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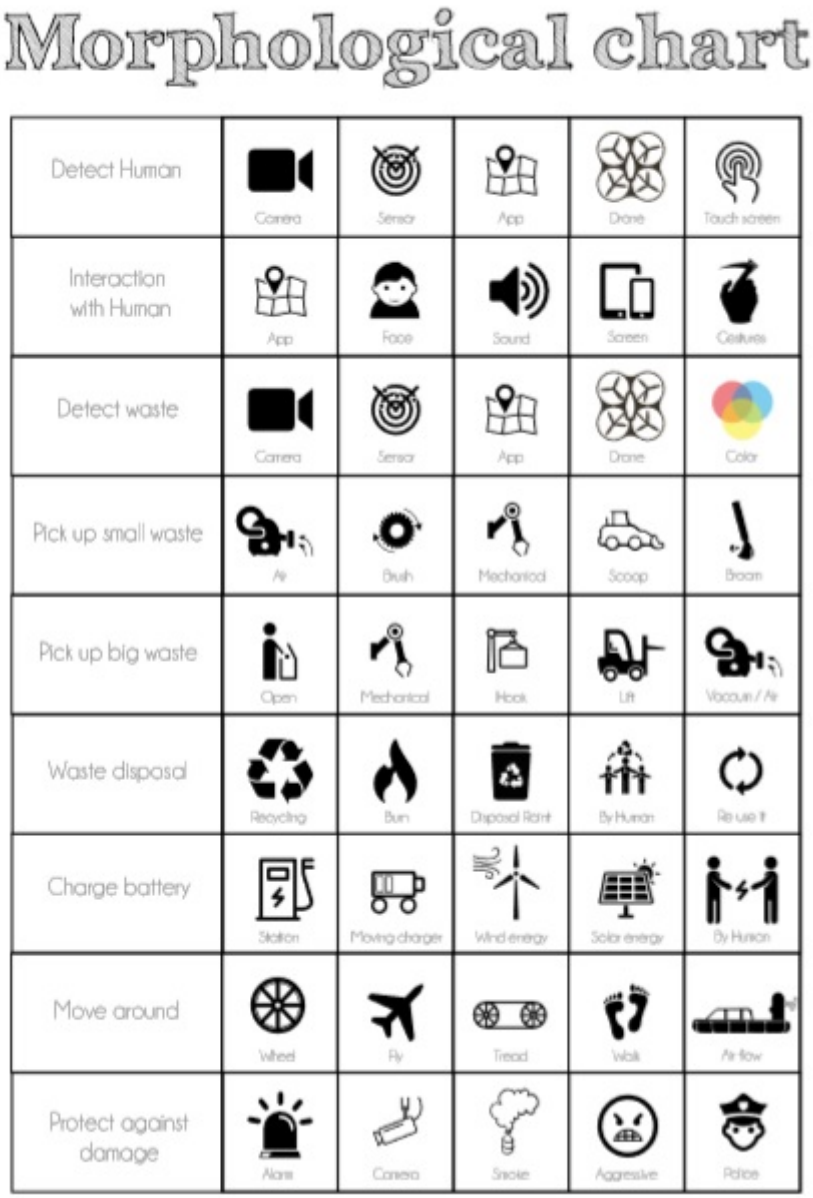
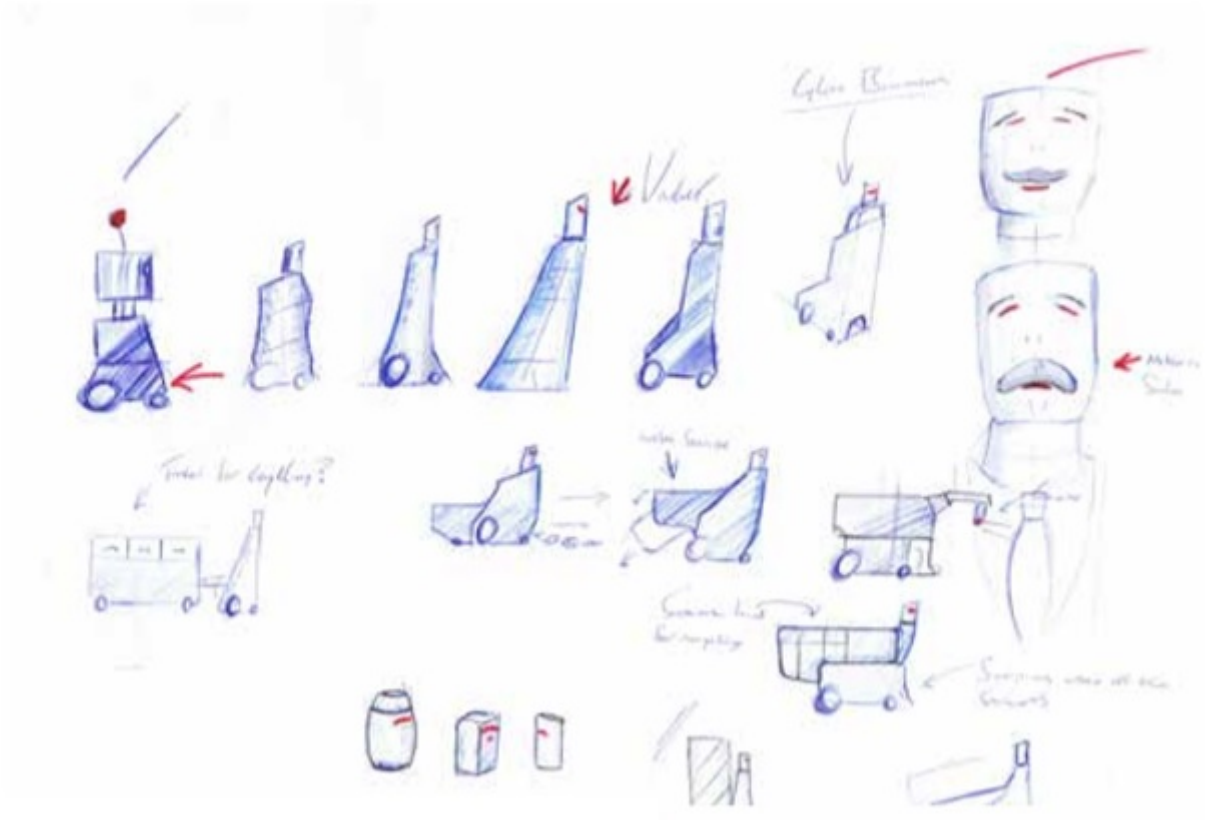
design history

1. Background

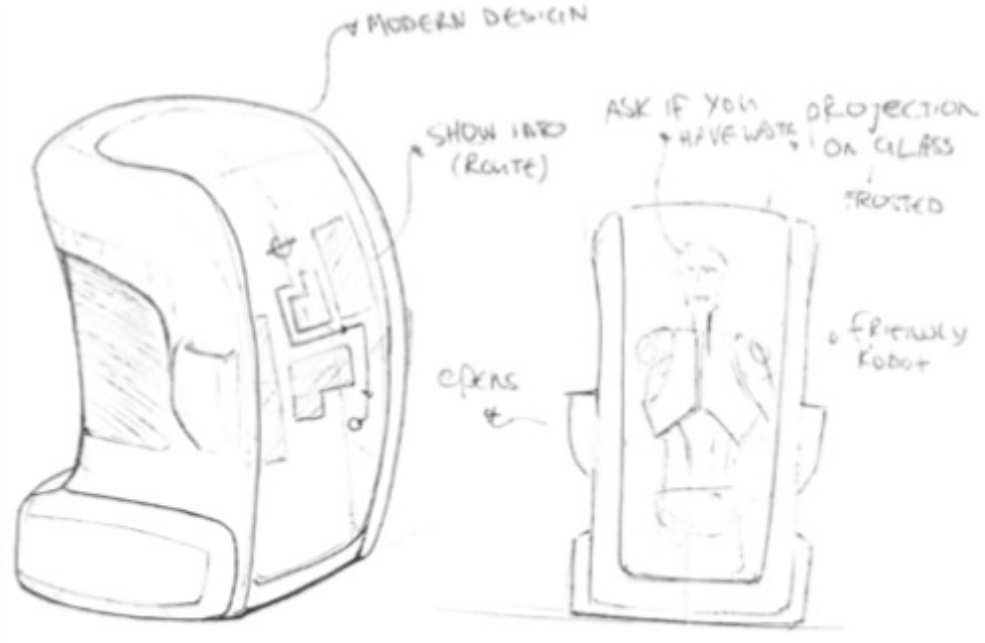
The original design was made by students of Industrial Product Design. One of the first things they produced was a morphological chart. The chart is made to create an overview of all options and functions of the robot.



With the morphological chart in mind they started brainstorming and made sketches from the ideas they had.



One of the early designs is the one below. In this design a large TV screen is already installed. The idea of a butler like robot came to mind. Willy has to be polite, informative and have a strong character.



Because of the complexity the idea above was not realistic to make as a prototyping project. This is one of the reasons why they made a less complex version which certainly is realistic to make.

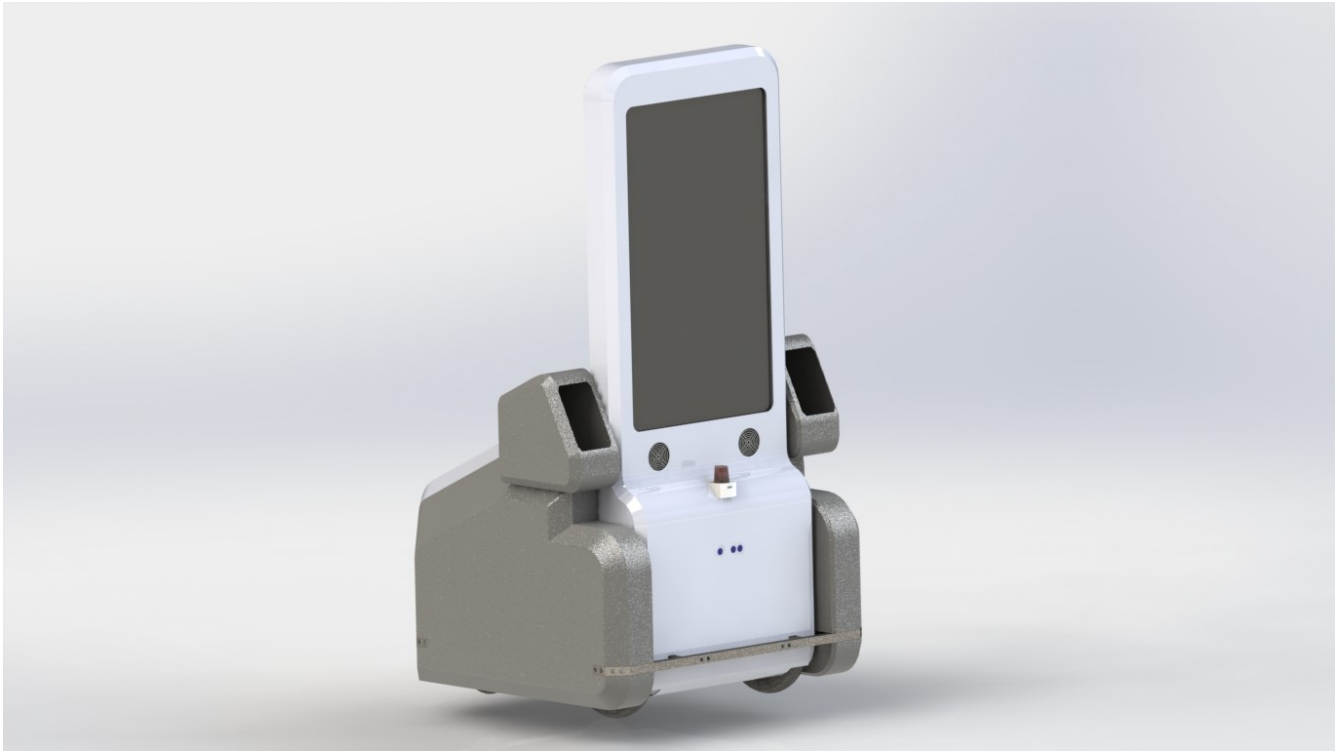
2. Technical

2.1. Definition List

Part	SolidWorks file which is a 3D drawing of a part of the robot.
Drawing	2D drawing of a Part which contains dimensions
Assembly	3D SolidWorks file which contains multiple Parts which are tied together with ‘mates’
Render	JPEG image file of a Part or Assembly in high resolution.

2.2. System overview

The render below contains all the parts and sub-assemblies that are included in our design. The 42” Display is used for interaction with people and as a way to bring information about the garbage problem and the robot. The speakers in the front are used to let Willy speak and can be used for the sound when displaying a video.



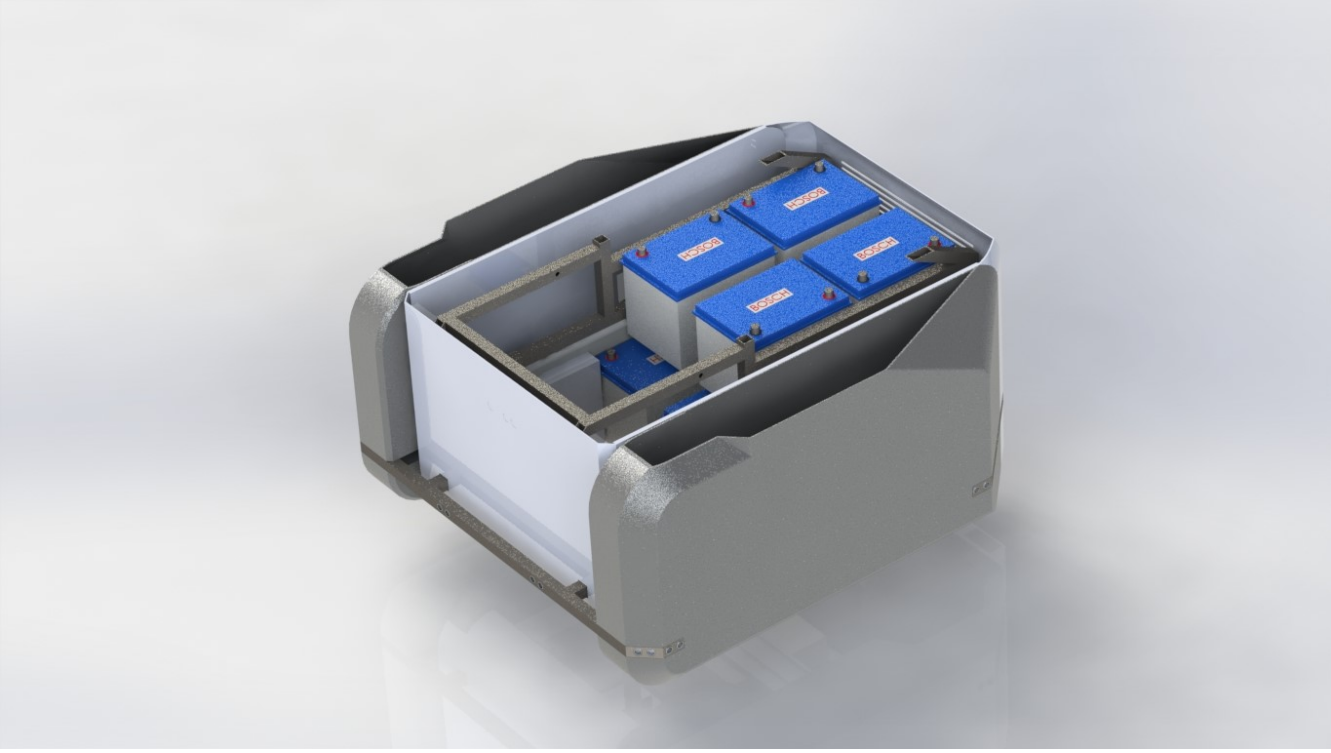
The bins on each side of Willy will be used to encourage people to throw away their garbage. Willy will ask for trash.

The bins are not in the current (12/02/19) build any more, since it is no longer a garbage collection robot.

The Kinect is used to look for people (skeletons) so that Willy can interact with them. The LIDAR which is placed on the front of the robot is used for indoor navigation and might be used for outdoor obstacle detection.

Behind the LIDAR there is a LEAP-motion controller which can be used to control the display with

gestures. The bumpers in the front and in the back of the robot is filled with ultrasonic sensors. Six in the front, six in the back and four downwards to look for kerbstones and potholes. Inside the robot there are four 33Ah car batteries which supply the necessary power. In the rear and top of Willy there are fans to cool the whole robot.



2.3. Part & assembly overview

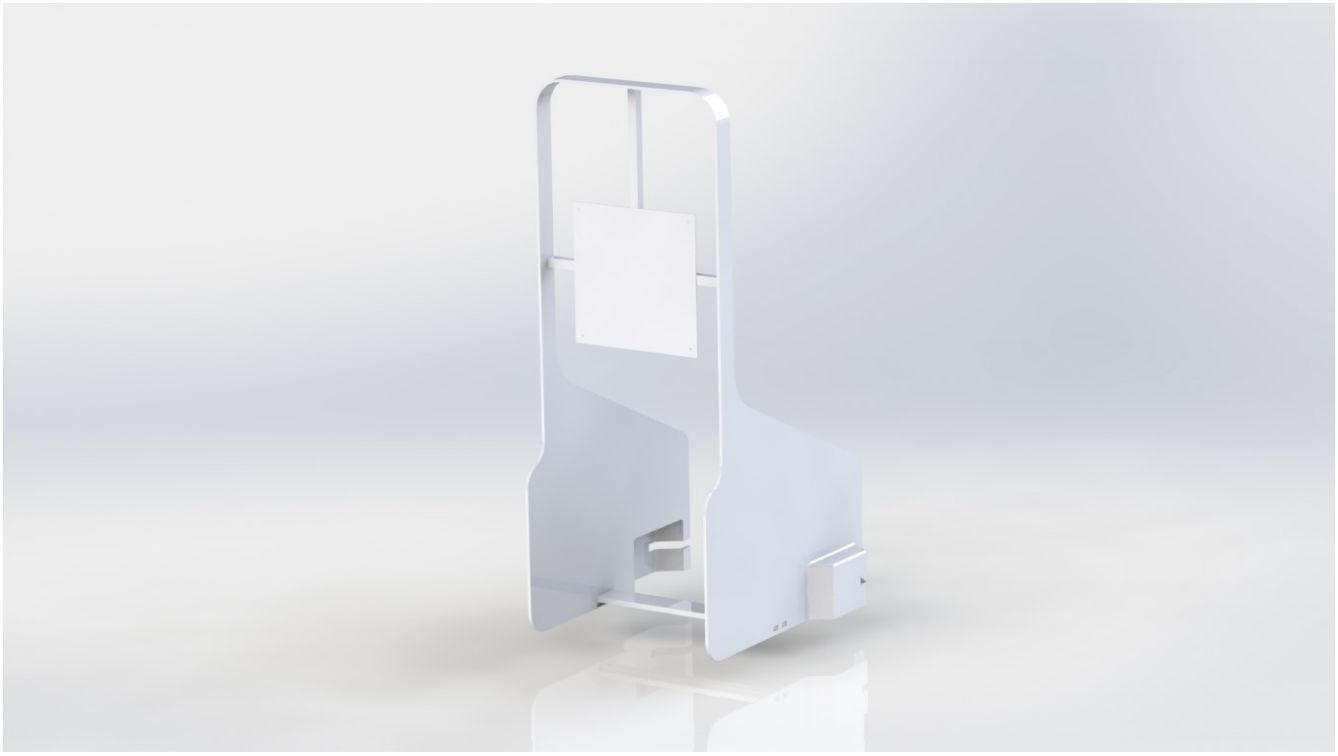
2.3.1. Part 1 front plane

The front plane is one of three pieces which are made out of glass-fibre in combination with a polyester resin. A mould is made out of Styrofoam plates. The front plane contains the tv screen, place for a Kinect sensor, a LEAP motion controller, a SICK TIM551 LIDAR and two speakers with grills. The frame goes through the two holes at the bottom of the front plane.

This part is made together with the midplane and backplane using the same mould. The front plane is fixed by the front of the frame.

2.3.2. Part 2 midplane

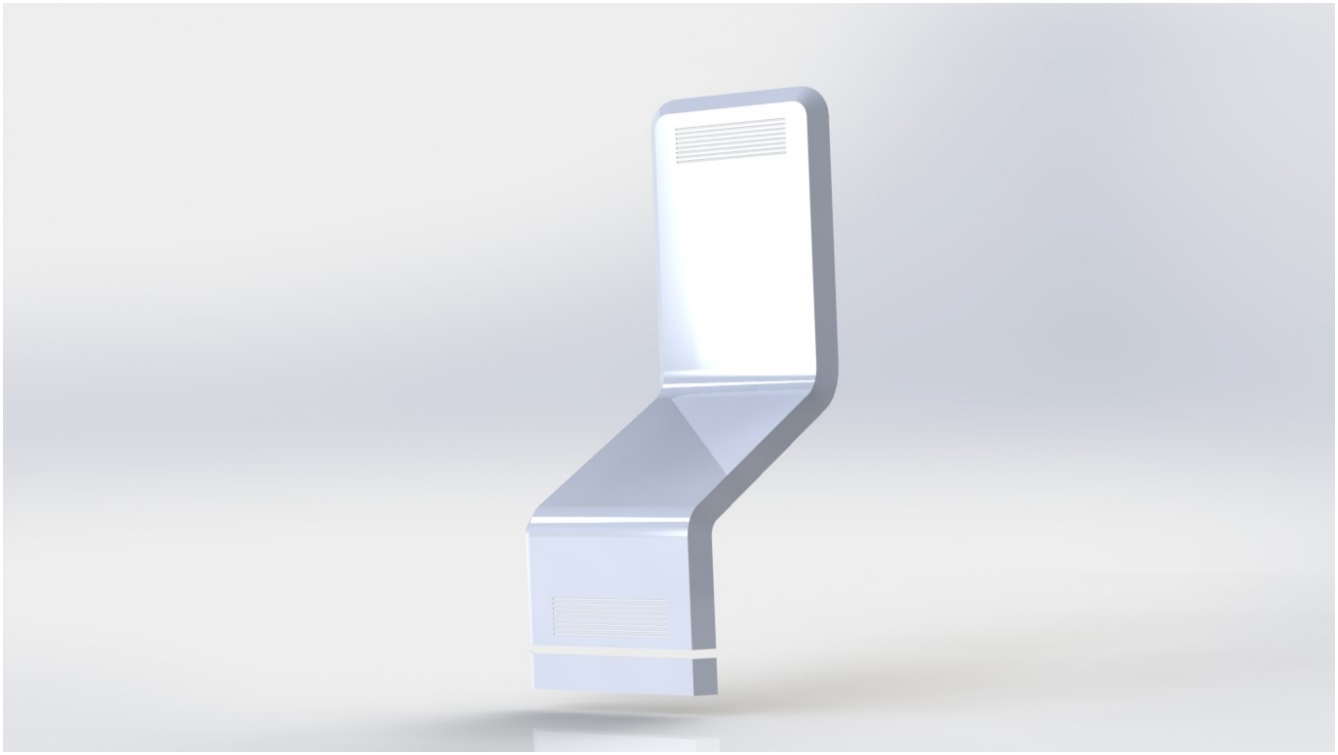
The mid plane is a frame on which the front and back plane are fixed. There are possibilities to fix the tv screen as well. At the bottom there are notches for the swivel wheels on both sides.



The midplane is made together with the front and backplane with the same mould.

2.3.3. Part 3 backplane

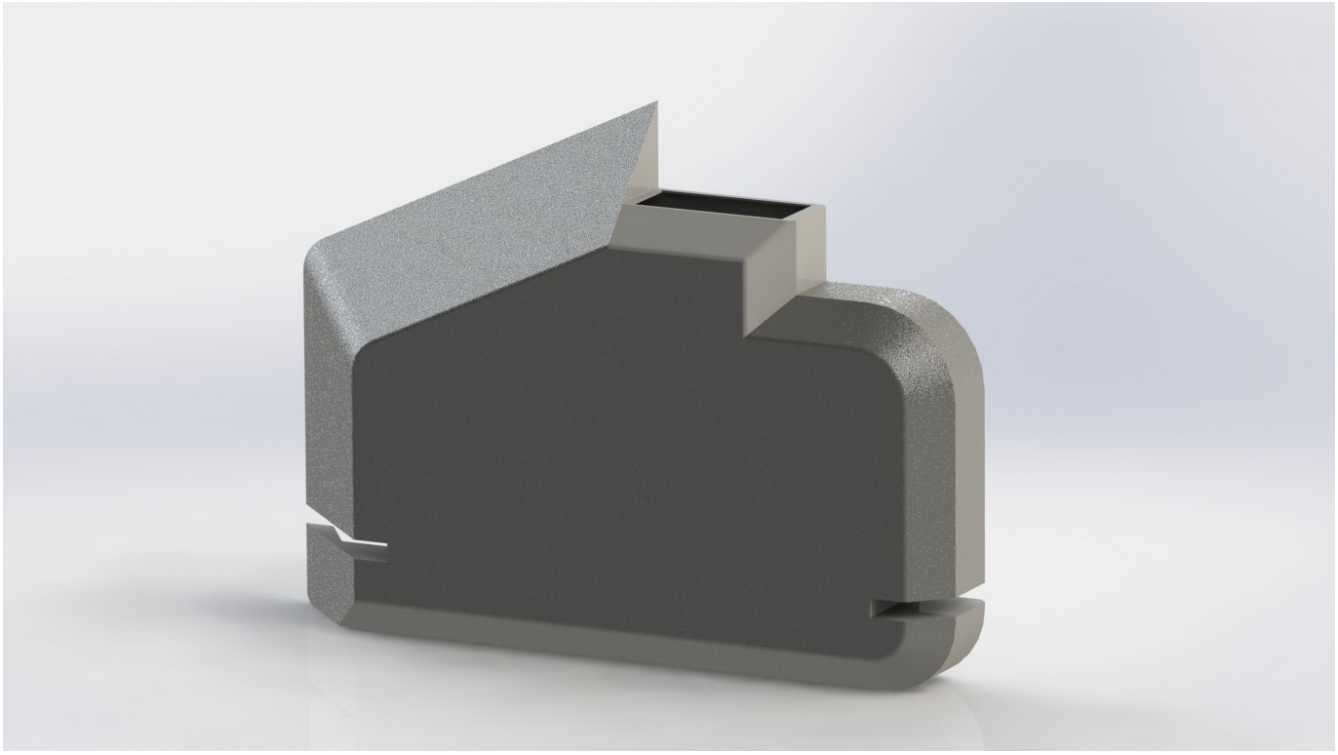
The backplane contains slots where the fans can be placed. The design of the backplane improves the flow of air from the bottom to the top of the robot where the air is blown out.



The slanted part is used as a hood so there is still a possibility to work on the electronics. The backplane is made together with the front plane and midplane with the same mould.

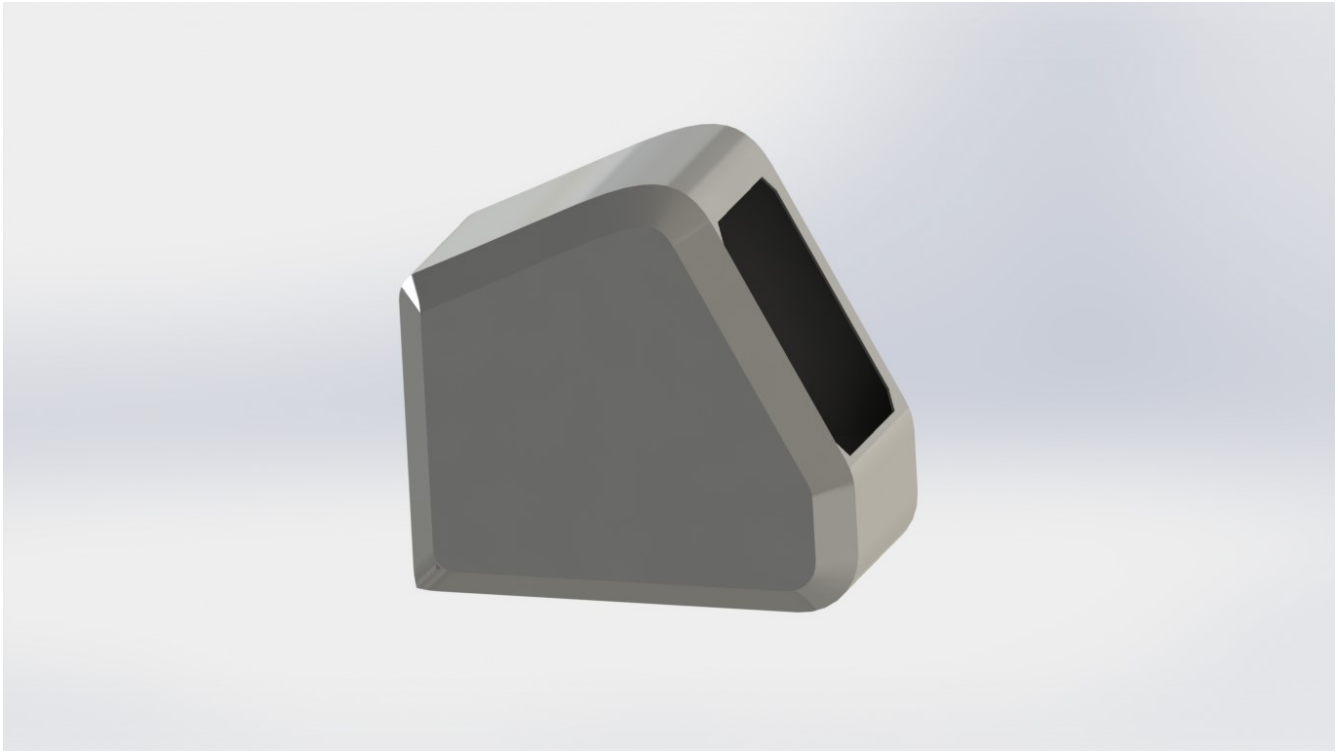
2.3.4. Part 4 bin

The bin is a part which is placed on both sides of the robot. It will be used to encourage people to throw away their garbage. There is a special bin opening part which is fitted on top of this bin.



2.3.5. Part 5 bin opening

The bin opening part is made to have access at the front of the robot.

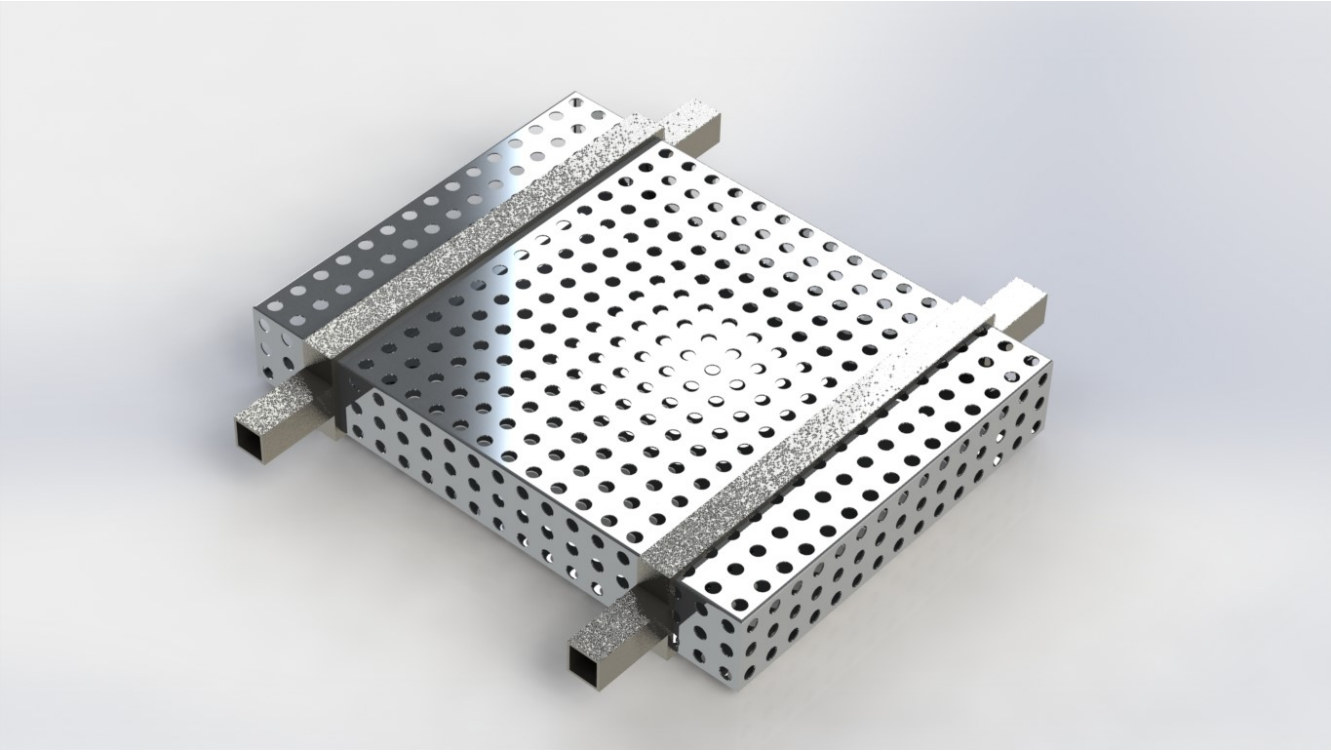


2.3.6. Part 6 speaker grill

The speaker grill is a part that protects the speaker from most of the larger items like rocks, cans and bottles. Besides that it protects the vulnerable speaker material from peoples' fingers.

2.3.7. Assembly 1 computer housing

This is a example of how the housing of the computer could be made. The brackets fit between the frame and the holes provide the computer with a cooler airflow.

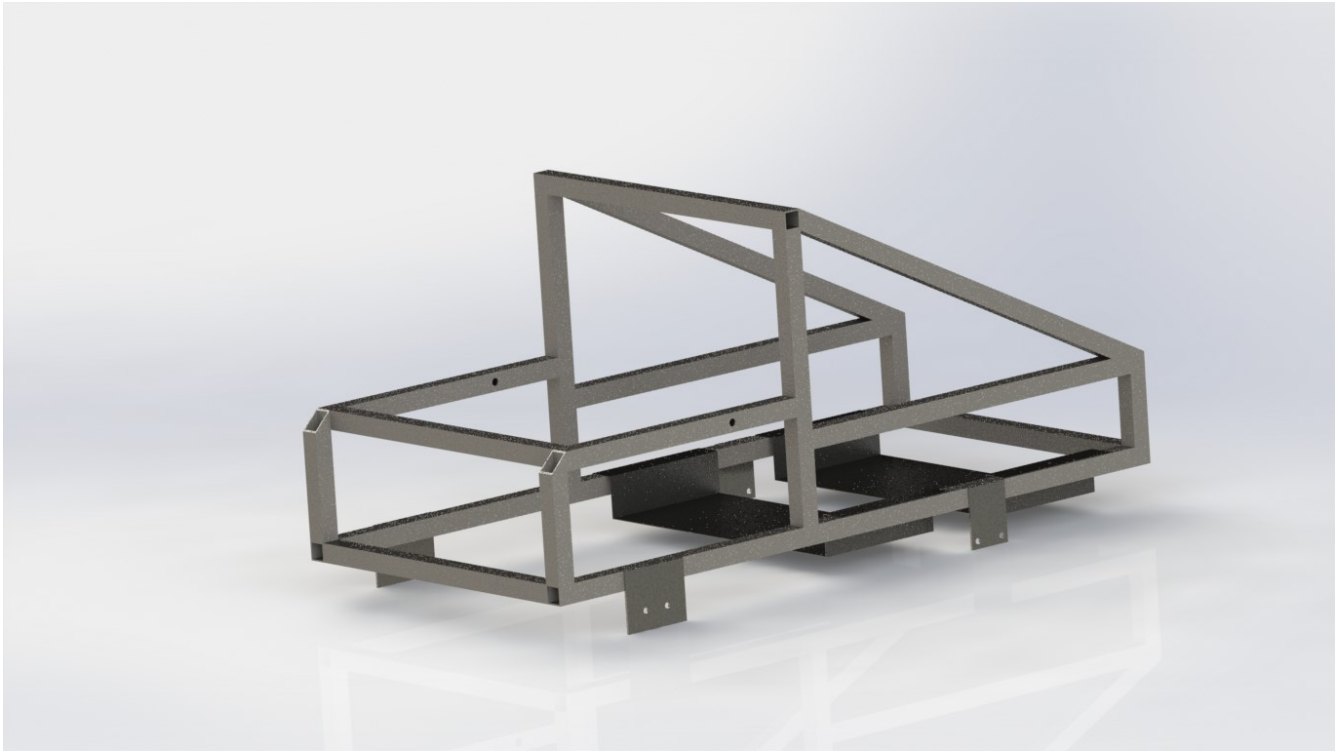


2.3.8. Assembly 2 fan

These fans are standard 140mm case fans which suck up air at the bottom rear of the robot while at the top they blow the hotter air back out.

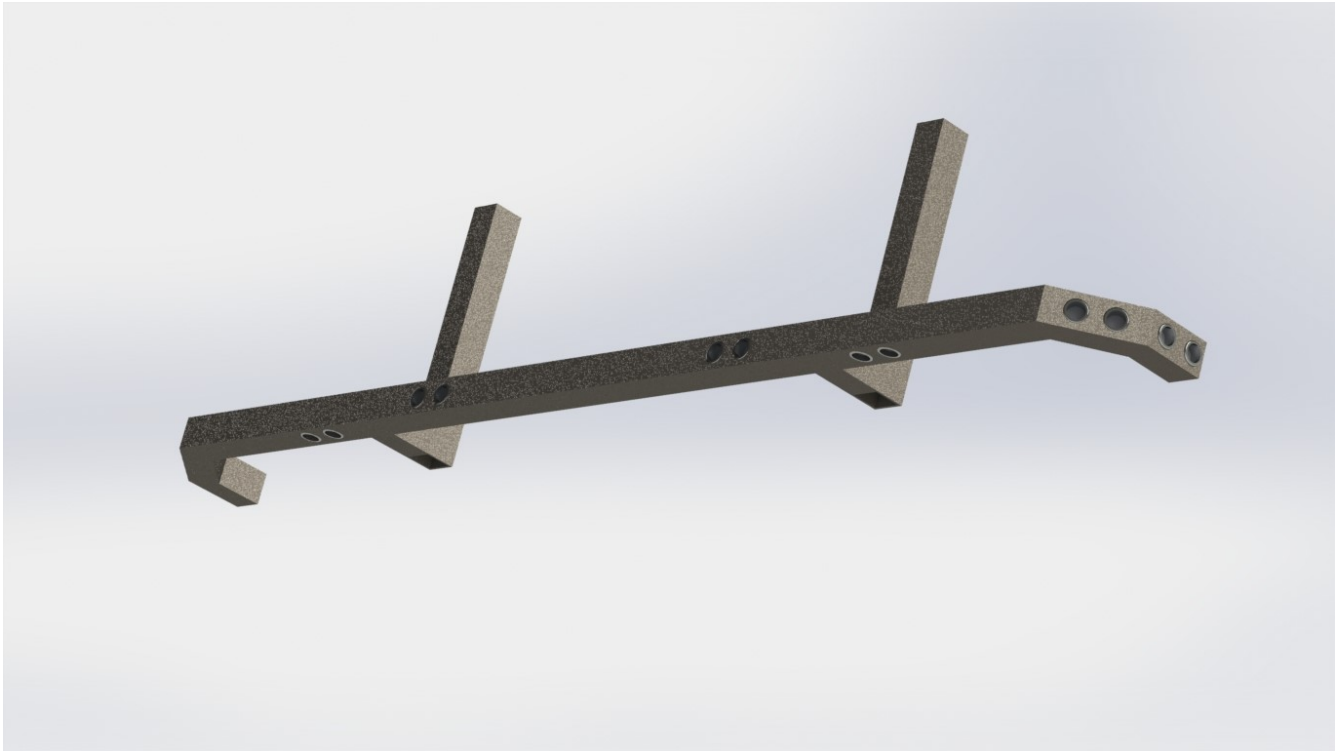
2.3.9. Assembly 3 frame

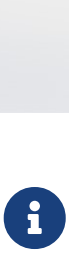
The frame is a part that provides the whole robot with a certain firmness. Parts like the batteries and the outer housing are fixed on the frame. The frame is in that case fixed on top of the wheelchair. The frame is made out of 25x25mm square steel tubes with a thickness of 1.5mm. The tubes are welded in place.



2.3.10. Assembly 4 front bumper

The front bumper contains six ultrasonic sensors for a wide view. It also has two sensors aimed to the ground. With these sensors things like a sidewalk or potholes can be detected.





The front bumber only contains 3 sensors at the moment (12/02/19), and there are 2 at the rear, one on each side. The actual cover is no longer really used due to changes in the design.

2.3.11. Assembly 5 rear bumper

The rear bumper also has six sensors placed outwards and two aimed at the ground. With the front and rear bumper combined there is an almost full 360 degrees view around the robot.

2.3.12. Assembly 6 wheelchair

The wheelchair assembly contains the motors and wheels combined with a frame that holds these parts fixed together. This is the base of Willy at the current state.

2.4. Design choices

The first choice we had to make with the design is which design we wanted to use. We made a design ourselves and there was a design available. The design that was available was not yet usable on the current frame. The design we made was usable in the current frame.

Together with the productowner we concluded that the available design was the best choice. The reasons for the choice were that there was a team behind that design that had researched the idea and that it was a quite simple design to build.

2.4.1. Parts design choices

The bin had a problem that the opening was too small for bottles and cans. Because of that we made it a bit bulkier than the original design. The bin opening part is adjusted accordingly.

2.4.2. Assembly design choices

The front bumper and rear bumper were an aluminium plate in which the ultrasonic sensors were mounted. Because of the design this had to be changed. We made it in the shape of the plating itself. In this way there is only a little gap between the plating and the bumper. This also ment that it needed a sixth ultrasonic sensor because of the widened front part.

Besides the 360 degrees ultrasonic view it needed sensors which had to be aimed at the ground. This helps with finding curbs and unevennesses in the road. Both the front and rear bumper are adjusted to fit two sensors downwards.