	25,00%			16,67%
Eyes with eyewhite, iris and pupil	33,33%	19,57%			100,00%	27,45%
Iris and Pupil	8,33%	23,91%		7,69%		12,75%
Iris Only		2,17%		7,69%		1,96%
Multiple camera eyes			6,25%			0,98%
Multiple eyes		2,17%	25,00%	7,69%		5,88%
No eyes visible				46,15%		5,88%
Pupil Only	25,00%	17,39%	31,25%	23,08%		18,63%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Camera as pupil

A total of at least 22 robots have cameras on the positions of the pupils. There might be more robots with this feature, but in some cases information is unavailable.

Category	**% occurrence within category**	**% total occurrence**
Human-Like	0%	0%
Cartoonish	21,7%	9,8%
Function defines form	43,8%	6,9%
Anthropomorphic human	25%	2,9%
Helmet-Like	23,1%	2,9%

Eyelashes

The robot Facebook concludes that eyelashes aren't a popular feature of robot faces. A total of 79,4% doesn't have any eyelashes. Only the human-like robots are an exception, 86,7% have human realistic hairy eyelashes.

	Product Categories					
Eyelashes	Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
Abstract	8,33%	2,17%				1,96%
Hair	16,67%	6,52%			86,67%	17,65%
None	75,00%	89,13%	100,00%	100,00%	13,33%	79,41%
Projected		2,17%				0,98%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Eyelids

57,8% of the robots in the database don't have any eyelids. As might be expected, almost all human-like robots (93,3%) feature eyelids.

Eyelids	Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
			Product Categories			
Double eyelids		21,74%			26,67%	13,73%
Eye change due to screen possibility		8,70%	18,75%			6,86%
Lower Eyelid	8,33%					0,98%
None	58,33%	56,52%	81,25%	92,31%	6,67%	57,84%
On/Off projection mechanism		4,35%				1,96%
Undefined				7,69%	13,33%	2,94%
Upper eyelid	33,33%	8,70%			53,33%	15,69%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Ears

38,2% of the robots in the robot Facebook don't have any type of ears. Remarkable is the high share of abstract ears in anthropomorphic human robots. With 41,7% it scores higher than anthropomorphic type ears (25%) that one would expect.

Ears	Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
			Product Categories			
Abstract	41,67%	19,57%	18,75%	76,92%		26,47%
Abstract|Projected		2,17%				0,98%
Animal-Like		23,91%	12,50%			12,75%
Anthropomorphic ears	25,00%	4,35%				4,90%
Hammerhead-Like		4,35%				1,96%
Human-Like					86,67%	12,75%
None	33,33%	45,65%	68,75%	23,08%		38,24%
Not visible due to hair					13,33%	1,96%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Eyebrows

72,6% of all the robots in the database don't have any eyebrows. Only Human-like robots (86,7%) are an exception.

Eyebrows	Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
			Product Categories			
Abstract	8,33%	4,35%	6,25%			3,92%
Anthropomorphic Eyebro..		10,87%				4,90%
Drawn	16,67%					1,96%
Hair		2,17%			86,67%	13,73%
Monobrow		2,17%				0,98%
None	75,00%	76,09%	93,75%	100,00%	13,33%	72,55%
Projected		4,35%				1,96%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Mouth

Overall, 42,2% of the robots in the robot Facebook have no mouth. As might be expected, all human-like robots have a human-like mouth.

Mouth	Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
Anthropomorphic mouth		6,52%				2,94%
Beak	8,33%	8,70%				4,90%
Carved	8,33%	13,04%	6,25%	7,69%		8,82%
Drawn		2,17%				0,98%
Drawn|Screen		2,17%				0,98%
function defines form		2,17%	6,25%	23,08%		4,90%
Human-Like	50,00%	2,17%			100,00%	21,57%
Marionette doll mouth		2,17%				0,98%
None	33,33%	41,30%	75,00%	61,54%		42,16%
Projected		13,04%	12,50%			7,84%
Screen		6,52%		7,69%		3,92%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Inner mouth

As most robots have no mouth, 47,1% doesn't have an inner mouth. At least 29,4% of robots have a black inner mouth.

Category	**Most popular inner mouth attribute**	**% occurrence within category**	**% total occurrence**
Human-Like	Human-like	33,3%	5,9%
Cartoonish	None	52,2%	47,1%
Function defines form	None	75%	47,1%
Anthropomorphic human	Black	58,3%	24,5%
Helmet-Like	None	69,2%	47,1%

Tongue

79,4% of the robots have no tongue and this the most common choice for every robot category. Only human-like robots might have a tongue, but 73,3% of them are invisible.

	Product Categories					
Tongue	Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
Abstract		2,17%				0,98%
Human-Like		2,17%			13,33%	2,94%
None	75,00%	89,13%	100,00%	100,00%	13,33%	79,41%
Not visible	25,00%	2,17%			73,33%	14,71%
Projected		4,35%				1,96%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Teeth

A total of 80,4% of all the robots have no teeth. Only the category human-like robots shows a difference; 80% have human-like teeth.

	Product Categories					
Teeth	Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
Abstract	8,33%	4,35%				2,94%
Human-Like	16,67%				80,00%	13,73%
None	75,00%	93,48%	100,00%	100,00%	6,67%	80,39%
Not visible					13,33%	1,96%
Projected		2,17%				0,98%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Nose

Overall, 53,9% of all the robots haven't got a type of nose. All human-like robots have a human realistic nose with air holes. Anthropomorphic robots most often have noses without air holes (41,7%).

	Product Categories					
Nose (group)	Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
Abstract	25,00%	10,87%				7,84%
Animal-Like		6,52%	6,25%			3,92%
Anthropomorphic human ..	8,33%	13,04%		7,69%		7,84%
Dot		8,70%				3,92%
None	8,33%	58,70%	93,75%	92,31%		53,92%
Nose with airholes	16,67%				100,00%	16,67%
Nose without airholes	41,67%					4,90%
Projected		2,17%				0,98%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Lips

67,6% of robots have no lips. Only human-like robots and anthropomorphic-human robots differ regarding lip preferences.

	Product Categories					
Lips	Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
Abstract	8,33%	10,87%				5,88%
Anthropomorphic lips	50,00%					5,88%
Drawn		2,17%				0,98%
Human-Like	16,67%				100,00%	16,67%
None	25,00%	80,43%	100,00%	100,00%		67,65%
Projected		6,52%				2,94%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Chin

There is not a coherent preference for a general type of chin. All human-like robots have a human-like chin, while most function defines form robots have no chin at all. 37% of the cartoonish robots have an abstract chin. Helmet robots have a helmet like chin and anthropomorphic robots are divided between anthropomorphic-human and human-like types of chin.

	Product Categories					
Chin	Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
Abstract		36,96%	18,75%	7,69%		20,59%
Animal-Like		6,52%	6,25%			3,92%
Anthropomorphic human ..	58,33%	19,57%				15,69%
Helmet-Like chin				84,62%		10,78%
Human-Like	41,67%				100,00%	19,61%
None		26,09%	62,50%	7,69%		22,55%
Projected|Screen-Like chin		2,17%				0,98%
Screen-Like chin		8,70%	12,50%			5,88%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Cheeks

Even though most robots have no cheeks, all human-like robots have human-like cheeks and half of the anthropomorphic robots have human-like cheeks.

	Product Categories					
Cheeks	Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
anthropomorphic cheeks	50,00%	39,13%	12,50%	7,69%		26,47%
Flat		2,17%				0,98%
Helmet cheeks		6,52%		84,62%		13,73%
Human-Like	50,00%				100,00%	20,59%
None		41,30%	81,25%	7,69%		32,35%
Projected		4,35%				1,96%
Screenish Cheeks		6,52%	6,25%			3,92%
Grand Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Neck

Most remarkable neck preferences are found among cartoonish robots of which 23,9% doesn't have a neck. Also remarkable, but not displayed below, is that 16,7% of anthropomorphic robots have their neck shorter compared to a human being.

Category	**Most popular inner mouth attribute**	**% occurrence within category**	**% total occurrence**
Human-Like	Human-like neck	93,3%	14,7%
Cartoonish	No neck	23,9%	10,8%
Function defines form	Tech visible	56,3%	25,5%

Anthropomorphic human	Anthropomorphic neck	50%	21,6%
Helmet-Like	Anthropomorphic neck	46,2%	21,6%

4.4 Robot category and robot purposes

Knowing the purpose of a robot is vital to determine its design requirements. For example: a difficult human task purpose robot is preferred to be mobile where a social robot is preferred to be able to talk. Therefore, it can be said that a robots purpose defines its form. This makes a robots purpose such an important attribute that the choice was made to categorize the purposes. All robots in the robot Facebook were labeled with their purpose or purposes. A resulting 22 purposes were determined as the information on all robots in the robot Facebook was studied. In this section, the five robot categories are matched to these 22 robot purposes.

45,1% of the robots in the robot Facebook are cartoonish. This makes the cartoonish robots the largest category. This makes their share relatively higher within every researched purpose. The tables will therefore also show the share of robot categories within the total 102 to provide a better comparable overview.

Entertainment purpose

A total of 28 robots are categorized with having an entertainment purpose. What expectations might predict is the high share of cartoonish robots with this purpose.

Product Categories	% entertainment purpose	Total
Anthromorphic human	7,14%	11,76%
Cartoonish	71,43%	45,10%
Function defines Form	3,57%	15,69%
Helmets	3,57%	12,75%
Human-Like	14,29%	14,71%
Grand Total	100,00%	100,00%

Toy purpose

A total of 7 robots are being labeled as having a toy purpose. All of them are cartoonish.

Product Categories	% toy purpose	Total
Anthromorphic human	0,00%	11,76%
Cartoonish	100,00%	45,10%
Function defines Form	0,00%	15,69%
Helmets	0,00%	12,75%
Human-Like	0,00%	14,71%
Grand Total	100,00%	100,00%

Guide purpose

A total of 4 robots are categorized as having a guiding purpose.

Product Categories	% guide purpose	Total
Anthromorphic human	25,00%	11,76%
Cartoonish	75,00%	45,10%
Function defines Form	0,00%	15,69%
Helmets	0,00%	12,75%
Human-Like	0,00%	14,71%
Grand Total	100,00%	100,00%

Caretaker purpose

A total of 12 robots are defined as being a caretaker. There is a higher representation of function defines form, helmets and anthropomorphic human robots. Most remarkable is that no human-like robot is labeled having a caretaker purpose.

Product Categories	% caretaker purpose	Total
Anthromorphic human	16,67%	11,76%
Cartoonish	41,67%	45,10%
Function defines Form	25,00%	15,69%
Helmets	16,67%	12,75%
Human-Like	0,00%	14,71%
Grand Total	100,00%	100,00%

Assistant purpose

A total of 26 robots are categorized as assistant. They are similarly divided in the categories relative to their total share in the robot Facebook. This might imply that there is no popular choice of robot category when designing an assistant purpose robot.

Product Categories	Purpose %	Total
Anthromorphic human	7,69%	11,76%
Cartoonish	46,15%	45,10%
Function defines Form	19,23%	15,69%
Helmets	15,38%	12,75%
Human-Like	11,54%	14,71%
Grand Total	100,00%	100,00%

Social purpose

46 of all robots are labeled as having a social purpose. This is almost half of the total analyzed robots in the robot Facebook. Helmet and function defines form robots seem to be having a social purpose less often.

Product Categories	% purpose social	Total
Anthromorphic human	10,64%	11,76%
Cartoonish	55,32%	45,10%
Function defines Form	8,51%	15,69%
Helmets	6,38%	12,75%
Human-Like	19,15%	14,71%
Grand Total	100,00%	100,00%

Companion purpose

15 robots are considered having a companion purpose. A notable aspect of robots with a companion purpose is the high amount of cartoonish robots. They make up 60% of the companion purpose, while they score 45,1% in the robot Facebook database. Almost no human-like and anthropomorphic human robots have a companion purpose. This might show that there is still barely a preference for a human looking companion.

Product Categories	% companion purpose	Total
Anthromorphic human	6,67%	11,76%
Cartoonish	60,00%	45,10%
Function defines Form	13,33%	15,69%
Helmets	13,33%	12,75%
Human-Like	6,67%	14,71%
Grand Total	100,00%	100,00%

Educational purpose

12 robots are labeled of having an educational purpose. Cartoonish and anthropomorphic human robots score higher compared to their overall amount in the database. No human-like robots are known for having an educational purpose.

Product Categories	% educational purpose	Total
Anthromorphic human	16,67%	11,76%
Cartoonish	66,67%	45,10%
Function defines Form	8,33%	15,69%
Helmets	8,33%	12,75%
Human-Like	0,00%	14,71%
Grand Total	100,00%	100,00%

Military purpose

Only 6 robots are considered as having a military purpose. As one might expect, function defines form robots are well represented (4/6). The other two are cartoonish robots that originate from the movies (Eve from WALL-E and R2D2 from Star wars).

Product Categories	% military purpose	Total
Anthromorphic human	0,00%	11,76%
Cartoonish	33,33%	45,10%
Function defines Form	66,67%	15,69%
Helmets	0,00%	12,75%
Human-Like	0,00%	14,71%
Grand Total	100,00%	100,00%

Space purpose

7 robots are labeled as having a space purpose. A remarkable aspect is the high share of helmet-like robots (42,9%). Interestingly, this might suggest that the human space suit look influences the choice of the robot look. The cartoonish robots here originate from the movies (Eve from WALL-E, R2D2 from Star wars and the Iron Giant).

Product Categories	% space purpose	Total
Anthromorphic human	0,00%	11,76%
Cartoonish	42,86%	45,10%
Function defines Form	14,29%	15,69%
Helmets	42,86%	12,75%
Human-Like	0,00%	14,71%
Grand Total	100,00%	100,00%

Destroy humans purpose

Just 2 robots are considered as destroying humans, both have an anthropomorphic appearance and originate from a movie.

Domestic purpose

A small total of 5 robots are having a domestic purpose. 80% are categorized as cartoonish.

Product Categories	% domestic purpose	Total
Anthromorphic human	0,00%	11,76%
Cartoonish	80,00%	45,10%
Function defines Form	20,00%	15,69%
Helmets	0,00%	12,75%
Human-Like	0,00%	14,71%
Grand Total	100,00%	100,00%

Logistic purpose

Only 1 robot has a logistic purpose in this database. It has an anthropomorphic human shape (Aila[23]).

Open source purpose

Even though there might be more open source projects, at least 6 robots are mentioned being an open source project. This might imply that these robots are also considered as a study.

Product Categories	% opensource purpose	Total
Anthromorphic human	16,67%	11,76%
Cartoonish	66,67%	45,10%
Function defines Form	16,67%	15,69%
Helmets	0,00%	12,75%
Human-Like	0,00%	14,71%
Grand Total	100,00%	100,00%

Study purpose

28 robots are considered of having a study purpose. They are generally equally divided compared to the overall numbers.

Product Categories	% study purpose	Total
Anthromorphic human	14,29%	11,76%
Cartoonish	42,86%	45,10%
Function defines Form	10,71%	15,69%
Helmets	14,29%	12,75%
Human-Like	17,86%	14,71%
Grand Total	100,00%	100,00%

Production purpose

Just 1 robot is defined as having a production purpose This robot has an anthropomorphic appearance (Aila).

Demonstration purpose

17 of all the robots in the database are labeled as having a demonstration purpose. The most remarkable aspect is the high amount of 41,2% of human-like robots. This might imply that exploring boundaries by creating human-like robots is a popular way of attracting public attention.

[23] http://robotik.dfki-bremen.de/en/research/robot-systems/aila.html

Product Categories	% demonstration purpose	Total
Anthromorphic human	11,76%	11,76%
Cartoonish	23,53%	45,10%
Function defines Form	5,88%	15,69%
Helmets	17,65%	12,75%
Human-Like	41,18%	14,71%
Grand Total	100,00%	100,00%

Therapeutic purpose

Just 4 robots are labeled as having a therapeutic purpose. 2 robots are anthropomorphic and 2 are cartoonish. The anthropomorphic-human robots with a therapeutic purpose both have a childlike frame composition (Milo[24], Kaspar[25]).

Product Categories	% therapeutic purpose	Total
Anthromorphic human	50,00%	11,76%
Cartoonish	50,00%	45,10%
Function defines Form	0,00%	15,69%
Helmets	0,00%	12,75%
Human-Like	0,00%	14,71%
Grand Total	100,00%	100,00%

Tele-existence purpose

5 of all the robots are labeled with a tele-existence purpose. As one might expect, a large share (40% anthropomorphic and 40% function defines form robots) serve this purpose.

Product Categories	% teleexistence purpose	Total
Anthromorphic human	40,00%	11,76%
Cartoonish	20,00%	45,10%
Function defines Form	40,00%	15,69%
Helmets	0,00%	12,75%
Human-Like	0,00%	14,71%
Grand Total	100,00%	100,00%

Sex purpose

2 human-like robots serve a sex purpose. Both are female and human-like.

Decision-making purpose

Only 2 cartoonish robots are considered having a decision making purpose.

Difficult human task purpose

[24] http://www.robokindrobots.com/robots4autism-home/
[25] http://www.herts.ac.uk/kaspar

3 robots are categorized in this way. They all have have a human structure.

Product Categories	% difficult human tasks purpose	Total
Anthromorphic human	0,00%	11,76%
Cartoonish	33,33%	45,10%
Function defines Form	33,33%	15,69%
Helmets	33,33%	12,75%
Human-Like	0,00%	14,71%
Grand Total	100,00%	100,00%

4.5 R3D3 insights

This section focuses on finding interesting guidelines for the R3D3 design requirement list, using insights found by combining data from the robot Facebook database. This serves as a practical example with the goal to deduct design guidelines.

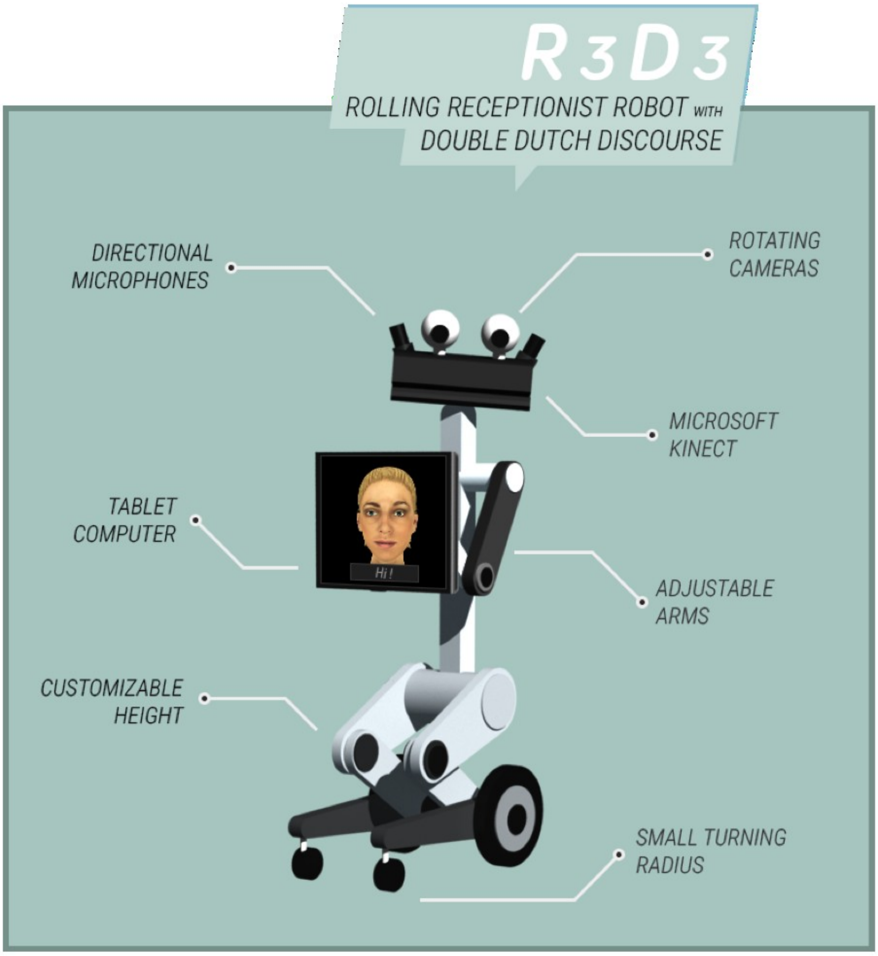

Figure 8. R3D3 (Leorobotics, January 2017)

The R3D3 robot[26] is a receptionist robot that can communicate with users in Dutch language. It is a joint project, part of the Dutch national COMMIT/project. It can learn through the use of data mining and has a compute vision which is able to detect the facial emotion of its users. The robot will hold a tablet which users can use for input.

It can be said that the R3D3 robot has a social and assistance purpose. Therefore, facial features of robots that are both assistant and social purposed (social+assistant) will be deeply analyzed in this section.
All attributes and their terms are added in a table. First the existence ratio of the attribute will be

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Figure 8. Http://www.leorobotics.nl/news/r3d3-rolling-receptionist-robot-double-dutch-dialogue

shown to help determine if the attribute is a commonly applied feature on social+assistant robots. If an attribute is chosen, it is interesting to know which term is the most popular. To be able to determine if the term is popular for social+assistant robots uniquely, it is needed to compare it to the data from the entire robot Facebook. Therefore, the percentage of robots with this term out of the total robots that do have this attribute will be added in the table. For the same reason, the percentage of robots in the entire database that don't have this attribute is also shown.

Assistant + Social

Attribute	No (%)	Yes (%)	Most popular term(s) of attribute if 'yes'	Occurrence of term if 'yes' (%)	Occurrence of term in total robot Facebook if 'yes'(%)	Occurrence of 'no' attribute in total robot Facebook (%)
Cheeks	25%	75%	Anthropomorphic Human-like	25% 25%	39,1%	32,4% -
Chin	0%	100%	Screen-Like chin	41,7%	26,6%	22,5%
Ears	50%	50%	Abstract/Abstract Projected/Animal Anthropomorphic ears/Human-like/ Not visible due to hair.	16,7%	Total of 96,8%	38,2%
Eye-Size		100%	Big Slightly bigger	41,7% 41,7%	52,7% 24,2%	
Eye Specification		100%	Eyes with eye white, iris and pupil	41,7%	29,2%	
Eyebrows	50%	50%	Hair	33,3%	50%	72,5%
Eyelashes	58,3%	41,7%	Hair	60%	85,7%	79,4%
Eyelids	25%	75%	Eye change due to screen possibilities	44,4%	16,3%	57,8%
Eyes		100%	One screen	41,7%	11,8%	
Eyeshape		100%	Human-Like	41,7%	28,1%	
Facial Hair	75%	25%	Head Hair	100%	45%	80,4%
Facial Shape		100%	Screen	41,7%	6,9%	
Inner Mouth	50%	50%	Black	66,7%	51%	47,1%
Lips	66,7%	33,3%	Human-Like	75%	51,5%	67,6%
Mouth	41,7%	58,3%	Human-Like Projected	42,9% 42,9%	37,3% 13,6%	42,2%
Mouth-Emotion	41,7% not defined	58,3%	Neutral	57,1%	61,7%	41,2%
Neck	16,7%	83,3%	Smaller compared to humans	42,9%	30,8%	10,8%
Nose	58,3%	41,7%	Nose with airholes	26,2%	36,2%	53,9%

Skin Color		100%	White human skin	25%	15,7%	
Teeth	66,7%	33,3%	Human-Like	50%	70%	80,4%
Tongue	58,3%	41,7%	Not visible	60%	71,4%	79,4%
Talking		100%	Talking without displaying it	41,7%	29,6%	30,4%
Head-neck-body		100%	Head-neck-body	66,7%	81,4%	
Gender	16,7% undefined	83,3%	Male	50%	54,8%	28,4%
Frame composition		100%	Mobile Vehicle	41,7%	26,5%	
Robot category		100%	Cartoonish	66,7%	45,1%	

With this data a general description can be made of how the R3D3 robot should look based on the features of existing robots with a social+assistance purpose. This table shall be summarized in the results section in order to derive the most popular design suggestions based on the robot Facebook.

5. Testing

This section explains two tests that have been conducted to help validate the robot Facebook project. The first test substantiates the self-made analysis choices with the goal to rule out subjectiveness. The second test aims to research the user friendliness of the database.

5.1. Substantiating analyses method

Link 1. (Asimo)
https://docs.google.com/forms/d/e/1FAIpQLSdv8ALd2So2mdoegMjn0E3HNjODAl_l25kztIJ_XME2WnBrVA/viewform?c=0&w=1

Link 2. (Geminoid DK)
https://docs.google.com/forms/d/e/1FAIpQLScasUxHbG9myCg-5EpSMVxT04l94ceBocaGXl5Ag3Eut8NXsQ/viewform?c=0&w=1

Link 3. (Keepon)
https://docs.google.com/forms/d/e/1FAIpQLSdIjlGIIH5O41lNB8vnaOblWNdsQ0BsBY9OKLqugnrMSWYbEg/viewform?c=0&w=1

Link 4. (Chimp)
https://docs.google.com/forms/d/e/1FAIpQLSczqixnfWx9Komr9h8Shgd3leC0cPFkQqdQ-sDmHiFW0-OVwg/viewform?c=0&w=1

Link 5. (Icub)
https://docs.google.com/forms/d/e/1FAIpQLSdz0xzqW28lGg-rLSV4jNS0zJUksY0ksZRBEQc8GzrDmJZcBQ/viewform?c=0&w=1

The robot analysis was transmitted from an objective but personal point of view. Still, due to a wide variety of personal factors like cultural background, choices made along the way might be different from others.
For example: in my opinion most robots did have a type of anthropomorphic cheek, although the shape varies greatly. Others might disagree to this. To criticize these attribute choices, 5 surveys were conducted in which a robot from each different category was displayed. The survey users were asked to define some of each robots attributes out of a list of corresponding terms. If the user happened to have a different idea, a blank space was available to enter their perception of the attribute.
User answers will be compared to the analysis choices made. Due to the sometimes unclear overlap between terms and the variety, it was decided to validate the choice if at least 40% of the users agree to it. The test results are included in appendix 5.
Some conflicts were found and highlighted here along with a suggestion for their cause:

Neck evaluation: There might be an issue with the chosen definition of the neck terms, this should be a point of attention for future improving of the robot Facebook. For example divide in two attributes: neck dimensions relative to human and neck specification.
Anthropomorphic definition: Users might have been uneducated on the definition of 'anthropomorphic' despite a small explaining text being shown on the survey page.
Cheeks definition: The difference between 'helmet like cheeks' and 'no cheeks' might be vague. Users might tend to relate cheeks to a human shaped head.
Asimo's smile: A too unclear picture was used for the survey example, on different computer screens the smile might or might not have been visible to users.

Conclusion

Improvements are to be made during future development of the robot Facebook. However, 85% of the users answered corresponding to the analyze choices made. This is enough to conclude a general verification without immediate need to modify the project.

5.2. User friendliness of website

The website design choices are verified in this section. One of the project goals is to create a visually appealing and user friendly website. To test if the website is considered user friendly, a user test was set up in which at least ten test subjects had to navigate around the website and accomplish 5 different tasks. The users were then asked to rate the difficulty of these tasks using a Likert scale table with options ranging from very difficult to very easy.

If the average rating of all tasks is considered to be 'easy'. The website proves to be user friendly. The following tasks were shown:
Website: http://robotfacebook.edwindertien.nl/

1) Find the robot Asimo.
2) Use advanced search and choose filter "Eye Size" -> "Out of proportion, big" and "Lips" -> drawn.
3) Find the "contact" information of the robot facebook.
4) Find out which mouth characteristic the robot Flobi has.
5) Find out which robot has a projected nose.

	Very difficult (1)	**Somewhat difficult (2)**	**Neutral (3)**	**Easy (4)**	**Very Easy(5)**
Task 1				4	6
Task 2			1	4	5

Task 3			3	3	4
Task 4		2	2	3	3
Task 5			1	2	7

It can be seen that the average rating is easy for every task. Task 4 shows more mixed results, perhaps because of the slightly higher difficulty of the task.

6. Results

This section starts with finding the requirement suggestions for the R3D3 robot project. Secondly the final prototype of the robot Facebook website will be presented and explained. Thirdly, the forthcoming data visualizations will be discussed.

6.1 Design requirements

The table from section 5.4 has been summarized to show the highest scoring design suggestions. Because sometimes the most prominent suggestion is closely followed by an alternative. An extra column showing the most common alternative feature has been introduced.

Attribute	**Implementing feature Yes/No**	**Most common (alternative) feature**
Cheeks	**Yes 75%**	**Anthropomorphic (25%)** **Human-like**
Chin	**Yes 100%**	**Screen-like chin**
Ears	Yes/no 50%	Abstract, Abstract|projected, animal-like, anthropomorphic ears, human-like, not visible due to hair.
Eye-Size		**Slightly bigger (41,7%)** **Big (41,7%)**
Eye specification		Eyes with eye white, iris and pupil. (41,7%)
Eyebrows	Yes/no 50%	Hair
Eyelashes	No 58,3%	Hair
Eyelids	**Yes 75%**	**Eye change due to screen possibility**
Eyes	**Yes 100%**	**One Screen | Projected (33,3%)**
Eye shape		Human-Like (41,7%)
Facial hair	**No 75%**	**Head hair**
Facial shape		Screen (41,7%)
Inner mouth	Yes/no 50%	Black
Lips	**No 66,7%**	**Human-like**
Mouth	Yes 58,3%	Human-like Projected
Mouth Emotion	Not defined 41,7%	Neutral
Neck	**yes 83,3%**	**Smaller compared to humans (25%)**
Nose	No 58,3%	Nose with airholes
Skin color		White human skin (25%)
Teeth	**No 66,7%**	**Human-like**

Tongue	No 58,3%	Not visible
Talking	Yes 58,3%	Talking without displaying it
Head-neck-body		**Head-neck-Body (66,7%)**
Gender	**Yes 83,3%**	**Male (41,7%)**
Frame composition		Mobile Vehicle (41,7%)
Category		**Cartoonish (66,7%)**

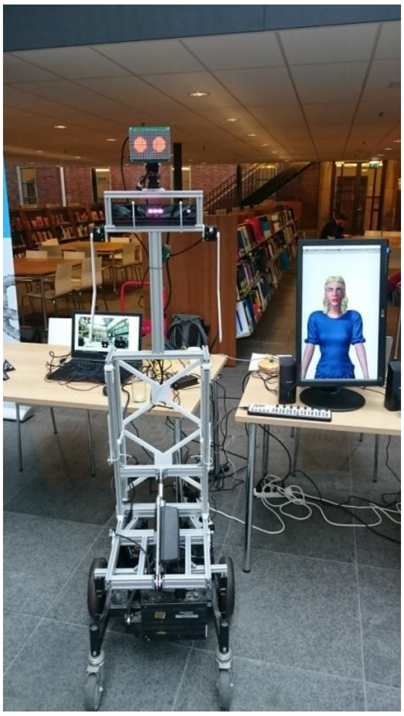

Figure 9. Prototype of the R3D3 robot (Picture taken by Pascale van de Ven).

For deciding whether to feature an attribute at all, results pointing towards a choice with a share bigger than 60% will be considered significant. The most commonly chosen term or terms will be discussed below.

All social+assistance robots in the robot Facebook have eyes.
The eyes of R3D3 are suggested to be projected on a screen. The eye shape should be human-like, with eye white, an iris and pupil. The eye size should be slightly bigger or big compared to human sized eyes. The eye screen should be able to show a blinking animation.

Facial hair and teeth are discouraged as both are an uncommon choice.

A neck is of importance, at least 83,3% of the social+assistance robots have a neck. A smaller neck compared to a human is most common. Most social+assistant robots are shown to have a white human skin, but this is merely a result of a wide variation of color possibilities in the database.

The choices for mouth, inner mouth, mouth emotion, talking method and tongue seem to be more freely as the divide is below 60%/40%.
The lips however, are suggested to be human-like (66,7%).

The overall facial shape is suggested to be screen-like. This matches with the suggestion of using a screen-like chin. However, cheeks are suggested to be either human-like or anthropomorphic. Most robots in this category were designed to have a head, neck and body and a mobile vehicle frame composition.

Depending on the design, the robot will likely be placed in the category cartoonish (66,7%) and least likely in the helmets category (0%).

6.2 Website database

The user test showed that the website was overall rated as being easy to navigate. This means that in this phase no alterations were necessary to make the website more user friendly.
Website: http://robotfacebook.edwindertien.nl/

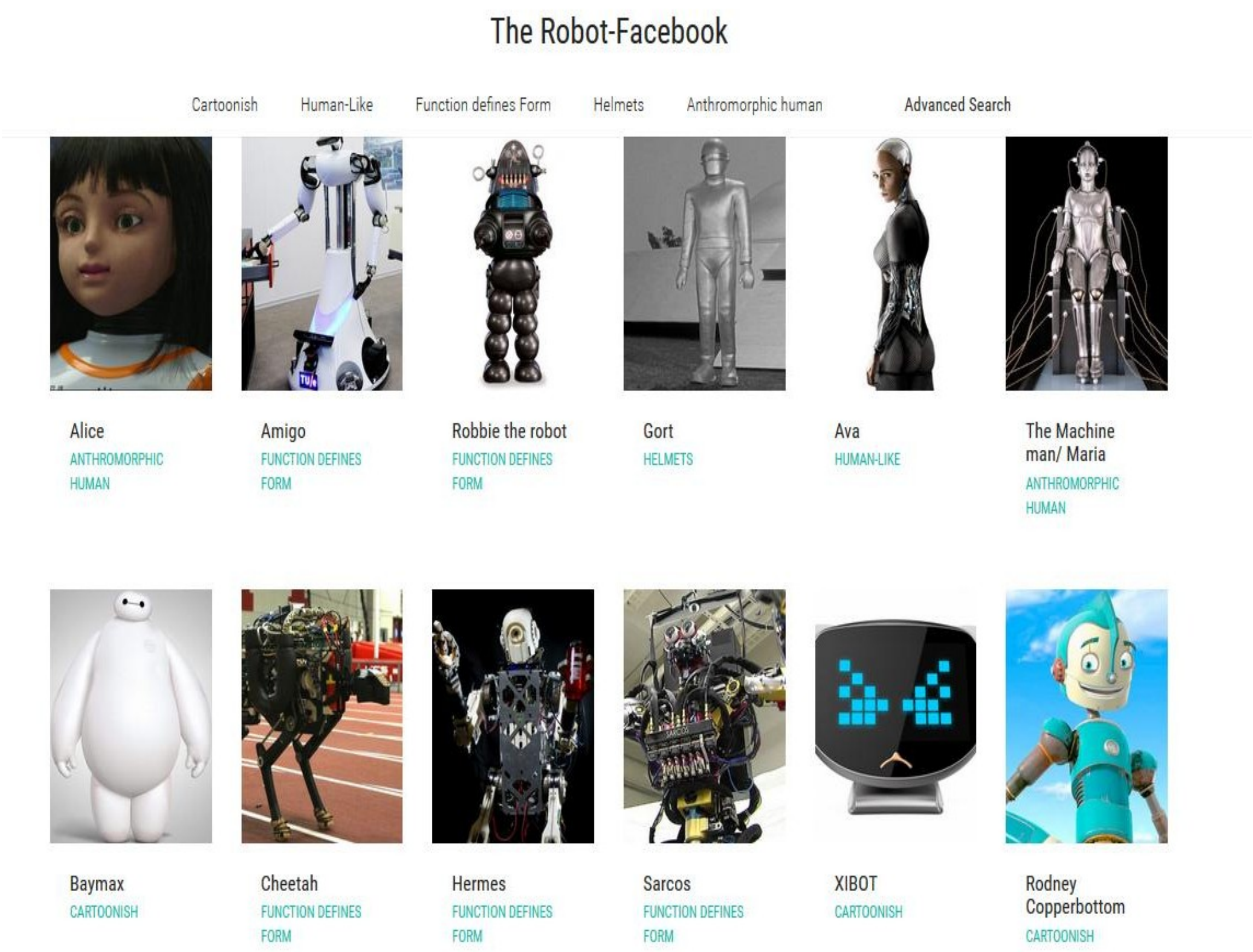

Figure 10. Final prototype version of the robot Facebook

6.3 Data visualizations

To help overview the large amount of data, two data visualizations have been created to gain insights about all the information of robots contained in the project.
The first visualisation focusses on the total database using all the robot categories as starting point.
The second visualisation focusses on the social+assistance robots, showing information and future design possibilities by using key characteristics of social+assistance robots in the database.
Both visualizations are interactive.

Visualisation 1:

Website: https://public.tableau.com/profile/eva3834#!/vizhome/Robotcategories_/Dashboard1

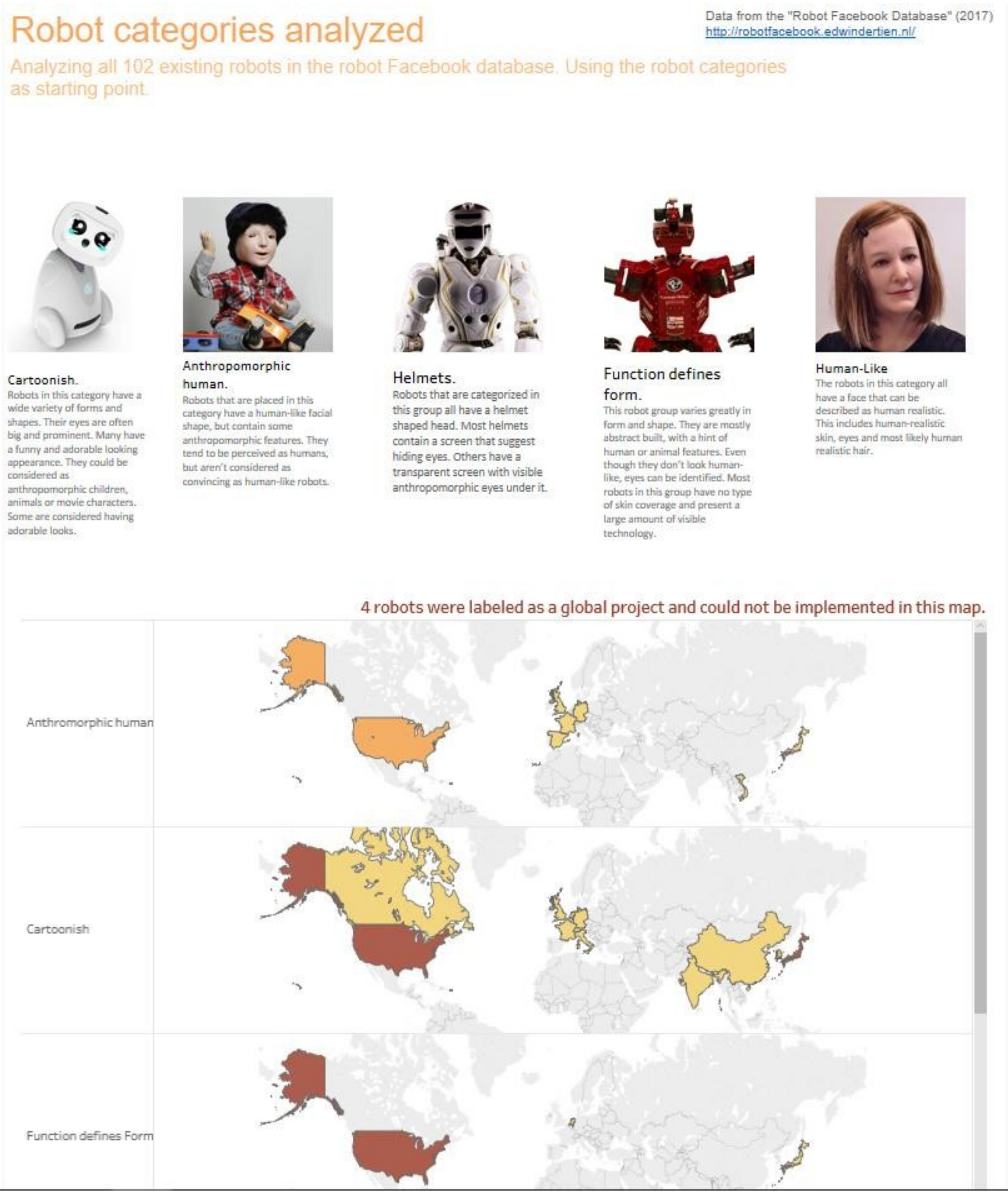

Figure 11. Visualisation based on the 5 main categories in the robot Facebook

Visualisation 2:

Website:

https://public.tableau.com/profile/eva3834#!/vizhome/Designsuggestionsforsocialassistantrobots/Dashboard

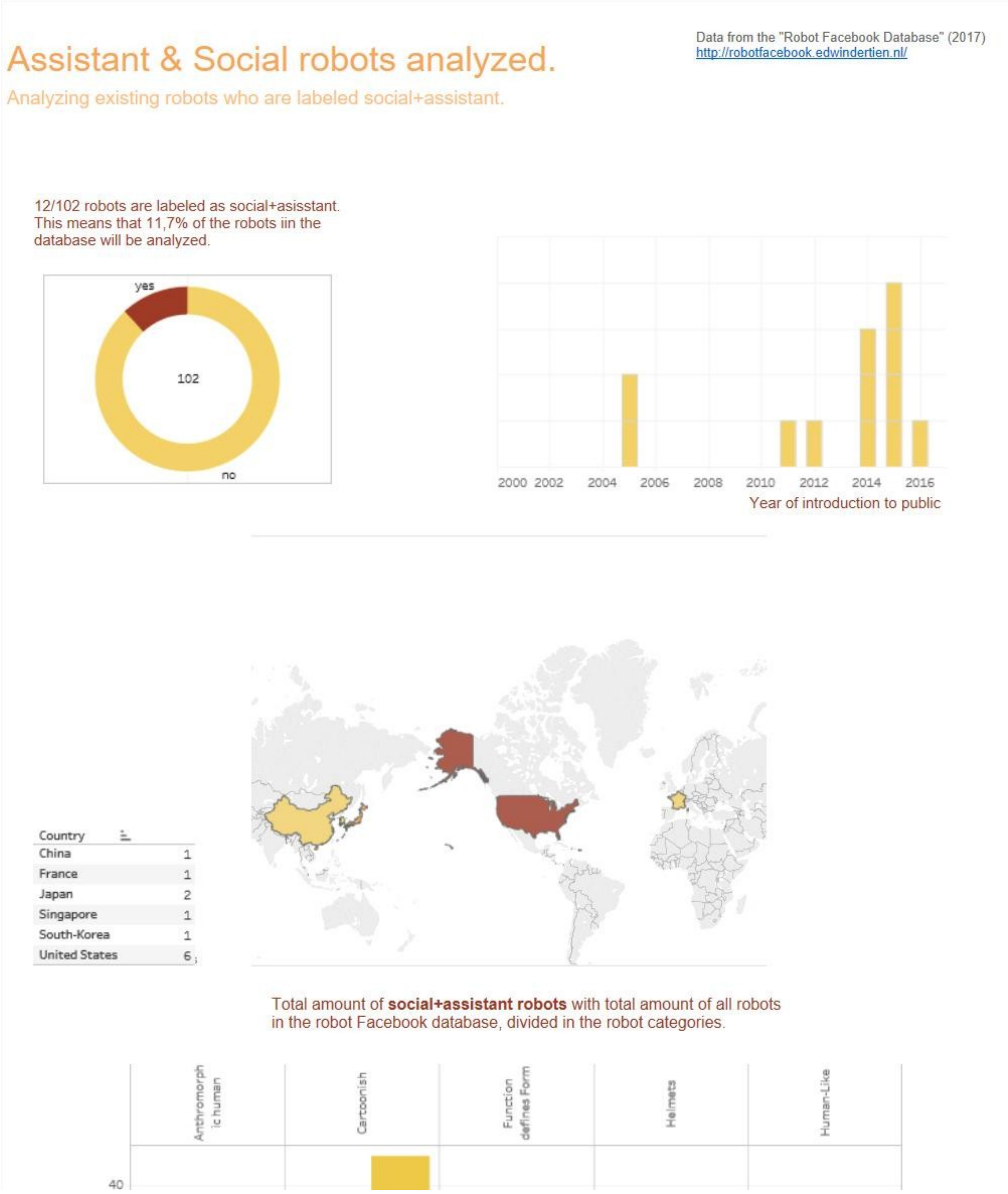

Figure 12. Visualisation based on the social+assistant robots in the robot Facebook

A complete overview of the data visualizations can be found in Appendix 6.

7. Evaluation

In this section the graduation project will be evaluated. Starting by evaluating the project requirements that are specified in the exploration phase. Next, the user experience of stakeholders is discussed. Conclusions will be sought regarding the research questions. Finally, this section offers starting points for future work possibilities.

7.1 Requirement list

In the exploration phase, 11 project requirements have been determined using the Moscow method. To evaluate if the robot Facebook project can be considered comprehensive, all the 'must' requirements, must have been realized.
Firstly the 'must' requirements are evaluated, followed by 'should' and lastly the 'could' requirements.

Must

There must be at least 100 robots.
The total amount of robots in this database is 102. This means that the requirement has been met.

There must be a user friendly online database that equals the book draft development requirement.
With the use of Wordpress, an online database was created. It could be considered as a replacement for a book draft. The user experience test showed a high user friendliness. Users found the website easy to navigate and the given tasks were mostly rated as being easy or very easy.

If information on attribute terms is unavailable, they must be ignored due to the timeframe.
Unfortunately a large amount of needed attribute terms could not be found and therefore, some of them were marked undefined. If >25% of term data was missing, it was still used in the project but marked as undefined.

The attributes must be exported into a spreadsheet.
This requirement has been successfully achieved by using an external Wordpress plugin, which translated the implemented database data into a usable Excel sheet.

Exported data from the database must come in a suitable format for use in a visualisation program.
The data from the spreadsheet was readable in Tableau after small modifications. Tableau was used to generate visualizations and help overview the R3D3 requirements.

Images must be included in the database.
Every robot page is accompanied by its own image and additional video.

Should

The chosen robots should have made an impact on the masses.
Every robot of the 102 met the requirements of impact at the moment of implementation.
The impact is measured using the following requirements:
-When an extensive amount of information can be found on Google and/or Youtube.
-Well known companies are using the robot as PR material.
-When in the list of most popular robot related movies according to IMDB[27], the biggest movie related database.
-Robots that are mentioned in popular media during the exploration phase (section 2.1).
-The first examples of robots, that were introduced in movies.

If the chosen robots didn't make impact on the masses, it should be significantly researched.
Although many robots have been significantly researched, all of the 102 robots in the robot Facebook are also meeting the before stated impact requirements.

Design requirements should be made for the R3D3 robot receptionist project.
The R3D3 robot is a social and assistant robot. To research the design features of previous robots with these purposes, all the robots in the robot Facebook with purpose social+assistant were analysed. This created a list of most common design options. Guidelines for the R3D3 were deducted from this.

Could

The database could be visually appealing.
The main goal of the robot Facebook database was its user friendliness. Aesthetics were added on the sideline but haven't been tested.

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[27] http://www.imdb.com/

7.2 Stakeholders and user experience

To understand if the database and visualizations can be considered useful, two interviews have been conducted with specialists in a social robotic area.
A couple of questions were asked to help understand stakeholders perspectives on robots, current design choices and robot Facebook database.

Interview 1

Cristina Zaga is a PHD student of the University of Twente. She is member of the research group human media interaction. She studies the verbal behavior of robotics. Connecting movement with sounds. The target group is children. She lets children play with a robot and records the behavior to help improve a robots behavior.

What are your experiences with robots?
I don't have a humanoid robot preference. Robots should be things on their own and not a replica of a human or animal for example. They should have their own language.

How do you think people research robot design at this moment?
Multidisciplinary and dependable on the robot. It's important to think about the function and the user. Many designers are more interested in the functionality of the robot. As with users, it's important to understand them. How do users behave around the robot? Children for example, see things differently. It also depends on your field of application. In Japan, for example, there is preference for humanoid robots.
I do think there must be guidelines, but there isn't a methodology written in stone.

What do you think about the way this data has been analyzed?
You took a lot of things into account. This way of analyzing might be useful for a designer, but if he/she is more into its industrial application field, you need to know more about the user interaction. For example: what kind of design space do we have? This would be helpful to answer.

Do you think this database/data visualization can contribute to future robot appearance design?
Yes, I do think these visualizations are interesting to look at.

Would you ever consult this database?
Yes, if I want to know more.

Do you have any extra suggestions?
Perhaps a ranking system of robots; a way to evaluate them. More information about user studies the developers did, reactions of users and further scientific research.

Interview 2

Daphne Karreman is specialized in the design of nonverbal interaction behavior optimized for robot-specific morphologies. She graduated studying a guide robot who showed people interesting places without pointing at them like a human guide. She is interested in researching robot behavior and user experience.

How do you think people research robot design at this moment?
Its two-sided. There are the robots that look like a finished product with a shell and ready to be used by consumers and the robots that are used for research; they look unfinished because they don't have a type of complete shell. If you want to create social robots, they need to look finished, otherwise you will not get them to be accepted in society. Robot designers should also think about the capabilities of a robot. Why does a robot need to walk instead of ride? Walking is more difficult and expensive.

What do you think about the way the data from the robot Facebook has been analyzed?
It's interesting, you can only study those robots that have been made. With this data you can extract trends. It's a good starting point for creating a robot.

Did this data give you any insights you were unaware of?
Yes; in which areas designers are more likely to build human-like robots. But because there is a lot of data I need more time to look through it.

Would you ever consult this database?
If I would continue robot research, certainly. So far, there wasn't a database so complete online.

Do you have suggestions?
I would like to suggest the article from DiSalvo [8] in which they search for a robots 'human-ness', 'product-ness' and 'robot-ness'. Perhaps you can do something with this in your project.

Observations

Both interviews showed existing interest in a tool like the robot Facebook. It provides a good base for further expansion. Basing future design requirements on existing robots is an interesting perspective, according to the interviewed stakeholders.
To proof the user friendliness of the Robot Facebook database, a small user test has been developed. The user experience test showed high user friendliness. Users found the website easy to navigate and the given tasks were mostly rated as being easy or very easy.

7. 3 Research conclusions

Main research question

- How to assist the design environment of robot facial design?

Sub-questions

- What research has been done regarding robot facial appearance?
- How to select existing robots and analyze them and their characteristics?
- How do attributes of a robot relate to its purpose?
- How to deduct guidelines for future robot design using the robot Facebook?

In order to help improve future robots it is vital to understand their current and past. As perhaps in evolution, improvements are always made regarding faults from the past stages of development.
An oversight of this current and past might be needed, the choice was made to collect and analyze existing robots in a database. As a start, literature research, similar projects and the current design environment needed to be studied to overview ***what research has been done regarding robot facial appearance***. Literature was studied to find answers on how to improve future social robots by using key facial characteristics from existing robots. A couple of papers mentioned the Uncanny Valley principle, which designers use as a tool when designing a robot. A critical in-depth reflection has been made and led to the idea that this principle seems limited by solely the robot appearance. This is where the need of a multidimensional uniform measuring space was substantiated. A similar work, popular sources and current design method study showed a lack of current public research that combined a large amount of robots to study the robot facial appearance. This combined with the idea of a need for a multidimensional uniform measuring space, implied enough novelty for the robot Facebook project.
A method had to be determined to find ***how to select existing robots*** included in this database. This without limiting to a specific category of robots but paying attention to the robot's general relevance. The general relevance of a robot for this project is measured by its impact on the masses and the presence of a face. Impact guidelines were created which every robot had to meet.
To find ***how to analyse the robots and their characteristics***, an analysis method was created that had to cover every robot. Due to the wide variation, the robots were categorized. As a starting point for analyzing facial characteristics, the most complex face form (the human face) was used to compile a list of facial features called 'attributes'. The next step was to divide these attributes into 'terms' to describe all the facial characteristics of robots in the database.
Along the way, the robots purpose showed to have a critical relation to the robot appearance. But the question rose ***how attributes of a robot relate to its purpose***. Using some examples, the idea was confirmed that a robots function defines its form. The robot purposes were divided into attributes and these were connected to the earlier chosen robot categories.
The resulting data showed to be useful for ***deducting guidelines for future robot design using the robot Facebook***. A practical case (the R3D3 robot) was studied by using its determined attributes (social+assistant purpose) as starting point. The robots who shared both purposes were used to find

a list of their most common facial features. A selection of design requirements came forward by adding the data in visualizations.
To assist in the design environment of robot facial design, guidelines for other robot projects can be found by implementing its determined attributes in the robot Facebook and visualizing the resulting data. The more robots included in the database, the more reliable the guidelines will be.

7.4 Future work

In this section, future expansion possibilities will be discussed. It mentions several aspects within the project that could have been done differently or more efficiently and gives suggestions and stepping stones for future work.

Validating analysis method.
Because the analysis method used is subjective, a test to validate the chosen attributes would substantiate this method. This should have been completed in an earlier stage of the project, as a large amount of data using the analysis method was already processed. Another solution could be to ask the database visitors to analyze the robots themselves. This could be a stepping stone to a public fed database.

Separation of multiple attributes in Excel.
A large amount of robots couldn't be described with just one term in an attribute. For this reason, multiple terms were attached to some robots attributes. The implementation in Excel placed the multiple attributes within one cell, which lead to unwanted new groups inside Tableau. To solve this problem, all multiple attributes in a cell had to be manually divided.
Some programming is needed in the future, to detect and automatically divide multiple attributes.

Developing a book using the robot Facebook.
The project requirements of the robot Facebook included the making of a draft version for a book. This requirement was replaced by creating a user friendly online database. In the future a book version could be developed using this online database.

A calculation system that gives direct guidelines for your robot design.
The data can be used to deduct design requirements that can be used for future robots. These insights were manually made visible using data visualization by Tableau.
However, if a user wants to create a specific type of robot with certain feature requirements, the data visualization need to be manually made again. A system that calculates the most common design possibilities, using the provided feature requirements, could create an easier oversight for the user.

References to scientific research that comes along with the direct guidelines.
The design requirements are based on existing robotic design choices. These choices might not create the best user acceptance, as literature research and the reflection paper already showed. For example; variations in the users demographic background might cause a potential one-sided view. References to related research could substantiate every design guideline and contribute to the robot Facebook usefulness.

More detailed robot information
The Robot Facebook gives a general overview of the most known robots. The more robots that are included in the database, the more reliable the out coming guidelines will be. A ranking system to evaluate robots could contribute to more user insight and a better understanding of design choices. As discussed in section 2.1, a similar project [8] researched every robots product-ness, human-ness and robot-ness. This points again to the stepping stone for an interactive public fed robot Facebook.

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Appendix 1. Literature research.

Improving future social robots by using key facial characteristics from existing robots.

Introduction.

The future is inseparably connected with robotics. Robots used to have a place in manufacturing, space-exploration and the military. However, nowadays Robots are extending their tasks in entertainment, healthcare, education, social and domestic domains.

Because robots have a wide variation of possible implementations, designing robotics in such a way that they do not negatively influence robot users is an important factor. When humans interact with each other they mostly focus on facial language, it is key in understanding one another. These same principles apply when humans communicate with robots.

Although there are many existing robots on the market, there is not a true guidance of facial principles that need to be taken into consideration. In order to develop this, the following research question will be discussed; how to improve future social robot faces by using key facial characteristics from existing robot faces?

The literature review starts with an introduction and explanation of the Uncanny Valley principle. The uncanny valley is a famous concept within the robot appearance design context. It's used by many researchers when designing or evaluating a robot.

Next, human realistic and anthropomorphic robot faces are described and their benefits and draw backs are discussed. There is a conflict between human realistic and anthropomorphic robot faces. Robot designers often choose for either anthropomorphic faces or human realistic faces, both options have pros and cons and affect user attitude. Next, this review will focus on how cultural factors such as religion, media, cultural expression and age influence robot acceptance and contribute in robot facial designs. It's important to note that there isn't a definitive solution to a robot facial design and that there are more aspects that need to be taken into consideration when designing a robotic face. Finally this research will explain how robot facial design is influenced by its domain of operation and gender, as demographic difference plays an important role in appearance preference.

The Uncanny Valley

Many robot designers and researchers use the Uncanny Valley as guidance through robot design and user tests. In 1970 Masahiro Mori describes the Uncanny Valley, which suggests that humans have no problem with anthropomorphic creatures, as long as they are within a certain spectrum of little human-likeness [1]. Once this robot reaches certain realism of humanness, a sense of eeriness and discomfort is experienced and the robot tumbles down into the uncanny valley. Masahiro believes that robots will remain in this uncanny valley until the human similarity is faultless and indistinguishable from actual humans. The Uncanny Valley is used by many robot researchers as guidance in robotic design. Because the uncanny valley makes a distinction in human realistic faces and anthropomorphic faces, by placing them on each side of the uncanny valley, researches also make this distinction.

Human realistic faces

Choosing human realistic robot faces has its benefits and drawbacks. Burleigh et al. [2] discovered that a feeling of uneasiness emerges when people could not determine whether a face was robotic or a human. Furthermore, expectations arise when a robot becomes realistic. When humans interact with each other they mostly focus

on facial language, it's the key in understanding on another. These same principles apply when humans communicate with robots [5].
When a human realistic robot doesn't behave like a human being, people start questioning their acceptance towards the robot. Reason for continuity in choosing a human realistic robot face lingers in the thought that people are accustomed to interact with other humans. Therefore, a human form should be easier and qualitatively better for social tasks [2].
Another drawback when choosing realistic human faces is the fear of losing control, as robots take over human tasks, with a human appearance.
Appel et al. concluded that robots with experience are most likely to be in the uncanny valley, while robots who were introduced as a tool were considered the least eerie. [1] However Mori et all. [4] showed opposite results and urges the importance of internal intelligence. The robot will remain in the Uncanny Valley when puppet-like behavior is shown.
When designing robot faces a human-like face has both beneficial aspects, and problematic ones. Tests showed different outcomes. Expectations arise and human-like behavior is projected upon the robots when choosing for a human realistic design. However, when the robot shows flaws people start questioning their acceptances towards it. Research contradicts each other when implementing self-consciousness into a robot.

Anthropomorphic faces

While some choose human realistic faces, another group believes anthropomorphic faces are the way to go. An anthropomorphic robotic face has fewer human facial features Due to fewer differences between anthropomorphic robot faces and other, which raises more similarity to one's own identity which create more affinity [4]. Another positive contribution of a reduction in facial features is the amplification of facial emotions and concentration on the message itself. As [2] discovered. Participants preferred anthropomorphic faces due to the perceived personality or expressiveness of the face. Realistic looking faces could be observed as someone else, while iconic faces might be be interpreted as "someone like me."
Anthropomorphic faces show higher likability and more focus on transferring the correct message, but they have less human familiarity. Judging by these results, this might lead to different rules of conduct for humans, a different attitude towards the robot, which could be problematic depending on its role. More research is necessary, regarding anthropomorphic faces and human attitude towards them. Anthropomorphic faces create more affinity, facial expressiveness and concentration on the message they are trying to convey. When designing anthropomorphic faces, the designer must always consider that users could establish new communication patterns with these faces - which could lead to unexpected results.

Facial Features

To understand the best facial design choices for a robot, the most desired facial features should be taken into consideration. These are the face, eyes and mouth [2]. Nose and ears were less desired.
Gellar et al [5] states that to create a convincing human realistic robot, eyes are the most important aspect. This is the place where people look at. When designing a human realistic face; mouth, eyelids and especially the nose were considered necessary to create credibility. Also skin of some kind amplifies humanness [3].
Finally the amount of features and human-like head shape contribute in human-like acceptance [3,6,7].
Because a robot face is a moving object, speed is an important factor in amplifying human realism. Sudden facial transitions or static expressions are viewed as unappealing. [3]
Another important discovery was the need for human-like communication. Appearance and human-like behavior are important when the robot performs social tasks, but not as much as human-like communication [3]

For both anthropomorphic and human realistic faces, symmetry is considered attractive. [6,7,8]. Even though humans are often not symmetrical over the central vertical line and in character animation asymmetry is an important aspect to avoid a “stiff and still” character.
Lastly a hint of smile from the robot face could create more likability at the robot user side. [2]
To understand the best facial design choices for a robot, one should look at the most desired facial features. Facial design features which create a more desirable face are the face itself, eyes and mouth. When creating human realistic faces, different features need to be implemented; mouth, eyelids and especially the nose. Also head shape and symmetry plays a role in human robot realism. Even though speed and human-like communication aren’t facial features, they are worth mentioning as they emphasize the human nature of the robot. Finally a hint of smile could create more sympathy.

Demographic background
Besides robot facial appearance and facial features, target group understanding needs to be researched when designing a social robot; culture, religion, cultural facial expression, robot gender and robot tasks all play important factors in robot perception.

Religion
Religion creates differences in robot acceptance. Many Japanese people believe in Animism, a component of the Shinto Faith religion. Animism tells that all objects, including robots, have a spirit. Although this doesn’t proof that Japanese people are robot lovers, it does tell that Japanese people might have a different, somewhat more positive perception of human robots compare to western countries who do not perceive human robots of having a soul. Hindu people also behaved more positively towards robots.
Mavridis et al. [9] discover that religions like Confucianism, Buddhism, Atheism, etc. self-marked as ‘‘Chinese’’ who are predominant in China show a slightly positive attitude towards robots, while other religions (Christianity, Islam) within the Asian continent have a more conservative look towards social robots. Many practice the Islam religion, which has an anti-iconic doctrine [8]. This might not even accept human realistic robots, as only God is allowed to create human-like images. Mavridis et all. [9] discovered that religion plays a role in robot acceptation, this difference can also be established within the same country, between different language groups . The country of origin of a technology often determines the basic cultural alignment. When a country has a close minded view of technical development, this could lead to difficulties in robot acceptance.
The correct facial appearance of a social robot depends on many demographic data from the user target group. Religion influences how users respond to robots, and Islamic religion might even disagree with a human robot form. A country’s attitude towards technology is another important factor, therefore social norms and cultural understanding should be considered when designing robots.

Facial expression
Between cultures, humans have different ways of interpreting facial cues. This could lead to a gap in recognition rates of expression in robots which could also lead to poor robot acceptance. [8]
Because robots have a multidisciplinary way of conveying information (voice, facial language, tone, appearance) it’s important to implement the right expression that fits within the country of implementation. To create a diverse range of possible robot expressions, a robot needs facial freedom of movement. This can be created by implementing a high amount of degrees in freedom. Another contribution could be the use of symbols being placed on the face. This reduces the realism in a robot but communicates emotions more clearly. While some countries like Japan use symbols regularly, others are rather unfamiliar with it. According to Trovato et al. [8] Western participants only recognized red cheeks and tears, which resulted in 66.8% of the

Western participants feeling no need for symbols, as compared to 20,7% of the Japanese participants. Between cultures, people use different facial language which leads to different interpretation of facial cues. To develop the correct robot expression for the country of implementation, more research is necessary. To create diverse expressions, the robot needs a high degrees of freedom. Alternatively the use of symbols could lead to better understanding of facial expression.

Age

Depending on the age group, results show differences in robot preferences.
Nomura et al. [10] discovered that people in their 20s had a more positive opinion about robots in comparison with other age group participants from Japan and the UK. This shows, that not only the country of origin but also different attitudes towards robots between younger and older adults should be included in robotic design. Because younger adults have a different attitude towards robots, this could also lead to different design solutions. Prakash et al. [2] found that older adults prefer a robot with hair and soft skin, while younger adults are negative about robots having at all. Overall, research showed that older adults favor a human appearance due to familiarity, reliability and expressiveness, whereas younger test participants had a preference for a mechanical looking robot.
Research showed different attitudes towards robots depending on age group. This also leads to difference in facial preferences. There isn't one true answer when designing a correct facial design. User target research is very important when designing the social robot. Without this research, the robot might not be accepted in the country where it will be used..

Robot tasks and gender.

The role and gender of a social robot needs to be taken into the facial design development.
Prakash et al. [2] mentioned that human-looking robots were accepted by both young (50%) and older adults (60%) when they performed tasks that entailed more social skills like healthcare and education.
Research by Mavridis et all. [9] supports this statement, it showed that only 25% of young adults preferred a human face for a domestic robot, while 65% older adults preferred this appearance to be human-looking.
Another research carried out by Prakash et al. [2], discovered that half of the younger adults preferred mixed appearance (between human realism and anthropomorphic) when the robot performed decision making tasks. Even though there was much negativity towards this appearance itself.
When considering roles as personal care, domestic care and decision making tasks, users feel uncomfortable when robots are used in personal care and decision making contexts. When robots take over the role of another human being, test groups experience this as uncomfortable.
This substantiates that users prefer machine-looking robots that did jobs that had less social applications, like domestic chores.
There is negativity when children are instructed by a robot. [2,9] Only Southeast people were neutral or slightly disagreeing about this option.
Robot gender is an important aspect to include in the facial design choices.
Younger adults prefer female features but older adults were neutral on this item. This same test showed the preference of female assistance in their homes, chores, personal care and social situations. Decision-making tasks shifted to a male-looking robot. A male-robot face also presented more strength. Robot gender could contribute in creating a better robotic face, depending on its task.
Robot facial design and tasks, and robot facial design and gender are correlated. The age if the target group also contributes design choices. Especially older adults prefer a human-looking face for social tasks such as healthcare and education. However, robots are experienced uncomfortable by humans when taking over these

social tasks, while domestic chores were better accepted.
There are many different attitudes towards robots, based on their tasks and appearance.
Preference varies extensively, Prakash et al. [2] came up with 4 categories of users to keep in mind when creating a correct design."Those who prefer a mechanical appearance, those who prefer some humanoid characteristics (i.e., a mixed appearance), those who prefer a human appearance, those with no strong preference for appearance."
Robot gender also affects task acceptance. Stereotypically female robots were preferred with domestic chores, personal and social tasks. Male robots are accepted with decision making tasks.

Conclusion

This research discussed the question concerning the improvement of future social robot faces by using key facial characteristics from existing robot faces. This question can only be partially answered, as there isn't one definitive solution for a correct facial design.
The decision between human looking and anthropomorphic robots still needs more research.
Future tests need to include positive and negative effects of expectations and familiarity that is reflected from a human looking appearance. A way to avoid the uncanny Valley feeling might be to introduce a robot as a consumer item rather than a "human-robot". Within this consumer spectrum a robot can be considered non-threatening, and the user will be in control [2]. Although the majority of test subjects in multiple researches prefers a human looking face when the robot performs social tasks, other research stated that older adults prefer a human looking face, while younger adults prefer a mechanical looking robot.
Only a couple of statements can be made regarding desirable facial features and necessary features to create a human-like face: face eyes and mouth, while human-realistic faces need to have a face, mouth, eyelids and especially a nose. Also symmetry, head shape, skin coverage and a hint of smile can contribute in a positive attitude towards robots.
Besides the robot facial appearance and facial feature; culture, religion, technical acceptance, facial expression and age should be taken into consideration. All these aspect are intertwined with each other and resulted in different robot preferences. User target research is very important when designing a social robot. Without this research, the robot might not be accepted.
The appearance of a robot could contribute in a positive experience regarding robot tasks. Robots operating in healthcare, education and as a companion had a preference for a female human face but users also showed some signs of discomfort. Reason for this discomfort is that robots are being seen as someone who is taken over a human role. There was less discomfort when robots did domestic chores. A male robot might be the best choice for decision-making or strength related.
As this research paper shows, demographic background plays a significant part in robot acceptance.
There is more research necessary regarding how demographic background influences robot facial acceptance. Aspects like education, robot age and differences in robot acceptance between sexes, could play a role in robotic facial design acceptance which haven't been mentioned in this research.

[1] M. Appel, S. Weber, S. Krause.,"On the Eeriness of Service Robots with Emotional Capabilities. (Human-Robot Interaction (HRI)", in 11th ACM/IEEE International Conference on 7-10 March, 2016.
[2] A. Prakash and W. Rogers, "Why Some Humanoid Faces Are Perceived More Positively Than Others: Effects of Human-Likeness and Task", *International Journal of Social Robotics*, vol. 7, no. 2, pp. 309-331, 2014.
[3] M. Blow, K. Dautenbahn, "Perception of robot smiles and dimensions for Human-Robot Interaction design", Robot and Human Interactive Communication, The 15th IEEE International Symposium, 2006.
[4] M. Mori, K.F. MacDorman, N.Kageki. (2012). The uncanny Valley (IEEE Robotics & Automation magazine, Issue 2) (pp 98 – 100).
[5] T. Geller, "Overcoming the Uncanny Valley", *IEEE Computer Graphics and Applications*, vol. 28, no. 4, pp. 11-17, 2008.

[6] R. Green, K. MacDorman, C. Ho and S. Vasudevan, "Sensitivity to the proportions of faces that vary in human likeness", *Computers in Human Behavior*, vol. 24, no. 5, pp. 2456-2474, 2008.
[7] C. F. DiSalvom F. Gemperle, J. Forlizzi, S. Kiesler, " All Robots Are Not Created Equal: The Design and Perception of Humanoid Robot Head ," (DIS '02 Proceedings of the 4th conference on Designing interactive systems: processes, practices, methods, and techniques, 2002, pp 321-326.
[8] G. Trovato, T. Kishi, N. Endo, M. Zecca, K. Hashimoto and A. Takanishi, "Cross-Cultural Perspectives on Emotion Expressive Humanoid Robotic Head: Recognition of Facial Expressions and Symbols", *International Journal of Social Robotics*, vol. 5, no. 4, pp. 515-527, 2013.
[9] N. Mavridis, M. Katsaiti, S. Naef, A. Falasi, A. Nuaimi, H. Araifi and A. Kitbi, "Opinions and attitudes toward humanoid robots in the Middle East", *AI & SOCIETY*, vol. 27, no. 4, pp. 517-534, 2011.
[10] T. Nomura, D.S. Syrdal, K. Dautenhan, "Differences on Social Acceptance of Humanoid Robots between Japan and the UK ," 4th International Symposium on New Frontiers in Human-Robot Interaction, 21-22 April 2015, Canterbury UK.

Appendix 2. Reflection Paper

Is the Uncanny Valley one-sided?

In 1970 Masahiro Mori first mentioned the Uncanny Valley. He writes that robots with a human appearance remain cute/attractive until they've reached a certain point in which an eerie feeling arise and the robot tumbles into the Uncanny Valley. Robots that are human-looking but have aspects that are slightly off create a sensation of discomfort, similar to prosthetic hand. We believe the hand is real until we hold it and experience the cold, plastic feeling that makes us shiver.

On the lowest point of the uncanny valley we should imagine zombies and dead people.

Masahiro believes that if we continue on developing human-realistic robots, another point will be reached in which the robot goes out of the Uncanny Valley and will be on the upper right side of the curve. Now the robot can't be distinguished from a human being. Mori suggests that this robot will be perceived as more positive than human beings.

The Uncanny Valley feeling is nothing new. Already in the days of Golem and Frankenstein people felt eerie when seeing something between alive and dead appearing in front of them.

Even though the Uncanny Valley is a principle that many researchers take into consideration, it's worth mentioning that not everybody agrees with the way it's being interpreted.

Hanson tells "Mori put forth the Uncanny Valley as a speculation, not as true scientific theory [1]". Also A. Prakash et al. have their doubts. "Measures used in studies investigating the Uncanny Valley theory include: affect evoked such as fear and anxiety; attractiveness versus repulsiveness; familiarity; likeability; and perceived eeriness . Each of these measures informs about a particular constituent of perceptions; however they cannot independently provide a complete picture of perception formation." [2]

Furthermore several test results have already refute the Uncanny Valley and showed different shapes and patterns.[1]

The feelings we perceive when seeing a human looking robot also depends on our sex, age, demographic background, religion and our preconceptions.

Religion is an important factor. Many Japanese people believe in Animism, a component of the Shinto Faith religion. It tells that all objects, including robots, have a spirit. To give an example; there are Aibo funerals in Japan (a popular robotic pet made by Sony in 1998). Islamic countries might not tolerate human looking robots at all. Islamic religion says that only god can create humans and for this reasons images (excluding pictures) that reflect humans are not allowed.

Another difference is the way we are growing up with robots. Robots in Japan are often portrayed as friendly and as helpers to the people, whilst western countries grow up with movies like Terminators showing robots as evil, human destroying monsters. If we experience WALL-E as a sweet, caring robot and terminator as repulsive, then movies might influence our opinions towards robots.

Different tests discovered that women have a more positive attitude towards robots than man. Women also rate humanness in robotics sooner than men. [3,4]

Robot gender is also an important topic when designing a robot. M. Appel (et al) discovered that robots whom operate in healthcare are better accepted in female form, whilst preference for tasks that are cognitively demanding shift to a male looking robot. He also discovered differences between age groups. Older adults favored a human looking robot with hair, whereas younger participants didn't want to see any hair at all and gave preference for a mechanical looking robot.

Participants in the research I've read were mostly educated people with a degree. I believe there is more research necessary to understand the attitude towards robots of people without a degree.

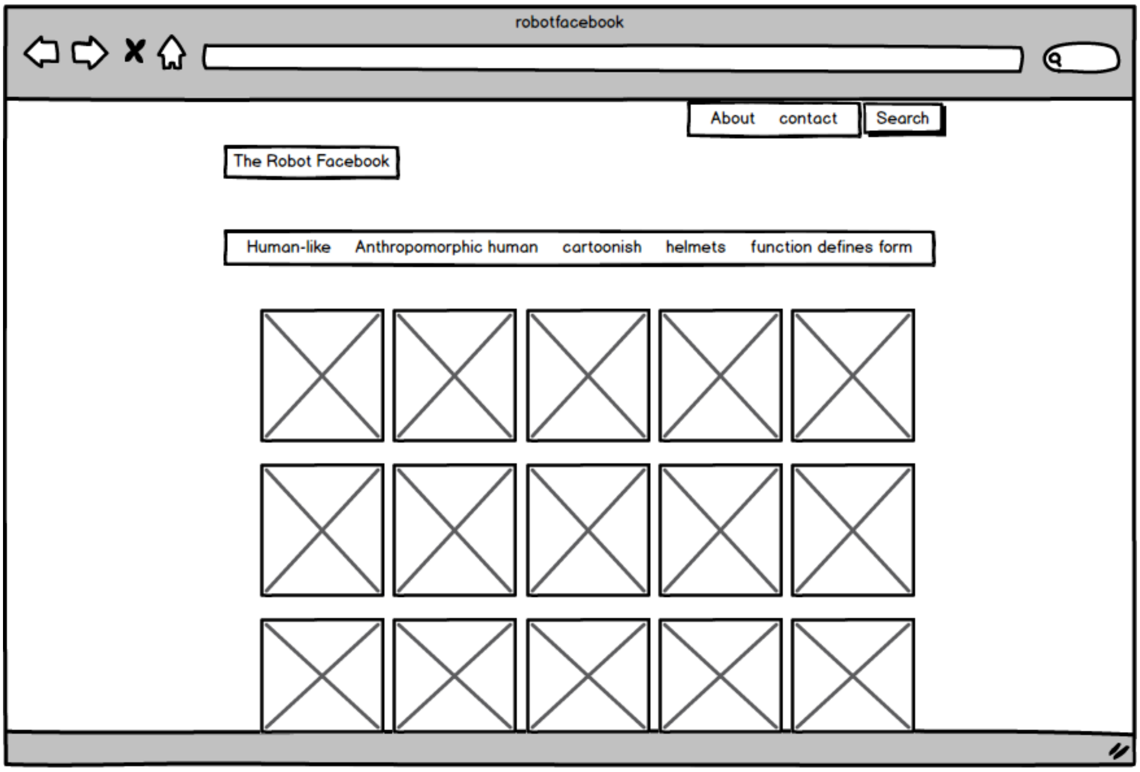
While I believe there is more research needed for understanding cultural influences that develops someone's opinion towards human shaped robots, even more research is necessary regarding facial design choices in human robots. R.D. Green[6] focused on attractiveness in robots and human beings. Even though this lead to interesting results I think it's questionable if a robot should be attractive at all. Humans judge other attractive humans as smart, more sociable and fun but can we expect the same results when applying attractive faces on robots?

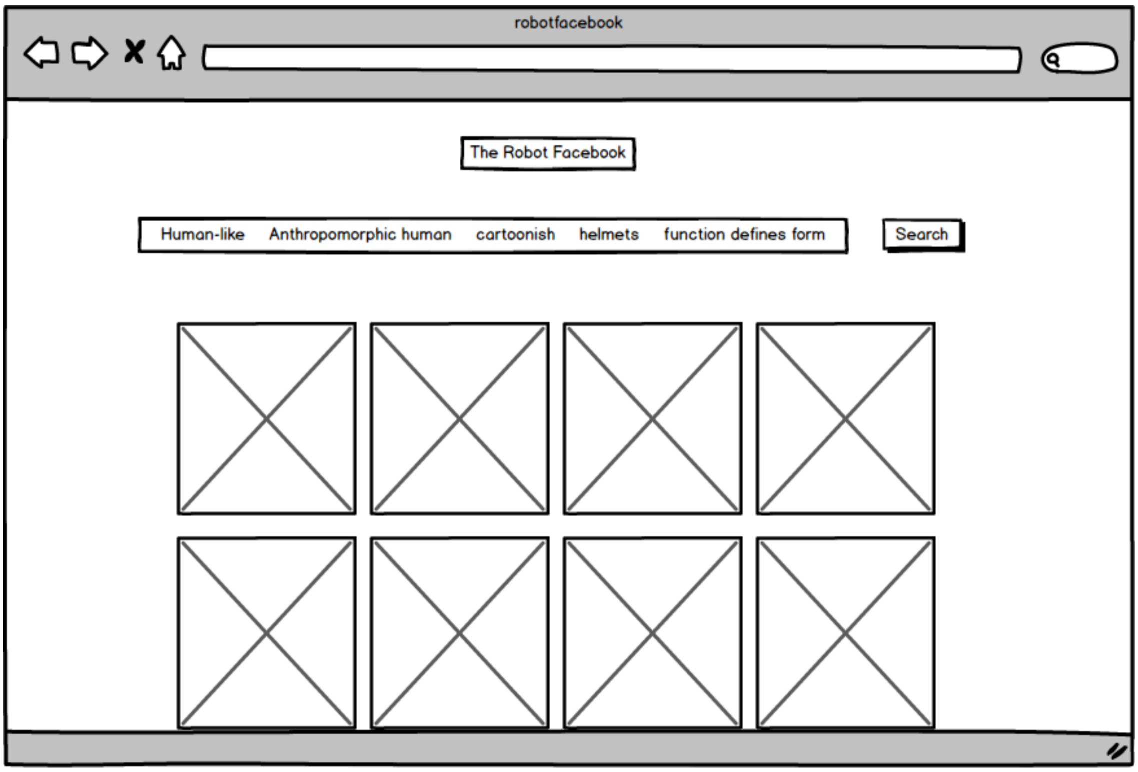
When taken all these aspects into consideration one can argue if the Uncanny Valley itself truly exists.
Sara Kiesler and Aaron Powers both remain uncertain about the uncanny valley. "There's some evidence that the valley exists, and some that it doesn't" [1]. Research already showed different outcomes and curves and some believe a 2D curve isn't enough anymore. I agree, maybe every robot needs its own curve. Maybe the robot needs a multidimensional measuring space regarding appearance, movement, speed and voice. I don't think you can determine a robot solely on appearance anymore, if we want to create them as social, autonomous situation judging,
, self thinking creatures.
That's why I believe it's important that future tests represent robots in a correct manner.
Some test participants worked with real robots, others with 3D animation, some solely with pictures and some without any supporting material at all. How can we combine all these results and filter a coherent conclusion?

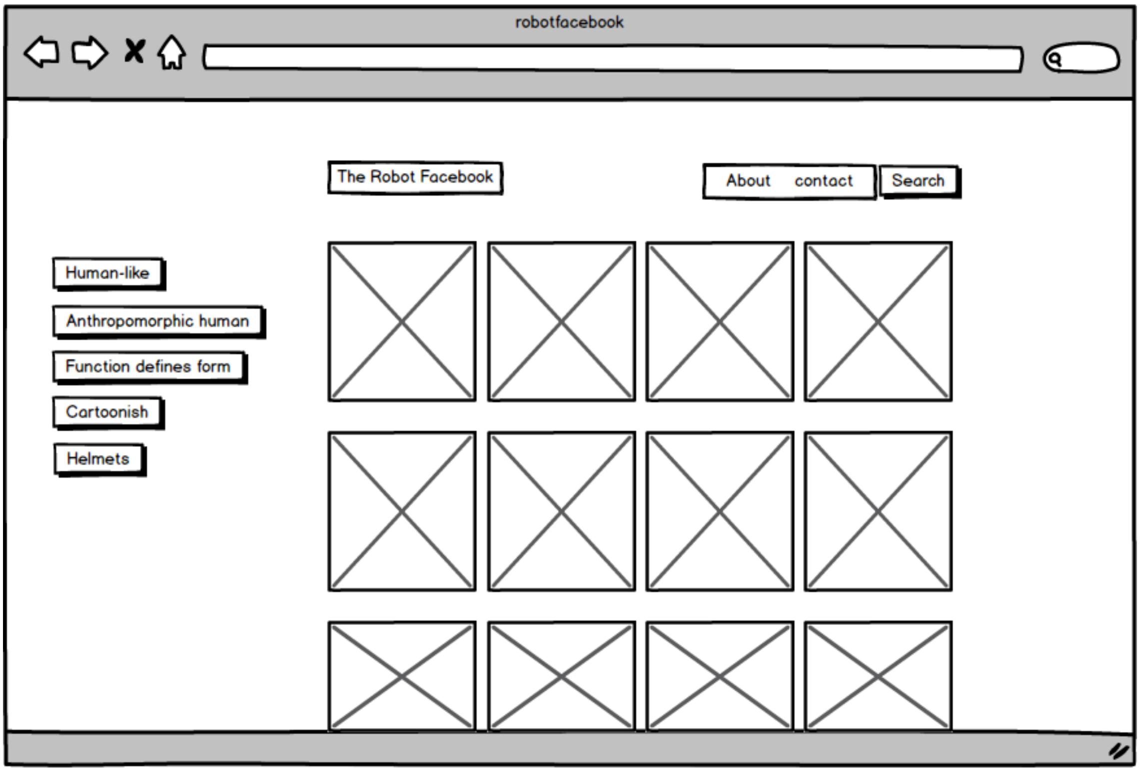
When taken all these aspects into consideration the question if "the Uncanny Valley is a good fit"
to judge people expectations about robots might be somewhat one-sided and results show a contradistinction.
It might be a good starting point for people who are unfamiliar with robotic facial attitudes, but it should not be a true guidance when you want to understand people's behavior towards social robots when the Uncanny Valley only measures robotic design.
Besides that culture, religion, preconceptions, sex, age and demographic should be taken into consideration before participants perform a test within this field.

[1]T. Gellar. (2008). Overcoming the Uncanny Valley (Computer Graphics and Applications ,Volume 28 Issue 4) (pp 11-17).
[2] A. Prakash, W.A. Roger. (2015) Why Some Humanoid Faces Are Perceived More Positively Than Others: Effects of Human-Likeness and Task (International Journal of Social Robotics, Volume 7, Issue 2, (pp 309–331).
[3] N. Mavridis, M Katsaiti, S.Naef, A. Falasi, A. Nuaimi, H. Araifi, A. Kitbi. (2011)Opinions and attitudes toward humanoid robots in the Middle East. (AI & Socieity, November 2012, Volume 27, Issue 4,) (pp 517–534)
[4] M. Blow, K. Dautenbahn (2006) Perception of robot smiles and dimensions for Human-Robot Interaction design. (Robot and Human Interactive Communication, 2006. ROMAN 2006. The 15th IEEE International Symposium).
[5] M. Appel, S. Weber, S. Krause. On the Eeriness of Service Robots with Emotional Capabilities. (Human-Robot Interaction (HRI), 2016 11th ACM/IEEE International Conference on 7-10 March 2016).
[6]R.D. Green. (2008) Sensitivity to the proportions of faces that vary in human likeness.(Elsevier, Volume 24, Issue 5, September 2008) (pp 2456–2474).

Appendix 3. Mockup Facebook website design






robotfacebook
The Robot Facebook
About contact
Search
Human-like
Anthropomorphic human
Function defines form
Cartoonish
Helmets

Appendix 4. All terms of Attribute list

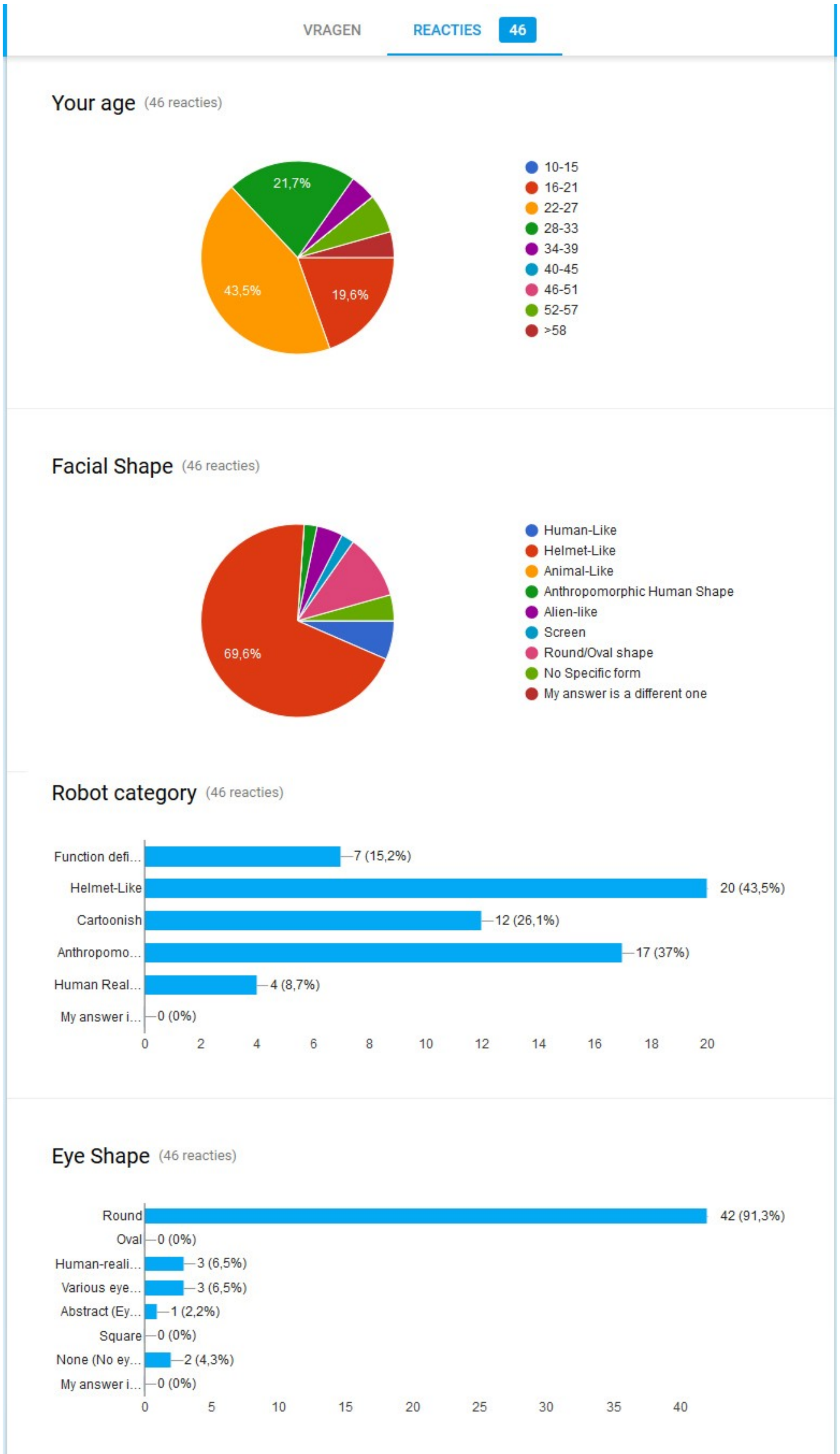
Name	Slug	Type	Order by	Terms
Introduction to public	build-year	Select (Public)	Name	1927, 1951, 1956, 1973, 1977, 1978, 1984, 1986, 1989, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016
Cheeks	cheeks	Select (Public)	Name	anthropomorphic cheeks, Flat, Helmet cheeks, Human-Like, None, Projected, Screenish Cheeks
Chin	chin	Select (Public)	Name	Abstract, Animal-Like, Anthropomorphic human chin, Helmet-Like chin, Human-Like, None, Projected, Screen-Like chin
Country	country	Select (Public)	Name	Canada, China, France, Germany, Global project, Great Britain, Hong Kong, India, Iran, Italy, Japan, Singapore, South-Korea, Spain, The Netherlands, United Arab Emirates, United Kingdom, United States, US, Vietnam
Created by Edit | Delete	created-by	Select (Public)	Name	20th Century Fox, A-SET, AKA Intelligence, powered by MUSE,, Alan Taylor, Aldebaran Robotics, Alex Garland, Anki, Artificial Intelligence Laboratory of the University of Zurich, ATR, Bielefeld University, Blue Sky Studios, Bluefrog robotics, Boston Dynamics, Brad Bird, Carnegie Mellon University, Center for Advanced Vehicles (CAV), Chen Xiaoping, Cynthia Breazeal, DFKI robotics innovation center, Disney, Dongbu Robot, Douglas Adams, Dr. Cynthia Breazeal, Engineered Arts Ltd, Fred M. Wilcox, Fritz Lang, Fujitsu Automation, FutureRobot, Gael Langevin, George Lucas, German Aerospace Center, Global project, Hanson Robokind, Hanson robotics, Harada Vehicle Design, Harvard, Hideki Kozima, Hiroshi Ishiguro, Honda, Ingen Dynamics Inc, Intel, Interactive Robots, Italian Institute of Technology, J.L. Huang, Jake Schreier, JSK Laboratory, Karlsruhe Inst. of Tech., Kawada Industries INC, KIST, Kokoro company ltd., Korea advanced institute of science and technology, McMaster University, Media Lab, Meka Robotics, MIT, Mitsubishi Heavy Industries, Nanyang Technological Univeristy, NASA, National Institute of Advanced Industrial Science and Technology, NEC Corporation, Neill Blomkamp, Nippon Institute of Technology, Osaka University, PAL Robotics, Philips Electronics, Pixar, Rex Bionics, RIKEN, Robo Builder Co., Ltd., ROBOTIS, Ryerson University, Samsung Electronics, Sarcos, Segway Robotics, Sharp, Softbank, Sony, Sony movie channel, Spin Masters, Sumitomo Riko Company Limited, Susumu Tachi, Takanori Shibata, Takara Tomy, Tiger Electronics, Toshiba, Tosy, Toyota, TrueCompanion, TU Delft, TU Eindhoven, Undefined. (Not Alfred Lanning)., University of Hertfordshire, University of Tehran, University of Tokyo, Vstone, Waseda University, Willow Garage, WowWee, Xiaomi, ZMP, ZNUG Design
Degrees of Freedom	degrees-of-freedom	Text (Public)	Name	0, 1, 12, 13, 18, 19, 2, 27, 3, 31, 4, 5, 6, 7, 8, Undefined
Ears	ears	Select (Public)	Name	Abstract, Animal-Like, Anthropomorphic ears, Hammerhead-Like, Human-Like, None, Not visible due to hair, Projected
Eye Size	eye-proportion	Select (Public)	Name	Human-Like, Out of proportion, big, Out of proportion, slightly bigger, Out of proportion, small, Undefined
Eye Specification	eye-specification	Select	Name	Camera as Pupil, Different eye styles, Eye White only, Eye Whites and pupil, Eyes with eyewhite, iris and pupil, Iris and Pupil, Iris Only, Multiple camera eyes, Multiple eyes, No eyes visible, Pupil Only
Eyebrows	eyebrows	Select (Public)	Name	Abstract, Anthropomorphic Eyebrows, Drawn, Hair, Monobrow, None, Projected

Eyelashes	eyelashes	Select (Public)	Name	Abstract, Hair, None, Projected
Eyelids	eyelids	Select (Public)	Name	Double eyelids, Eye change due to screen possibility, Lower Eyelid, None, On/Off projection mechanism, Undefined, Upper eyelid
Eyes Edit | Delete	eyes	Select (Public)	Name	Abstract, Anthropomorphic human eyes, Carved, Drawn, Holes, Human-realistic, LED, Multiple eyes, Not visible, One eye, One screen, Projected, Round Camera Lense, Screen shaped eyes
Eyeshape	eyeshape	Select (Public)	Name	Abstract, Human-Like, None, Oval, Round, square, Triangles, Various
Facial Hair	facial-hair	Select (Public)	Name	Anthropomorphic hair, Beard, Furr, head hair, Moustache, None
Facial shape	facialshape	Select (Public)	Name	Alien-Like, Animal-Like, Anthropomorphic Human Shape, Helmet-Like, Human-Like, No specific form, Oval/Round, Screen
Frame composition	frame-composition	Select (Public)	Name	Ambiguous Human shape, Animal-Like, Child Like, Head Only, Human-Like, mobile vehicle, Other, Walking structure
Gender	gender	Select (Public)	Name	Can take both genders, Female, Male, Neuter, Undefined
Head-Neck-Body	head-neck-body	Select (Public)	Name	Fusion of Head-Neck-Body, Head-Body, Head-Neck, Head-Neck-Body
Inner Mouth	inner-mouth	Select (Public)	Name	Black, Human-Like, None, Projected, Skin colored, Technology, Undefined, White
Lips	lips	Select (Public)	Name	Abstract, Anthropomorphic lips, Drawn, Human-Like, None, Projected
Mouth	mouth	Select (Public)	Name	Anthropomorphic mouth, Beak, Carved, Drawn, function defines form, Human-Like, Marionette doll mouth, None, Projected, Screen
Mouth emotion	mouth-emotion	Select (Public)	Name	Astonished, curious, Neutral, Not defined, Smiling
Neck	neck	Select (Public)	Name	Animal-Like, Anthropomorphic Neck, Closer to the upper body compared to humans, Further away than Humans, Human-Like, Larger compared to human proportion, None, Projected, Smaller compared to humans, Tech visible
Nose	nose	Select (Public)	Name	Abstract, Animal-Like, Anthropomorphic human nose, Dot, None, Nose with airholes, Nose without airholes, Projected
Origin	origin	Select (Public)	Name	Consumer item, Contest winner, Helper, Historical Figure, Movie, Study, Toy, Transport, Undefined
Purpose	purpose	Select (Public)	Name	Assistant, Caretaker, companion, Decision Making, Demonstration, Destroy humans, Domestic, Education, Entertainment, Guide, Logistics, Military, Opensource, Operating difficult human tasks, Production, Receptionist, Sex, Social, Space, Study, Telexistence, Therapeutic, Toy, Undefined
Skin Color	skin-color	Select (Public)	Name	Black, blue, Gold, Green, Grey, Metallic, Orange, Pink, Red, Several possibilities, Transparant White, White, White human skin, Yellow
Skin Type	skin-type	Select (Public)	Name	Aluminum, Aluminum with steel, Dense Alloy, Furr, Latex/Silicone rubber, Metal, Metallic, No skin, Non-Metallics, Not defined, Plastic, polycarbonate, Screen, Thermoplastic elastomer

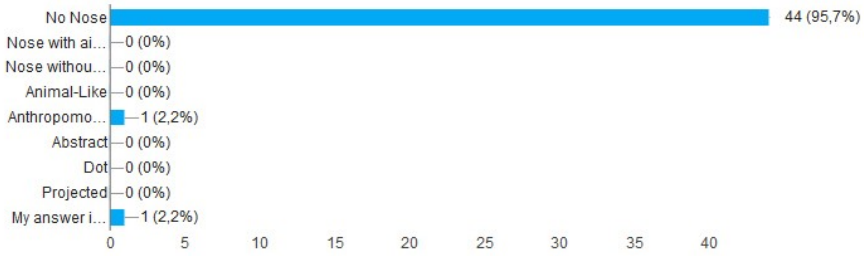
				skin, Yellow
Skin Type	skin-type	Select (Public)	Name	Aluminum, Aluminum with steel, Dense Alloy, Furr, Latex/Silicone rubber, Metal, Metallic, No skin, Non-Metallics, Not defined, Plastic, polycarbonate, Screen, Thermoplastic elastomer
Talking	talking	Select (Public)	Name	Child-Like, Human-Like, LED Blinking, None, Projection, Sound effects, Talking without displaying it, Undefined
Target group Edit | Delete	target-age-group	Select (Public)	Name	All ages, Astronauts, Consumers, Drivers, Movie 12+, Movie 16+, Movie 6+, People in need of Psych/Physical help, Researchers and Programmers, Students, Transport companies, Undefined
Teeth	teeth	Select (Public)	Name	Abstract, Human-Like, None, Not visible, Projected
Tongue	toungue	Select (Public)	Name	Abstract, Human-Like, None, Not visible, Projected
Version	version	Text (Public)	Name	3, 4, 8, Cancelled, F, Finished, Ongoing, Original Version finished (1998), R2 Finished 2016, Undefined

Appendix 5. Substantiating analyses method user test

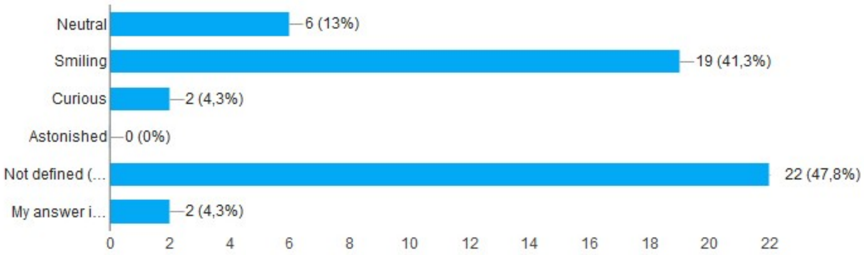
Results Asimo.



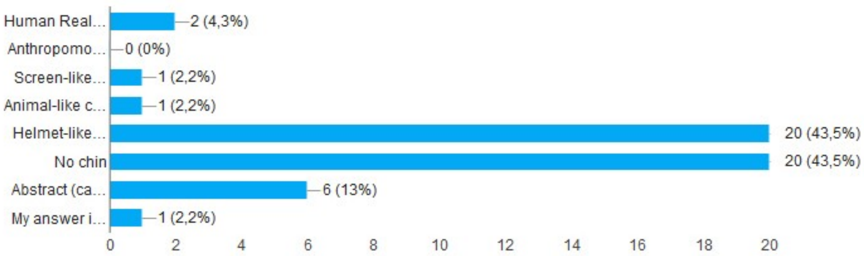
Nose (46 reacties)



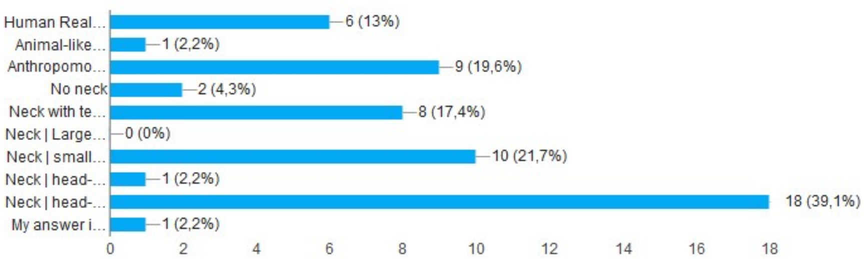
Mouth emotion (46 reacties)



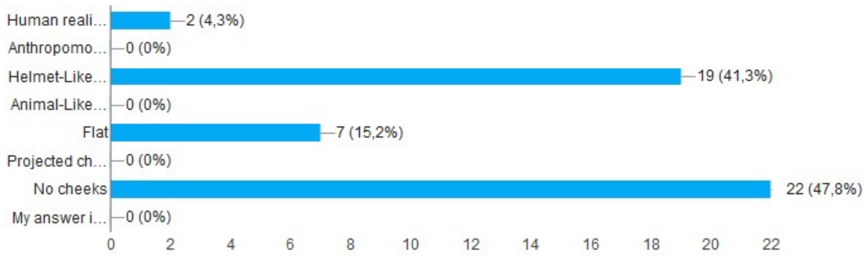
Chin (46 reacties)



Neck (46 reacties)



Cheeks (46 reacties)



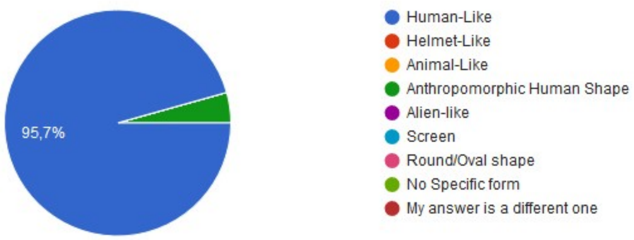
If a certain question couldn't be answer, please explain which one and why. (0 reacties)

Nog geen reacties op deze vraag.

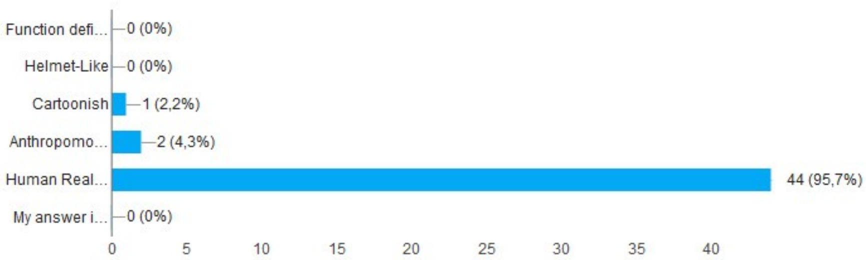
Results Geminoid DK.

VRAGEN REACTIES 46

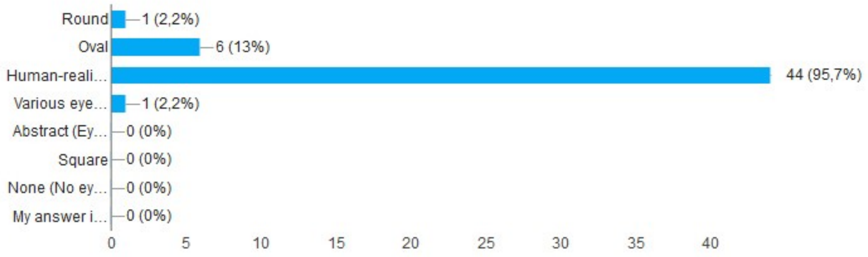
Facial Shape (46 reacties)



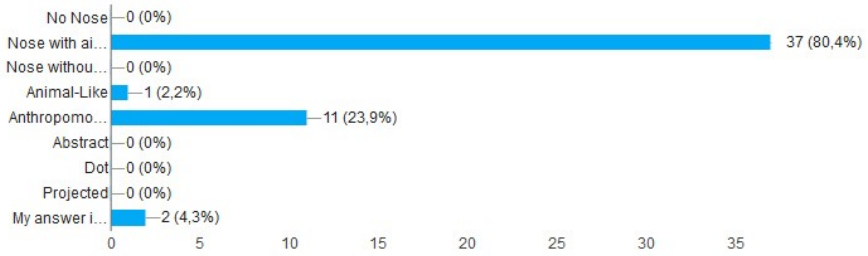
Robot category (46 reacties)



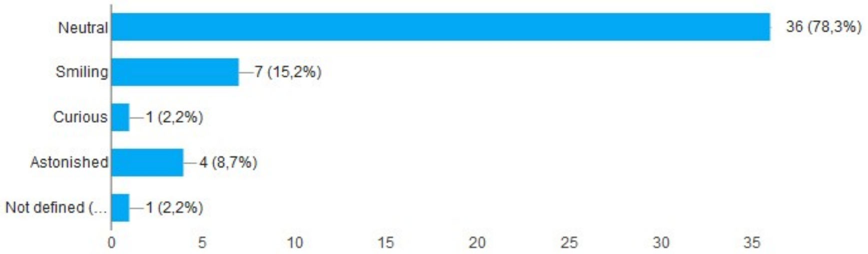
Eye Shape (46 reacties)



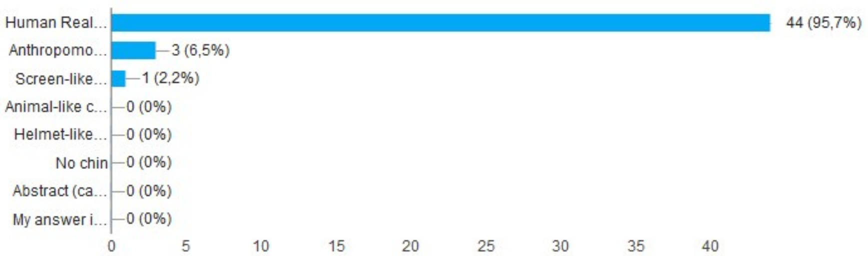
Nose (46 reacties)



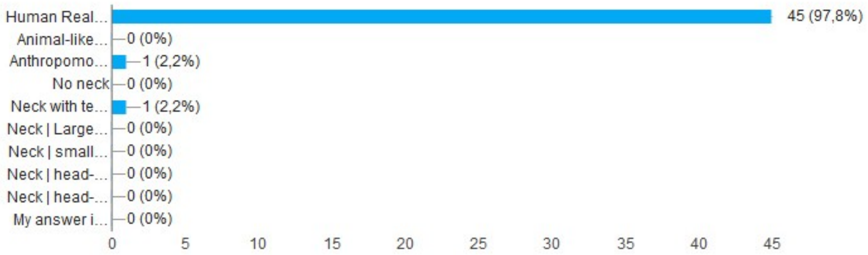
Mouth emotion (46 reacties)



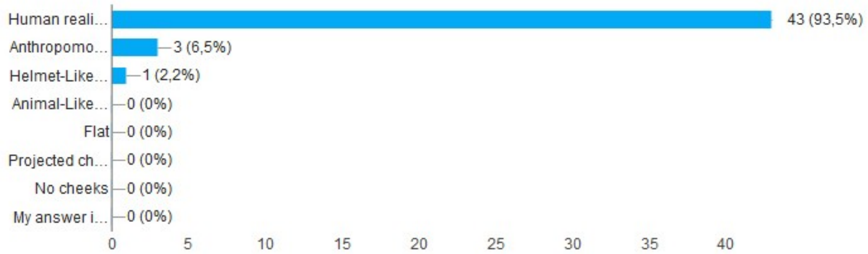
Chin (46 reacties)



Neck (46 reacties)



Cheeks (46 reacties)



If a certain question couldn't be answer, please explain which one and why.

(2 reacties)

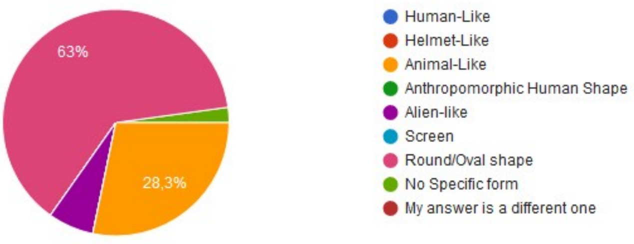
Nose - did not have the option for human-realistic

Nose: Human realistic

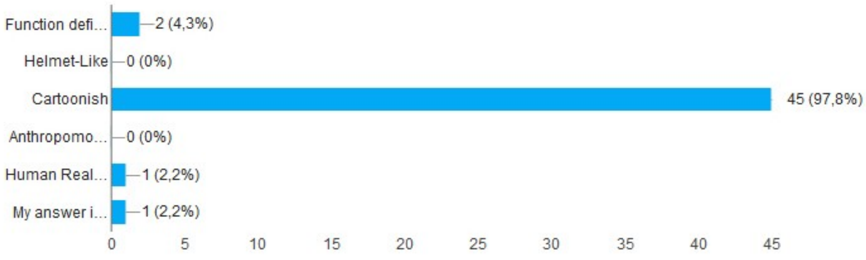
Results Keepon

VRAGEN REACTIES 46

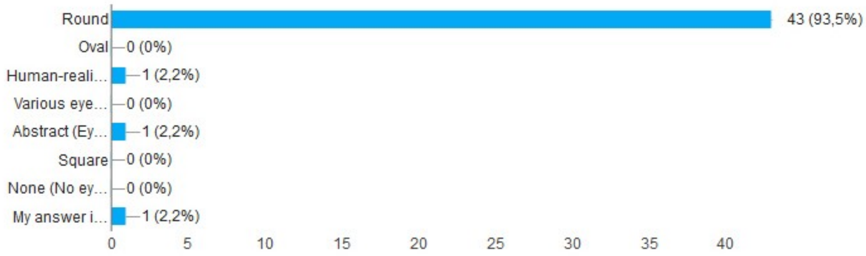
Facial Shape (46 reacties)



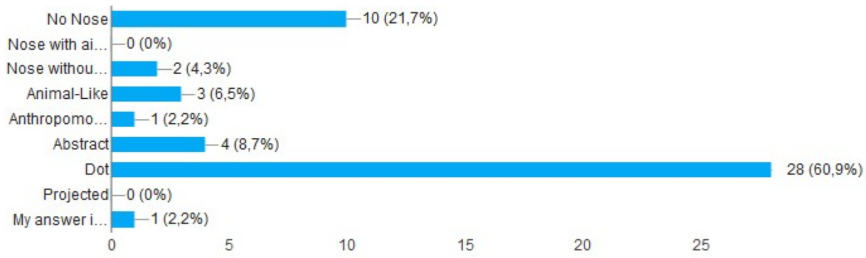
Robot category (46 reacties)



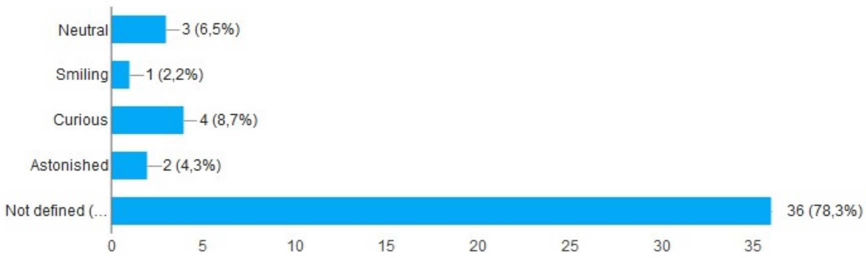
Eye Shape (46 reacties)



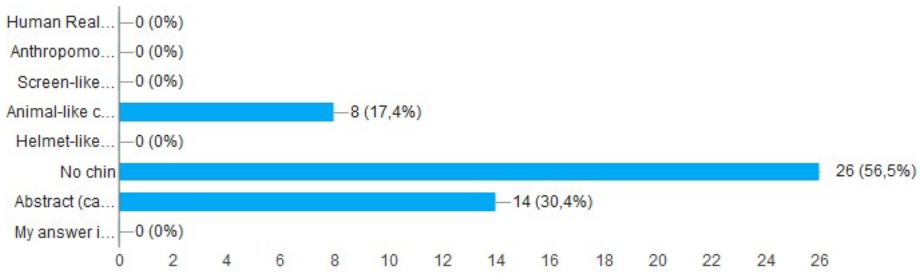
Nose (46 reacties)



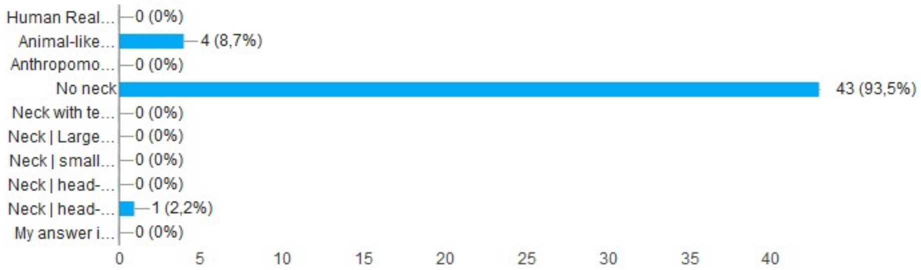
Mouth emotion (46 reacties)



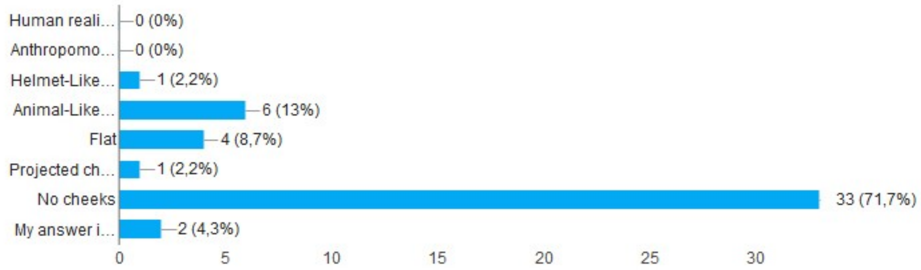
Chin (46 reacties)



Neck (46 reacties)



Cheeks (46 reacties)



If a certain question couldn't be answer, please explain which one and why.

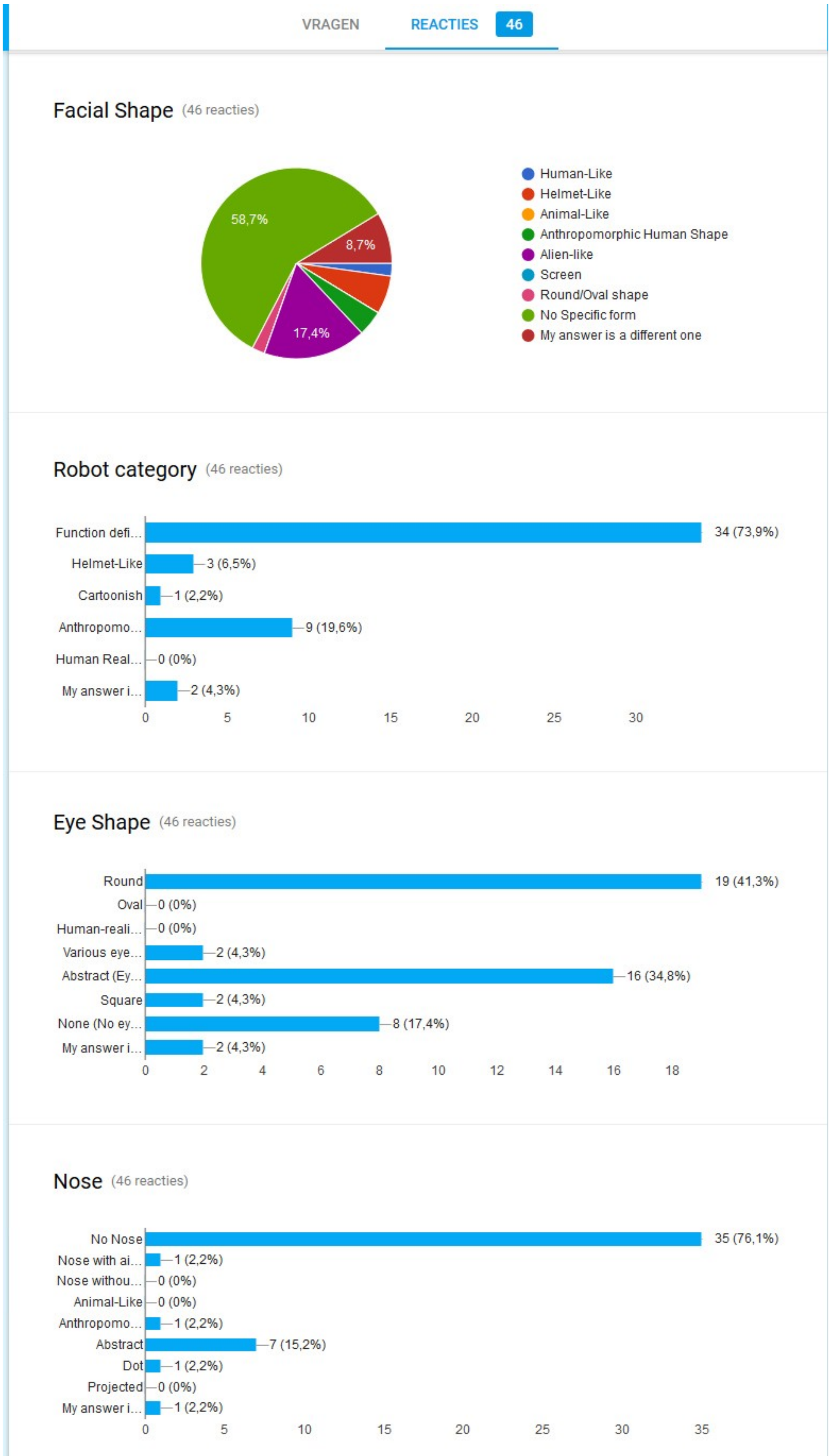
(3 reacties)

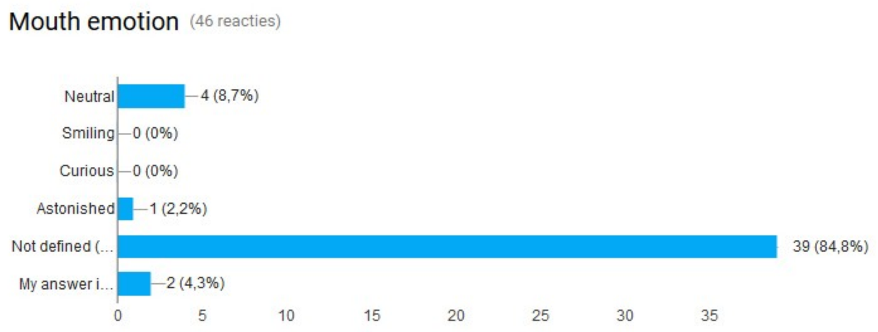
The robot is crap.

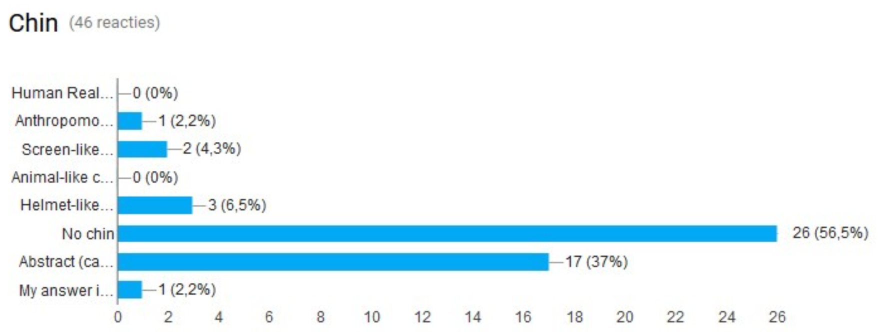
Related to the cheeks, it could be a sort of "cartoonish cheeks" given by a full-round face

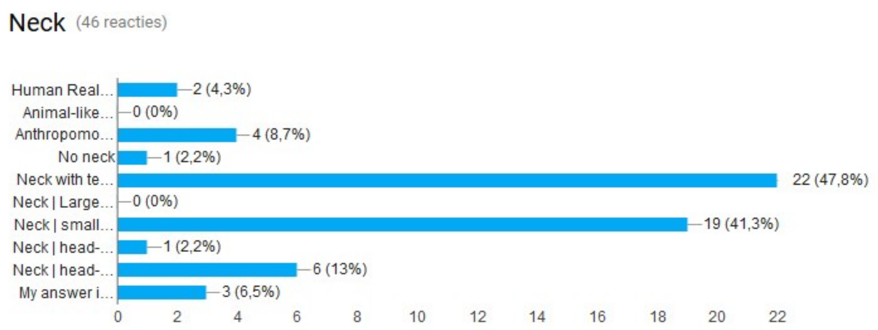
the black dot could either be seen as a nose/mouth or beak. I decided to see it as a nose

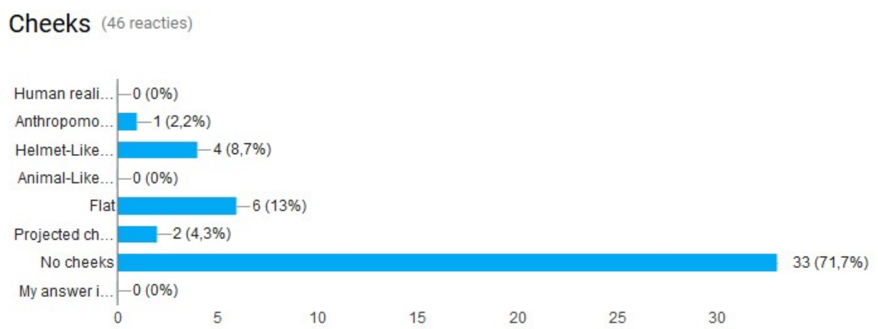
Results Chimp




Mouth emotion (46 reacties)
Neutral
4 (8,7%)
Smiling
0 (0%)
Curious
0 (0%)
Astonished
1 (2,2%)
Not defined (...
39 (84,8%)
My answer i...
2 (4,3%)
0
5
10
15
20
25
30
35


Chin (46 reacties)
Human Real...
0 (0%)
Anthropomo...
1 (2,2%)
Screen-like...
2 (4,3%)
Animal-like c...
0 (0%)
Helmet-like...
3 (6,5%)
No chin
26 (56,5%)
Abstract (ca...
17 (37%)
My answer i...
1 (2,2%)
0
2
4
6
8
10
12
14
16
18
20
22
24
26


Neck (46 reacties)
Human Real...
2 (4,3%)
Animal-like...
0 (0%)
Anthropomo...
4 (8,7%)
No neck
1 (2,2%)
Neck with te...
22 (47,8%)
Neck | Large...
0 (0%)
Neck | small...
19 (41,3%)
Neck | head-...
1 (2,2%)
Neck | head-...
6 (13%)
My answer i...
3 (6,5%)
0
2
4
6
8
10
12
14
16
18
20
22


Cheeks (46 reacties)
Human reali...
0 (0%)
Anthropomo...
1 (2,2%)
Helmet-Like...
4 (8,7%)
Animal-Like...
0 (0%)
Flat
6 (13%)
Projected ch...
2 (4,3%)
No cheeks
33 (71,7%)
My answer i...
0 (0%)
0
5
10
15
20
25
30

If a certain question couldn't be answer, please explain which one and why.
(4 reacties)

Facial shape is only defined by aligning technology in a way that it could (remotely) imitate human eyes etc.

The "facial shape" seems to be more "trapezoid".

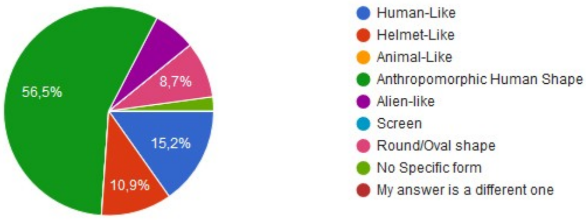
Face looks like its created based on function

I would say function defines form of the face too

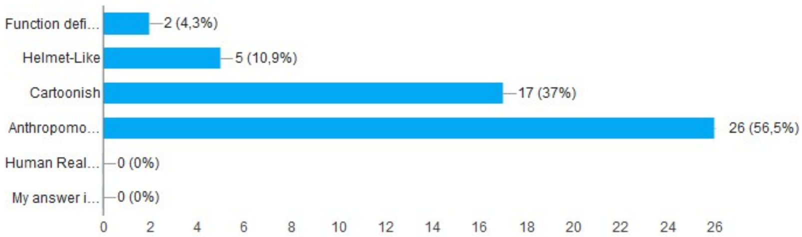
Results Icub.

VRAGEN REACTIES 46

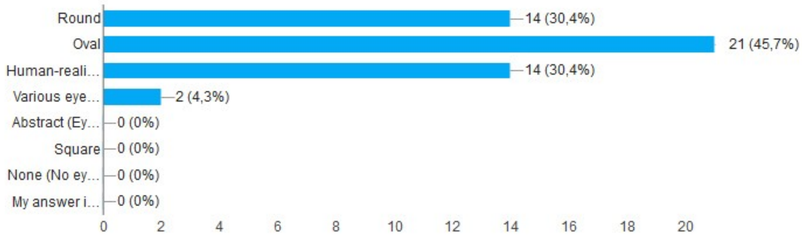
Facial Shape (46 reacties)



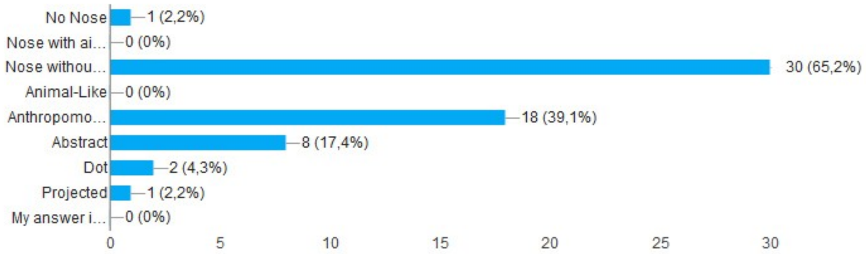
Robot category (46 reacties)



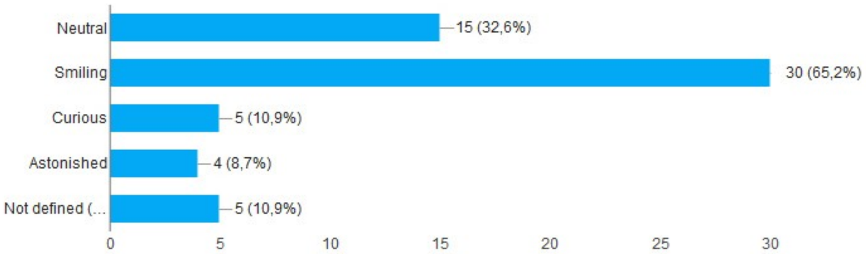
Eye Shape (46 reacties)



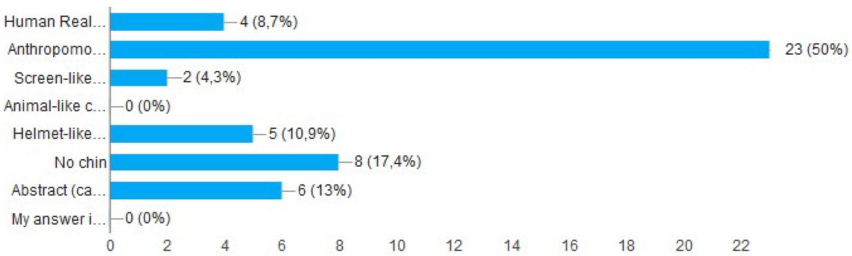
Nose (46 reacties)



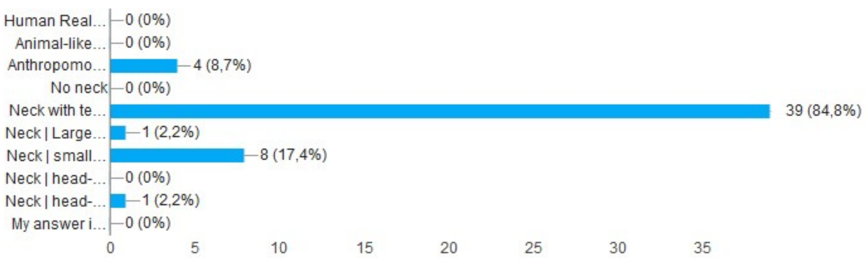
Mouth emotion (46 reacties)



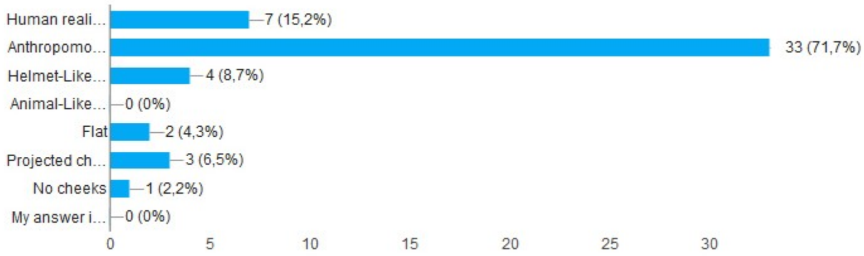
Chin (46 reacties)



Neck (46 reacties)



Cheeks (46 reacties)



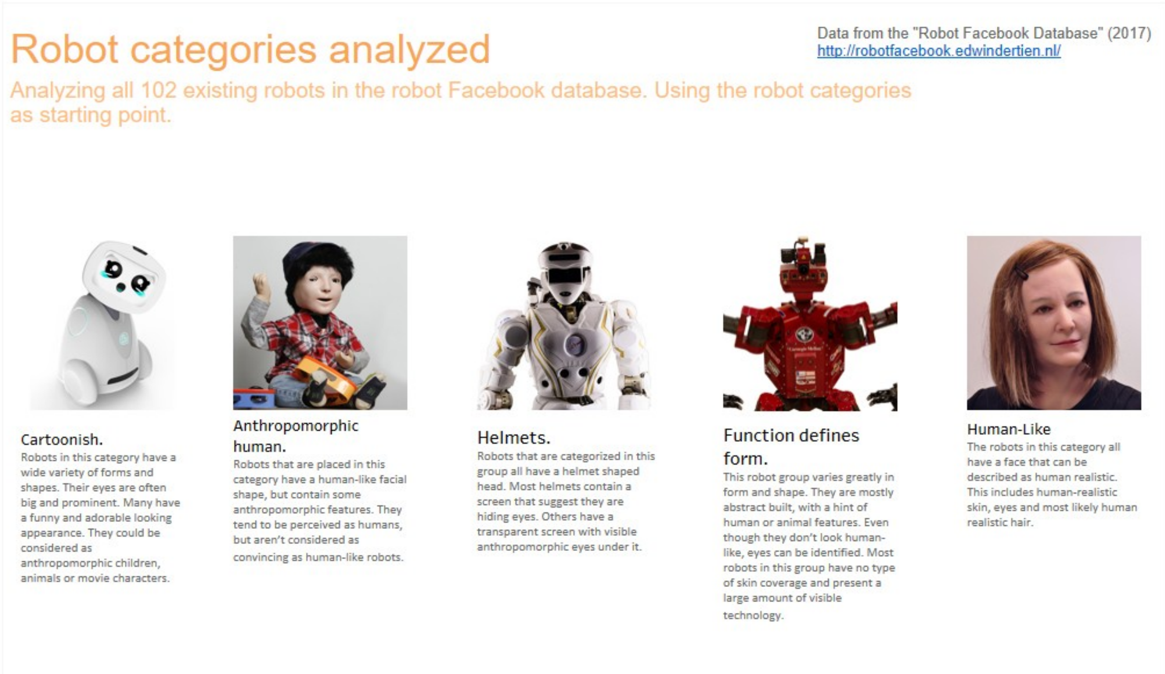
If a certain question couldn't be answer, please explain which one and why.

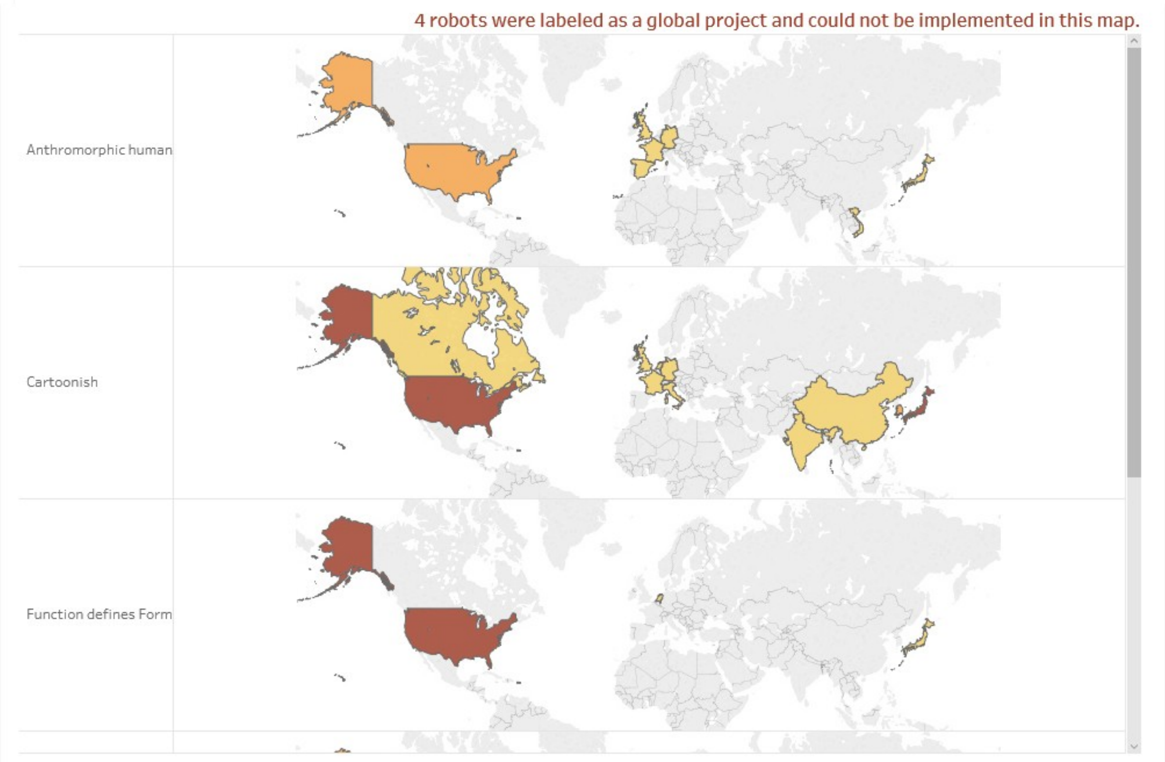
(1 reactie)

THE last

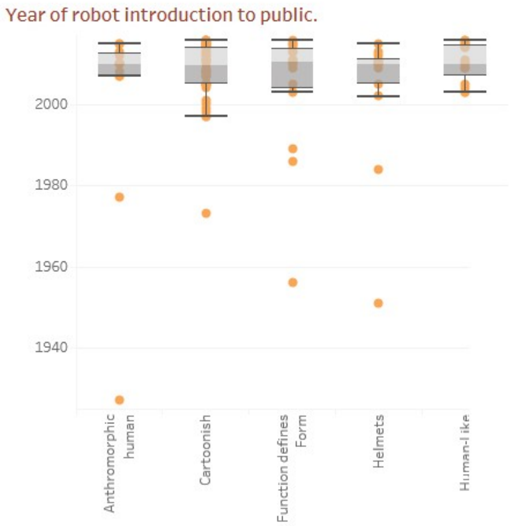
Appendix 6. Data Visualizations

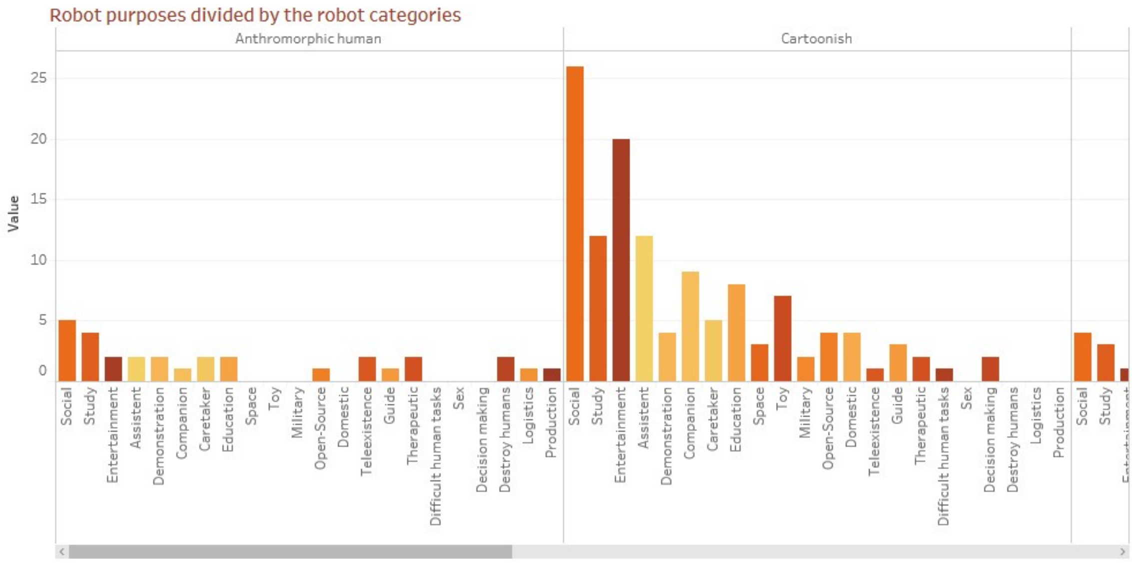
Visualization 1. Main category based.

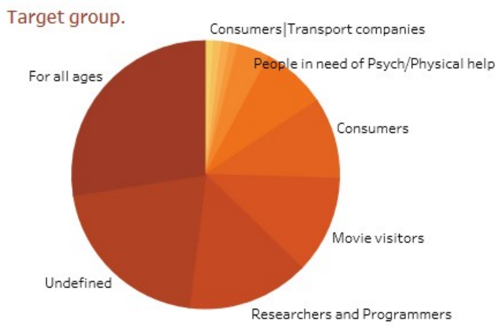


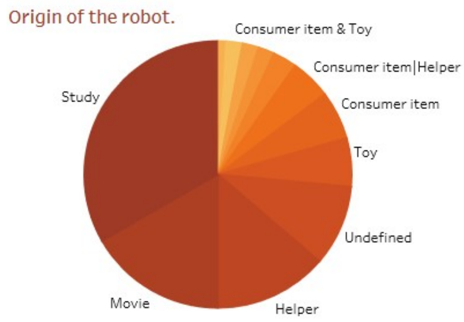


Country	Anthromorphic human	Cartoonish	Function defines Form	Helmets	Human-Like	Grand Total
United States	4	14	13	4	4	39
Japan	2	13	1	5	7	28
Germany	2	2		2		6
South-Korea		4				4
France	1	2				3
The Netherlands		2	1			3
United Kingdom	1	1			1	3
Canada		2				2
Global project		1	1			2
Global Project		1			1	2
Singapore				1	1	2
China		1				1
Hong Kong		1				1
India		1				1
Iran				1		1
Italy		1				1
Spain	1					1
United Arab Emi..					1	1
Vietnam	1					1
Grand Total	12	46	16	13	15	102

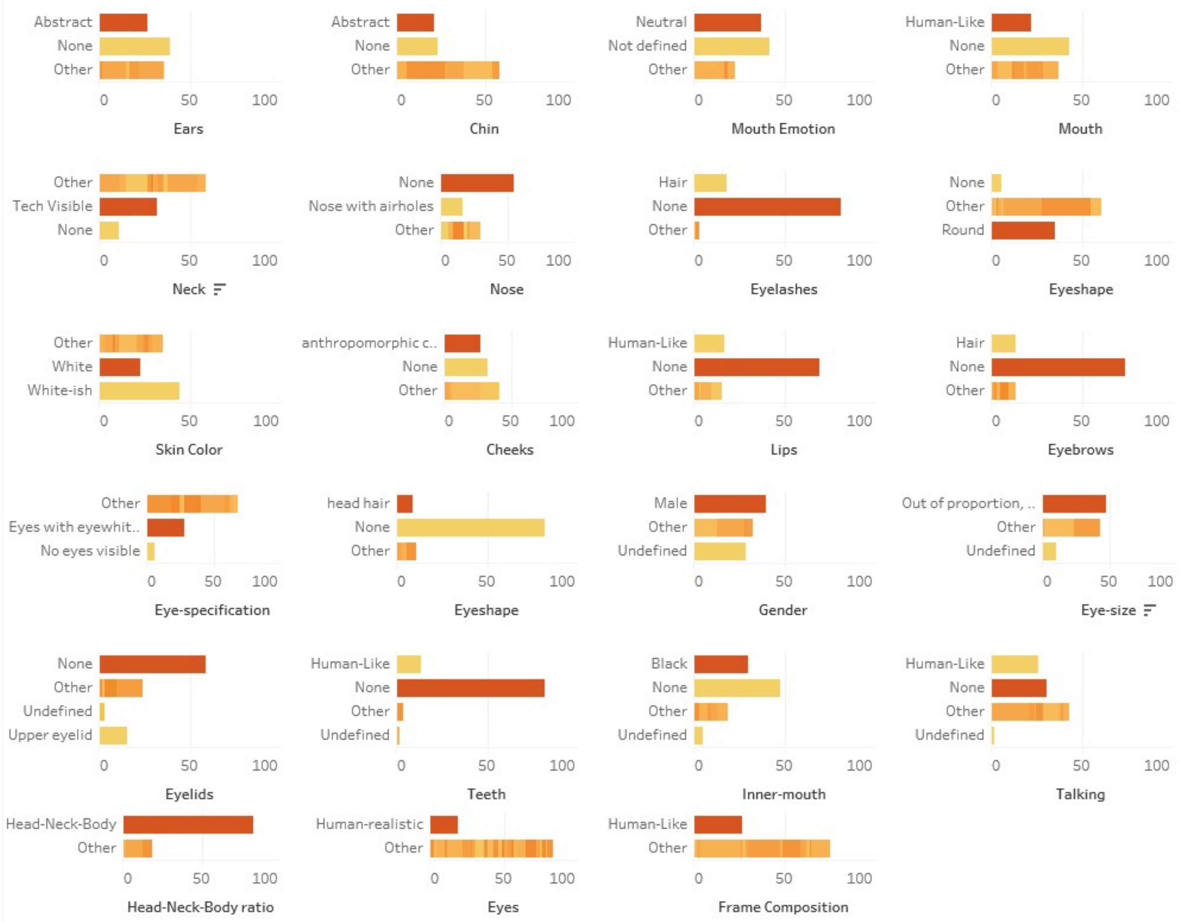






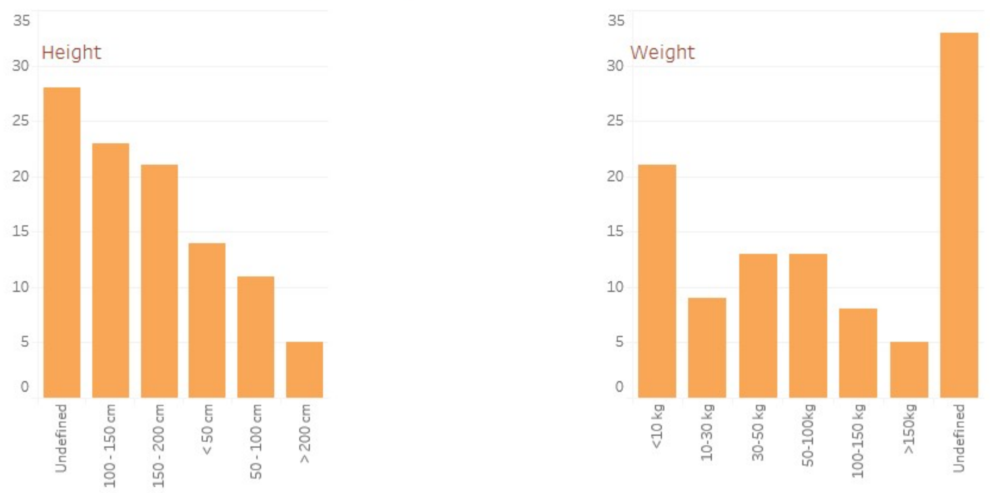


All facial characteristics displayed. Most "common" feature highlighted in red.

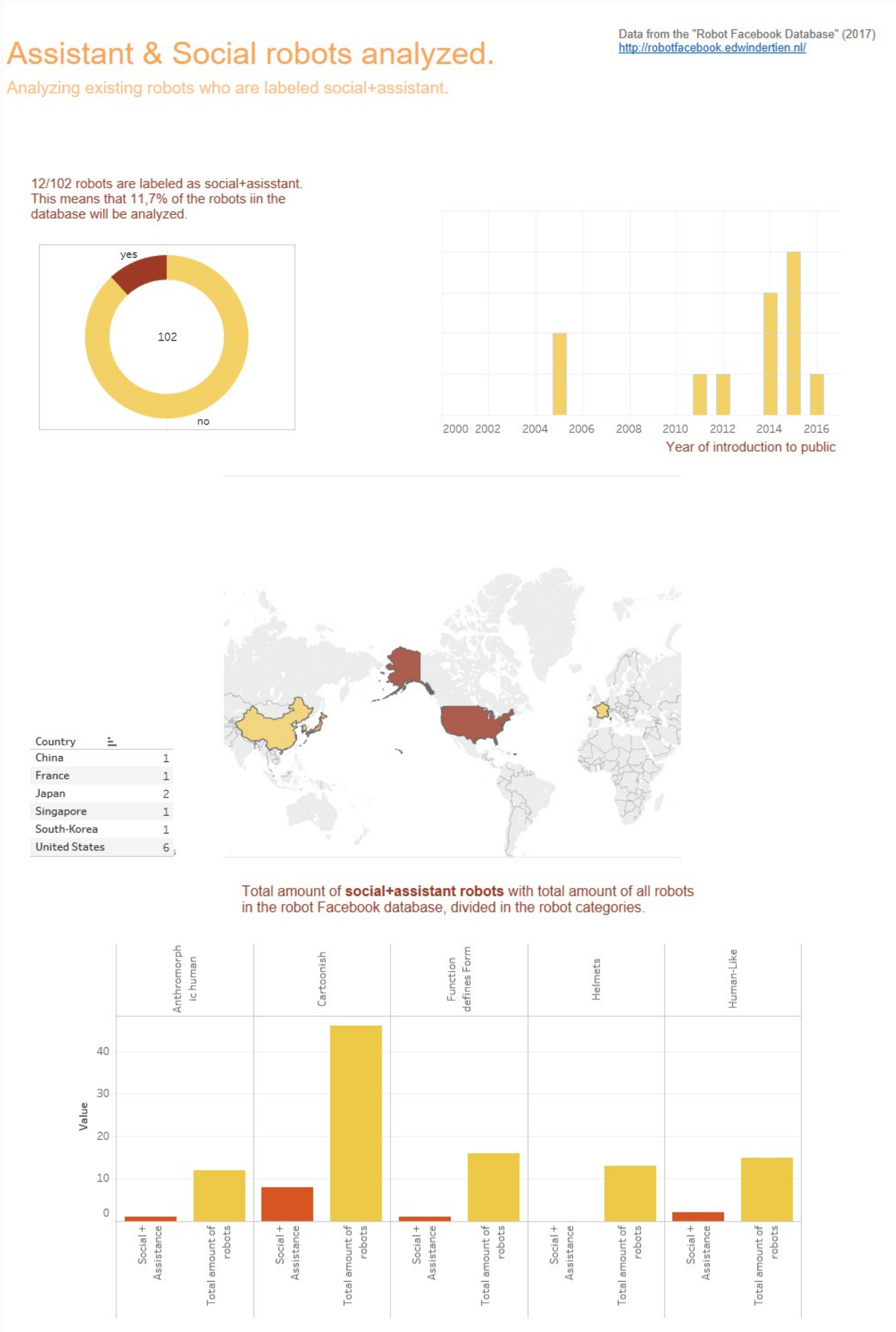


Height and weight.

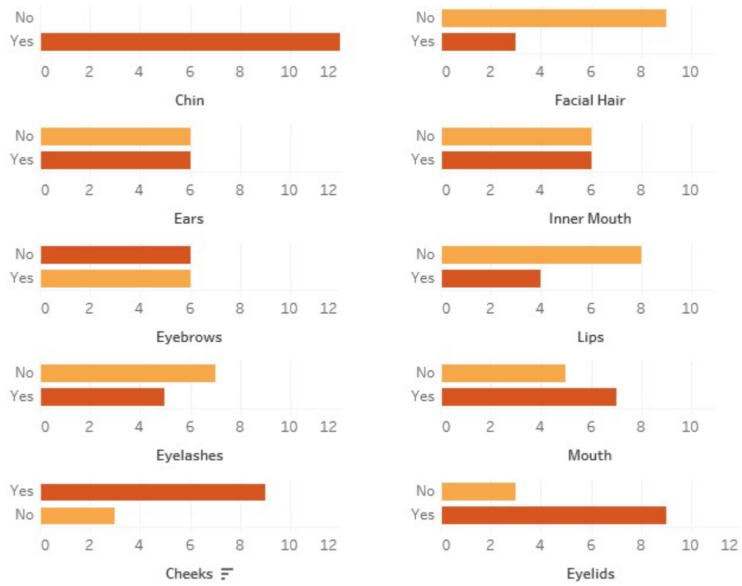
Unfortunately many robots weight and height remained unknown and had to be marked as undefined.

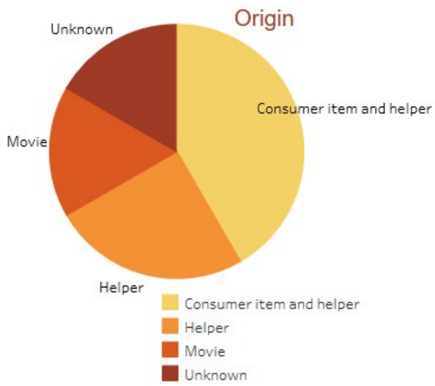


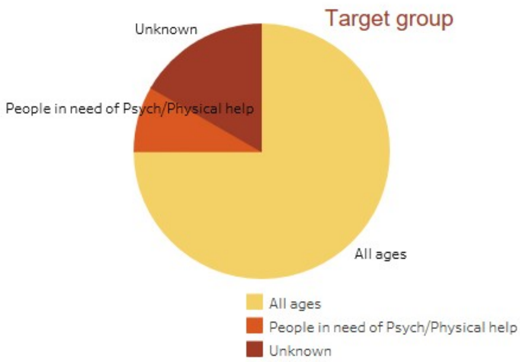
Visualization 2. Assistant and social based.

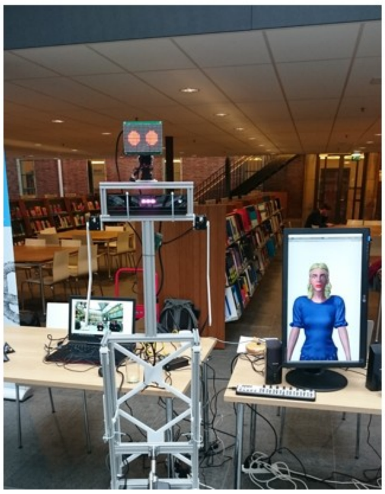


Social+assistant facial features suggestions based on human appearance.









Most common facial characteristics in %.

Cheeks	Anthropomorphic human-cheeks	25%
	Human-like cheeks	25%
Chin	Screen-like chin	41.7%
Ears	-	
Eyesize	Big	41.7%
	Slightly Bigger	41.7%
Eye specification	Eyes with eye white, iris and pupil	41.7%
Eyebrows	-	
Eyelashes	-	
Eyelids	Eye change due to screen possibilities	44.4%
Eyes	One screen	41.7%
Eye shape	Human-Like	41.7%
Facial Hair	No	
Facial Shape	Screen	41.7%
Inner Mouth	-	
Lips	No	
Mouth	-	
Mouth emotion	-	
Neck	Smaller compared to humans	25%
Nose	-	