BOTANO: A Smart Gardening And Cooking System

Hannah C. van Iterson
Eindhoven University of Technology
5612 AZ Eindhoven, NL
h.c.v.iterson@student.tue.nl

Anniek Jansen
Eindhoven University of Technology
5612 AZ Eindhoven, NL.
a.jansen1@student.tue.nl

Thomas H.M Pilaet
Eindhoven University of Technology
5612 AZ Eindhoven, NL
t.h.m.pilaet@student.tue.nl

Xander Verstraeten
Eindhoven University of Technology
5612 AZ Eindhoven, NL
x.verstraeten@student.tue.nl

Abstract

This report describes the design process of Botano, a family of products that together form one intelligent system. Botano was developed to give a family a set of tools to collectively take care of plants and eventually create recipes with them. Several iterations are shown and discussed in this report. The presented iteration at Demo Day consisted of three parts: a base element ('Botano Base'), a smart cutting tool ('Clipper') and a set of soil sensors. The evaluation of this iteration is discussed as well. Afterwards, a final design proposal is given together with a business plan. The report closes with a discussion chapter.

Figure 1: The final design of Botano

Introduction

Home, the place we probably know best of all. Still, the way we live is constantly changing. The year 2020 has showed us, just how fast this can happen [18, 49, 32, 20]. Many of us learned this year that working from home asks for separate life and work-boundaries [4, 53]. These can be made through amongst other things creating clear spaces for work and for relaxation. For example, a study or the kitchen table for work and the couch or garden for relaxation.

Compared to the rapid changes that COVID-19 brought, other factors have had a more gradual and longer influence on our concept of home. Such factors are for example urbanization, ecological trends and aesthetical trends. Urbanization can bring much change to the average home. The current expectation is that approximately 68% of the world population will live in cities in 2030 [51]. With that the likelihood of houses having a private garden decreases. Losing or not having a garden space can have negative effects in a person's live.

Namely, several studies have shown that relaxation and recreation are important functions of an outdoor space [58]. Gardening, whether it is taking care of decorative or edible plants, is often done as a hobby or relaxation. Other motivations include the beneficial effects of gardening for financial, physical or mental health [28, 36]. For these reasons we should try to keep a garden space or at least the activity of gardening part of our homes and lives.

However, gardening is not as easy to learn as one might think [46]. Light, water, nutrients and temperature all have to be maintained just right for plants to optimally grow [31]. Even with all of these things figured out, pests or diseases can still throw a spanner in the works. Such difficulties can form an obstacle for people to get into gardening.

Nevertheless, having plants and taking care of them is becoming increasingly popular [3]. As shown by for example the rise of the Urban Jungle Project [56], the recent popularity surge due to the pandemic [48, 16, 62] and other trends such as filling your urban home with decorative and edible plants [41]. Due to trends as these gardening communities have popped up where members exchange knowledge, experiences or plants.

Looking at both the increase in the need and popularity of gardening design possibilities emerge. Also taking the difficulties in gardening into account an intelligent system that can help people in gardening at home may be a way to involve more people into growing their own vegetables. Having people maintain plants in their own homes will not only result in better air quality indoors [6, 9], but also provide a fun way of relaxation [72, 12]. Which is why, we propose the concept of Botano. Botano is a family of products, created with the purpose of aiding a family in collectively taking care of plants and creating recipes with them. Botano was designed to be suitable for both gardening novices and experts.

The aim of Botano is to guide users in taking care of their plants. However, we do not want do this by taking tasks from their hands through automation. Instead we want Botano to give them a new form of engagement with their plants. Using a Machine Learning (ML) model, the system and user can even learn from each other. In this way, Botano combines the strengths of the system and the user. The system can excel at knowing what a plant needs, estimating when a plant should be ready for harvest and providing the user with possible recipes from these harvestable plants. A user is able is be able to notice peculiarities in a plants growth process such as diseases or a divergent growth process.

In this report, the design process of Botano is described. This includes bench marking, several iterations and a user test. The latter was done remotely and consisted of an interview and questionnaire. Qualitative and quantitative findings were gathered on the overall concept and in specific the user interface. Using these findings we validated several design choices and learned what could be improved. Subsequently, a redesign together with a business model are presented.

We think that this design process is a good example of combining the strengths of AI and human. A strong collaboration towards successfully maintaining plants is created. Additionally, Botano is an example of a tool to help people get started or involve others in gardening and cooking.

Related Work

This project was part of the squad Designing for Growing Systems in the Home (DIGSIM) of the faculty of Industrial Design. Specific to the design and research process in this squad is the use of the IoT (Internet of Things) Sandbox [25]. This semester the IoT Sandbox consisted of home with a family of mundane characters, the Gorré family, living there in 2030. The inclusion of the sandbox influenced our design process, since the mundane characters determined the target group and the other design projects in the IoT Sandbox were also to be considered to prevent a multiverse of systems within the squad.

Urban Gardens in 2030

Our design space in the IoT Sandbox was, in the beginning, the outdoor garden. Later in the process, this shifted to a more flexible space: wherever the plants are located in the home and a small product unit in the kitchen. To determine the expected context in 2030 we analysed current trends and reflected on the changes in the last ten years.

In ten years time, 68% of the people will live in cities [51], thus the majority of gardens that do exist, will be urban gardens. Urban gardens are part of Urban Agriculture and differ from Urban Farming in that there is no desire or dependency on making a profit from the food production and the goals are mainly societal [61]. Urban gardens can be split into three categories: home gardens, allotment gardens and community gardens [8]. Outdoor home gardens in the urban environment will be rare due to space limitations, but vertical farms could be used as a space-saving alternative. This project focused on home gardens which could be either indoors or outdoors. The popularity of gardening depends on several factors. One of them is the socio-economical situation; during an economic crisis a garden is considered a reliable way of producing food [36]. Moreover, the current emphasis on sustainability and the demand for organic food also resulted in more people growing their own food in the past years.

System design

When designing a sensing system the communication between human and computer must be properly designed [5]. For Graphical User Interfaces (GUIs) there are established methods, but when designing tangible interfaces these interactions cannot be copied from a GUI. This challenge can be split into five components upon which are reflected upon during the design process:

1. Address: how does the user address the system?
2. Attention: how does the system show that it is attending?
3. Action: how to specify and control the action?

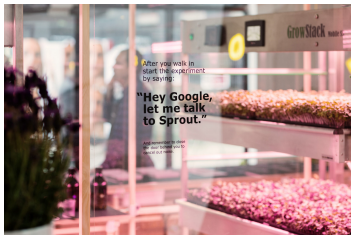

Figure 2: Sprout - a gardening tool with natural language interface. Photo: SPACE10 [60].

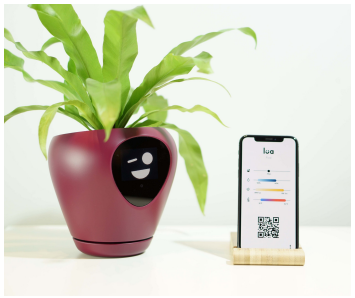

Figure 3: Lua - a smart flower pot with facial expressions Photo: Mu Design [13].

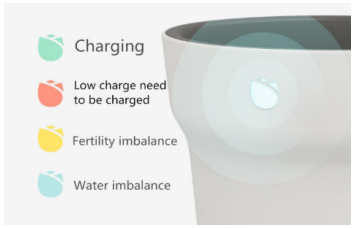

Figure 4: Xiaomi Flora - a smart flower pot with information LED Photo: Xiaomi [70]

4. Alignment: how does the user know the system is doing/has done the right action?
5. Accident: how can the user avoid and correct mistakes?

Besides the challenge of creating an interaction, designing for systems also has other pitfalls [76]. Examples of this are privacy issues, latency when connected to the cloud and quality of service guarantee; what happens when e.g. the internet stops working for a moment. These considerations are taking into account and reflected on during the design process and in the discussion.

HCI and gardens

Different studies within Human Computer Interaction (HCI) have focused on the garden as design space [58]. Working in a garden has positive effects for your health and well-being, provides opportunities for self-expression, has a social role and a garden has benefits for the local ecology. Three barriers are identified to engagement and participation [46]: 1) Space 2) Maintenance and 3) Knowledge. With our design, we address both the maintenance and knowledge aspects that can prevent novices from starting to grow their own food. Space is addressed by the compactness and flexibility of the design.

Machine Learning in Design

Artificial Intelligence (AI) is becoming a more important aspect in everyday applications, for example the spam filter in your email. AI in the area of HCI can be used as a way to ultra-personalize, since the system can make recommendations for each individual user [14]. Furthermore, it can be used to automate certain tasks. However, it is not recommended to automate all tasks; when automatizing all the simple tasks you risk the Leftover Principle where the remaining tasks are too hard for the humans to perform [40]. A better approach is using the Compensatory Principle where humans and machine both do what they excel at. Another approach for determining the role of AI in a creative process is by determining the role of the AI: either as a nanny, a pen-pal, a coach or as a colleague [43]. As a nanny, it can monitor and support the user while as a coach the AI teaches the user skills and strategies for creation [29]. We used a combination of both approaches. First determining the role of the AI and afterwards looking at which tasks humans excel.

Smart gardening tools

Simply put, combining AI and gardening results in smart gardening tools. Some smart gardening tools already exist, but they do not always use AI but sensors in combination with data analytics. This information can then be communicated through an app [55, 30] or through colours/expressions on the flower pot itself [70, 13]. Some of these products can also be connected to the IoT system in a home. An example of this is Sprout [60], which uses the Google voice-assistant Home to facilitate natural communication between the plant and the user, with the aim to teach people how to take care of plants in hydroponics. Other systems such as Parrot Pot [55] automate the watering tasks. A clear difference between these products can be found in how the plants and their needs are presented. This difference can be separated into two categories. One category in which products show the data and give alerts that your plant needs something through the app or an LED [70, 71, 55]. The other category uses personification and the needs are communicated from a first-person perspective [60, 30, 13]. With Botano we try to create an educational tool where both the user and the system (AI) are learning. In the current products the systems seem to be knowledgeable and do not afford the user to collaborate with the system.

Figure 5: "The Architect" scenario .

Recipe Recommender systems

Another option for combing AI and gardening is by recommending recipes based on available plants in the house. Numerous sites on the internet already provide the option to search recipes by ingredients or keywords. However, few sites personalize the recommendations based on your previous behaviour or selected cuisines [75]. Epicurious [17] has a site to help find recipes based on ingredients in your pantry, but this requires manual input. To the best of our knowledge, no commercial sites use recommender engines. Several tutorials can be found on how to build those models [78, 15, 63, 10]. This technique is used by large companies like Netflix and Spotify to recommend films and music [11] and will be used in Botano to recommend recipes based on the available plants in the home.

Design process

Iteration I

Quite early on in our design process, the decision was made to focus on gardening and plant care. Literature research on gardening was done as to get an early overview of what design possibilities lie in that area. Moreover, benchmarking helped us map out what products already exist, which gave us insight on what aspects of those products we could improve and build upon. Next, a 'role' had to be chosen for the AI. By doing this we could make designing with an AI and implementing it in our concept easier. AI can take several roles while cooperating with a human [43]. To start, we created a chart of which the x-axis goes from full AI-control, to full human-control, and the y-axis goes from no automation in tasks to a fully automated system. On the extreme points of each axis, a scenario was created.

These scenarios helped us get an idea of the design possibilities with AI and what we wanted to incorporate and what to avoid. Especially the 'Architect' scenario, which can be seen in figure 5, is one to avoid. In this scenario the humans are turned into unpaid labourers for the AI. After these conclusions we could decide on what role to give to the AI. We decided to give our design the coach role. This role is one in which the AI takes an advising role, is active in gathering data and interpreting it, but does not automatically do the task. The AI, therefore, 'coaches' the humans in taking care of their plants.

The research and ideation of possible systems eventually turned into the first iteration. This Iteration I, shown in Figure 6, consisted of two parts: a vertical garden and Spookje (a gardening agent). The vertical garden is much like a display cabinet, with plants and specialized lights on the different shelves. On these shelves and along the sides, rails would be installed. Spookje would be a semi-autonomous system gliding over these rails, past the plants planted in the vertical garden. Its task was to monitor and capture the growth of the plants in the vertical garden

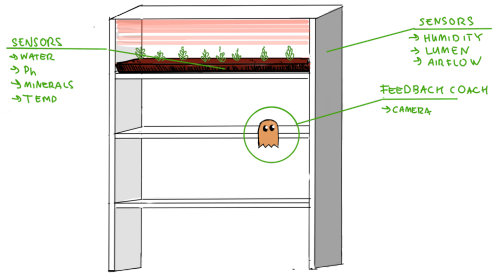

Figure 6: Spookje and vertical garden from iteration I.

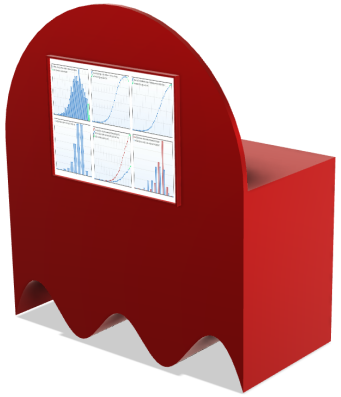

Figure 7: Spookje from iteration II.

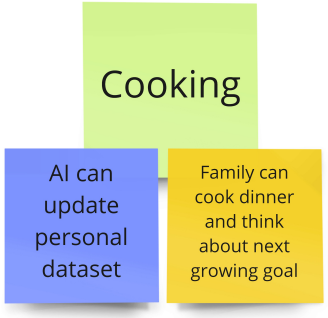

Figure 8: Example of user scenario with AI and human perspective

using a camera located in Spookje and information of sensors built into the cabinet.

Iteration II

To enhance the user's dedication and connection to growing plants game elements were incorporated in the design. These elements were based on the Design with Intent Cards [42] to help influence the users' behaviour positively. Growing your own produce would become a game, where the game played a big role in the overall product as a central pillar of attention. These game elements ranged from light indication and point collection to assigning different difficulty levels of plants to take care of. These game elements were developed parallel to the gardening tools. Spookje was further developed into the shape as illustrated in Figure 7. A display for possible collected plant data was integrated for real-time showcasing.

Iteration III

The purpose of the concept from Iteration II derived from gardening as their main purpose. Game elements were added to create a more engaging experience. However, expert feedback indicated that for the user to stay engaged with gardening, that itself should already be interesting enough. For this reason gardening was set back to be the main design focus and the main purpose of the design. To explore the existing interaction opportunities in gardening, different use scenarios were explored from user and AI perspectives (see Figure 8). From these use scenarios, two elements were chosen as focus: choosing recipes to cook with your own ingredients and an agent to help with the gardening tasks. Based on these two elements our midterm concept was developed which aimed to give the Gorré family a set of tools to choose and plan recipes of which the ingredients can be grown in their vertical garden. Therefore, a goal-setter (see Figure 10) and a new version of Spookje

Figure 9: Spookje in vertical garden

were developed (see Figure 6). The goal-setter could be used to give an overview of the growth process and to select recipes. A constraint solver could make the layout for the vertical garden based on the needed ingredients for the recipes. Spookje had sensors inside and could be used to collect data from the user's plants. This data was input for a regression model to analyse the growth process and could be used to guide the user in taking care of their plants.

Iteration IV

After the midterm presentations changes were made on the overall design. The most notable changes were made on how to plan recipes, a redesign of Spookje and a way to create a richer interaction. A new concept was developed as shown in Figure 13. This new concept included not only the above changes, but at the same time also easier handling for selecting recipes and gathering plant data from the sensors.

This concept introduced stand-alone plant sensors that could be inserted into the soil next to each plant type to facilitate continuous data gathering, giving a better indication of the growth process over time. Moreover, these sensors gave the user the flexibility to use the sensors both in- and outdoors. This data could be viewed quickly with the updated Spookje, indicating that the planted needed maintenance, for example

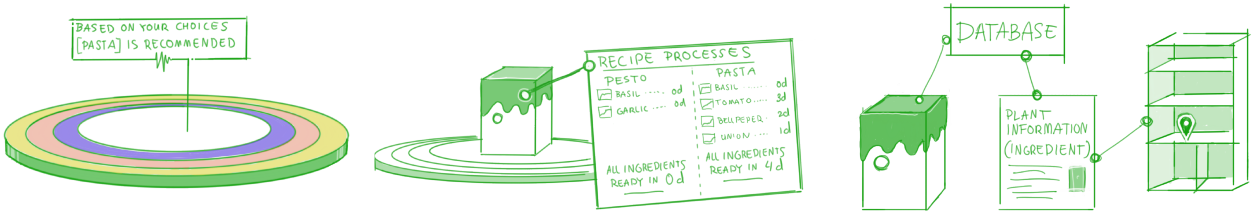

Figure 10: Components of the midterm design

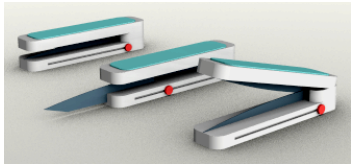

Figure 11: First prototype of Clipper

Figure 12: Table top concept

if water was needed. Where afterwards Spookje could be connected to the goal-setter with a screen displaying detailed information about the plants and recipe options.

The changes to Spookje were considerable enough for us to give it a new name: Clipper, as shown in Figure 13. With the introduction of the sensors, Spookje no longer needed to have incorporated sensors. However, we still wanted to include a handheld device that could give the user maintenance information at the location of the plants. This would allow them to have a directer and more efficient interaction. A better solution compared to constantly returning to the base to view information on what their plants need. To reduce the tools that needed to be carried to the plants, Clipper is a combination between a cutting tool and a screen to display for example maintenance information.

To create more of a familial-feeling where people could sit around the table and interact together with the goal setter, a table-top version of the goal setter was created as shown in figure 12. Based on a kitchen knife stand it holds the plant sensors and Clipper in it as one big unit. These concepts were the starting point for the final design of Botano.

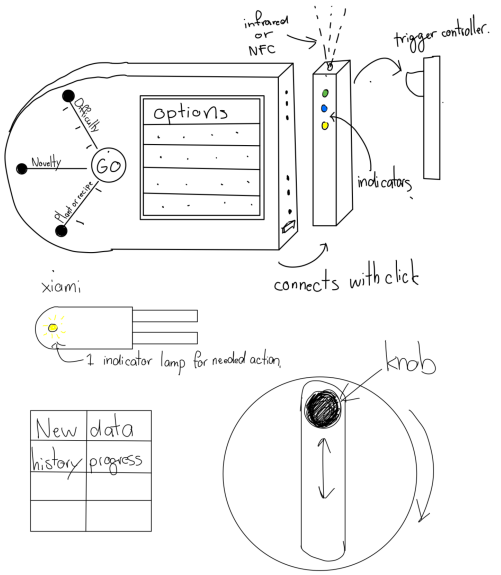

Figure 13: Concept from iteration IV.

Botano Design

Design considerations

As Demo Day approached the urge for finding a name for our concept finally got to us. With that the total concept was now named 'Botano'. From the iterations that took place multiple criteria were created from a system design perspective [5]. For novices in gardening it can be difficult to find the right information, especially the specific information that suits their home and the kinds of produce they want to grow. This lack of knowledge and no clear task overview can generate waste by plants that are not harvested in time [46]. Therefore, it is important not to overload the user with information from the system but guides them at the start. The user should address the system by chronicle steps, from first selecting plants to incorporating them in recipes. The system should then notify back to the user it is actually attending what is happening, during measuring the measurements of plants as well as cutting them.

Gardeners mostly have a negative view on sensing systems that take over tasks and or decisions made. In their eyes knowledge and knowledge transfer to novices is gathered by interaction with the plants, creating also partially intuition [47]. Therefore, the system should not take its own actions but should only log information and give advice that the user can use. At the same time the system should directly process actions that the user undertake, for example giving water and nutrition should get registered in the system directly. Hereby the chance of mistakes gets reduced seen the user will always see updated plant levels.

Clipper

The overall design of Clipper is based on commonly used garden shears that are currently available on the market [35]. These types of shears have a curved blade and handle for easier use. Clipper on the other hand has a more

Figure 14: Clipper prototype

straight design that is formed due to the electronics inside that operate its functionalities. To maintain the handheld ability of Clipper its dimensions have been kept to a minimum with a rounded edge at the back, making it possible to rest in the palm of your hand. The buttons on Clipper to navigate up and down in the menu have been located on the right side for easier use, this right side is chosen because most people are right-handed [54]. Figure 14 shows the prototype of Clipper and main functionalities.

These buttons give the user the access to go up and down through the menu options, displayed on the small OLED screen located on top of Clipper. This menu can showcase the basic four values that are retrieved from the plant sensors, these values will be further explained in the subsection Sensors. This data gathering from the sensors is established by tapping Clipper against the sensor. The radio-frequency identification (RFID) tag located in the sensor will be read by the RFID reader in Clipper. Then through OOCSI [26] the data is gathered from the sensor to the build in ESP32 of Clipper that displays the information on the display.

Another functionality Clipper has, is registering the motion of cutting so that the system can keep track of the amount of produce that is left on the plant. This is technically established by a reed switch in the top end of Clipper. A high signal will be created if Clipper makes a cut, making the reed switch come close enough to the magnet on the bottom end of the Clipper. There might be instances where the user only wants to do maintenance to a plant, for example cutting of dead parts. This can be done with the same act of harvesting by cutting with Clipper, but to discard the cut as harvest Clipper can be shaken to make the system recognize maintenance, this shaking motion is registered with an accelerometer. To get a total overview of

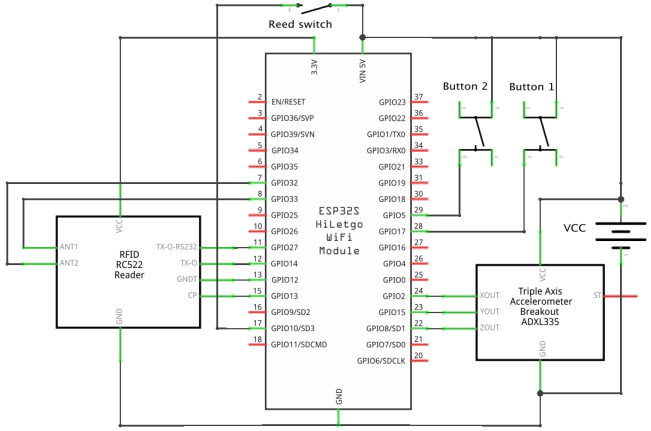

Figure 15: Clipper schematic

the electronics inside clipper a schematic is shown in figure 15.

Clipper can be stored in the Botano base where it will be charged wirelessly. There will be no direct connection between the base and Clipper, seen Clipper has its own WiFi connection for data gathering of the tapped sensors. Clipper gives the user freedom to walk around the house and check plants while interacting them.

Sensors

In the current design, Xiaomi sensors (specifically Xiaomi Vegtrug Flora Plant Sensor)[71] were used, as shown in figure 16. This sensor monitors the temperature (℃) around the plant, the humidity (%) and conductivity (µS/cm) of the soil and the light intensity (lx). Using these four factors, nearly all needed information can be collected from the plants. Additionally, these sensors are small and the sensor values can be read using Bluetooth.

Figure 16: Xiaomi sensor .

Our choice for picking these sensors was based on the different capabilities they had. Additionally, we deemed it important that the focus was on the machine learning part and interaction when making Botano. Not creating our own sensors for this project saved time and allowed us to spend our time on that. Additionally, creating them ourselves would not have resulted in the compact design of the current Xiaomi sensors.

In the future, we predict these sensors to be even smaller than they are now. Additionally, we would like to have them build by Botano Inc, which would allow us to include a built-in WiFi connection and unique RFID-tag.

The connection between the sensor's Bluetooth Low Energy (BLE) and the OOCSI server, in the current design, was created using an ESP32 [65].

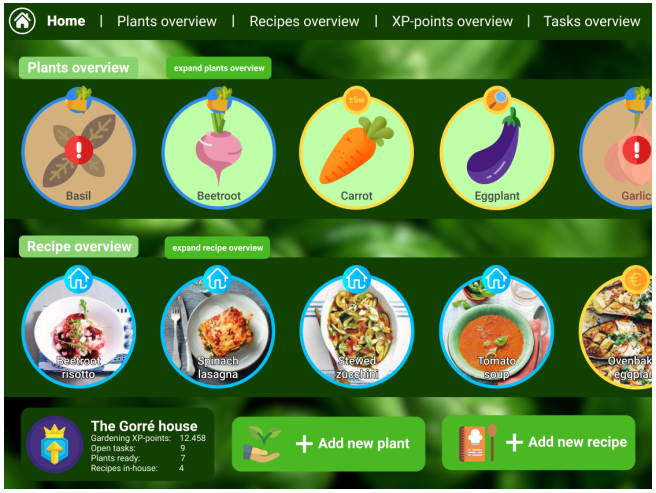

Figure 17: First iteration of the home screen for the Botano Base

Botano Base

The base consists of two parts. The main part is the GUI. This interface includes several overviews. It also enables collaboration between the user and the system and between users themselves. Next to the interface the Botano Base also has a storing and charging location for Clipper and the sensors, as shown in figure 19.

Interface overviews

The main purpose is to give the user an overview of several elements surrounding the Botano system. First and foremost, they are given an overview of the current status of their plants and the recipes they can make with those plants. This information is shown in respectively a plants overview and a recipe overview on the interface screen. These two overviews had a separate tab, but were also visualized at the same time in the home screen as shown in

Figure 18: An example of the first iteration of a plant overview

The Botano Family

Base

Overview point of the Botano system. This is the main storing and charging place for both the data from Clipper, Clipper itself and the sensors.

Sensors

Plant sensors which measure moisture and fertility of the soil and the temperature and light intensity around the plant.

Clipper

The hand-held device which can be used to cut plants, and give information to the user about the current state of the plants.

Figure 19: Botano family

Figure 17. Users could also get specific information on plants and recipes on their individual pages. An example of this for the aubergine is shown in Figure 18. Besides plant and recipe overviews the interface can also show what gardening and cooking tasks need to be done in a separate tasks overview. Moreover, the interface also has an overview of the user's experience points (XP-points). These XP-points can be gathered through the use of Botano, specifically when plants are for example successfully maintained and then harvested. More information on these XP-points can be found in the 'Business plan' section.

Storing and charging

To make life easier for the users the sensors and Clipper can all be stored and charged in the Botano Base when they are not in use. This enables the users to quickly grab a sensor when they have added a new plant. Moreover, Clipper can upload and store its data to the base during usage and afterwards is easily accessible for the next usage.

Human-AI collaboration

In Botano, ML is used as a coach [43]: it educates and supports the user with their gardening tasks and by suggesting recipes. This approach was chosen to prevent automatizing, because this is viewed negatively by gardeners since it interrupts existing processes of gaining knowledge and intuition [47]. Furthermore, as a coach the computer can use its strength to analyse data while the user does the physical actions, which makes it possible to continue learning and gain tacit knowledge [40, 47].

A database with 26 recipes was made which was used to create a Wizard of Oz prototype of a recipe recommender system. The total system can be seen in figure 20.

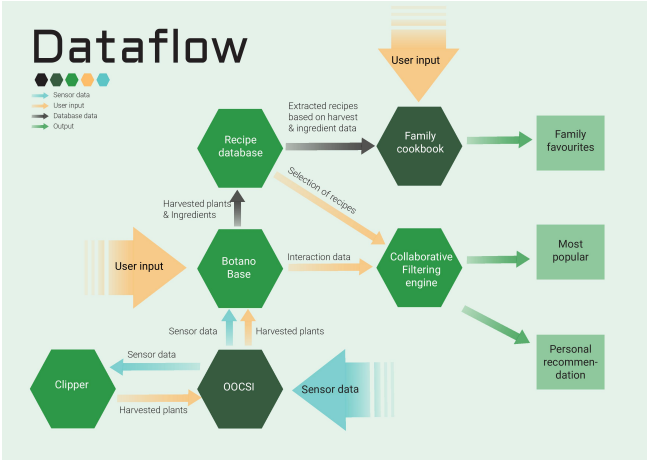

Figure 20: Dataflow of Botano

Database

A database [65] was created with 26 recipes from the Albert Heijn [7]. All information from the site was copied to columns (e.g. preparation time, tags and ingredients). An extra column was added with the ingredients that could be grown at home and this column and the original ingredient column were transformed to ingredient vectors. These vectors could be used to calculate the cosine similarity between different recipes.

Implicit interaction data

The next step was to get interaction data that could be used to recommend recipes to the user. Two types of data can be used to train a recommender system [39]: explicit rating data (e.g. 4 out of 5) or implicit data (five times clicked, saved once as favourite). Botano collects implicit data, since this can be done without extra input from the user as they are not likely to always rate their recipes. The implicit

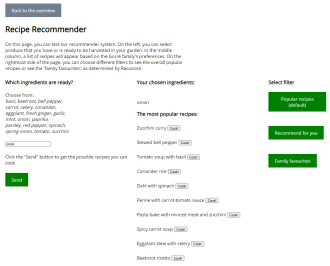

Figure 21: Prototype recipe recommender system

data exist of the number of times a recipe is viewed (weight = 1), the number of times the recipe is cooked (weight = 3) and whether it is saved as a family favourite. This implicit data was collected by using Google Analytics on a custom-made website where people could view and select recipes for each day of the week [67]. However, in the end, it was not possible to access the individual data with a free account [1, 27]. We did use this data to get the general popularity, but it was not possible to create our own personalized recipe recommender.

Recommender algorithm

To recommend recipes, there are three approaches [45]:

1. Simple recommenders, which recommend the most popular recipes and do not tailor it to the current user.
2. Content-based recommenders, which suggest similar items based on metadata.
3. Collaborative filtering engines which predict the rating based on ratings given by other users or on other items.

The Botano systems uses two of those approaches: a simple recommender when the user filters on "most popular recipes" and collaborative filtering engine when the user filters on "recommended recipes". While we have not realized a recommender system we did approached it from a theoretical perspective to make sure we understood how it would work and how we could implement it if there was data.

Collaborative filtering works differently with explicit and implicit data [68]. With implicit data you also need to take the missing data into account since this might mean the user did not like that item, but it could also mean that they have not yet interacted with that item while they might like it. Hu, Koren and Volinsky [33] created an approach which uses data to indicate positive and negative preferences (positive if the user interacted at least once with the recipe) with varying confidence (larger confidence if the user has often interacted with the recipe). The Alternating Least Square model is then used to find the two matrices (one with user vectors and one with item vectors) that represent the original database. Since the database will be mostly empty, not every user has interacted with every item, sparse matrices are used.

In Python, the Implicit library [19] can be used for this approach which makes it easier to find similar items and to make recommendations for a user. Similar items are found by calculating the dot product between the transpose of the item vector and all the item vectors. The higher the result, the higher the similarity. Recommending items (e.g. recipes) to a user is done by calculating the dot product between the vector of that user and the transpose of all the item vectors. Again, a higher score means better recommendations. These steps are embedded in the library and similar items and recommendations can be found using their functions.

Prototype recommender system

To communicate the concept we developed a website [66, 65] where users could enter ingredients that would be ready in their garden (see Figure 21). Based on these ingredients they would see ten recipes, which recipes depended on the selected filter. The website communicates through OOCSI [26] with a Python code [65] which would extract the recipes with at least one of these ingredients and sort them according to the selected filter. The user can filter on *Popular recipes*, *Recommended for you* and *Family favourites*. The filter *Popular recipes* uses the scores

Figure 22: The different icons for the three growth stages [21, 24, 22, 50, 23]

extracted from Google Analytics to sort the recipes. The filter *Recommended for you* used a manually added column with random data to sort the recipes. This was done because we were unable to train a recommender system with collaborative filtering but still wanted to give the user the feeling that it worked. The last filter, *Family favourites* uses binary values which represent whether the recipe is in the family cookbook [64]. Only recipes that are in the family cookbook are shown.

Plant growth estimation

The Botano system also needs to have an estimate of when plants are ready to be harvested. The collected sensor data is not sufficient for predictions and alternatives such as computer vision in combination with a Convolutional Neural Network[77] or monitoring the stem diameter as one of the inputs for a deep learning model [2] are too costly and complex for the mundane home gardener.

With Botano the user is able to see when a plant is ready for harvest without having any previous gardening experience. To achieve this, however, the Botano system also needs help from the user. To adequately estimate the current growth stage of the plant Botano regularly asks the user to do a check-up on the plant. The user is shown several images of different growth stages, with some textual descriptions for each stage. The user is asked to click on the stage which they think fits their plant best. Botano can show three different growth stages in the plants overview: the estimated amount of weeks for when the plant is ready for harvest, a thumbs-up icon when the plant is ready for harvest and a dead plant icon when the plant's harvesting season is over (see figure 22). Next to the user input, the growth stages are also estimated through for example sensory data. Botano gives the users an overview of the collected data and notifies the user when a sensor reading is below a threshold, but the users still have to make their own judgement and have to execute the action.

Collaboration with Recuisine

During the earlier stages of the project a collaboration was started with another student group within the squad. They were the other M1.1 group from the Human-AI collaboration challenge. In the end with their concept, called Recuisine, the Gorré family could create their own family cookbook in which they could find recipes they ate or liked the most. Furthermore, the Recuisine system could suggest to the users what ingredients/items to buy from the grocery store to become for example more sustainable. Through the Recuisine cookbook it is possible for Botano to gather some of the family's favourite recipes and incorporate those in the filtering of the Botano recipe overview. In addition, through Botano's knowledge in what plants in the household are available for cooking it is possible for Recuisine to adapt their system to the usage and availability of the different plants.

Evaluation

Study setup

To evaluate our concept, a user study was conducted with eight participants of whom six own a garden and grow their own vegetables and two with expertise in user interfaces and/or machine learning systems. A semi-structured interview approach was chosen to evaluate the concept. The interview was done through Microsoft Teams and started by showing the participants a video which explained the concept and showed the prototypes. After the video, the participants were asked to explain the concept and questions related to their own habits when gardening. Next, the participants were asked to execute certain tasks within the interface prototype. Following these tasks, more detailed questions were asked and the participant had the

opportunity to give their general opinion on the concept. The interview was ended by filling in the Usability questionnaire [44].

Analysis

The analysis of the user test was split into three sections

Interface

To analyse the interaction with the interface, the screen and time were recorded. This was used to create an overview of how long participants spent on an interface tab and what they clicked on those tabs. Heatmaps were made of the clicks as well. The screen recording for one of the participants failed. Therefore, the interface user test could only be analysed for seven participants.

Thematic analysis

During each interview, one of the researchers took minutes. These minutes were used to perform an inductive thematic analysis on the most important questions.

Usability

The results of the USE questionnaire were analysed by combining the scores of the questions belonging to a dimension (e.g. satisfaction) to get an overall score.

	Scenario 1	*Scenario 2*	*Scenario 3*
Completion rate (n/o participants)	7/7	5/7	3/7
Average time (seconds)	69	185	55

Table 1: Results for interface user test

Findings

Interface

The performance of the participants when doing the interface tasks widely differed. Some participants navigated through the interface quickly whilst others had more difficulty in immediately understanding the layout. The results of this interface user test can be found in Table 1. Some participants were given a hint if they were not able to finish a task correctly. For analysis purposes these attempts were considered as a failure. However, for the calculation of the average time needed to finish a scenario all attempts were taken into consideration. Combined with the results from 1, the heatmaps such as in Figure 23 and the qualitative feedback some findings were found. From the findings of *Scenario 2* we could see that the individual plant

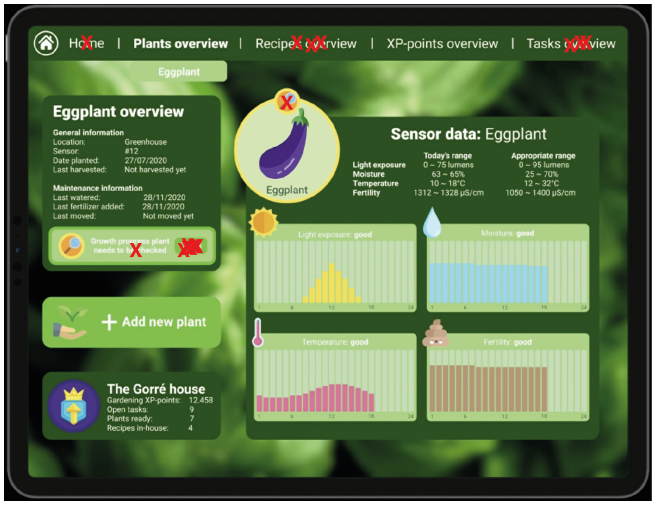

Figure 23: An example of one of the heatmaps with red crosses as clicks

pages were too clustered, and it was not clear when a checkup needed to be performed. From the findings of *Scenario 3* it was concluded that the interaction flow of the cooking process was not clear. A majority of the participants imagined that all tasks connected to a certain recipe would be shown on that recipe's page instead of only in the task overview. Next to findings specifically related to the scenarios more feedback was given. Examples of findings from that feedback were that the home screen was too noisy and some scrolling functionalities were difficult to notice. From these findings changes were made in the interface, which can be found in the 'Redesign' section.

Thematic analysis
Using an inductive thematic analysis, feedback and comments were ordered in themes per question. Using these themes, we determined three main parts on which improvement was needed: the readability of the interface, the safety of Clipper, and the clarity of the purpose of the system. Additionally, we learned about the participants perceived user group for Botano, the influence of produce being in-season and some ideas on our business model.

Notes on the interface of the base Aside from the interaction user test there were remarks on the interface in terms of how much information was shown, and the readability of certain parts of text. These were all taken into consideration in the redesign of the interface, which will be elaborated upon in the 'Redesign' section.

Perception of clipper Clipper, was viewed as possibly dangerous. Quotes such as "Het is een soort guillotine mes"/"It is like a type of guillotine knife", give a clear indication that a redesign is needed. This redesign will be described later in this report, focusing more on safety and the main purpose of the Clipper: clipping plants.

	Mean	*SD*
Usefulness	4.25	0.53
Ease of Use	4.19	0.38
Ease of Learning	3.54	0.73
Satisfaction	3.93	0.75

Table 2: Results usability.

User group insights Most of the participants felt like this product could be well suited for both beginners and those more advanced. For the beginners, this product could help them and their partners or children get started, whereas the more advanced could involve their family or get more insight in more 'difficult' plants to grow.

The insights gained from this thematic analysis were used to support choices made in the rest of the process.

Usability
The mean and SD of the four dimensions can be found in Table 2. These results suggest that Botano is perceived somewhat positive but that there is still improvement (maximum value is 7.0). A future study could test a redesign and compare the scores on the different aspects to see if it improved.

Redesign

After the Demo day feedback in combination with the user test a new iteration of Botano was made. This included a safer Clipper design, the integration of a user collaboration method in the interface and additional changes in the interface.

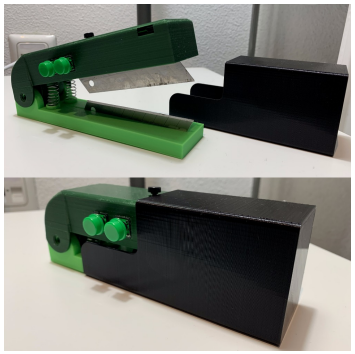

Figure 24: Clipper sleeve

Clipper safety measurements

During the Demo Day feedback from multiple participants was given on the final design of the entire Botano family. The most occurring comment over time was that Clipper does not look safe, because of the blades that are always open. But just like with garden shears it's cutting functionality for harvesting plants would decrease, if the blades were always covered. To give Clipper a safer feeling a sleeve has been designed to cover the blades when not in use, as shown in figure 24.

Enabling collaboration between users

An attempt was made to include a method through which users could collaborate instead of working with Botano alongside each other. This method exists of notes which the users can write down and add to each plant. Examples of notes could be: "Could someone help me with the check-up of this plant?", "Perhaps we can plant some more of this soon?" or "Don't use! Gonna make tomato stew tomorrow". These notes are then shown on the plant's pages and the interface lock screen. With the latter users can quickly see what users are up to when they walk by the Botano Base. An example of the notes can be seen in 25. For future work it is also possible that Botano is included with a platform through which users can collaborate with other households that use Botano in the neighbourhood. This platform could include a map of the neighbourhood to which users can go to trade plants, seeds, supplies or advice. Specifically, the latter could be helpful for novice gardeners as they can ask more experienced gardeners to come to their household for a one-on-one gardening lesson. Adding this platform however might also increase the ethical concerns people have with using Botano.

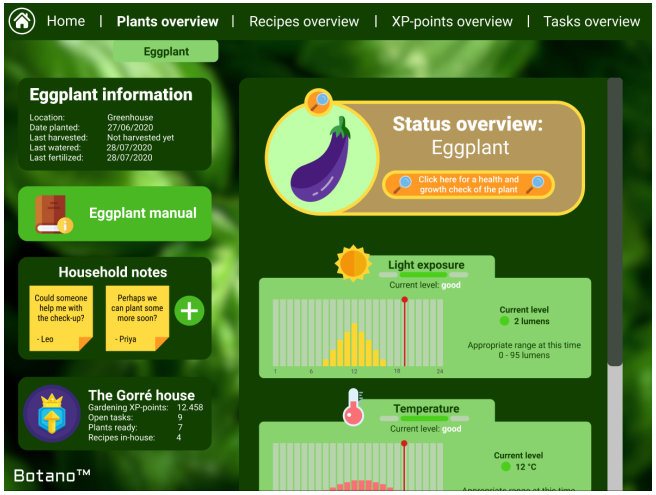

Figure 25: An example of the redesign of a plant overview

New interface iteration

To reduce the change that the user is overloaded with information when unlocking the Botano interface, the home screen was made less noisy. Instead of showing just a horizontal overview of the plants and recipes the home screen was changed to show the most important or unique information. Comparing the old home screen in Figure 17 and the new home screen in Figure 26 this change can clearly be seen. Next to the changed home screen, the overview of a specific plant was changed. Now, if the user is uncertain of the plant's current growth progress or its health they can always check each plant's specific manual. This manual would also include other handy information on the plant. Moreover, the check-up of a plant now also includes a check-up of its current health. An example of the changed plant overview can be seen in Figure 25. Comparing this to the old overview in Figure 18 the new overview is less clustered and the tasks are easier to notice. Lastly, the user

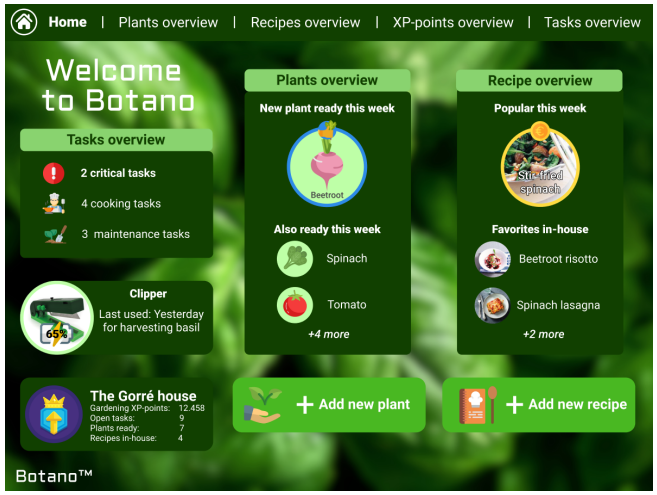

Figure 26: The redesign of the home screen of Botano Base

is now also given the cooking tasks on the page of the recipe that was chosen. This change was based on the results of the user test since users indicated that they wanted to have separate cooking and gardening tasks.

Business plan

In this section we discuss some parts of a possible business plan that could be used for the commercialization of Botano. Firstly an initial sales strategy will be discussed, then the revenue in the first year will be calculated, afterwards we will further elaborate on the XP-point system and finally a business model canvas in Figure 27 is given.

Initial pricing strategy

When Botano would go to the market, users would only have to make a one-off purchase directly to the Botano company. When having purchased the Botano Family it is ownership of the user, and they are not stuck with monthly or annual subscription fees. In essence, Botano could already be produced and sold with today's technology. With this, a cost price and sales price was set up if Botano would be sold in stores today. The cost price of all parts was calculated from consumer prices, which means the cost price could go down if the parts would be bought in bulk. In any case, the current cost price was calculated at €344,10. As Botano could be considered as a luxury product an approximate twenty percent profit margin could be added to this price [34]. This leads to a neat sales price of €399,- if Botano would be sold in stores today.

Revenue in the first year

With the sales price set, it is also possible to calculate the revenue Botano can make in the first year of business. For this the possible market size and initial market penetration are needed. In the United States one-third of households cultivated their own edible plants in 2014 [3]. Considering that the American culture is relatively similar to the Dutch culture this ratio is translated to that in 2021 a third of the Dutch households will cultivate their own edible plants. In 2020 the Netherlands contained 7.9 million households over a population of 17.4 million people [69]. This means that the number of households amount to 45 percent of the total Dutch population. As Botano was developed for the Dutch market these numbers give the possible market size of (1/3 * 7.900.000 =) approximately 2.630.000 people. However, it is unreasonable to assume that in the first year of sales this market can already be addressed. Instead, an initial market size is calculated from the regional area of Brabant Zuidoost (Brabant Southeast) in which 756.615 people lived in 2017 [57]. This leads to a regional market size of (0,333 * 0,45 * 756.615 =) 114.507 people. A reasonable market penetration for the first year could be set at two percent of the total regional market. This finally leads to an initial

market penetration of 2.290 people. Concluding, the revenue in the first year could be estimated at (2.290 * €399 =) €913.710 for Botano product sales only.

Additional revenue through Botano XP-points

As a way of gamifying the plant maintaining process experience points (XP-points) were added to the Botano concept. Users are able to gather points when they do certain tasks or activities surrounding the maintenance of their plants. Depending on the difficulty, duration or novelty of a task the given points after finishing the task changes. A user for example receives more points for successfully maintaining and then harvesting a difficult to maintain plant compared to a simple to maintain plant. These points are displayed in one of the tabs in the interface. Through partnerships with companies in sectors such as gardening (tools), cooking or grocery stores it could be possible to give discounts on certain purchases from those companies. The more points a user gathers the more discount they are given. If a user purchases a partnered company's product using a Botano discount we could ask for a payment to the Botano company in return.

Discussion

In the end, it was not feasible to create our own recommender system, due to our approach we were not able to access the individual data. While the current alternative is sufficient for the user experience, it would have been better for the Human-AI collaboration aspect if we had the model working. Since evaluating the accuracy, fairness and how the user input is used, is hard to do without a working model [52]. Moreover, a larger recipe database would be needed if the product would be launched.

The current design cannot fully incorporate the growth process of the plants and possible diseases that can occur. There is a possibility for the user to keep track of the growth process in the software of the Botano base, but this logging of the size of the plant with selecting different growth levels is not very precise and can only give an estimation. More detailed tracking of the growth process and thereby the possibility to generate more produce can be realized by incorporating image processing technology Growth prediction technology needs to mature [38]. This also goes up for plant diseases, that are manually very difficult to monitor [37].

One of the risks with connect systems is when the internet connection or power supply stops. In our case, this would not result in problematic situations. Plants can also be grown in the "old-fashion" way without our system. Moreover, the sensors work on a battery, so they can continue working during a short power break. When the internet connection stops the data can be saved in the sensor itself for a while before sending. The Botano base and Clipper would not work without internet connection but when the connection is restored they can receive the missed information from the sensors.

Ethical aspects also need to be considered when Botano is further developed or put into production. Luckily, with the final design no personal data can be gathered. The user would only need to connect their email address to which the discount codes from the XP-points can be sent. However, indirectly personal information is gathered through the analysis of their recipe and plant preferences and through the partnerships with other companies. From these sets of data, a profile is made of the user's household in terms of their food preferences. In terms of privacy issues of recording or measuring things in the household some concern can also be given. Botano is not equipped with microphones or cameras of any kind. However, through

The Business Model Canvas

Designed for: Botano | *Designed by:* Hannah van Iterson, Anniek Jansen, Thomas Pilaet & Xander Verstraeten | *Date:* 05/01/2021 | *Version:* 2

Key Partners

Suppliers for plants seeds

Gardening tool manufacturers

Grocery stores

Cookbook services

Key Activities

Data mining on recipe suggestions

Data mining on plant growth

Creating/Maintaining brand awareness

Key Resources

Data base on plants

Data base on recipes

Sensor data of plants

User recipe selections

Use of discounts

Value Propositions

Easier & closer insight in plant growth

Quick insight in harvestable plants

Finding inspiration for recipes

Increasing collaboriation in household

Easy-to-learn method for gardening

Customer Relationships

Personalized plants recommendations

Personalized recipe recommendations

XP-point rewards

Channels

Botano webshop

Third party webshops

Garden centers

Customer Segments

in order of focus:

Families with 1- 2 children

Couples

One person households

sectors for business expansion:

Restaurants with vegetable garden

Agricultural businesses

Cost Structure

Manufacturing costs

Data mining costs

Marketing costs

General & Administrative

Revenue Streams

Product purchases

Revenue from data mining

Purchases with discounts from XP-points

Advertisements & sponsor deals

DESIGNED BY: Strategyzer AG
The makers of Business Model Generation and Strategyzer

Strategyzer
strategyzer.com

Figure 27: An example of a business model canvas for Botano

usage of time stamps and sensory data certain information from the user can be extracted. For example, at what time they get home from work. We do not want this observed data to fall in the wrong hands. Therefore, measurements would need to be taken on for example save and anonymous data storage.

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Reflection Anniek

Professional Identity and Vision

At the start of this project, I was doubting about the second competency area on which I would focus during my master. It was clear to me that I wanted to continue with MDC, but I switched constantly between C&A and T&R. This project and the course Interactive Materiality made it clear that my strengths and interests are with T&R. Furthermore, my PI-shaped identity took an even more concrete shape by choosing the research track and a research topic: a Machine Learning (ML) roadmap for UX designers. These decisions were of great influence on the tasks I did during this project and my learning outcomes.

Group collaboration

Our ideation process took quite a long time, which I think was partly the result of getting used to working online. Especially during the ideation process, this was an obstacle, but Miro proved to be a good alternative. Another challenge in our process was making decisions and not making our concept too broad.

After the midterm, our meeting style switched to, a for me, more professional style. We had group meetings twice a week to stay on the same page and divide tasks. The rest of the week we worked individually or had one-on-one meetings. In our group, we had all competency areas represented which made it easy to divide tasks. This way of working has my preference and I will try to apply it in future group projects.

My role as designer

My role within the team during meetings was to bring back focus and keeping the overview. I often take this role during a group project because I enjoy organising and think you work better with some structure.

The other role I had during this project, was the role of researcher and data scientist. While this was a design project, I tried to incorporate research throughout the whole project. For example, in the beginning, to gain a better understanding of the context and during the evaluation phase to find appropriate methods. This has made me feel informed about the field and more confident about our decisions and actions. Furthermore, I was responsible for working with the data and trying to realize the ML aspects. I gained more experience with Python, OOCSI, HTML and JavaScript to create our demoday application.

Learning points

My main learning point was understanding the importance of collecting the right data to train your model and experiencing how difficult this can be. Previously I thought ML could be quite easily implemented because I used an existing database or simple data from a sensor, but interaction data proved to be more difficult. Besides, it also raised some ethical and design questions that required considerations. I started to approach it more from a data perspective during the project which is useful to judge the feasibility and realize the model. However, I need to stay aware that I am a designer and the interaction aspect is equally important. Moreover, I think designers can be off great importance when considering the ethical aspects since they are trained to take different perspectives and look holistically at design.

During this semester, I also worked on a research project related to teaching ML to designers and based on the papers I read for that project I started reflecting on my own experiences. These papers [14, 73, 74] discuss how much formal knowledge designers need to work with ML, but the findings remain inconclusive. In our project, we tried to do the work of data scientists, which proved to be too difficult. I

was eager to get a real model working, but I underestimated the value of a good Wizard of Oz prototype, especially when knowing that it would be possible to realize with the right data. However, I do feel that having a basic formal understanding of data analytics and ML makes it easier to design with ML as a design material. Moreover, I think some knowledge is crucial to consider limitations and ethical aspects during the design process.

I hope to focus more on this aspect of my research project. There, I might also address another point which could have been further explored in our project: the human-AI collaboration, e.g. which input needs the AI to function, what does the user expect of the AI and how do they perceive them. An interesting article [59] already conducted research to see users' attitude towards the punishments of robots.

Concerning the competency T&R, I have mainly developed my software skills since I did not work with the electronics of Clipper. While I have been able to work on this during my courses I think it would have been nice to also have a working physical prototype for our project as a proof of concept.

Even though we worked individually, it was possible to ask for help and learn from each other. My goal for U&S was to gain more experience with qualitative user studies. I prepared our interview questions which required us to clearly formulate our project and the goal of the interview. Moreover, thanks to Hannah I was able to learn more about thematic analysis. I still feel unsure about these methods and need to gain both more knowledge and experience.

I had difficulties with the C&A aspect of the project because I was not able to experience our physical prototypes. This made that the interaction aspect of our design was one of the last aspects we addressed. The learning points of Interactive Materiality did help me find opportunities to create a richer interaction, but in the end, I think we have only touched the surface of this.

All in all, this project helped me to define my PI-shaped identity and gain more experience in the competency areas MDC and T&R. Furthermore, it made clear to me what I would like to address in my research project and which skills need more attention.

Reflection Hannah

Professional Identity and Vision

For my Master, I have decided to focus on the User and Society (US) and Technology and Realization (TR). I feel most attuned to these competencies and value them as I, as a designer, want to lay the link between user and technology. This means trying to fit and adapt new and older tech, to the needs and wants of the user.

To do this, I know that having a clear idea of emerging technologies and knowledge about the many types of programming is useful. As well as being fluent in communicating with, and understanding of, users through interviews or user tests.

I am interested in the specifics of human-technology interaction, and the psychological aspects involved. How technology can facilitate tasks calmly, without needing to be in the centre of attention. I, however, picked human-AI collaboration to gain a better understanding of intelligent systems and human-AI collaboration, and what the possibilities are with Machine Learning (ML) and Artificial Intelligence (AI), as a follow up to the Interactive Intelligent Products course.

Development

Due to COVID-19, working from home became the standard. Because of this, we have picked up important professional skills concerning working online. Being able to work parallelly, have effective meetings, prevent online distractions and communicate effectively over video calls are all examples of this.

Next to professional skills, I developed new technical skills by coding PHP, HTML, JavaScript (JS) and C++/Arduino programming, as well as working with connected systems using OOCSI. Additionally, I worked with Xander on the physical wooden base of Botano in Vertigo, revisited my thematic analysis experience and gained some insights in designing with AI.

Design process & teamwork

Our design process started with a long process of ideation. The scope and design challenge were chosen quickly. We however took a lot of time to do research, discuss possible designs, and investigate what products already existed in the niche we had chosen. During this, we worked together closely using Miro and Teams. We therefore had a clear stance on what we had and what we knew, even though we had only seen each other in real life once.

While ideation and communication went quite smoothly, decision-making did not. We, as a group, learned to make decisions throughout the second part of the semester.

Our idea had so many options, possibilities and functions, that we could not possibly design or realize them on the level we expected of ourselves. We therefore changed our approach: meetings became decision-making meetings, and we slowly started to narrow down our idea. After picking what we wanted to realize, tasks were divided based on interest, skill and learning goals. Information was exchanged one-on-one if needed, and shortly discussed in plenary meetings. Through this switch in meeting and working style, we were able to make large steps in the development of our demoday prototype.

This approach sounds logical when reflecting, but I have come to see that it is quite a challenge to let everyone work on a part of the prototype, without creating four different prototypes. Communicating and keeping track of each other work goes more naturally when working on campus. You bump into someone, and you shortly discuss the things that you are doing. This does not happen online, so you have to

actively keep in contact with each of your group members and their progress, without coming across as a police officer checking if they are doing their part. Finding balance was hard at first, but with this experience, it will get easier for future projects.

My role
My focus during this project became the realization of the prototype, which included the Botano base, the different websites for data gathering for the AI and the OOCSI connections between products and projects. I worked closely with Xander and Anniek, who both also played a part in the creation: Xander the hardware of Clipper and the Base, Anniek the ML model and recipe database.

Creating the connection between the flora sensor(s) and OOCSI via an ESP32 using C++/Arduino programming, required a set of skills from me that I had to (further) develop. Skills like: being able to read code from similar projects; understanding partition schemes of Arduino's and how to neatly send the obtained data to the OOCSI system.

Additionally, I decided to learn how to use GitHub in order to get a better version control on my coding projects. Having acquired this skill will be valuable the next time I need to code or program anything. For the data collection, we decided to use Google Analytics (GA) and the several JS scripts they use. JS was completely new to me. Learning about it, through GA immediately helped me when I used the OOCSI web plugin based on JS to visualize our collaboration with the other groups and data collection for the demoday on my website.

Finally, I do think I missed some opportunities to get more insights in the ML model that we used. This became mainly Anniek's focus, but I could have been more forthcoming in my willingness to learn more about this. Likewise for the Clipper prototype. As mentioned, the pandemic made it hard to cooperate on this specific part of the project, but would have liked to have got Clipper functional.

Conclusion
To conclude, I am quite satisfied with the project, teamwork and my personal development. It helped that, in our team, everyone has a clear vision of the type of designer they want to be. We all had our strengths and facets that we wished to develop. I feel like I have got the space to do this during this project.

Personally, I feel I have grown professionally, but also gained more experience and skills fitting the TR competency. I will be more confident in next projects when designing a connected system, or when sharing data. To balance my development, I will shift my learning goals more towards the research skills and competences fitting the US competency in M2.1 during the research project.

Reflection Thomas

For this project I was part of the Human-AI Collaboration challenge within the DIGSIM squad. During the project we designed a product which supported families growing their own edible plants and eventually cooking recipes from them. In this reflection I will describe several elements of my personal development in the past semester. My learning process is incorporated in the chapters, including its outcomes and missed opportunities.

Development expertise areas

As a designer I aim to develop myself during my masters towards being able to facilitate a collaborative and mutually beneficial interaction between users and intelligent systems, in specific products with AI integrated. Moreover, I want to develop myself towards being a skilled project manager. Following this my focus lies on three different competency areas during my masters, namely 'Math, Data & Computing', 'User & Society' and 'Business & Entrepreneurship'. During the project I improved my MDC skills mainly in how to apply AI as a design material and what the important aspects are of a collaboration between human and AI. I improved these skills through reading literature and feedback from experts and peers. In US I improved mainly in my knowledge about a user's interaction with an IoT system. For example in balancing user values during such an interaction. Lastly, in BE I improved mainly on creating an intelligent system that is desirable on the market and on creating business plans. Lastly, I also improved in the area of 'Technology & Realization' and 'Creativity & Aesthetics' as I created the interface of our design.

Development professional skills

This project was the first online project (due to COVID-19) I did. During the semester we only had one physical meeting on campus together. To handle this I learned how I could best express myself during online meetings and how I should present my materials. Next to that doing a project online also asked for more individual work on the project. Where normally more work is done during physical meetings I now had to learn to do more work on the project alone with only the option to ask for 'indirect' feedback through WhatsApp or Teams.

Overall development as designer

Next to the aforenamed things I have also improved my skills in for example user testing, presenting, ideation. Sadly, I could not improve my skills in working in a multidisciplinary team as the project was not done at Innovation Space, which was the initial intention. For this reason I hope that I can improve on this in my M2.1 when I do a project at a company.

Analysis personal learning goals

In my PDP I had set three goals: improving my (Python) programming skills, gaining international experience and learning how to apply AI as design material. For the project I mainly development on the latter as I have said above. I also improved my programming skills during courses and I hope to gain international experience at a foreign company during my M2.1 semester.

Collaboration process

In my opinion our group performed well in teamwork, task division and overall efficiency. There were no hiccups in forms of group feeling or collaboration. We asked for help when necessary, which was then also given. I found that this is one of the most important factors to achieve a good result during a course or project, especially during online education. I am grateful that we were able to work together this well.

Role in the team and contribution to the design process
As said I feel that tasks were divided well. This also goes for division of roles in the team. In the later stages I mainly focused on designing the interface, whilst in the earlier stages we equally worked on making design decisions and creating concepts. For a possible next group project I hope that I will be experienced enough in AI to also take an important role in that area. I felt that I lacked some valuable skills in that area for now and therefore could not take a large role in designing with AI. This is something I therefore need to work on.

Reflection Xander

Professional identity and vision

I started the master with the intention to focus on Business and Entrepreneurship, Math Data and computing and Technology and realization. To combine these for the track of Design leadership and entrepreneurship (DLE). This because I like love to bring concept/ideas to reality while incorporating new technology, and surprise people with that is possible. From earlier experience of working in companies I quickly learned that marketing is sometimes the most important part you have to work towards to as a designer. I could design a product that fully works for me but if it doesn't suit customer whishes or looks horrible it would never sell. With joining what would be initially an innovation space project, I hoped to specify this direction of DLE even more and be certain of my professional choice direction. Due to communication mistakes innovation space projects were canceled and I was directed to DIGSIM. This change in squad and following courses of the chosen tracks made me change my mind to not peruse DLE. ID has so many directions you can go to, that none of them really feel they grasp the core of its direction. I started to notice that within ID people don't get thought how to bring products to the market but dive more in theoretical aspect, that in my opinion don't give you entrepreneurs the right tool kit to start in the real world outside of the ID bubble. Therefore, I am now changing my focus to Research, Design and development (RDD). In the hope that this track gives me as a young professional more tools that can be used in practice.

Personal development

Actually COVID-19 might have had a positive effect on my professional development but a negative effect social cohesion. I believe that online meetings can make your life more time efficient and you have better focus on what you are working on, with an emphasis on what YOU are working on. For myself and maybe others also I tend to lose touch with what others are working on. Creating a small gap between people can bring hardship if you have to work together to combine thoughts into one design. Bridging this gab by making consensus between people their visions online, gave me the most valuable soft skill I believe. I noticed while working in companies that communication between people is the first step to create success in the long run. The constraints that the IOT sandbox with the mundane characters gave was good to channel the design process. It gave an instant list of design requirements that had to be met, that I had not seen before within ID. This forced me to reconsider every step taken if it would fit in the picture we are designing for.

Project roll

During the project my focus was mostly on designing, making and assembling clipper, from a prototype perspective. Seen its functionalities and overall use were always made with group effort. Although every week everybody had their own tasks, everything would be discussed together beforehand. The end result really benefited from this approach because every designing consideration had a second opinion from a co-student. For the mid-term demo day as well as the final demo I day focused on assembling and creating Clipper to get a family of products feeling. With the use of colors, shapes and interaction between the different components of Botano. A strong synergy was created for the entire Botano family.

Design project evaluation

A new product that brings enough market value with it and that at the same time is revolutionary, is not easy to create. That's I think the biggest reason why the ideation in the start of the project took so long. There were so many ideas but

at the same time you think “Is this the best one?”. Making it very hard to have hard decisions of which direction to go in. To me it felt that every time we went into a direction a big change would happen if there would be feedback from a lecturer. This doesn’t have to be necessarily bad, but it does indicate to me that we were not always confident about our own design choices maybe.

Missed learning opportunities

I hoped in the master and in my first design project to learn more standardized design process methodologies. Every project in almost every squad has a very loose structure where you just start working and there is no fixed path for you to follow. People take some aspects like divergence or convergence of idea generation into the process. I do agree that this loose structure give the freedom to basically do what every you want. It’s rare that a company works with this less structure and you can start designing what you want. Freedom brings creativity but also the downfall that you drown in your own tunnel vision of your own design. If I look at a lot of demo day projects, I think by myself “Does this have market value, and could it work outside of a university setting?”. Seen I believe we are student that are here to get educated to excel in the work field.