Barrie the bartender

"A brand new way of ordering drinks"

Concept Design, Minor Robotica TU Delft

Casper Cromjongh	4494156
Teun Bakker	4494490
Joppe de Waart	4365399
Vincent van Parijs	4454022
Jonathan Raes	4300343

Contents

1. Introduction

1.1 Minor

The minor robotics at the TU Delft instructs students to design a functional robot in a multi-disciplinary team. Each team of five or six students receives a problem description for which they need to design and build a robot that solves that problem. Projects involve a client which is often a company in need of the robot described by the problem. The project will last one semester.

1.2 Group

Barrie Robot Design is a multidisciplinary team of 5 students from the faculties Mechanical Engineering, Electrical Engineering, Industrial Design and Computer Science. Together we are able to tackle objectives which we couldn't tackle on our own and our objective is to design an innovative bartender robot to replace the current coffee corner.

1.3 Client

The client of our project is the University museum called the Science Centre Delft. The Science Centre has a coffee corner currently that is very simple. Clients need to get their own coffee from a coffee machine and walk to the front desk to pay for it. The Science Centre wants to see this improved by introducing robotics to the coffee corner. We will design an autonomous coffee robot where visitors can order and pay for a cup of coffee, or other drinks and snacks, in a fun and interactive way.

Besides the coffee robot another team will design a host robot that will greet people when they enter the lobby and gives them information about the building and where to go. Visitors will also be able to order a drink or snack at this 'host robot', which will then be communicated to the bartender robot which will prepare the order.

2 Context Analysis

2.1 Current situation

The coffee corner is located in the corner of the entrance of the Science Centre museum. At this entrance, there's room to sit as well. It's a self-service coffee corner, and when you got your drinks and snacks, you have to pay at the service desk.
The coffee corner is mostly used by the visitors of the science centre and the employees of the science centre. Other people and students working in the science centre, get their (free) coffee somewhere else in the building.

Different drink options
The following list of beverages and snack can be bought at the coffee corner.

<u>Hot drinks</u>
- Coffee
- Espresso
- Hot chocolat
- Hot water

<u>Cold drinks</u>
- Cola
- Cola light
- Fanta
- Applejuice
- Sisi (small)
- Dubbelfris
- Spa blue

<u>Snacks</u>
- Waffles (2 flavours)
- Oerkoek (5 flavours)
- Mars
- Twix
- "Stroopwafel"
- Almond paste cake ("Gevulde koek")

<u>Payment system</u>
- PIN at the service desk

2.2 The scope of the prototype

The scope of the project is to develop a Bar Robot that automatically serves your drinks, instead of the current self-service system. It should do this while interacting with the visitors of Science Center, staff/personnel and visitors of conferences in a fun way. The Bar Robot should be able to interact with people from every age and at all times.
Furthermore should the Bar Robot be able to communicate with the Host Robot. Because of this communication between the Host and the Bar, people are able to place orders at the host.

2.3 Tickets

According to the original project description the bar robot should allow people to buy entrance tickets to the Science Centre. However while creating our concept it became clear that this feature is not necessary. This is because the NFC card system will let people pay for their entrance tickets when they leave the museum, together with paying for all the drinks and snacks they enjoyed. As each visitor (or group of visitors) will receive such an NFC card, there is no need to provide tickets at the coffee corner.

3 User Analysis

3.1 Personas

The Science Centre is a building used by many different users. However, not all of those people actually go to the Science Centre coffee corner to get their coffee, drinks and snacks. Therefore, it is important to distinguish the different users that will be using our bartender robot. After interviewing the people form the service desk of the Science Centre, which could give us a lot of information about the people using the current coffee corner, we can define the following different persona's that will use our bartender robot.

Child: Joris

Ages:	8
Situation:	Visits the science centre with parents
Preference:	Cola and mars
Ticket price:	€4
Note:	Quickly distracted, finds everything amazing

Grandparents: Hans en Thea

Age:	73
Situation:	Live in the neighbourhood, are retired and looking for fun things to do
Preference:	A cup of tea
Ticket price:	€7 each
Note:	Interface should be simple and intuitive to use

Science Centre employee: Sanne

Age:	31
Situation:	Works in the Science Centre
Preference:	Gets 4 cups of coffee on a tray, for her and her colleagues
Ticket price:	Free entrance and free coffee
Note:	Prefers a quick and robust machine to a fancy experience

Student: Joost

Age:	20
Situation:	Visits the science centre with student friends
preference:	Cup of coffee
Ticket price:	Free entrance
Note:	Gets free entrance because he is a student, but no free drinks or snacks.

School Class of 20 students and one teacher

Ages	5-12
Situation	A preschool class visits the science centre for a workshop

3.2 User context

The number of visitors of the Science Centre varies greatly on different days, and so also the amount of visitors to the coffee corner. On quiet days there can be only 2 visitors in an entire day, but normally on a weekend day this number is much higher at 150-200 visitors.
On busy holidays the number of visitors is even higher, and can go up to 600 visitors in a day. Furthermore, the amount of visitors is highly weather dependant. On nice warm days, less people visit the museum, and on cold or rainy days more people come to visit.

On a normal day at the Science Centre a visitor enters the building and is immediately presented with the host robot which grabs the attention. From the host the visitor will receive a NFC card. When the visitor goes to the coffee corner and wants to buy a drink or snack, the visitor scans the card and can subsequently choose an item. All the ordered items together with the amount of tickets (a family can enter and take only one NFC card) are stored in a database.
When the visitor leaves the science centre, he or she can scan the NFC card at the front desk, there the orders are read from the database and can be paid all at once.

Because of this diverse amount of guests that can be inside the Science Centre where it may be quite busy at times. This means that there can be a lot of guests in the coffee and corner possibly multiple people wanting to buy drinks or snack. In order to deal with this the bartender robot needs to be sufficiently fast enough when preparing and delivering drinks.

If many guests are in the coffee corner people will easily get in each other's way, especially if people hang around the coffee corner and block others from accessing the machine. This is why the bar robot should mainly be a place to come and get your coffee, not a place to sit down.

4 Requirements

Based on the wishes from our client and the analysis of both the context and the user, we could create the following list of requirements:

Must have

- **Preparation of hot drinks** - Since the system needs to substitute the current coffee corner, the same functionalities are requested as the current coffee corner. One of these functionalities is the preparation of different coffee types and tea. So the system must be able to prepare hot drinks.

- **Preparation of cold drinks** – Since cold drinks could also be ordered at the current coffee corner and some customers would like a cold drink instead of a hot drink, the system must be able to prepare cold drinks as well.

- **Safety** – Safety is always an important part to consider. To obtain zero injuries to the customer, all the moving parts must be unreachable for the customer. Furthermore no swift and unexpected movements must be made to shock the customer.

- **Feasibility** – It is required that the system needs to work in only 6 months, this gives us the restriction of time which means that complicated concepts are most likely to fail.

- **No audio** - The Science Center wants to keep the noise pollution as low as possible since there are many assembly's at the Science Center. So the Bartender Robot isn't allowed to use any kind of audio to, for example, communicate with the customer.

- **Easy to be cleaned** – As coffee can be spilled during transportation or by an accident caused by the customer it is required that the system can easily be cleaned by the cleaners of the Science Center.

- **Delivery of the order** – As the system not only needs to substitute the current coffee corner, but also needs to have improvements compared to the current coffee corner. The system should be able to deliver the complete order to the customer.

Should have

- **Entertainment** – A nice addition to the system is to make it more entertaining for the customer. For example, an interactive way of ordering.

- **User Friendly** – The system must be user friendly and thus must have an easy, but fun, way of ordering drinks.

- **Speed** – A long waiting time for your drinks isn't appreciated. Therefore it is desirable to make the system as fast as possible.

Could have

- **Communication with the Host Robot** – It would be a nice feature if orders can be placed by the Host Robot so that the system can prepare the drinks faster for the customer. A communication with the Host Robot is needed to realize this feature.

- **Preparation and delivery of snacks** – The snacks delivery system is separate from the hot and cold drink systems and will be added only if time permits us to.

Won't have

- **Dispense of additives** – Since a time restriction is set to this project and it is suggested to make not so complicated concepts, the dispense of teabags, milk, sugar and coffee creamer will not be done by the system.

5. Functional Analysis

To generate ideas, we defined the different functions that the robot will have and brainstormed for solutions. In the overview below, you can see some of these solutions. We choose the most applicable ones from our brainstorm session.

Morphological overview					
Hot Drinks	Current machine	New machine			
Cold Drinks	Cans	Plastic bottles	glass bottles	Post mixer	Juice box
cooling cold drinks	Fridge	Ice	Liquid Nitrogen		
Product Display	Poster	Digital	Inside the bar	Hologram	
Ordering / choosing a product	Kinect (gestures)	Touch Screen	Buttons		
Payment	Pin	Cash	NFC-Tags	Campus card	
Transport	Monorail	Air hockey	Hanging	Rotating arm	Platform moving in XYZ-directions
Controls	Arduino	Raspberry-pi e	Desktop/Lap top	Tablet	
Communica tion host	Bluetooth	WiFi (LAN)	Cable (Ethernet)	NFC	

5.1 Host robot communication.

The host robot will accept orders which will be prepared by the bartender. For this feature a communication channel is needed. This will go through the LAN network of the science centre.
The host robot will give visitors an NFC card that identifies them with an ID code. Central to the robots there will be a server running that records the orders made at both locations in a database and links them to the NFC card placing the order. The database will be easily accessible to both robots using an API that accepts simple http requests. When the visitors leave they can scan the NFC card and pay for their whole bill in one go. When the visitor leaves the bill is wiped from the system and the NFC card can be re-used.
The database can also contain fields providing information about other conditions such as the weather. The bartender can use this information to provide choice suggestions. During cold weather the bartender can reccomend buying hot drinks for example.

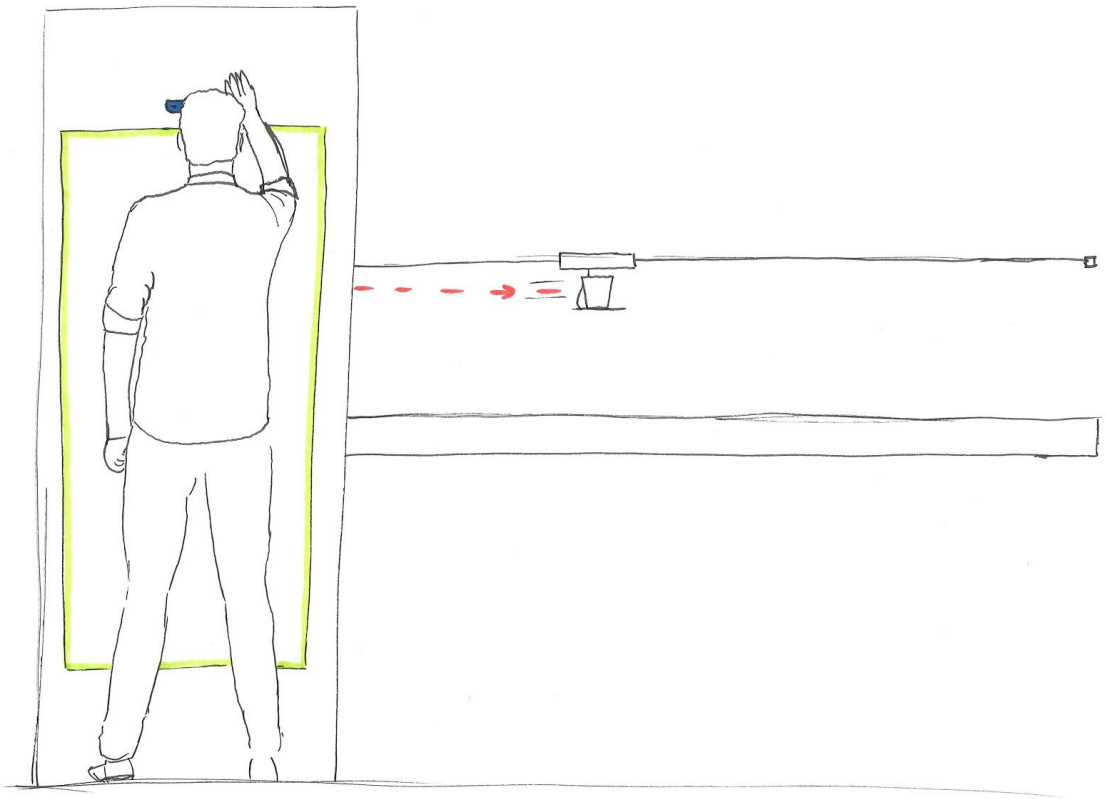
6 Concepts

With the morphological overview, we created a lot of concepts. We had a meeting with our client and discussed the different concepts. After this meeting, we combined several concept to 2 final concepts. the chart below shows which solutions from the functional analysis are used in these concepts.

Morphological overview:					
Hot Drinks	Current machine	New machine • •			
Cold Drinks	Cans • •	Plastic bottles	glass bottles	Post mixer	Juice box
cooling cold drinks	Fridge • •	Ice	Liquid Nitrogen		
Product Display	Poster	LCD-Scherm •	Inside the bar	Hologram •	
Ordering/choosing a product	Kinect •	Touch Screen •	Buttons		
Payment	Pin • •	Cash	NFC-Tags • •	Campus card • •	
Transport	Monorail	Air hockey	Hanging spill-not •	Rotating arm	Platform moving in XYZ-direction •
Controls	Arduino	Raspberry-pie • •	Desktop/Laptop	Tablet	
Communication host	Bluetooth	WiFi (LAN)	Cable (Ethernet)	NFC	None •

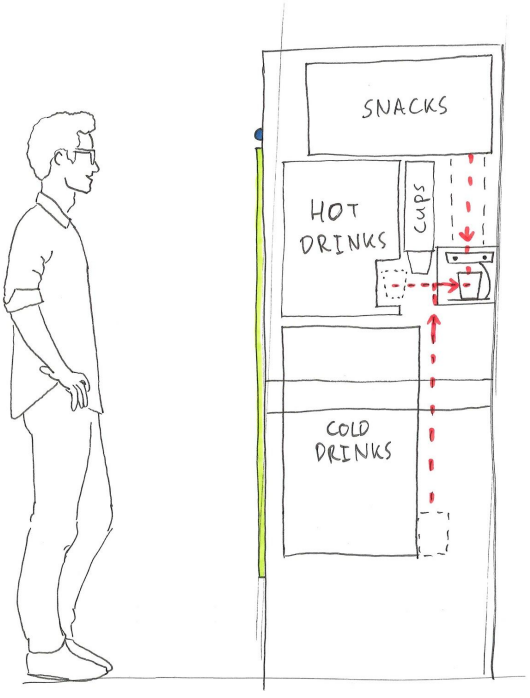
Concept 1: **Blue** • Concept 2: **Red** •

6.2 Concept 1



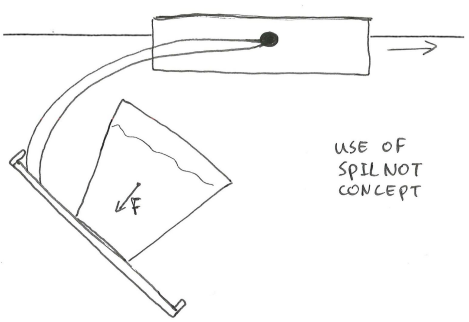
Front view

This concept is based on gamification of the process of getting a drink. The robotic bar should be easily cleanable and very robust. Because of this wish/constraint, less external moving parts are preferable to protruding moving arms. To still offer a great level of interaction with the machine, a Kinect will be used in conjunction with a large screen. The screen will present an interface containing floating bubbles and an outline of the user's body. The interface will adapt for the length of the person interacting with the machine. Other adjustments could be a change of the colour scheme or making the interface more playful in other ways to enhance the experience for children. Of course, a parent is most likely going to pay for the wares, so a clear overview will be given that has to be confirmed.



Side view with internal components

The delivery of the drinks will be done using a railing baring a little cart that carries the drink. This cart will accelerate from the main body of the machine and stop in front of the user's place at the table. To compensate for the acceleration of the fluid, two systems are proposed.



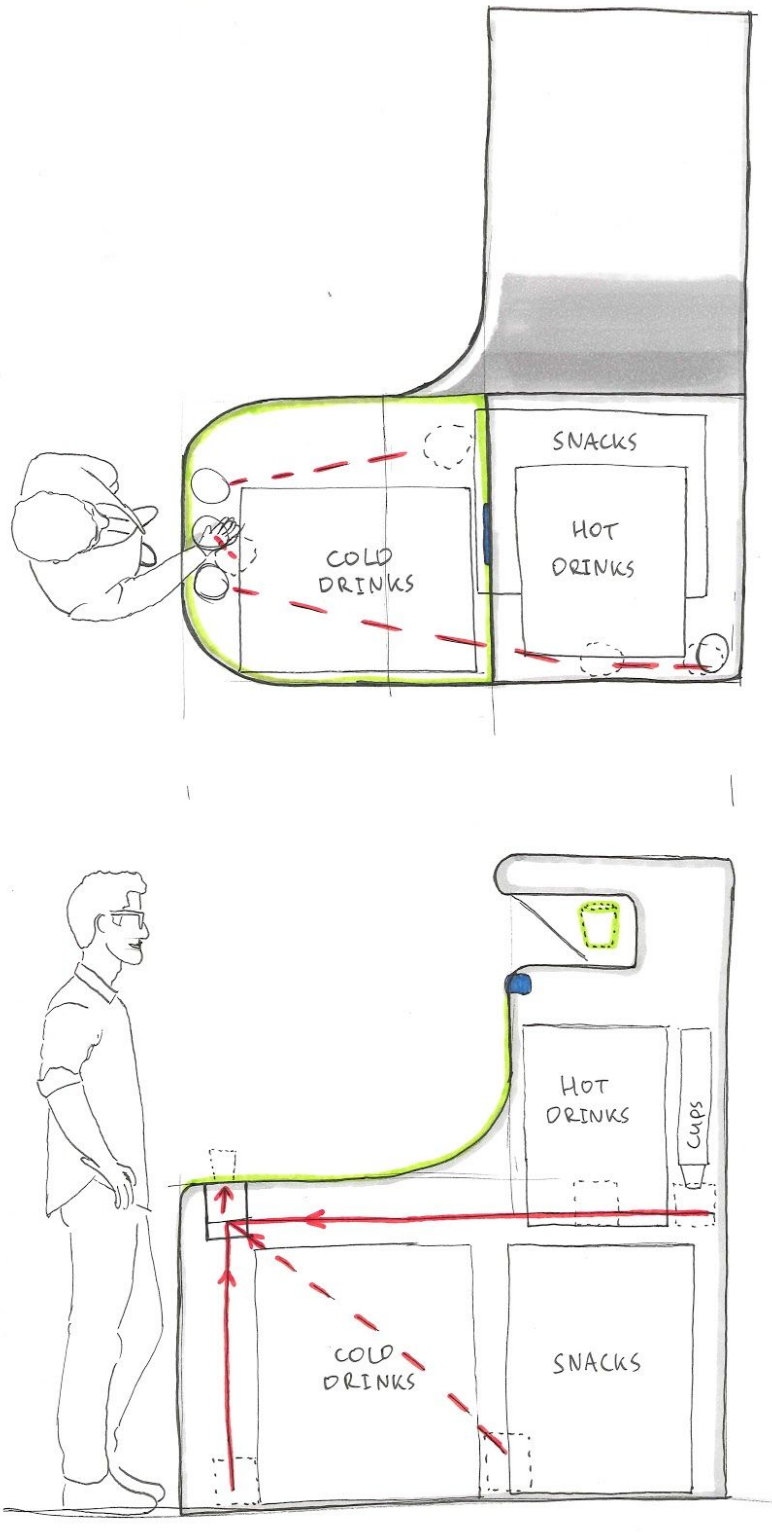
The first is a simple mechanical swing the drink stands on, with the hinge above the center of mass of the cup. This way, acceleration forces will be perpendicular to the base of the swing and thus no fluid will be spilled.
The second method is to use (servo) motors to tilt the drink when it is being moved, based also on acceleration. This method is more difficult, but has the advantage of the ability to reduce swinging when the cart comes to a halt.
Mechanical swing idea

Below a render of the concept idea is shown.

Computer render of the concept

6.3 Concept 2

The second concept is an interactive bar to order drinks and sit at.
The tabletop (green part in the sketch) is made interactive using a beamer and sensors, so that it becomes a touchscreen. On this table, the user can select if it wants a snack, cold drink or hot drink. After choosing the category, the different options are on by one shown as holograms at the top of the bar (green object at eye level in the sketch). The user can swipe on the table to scroll through the different options.
After selection and payment of a snack or drink, the hologram will “fall” down and an animation will be projected on the tabletop. This animation will draw the attention back to the table top and will make it look like the order comes rolling (for example) to the user. Also further information about the selected drink or snack could be projected.
During the animation, the drink or snack is being prepared and moved to the front side of the table. As the animation also focusses on of the three holes, the hole will open and the drink or snack will magically rise out of the table.
The robot is built in the form of a bar, so people could also sit at it. But just picking up orders is possible as well.



Top view (above) and side view (below) of the concept

On the next page, two computer generated images are shown to present how the bar would fit into the room.


HIER ALLEEN
PINNEN


TU DELFT TV
new episodes every 2 Fridays
www.tudelft.tv
OP REIS MET RUBEN TERLOU
HIER ALLEEN
PINNEN
Cold drinks
Use touch screen to
make a selection

7 Concept of Choice

In the following table the two concepts are assessed using the requirements set in chapter 4. A value from 1 to 5 is given for each different requirement which are not so good to very good respectively. A weight factor is given to each requirement to indicate some requirements are more important than others.

	Weight	Concept 1	Concept 2
Safety	5	4	5
Feasibility	5	4	4
Cleanable	4	4	3
Entertainment	3	3	5
User Friendly	3	3	4
Price	1	3	3
Durability	2	4	3
Speed	2	2	3
Total		89	99

The table shows that Concept 2 is the favourable concept. Concept 2 will now be further examined and improved. There are still some points which need to be thought true. A few points are:

- Dispensing and storing cold drinks while keeping them cool.
- Designing cleanable baskets to transport the drinks.
- Arranging the internals of the furniture for easy access to refill and clean.
- Developing an interactive table top
- Developing a system to present a hologram.
- To further elaborate the concept.