# JESI

## FBP REPORT

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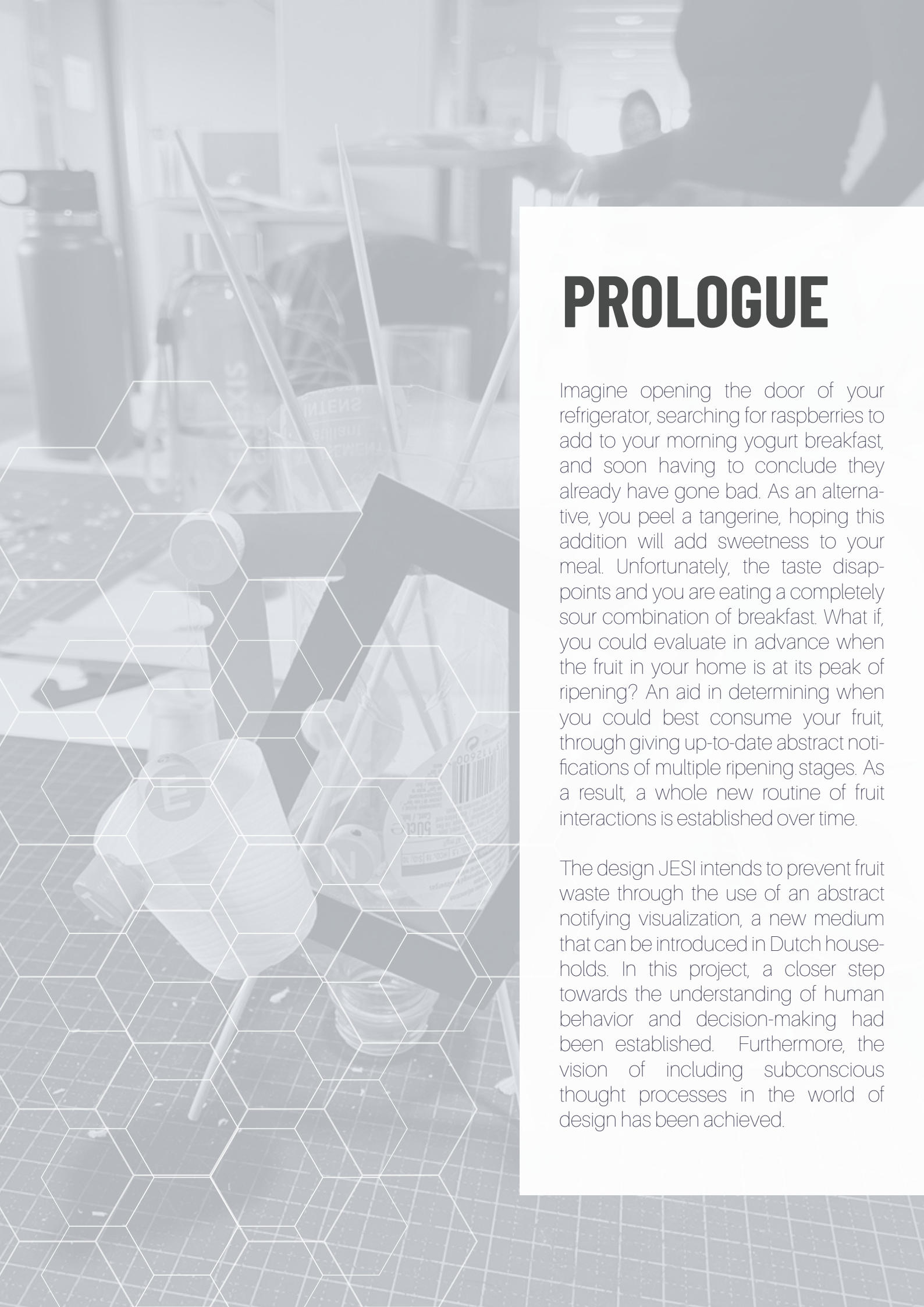

# PROLOGUE

Imagine opening the door of your refrigerator, searching for raspberries to add to your morning yogurt breakfast, and soon having to conclude they already have gone bad. As an alternative, you peel a tangerine, hoping this addition will add sweetness to your meal. Unfortunately, the taste disappoints and you are eating a completely sour combination of breakfast. What if, you could evaluate in advance when the fruit in your home is at its peak of ripening? An aid in determining when you could best consume your fruit, through giving up-to-date abstract notifications of multiple ripening stages. As a result, a whole new routine of fruit interactions is established over time.

The design JESI intends to prevent fruit waste through the use of an abstract notifying visualization, a new medium that can be introduced in Dutch households. In this project, a closer step towards the understanding of human behavior and decision-making had been established. Furthermore, the vision of including subconscious thought processes in the world of design has been achieved.

# 01 CONTENT

# 02 INTRODUCTION


Phylosophically inspiring photograph of foodwaste in relation to humanity by Foundry (n.d.)

Worldwide, food waste has long been recognized as a pervasive problem. Due to human conduct, 931 million tons of food are wasted in both high and low-income countries as of 2021 (UNEP, 2021). Although food waste has distinct harmful consequences in each sector of the global food chain, a deliberate amount of 61% of this waste is generated in consumers' households (UNEP, 2021). As a result, foodwastage at the consumer's end is leading to a current responsibility of 9% of the world's greenhouse gas emissions (University of Oxford, 2020), making it a significant sustainability challenge in the modern world.

*Design goal*

In response, this design approach employs a HCI methodology that focuses on the connection between the household fruit waste issue on the one hand, and human behavior and decision-making on the other, noting that fruit waste deliberately is the largest cause of household foodwaste today (Too Good To Go, (n.d.)). During the project, a solution towards the design goal stood as focal directive; 'How might a tangible abstract visualization signify a new medium for the consumer's ritual of fruit consumption and purchase, while at the same time being the cause of a reduction in the yearly amount of household food waste in the Netherlands'. Fruit freshness, non-cognitive decision-making, abstract visualization, household foodwaste, and HCI are considered and evaluated keywords in relation to this report.

# 03 DESIGN PROCESS

## 3.1 RELATED WORK

### Foodwaste in households

In order to create a design approach to the global food waste issue in a household setting, it is first crucial to understand the context and its possible causalities. Over the past centuries, rapid industrialization and the continuing fast change in lifestyle have made it possible to increase the availability of convenience food and consumerism culture (Kearney, 2010). According to a study that investigated the areas of marketing and consumer research (Chandon & Wansink, 2012), current household

foodwastage can be divided into three predictable stages: when shopping, storing and serving. That is, food being purchased and never prepared, prepared and never served, or served and never eaten. According to Ascheman-Witzel et al., decisions concerning foodwastage can have many motives, both rational and irrational (Aschemann-Witzel et al. 2015). Low prices, a short expiration period, limited and poor storage capacities, and perceived product quality as well as facilities in household food activities are factors for having food waste as an outcome (Aschemann-Witzel et al. 2015). This indicates that food waste cannot be attributed to a single action, but hold accountable for a variety of behaviors and complicated circumstances.

### *Attributes of food products*

Another perspective to understanding food waste generated at the consumer's end can be found when looking at the notion from the two factors in play: the first relating to the attributes of the food product, and the second relating to customer characteristics and behavior. Regarding the 'attributes of the food product', earlier research has demonstrated that the amount of food waste is strong depending on the food category. The synthesis report on Food Waste in Dutch Households in 2019 reveals that bread, dairy products, vegetables, fruit, and potatoes are wasted most (Food waste in Dutch households, 2019). In agreement, a study in the United States (Conrad, 2020) found that fruits, vegetables, meat, and seafood were the leading categories of waste. These results make sense, given that fresh products are generally easier wasted than long-life products (Jörissen et al., 2015). The aesthetic appeal of a product, which consumers categorize into optimal and suboptimal states based on certain visual cues (de Hooge et al., 2017), is the second product attribute that contributes to waste. This distinction usually arises from external symptoms like shape, size, color, smell, lack of defects, a fresh and clean look, and information on the package such as an expiry date.

### *Customer charasteristics & behavior*

A study performed in 2017 seeking the effects of what habits and emotions conduce in daily food waste shines an intriguing light on understanding customer behavior (Russel et al., 2017). According to this study, habits and emotions are strong influential factors when it comes to food waste behavior, indicating that non-cognitive drivers deserve much more attention than they have received in past research. On top of that statement, the study appeals to future researchers to rather than attempting to change current behavior and attitudes, design with an emphasis on establishing new, more constructive behaviors.

## Determining the freshness of food

The term "food freshness" can be seen as a social descriptor rather than a finite definition, where the recentness of a food's production, harvest, or amount of preservation is of value (Seatle Sutton's, (n.d.)). Previous research that sought to determine the degree to which this food freshness was relevant, discovered that the food's flavor was the most significant factor when it comes to purchasing interest (Cardello et al., 2002). In other words, according to this research, food freshness, the expected flavor, and the decision-making of purchasing that food are in relation with each other. A study performed to seek understanding of freshness perception from the cognitive mechanisms of flavor might add depth to this phenomenon. It was concluded that the attributes that indicate freshness are located at higher cognitive levels of our brain, and thus our sensory expectations (Roque et al., 2018). However, crossmodal correspondence mechanisms still remain to be explored in freshness perception, and thus which exact attributes play a role in the link between flavor and freshness perception (Roque et al., 2018). Furthermore, knowing how to trigger the mechanisms of crossmodal or cross-level correspondences regarding freshness could facilitate consumers' categorization of a given product as being fresh or even lead to an increased estimation of freshness (Roque et al., 2018).

## Color and flavor assosciation

A clear understanding on the relationship between flavor and color is addressed in order to provide a theoretical foundation. In the color-flavor connection, Jenn David provides a contribution to the understanding of why these attributes are closely linked. He explains that "the connections between taste and color are fundamentally ingrained in us soon after birth when we begin to experience foods from a very early age, and the links start forming then" (Connolly, 2015). Consequently, he argues, these links fundamentally harden and are challenging to alter. Ken Philips agrees with David, stating different food feature different colors, and thus connections between specific colors and corresponding flavors are formed; "depending on culture and past experiences, you might assume that a red drink is cherry, strawberry, cranberry or even tomato-flavored" (Philips, 2022). On top of that, color is so powerful that it can override what our other senses are telling us to be true, being able to let us experience flavors that aren't present (Philips, 2022). This can be explained

by diving into the concept of 'window of opportunity' (Connolly, 2015). Over 50% of our cerebral cortex is devoted to visual processing while only 1-2% is involved in taste. Therefore, in the 2-3 second window, and thus the short 'window of opportunity' of seeing a food product, a person relies on visual information, that is planted in the brain through experiences from the past (Philips, 2022). Because of this wiring, our brains significantly rely on visual information, especially color, to plan and anticipate our encounters with food.

### *Natural cause*

Next to using color as a cue for anticipating flavor, it also warns us when food undergoes physical or chemical changes. In fruits for example, the green colour of unripe fruit is caused largely by the presence of chlorophyl, a photosynthetic pigment that makes photosynthesis possible (Today I Found Out, 2017). During the process of ripening, an increase in the hydrocarbon gas ethylene is registered (Today I Found Out, 2017). This ethylene enzyme converts chlorophyl pigments into hydrolytic enzymes, ultimately removing the green color and making room for the development of 'ripe indicating' colors, such as orange and yellow caused by the formation of caratenoids, and purple, red, and blues caused by the formation of panthocyanins (Today I Found Out, 2017). Studies performed to investigate the purpose of color change during the fruit ripening process in relation to birds, the most dependable outside frugivore animal for trees to spread their seeds, concluded that the hue, brightness, and location serve 3 purposes; firstly, it draws attention to the fruit (Figure 1)(Thought-Co, 2018), secondly, it reveals or camouflages the fruit's location (Figure 2)(Kroes-Mulder, 2018), and thirdly, it signals when the fruit is ripe and optimally tasty for its target consumer (Figure 3)(Today I Found Out., 2017).

Figure 1. Drawing attention

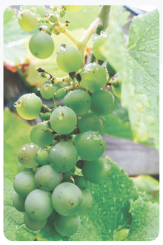

Figure 2. Camouflage

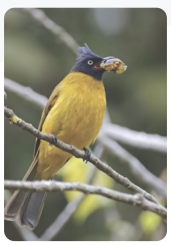

Figure 3. Optimally tasty

## 3.2 BENCHMARKING

In the field of design, tackling the issue of fruit waste in the household setting does not appear to have made a significant advancement in terms of its targeted customers, as no leading innovation is currently being used with this objective in mind. Thereby, no design of visualizing fruit ripening in any way, and thus also using colors as indicators is found on the market. However, future concepts in the fruit waste sector, either still in progress or in a more technological advanced scenario are making promising advancements.

### All-in-one digital table IKEA

Lund University, Eindhoven University of Technology, and design consultancy IDEO have developed a concept kitchen table for IKEA that acts as an integrated cooking hob and dining table, where suggestions of recipes can be visualized based on ingredients you put on the surface (Figure 5) (Hobson, 2015). In the case of fruit, just like with the design JESI, a visualization of when the fruit is edible is displayed. However, the all-in-one digital table uses letters as visualization, indicating days of the week (Figure 5), while JESI uses a changing color combination linked to the riping process of the fruit. This design is visioned to be functioning in 2025, and has the goal to promote cooking, reduce the amount of food that gets thrown away, and let the user be more mindful of their food. Furthermore, IKEA aims to get people more engaged with their food. Part of the aim with JESI; people staying more in touch with the ripeness of their fruit over time, is recognized in this design objective.

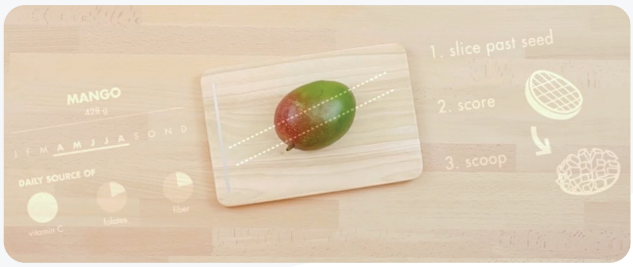


Figure 5. All-in-one table IKEA. by Dezeen (2016).

### Food probe by Philips Design

Philips Design in Eindhoven has designed a conceptual product that prints combinations of ingredients into shapes and consistencies specified by the user (Etherington, 2009). Briefly described, the design is able to print nutrients you would need at a particular day into a certain shape or form for the user to consume (Figure 6). Although this concept is only part of investigating how we may live in 15-20 years time, it still has been an inspiration in regards to how food would 'optimally' look like when it can be printed from scratch. In the case of fruit, a different shape or form could be made using e.g. the colors of 'ripe' fruit in order to create an aesthetically appealing

product. This again, would mean that there effectively is a moment, or a particular time frame that the fruit is seen as the most ripe by humans. When that moment exactly is, or how large this time window could be, which shape of the fruit could function in the re-design, or which colors play a significant factor for this identification have been inspirational philosophic notions that are used in regard to this design process.

Figure 6. Food probe by Philips Design (2009).

# 3.8 IDEATION

## Functionality brainstorm

As a starting point for the functionality brainstorm (Appendix A), various themes were chosen to help understand the relatively extensive concept of food waste. The brainstorm was performed with the goal to grasp an understanding of the base-level food waste concepts, encouraging open and ongoing parameters that come to mind. Using the first person perspective, the following themes were created; 'supermarket', 'consumer', 'storage', 'purchase', and 'supplier'.

### *Supermarket*

One of the outcomes from this concept mapping had been related to practicalities the user needs to perform when buying food products. Bringing a bag to the store, picking a basket or cart at the supermarket, choosing products on the shelf, and knowing what you need to buy are examples of processes the user needs to repeatedly perform. Having these actions explicitly listed has been of assistance in the design process due to better understanding the user's perspective on 'going to the supermarket', or 'purchasing food'.

### *Consumer*

Based on this concept mapping, the ideation of consumers' behavior being somewhat predictable is established. For example, customers being able to purchase food, but being limited to the food available in supermarkets, eating either together with family or eating alone, forgetting your own prepared food to work, and passing down food recipes from generation to generation are fore-seeable practices. In other words, it is not the case that every day new constructs in relation to consuming foods are developed. A large ritual is at play where hypothetically a prospective design might either enhance current practices or serve as the catalyst for a new ritual.

### *Storage*

Although there is knowledge about an increase in development for sustainable and overall better packaging possibilities for food products (Neela & Harloveen, 2019), the printed-on expiration date is the only source of information regarding the freshness of the food products offered by the supplier. Thereby, after performing a small exploration in the home, it was noticed that a selection of the stored food is overlooked. This could be explained by e.g. certain food products not often being used and therefore becoming 'one with the background'.

### *Purchase*

Noticeable from this concept mapping was the link between 'shopping list', and 'mostly buying the same products'. Purchasing food for a great deal relies on these practicalities. Consequently, purchasing the exact amounts of food without creating waste could be linked back to familiarity and experience.

### *Supplier*

In order to understand how food waste is generated in low-income countries, an external source was obtained. accordingly, as of 2021, 630 million tons of food is wasted in developing countries due to the limits of farmers harvesting crops too early, farmers possessing inadequate farming technology, having poor storage systems, and residents employing improper transportation (Not Complicated, 2021). Also remarkable, is the amount of food waste generated in hospitals in high-income countries, where the largest percentage is caused by the portioning process with 41% of the total (Wageningen Food & Biobased Research, 2014).

## Sketching

Sketching as a method of ideation, which involves outlining potential solutions and ideas, was used to explore multiple scopes of the food waste problem (Figure 7). Based on the concept mappings from the functionality brainstorm, these scopes include; hospital foodwaste, fruit and vegetable foodwaste, household foodwaste, and ecological recycling. The full output of the sketching ideation method can be viewed in Appendix B.

Figure 7. Grasp of Sketching output concerning the foodwaste problem

### *Hospital foodwaste*

Hospital food waste has contributed significantly to the food waste issue (Antasouras et al., 2022). Namely c.a. 40% of the total amount of food prepared in hospitals is wasted (Wageningen Food & Biobased Research, 2022). From that percentage of waste, the cause can de linked back to 1% being originated at preparation, 41% originated at portioning, 29% originated at cleared patients, and 29% originated at patients eating less, also known as 'plate waste' (Wageningen Food & Biobased Research, 2022). In the sketching ideation method, the first idea is based on patients receiving their own personalized meal, using technological advancements that are linked back to the kitchen (Figure 8). Subsequent to this idea, research had been performed on how food is actually prepared in hospitals. It was learned that the hospital kitchen prepares three meals a day; breakfast, lunch and dinner, that is served two days later (SETHLUI, 2019). Consequently, instead of having a menu to pick from, the user is more likely to be limited in the food that is served. Therefore, in relation to 'plate waste', an iteration on the first idea was generated where the user can communicate in an efficient manner on what food they certainly won't be eating, while putting no extra pressure on hospital staff or doctors, accordingly tackling the 41% porioning causation of hospital foodwaste (Figure 9).

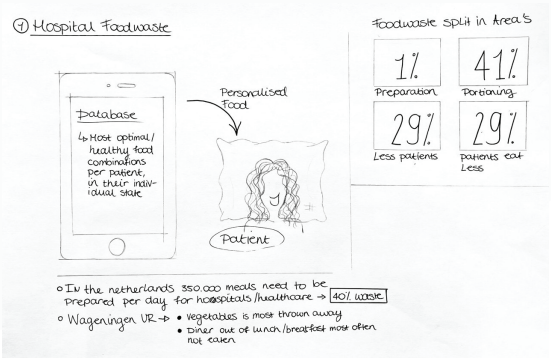


Figure 8. Sketch hospital foodwaste - Idea 1

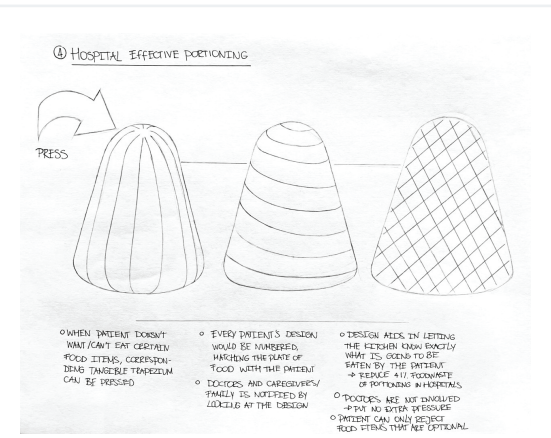


Figure 9. Sketch hospital foodwaste portioning iteration

### *Fruit & vegetable foodwaste*

According to nationally conducted studies in EU countries, the category of 'fruit and vegetables' is for almost 50% responsible for the foodwaste that is generated in households (Laurentiis et al., 2018). Deterioration of fruit and vegetables can be bluntly categorized into 4 factors of causation; time, temperature, light, and humidity (Safe-In-Home Air, (n.d.)). The first sketch output was focussed on controlling these factors of fruit and vegetable deterioration, as postharvest deterioration can't be stopped, but it can be slowed down (Philips, 2022). Accordingly, the idea reflects an hermetically sealed

basket that functions as a storage upgrade, rather than storing them in the fridge or at home temperature (Figure 10). Technical advancements such as controlling humidity levels, timing when the lid is removed, and monitoring ethylene gas emissions that keep the stored combination of the fruits and vegetables in check could be implemented in the design (Philips, 2022).

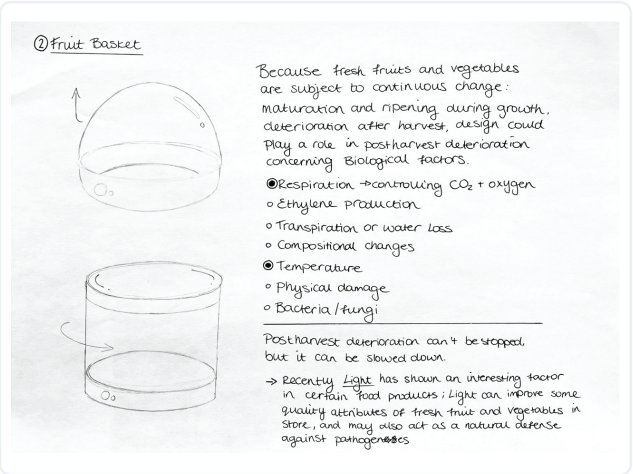


Figure 10. Sketch controlling fruit & vegetable deterioration

## *Household foodwaste*

Out of the 931 million tonnes of food that are wasted each year, around 61% is generated inside households (UNEP, 2021). A big part of that problem starts in the fridge, based on the research that investigated food discarding decisions regarding refrigerator foods (Davenport et al., 2019). Another finding in this research was that date labeling vastly reduces the likelihood of food items being consumed to their full potential (Davenport et al., 2019). Therefore, a concept was sketched out where the user could define the freshness of food products by looking at another indicator for determining food freshness, rather than exclusively using the expiration date as information source (Figure 11). In this concept, a round label would be placed on refrigerator food, that, depending on how it is packaged, could have different methods of application. In an instant, when opening the refrigerator's door, the user would get an impression of which foods almost reach the expiration date, using either a repetitive indicating color pattern, a timer lay-out, or e.g. displaying percentages.

In relation to food freshness, another perspective on household food waste was created, where a deeper take on color and flavor as indicative variables stood central (Figure 12). This design concept was formed after being inspired by the research on the color-flavour connection within food consumption provided by o.a. Jenn David and Ken Philips, as well as the study of Russell et al. suggesting that non-cognitive drivers should deserve much more attention in relation to foodwaste behavior (Related work). The idea focusses on notifying the user when certain food should be consumed, either when it is optimal for consumption, or is close to expiration. The first ideas of using a new medium to reduce household foodwastage in Dutch households were generated in this sketching session.

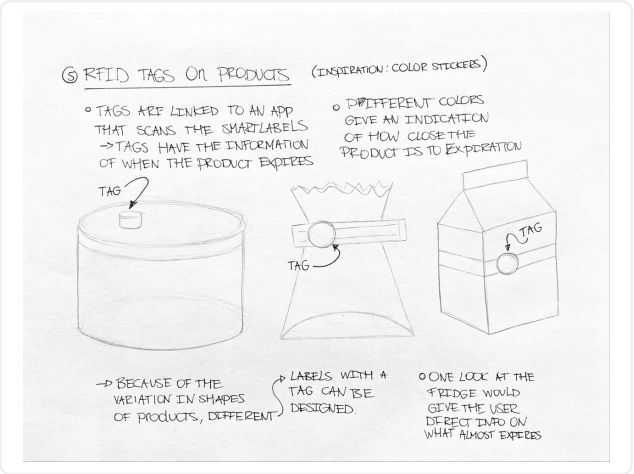


Figure 11. Sketch RFID tags on products

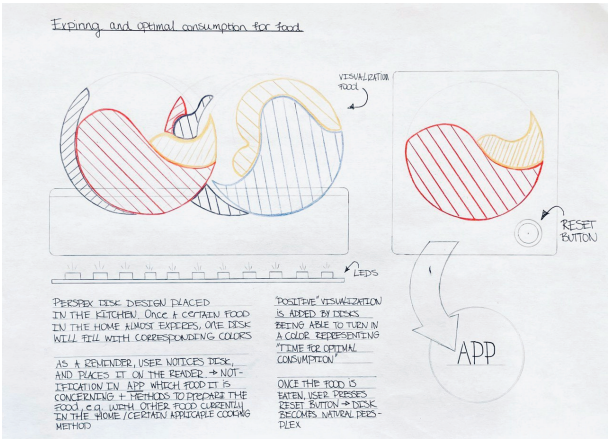


Figure 12. Sketch Expiring and optimal consumption for food

## *Ecological recycling*

Furthermore, in the sketching process the thought of ecological recycling emerged where non-organic remains such as fruit peels and vegetable endings can be used to reproduce organic matter, such as e.g. herbs (Figure 13). Imagine a supply of multiple herbs to choose from in your kitchen, completely grown using a nutrient cycle. This idea was intended to be combined with the fruit basket idea in Figure 10. Consequently, fruits and vegetables are staying fresh for a longer amount of time, while the remains are not thrown away but used for growing your own spices that can be used while cooking.

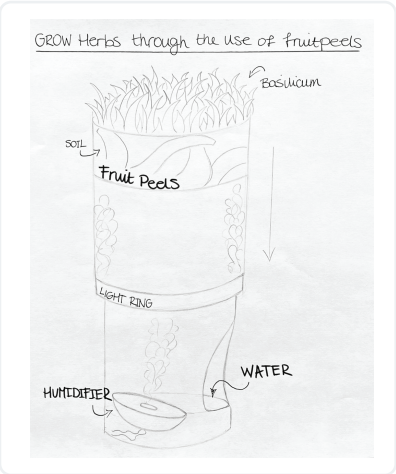


Figure 13. Sketch growing herbs out of remains

## Lo-fi prototype

Although all 4 scopes of the sketching ideation outcome could have been investigated further in this design process, learning that 61% (UNEP, 2021) of foodwaste is generated in households in high-income countries, and thus the potential this category holds for improvement, resulted in the decision of continuing the process in this direction. Consequently, a low-fi prototype was created based on the household foodwaste sketch; 'Expiring and optimal consumption for food' for the quarter-term demoday (Figure 12). A digital render can be viewed in Figure 17.

Figure 14. Prototyping

Figure 15. Lo-fi prototype

The design, which consists of four rounded disks and a sturdy base, visualizes the food's freshness that Dutch householders possess in their homes (Figure 15). The design has the purpose to function as a notification when food is getting close to expiration and/or is optimal for consumption (e.g. fruit, cheese, and wine). When one of these two causalities occurs regarding one food product, one single disk will illuminate in corresponding colors. This creates an abstract visualization, leaving the user in control of when information is received. Therefore, when a disk lights up, and the user is 'ready' to receive the according information, he/she can lift the applicable disk and place it on a base. Establishing contact with the base will lead to a digital notification giving the user necessary information about the selected food product. This information could be e.g. the time limit before the food expires according to the supplier, the time frame of when a certaing food, e.g. mozerella tastes the best, or the flavor the food categorizes in at a certain moment. Afterward, the user can either choose to consume the food or place it back in the base, for another family member to be notified.

### *Smart labels*

The information on the expiration dates of food products in this concept would be obtained by scanning smart labels in the supermarket. Currently, the supermarkets 'Albert Hein' and 'Jumbo' are providing self-scanners intended for the customers to self-scan their articles (Zelfscannen | Albert Heijn. (n.d.)) (Boodschappen doen met Zelfscan | Jumbo. (n.d.)). When doing so, only the product code is essential in order for the client to correctly complete payment obligations. However, information such as the journey the product has traveled, and therefore accurate expiration dates could be obtained in more advanced barcodes or labels, called 'smart labels' (Clearmark, 2022). Companies have been utilizing the forthcoming innovation of smart labels in food packaging more and more in recent years, as it could make major breakthroughs in product traceability, ensuring food safety, and reducing foodwaste (Wevolver, 2022) (Figure 16). In 2022, a news article from 'The IndianExpress' even confirmed QR-codes help buyers to to check the tree from which a cerain fruit is picked (Biswas, 2022). Therefore, in the design project, this upcoming innovation has been kept in mind as a possibility to tackle the household foodwaste problem in the field of HCI.


Figure 16. Example of smart label on fruit product by Claeys (2022)

### *Expiration knowledge*

Prior research has concluded that consumers have an insufficient understanding of expiration dates; it leads to confusion and misunderstanding, and in turn to the disposal of food that might still be edible (Barone & Aschemann-Witzel, 2022). Dynamic expiration dates, therefore, can be seen as an iteration on the understanding of the freshness of

food, as dynamic expiration tools have effectively proven to reduce household foodwaste (Barone & Aschemann-Witzel, 2022). However, current households in the Netherlands are restricted in determining the freshness of food through searching for printed-on expiration dates, and using their own senses. In conclusion, research has proven that innovation regarding dynamic real-time feedback about the quality and freshness of food leads to a reduction in foodwastage, however, this is currently not effective in the daily lives of Dutch households.


Figure 17. Digital render Lo-fi prototype

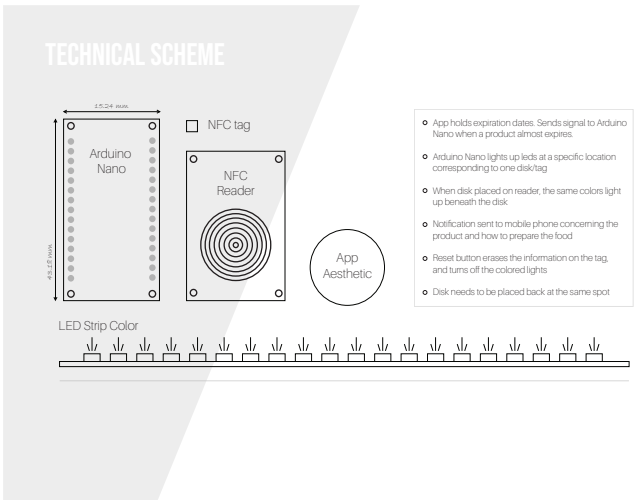


Figure 18. Technical scheme design concept quarter-demo

## *Quarter-term Demoday feedback*

The feedback that had been received from the lo-fi prototype design at the quarter-term demoday, had been mainly a suggestion to visualize a map of the steps the user goes through when interacting with the design, or even play it out. When developing this concept further, this could be an aid in making decisions in the design process, as well as clearly describing the concept to a layman.

## *Rethink aesthetics + interaction*

After the quarter-term demoday, a reshaping inspirational rendering session made it possible to clearly see what iterations have potential in this design concept. Firstly, intead of the design consisting out of 2 components; a visualization and a base, an iteration was created where the disk can be placed at the front side of the base itself (Figure 19). Namely, after placing the lo-fi prototype in the kitchen, it was observed two components might not be ideal as one component can be replaced somewhere else, and this would result in the design not function in the intended manner anymore. Additionally, the glass disks in the render have a distinct structured surface. When picking one disk up, the user would next to seeing the color, feel a corresponding structure. This concept however is discarded, due to the concept being too abstract and limited in relation to easily identifying food.


Figure 19. Digital render Lo-fi prototype iteration base

In a different notion, the base and the disks would both appear transparent. Because of this, the user would be able to see the colorful disk in its whole rather than an area that has been "blocked off" (Figure 20). However, from this rendering it was noticed that the glass base causes a diversion in light under a certain angle, a side-effect that is not desired in this concept.

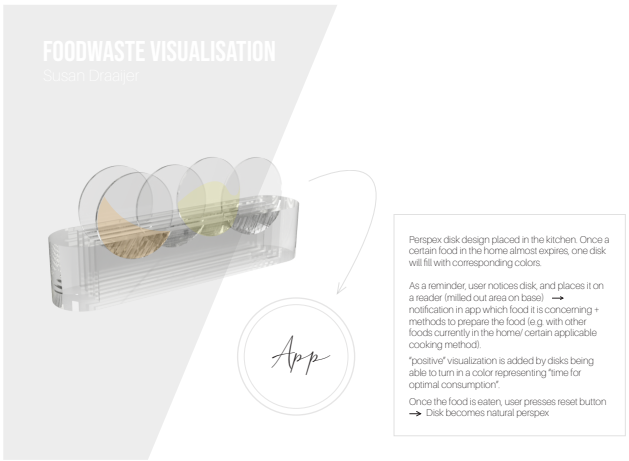


Figure 20. Digital render Lo-fi prototype transparent base

## High-fi prototype

The High-fi prototype that was presented at the mid-term demoday can be seen as an abstract notifying visualization that indicates when food is getting close to expiration. With this concept, the food that is thrown away due to either obliviousness or incorrect understanding of expiration labeling is prevented. The rectangular pieces of glass are able to light up and show one or two colors corresponding to the flavor of a particular food product that is currently present in the household. By explicitly visualizing flavor using modifying colors as parameter, the design would allow the user to experience and be critical of the freshness of food through the use of a whole new medium. Additionally, the user's awareness is enhanced by giving them the opportunity to adapt to a new routine designed to help them stay in touch with the freshness of food over time.

Once a rectangular glass component lights up and displays a certain color pattern, the user can hold their phone near a white disk that is situated at the left end of the base. When doing so, a digital notification will pop up instantly, with the aim of lowering the treshhold to interact with the design; rather then searching for an expiration label on the packaging of the food, the user would perform this practice. In this notification, there is information about e.g. which exact food is expiring, the journey the food has traveled, and how you could optimally prepare a meal with other foods the user posesses at home. If the user chooses to eat the concerning food, he/she is able to dismantle the corresponding rectangular glass through the use of an app. A journey map of the steps the user follows in regards to this concept is visualized in Figure 21.

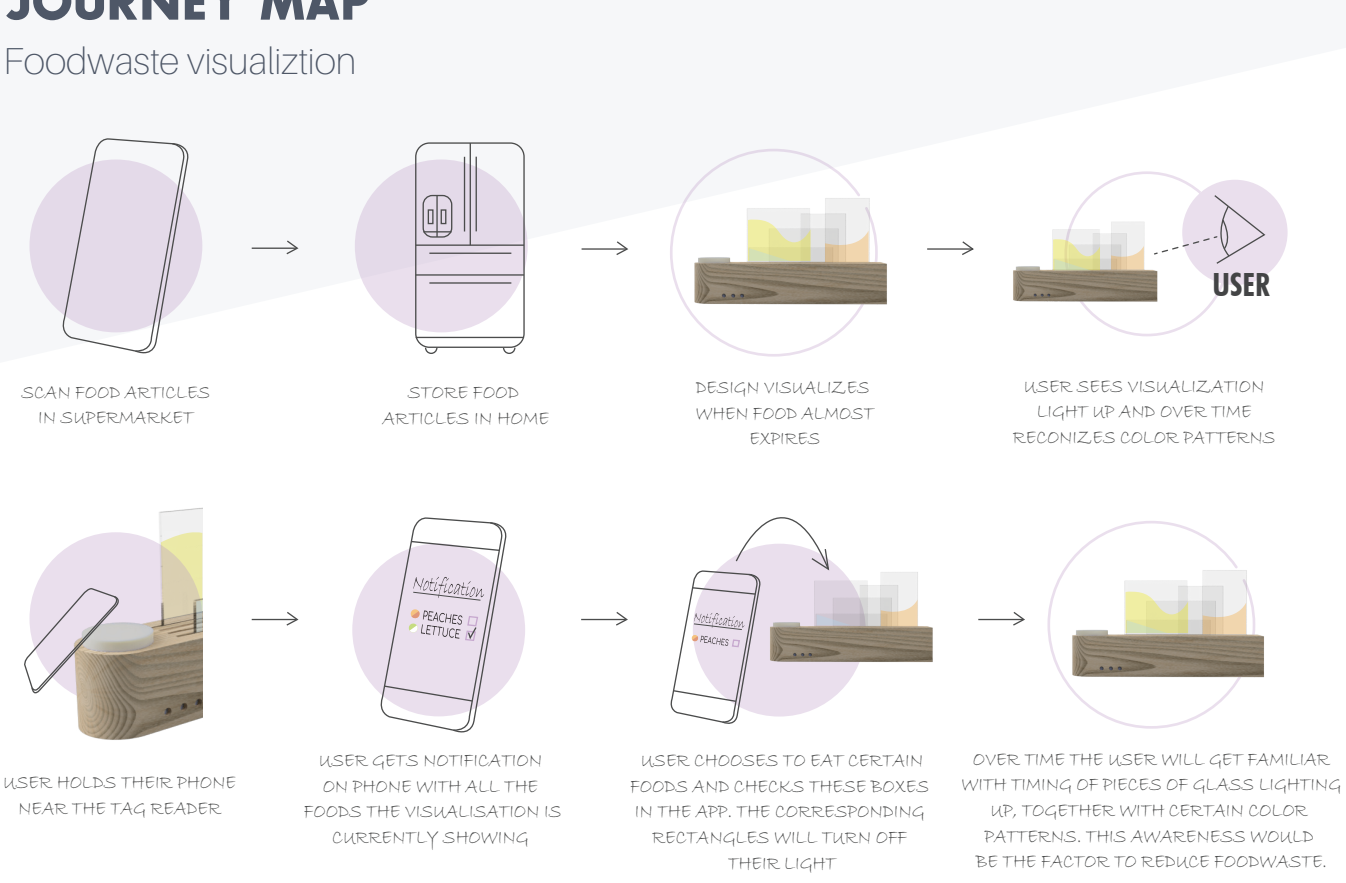


Figure 21. Journey map

## Manufacturing

### *Milling base*

The side of the base that is equipped with the RFID tag hidden in a white disk is intentionally rounded off. Namely, when the user scans the tag with their phone, they will not be bumping into sharp pointy corners, accidentally harming themselves. In order to realize this designed round corner, a milling machine was used that removes -layer for layer- MDF wood (Figure 22 ). The design was first sketched out in the software program Autodesk Fusion 360 (Figure 23-25), and afterwards converted to G-code. This process is repeated three times in total, resulting in three different bases that can be stacked on top of each other; labeled ground, middle and top base.

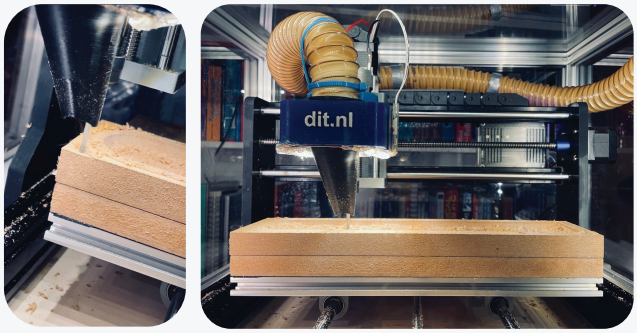


Figure 22. Milling base out of MDF wood

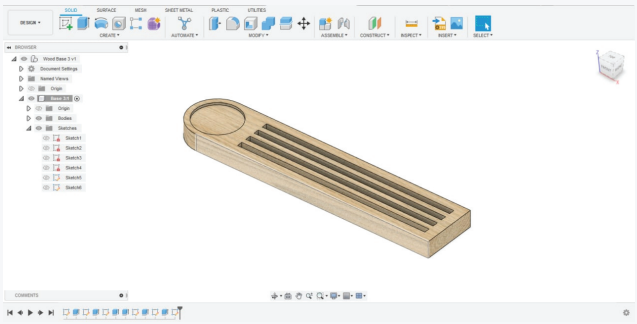

Figure 23. Top base sketch Autodesk Fusion 360

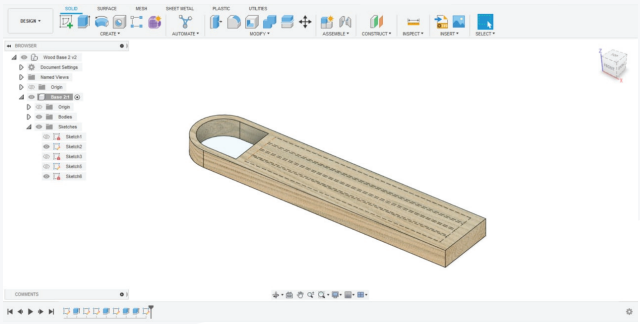

Figure 24. Middle base sketch Autodesk Fusion 360

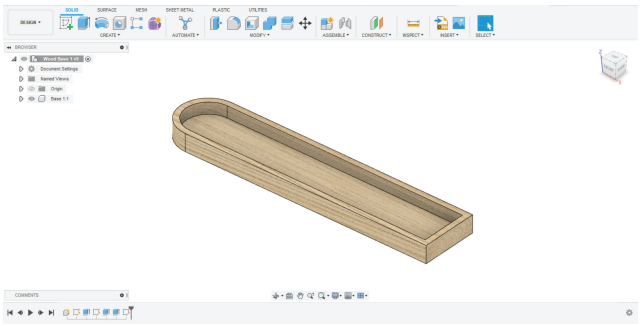

Figure 25. Ground base sketch Autodesk Fusion 360

## *3D printing disk*

The RFID tag covering disk is printed on an Endor 5 plus 3D printer using white filament (Figure 26). The color white is chosen due to its clean and neutral representation, as a variation of colors next to this disk is being displayed over time (Smith, (n.d.)). Furthermore, the disk functions as a tangible area, clarifying where the RFID tag can be scanned. In the manufacturing process, the disk again is first sketched out using the software program Autodesk Fusion 360 (Figure 27), and afterwards converted to STL and eventually G-code. The disk fits perfectly between the rounding corner of the base and the start of the slots in the MDF wood.

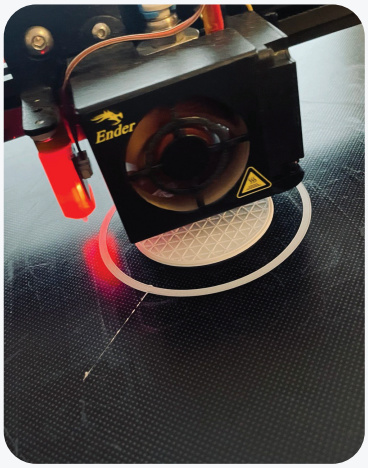


Figure 26. 3D printing white disk

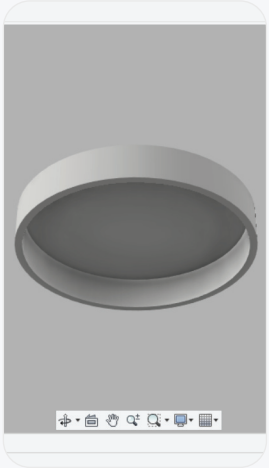

Figure 27. Sketch Fusion 360

## *LED emiting colors*

At the surface of the second MDF base, 4 rows of colored LED's are situated (Figure 28). The LED's are programmed using the software program Arduino, and turned on-and off using smoothly fading brightness transitions. Furthermore, the LED's are controlled with an ESP8266 WiFi microcontroller and powered with a 5-volt battery. The LED's can be individually controlled and emit 0-255 colors in RGB combinations. Only the LED's that are covered with a rectangular piece of glass on top will be able to emit light in this design concept (Figure 29).

Figure 28. Three bases milled out and the middle covered with LEDs

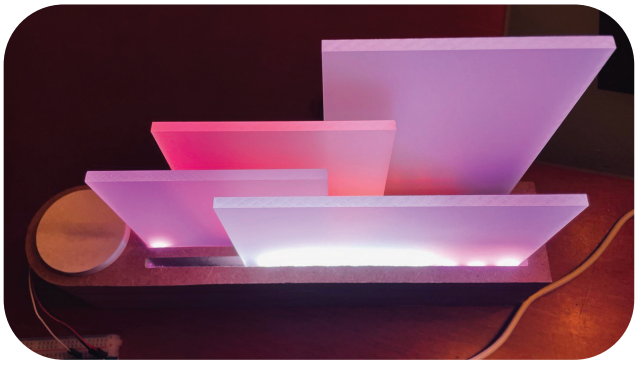

Figure 29. LED's emitting light under frosted perspex glass

## Midterm Demoday

At the midterm demoday, the end of the first half of the semester, a short 5-min. pitch was presented at the Transforming Practices design squad. Additionally, a prototype of one's current design concept had to be displayed. Consequently, the current design concept (Figure 21) in combination with the design prototype (Figure 30-31) had been presented to a divided group of c.a. 10 people.

Acquired from the midterm demoday, was the reassurance the design has a very engaging look; it encouraged the audience to interact with the design and want to learn more about it. Furthermore, a suggestion about focussing specifically on the relationship between the user and the design, rather then the technical components was given. Another notion that was discussed concerned the theory of how the user could best learn the design visualization. Namely, at this moment the user mostly has to rely on the app to receive the exact information, possibly avoiding actually learning the visualization itself. Therefore, a followed-up notion was discussed to reshape the design in a way the user in an instant is able to understand what the design is visualizing, and utilize the app as additional support or remove it completely.

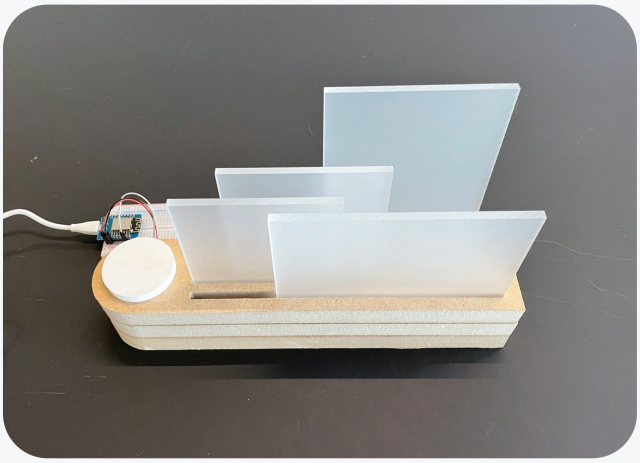

Figure 30. First take high-fi prototype (no fruit currently ripening)

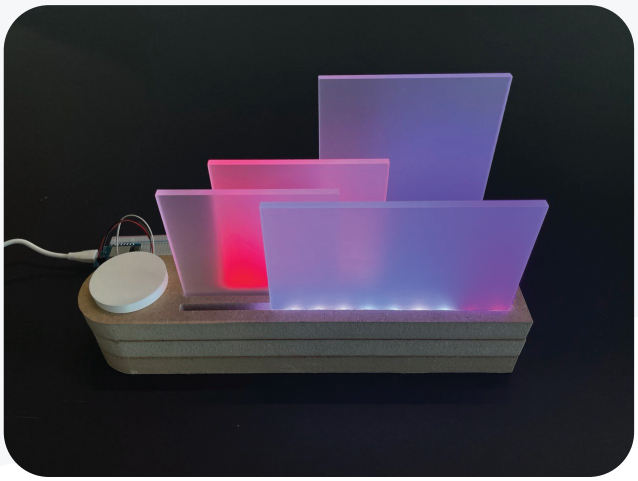

Figure 31. High-Fi prototype design visualization

## Visualizing fruit freshness

In light of the received midterm feedback, it was evaluated the visualization is perceived as too abstract, and needs to be narrowed down to a specific category in order to attempt a visualization that is easily learned. Earlier obtained research concerning avoidable foodwaste in Dutch households concluded that *bread, dairy products, vegetables, fruit,* and *potatoes* are wasted most (Food waste in Dutch households, 2019). Due to fruit undergoing a process of ripening and different stages of freshness, this category was explored further.

### *Correspondences between color and taste*

Can basic tastes, such as sweet, sour, bitter, salty, and umami, be conveyed by means of color? According to research that investigates crossmodal correspondences between colors and basic tastes the answer is yes; "Colour clearly conveys to the brain what taste is to be expected" (Spence et al., 2015). The research utilizes the results of another study that specifically obtained the taste-color correspondences between bitter, salty, sour, sweet, and umami and the colors black, blue, brown, green, grey, orange, pink, purple, red, white and yellow in percentages (Wan et al., 2014) (Figure 32). In the preceding design concept, the correspondence between every illustrated color and the taste of sweetness is specifically spotlighted, due to the increase in sweetness that occurs in the riping process.

### *Fruit riping*

Fruit-carrying plants rely on animals to spread their seeds toward areas where they have room and resources to grow (Figure 3). Plants however, don't want animals to show up too early; seeds that get carried away before they have obtained the needed nutrients to sprout are wasted. This is where the ripening process comes in. Before the seeds are ready, fruits obtain a thick skin, hard flesh, and bitter chemical compounds (MinuteEarth, 2021). Furthermore, the fruit carries a color that ensures camouflage in relation to the plant (Figure 2) (Today I Found Out, 2017). As the fruit matures, ethylene is produced as a signal to induce fruit ripening; a hormone gas that converts starch into sugars (University of Maryland, (n.d.)) (Figure 33 ). Due to the fact ethylene


Figure 32. The taste-colour correspondences documented by Wan et al. (2014)

levels correlate directly with how far along the fruit is in its ripening process (University of Maryland,(n.d.)), displaying an ethylene graph effectively conveys the 'ripeness' of the fruit, and, consequently, also it's subjective freshness. This observation will be addressed later in the report. Finally, as fruits ripen, the color change that happens is caused by the specific antioxidants present in the fruit, which leads to the creation of various hues depending on the fruit type (Krosofsky, 2021). Also known, is that the colors eventually darken further down in the ripening process (Krosofsky, 2021).

### *Climacteric/ non-climacteric fruit*

On the basis of ripening behavior, fruits can be classified into climacteric and non-climacteric fruits (University of Maryland,(n.d.)). Climacteric fruits are defined as fruits that enter a 'climacteric phase' after harvest, which means they continue to ripen and increase in sweetness after they are plucked from a tree (University of Maryland,(n.d.)). Non-climacteric fruits however, do not ripen further after harvest, and do not increase in sweetness after plucking (University of Maryland,(n.d.)). Therefore, non-climacteric fruits need to be harvested when they are fully ripe. A list of fruits, indicating if they are climacteric or non-climacteric, is displayed in Table 1.

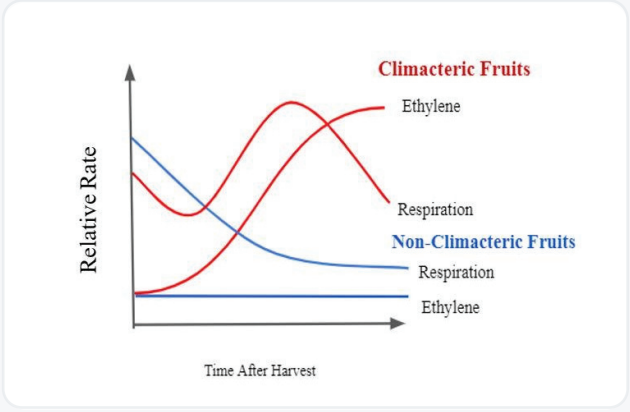


Figure 33. Ethylene levels during fruit ripening by University of Maryland (n.d.)

| | |
|---|---|
| Apple | *Climacteric* |
| Banana | *Climacteric* |
| Pear | *Climacteric* |
| Tangerine | *Climacteric* |
| Orange | *non-climacteric* |
| Grape white | *non-climacteric* |
| Grape dark | *non-climacteric* |
| Strawberry | *non-climacteric* |
| Kiwi | *Climacteric* |
| Pinneaple | *non-climacteric* |
| Melon | *Climacteric* |
| Cherry | *non-climacteric* |
| Blueberry | *non-climacteric* |
| Raspberry | *non-climacteric* |
| Lemon | *non-climacteric* |
| Mango | *Climacteric* |
| Peach | *Climacteric* |
| Plum | *Climacteric* |

Table 1. Fruit sortened in climacteric (increase in sweetness) or non-climacteric fruit (flavor doesn't change) (keep it fresh, 2019).

## Online research survey

Directly understanding an abstract visualization that displays fruit is highly dependent on the user's ability to identify a specific fruit type. In the earlier addressed concept 'window of opportunity', and thus the first 2-3 seconds the user engages with the design, over

50% of the user's cerebral cortex is devoted to visual processing (Connolly, 2015). Therefore, in order to recognize an object within the first 2-3 seconds after locking attention with the design, color is consequently crucial. A digital research survey was developed to investigate how closely different fruit types are associated with visual colors (Appendix C). The findings of this study will serve as the foundation for choosing the color, or color combination that will be used to recognize a particular fruit type.

## *Method*

The online survey uses a qualitative research methodology and consists of 19 identical questions. The participants were asked to choose between sixteen different colors (light and dark version) that in their opinion best portrays a particular fruit type (Figure 34). A limited number of colors was available for selection, in order to significantly distinguish between colors. As additional cues for the participant to understand the question correctly, the following notes were listed;

- Respond to the question using your own interpretation when solely thinking of the fruit.
- Choose **one** or **two** colors from the scheme.

* The selection is limited to one or two colors, due to previous research concluding 3 colors or more do not result in any recognition when it comes to identifying color with flavor (Spence et al., 2015).

Participants were required to confirm that they do not suffer from any form of colorblindness, and live longer then 5 years in the Netherlands. Furthermore, this research has been classified as minimal-risk, and participants were at least 18 years old. Participants have been recruited voluntarily using a link that directs to Microsoft forms, and signed a consent form, describing the ethical regulations and experiment, before entering the survey (Appendix D). The researcher has declared to follow the general data protection regulation (GDPR) when signing the ERB form that is approved by the supervisor of this project; squad leader of Transforming Practices Daisy Yoo, Eindhoven University of Technology.

## *Results*

The fruit types included in this study are based on the average top 10 fruits that are consumed in the Netherlands (aHealthylife, 2021). Namely, fruit that is

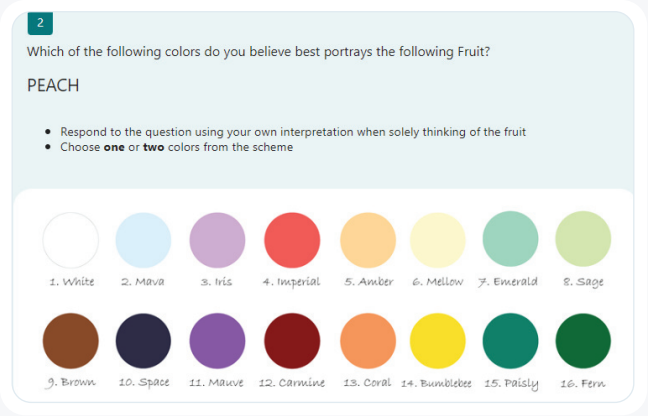


Figure 34. Example question research survey

consumed on a regular note might subconsciously be more accurately registered in regards to aesthetics and flavor, than fruit that is never eaten. However, due to an uncertain quantity of useful results, seven additional well-known fruit types are added to the list. In total 26 participants have filled out the online research survey voluntarily and anounymously. The color and fruit association results can be seen in Table 2, acquired from the more detailed survey results located in Appendix C. The first 10 fruits in the list account for the top 10 most consumed fruits in the Netherlands as of 2021 (aHealthylife, 2021).

| | |
|---|---|
| Apple | *Imperial + Bumblebee / Sage* |
| Banana | *Bumblebee + Mellow* |
| Pear | *Sage + Mellow* |
| Tangerine | *Coral* |
| Orange | *Coral + Amber* |
| Grape white | *Sage* |
| Grape dark | *Carmine / Space* |
| Strawberry | *Imperial* |
| Kiwi | *Fern + Brown* |
| Pinneaple | *Bumblebee + Fern* |
| Melon | *Imperial + Fern* |
| Cherry | *Carmine* |
| Blueberry | *Space + Mauve* |
| Raspberry | *Imperial* |
| Lemon | *Bumblebee + Fern* |
| Mango | *Imperial + Bumblebee* |
| Peach | *Amber + Coral* |
| Plum | *Space + Carmine* |

Table 2. Digital survey results; association between fruit and color

## *Data analyse* (Appendix C )

Noteworthy observations regarding the outcome of this investigation can be divided into four categories. Firstly, the 10 most consumed fruits do not stand out from the remaining seven fruits in terms of definite results. For example, the fruit type apple had as leading result the color 'Imperial'(17 clicks), but a devided second place was obtained by 'Bumblebee'(5 clicks) and 'Carmine'(5 clicks). Out of the light and dark color red, which is both present in the skin of the fruit at a certain point in the ripening process, the light-red color 'Imperial' is chosen in combination with 'Bumblebee' for the recognition stage in the design concept. Furthermore, the colors 'Fern'(3 clicks), 'Emerald'(1 click) and 'Mellow'(1 click) had been checked as well. In contrary, the fruit type peach, which does not appear in the top 10 list, showed very clear results; 16 out of 26 participants choose the two portraying colors 'Amber' and 'Coral'. The remaining answers consisted of solely either one of these colors, together with one hit on 'Imperial', a color that comes forward at a later stage of the ripening process. The second noteworthy observation relates to findings on colors that are either only visible on the surface of a certain fruit type or visible on the inside as well. The fruit type banana for example, is portrayed not only by the outside color 'Bumblebee' (26 clicks), but also the inside color 'Mellow' (7 clicks). Furthermore, the third observation relates to additional leaves being incorporated in the color selection. The fruit type pinneaple and lemon for example both are assosciated through the colors 'Bumblebee' and 'Fern'. The part of the fruit that is edible, however, only contains yellow pigments. The last observation, which could serve also as justification for this outcome, can be explained by the present culture of marketing and commercialism (Kearney, 2010). In advertisements of e.g. beverages, an idealized image is put forward (Figure 35). In the results, consequently, the fruit type pear is declared by the colors 'sage' and 'Mellow. In real life, however, this fruit type is entirely covered with brown dots (Figure 36), a color that is only chosen twice in the research survey for portraying the fruit type pear.

Figure 35 . Original pear by Fone (2021)


Figure 36 . Idealized image by Crystal Clear (n.d.)

## Exploratory prototyping

Next to the investigated color combination portraying a certain fruit product, further exploration in regard to the aim of the user directly understanding the abstract visualization had been performed. During a 2D exploratory prototyping session, eight new iterations were gathered and evaluated (Figure 37).

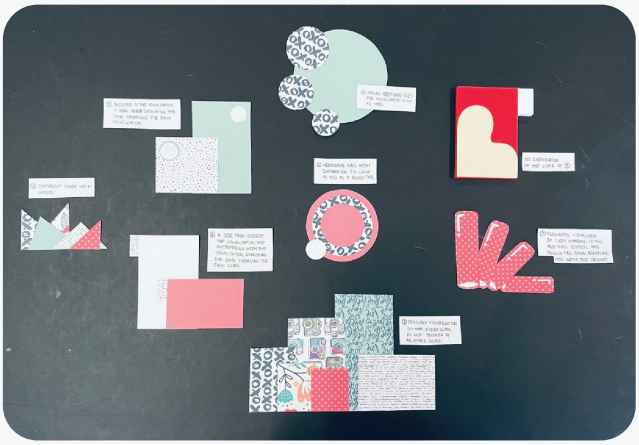

Figure 37 . Exploratory prototyping iterations (Appendix G10)

Firstly, different shapes of visualizing fruit, either round, triangular, cylindrical or rectangular had been observed. In the evaluation, it was concluded a rectangular shape would most accurately fit with portraying fruit, as you are able to imagine a box around every fruit type, signifying size. Consequently, the first iteration that would be utilized in the design concept are different sizes of rectangular-shaped perspex glass, in perspective matching the size of a particular fruit type. The reason why the remaining shapes are discarded is the following: utilizing a triangular, round, or cylindrical shape simply wouldn't make sense as no correlation can be found between these shapes and different kinds of fruit. Matching e.g. a banana with a triangle would not be logical, and would not result in a direct understanding of the visualization. The second evaluation concerns the movement of the cylindrical shapes iteration: standing up straight, towards becoming one with the ground. This iteration, however, is not included in the design concept as this symbolizes not the fruit ripening process, but a stage when it is too late to prevent fruit waste; namely the process of decay. Lastly, additional information might be of help when looking at the design. Multiple iteration ideas of adding a tab towards each visualization possibility had been generated. Either inside the borders of the perspex glass, outside the borders of the perspex glass, a rectangular or round shape, and multiple or just one tab. Ultimately, the second iteration consists of a single rectangular outside tab for every perspex piece of glass. The rectangular-shaped aesthetic is

chosen, in order to match the larger rectangular piece of glass, simplifying the design. The tab is located at the outside border with the aim to distinguish this particle from a distance. Ultimately, in this design concept, this tab is used as a last reminder for the user to prevent fruit waste, notifying the user a day before the fruit is not edible anymore by emitting white light (Figure 38).

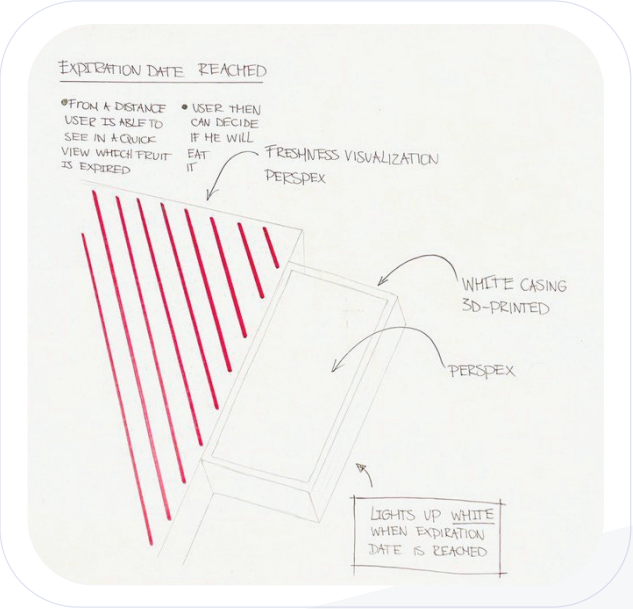


Figure 38 . Iteration tab

## *Color change corresponding to sweetness*

The design functioning as an abstract notifying visualization that is easily understandable and/or learnable has been acquired through the previously explained design iterations. Because of the gathered knowledge about the ripening process of the fruit, the color associations with specific fruit types gained from the research survey, and the conclusion of Spence et. al regarding which colors correspond to sweetness in particular, the following visualization stages in the design have been created; recognition, ripe, and over-ripe (Figure 39). Diving deeper into the last step, the over-riping process, which occurs after the fruit reaches its peak in riping, and before the fruit starts to decay, a color shift will take place based on the boxplot in Figure 32. An example is given by using the fruit type apple. According to the research of Spence et. al, out of the two recognizable colors 'imperial' and 'bumblebee', red correlates with sweet, and yellow correlates with sour. Due to an increase in sweetness of the fruit over time, therefore red increases in area, and yellow decreases in the visualization. The aim is that the user is able to understand the increase in sweetness through using their own experiences and encounters with fruit. To which extent this theoretical color shift is understandable for the user should be investigated with a user test.

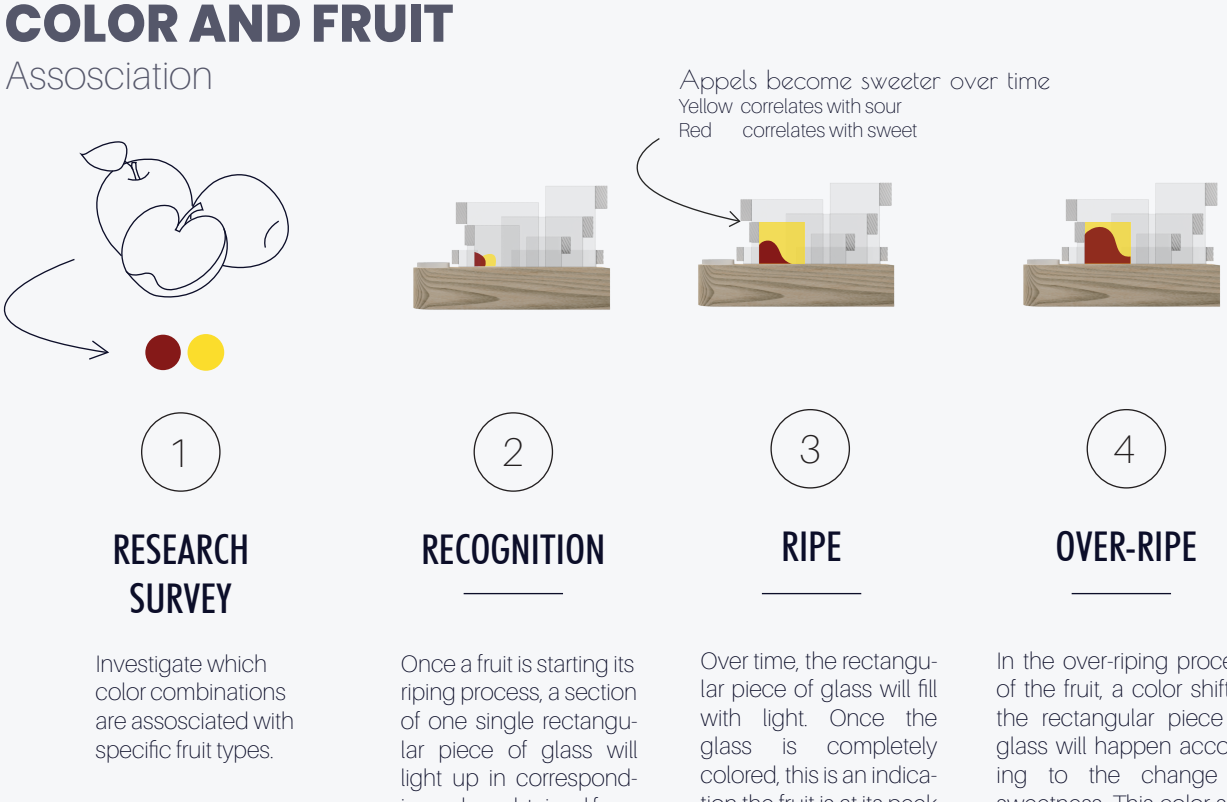


Figure 39 . Color and fruit assosciation

## Manufacturing iterations

### *Rectangular perspex*

From the eighteen investigated fruit types, seven classes of size have been created that match the true size of fruit in perspective (Figure 40). The sizes take into account how the fruit is packaged or purchased in the supermarket. Pineapple e.g. is represented by an elongated vertical rectangular shape, matching the shape of a full-in-tact pineapple. Melon is represented through a more squared shape, as this shape would be the outcome when imagining a box around a round melon. Continuing with mango, and the two kinds of grapes, a match in size and shape was obtained. Kiwi and tangerine are separately categorized from peach, orange, lemon, pear, apple and plum due to their significantly smaller size. Furthermore, the banana is portrayed through an elongated vertical shape at the front. Although bananas are known to possess a curve, rotating the banana 90 degrees results in the obtained visualized box. Lastly, the smaller fruits; cherry, blueberry, strawberry, and raspberry contain multiple pieces per package, but are not connected, such as with grapes. Therefore, these fruits are categorized to the smallest rectangular piece. Manufacturing these shapes is realized through the practice of milling (Figure 41). Once finished, the glass will be placed right on top of the LED's, situated on the 'middle base' in order to prevent any loss of light.


Figure 40. Fruit categorized to size

### *Supplementary tab*

The supplementary tab is visioned at the side of each single rectangular piece of perspex, creating the possibility to notify the user a last secondary time on the deterioration of fruit (Figure 42). The tabs will be

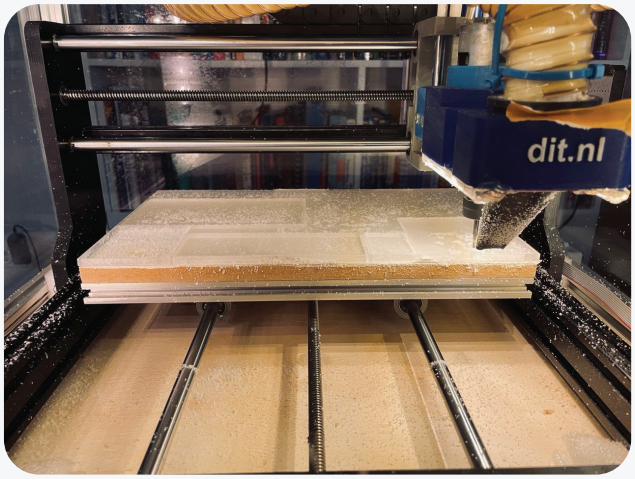


Figure 41. Milling perspex glass

matching the sizes in perspective, subconsciously reflecting the size of waste. To avoid being blocked by a component in front of it, the tab is positioned on either the left or right side of the glass. Seven supplementary tabs are manufactured using an Endor 5 plus 3D printer machine (Figure 43). The color white matches the white colored disk, portraying a neutral, clean image (Smith, (n.d.)). Instead of a smooth surface, emerging rigids are added to the design, inspired by the 'forbidden logo', that is often displayed with an oblique line.

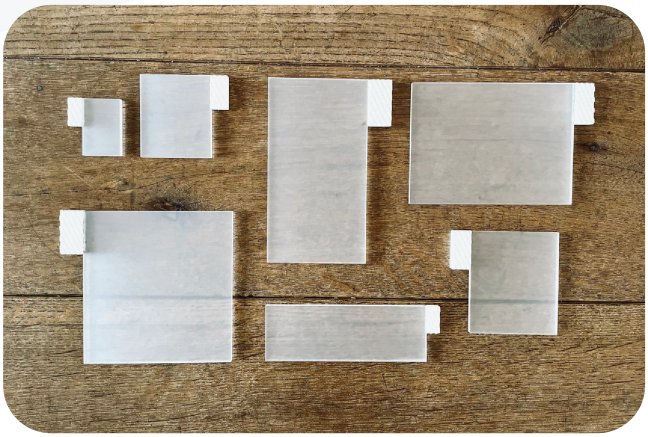

Figure 42. Supplementary tab added to perspex

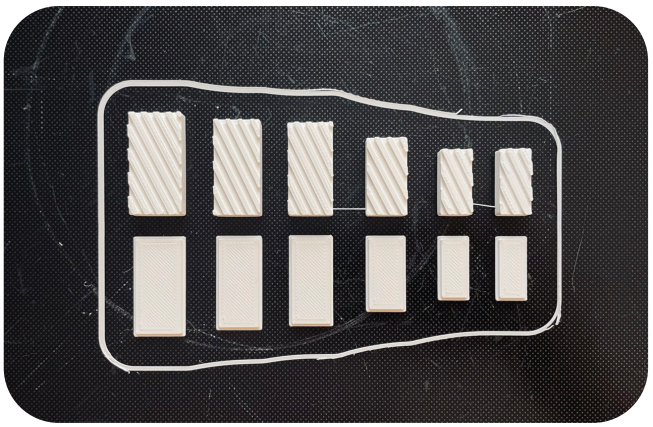

Figure 43. 3D printing supplentary tabs

## *White oak base*

To ascertain whether the material of the base would produce the desired aesthetic, the concept was initially tested in a rendering process (Figure 49). Eventually, a white oak hardwood appearance was chosen. This material appearance as foundation could be implemented in any kitchen aesthetic due to the often-used wooden elements or accessories. Think about a wooden cutting board, spoons and spatula, storage jars, or a wooden tea box. On top of that, the wooden look won't be a disturbing color in relation to the visualization, as wood generarlly is perceived as a material that is used in house furniture. In order to convert the MDF base to a white oak look, a thin layer of veneer is used (Figure 47). The top layer with 4 openings is cut out with a milling machine, using the same file as 'Top base' (Figure 23). Afterwards, another stroke of veneer is carefully bent through the practice of steaming; with the use of a hot iron, the wood becomes soft and bendable (Figure 44). The stroke of veneer is then situated in place with clamps in order to shape the wood in the desired form (Figure 45+46). Finally, the white oak veneer is put together in a box that can be shoved over the MDF wood, in order to modify the electronics if necessary (Figure 48).

Figure 44. Steaming white oak veneer

Figure 45. Bended veneer

Figure 46. Fixed in place

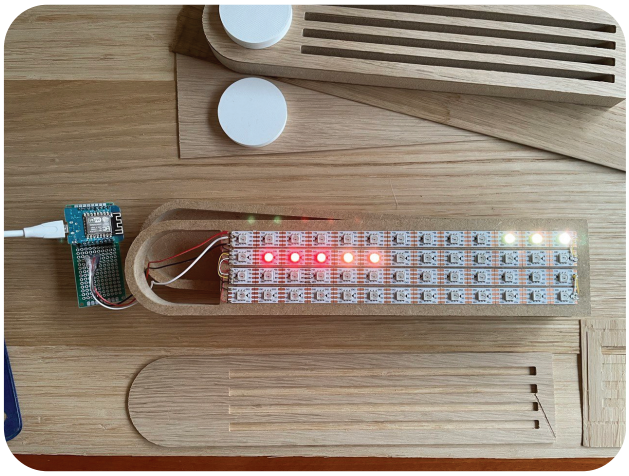

Figure 47. Veneer

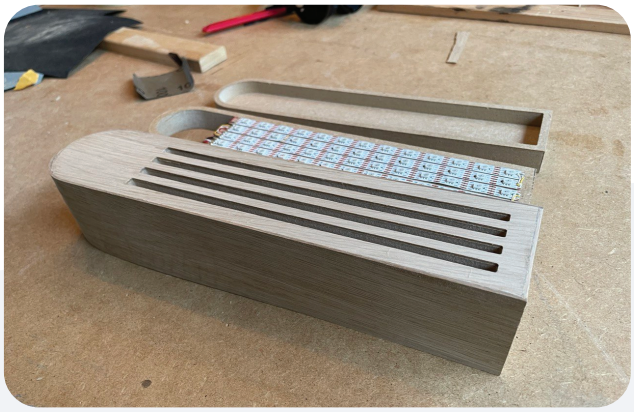

Figure 48. White oak veneer cover

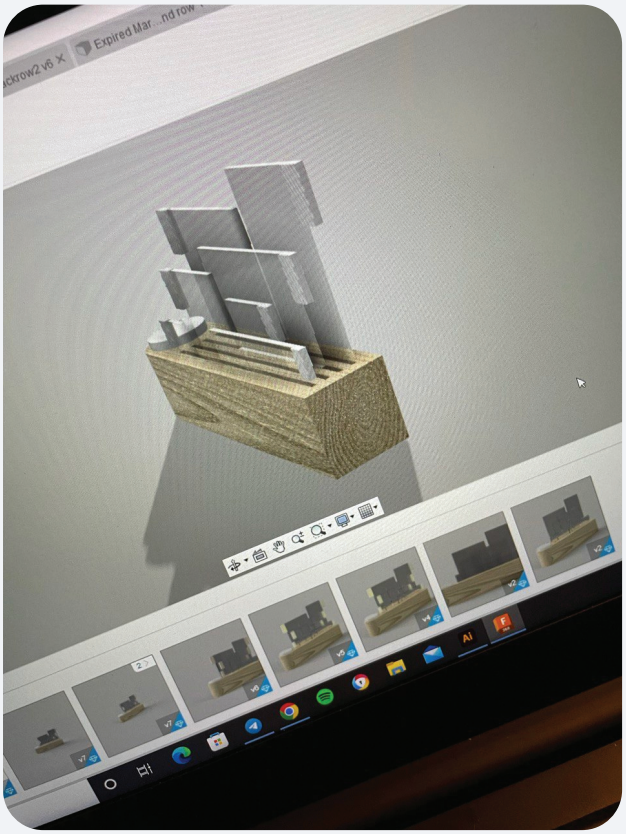

Figure 49. Rendering final concept

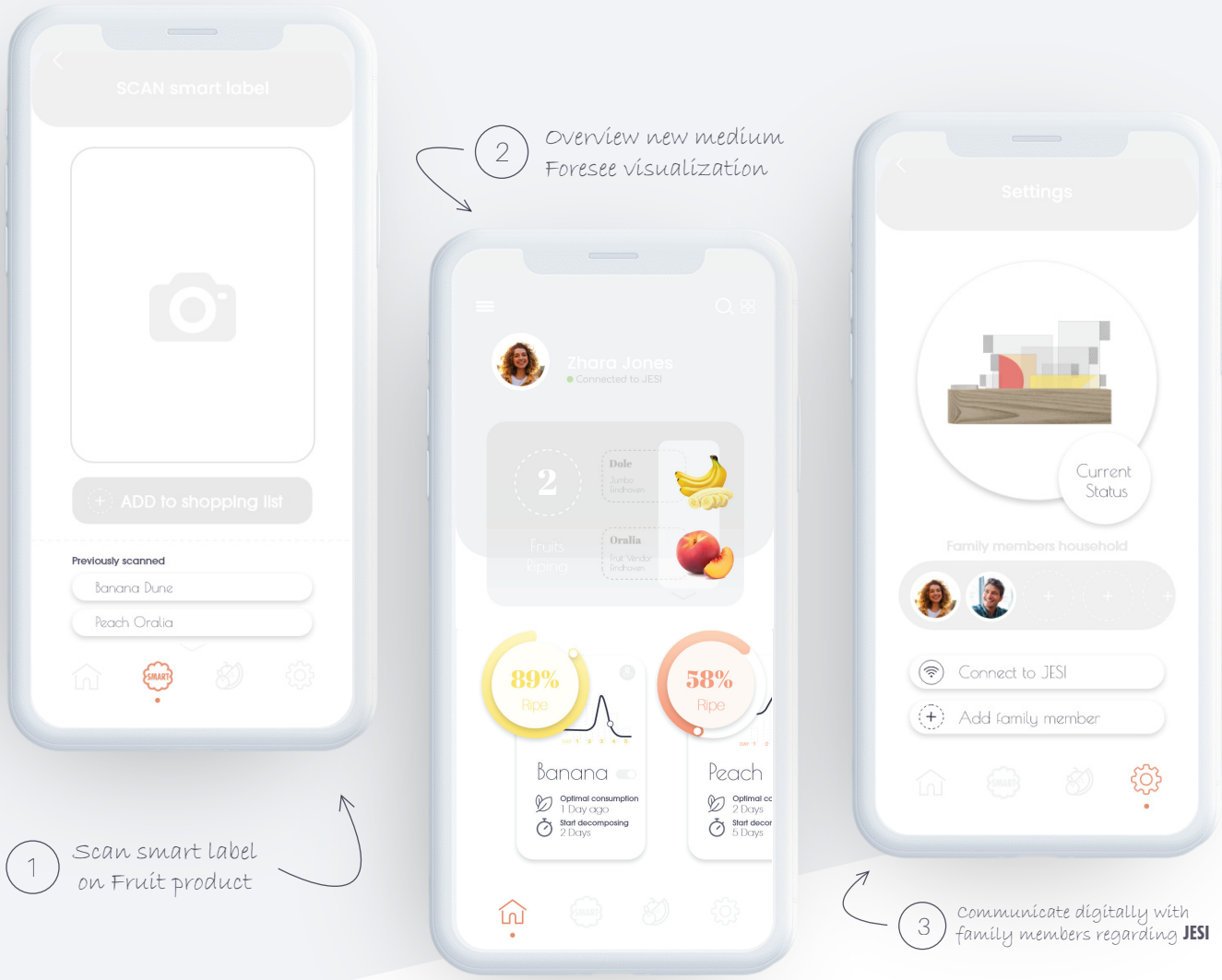


Figure 50. Jesi app 3/5. Peach and lemon by Schoolfruit (n.d.). Photograph man and woman by AdobeStock (n.d.)

# App

The project has placed a strong emphasis on creating a new medium that modifies the ritual of fruit consumption and purchase aiming to reduce food waste in Dutch households. To enhance the design towards the user's perception, multiple iteration processes had been deployed in an attempt to realize this objective. However, presenting a new medium that illustrates the fruit ripening process might not be accepted if the data the visualization is built upon is not transparently conveyed. In order to effectively provide this transparent information, an RFID tag can be scanned that is hidden under a white disk (Figure 50). When this tag is scanned, the JESI app will activate immediately (Figure 51), allowing the user to access more specific information regarding the ripening process. Transparency in brands is known to built trust an loyalty towards its customers (Nguyen, 2022); these attributes could be crucial for integrating the design in the user's routine of fruit consumption and purchase.

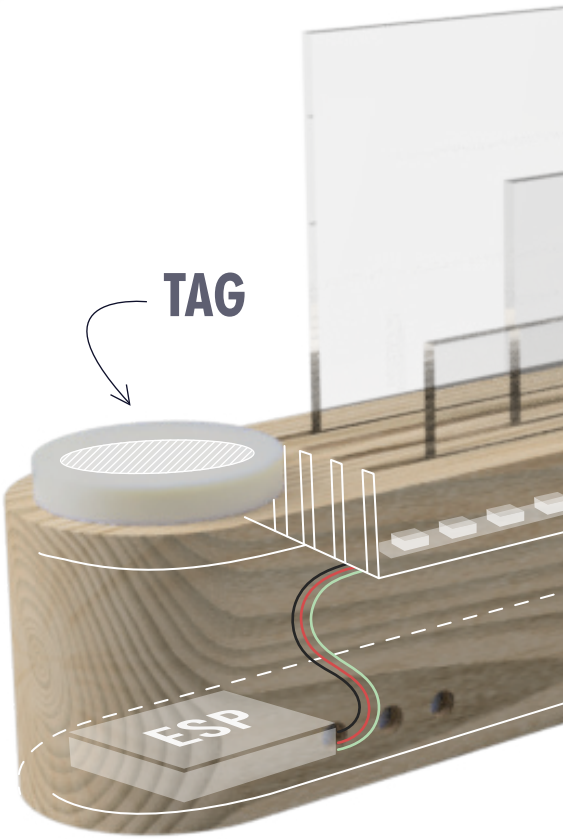


Figure 51. Electronic components

*App features*

In the design concept, the data for the fruit ripening visualization is obtained from the 'smart label' displayed on the packaging of the fruit product (Figure 16). In the app, therefore, a feature of easily scanning this label is implemented (Figure 50). In addition, once the user is throwing away a certain fruit product, this fruit can be scanned and added to the user's shopping list. Making a list of the products you need before shopping reduces food waste as it prevents overbuying (Fleguel, 2022). Another feature is implemented in the app with preventing overbuying as goal. Due to the app having the knowledge of which exact fruit products are present at home, a clear overview can be displayed (Figure 52). In case the user is unsure of this fact in the store, he/she can simply check the app and buy the required amount. Also the fruit that has been prevented from becoming waste is displayed, as it may occur that another family member has eaten a certain fruit product (Figure 52). The effect of displaying explicitly what fruit is prevented from waste could be investigated with a user test.

Furthermore, the home-screen of the app displays a detailed informative overview regarding the current ripening stage of the fruit products. In order to draw attention to this feature, the app's layout is based on the neutral tones white and grey. In this detailed overview, the percentage of ripening, the days until the fruit is at its peak of the ripening process, the days until the fruit is starting to decompose, and a graph of ethylene is displayed. The ethylene graph correlates effectively with the ripening stage of the fruit, and thus a clear peak of ripening can be established (University of Maryland,(n.d.)). Although the ethylene graph descends after its peak, the fruit still continuously increases in sweetness in regards to climacteric fruit (University of Maryland,(n.d.)). In the case of non-climacteric fruit, however, the peak of ripening would be at the moment of harvest, and the ethylene graph would be visualized as a descending line. Lastly, the app is provided with a chat specifically indended to communicate about fruit products in the household (Figure 53). This chat has the aim to contribute to the shift of regurlary staying in touch with your fruit fruit freshness. Furthermore, the chat gives an overview on what happens or has happened with all the fruit products in the household.

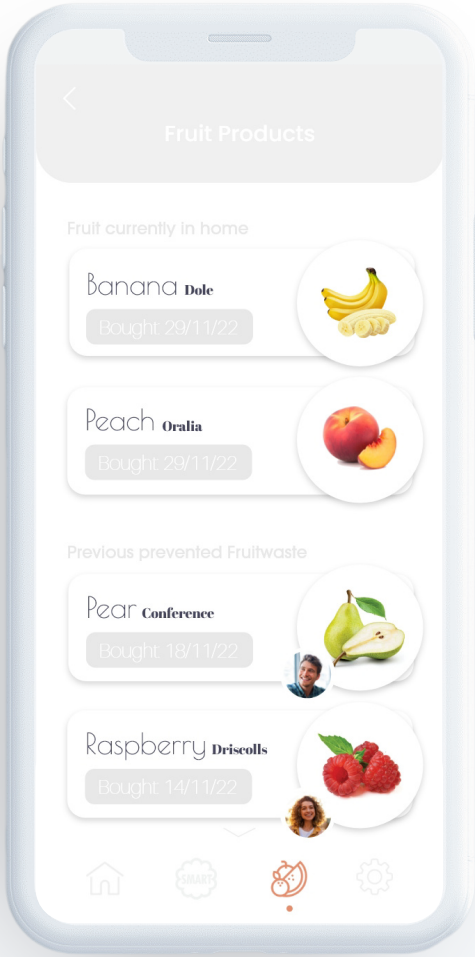


Figure 52. Jesi app 'Fruit produts' present at home

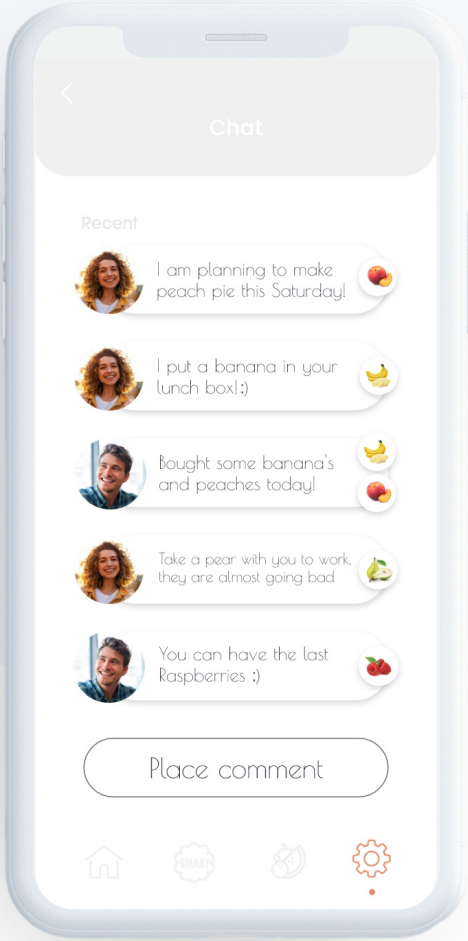


Figure 53. Jesi app 'Chat'

## Final Demoday

At the Demoday set-up, the following assets could be observed; the main poster, an empty fruit bowl, two additional posters, a mobile phone with an app, and the design 'JESI' itself (Figure 54). An expanded image of the app is depicted on the main poster, illustrating how the design concept is related to the field of human-computer-

interaction. The two smaller posters supplement the physical design with additional information. The first poster provides a detailed scheme of the glass sizes in relation to the many fruit varieties, while the second poster presents a condensed journey map on the relationship between fruit and color (Figure 55). The LED's of the design were programmed in such a way that various fruit types with their corresponding color combinations were displayed in a loop (Appendix E ).

### *Feedback*

Overall, visitors appeared to be interested about the ability to hold the phone close to the tag-reading disk, which results in the app opening instantaneously. Furthermore, due to the visitor's personal experiences and marketing knowledge, there was also a great deal of curiosity in the subconscious association between fruit and color, as follow-up questions about this specific topic were asked. The project's coach, Daisy Yoo, added the insight that, rather than displaying the predetermined "peak of ripening" with the ethylene graph, it might be interesting to individualize the design and display the user's personal "optimal moment of consumption". Furthermore, comments like 'it looks finished' and 'it looks complete' were often made.


Figure 54. Final Demoday at Eindhoven University of Technology


Figure 55. Posters Demoday (Appendix F)

## Final design JESI

'JESI' can be viewed as a new medium to be introduced in dutch households, where a new ritual for consuming and purchasing fruit can be established through the use of an abstract notifying visualization (Figure 56). Using color combinations and transitions, the design lets the user stay in touch with the sweetness of the fruit at every moment of its riping process, in order to consume the fruit at user's preferred moment in time. A shift towards the direction of consumers being able to engage with their fruit freshness on a regular note is encouraged, in order to reduce the large numbers of foodwaste in the Netherlands. The final functioning of the design; JESI Visualizing Fruit Freshness, can be viewed in Figure 57.

### *Target group*

The general population of Dutch households served as the target user during the design process, hence the performed online survey investigation. However, a starting couple will be the main focus of the design when it is released on the market as they are going through the process of adapting to various new routines in the household. Introducing a new medium here, could be better incorporated and tested in regards to how this effects the user.

Figure 56. JESI

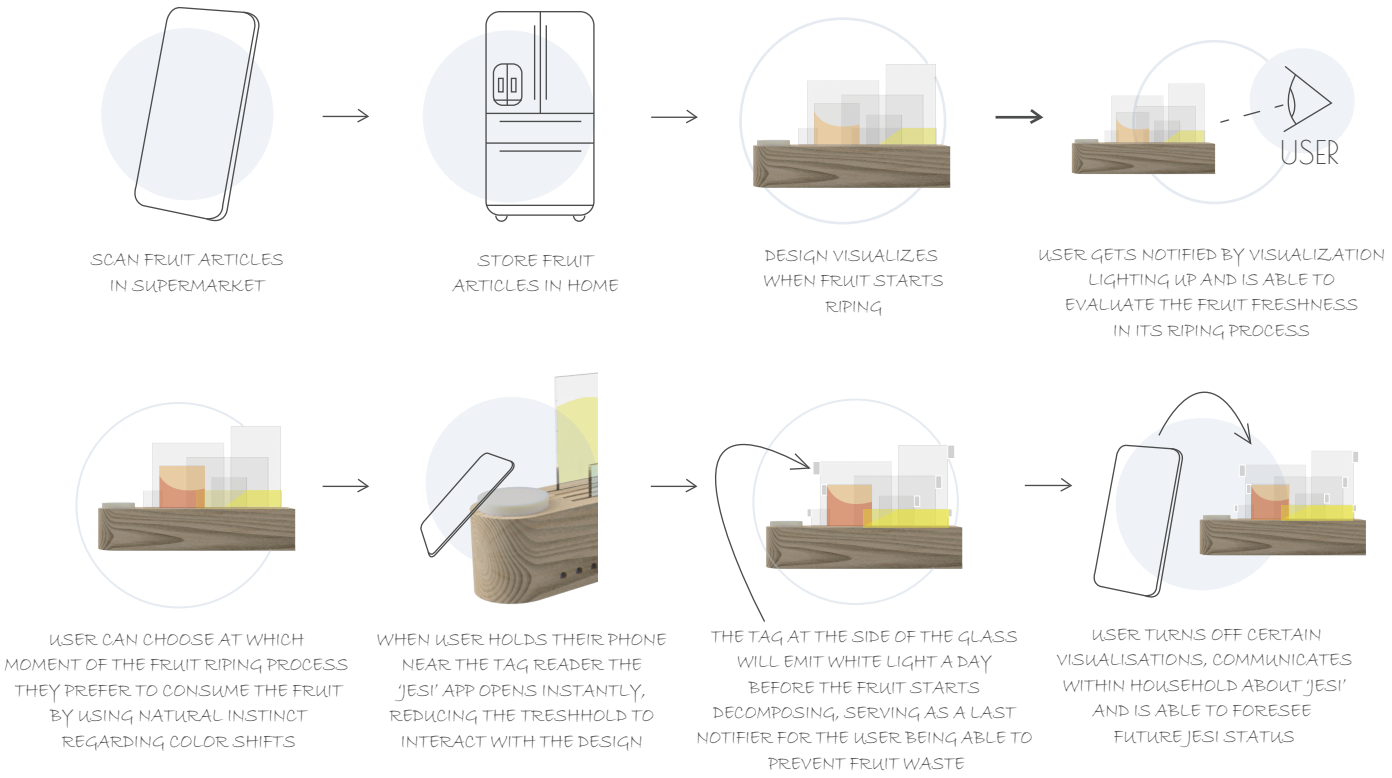


Figure 57. JESI design concept

# 04 DISCUSSION

A new medium is designed, based on the daily subconscious human experiences in life (Connolly, 2015), with the objective to serve as a catalyst for a new fruit waste-reducing habit. In order to grasp an understanding of the associations that are made with multiple fruit types, a private investigation as well as outside scientific research had been obtained.

## *Color assosciation*

Dutch citizens' interpretations on the assosciation between fruit and color were examined with the aid of a specific color scheme (Appendix C). Although a light and dark version for 9 distinct colors were selectable, it can be questionable if a larger number of colors would lead to more valid results. In this hypothetical investigation, the chance of the assosciated colors matching however lessens, as a clear distinction between colors now is not easily made. Also, a limitation of selectable colors in this survey was required in order to match the results with the emitted light from the LED's. Furthermore, It became apparent throughout the design process that various lighting situations alter how colors are perceived, and, cause the perception of brightness levels to rise in darker conditions. The color transition in the visualization in regards to the 'over-riping' process of the fruit is based on the research of Spence et al., indicating an increase in sweetness during the ripening process. This notification of sweetness increase was implemented with the intention to visualize the fruit in

an appealing manner. However, the tipping point of a too-far deviation from reality in regards to the original color balance of the fruit is not included in this research.

### *Learnable design*

When looking at the results of the online research survey, it is noticeable that certain fruit types are more evident then others. However, a decision regarding the ultimate design was made to include all the investigated fruit types and their color assosciations.

Namely, in the design concept, the purpose was set on the user being able to learn the design. Therefore, in the scenario e.g. the fruit type apple for a particular user is portrayed solely by the color 'imperial', and the design uses both 'imperial' and 'bumblebee' for the recognition stage, the user is able through repeatedly seeing this visualization learn that this portrayed color combination means apple. To which extent this learnability can be obtained could be investigated in future research. In conclusion, due to the design's involvement with subconscious levels in the brain, unstable territory is attended and definitive research could furhter optimize the design.

# 05 FUTURE STEPS

In order to best opimize the design for the target user, future user tests on different aspects of the design, e.i. earlier adressed color recognition, color transition indicating sweetness, sizing of the perspex glass, and the application of the app should be conducted and evaluated. Furthermore, a specific user test in regard to the design goal could give insight to which extent a reduction in fruit waste is succesfully achieved. Part of this prospect has been set-up in the earlier described plan of placing the design on the market. The initial target user would be a starting couple, intended to investigate if the design is incorporated in their daily life and if a new ritual of consuming and purchasing fruit is established. Observations and reviews in regards to this user experience would result in iterations and tweekings of the design, and a second iterated version would afterwards become available on the market for the entire Dutch population. Additional possible future steps in regards to the design potential could be an individualization of the medium. This way, the design would become more reliable to each user specifically, rather then sending one version to every household. Think about customizing a selection of fruit types, or programming the app in such a way it is able to learn when the user is most likely to eat their fruit.

Currently, the user must use the JESI app in order to retrieve data about the ripening stage of the fruit product. Due to the upcoming 'smart label' innovation (Wevolver, 2022), the design JESI consequently is intended for a future scenario in the household. The already existing self-scanners in supermarkets also utilize the self-scan practice, however, with a different purpose (Boodschappen doen met Zelfscan | Jumbo. (n.d.)). A collaboration between JESI and supermarkets would facilitate the process of obtaining data for the user, instead of scanning the product twice, with e.g. both the Jumbo app (Figure 58) and the JESI app (Figure 59). Acquiring this collaboration would therefore be one of the first actions that will be made in a potential future prospect for the JESI concept.

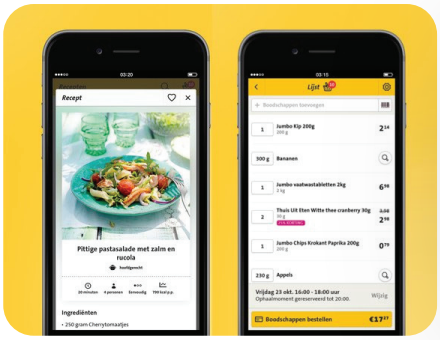


Figure 58. Jumbo app

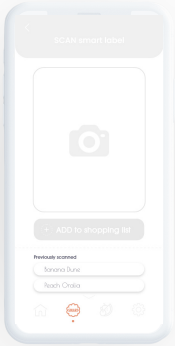

Figure 59. JESI app

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# Appendix A Functionality brainstorm

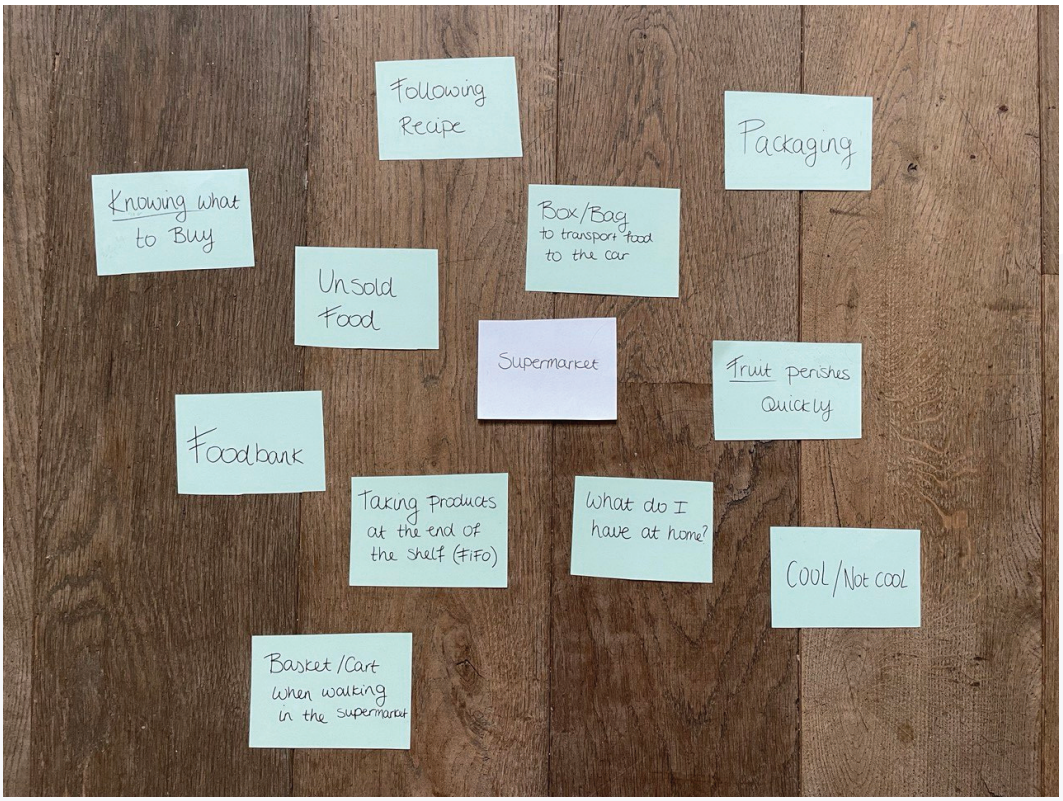



Figure A1. Supermarket

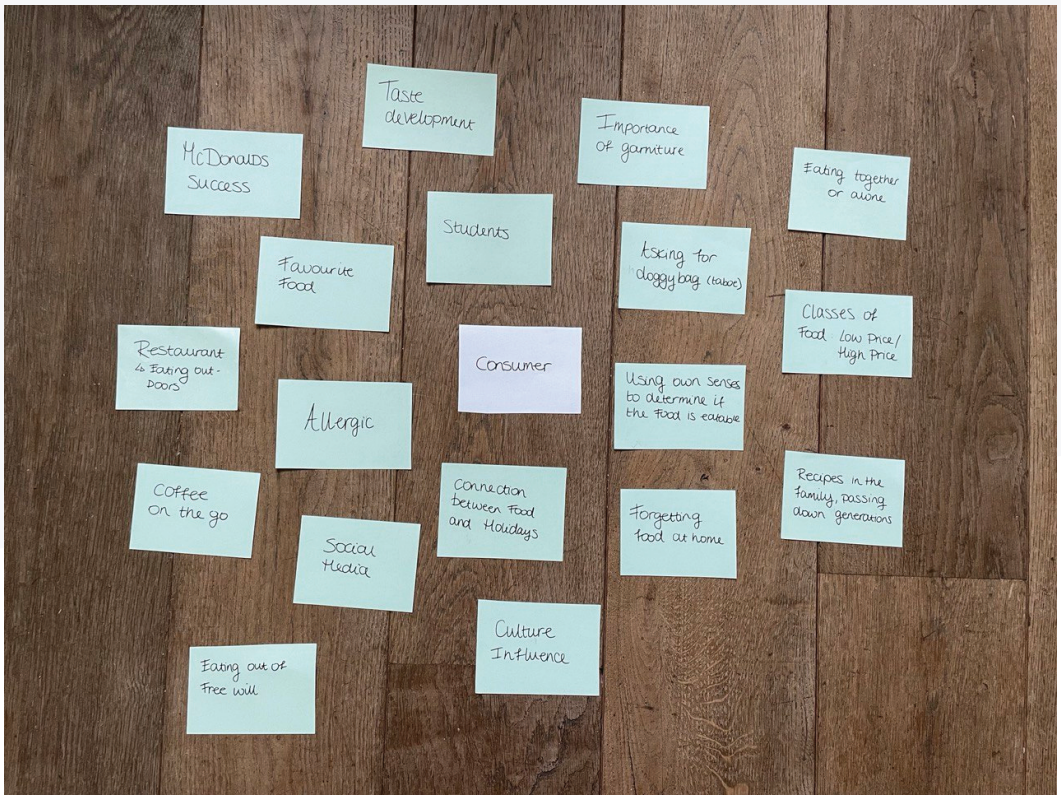



Figure A2. Consumer

# Appendix A Functionality brainstorm

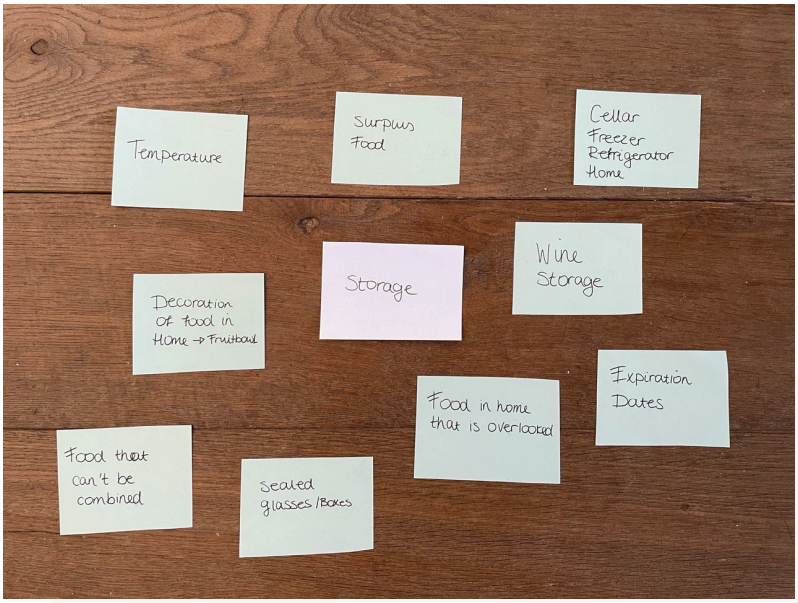



Figure A3. Storage

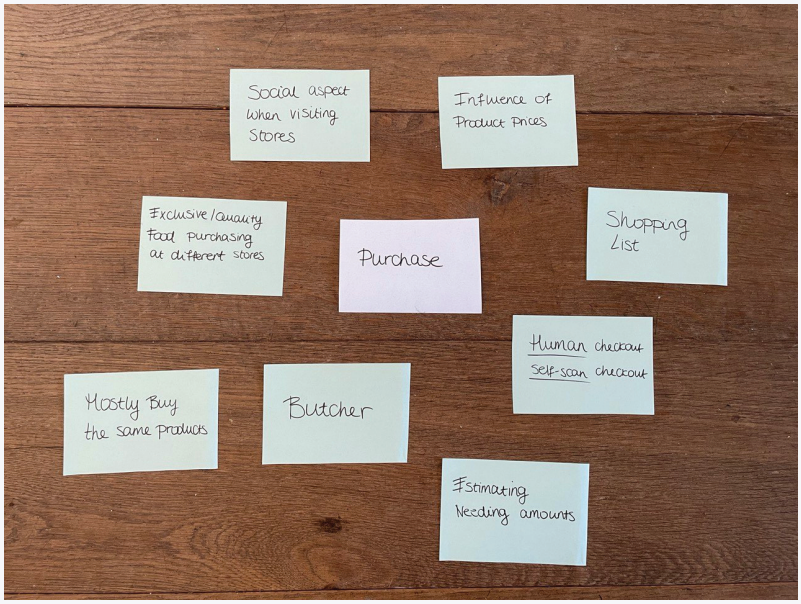



Figure A4. Purchase

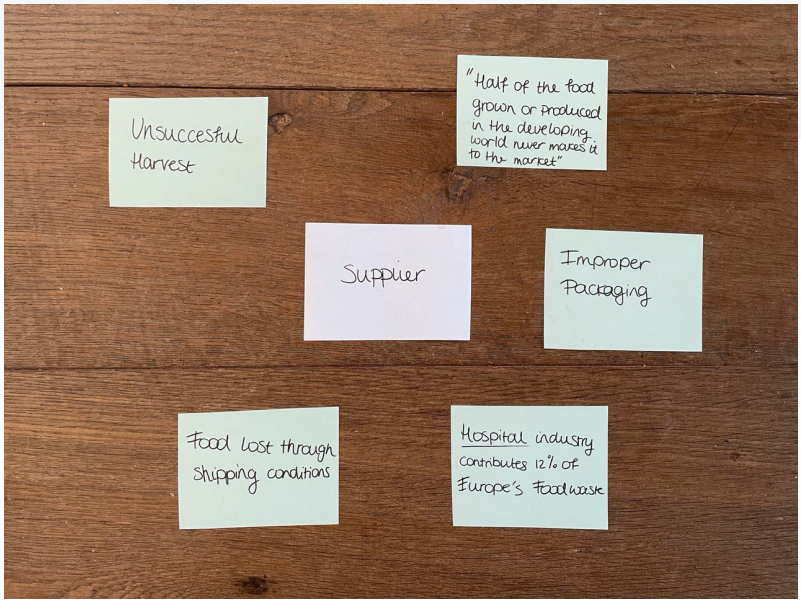



Figure A5. Supplier

# Appendix B Sketching

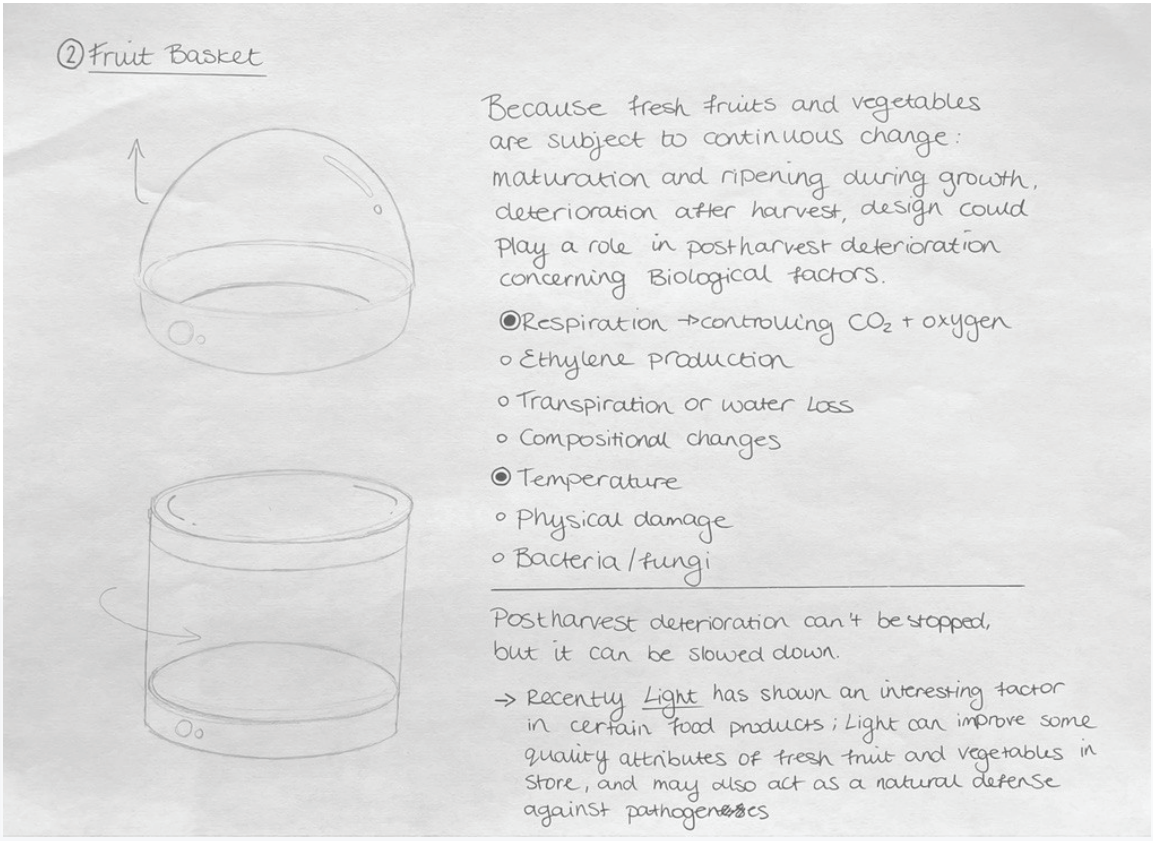



Figure B1. Sketch controlling fruit & vegetable deterioration

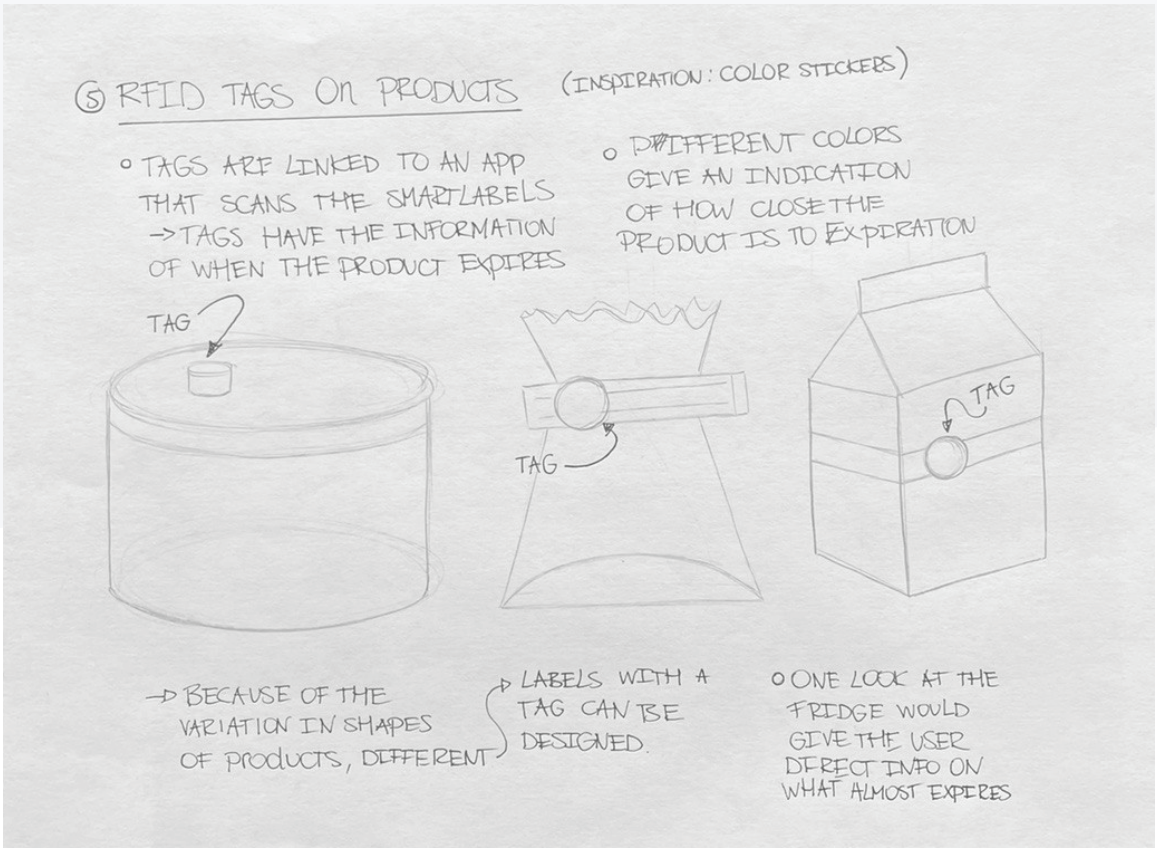



Figure B2. Sketch RFID tags on products

# Appendix B Sketching

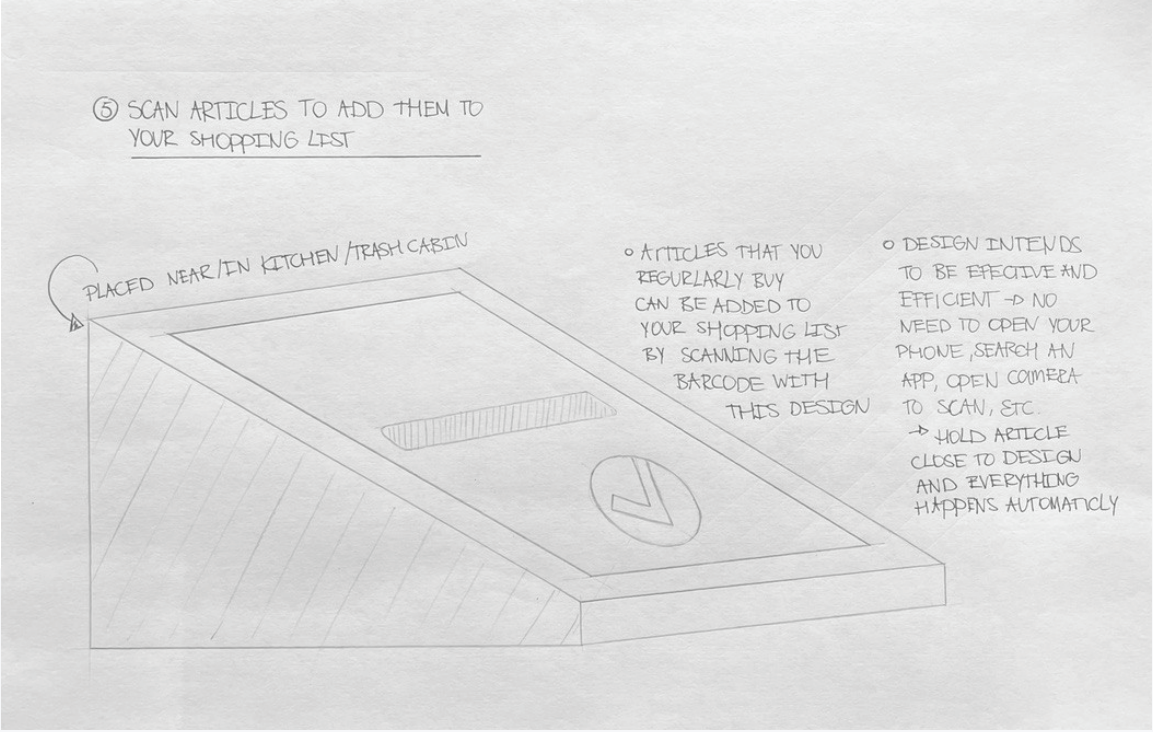



Figure B3. Scan efficiently

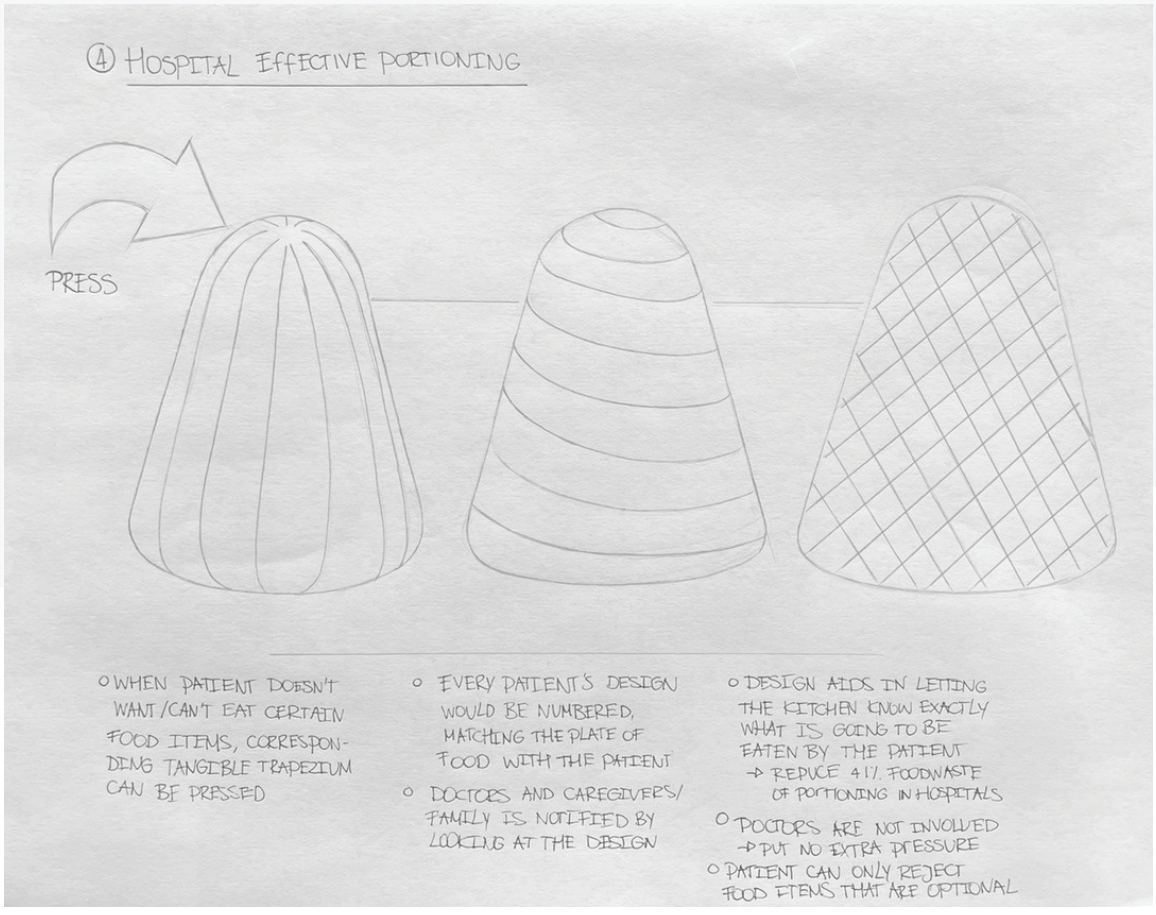



Figure B4. Sketch hospital foodwaste portioning iteration

# Appendix B Sketching

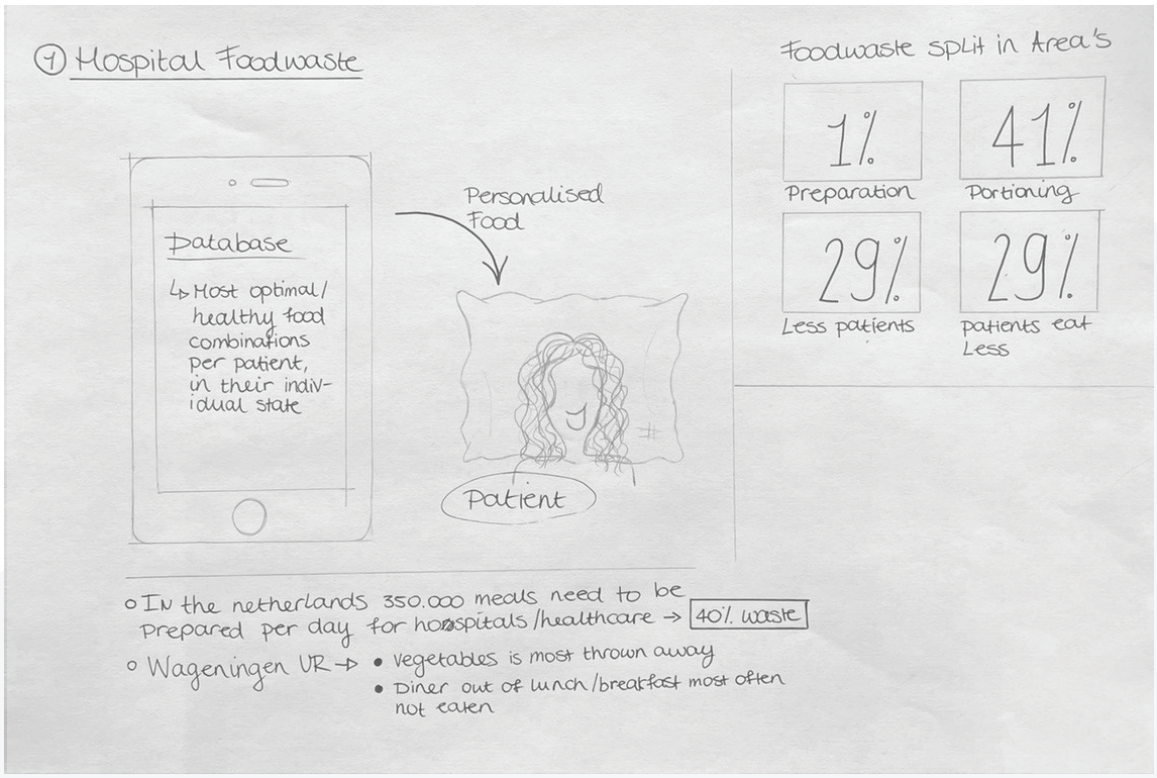



Figure B5. Hospital foodwaste

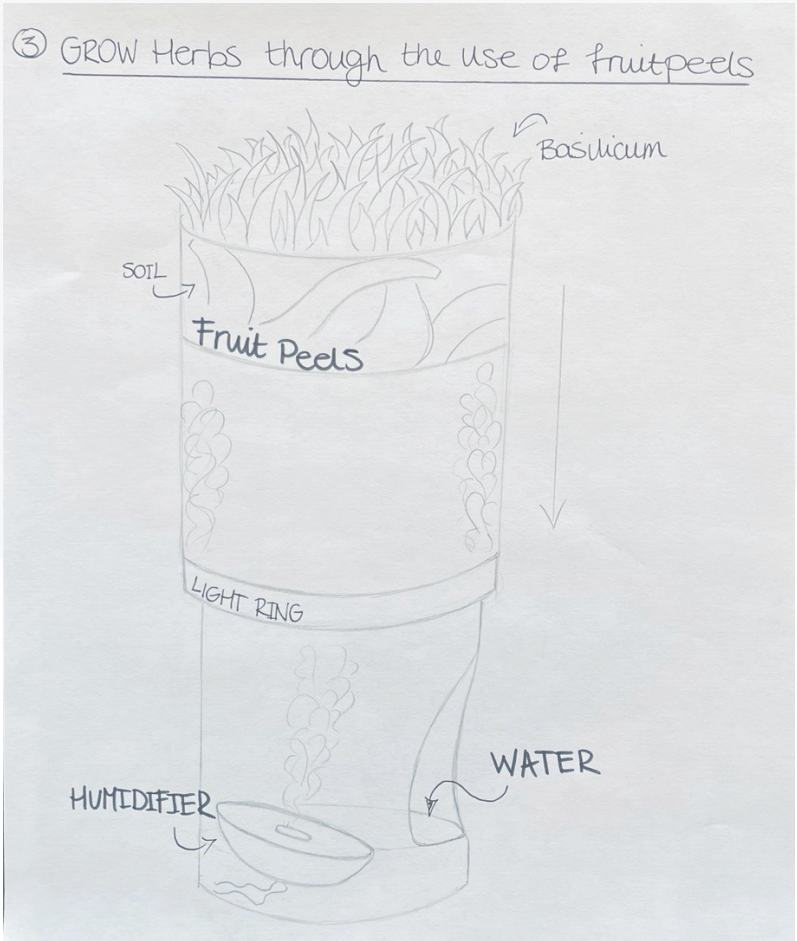



Figure B7. Sketch growing herbs out of remains

# Appendix B Sketching

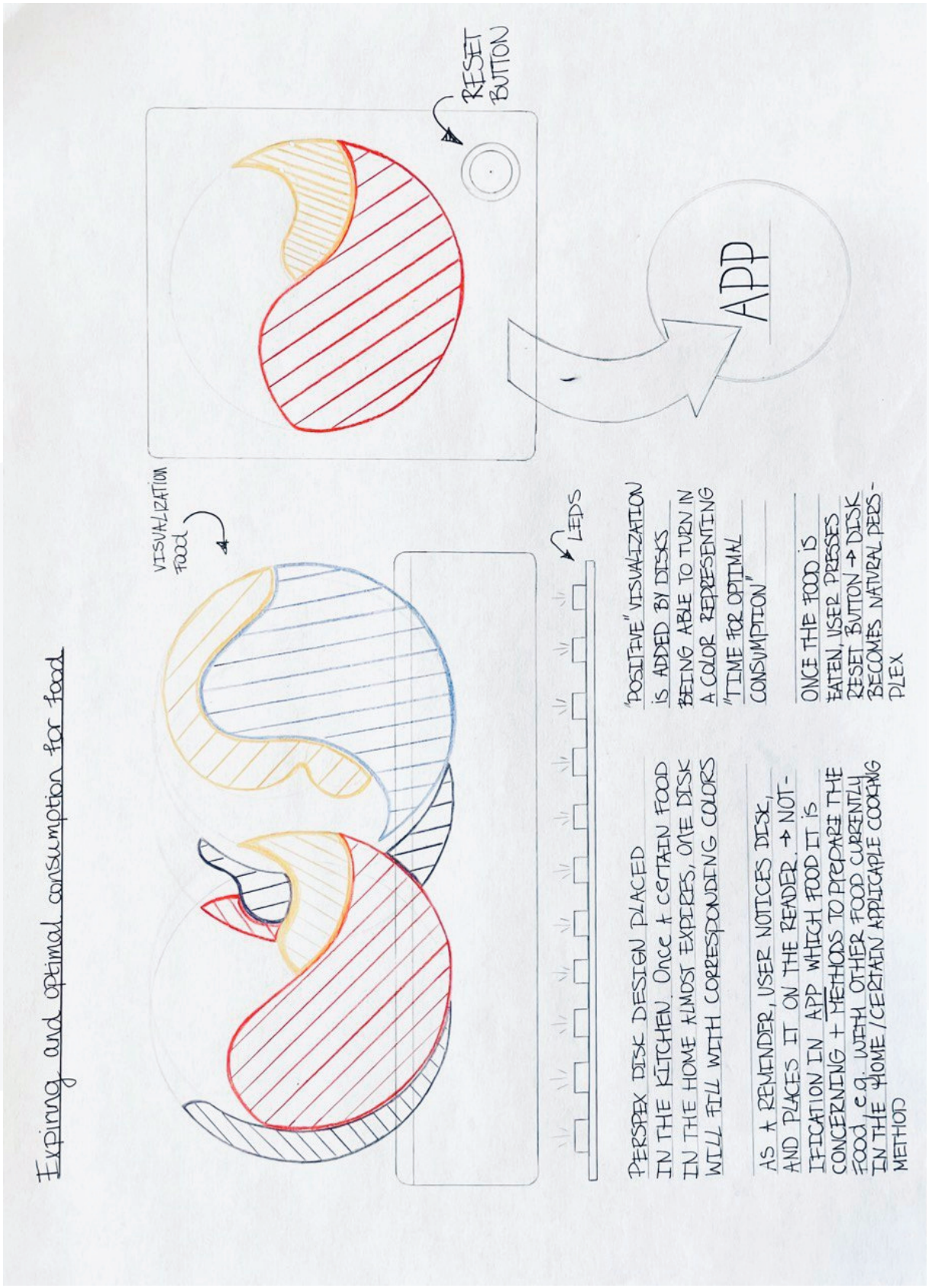



Figure B7. Sketch Expiring and optimal consumption for food

# Appendix C Online research survey

* The colors of the boxplot **do not** correspond to the colors of the color scheme. The *names* in the vertical list **do** correspond with the *colors* in displayed in Figure C1.


Figure C1. Color scheme

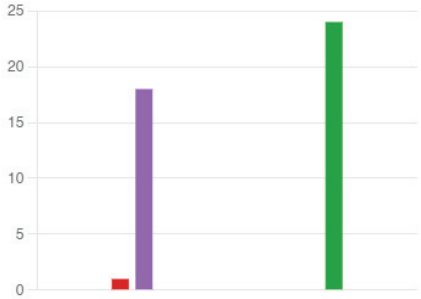
2. Which of the following colors do you believe best portrays the following Fruit? (0 punt)

PEACH

- Respond to the question using your own interpretation when solely thinking of the fruit
- Choose **one** or **two** colors from the scheme

Meer details

| | |
|---|---|
| 1. White | 0 |
| 2. Mava | 0 |
| 3. Iris | 0 |
| 4. Imperial | 1 |
| 5. Amber | 18 |
| 6. Mellow | 0 |
| 7. Emerald | 0 |
| 8. Sage | 0 |
| 9. Brown | 0 |
| 10. Space | 0 |
| 11. Mauve | 0 |
| 12. Carmine | 0 |
| 13. Coral | 24 |
| 14. Bumblebee | 0 |
| 15. Paisly | 0 |
| 16. Fern | 0 |



# Appendix C Online research survey

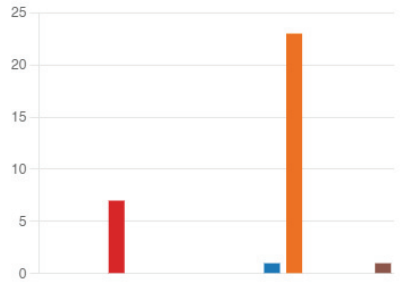
3. Which of the following colors do you believe best portrays the following Fruit? (0 punt)

CHERRY

- Respond to the question using your own interpretation when solely thinking of the fruit
- Choose **one** or **two** colors from the scheme

Meer details

| | |
|---|---|
| 1. White | 0 |
| 2. Mava | 0 |
| 3. Iris | 0 |
| 4. Imperial | 7 |
| 5. Amber | 0 |
| 6. Mellow | 0 |
| 7. Emerald | 0 |
| 8. Sage | 0 |
| 9. Brown | 0 |
| 10. Space | 0 |
| 11. Mauve | 1 |
| 12. Carmine | 23 |
| 13. Coral | 0 |
| 14. Bumblebee | 0 |
| 15. Paisly | 0 |
| 16. Fern | 1 |



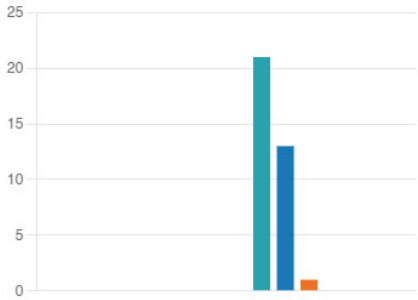

4. Which of the following colors do you believe best portrays the following Fruit? (0 punt) )

BLUEBERRY

- Respond to the question using your own interpretation when solely thinking of the fruit
- Choose **one** or **two** colors from the scheme

Meer details

| | |
|---|---|
| 1. White | 0 |
| 2. Mava | 0 |
| 3. Iris | 0 |
| 4. Imperial | 0 |
| 5. Amber | 0 |
| 6. Mellow | 0 |
| 7. Emerald | 0 |
| 8. Sage | 0 |
| 9. Brown | 0 |
| 10. Space | 21 |
| 11. Mauve | 13 |
| 12. Carmine | 1 |
| 13. Coral | 0 |
| 14. Bumblebee | 0 |
| 15. Paisly | 0 |
| 16. Fern | 0 |



# Appendix C Online research survey

unt)

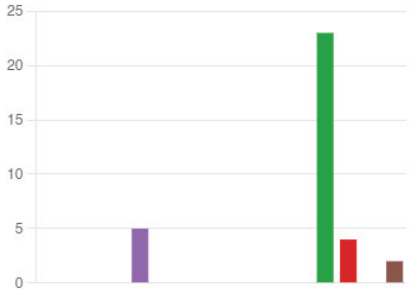
5. Which of the following colors do you believe best portrays the following Fruit? (0 punt)

ORANGE

- Respond to the question using your own interpretation when solely thinking of the fruit
- Choose **one** or **two** colors from the scheme

Meer details

| | |
|---|---|
| 1. White | 0 |
| 2. Mava | 0 |
| 3. Iris | 0 |
| 4. Imperial | 0 |
| 5. Amber | 5 |
| 6. Mellow | 0 |
| 7. Emerald | 0 |
| 8. Sage | 0 |
| 9. Brown | 0 |
| 10. Space | 0 |
| 11. Mauve | 0 |
| 12. Carmine | 0 |
| 13. Coral | 23 |
| 14. Bumblebee | 4 |
| 15. Paisly | 0 |
| 16. Fern | 2 |



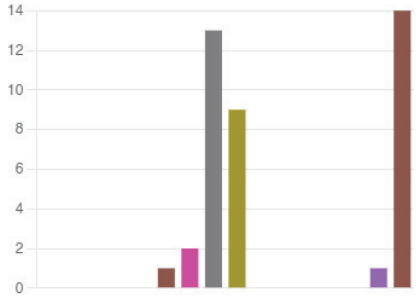

6. Which of the following colors do you believe best portrays the following Fruit? (0 punt)

KIWI

- Respond to the question using your own interpretation when solely thinking of the fruit
- Choose **one** or **two** colors from the scheme

Meer details

| | |
|---|---|
| 1. White | 0 |
| 2. Mava | 0 |
| 3. Iris | 0 |
| 4. Imperial | 0 |
| 5. Amber | 0 |
| 6. Mellow | 1 |
| 7. Emerald | 2 |
| 8. Sage | 13 |
| 9. Brown | 9 |
| 10. Space | 0 |
| 11. Mauve | 0 |
| 12. Carmine | 0 |
| 13. Coral | 0 |
| 14. Bumblebee | 0 |
| 15. Paisly | 1 |
| 16. Fern | 14 |



# Appendix C Online research survey

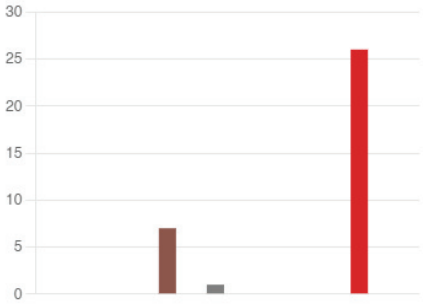
7. Which of the following colors do you believe best portrays the following Fruit? (0 punt)

BANANA

- Respond to the question using your own interpretation when solely thinking of the fruit
- Choose **one** or **two** colors from the scheme

Meer details

| | |
|---|---|
| 1. White | 0 |
| 2. Mava | 0 |
| 3. Iris | 0 |
| 4. Imperial | 0 |
| 5. Amber | 0 |
| 6. Mellow | 7 |
| 7. Emerald | 0 |
| 8. Sage | 1 |
| 9. Brown | 0 |
| 10. Space | 0 |
| 11. Mauve | 0 |
| 12. Carmine | 0 |
| 13. Coral | 0 |
| 14. Bumblebee | 26 |
| 15. Paisly | 0 |
| 16. Fern | 0 |



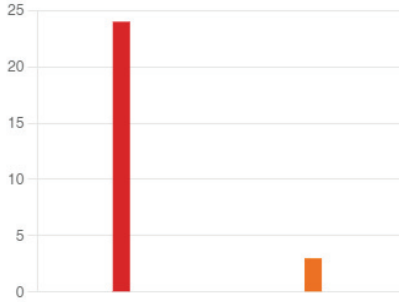

8. Which of the following colors do you believe best portrays the following Fruit? (0 punt)

STRAWBERRY

- Respond to the question using your own interpretation when solely thinking of the fruit
- Choose **one** or **two** colors from the scheme

Meer details

| | |
|---|---|
| 1. White | 0 |
| 2. Mava | 0 |
| 3. Iris | 0 |
| 4. Imperial | 24 |
| 5. Amber | 0 |
| 6. Mellow | 0 |
| 7. Emerald | 0 |
| 8. Sage | 0 |
| 9. Brown | 0 |
| 10. Space | 0 |
| 11. Mauve | 0 |
| 12. Carmine | 3 |
| 13. Coral | 0 |
| 14. Bumblebee | 0 |
| 15. Paisly | 0 |
| 16. Fern | 0 |



# Appendix C Online research survey

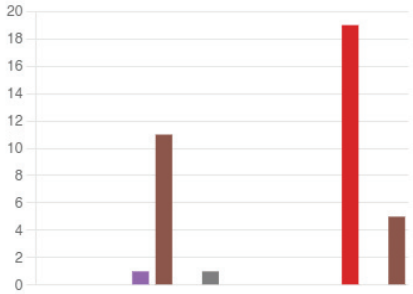
9. Which of the following colors do you believe best portrays the following Fruit? (0 punt)

PINEAPPLE

- Respond to the question using your own interpretation when solely thinking of the fruit
- Choose **one** or **two** colors from the scheme

Meer details

| | |
|---|---|
| 1. White | 0 |
| 2. Mava | 0 |
| 3. Iris | 0 |
| 4. Imperial | 0 |
| 5. Amber | 1 |
| 6. Mellow | 11 |
| 7. Emerald | 0 |
| 8. Sage | 1 |
| 9. Brown | 0 |
| 10. Space | 0 |
| 11. Mauve | 0 |
| 12. Carmine | 0 |
| 13. Coral | 0 |
| 14. Bumblebee | 19 |
| 15. Paisly | 0 |
| 16. Fern | 5 |



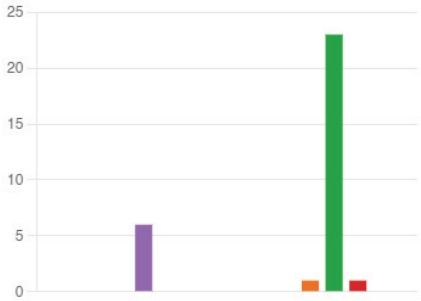

10. Which of the following colors do you believe best portrays the following Fruit? (0 punt)

TANGERINE

- Respond to the question using your own interpretation when solely thinking of the fruit
- Choose **one** or **two** colors from the scheme

Meer details

| | |
|---|---|
| 1. White | 0 |
| 2. Mava | 0 |
| 3. Iris | 0 |
| 4. Imperial | 0 |
| 5. Amber | 6 |
| 6. Mellow | 0 |
| 7. Emerald | 0 |
| 8. Sage | 0 |
| 9. Brown | 0 |
| 10. Space | 0 |
| 11. Mauve | 0 |
| 12. Carmine | 1 |
| 13. Coral | 23 |
| 14. Bumblebee | 1 |
| 15. Paisly | 0 |
| 16. Fern | 0 |



# Appendix C Online research survey

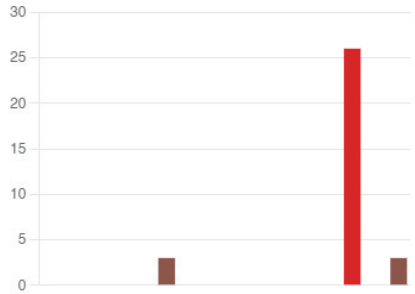
11. Which of the following colors do you believe best portrays the following Fruit? (0 punt)

LEMON

- Respond to the question using your own interpretation when solely thinking of the fruit
- Choose **one** or **two** colors from the scheme

Meer details

| | |
|---|---|
| 1. White | 0 |
| 2. Mava | 0 |
| 3. Iris | 0 |
| 4. Imperial | 0 |
| 5. Amber | 0 |
| 6. Mellow | 3 |
| 7. Emerald | 0 |
| 8. Sage | 0 |
| 9. Brown | 0 |
| 10. Space | 0 |
| 11. Mauve | 0 |
| 12. Carmine | 0 |
| 13. Coral | 0 |
| 14. Bumblebee | 26 |
| 15. Paisly | 0 |
| 16. Fern | 3 |



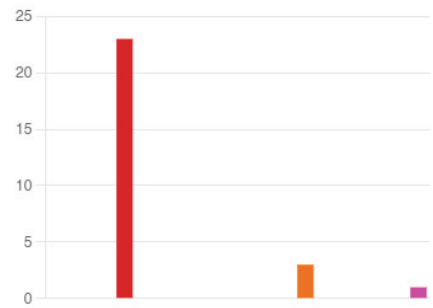

12. Which of the following colors do you believe best portrays the following Fruit? (0 punt)

RASPBERRY

- Respond to the question using your own interpretation when solely thinking of the fruit
- Choose **one** or **two** colors from the scheme

Meer details

| | |
|---|---|
| 1. White | 0 |
| 2. Mava | 0 |
| 3. Iris | 0 |
| 4. Imperial | 23 |
| 5. Amber | 0 |
| 6. Mellow | 0 |
| 7. Emerald | 0 |
| 8. Sage | 0 |
| 9. Brown | 0 |
| 10. Space | 0 |
| 11. Mauve | 0 |
| 12. Carmine | 3 |
| 13. Coral | 0 |
| 14. Bumblebee | 0 |
| 15. Paisly | 0 |
| 16. Fern | 0 |
| Andere | 1 |



# Appendix C Online research survey

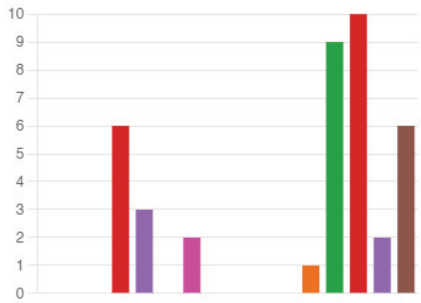
13. Which of the following colors do you believe best portrays the following Fruit? (0 punt)

MANGO

- Respond to the question using your own interpretation when solely thinking of the fruit
- Choose **one** or **two** colors from the scheme

Meer details

| | |
|---|---|
| 1. White | 0 |
| 2. Mava | 0 |
| 3. Iris | 0 |
| 4. Imperial | 6 |
| 5. Amber | 3 |
| 6. Mellow | 0 |
| 7. Emerald | 2 |
| 8. Sage | 0 |
| 9. Brown | 0 |
| 10. Space | 0 |
| 11. Mauve | 0 |
| 12. Carmine | 1 |
| 13. Coral | 9 |
| 14. Bumblebee | 10 |
| 15. Paisly | 2 |
| 16. Fern | 6 |



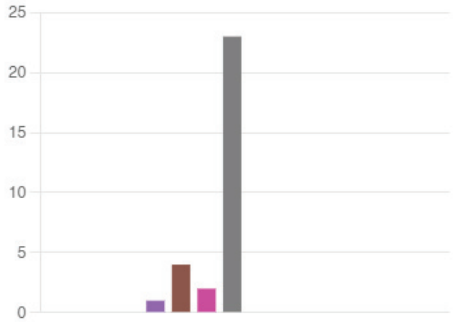

14. Which of the following colors do you believe best portrays the following Fruit? (0 punt)

GRAPES (WHITE)

- Respond to the question using your own interpretation when solely thinking of the fruit
- Choose **one** or **two** colors from the scheme

Meer details

| | |
|---|---|
| 1. White | 0 |
| 2. Mava | 0 |
| 3. Iris | 0 |
| 4. Imperial | 0 |
| 5. Amber | 1 |
| 6. Mellow | 4 |
| 7. Emerald | 2 |
| 8. Sage | 23 |
| 9. Brown | 0 |
| 10. Space | 0 |
| 11. Mauve | 0 |
| 12. Carmine | 0 |
| 13. Coral | 0 |
| 14. Bumblebee | 0 |
| 15. Paisly | 0 |
| 16. Fern | 0 |



# Appendix C Online research survey

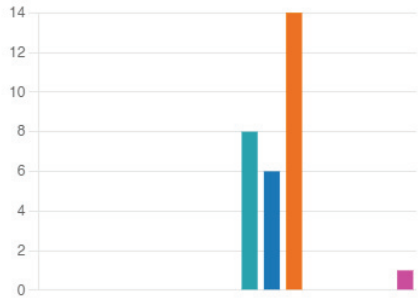
15. Which of the following colors do you believe best portrays the following Fruit? (0 punt)

GRAPES (DARK)

- Respond to the question using your own interpretation when solely thinking of the fruit
- Choose **one** or **two** colors from the scheme

Meer details

| | |
|---|---|
| 1. White | 0 |
| 2. Mava | 0 |
| 3. Iris | 0 |
| 4. Imperial | 0 |
| 5. Amber | 0 |
| 6. Mellow | 0 |
| 7. Emerald | 0 |
| 8. Sage | 0 |
| 9. Brown | 0 |
| 10. Space | 8 |
| 11. Mauve | 6 |
| 12. Carmine | 14 |
| 13. Coral | 0 |
| 14. Bumblebee | 0 |
| 15. Paisly | 0 |
| 16. Fern | 0 |
| Andere | 1 |



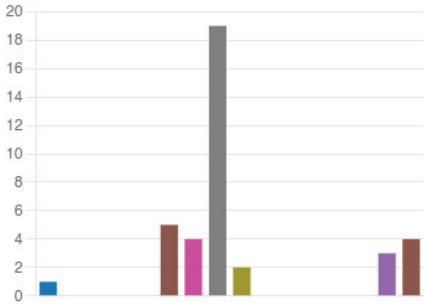

16. Which of the following colors do you believe best portrays the following Fruit? (0 punt)

PEAR

- Respond to the question using your own interpretation when solely thinking of the fruit
- Choose **one** or **two** colors from the scheme

Meer details

| | |
|---|---|
| 1. White | 1 |
| 2. Mava | 0 |
| 3. Iris | 0 |
| 4. Imperial | 0 |
| 5. Amber | 0 |
| 6. Mellow | 5 |
| 7. Emerald | 4 |
| 8. Sage | 19 |
| 9. Brown | 2 |
| 10. Space | 0 |
| 11. Mauve | 0 |
| 12. Carmine | 0 |
| 13. Coral | 0 |
| 14. Bumblebee | 0 |
| 15. Paisly | 3 |
| 16. Fern | 4 |



# Appendix C Online research survey

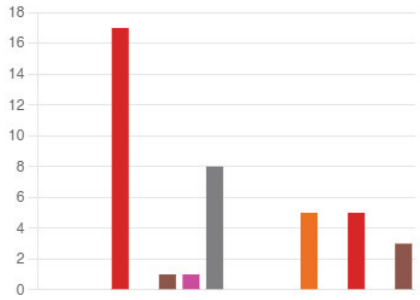
17. Which of the following colors do you believe best portrays the following Fruit? (0 punt)

APPLE

- Respond to the question using your own interpretation when solely thinking of the fruit
- Choose **one** or **two** colors from the scheme

Meer details

| | |
|---|---|
| 1. White | 0 |
| 2. Mava | 0 |
| 3. Iris | 0 |
| 4. Imperial | 17 |
| 5. Amber | 0 |
| 6. Mellow | 1 |
| 7. Emerald | 1 |
| 8. Sage | 8 |
| 9. Brown | 0 |
| 10. Space | 0 |
| 11. Mauve | 0 |
| 12. Carmine | 5 |
| 13. Coral | 0 |
| 14. Bumblebee | 5 |
| 15. Paisly | 0 |
| 16. Fern | 3 |



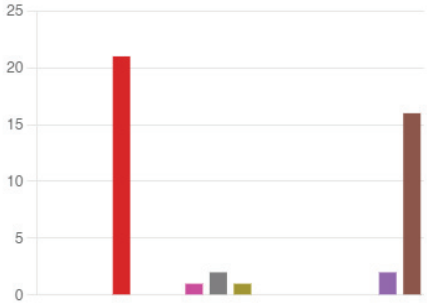

18. Which of the following colors do you believe best portrays the following Fruit? (0 punt)

WATERMELON

- Respond to the question using your own interpretation when solely thinking of the fruit
- Choose **one** or **two** colors from the scheme

Meer details

| | |
|---|---|
| 1. White | 0 |
| 2. Mava | 0 |
| 3. Iris | 0 |
| 4. Imperial | 21 |
| 5. Amber | 0 |
| 6. Mellow | 0 |
| 7. Emerald | 1 |
| 8. Sage | 2 |
| 9. Brown | 1 |
| 10. Space | 0 |
| 11. Mauve | 0 |
| 12. Carmine | 0 |
| 13. Coral | 0 |
| 14. Bumblebee | 0 |
| 15. Paisly | 2 |
| 16. Fern | 16 |



# Appendix C Online research survey

19. Which of the following colors do you believe best portrays the following Fruit? (0 punt)

PLUM

- Respond to the question using your own interpretation when solely thinking of the fruit
- Choose **one** or **two** colors from the scheme

Meer details

| | |
|---|---|
| 1. White | 0 |
| 2. Mava | 0 |
| 3. Iris | 0 |
| 4. Imperial | 1 |
| 5. Amber | 0 |
| 6. Mellow | 1 |
| 7. Emerald | 0 |
| 8. Sage | 0 |
| 9. Brown | 0 |
| 10. Space | 14 |
| 11. Mauve | 7 |
| 12. Carmine | 7 |
| 13. Coral | 4 |
| 14. Bumblebee | 0 |
| 15. Paisly | 0 |
| 16. Fern | 0 |

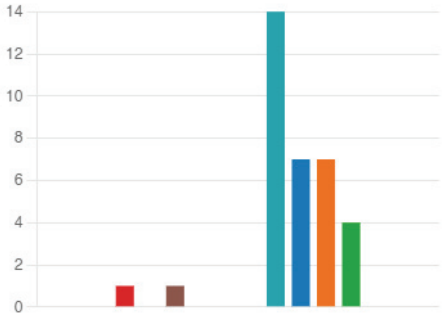




Figure C1. Color scheme (Repeat)

# Appendix D Consent form

## Final Bachelor Project - Color and Fruit assosciation

○ 5 min.
○ Voluntary participation
○ You may participate in the survey if you don't suffer from any form of color-blindness and live longer then 5 years in the Netherlands

Hi! My name is Susan, and currently I'm working on my Final Bachelor Project at the TU/e. In this project, I am focussing on the ecological issue of foodwaste in relation to human behaviour. Including in the research of my project, I looked into how people unconsciously connect various types of fruits with particular colors. This short survey is intended to measure just which fruit people think of when seeing a combination, or a single color visualized.

There are 19 multiple-choice questions regarding the colors that in your opinion best reflect various fruit products. If a color you'd like to choose isn't in the color scheme, please choose the color that comes closest to what you had in mind. Due to the ability to distinguish significantly between colors, a limited number is available for selection.

This form is fully anonymous, and thus no personal data will be collected. Also no information that can be used to personally identify you will be shared with others. You can stop your participation at any time during the study, this will have no consequences whatsoever. All research conducted at the Eindhoven University of Technology adheres to The Netherlands Code of Conduct for Research Integrity and the Code of Scientific Conduct.

If you want more information about this study, the study design, or the results, you can contact [Susan Draaijer], contact email: [s.h.m.l.draaijer@student.tue.nl]. If you have any complaints about this study, please contact the supervisor, [Daisy Yoo] contact email: [d.yoo@tue.nl]. You can report irregularities related to scientific integrity to confidential advisors of the TU/e.

Thank you in Advance!

Figure D1. Conent form + explenation experiment

1. I consent the data I voluntary and anonymously provide by filling out this form will be used by the researcher. I understand I can exit the survey at any time, without submitting my answers (0 punt)

Meer details

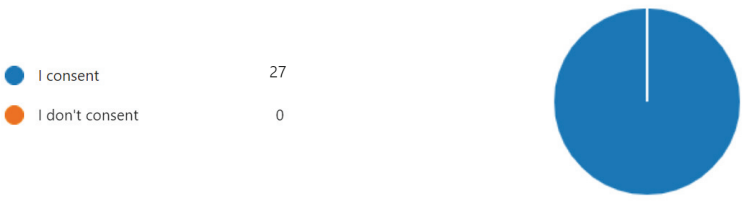



Figure D2. Given consent (anonymous)

2. I do not suffer from any form of colorblindness and live longer than 5 years in the Netherlands (0 punt)

Meer details

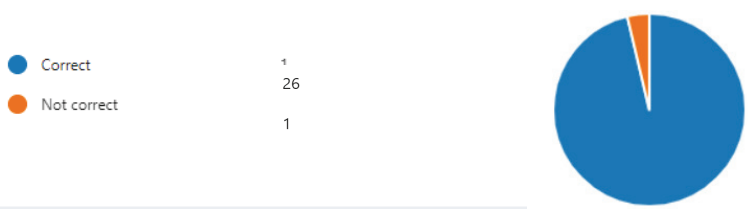



Figure D3. Colorblindness, 26 Useful answers

# Appendix E Arduino code

```
#include <Adafruit_NeoPixel.h>

const uint16_t PixelCount = 52;
const uint8_t  PixelPin = 5;                                                    // GPIO3 = D5 for the D1 mini (esp8266)
int which_led, color=1;

#define colorSaturation 225

Adafruit_NeoPixel strip(PixelCount, PixelPin, NEO_GRB + NEO_KHZ800);
const boolean serial_active = false;
const uint8_t c_MinBrightness = 8;
const uint8_t c_MaxBrightness = 255;
int gap[4][13] = {{ 0, 1, 2, 3, 4, 5, 6, 7, 8, 9,10,11,12},                     // gap 0..3 represent 4 gaps, every gap has 13 leds
                  {25,24,23,22,21,20,19,18,17,16,15,14,13},
                  {26,27,28,29,30,31,32,33,34,35,36,37,38},
                  {51,50,49,48,47,46,45,44,43,42,41,40,39}};

int i,j,t;

void setup()
{
  if (serial_active)
  {
    Serial.begin(115200);
    while (!Serial);                                                            // wait for serial attach

    Serial.println();
    Serial.println("Initializing...");
    Serial.flush();
    Serial.println();
    Serial.println("Running...");
  }

  strip.begin();
  for (i=0; i<13; i++)                                                  // all off
    for (j=0; j<4; j++)                                                  // all off
      strip.setPixelColor(gap[j][i], (0,0,0));
  strip.show();
  delay(1000);

}
void loop()
{
  for (t=0; t<100; t++)                                                         // 1st strip glows up (light yellow)BANANA
  {
    for (i=13; i<=13; i++) strip.setPixelColor(gap[0][i-1], dim(221,254,49,t*255/100));
    strip.show();
    delay(10);
  }

   delay(2000);

  for (t=0; t<100; t++)                                                         // 1st strip glows up (yellow, light yellow)BANANA
  {
    for (i=12; i<=12; i++) strip.setPixelColor(gap[0][i-1], dim(150,150,20,t*255/100));
    strip.show();
    delay(10);
  }

   delay(2000);

   for (t=0; t<100; t++)                                                        // 1st strip glows up (yellow, light yellow)BANANA
  {
    for (i=11; i<=11; i++) strip.setPixelColor(gap[0][i-1], dim(150,150,20,t*255/100));
    strip.show();
    delay(10);
  }

  delay(2000);

   for (t=0; t<100; t++)                                                        // 1st strip glows up (yellow, light yellow)BANANA
  {
    for (i=10; i<=10; i++) strip.setPixelColor(gap[0][i-1], dim(150,150,20,t*255/100));
    strip.show();
    delay(10);
  }

  delay(2000);
```

# Appendix E Arduino code

```
for (t=0; t<100; t++)                                                    // 1st strip glows up (yellow, light yellow)BANANA
{
  for (i=9; i<=9; i++) strip.setPixelColor(gap[0][i-1], dim(150,150,20,t*255/100));
  strip.show();
  delay(10);
}

delay(2000);

for (t=0; t<100; t++)                                                    // 1st strip glows up (yellow, light yellow)BANANA
{
  for (i=8; i<=8; i++) strip.setPixelColor(gap[0][i-1], dim(150,150,20,t*255/100));
  strip.show();
  delay(10);
}

delay(2000);

 for (t=0; t<100; t++)                                                   // 1st strip glows up (yellow, light yellow)BANANA
{
  for (i=7; i<=7; i++) strip.setPixelColor(gap[0][i-1], dim(150,150,20,t*255/100));
  strip.show();
  delay(10);
      -
}

 delay(2000);

  for (t=0; t<100; t++)                                                  // 1st strip glows up (yellow, light yellow)BANANA
 {
   for (i=6; i<=6; i++) strip.setPixelColor(gap[0][i-1], dim(150,150,20,t*255/100));
   strip.show();
   delay(10);
 }

 delay(2000);

  for (t=0; t<100; t++)                                                  // 2nd strip glows up (red/orange)PEACH
 {
   for (i= 2; i<= 2; i++) strip.setPixelColor(gap[1][i-1], dim(255,23,0,t*255/100));
   for (i= 3; i<= 3; i++) strip.setPixelColor(gap[1][i-1], dim(255,94,5,t*255/100));
   strip.show();
   delay(10);
 }

 delay(4000);

  for (t=0; t<100; t++)                                                  // 2nd strip glows up (red/orange)PEACH
 {
   for (i= 4; i<= 4; i++) strip.setPixelColor(gap[1][i-1], dim(255,94,5,t*255/100));
   strip.show();
   delay(10);
 }

 delay(4000);

 for (t=0; t<100; t++)                                                   // 2nd strip glows up (red/orange)PEACH
{
  for (i= 3; i<= 3; i++) strip.setPixelColor(gap[1][i-1], dim(255,23,0,t*255/100));
  for (i= 5; i<= 5; i++) strip.setPixelColor(gap[1][i-1], dim(255,94,5,t*255/100));
  strip.show();
  delay(10);
}

delay(4000);

 for (t=0; t<100; t++)                                                   // 2nd strip glows up (red/orange)PEACH
{
  for (i= 6; i<= 6; i++) strip.setPixelColor(gap[1][i-1], dim(255,94,5,t*255/100));
  strip.show();
  delay(10);
}

delay(2500);

for (t=0; t<100; t++)                                                    // 2nd strip glows up (red/orange)PEACH
{
  for (i= 4; i<= 4; i++) strip.setPixelColor(gap[1][i-1], dim(255,23,0,t*255/100));
  strip.show();
  delay(10);
}
```

# Appendix E Arduino code

```
delay(4000);

 for (t=100; t>0; t--)                                                    // 1st strip glows down (yellow, light yellow)BANANA
{
  for (i= 6; i<=12; i++) strip.setPixelColor(gap[0][i-1], dim(150,150,20,t*255/100));
  for (i=13; i<=13; i++) strip.setPixelColor(gap[0][i-1], dim(221,254,49,t*255/100));
  strip.show();
  delay(10);
}

delay(2000);

for (t=0; t<100; t++)                                                     // 1st strip glows down (light green)GRAPES WHITE
{
  for (i= 9; i<=11; i++) strip.setPixelColor(gap[2][i-1], dim(180,255,0,t*255/100));
  strip.show();
  delay(10);
}

delay(8000);

for (t=100; t>0; t--)                                                     // 3rd strip glups down (red/orange)PEACH
{
  for (i= 2; i<= 4; i++) strip.setPixelColor(gap[1][i-1], dim(255,23,0,t*255/100));
  for (i= 5; i<= 6; i++) strip.setPixelColor(gap[1][i-1], dim(255,94,5,t*255/100));
  strip.show();
  delay(10);
}

delay(1000);

for (t=0; t<100; t++)                                                     // 1st strip glows up (red imperial) RASPBERRY
{
  for (i= 1; i<= 1; i++) strip.setPixelColor(gap[0][i-1], dim(50,6,6,t*255/100));
  for (i= 2; i<= 2; i++) strip.setPixelColor(gap[0][i-1], dim(50,6,6,t*255/100));
  strip.show();
  delay(10);
}

delay(8000);

for (t=0; t<100; t++)                                                     // 1st strip glows up (orange) TANGERINE
{
  for (i= 7; i<= 10; i++) strip.setPixelColor(gap[1][i-1], dim(255,94,5,t*255/100));
  strip.show();
  delay(10);
}

delay(8000);

for (t=100; t>0; t--)                                                     // 1st strip glows down (light green)GRAPES WHITE
{
  for (i= 9; i<=11; i++) strip.setPixelColor(gap[2][i-1], dim(180,255,0,t*255/100));
  strip.show();
  delay(10);
}

delay(8000);

for (t=0; t<100; t++)                                                     // 1st strip glows down (red, green)WATERMELON
{
  for (i= 1; i<= 5; i++) strip.setPixelColor(gap[3][i-1], dim(255,6,8,t*255/100));
  for (i= 6; i<= 7; i++) strip.setPixelColor(gap[3][i-1], dim(134,255,0,t*255/100));
  strip.show();
  delay(10);

 }

 delay(1000);

 for (t=100; t>0; t--)                                                    // 1st strip glows up (imperial red) RASPBERRY
 {
   for (i= 1; i<= 2; i++) strip.setPixelColor(gap[0][i-1], dim(50,6,6,t*255/100));
   for (i= 7; i<= 10; i++) strip.setPixelColor(gap[1][i-1], dim(255,94,5,t*255/100));
   strip.show();
   delay(10);
 }

 delay(6000);
```

# Appendix E Arduino code

```
   for (t=0; t<100; t++)                                                    // 2nd strip glows up (light green, mellow)PEAR
   {
     for (i= 2; i<= 4; i++) strip.setPixelColor(gap[1][i-1], dim(134,255,0,t*255/100));
     for (i= 5; i<=6; i++) strip.setPixelColor(gap[1][i-1], dim(221,254,49,t*255/100));
     strip.show();
     delay(10);
   }

   delay(5000);

    for (t=100; t>0; t--)                                                    // 1st strip glows down (red, green)WATERMELON
   {
     for (i= 1; i<= 5; i++) strip.setPixelColor(gap[3][i-1], dim(255,6,8,t*255/100));
     for (i= 6; i<= 7; i++) strip.setPixelColor(gap[3][i-1], dim(134,255,0,t*255/100));
     strip.show();
     delay(10);
   }

   delay(4000);

   for (t=0; t<100; t++)                                                    // 1st strip glows up (purple,blue) BLUEBERRY
  {
    for (i= 1; i<= 1; i++) strip.setPixelColor(gap[0][i-1], dim(14,0,37,t*155/100));
    for (i= 2; i<= 2; i++) strip.setPixelColor(gap[0][i-1], dim(21,22,37,t*255/100));
    strip.show();
    delay(10);
  }

  delay(4000);

  for (t=100; t>0; t--)                                                     // 2nd strip glows down (light green, mellow)PEAR
  {
    for (i= 2; i<= 4; i++) strip.setPixelColor(gap[1][i-1], dim(134,255,0,t*255/100));
    for (i= 5; i<=6; i++) strip.setPixelColor(gap[1][i-1], dim(221,254,49,t*255/100));
    strip.show();
    delay(10);
  }

  delay(4000);

  for (t=0; t<100; t++)                                                     // 1st strip glows up (green,yellow) PINNEAPLE
  {
    for (i= 9; i<= 9; i++) strip.setPixelColor(gap[3][i-1], dim(90,200,0,t*255/100));
    for (i= 10; i<= 13; i++) strip.setPixelColor(gap[3][i-1], dim(255,255,0,t*255/100));
    strip.show();
    delay(10);
  }

  delay(5000);

   for (t=100; t>0; t--)                                                    // 1st strip glows up (purple,blue) BlUEBERRY
  {
    for (i= 1; i<= 1; i++) strip.setPixelColor(gap[0][i-1], dim(14,0,37,t*155/100));
    for (i= 2; i<= 2; i++) strip.setPixelColor(gap[0][i-1], dim(21,22,37,t*255/100));
    strip.show();
    delay(10);
  }

   for (t=100; t>0; t--)                                                    // 1st strip glows up (green,yellow) PINNEAPLE
  {
    for (i= 9; i<= 9; i++) strip.setPixelColor(gap[3][i-1], dim(90,200,0,t*255/100));
    for (i= 10; i<= 13; i++) strip.setPixelColor(gap[3][i-1], dim(255,255,0,t*255/100));
    strip.show();
    delay(10);
  }



  delay(3500);
}

uint32_t dim(short r, short g, short b, short d)  // red[0-255] green[0-255] blue[0-255], dimlevel[0-255]
{
   r = short(d*r/255);
   g = short(d*g/255);
   b = short(d*b/255);
   uint32_t a=0;
   a = a + r << 8;
   a = a + g << 8;
   a = a + b;
   return a;
}
```

# Appendix F Demoday Posters


Figure F1. Main poster

# Appendix F Demoday Posters

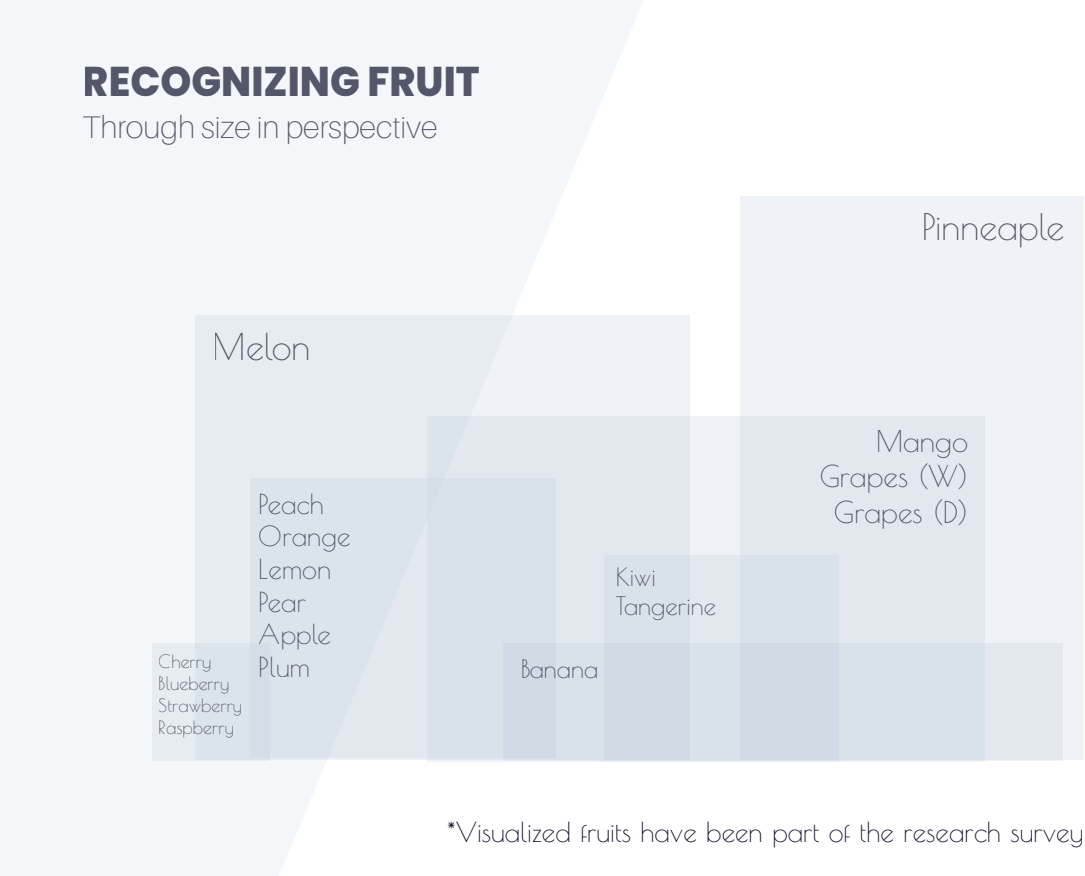



Figure F2. Small poster 'Recognizing fruit through size in perspective'

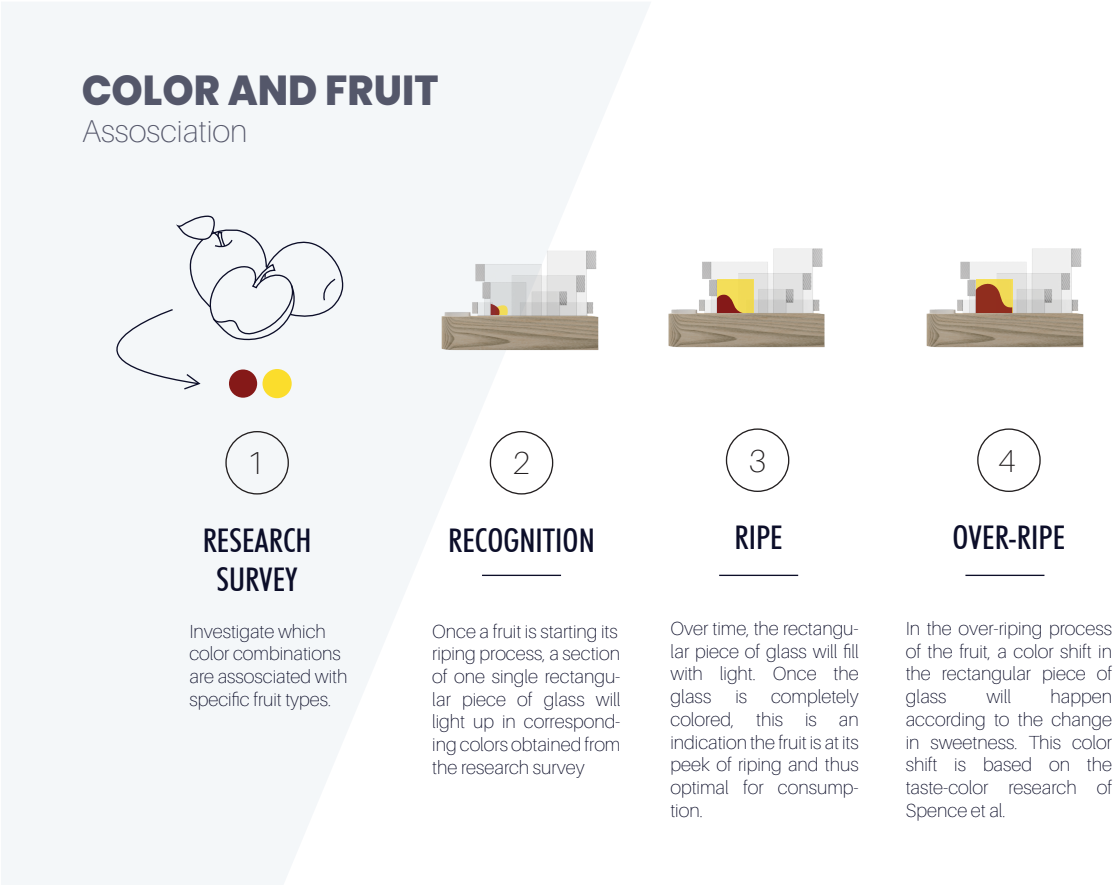



Figure F3. Small poster 'Color and fruit assosciation'

# Appendix G Additional figures

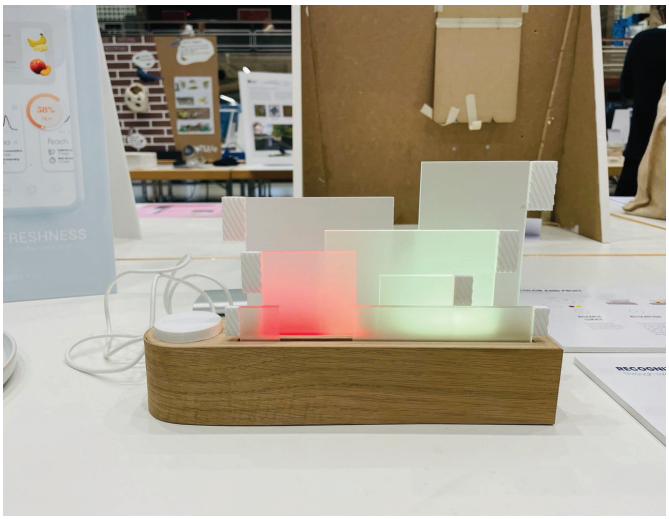


Figure G1. Demoday set-up, (peach + grapes white)


Figure G2. Lo-fi prototype components


Figure G3. Top, middle and ground base clean wood look

Figure G4. Sanding top base

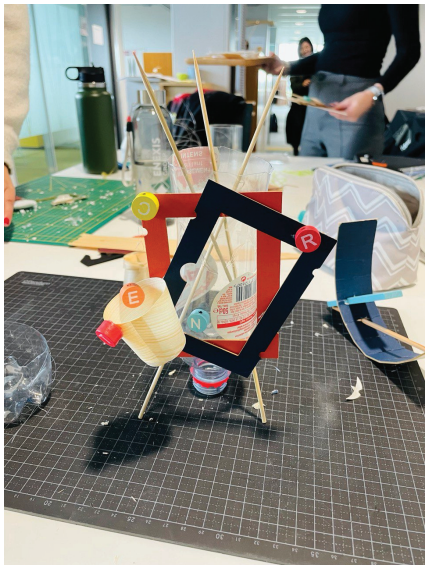


Figure G5. Workshop, foodwaste inspiration

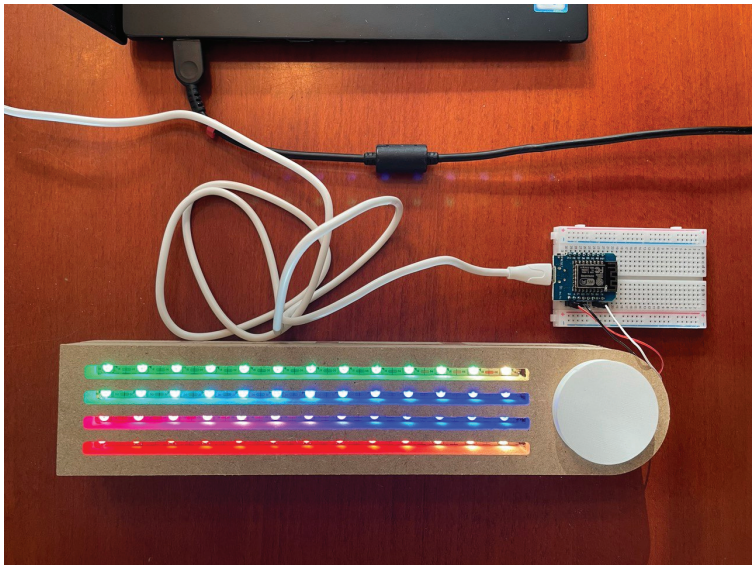


Figure G6. First test LED lights rainbow colors

# Appendix G Additional figures

Figure G7. Rehearsal demoday top view

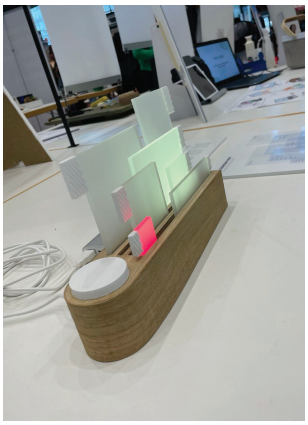


Figure G8. Raspberry + grape

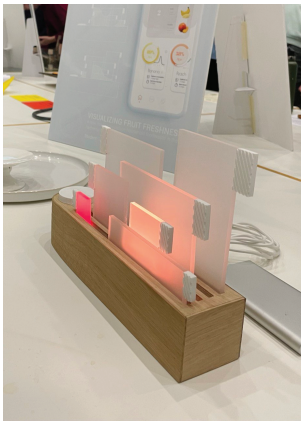


Figure G9. Tangerine + rb

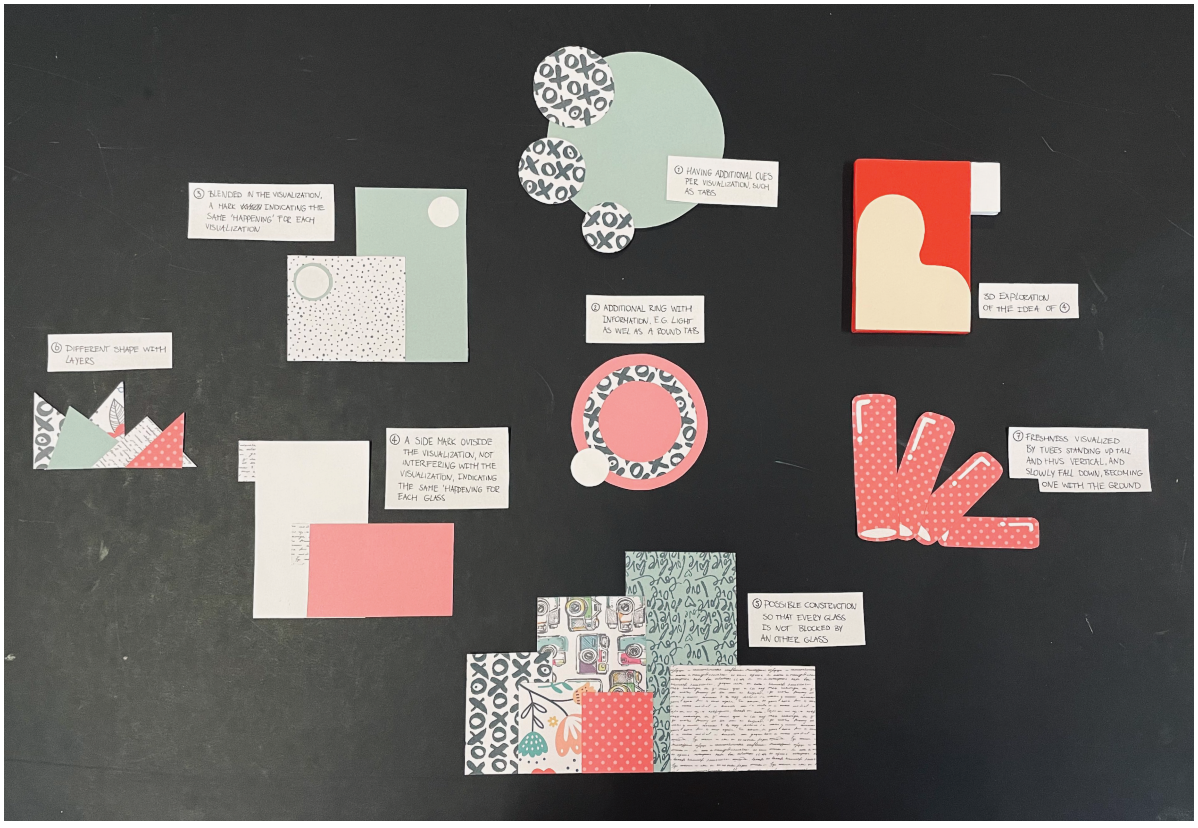



Figure G10. Enlarged figure exploratory prototyping

Figure G11. Printing Poster

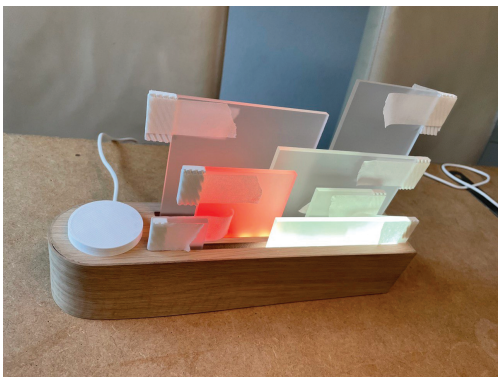


Figure G12. Attaching tabs (peach + banana)


Figure G13. Gluing tabs