DESIGN PROCESS JOURNAL

legibilis

Luxi Chen
MSc Product Design Engineering
15/08/2022

Design tutor: Stuart Bailey

PROBLEM

Background

There's a significant amount of people with visual impairments due to both diseases and age effect. Based on the research data, more than 2 million people in the UK are living with sight loss that brings impacts to their day-to-day life. Among this huge group of people, approximately 360,000 are registered with their local authority as sight impaired or severely sight impaired, which means they have severe and irreversible sight loss.

During the sudden lock-down took place in Shanghai months before, which was caused by COVID pandemic, numbers of cases was reported for unwarranted living quality of the visual impairments when outside assistance being mainly, even completely cut off.

The number of people with sight loss has been predicted to have significant rise due to the aging population and an increasing prevalence of key underlying causes of visual impairment, the special living experience of visual impaired people should pay close attention to. It is critical that the living environment, especially for the essential cooking process, the kitchen, is adapted to promote safety and support independence.

285 million people are visually impaired globally

246 million have low vision

39 million are blind

(International Centre for Eye Health, London School of Hygiene & Tropical Medicine, 2016)

Aim

- Produce a series of product focusing on operations required specific accuracyduring cooking, for example, seasoning.
- Develop the product into an inclusive -design product that can meet requirementsunder similar scenarios.
- Apply engineering skill to ensure the usability, feasibility of manufacturing andproduct sustainability.

Inspiration

When looking into the existing solutions for the scenario, according to the related websites released by the government or related organizations, only **basic rules** are advised.
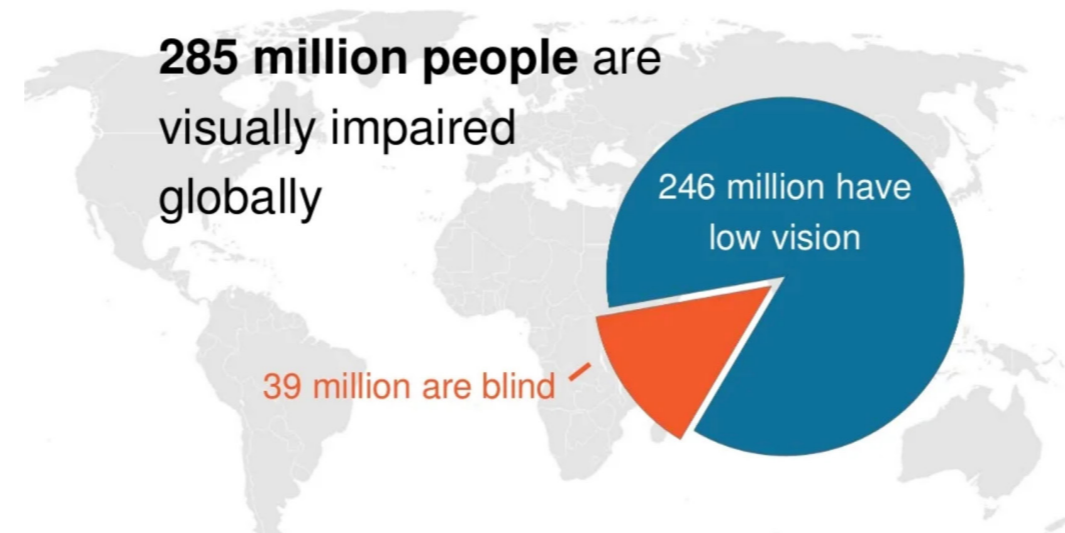
The provided solutions are now limited to:

- Using labels for categorizing
- Applying specific products, e.g. a talking kitchen scale, a timer.
- Using colour contrast method for assistance

(Guide Dogs NSW/ACT, 2019)

For those people, the cooking process is now reached still mostly relying on personal experiences and additional assistance.

(Jexter Lim, 2017)

(Tai,2017)

Products designed specifically for visual-impaired people are now limited to ensure safety and accessibility of cooking process. Safety during cooking has been seriously focused on as a basic requirement, while no more details focused.

Reference |

International Centre for Eye Health, London School of Hygiene & Tropical Medicine (2016). Global Blindness: Epidemiology and visual impairment. [online] Available at: https://www.slideshare.net/InternationalCentreforEyeHealth/epidemiology-andvisualimpairment.
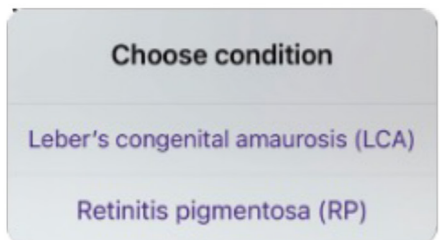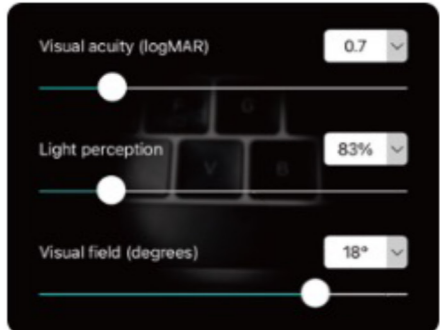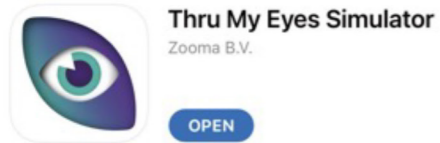
Tai, M. (2017). No more scars: NUS student designs cooking tools for the visually disabled. [online] The New Paper. Available at: https://tnp.straitstimes.com/news/singapore/no-more-scars-nus-student-designs-cooking-tools-visually-disabled [Accessed 15 Aug. 2022].

Jexter Lim (2017). EATSY - Adaptive Tableware for the Visually Impaired. [online] Behance. Available at: https://www.behance.net/gallery/52272319/eatsy-adaptive-tableware-for-the-visually-impaired.

Guide Dogs NSW/ACT. (2019). Young people with low vision or blindness learn cooking skills with 'Hurricane Chef'. [online] Available at: https://nsw.guidedogs.com.au/news/young-people-with-vision-impairment-learn-cooking-skills-with-hurricane-chef-2/ [Accessed 15 Aug. 2022].

RESEARCH & DEFINE

Thru My Eyes Simulator
Zooma B.V.

OPEN

Visual acuity (logMAR) 0.7

Light perception 83%

Visual field (degrees) 18°

Choose condition

Leber's congenital amaurosis (LCA)

Retinitis pigmentosa (RP)

The research and define stage was moved on with applying **practical research method**. The aim of applying this method was to experience and gather **first-hand information** from the **designer perspective** under visual-impaired condition. The cooking process could be divided into detailed stages during the research in order to identify potential problems and design opportunities.

The APP *Thru My Eyes Simulator*, being developed as an interactive tool to describe the sight of visual-impaired people or help people understanding how impaired vision sees the world, which perfectly met the purpose of practical research was therefore selected. Parameters could be adjusted for a required sight condition.
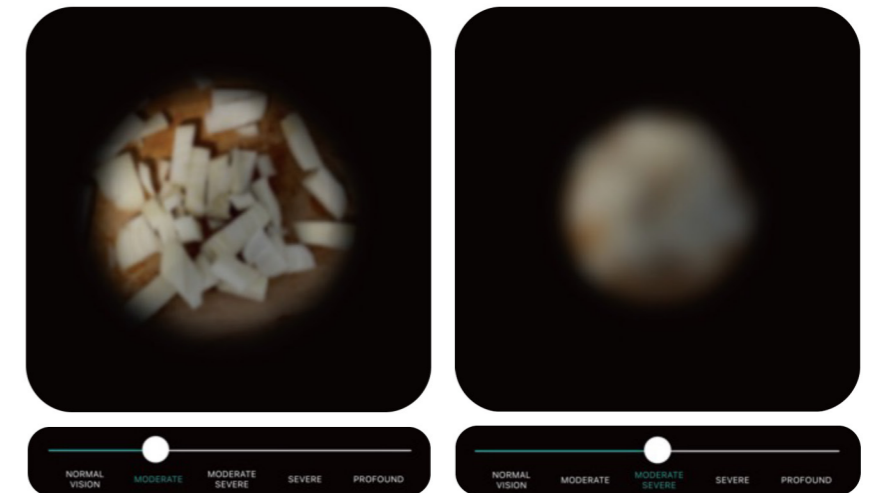
Smartphone with the simulator software, being applied as sight
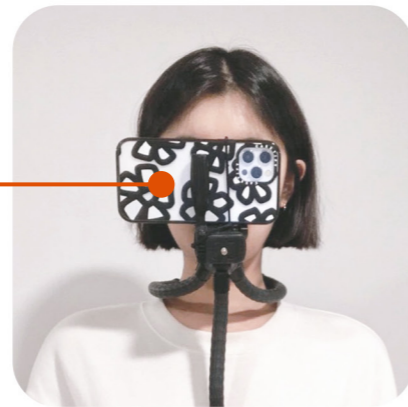
Use flexible camera tripod as support

Level of moderate severe was selected after evaluation for more reliable findings.

An ideal method would be using a Virtual Reality headset for better-quality simulation, however, due to the practical limitation, the final solution for the research has been demonstrated above. The key point was to ensure the position and angle of the screen could **shield the original eye sight** to reach better research findings.

The simulated visual-impaired sight during the process was documented by screen recording. All problems recognized during the process was identified and demonstrated by the related scene for evaluating design opportunities.
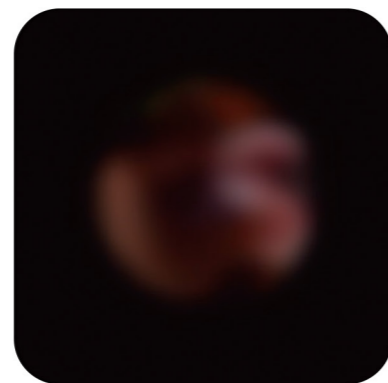
Findings

The key findings during the process is listed as follows. Based on the identified problems, design opportunities were evaluated in detail at the next stage.
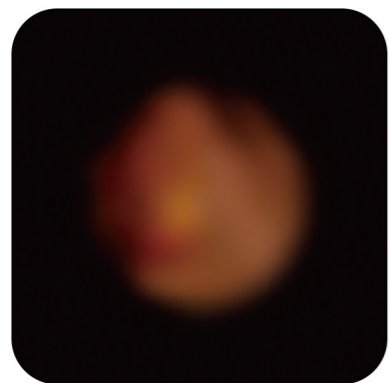
- Difficulty in locating items due to poor colour contrast with utensils.
- Potential of risk due to poor physical indicator and slippery while operating kitchen scissors.
- Difficulty in estimating the amount of ingredient.
- Difficulty during operating with induction stove without physical indicator or instruction.
- Difficulty in differentiate seasonings due to similar packagings.
- Difficulty in locating the edge of the pot and potential danger to be burnt while tasting.
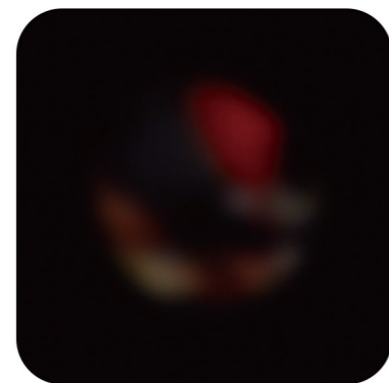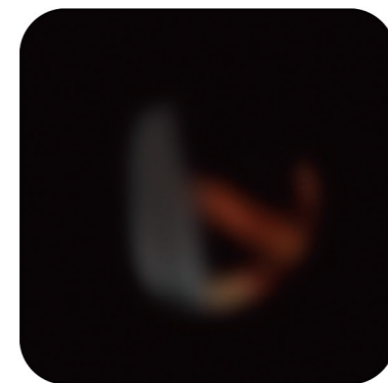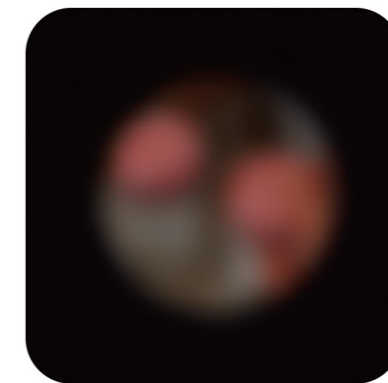
Reflection | Applying practical research method made remarkable progress in identifying potential problems of user experience that could be easily neglected by aimed users (visual-impaired people) while already being used to the situations.

OPPORTUNITY

Since the project focused on improving user experience of visual-impaired people during the cooking process, based on the result of practical research, the **cooking process** was divided into stages to **conclude** detailed findings and insights of **potential problems** and **inspired design opportunities** were categorized following the cooking process after evaluating the key findings at the RESEARCH & DEFINE stage.

PREPERATION	SETTING	COOKING	SEASONING	TASTING	SERVING

PREPERATION

POTENTIALS

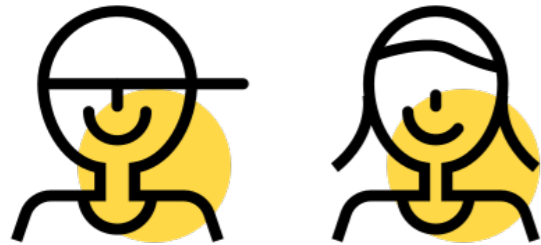- Inidividuals can only provide **rough cutting result** even based on personal experiences.
- Kitchen scissors **prevents direct contact with blades** that provides higher safety factor and feasibility, however still discovered potential risks while being **poor in physical indicating**.
- Most existing dicing assistance products in the market have **complex structure** and a number of accessories, not a good choice for users being poor in item locating.

OPPORTUNITY

Integrating **kitchen scissors**, improving safety index for visual-impaird people, providing cutting result with higher quality, fulfilling a wider range of using scenario, including dicing assistance, boning, etc.

LOW DESIGN OPPORTUNITY

COOKING / SEASONING

POTENTIALS

- Though being professionally advised, **categorizing** ingredients can hardly depend on labels.
- Labeling ingredients requires additional assistance.
- **Navigation** to different required ingredients is always poor when the space is not well-organized.
- The amount of ingredients, especially seasoning, is hard to be accurately measured. Existing assisting tools always meets limitations.

OPPORTUNITY

Building an **interactive system**, assisting categorizing utensils or ingredients, providing navigating function to assist the cooking process. Integrating **package of seasoning ingredients**, providing direct measuring method from the package, improving package labels.

HIGH DESIGN OPPORTUNITY

TASTING

POTENTIALS

Visual-impaired people rely a lot on tasting to ensure the quality of result. However,
- They might get injured by the high temperature of water steam
- Metal spoons or kitchen utensils may provide unsuitable temperature for direct tasting.

OPPORTUNITY

Producing specific **tasting utensil**, improving the tasting experience, integrating related material to prevent from risks.

LOW DESIGN OPPORTUNITY

REQUIREMENT

USER

SOLITARY VISUAL-IMPAIRED PERSON

- **GOALS**

  No need to do additional labelling works with bottles

  Save time in finding required ingredients

  Ingredients can be well organised

  Easy understanding instructions to operate

  Easy installation

  Space-saving

  High stability

PRODUCT REQUIREMENTS

	INTERACTIVE SYSTEM	SEASONING PACKAGE
EFFECTIVENESS	• accuratelly recognize different bottles • assist to deliver the required bottle • have enough storage space	• Accuratelly controlled the amount of every output of ingredients
EFFICIENCY	• the process of directing to the required bottle do not take long • easy and convenient to apply command	• easy and quick to export measured amount of ingredient • easy and quick to open and close
SAFETY	• the structure is stable • the structure do not contain sharp edges	• the structure do not contain small detachable components • the material meets food-contact material specification
UTILITY	• item recognition • space-saving storage ability • fit in small kitchen spaces	• reliable physical mechanism • hodable by one hand
LEARNABILITY	• easy to learn for visual-impaired people • provide enough physical indicators	• easy to learn for visual-impaired people • provide enough physical indicators
MEMORABILITY	• easy to remember operation process	• easy to remember operating action

Luxi Chen | MSc Product Design Engineering 2022

University of Glasgow · THE GLASGOW SCHOOL OF ART

CONCEPT

Concept 1
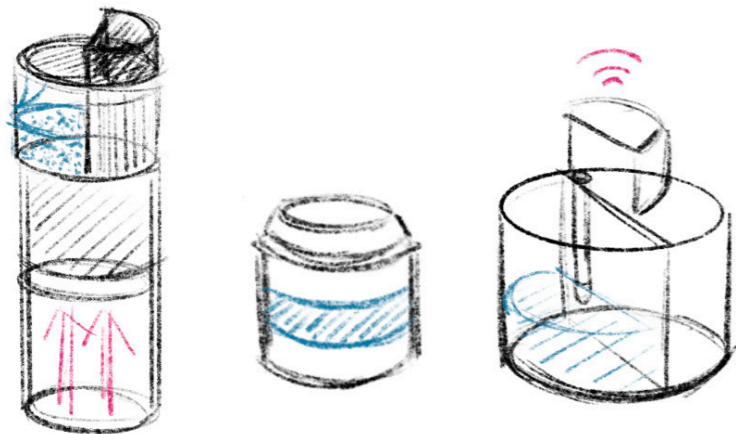
VACUUM STORAGE BOTTLE

The ingredient could be pushed up applying the vacuum theory. The operation based on pressing the top botton. The amount of powder is fixed every press.
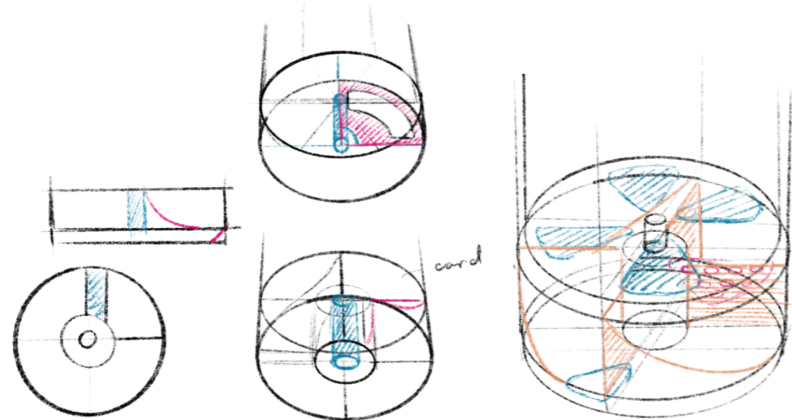
Requirement

Calculating the relationship between pressure applied and the amount of powder being pushed up at every press.

Potential difficulty in applying the vacuum theory.

- **Discard the concept.**

Concept 2

WATERWHEEL BOTTLE EXPORT

The ingredient could be stored in the blocks that the capacity of each block is a fixed amount of ingredient. Seasoning can be applied by rotating.
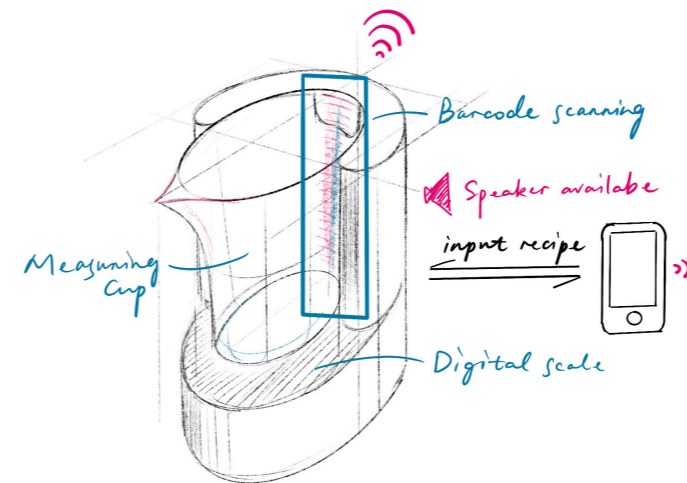
Requirement

Work out the detailed mechanism. Calculate the detailed dimensions to ensure the suitable capacity of each block.

Provide simple operation through only physical mechanism.

- **Keep the concept.**
- **Refine detailed requirements.**

Concept 3

Barcode scanning
Speaker availabe
input recipe
Measuring cup
Digital scale

INTEGRATED INGREDIENT STATION

The device can recognize ingredient by scanning barcode. The main part is a measuring cup with a digital scale. The devide can be linked to the phone for importing recipes. Provide speaking guidance of required ingredients.
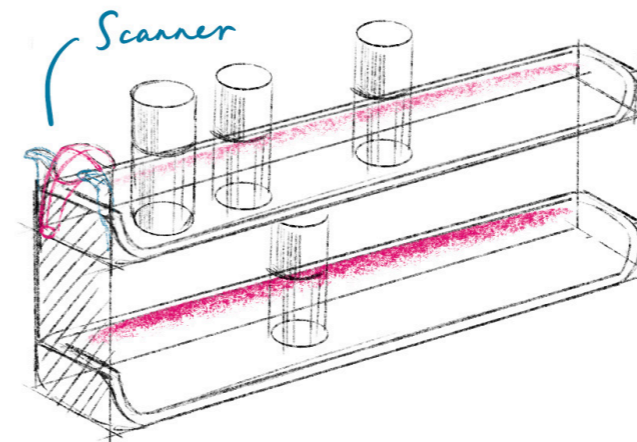
Requirement
Build up different modules for combining various functions.
Low efficiency in the scanning process.

- **Discard the concept.**
- **Keep the scanning process but improve efficiency**

Concept 4

Scanner

SPICE RACK WITH PORTABLE SCANNER
The device has a portable scanner to recognize different ingredients. The bottles have fixed positions on the rack which ensured scanning efficiency.

Requirement

Build up scanning module.

Reduced operation steps compared with Concept 3. Steps after recognizing bottles are still with low efficiency.
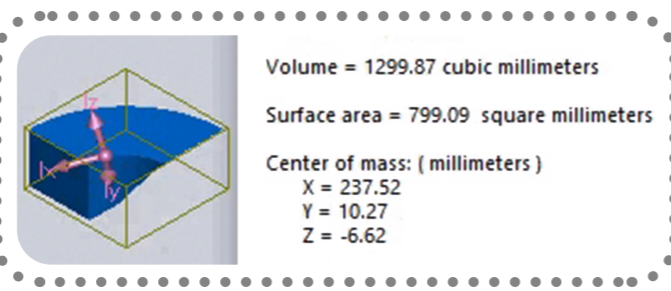
- **Keep and improve the concept.**
- **Improve the scanning method to reduce operation.**

DEVELOPMENT Mechanism & Structure | Integrated Seasoning Powder

Refine

Based on concept 2, the structure was further developed to meet the detailed requirements. The factors being considered during refinement were:

- **The export**: the hole for export should be big enough to prevent from ingredients being easily stuck (e.g. spices), ingredients should be able to export directly, without turning upside down to simplify the operating process as much as possible.
- **The cap:** the cap should be able to open for the user to refill in the same ingredients
- **The capacity of measuring blocks:** refering to *the National Academy of Medicine*, the recommended salt intake amount is 6g per day, which is 1tsp. Also refering to the reripes available online, the general minimum unit of seasoning (especially powdery ingredients, salt, spice, cinammon, etc.) is **1/4tsp**, which was finally defined as the capacity of each block, therefore the detailed dimentions of the export were calculated.

Volume = 1299.87 cubic millimeters

Surface area = 799.09 square millimeters

Center of mass: (millimeters)
X = 237.52
Y = 10.27
Z = -6.62

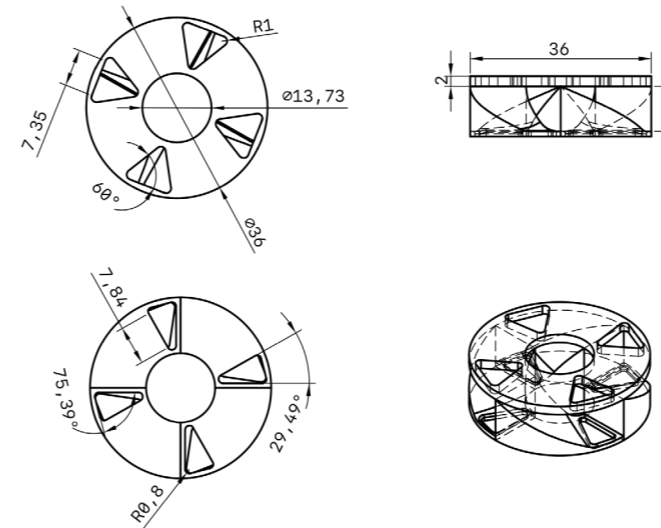**Detailed calculation of product dimentions could refer to P16-17 of Technical Report**

Prototyping

The reliability and feasibility of the structure was then tested through **3D printing**. After user testing and evaluation, the structure could **reliably** work. After testing, the initial idea of unidirection rotating was proved to be unnecessary, rotating in both directions could work.
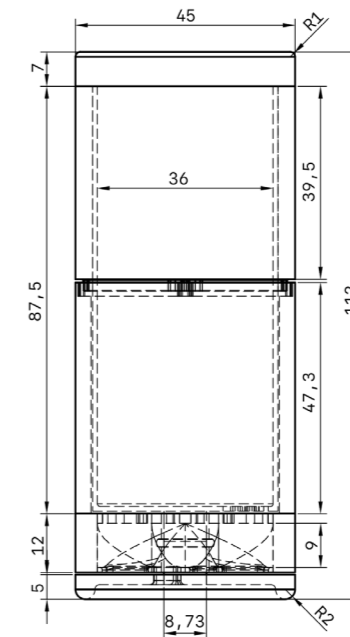
For further development, **structural mechanism** should be added to fix the rotating angle per operation. Since the export block was divided into 4 parts, the **rotation angle** should be **fixed at 90º**.
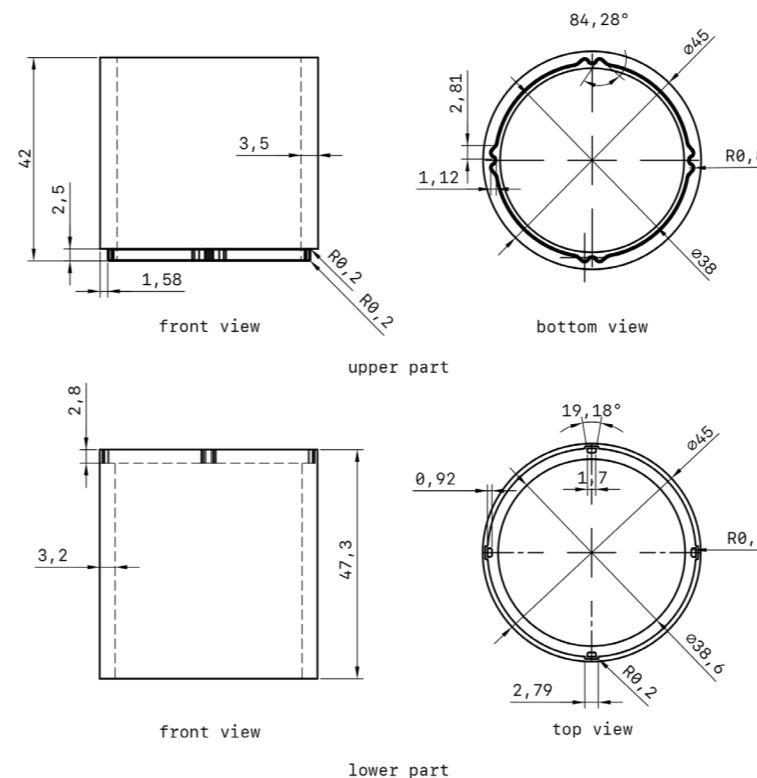
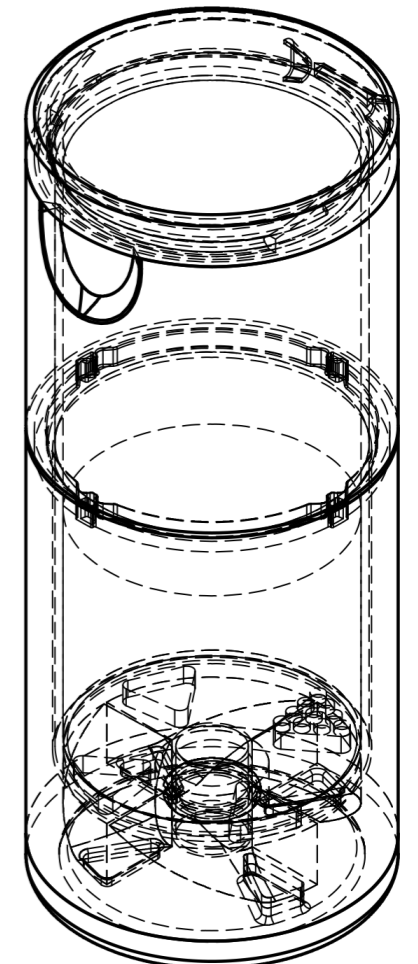- **Structure of the measuring blocks**
- **Dimentions of the bottle**

- **Structure and dimentions of the shell**
- **The rotation mechanism between upper and lower parts**

upper part

front view

bottom view

lower part

front view

top view

UNITS
mm

**Luxi Chen** | MSc Product Design Engineering 2022

DEVELOPMENT

Mechanism & Structure | Smart Spice Rack

Refine

- For improving the scanning method, the structure was considered to be a **rotating structure** with a **fixed scanner** on top.
- The bottles can be stored on a rotating platform with **fixed positions**.
- To associate with this device, the QR code (the same purpose as barcodes on products in current market) should be attached **on the top of** the bottle for scanning.

Initial sketch for the refined version of Concept 4


Embedded Scanner
QR Code
Rotating Platform
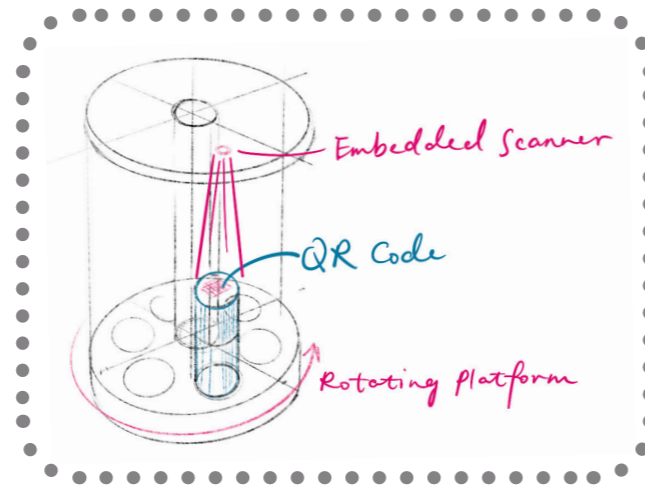
Prototyping

The reliability and feasibility of the structure was then tested through **3D modelling** with combined materials (foam, cardboard and wood). The structure could **reliably** work. During prototyping, an attempt of integrating the structure into a **two-story structure** was made. Based on user testing, the structure could **reliably** work that could improve storage capacity.

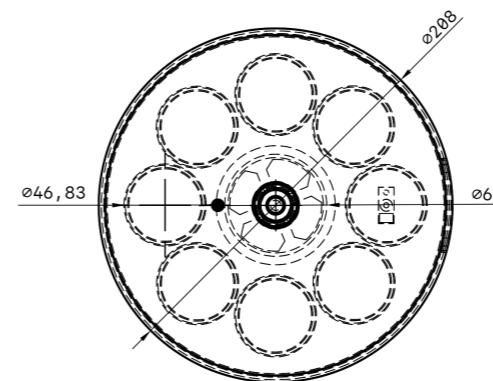Also, **fence** of each platform with **physical indicator** to indicate the position of the recognized bottle was added.

For further development, how the structure can be drived and controlled by electronic interaction system and motors should be worked on.
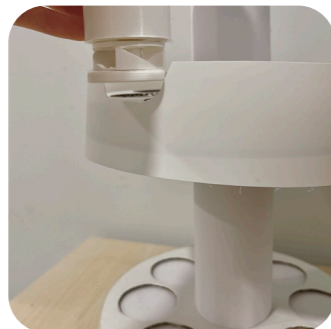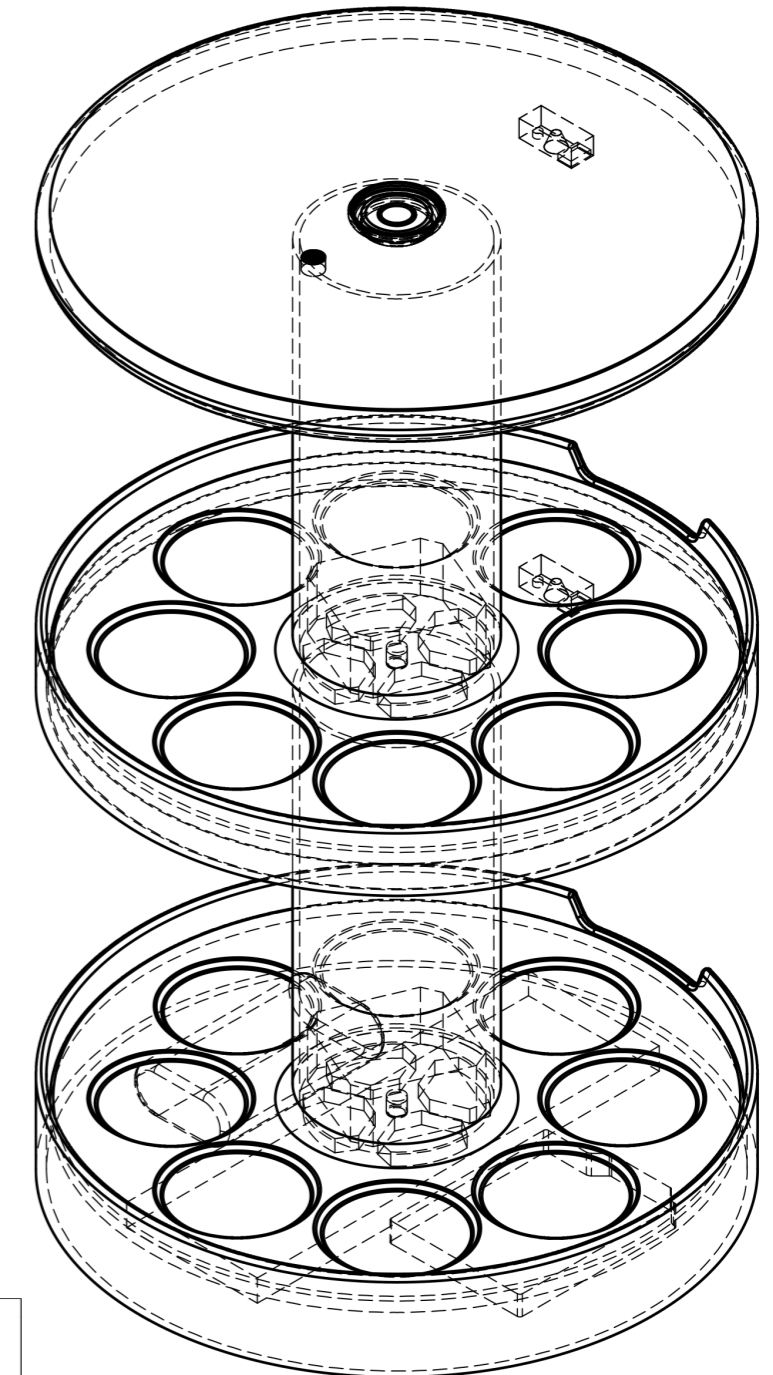

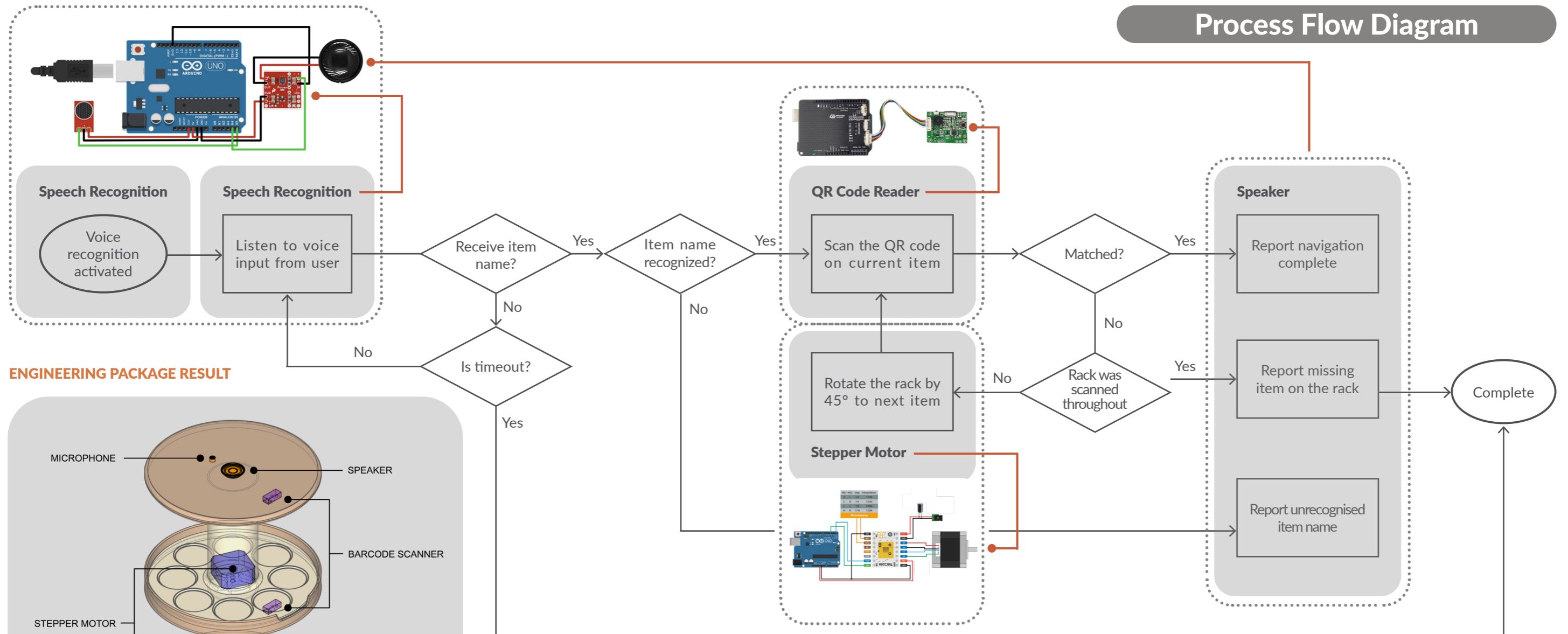- **Dimentions of the spice rack**
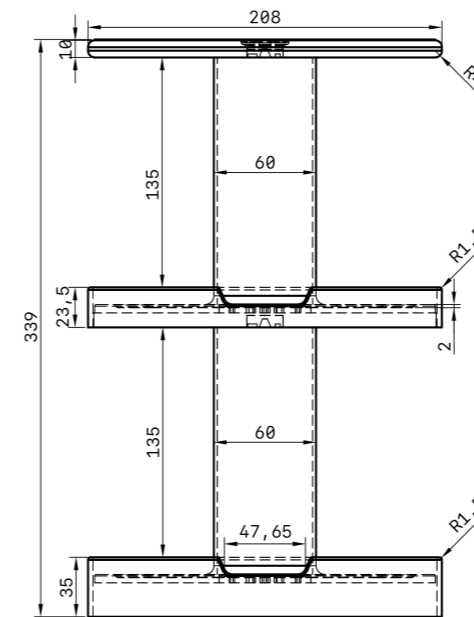
SCALE 1:3

SCALE 1:3

TITLE	UNITS
rack dimension	mm

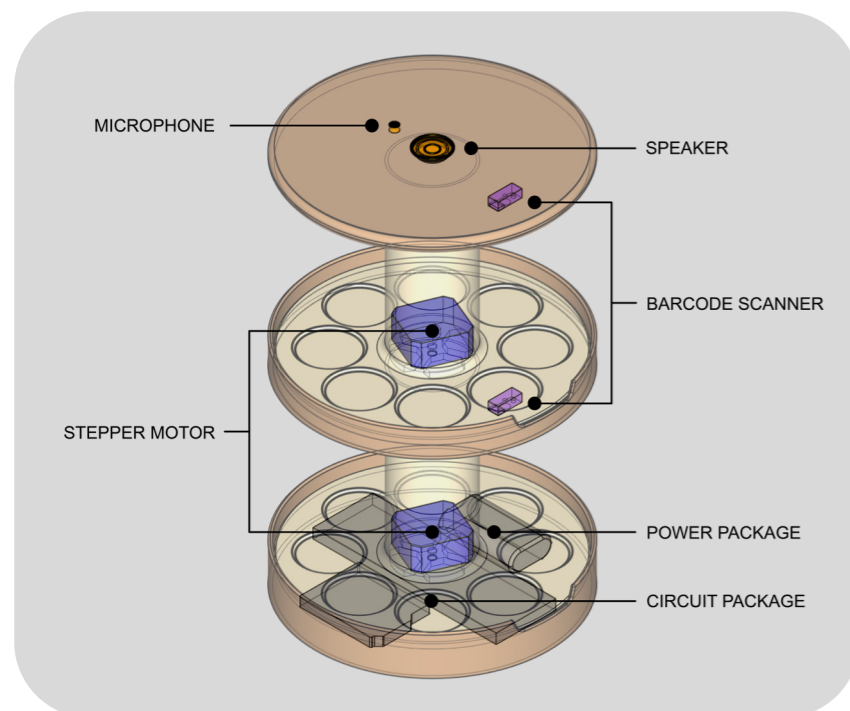**Luxi Chen** | MSc Product Design Engineering 2022

DEVELOPMENT Functional Process | Smart Spice Rack

REQUIRED FUNCTIONS | ① controlled by users through voice command ② automatically drived to search for the required bottle ③ recognize each item accurately ④ inform the operation conditions via speech

Process Flow Diagram

Speech Recognition

Voice recognition activated

Speech Recognition

Listen to voice input from user

Receive item name? — Yes — Item name recognized? — Yes

No — Is timeout? — No

Yes

No

QR Code Reader

Scan the QR code on current item — Matched? — Yes

No

Stepper Motor

Rotate the rack by 45° to next item — No — Rack was scanned throughout — Yes

Speaker

Report navigation complete

Report missing item on the rack

Report unrecognised item name

Complete

ENGINEERING PACKAGE RESULT

MICROPHONE

SPEAKER

BARCODE SCANNER

STEPPER MOTOR

POWER PACKAGE

CIRCUIT PACKAGE

FUNCTIONAL PROCESS

The functions were subdivided into flows of processes specifying internal operations and rules. *PROCESS FLOW DIAGRAM* was applied at this stage to also define constraints and relationships between processes and corresponding system components.

As demonstrated, the user should first activate speech recognition and speak out the command. If an item name is successfully captured, the QR code scanner starts scanning the code on current item. Items are iterated through the code reader by spinning the rack controlled with stepper motors. Before reaching the end, the rack rotates 45° to position the next item right under the code reader. If a matched item is found, the speaker would notigy the user, and the process is completed. If the item could not be found, the speaker would then report the missing item.

Detailed specifications and considerations of components and circuit has been demonstrated in P9-12 of the technical report.

University *of* Glasgow THE GLASGOW SCHOOL:◦:ARt

Luxi Chen | MSc Product Design Engineering 2022

USER JOURNEY

The storyboard visualises a typical process of a user looking for paprika during cooking process using the smart spice rack.

STARTING THE COOKING PROCESS

PAPRIKA

SPEAKINGING OUT THE REQUIRED ITEM TO THE DEVICE

THE DEVICE STARTING TURNING AND SCANNING

QR CODE ON THE TOP OF THE CAP BEING SCANNED

THE SCANNED ITEM DO NOT MATCH THE USER DEMMAND

THE DEVICE CONTINUE TURNING AND SCANNING BY STEPS

PAPRIKA FOUND

THE DEVICE RECOGNIZED THE REQUIRED ITEM AND REPORT FINDING

PAPRIKA BEING COLLECTED BY USER

FINAL PRODUCT

- The final concept is a set of products consist of a **smart spice rack** and **integrated seasoning package**. The project went through the process of concept generation, evaluation, prototyping and the final result would be demonstrated as **3D renders**.
- The set was designed for **automating** the process of item navigation during cooking for **visual-impaired people** and turning the process into an **interactive operation**. **Physical indicators** were essentially designed for the structure to improve convenience and feasibility associated with the interactive function.
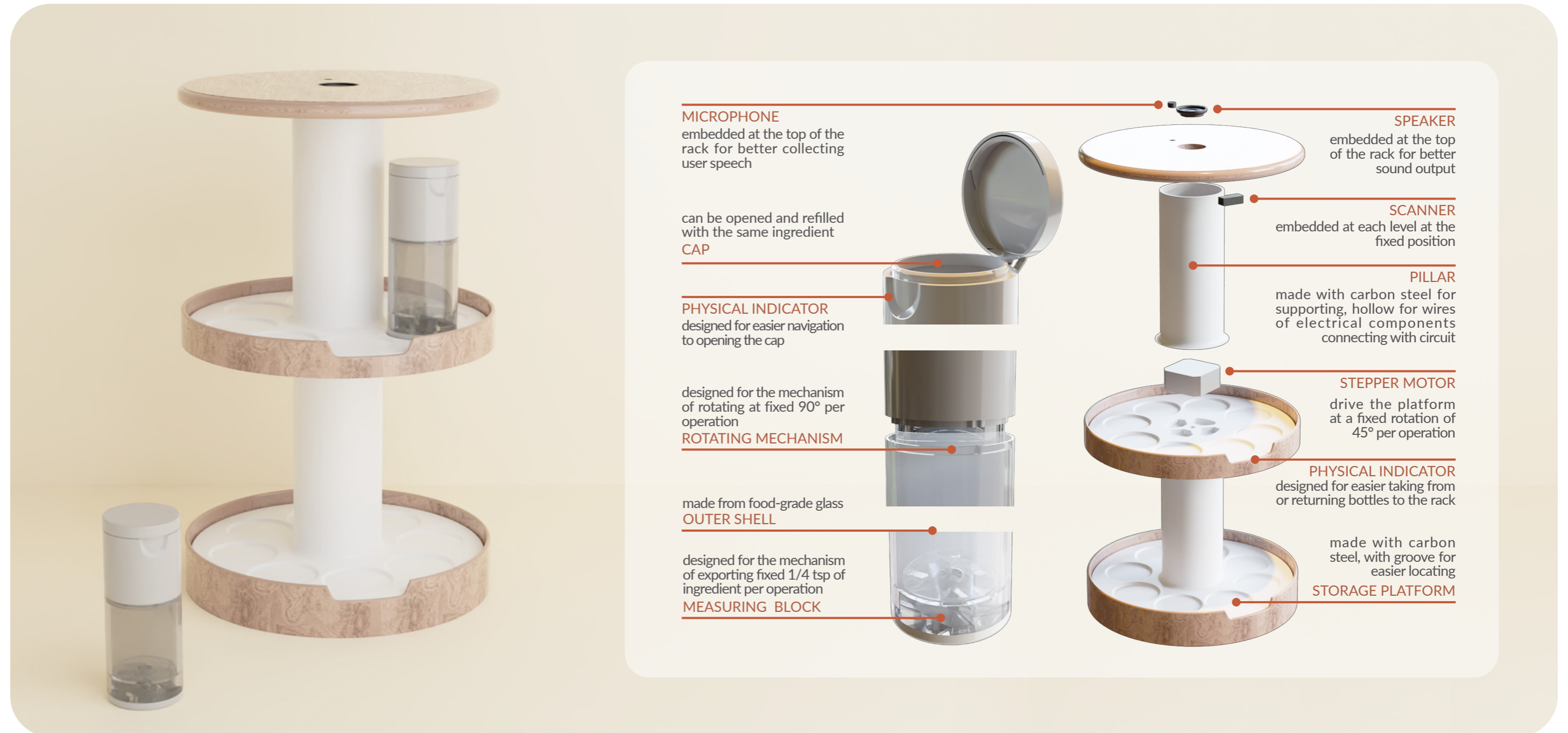
MICROPHONE
embedded at the top of the rack for better collecting user speech

can be opened and refilled with the same ingredient
CAP

PHYSICAL INDICATOR
designed for easier navigation to opening the cap

designed for the mechanism of rotating at fixed 90° per operation
ROTATING MECHANISM

made from food-grade glass
OUTER SHELL

designed for the mechanism of exporting fixed 1/4 tsp of ingredient per operation
MEASURING BLOCK

SPEAKER
embedded at the top of the rack for better sound output

SCANNER
embedded at each level at the fixed position

PILLAR
made with carbon steel for supporting, hollow for wires of electrical components connecting with circuit

STEPPER MOTOR
drive the platform at a fixed rotation of 45° per operation

PHYSICAL INDICATOR
designed for easier taking from or returning bottles to the rack

made with carbon steel, with groove for easier locating
STORAGE PLATFORM

Reflection | The project went through whole process of background research, personal experience, problem evaluation, ideation, concept development, prototyping and testing, the solution can be considered as successfully achieving the initial aim of the project. Challenges were encountered in software implementation that functions were compromised into a simpler structure. However the whole system remained logical and feasible.