Project III

Designing a Cooking Aid for the Blind

Submitted by

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1.0 Introduction

1.0.1 Preface

Food preparation has been a constant chore since the first human beings picked up cutting and mashing stones. In return, this effort to make food edible, preserve it, and transform its character has sustained an ever-increasing population. Many techniques, including grinding, sifting, drying, salting, sealing, fermenting, and applying heat, are extremely ancient. Few fundamentally new techniques have been introduced in the past two centuries, among them microwaving.

Preparing a meal is a basic activity needed for survival and it's a skill that everyone should able to learn. It is a complex task which involves multiple sensory organs to indicate the state of preparedness of any particular dish. This is true when preparing Indian meals like breads, complex gravies, fried snacks and desserts.

Unless you order takeout for three meals a day, cooking is a necessary chore in daily life. When it comes to blind cooking, there is danger in the high heat and flames involved, and it is easy to mess up a recipe by pouring in the wrong ingredient, or even too much of the right one.

While preparation of meal there are many steps involves which includes ingredients procurement by navigating to grocer, arrange the ingredients in the kitchen, apply various cooking methods such as cutting, stirring, kneading, frying to prepare the meal and finally clean the vessels that were used in cooking. To prepare a meal independently can directly determine the quality of life of an individual. Research has indicated that those Visually Impaired Person (VIPs) prepare meal independently have lower level of nutritional value in their food.

Loss of sight leads to lowered richness of information available to VIPs to make many decisions while cooking. This forces VIPs to use their other sensory organs such as tactile, auditory and olfactory. A healthy human has a set of senses. Sight, hearing, taste, smell, and touch are defined as the five traditionally-recognized senses. If one of the five traditionally recognized senses is impaired, the human's behavior will also be affected, and some of the necessary skills may not be completed fluently. For visually-impaired individuals, the factor of impaired sight affects this collaboration of the senses. All of the healthy senses are needed to compensate for the impaired sight in order to normalize each individual's daily activities.

1.0.2 Understanding medical blindness

Visual impairment is the damage to any part of the eye that affects the normal functioning of the organ i.e. the eye. This disability can be measured with tests like the visual acuity test, color vision test, visual field test etc.

Blindness: Blindness is a lack of vision. It may also refer to a loss of vision that cannot be corrected with glasses or contact lenses. Partial blindness means you have very limited vision. Complete blindness means you cannot see anything and do not see light.

Color Blindness: Color blindness occurs when you are unable to see colors in a normal way. It is also known as color deficiency. Color blindness often happens when someone cannot distinguish between certain colors. This usually happens between greens and reds, and occasionally blues.

Night Blindness: Night blindness (nyctalopia) is your inability to see well at night or in poor light such as in a restaurant or movie theater. It is often associated with an inability to quickly adapt from a well-illuminated to a poorly illuminated environment.

1.0.3 Levels of visual impairment

20/30 to 20/60: Near-normal vision
20/70 to 20/160: Moderate low vision
20/200 to 20/400: Severe low vision
20/500 to 20/1000: Profound low vision
More than 20/1000: Near total blindness
No light perception: Total blindness

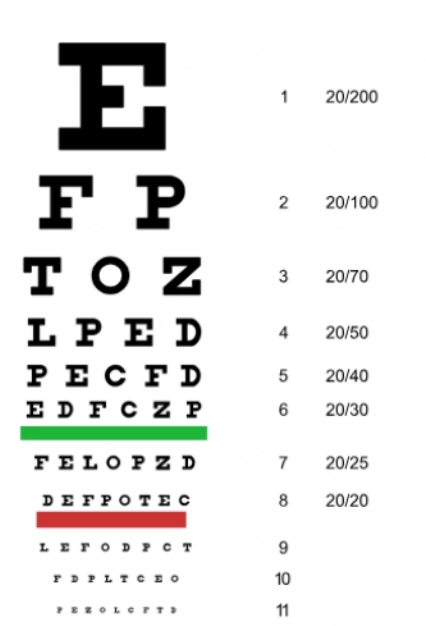


Figure 1: The Snellen Eye Chart

1.0.4 Senses of the visually-impaired people

A generally acceptable definition of sense is: "A system that consists of a group of sensory cell types that responds to a specific physical phenomenon, and that corresponds to a particular group of regions within the brain where the signals are received and interpreted."

The traditional five senses are sight, hearing, touch, smell, and taste, touch and hearing are the most important senses for visually-impaired people.

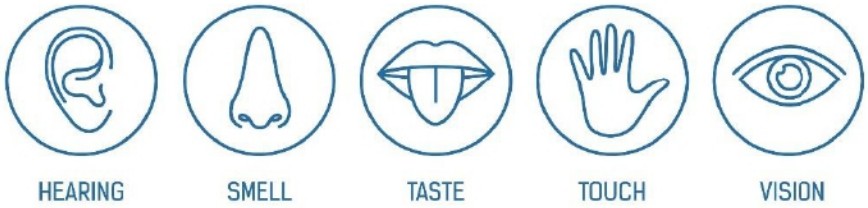


Figure 2: Five human senses

Sound: Sound is one of the most significant senses used by visually impaired individuals to locate objects in the surrounding environment. Echolocation describes this activity. Echolocation is when sound waves produced from some formats of noise such as speech, reflect from objects and bounces back to provide a rough idea of the location and status of the objects. The person is not able to specifically describe details of an item based on sound, but rather they can assume the approximate location and status of objects and then make a decision whether to interact with or avoid them.

Touch: Touch is another important sense utilized by visually-impaired individuals. It provides diverse tactile information within an individual's immediate surrounding environment. Tactile information includes shape, size, texture, temperature, and other features which can be felt by touching an item. Touch also helps people with Braille communication, the approach used by visually-impaired individuals. They use touch to feel elevated bumps on a surface in order to understand the meaning interpreted from the arrangement of these bumps. One limiting factor of touch is that not all of objects can be felt by finger such as a hot pot boiling water. Another limitation of identifying objects with touch is that this method requires more time than sight. All of important information for integrating an object can be constructed in the brain immediately by sight; by touch, all details are required to be understood one by one.

2.0 Research

2.0.1 Literature Review

There is not literature directly related to cooking techniques and other processes of the kitchen, especially in the Indian context. This motivates investigation of literature that looks at the challenges, strategies and products that use to aid the VIPs in daily life.

1) The article was a part of a study on Daily Living of Persons with Disabilities in Urban Area. The aim of this article was to present the experiences, behaviors and needs of persons with disabilities to do shopping in their day-to-day living. Results showed that shopping behaviors and needs of shoppers with visual impairment, and shoppers with physical or mobility impairment in this studied were similar. Major barriers faced in doing shopping were related to accessibility issues; i.e., inaccessibility of shopping information, such as product labels, price tags, sales promotion brochures for shoppers with visual impairment and; physical environment accessibility such as narrow shopping spaces, too high shelves, lack of ramps for those with physical or mobility impairment. Another barrier due to lack of experience or understanding of salespersons and entrepreneurs on how to interact and provide support for shoppers with disabilities. This is not related to the situation in India.

2) The aim of this study was threefold: to investigate factors determining the choices of food products in people with various levels of impaired vision; to identify obstacles they face while purchasing food, preparing meals and eating out; and to determine what would help them in the areas of food shopping and meal preparation. Considerable amount of work done in the area of identifying needs for visually impaired persons while shopping. The study also focuses on meal preparation, particularly peeling, slicing and frying, posed many challenges to the visually impaired and it is focused on the meal preparation in western homes which involves usage of cheese, breads and meats. The study provide valuable insights into the food choices and eating experiences of visually impaired people, and also suggest some practical implications to improve their independence and quality of life.

3) Visually impaired people need skills on daily living, such as cooking. The objective of this study was to design and evaluate a kitchen for persons with visual

impairments. Before designing the kitchen, interviews and an observation were carried out to obtain information on the needs of blind and low vision persons. Consequently, a kitchen model was developed, and it was evaluated by 10 persons with visual impairments. After the design improvement, the kitchen was built and has been routinely used for training persons with visual impairments to prepare meals. Finally, a post-occupancy evaluation of the kitchen was conducted by observing and interviewing both trainers and those with visual impairments during the food preparation training. The results of the study indicated that kitchens for persons with visual impairments should have safety and usability features. The results of the post-occupancy evaluation showed that those who attended cooking courses were able to cook safely in the kitchen. However, the kitchen still had limitations in some features.

4) To provide form-based cues many physical products have been designed for the VIPs in the kitchen tasks involving identifying containers, navigating the kitchen and other mechanical tasks such as cutting, peeling and pouring liquids. Kevin Chaim an Industrial Designer developed kitchenware such as chopping board side tray, pot lid, stove ring, buoyant teaspoon and knife.

5) The study focuses on integrated services for people with visual impairment. Web based information services have already been adapted for people with varying degrees of disability. What is needed now is a service-oriented architecture that integrates information services with smart care technology such as sensor devices that generate data for input, processing, storage and query. The main new challenge identified here is that users may be living in a perplexing contexture - a chain of barriers affecting their ability to live independently.

6) Other studies were based on the possibility of redesigning a kitchen for more universal accessibility, but this is rarely possible in Indian context. Due to the lack of research and thorough understanding present with regards to visually impaired cooks, an extensive primary research was needed in order to define the needs to made for an assistive product.

2.0.2 Insights gained from literature review

- The solutions in the food category primarily focuses on the points such as navigation in organised grocery stores through expensive technology or through massive service of infrastructure, which are not suited for the predominantly resource constrained society. Also, their studies do not directly addressed difficulties faced in meal preparation, but it was more focused on the background task.

- The studies which are focused on meal preparation by VIPs, they have primarily been done with western audiences, whose learnings do not translate to the Indian context.

- Some products have been designed to allow VIPs to perform tasks in the kitchen without fearing for their safety, but these tasks do not involve the application of heat which is required for most of the Indian meals.

Thus, user safety, authorize independence and desires of the VIPs are the key points while designing an aid for visually impaired. So, the goal of this project is to understand and define the problems faced by VIPs in meal preparation and design an aid which enables independence and confidence in the kitchen while taking safety, cost, comfort, accessibility into consideration with everyday tasks.

2.0.3 Primary Research

Due to the lack of utilitarian secondary research, the primary research was conducted to gain the necessary insights to develop an aid for VIPs.

Because of the special needs and abilities of my target users, the visually-impaired person, I believe that it is necessary to conduct interviews in order to receive a more complete comprehension of their thoughts and behaviors. Also, I decided to find multiple visually-impaired people with distinct backgrounds and living habits. Initial insights on the general problems faced by VIPs were collected through semi structured interviews. Six individuals with different blind stages were interviewed to gain the insights of problems when performing task in kitchen in daily life.

The problems were noted varied in nature, and not all had to do with the act of preparing a meal. There are many activities varied from measuring to filtering and cleaning foods. The problems have been listed in the table 1.0 and table 2.0 under the categories of problems, sensory organs used to substitute sight and the activity group of the problem.

Problems	Sensory used	Activity type
Cleaning vegetables	-	Cleaning
Removing stones from rice	-	Cleaning
Identification of spoiled pulses	-	Cleaning
Understanding when chapati is done cooking	Smell, Touch	Cooking
Understanding when a dish is finished deep frying	Smell, Touch	Cooking
Being able to fry more than one at a time	-	Cooking
Straining tea leaves	Touch, Sound	Filtering
Buttons on many devices are not discernible	Touch	Finding

Table 1.0: Problems faced by VIP

Problems	Sensory used	Activity type
How to use non-speaking microwaves/mixers	Touch	Hearing
Understanding when milk rises	Sound	Levelling
Understanding level of flame	Heat near hand	Measuring
How much atta has been used in chapati	Touch	Measuring
Measuring quantities of spices to put into food	Touch	Measuring
Pouring tea into a cup	Touch	Measuring/levelling
Placing batter into boiling oil	Feel, touch	Placing/positioning

Table 2.0: Problems faced by VIP

3.0 User Study

It becomes clear that there are multiple problems faced on a daily basis by VIPs. However, VIPs developed various strategies to overcome many problems. For example pouring tea into a cup is a visual task and hence quite a challenge to VIP. For the better understanding of their need I had the opportunity to visit the kitchen of one VIP named Kailash Tandel who is researcher at IITB Monash Academy and he is complete blind. I did the user study at his place in Colaba where he prepared "poha" for breakfast.

The following images shows the steps he followed while making breakfast:

Figure 3-11: Steps followed by VIP for making Poha

1. Chopping

2. Finding spices

3. Switching ON stove

4. Placing vessel in center

5. Checking temperature of the vessel

6. Adding oil with by taking vessel top as reference

7. Adding ingredients

8. Stirring and checking temperature of vessel by other hand

9. Mixing all ingredients by revolving vessel

3.0.1 Findings from user study

- They generally keep different powdered species in different shaped containers so that it becomes easy to identify.
- Chopping/cutting process takes lot of time.
- Chopping tools plays very important role while cooking.
- They constantly touch the top surface of vessel to check temperature of the vessel and it act as guide to put spices and other ingredients too.
- External assistance is required if they miss any step or any ingredient while cooking.
- They use sense of smell and sound to check whether food is cooked or not.
- It's difficult to place any vessel or pan exactly in centre on the burner.
- He hears the gas from stove in order to know whether the stovetop is on or off.
- It is hard to see the level of fire (no feedback from stove/button).
- The particular positions of utensils which will be used is important (he places utensils in specific positions).
- There are disorganized items within the refrigerator (making it hard to know if the items gathered from the refrigerator are correct)
- Forgetting to turn off electronic products is a potential danger.
- It may be hard to for him to figure out the position of cooking materials, and there are times when necessary materials are in a dangerous place (i.e. the edge of the table, knife on kitchen platform)

3.0.2 Design Opportunities

Design opportunities have been listed down from the interviews and user study. Following list shows the opportunities for design intervention.

1. Chopping and peeling of vegetables/fruits by knife
2. To understand the orientation of the kitchen
3. Difficulty in putting different spices into the vessel without spillage
4. Identification of spoiled pulses
5. Confusion while using a set of measuring spoon
6. Difficulty in using spice organizers
7. Deep frying
8. Accessibility issues while using vegetable choppers
9. Accessibility issues while using the pressure cooker
10. Difficulty in accessing utensil kitchen rack (wall mounted one)

4.0 Market Study

There are a few products in the market that have been designed to allow VIPs to perform tasks in the kitchen without fearing for their safety, but these tasks do not involve dealing with application of heat, as is required by most Indian meals.

This research was more focused on the market trends like what are the current tools are there in market, what is actual need, what they are providing and so on. This data helped me to find the focus area of my design.

Cooking Devices

Figure 12-16: Cooking devices designed for VIP

These stoves and microwave reads its settings out loud as you set the temperature. It has safety features such as turning off after a preset period, and a magnetised base for stainless steel pans and pots. The hob also turns off immediately when a pan is removed.

Chopping Tools

Chopping board with the side tray, which pegs freely on the sides of the board, acts as an extension of the hand to gather and efficiently transfer ingredients with less spillage.

Also, finger guards are available to protect your fingers from any accident.

Figure 17-20: Chopping tools designed for VIP

Measuring Tools

Figure 21-23: Measuring tools designed for VIP

Measuring cups and spoons are available with braille or tactile markings. Liquid level indicator, an electronic device that hangs over the edge of your glass or bowl is available in market. Now you don't have to burn your fingers or embarrass yourself overfilling cups when entertaining guests.

4.0.1 Inferences from market study

- Mostly form based products are available in market.
- Limited products are available to perform task in the kitchen without fearing for the safety.
- Most of them are designed by taking western audience in consideration.
- Electronic devices are available but it's not fitting with Indian context.
- Limited products designed which involves direct dealing of heat.
- Cost factor is very high.
- Most of them are not useful for Indian meal preparation.

5.0 Indian Cuisine

While speaking to experts in home cooking allowed me to gain a sense for the various cooking techniques typically needed for the preparing Indian dishes.

India is quiet famous for its diverse multicuisine available in a large number of restaurants, which reminiscent unity in diversity. The traditional food of India is widely appreciated for its fabulous use of herbs and spices.

5.0.1 Cooking techniques

Cooking anywhere in the world use a universal method, which is the use of some form of heat to bring raw food to an edible consistency. There are different types of cooking methods used to cook food. Frying, boiling, sauteing, grilling are some of the most popular methods used to cook food. Indian cuisine uses all the above methods and more. The difference lies in how the techniques are applied during the cooking process.

There are main four techniques identified that are typically used to prepare meal in Indian homes.

1. Boiling
2. Simmering
3. Roasting
4. Frying

1) Boiling

Boiling is used primarily to cook lentils, rice and vegetables. The extent of cooking varies according to individual taste and regional or traditional dictum. Not the most recommended or used method for cooking Indian food as it tends to reduce the flavour of ingredients especially spices and losses nutrients. This generally results in vegetable becoming soft and tender.

Popular Dishes:

Pulao Rice, Rassam, daal (lentils), sambar

2) Simmering

This involves cooking liquid on top of a stove in a pot or pan. It should be carried out on a low heat, and you will see bubbles appearing on the surface of the liquid as your dish cooks. Simmering is a food preparation technique by which foods are cooked in hot liquids kept just below the boiling point of water and above poaching temperature.

Popular Dishes:

Most Indian curry-based dishes like Fish Korma, Vindaloo, Palak Paneer, Chickpeas masala

3) Roasting

Roasting is basically a high heat form of baking, where your food gets drier and browner on the outside by initial exposure to a temperature of over 500F. This prevents most of the moisture being cooked out of the food. The temperature is then lowered to between 425 and 450F to cook through the meat or vegetables. It's a dry heat cooking method where small amount of fats is used.

Popular Dishes:

Roti, Dosas and Processed meat

4) Frying

Frying, the cooking of food in hot fats or oils, usually done with a shallow oil bath in a pan over a fire or as so-called deep fat frying, in which the food is completely immersed in a deeper vessel of hot oil. Similar to sauteing, pan-fried foods are generally turned over once or twice during cooking, using tongs or a spatula, while sautéed foods are cooked by "tossing in the pan". A large variety of foods may be fried.

Popular Dishes:

Puris, Vadas, Pakodas, French fries, Fried chicken

5.0.2 Problem Identification

- **Roasting** and **Frying** technique are quite challenging for VIPs and hence there are many weaknesses in this area, but it is not so with Boiling and Simmering.

- It is studied that VIPs are strong in **Boiling** and **Simmering**. This is contradictory with the Frying and Roasting because its dependent on timely executed manoeuvre.

- VIPs faces maximum weaknesses in **Roasting** and **Frying** so it has a great opportunity to design an aid which helps them to make these techniques more accessible.

- From all the threats, fear of technique and various risks make **Frying** a challenging activity to encourage as compared to Roasting.

In addition, Frying is a popular technique used to make most of the Indian dishes and it is frequently used in Indian kitchens. Also, from the research and user studies immediate need is identified for this area. Thus, the purpose of this project, the focus of the intervention will be to do with the technique **Frying**.

5.0.2 Frying

This section includes the detailed study of the technique frying including behaviors, challenges and strategies employed by VIPs during cooking.

Frying is a cooking technique whereby heat is transferred to a food item from the hot oil that surrounds it. Frying, the cooking of food in hot fats or oils, usually done with a shallow oil bath in a pan over a fire or as so-called deep fat frying, in which the food is completely immersed in a deeper vessel of hot oil. Because the food is heated through a greasy medium, some authorities consider frying to be technically a dry-heat cooking process.

People have been frying food in oil for centuries, not least because frying oil transfers heat much faster than air in baking or water in boiling. Frying also has the added benefit of creating a distinctive flavour and crispy crust on the surface of whatever foodstuff is being fried. It's both the taste and convenience of frying that make it one of the most popular cooking techniques in the world today.

The technique of frying is ancient, ubiquitous, and highly versatile; it has been used since antiquity and in most cultures to prepare meats and fish, vegetables, and breads. This popularity, together with the fairly low cost of large-scale frying, made fried foods the staples of the late 20th-century fast-food industry.

Figure 24: Deep frying puri

5.0.3 Frying Methods

Frying techniques vary in the amount of fat required, the cooking time, the type of cooking vessel required, and the manipulation of the food. Sauteing, stir frying, pan frying, shallow frying, and deep frying are all standard frying techniques.

- **Deep-frying**, where the food is completely immersed in hot oil
- **Stir-frying**, where you fry the food very quickly on a high heat in a oiled pan
- **Pan-frying**, where food is cooked in a frying pan with oil
- **Sauteing**, where the food is browned on one side and then the other with a small quantity of fat or oil

From all the above methods, deep frying and shallow frying are the most common used in Indian homes. Below chart indicating the technique, ideal cookware, heat application and uses.

Method	Technique	Ideal Cookware	Heat Applications	Used For
Deep Fry 	Cook food in submerged hot oil		Medium heat	For making crispy food items
Shallow Fry 	Cook food items in oil which is ⅓ of height of the food		Low to medium heat	For cooking flat or sliced food items

Table 3: Classification of two frying methods

5.0.4 Frying Process

Fried food may sound like fare only fit for a diner or greasy spoon, but you can perfect the technique at home with a couple of kitchen tools. It's important to take a few steps to stay safe, as hot oil can easily burn you. Choose deep-frying for things like wet-battered food, as it will be easier to keep the coating on, or shallow-frying for coating-battered foods, such as fried chicken or chicken fried steak. Shallow-frying is different from pan-frying. With shallow-frying, you use enough oil to come up the side of the food, not just enough oil to coat the bottom of the pan.

There are many steps involved in Frying . The following flowchart shows the detailed frying process.

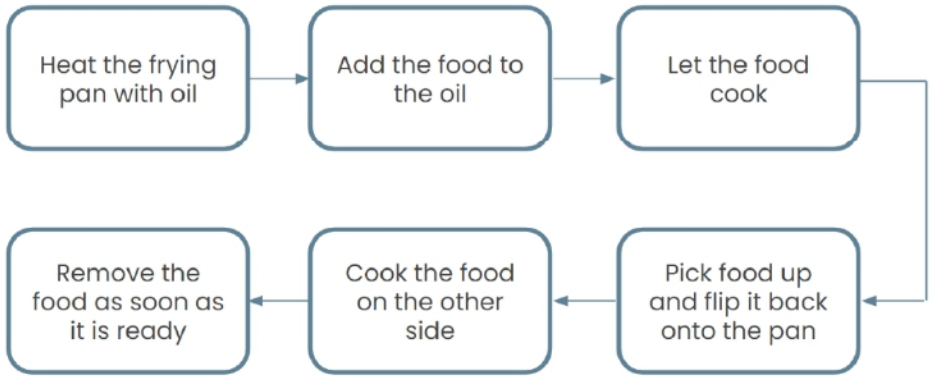


Figure 25: Flowchart indicating frying process

5.0.5 Problems identified for Frying

Second round of interview were conducted and questions were asked only about frying. From the user feedback, the problems were identified and listed down below:

- Frying fish is difficult as it needs to flip in oil to cook both sides properly
- Flat tawa is not accessible as there is a chances of hot oil spillage
- Pan or vessel with handle is always better because it helps in maintaining balance
- It's difficult to deep fry 2-3 fish pieces at time because it's hard to check whether which one cooked.
- Understanding when dish is finished deep frying
- How to check whether the oil is hot or not?
- Placing batter into boiling oil

5.0.6 Categorization of deep-fried dishes

Deep fried starters play important role in Indian cuisine. From traditional delights like Paneer Pakoda to the new-age teats like Corn Cheese Balls, deep-frying always seems to add more pep to snack. A crunchy outer layer and a soft interior, a phenomenon achieved through deep-frying. There is endless list of deep-fried snacks from Indian cuisine.

Cutlet, kachori, samosa, vada, pakora are popular Indian deep-fried dishes. While some can eaten for morning breaksfast, some can be relished as evening snacks and some can even be enjoyed as starters before the beginning of a meal.

Medu Vada, Chana Dal Vada, Masala Vadas are famous South Indian dishes that have different mouth-feel and a perfect flavour. Even puris are the most commonly made fried dish in Indian homes.

The following list shows the most common Indian fried dishes-

1. Puri
2. Samosa
3. Kachori
4. Pakora
5. Papad
6. Medu vada
7. Potato wedges
8. Gulab jamun
9. Jalebi
10. Shakarpara
11. Badusha
12. Kofta/cutlets
13. Wafers
14. Fried chicken/fish/prawns
15. Fafda
16. Boondi
17. Murukku

Food classification can be done on the following three factors-

1. Light weight food

2. Semi solid food

3. Liquid consistency food

Following table shows the classification of common deep-fried dishes

Light weight food	Semi solid food	Liquid consistency food
Papad	Puri	Pakora
Wafers	Koftas	Medu Vada
Frymes	Fried vegetables	Potato Pakora

Table 4: Classification of deep-fried dishes

From above classification **Papd, Puri** and **Pakora** from each category can be taken forward for further experiments.

6.0 Design Objective

Designing an aid for VIPs to facilitate frying activities

Aim:

The aim of this project is to elaborate on the challenges of cooking frying foods and design an assistive device for VIP's that tackles problems while keeping Indian cooking methods, practices and resources in mind.

7.0 Design Brief

To develop an assistive device/set of accessories that would empower individuals with vision impairments to perform deep frying activity independently.

Based on the problems identified, the device should:

- Should assist for all deep-frying activities
- Minimize the risk of oil splattering
- Assist them without burning hand
- Allow the user to flip the food easily
- Indicate oil temperature
- Allow user to cook multiple foods on the same pan
- Easy to clean

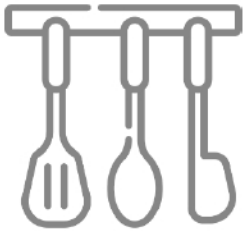
8.0 Design Directions

01

To design multi-functional cooking pot which performs all the operations required for deep-frying

02

To design a set of accessories which assist user to perform maximum deep frying activities as possible



9.0 Initial Ideations

For Direction 1

Ideation 1

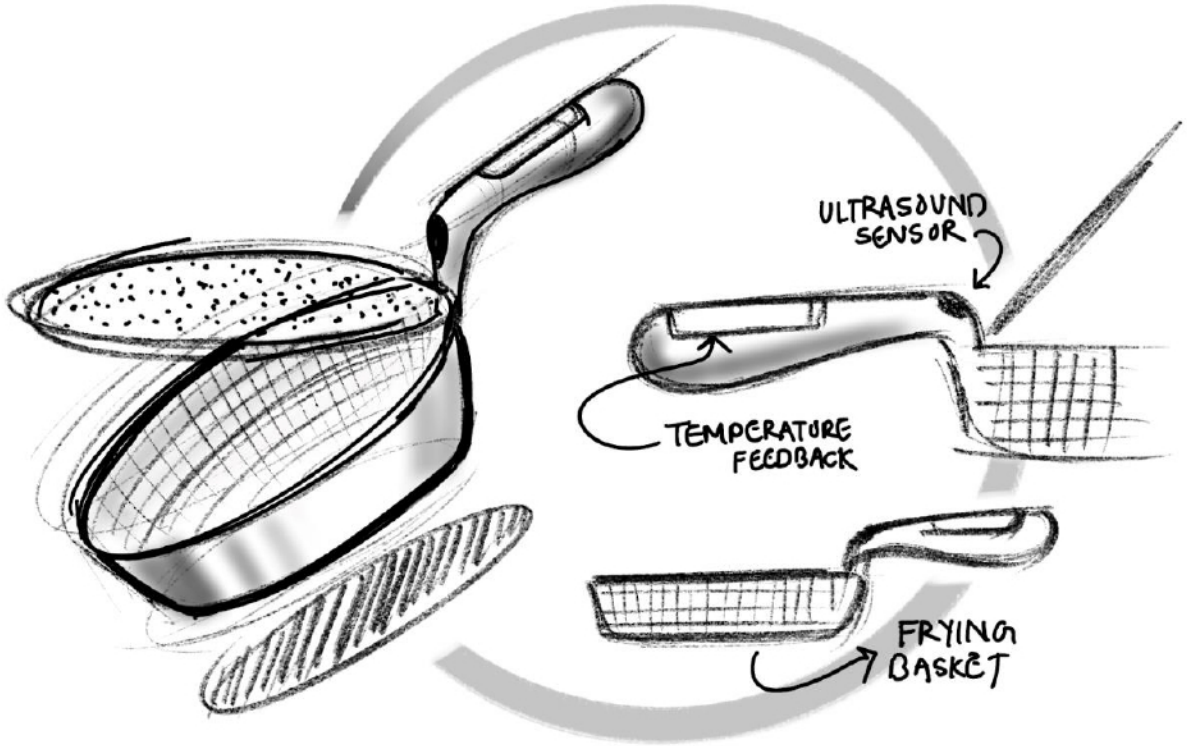


Figure 25: Components and working of ideation 1

This ideation has a frying basket with the splatter guard attached to it. Splatter guard creates a protective, splatter trapping shield around pots and pans while frying and cooking foods to eliminate mess and it prevents from unwanted oil splattering.

The handle has a ultrasound sensor which would be able to tell when an object was near the sensor. Also, braile temperature feedback module is inbuilt to indicate the temperature of oil.

Ideation 2

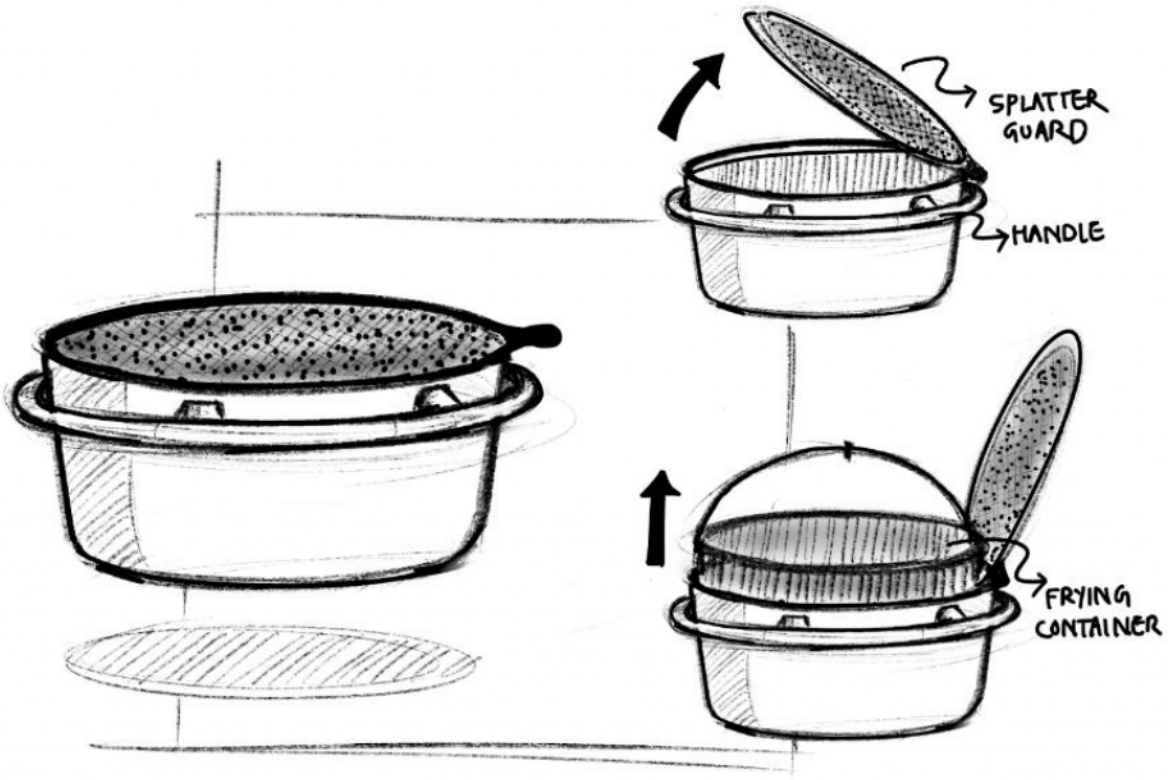


Figure 26: Components and working of Ideation 2

This ideation has a multi-functional cooking pot consists of 3 parts. There is a ceramic shell outside which limits surface heat and a metal frying basket insert with a silicon rim for safe touching.

The splatter guard will protect from oil splattering. Handle will be coated with heat resistant material.

Ideation 3

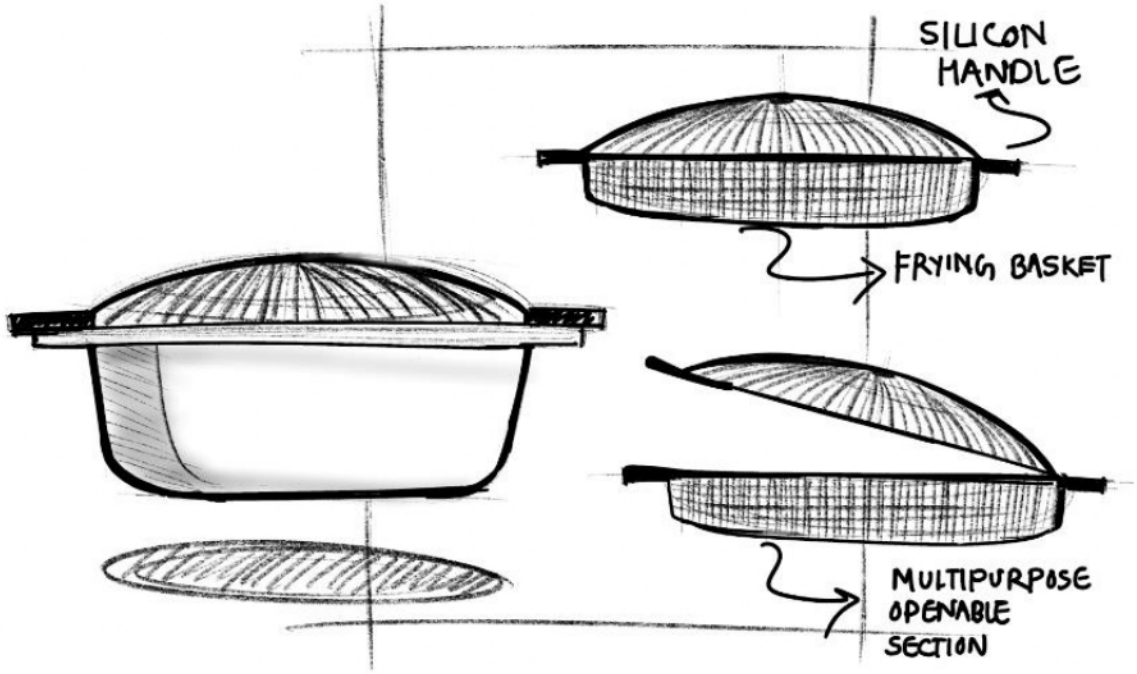


Figure 27: Components and working of Ideation 3

This ideation is similar to ideation 2 where there is a pot with ceramic shell coating and a frying basket.

Frying basket has silicon handle for safe touching and multipurpose openable section where variety of dishes can be cook according to its requirement.

Ideation 4

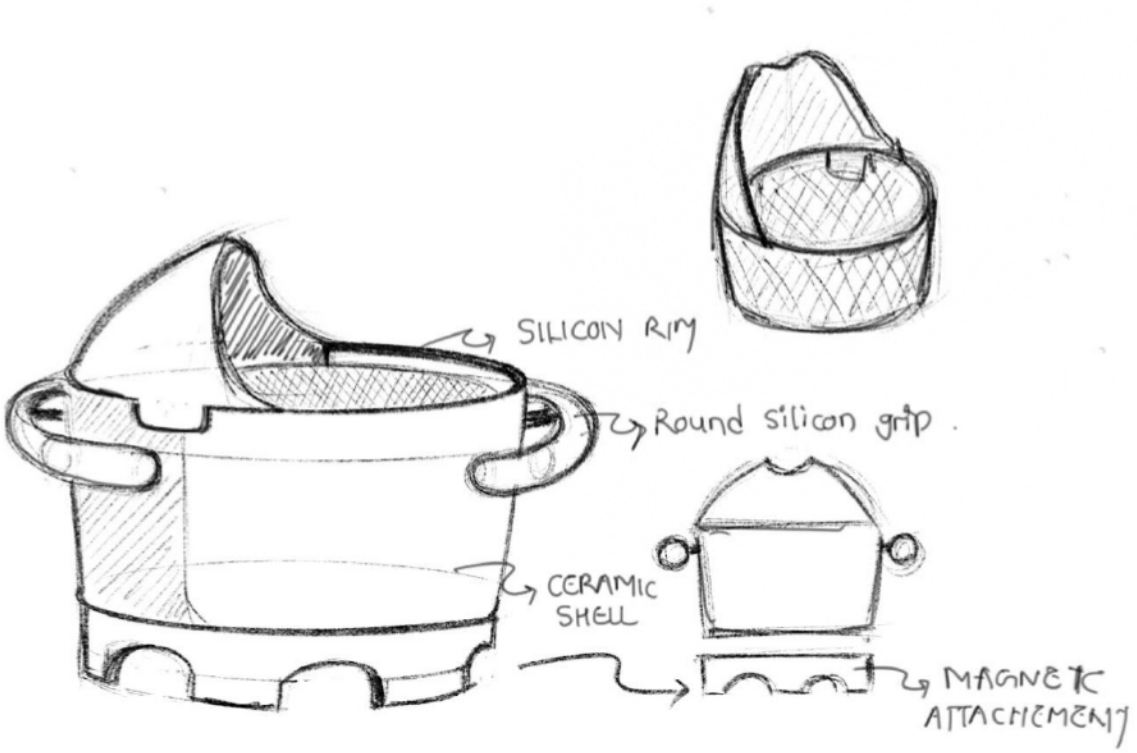


Figure 28: Components and working of Ideation 4

This ideation is a modified version of ideation 2 where it has a multi-functional cooking pot. Pot has ceramic shell outside which limits surface heat and there is a metal frying basket attached with a splatter guard an silicon rim. Splatter guard will act as a handle as well as strainer guide also.

Heat protection guard is attached directly to the pot with magnetic attachment.

Ideation 5

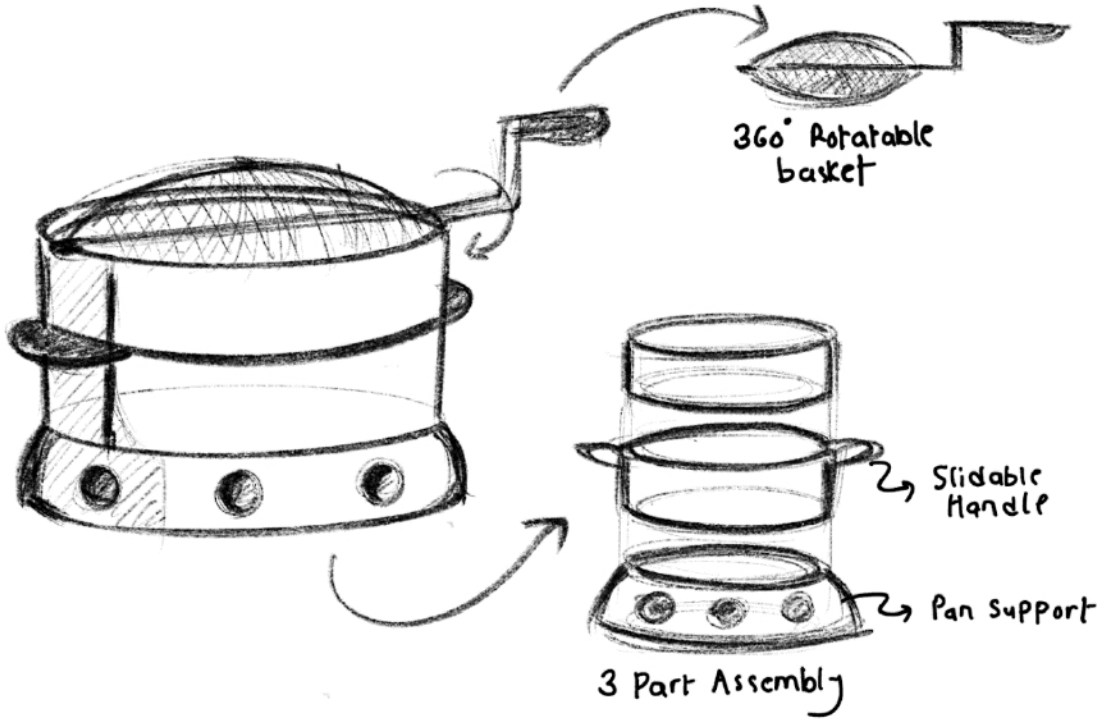


Figure 29: Components and working of Ideation 5

This ideation consists of 3-part assembly where bottom part is pan support and above there are 2 containers with slidable handle which can be magnetically attached depending on the dish one need to fry. Depth of vessel can be adjusted by attaching containers.

Also, there is rotatable basket to achieve 360-degree rotation.

Ideations for direction 2

For direction 2 ideations were done by categorizing the problems and addressing them separately.

Oil splattering

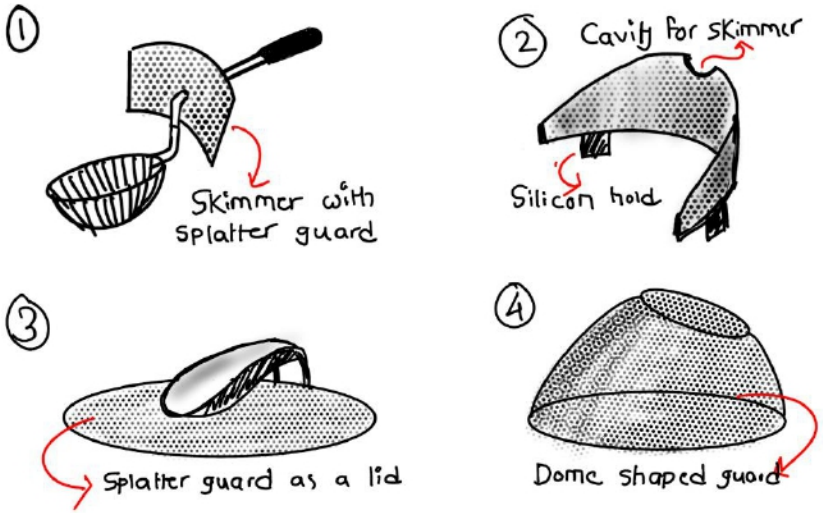


Figure 30: Ideation for oil splattering

These are the tools which reduces the risk of oil splattering. There is strainer with splatter guard attached to it and different types of vessel top.

Flipping of food

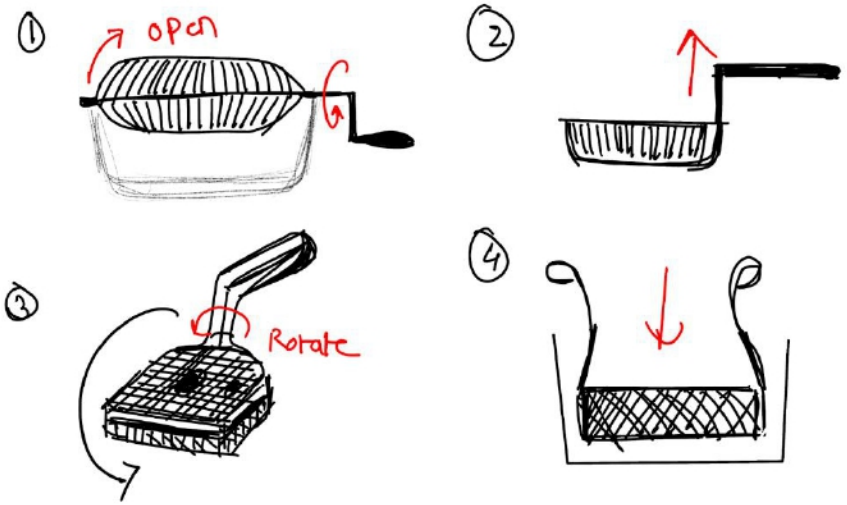


Figure 31: Ideation for flipping

These are the openable metal mesh baskets where food can be put inside which can be submersed inside the oil. Multiple mechanisms were explored for flipping of food.

Oil temperature indicator

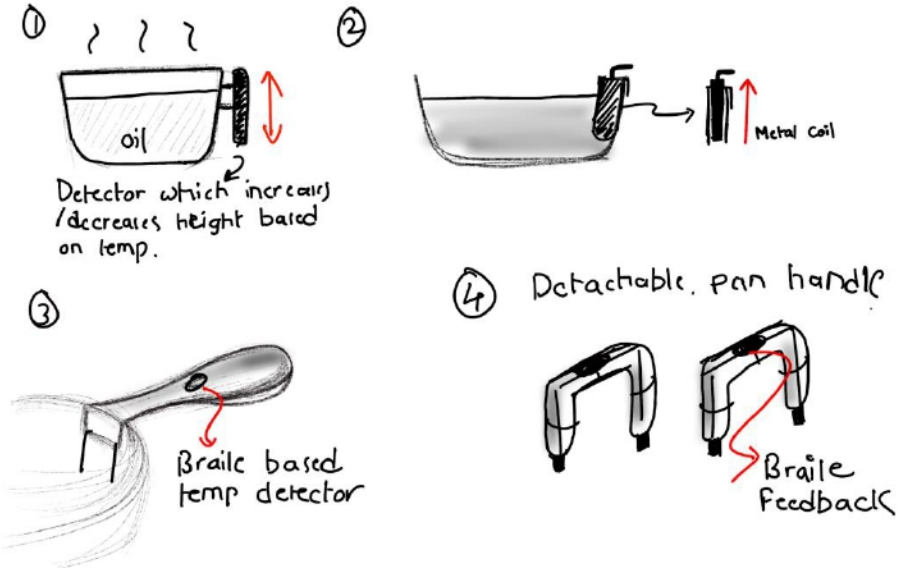


Figure 32: Ideation for oil temperature indicator

Multiple ideas were explored for oil temperature indicator including detachable briale based temperature feedback. Also for tactile feedback, mechanical approach were explored for tempertaure detection by using metal coil mechanism.

Heat protection guard

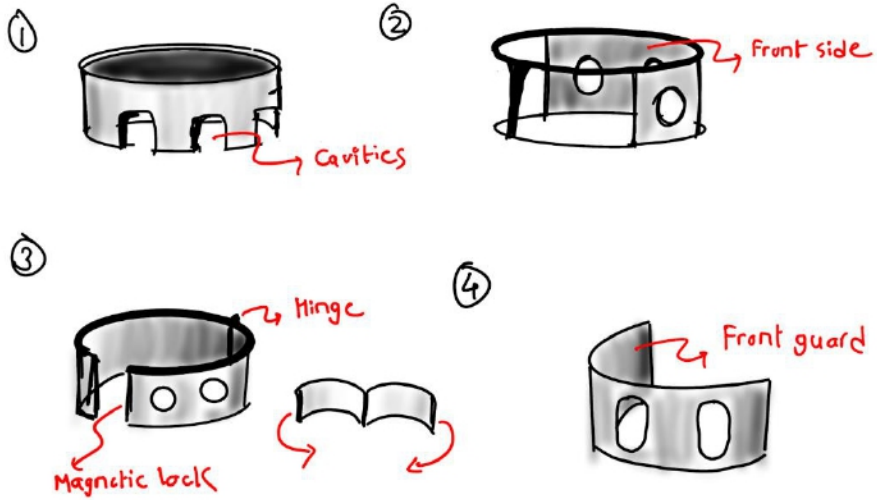


Figure 33: Ideation for heat protection guard

Heat protection guard can be directly fit around the burner. Multiple concepts were explored where some can be fixed directly on top and some have magnetic lock and hinge for opening-closing.

9.0.1 Initial Mockups

Mockup 1

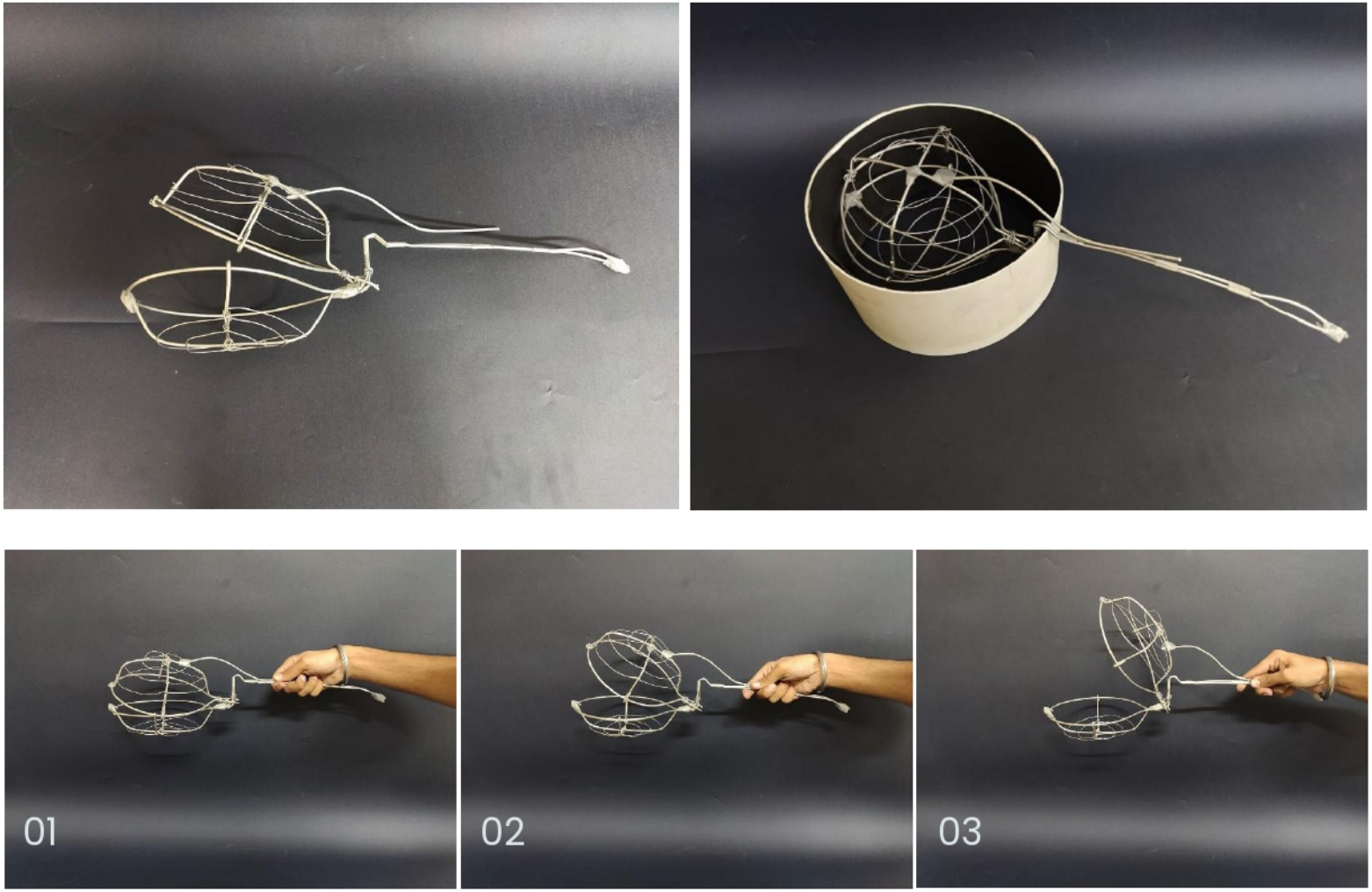


Figure 34-38: Working of mock-up 1

Mockup 2

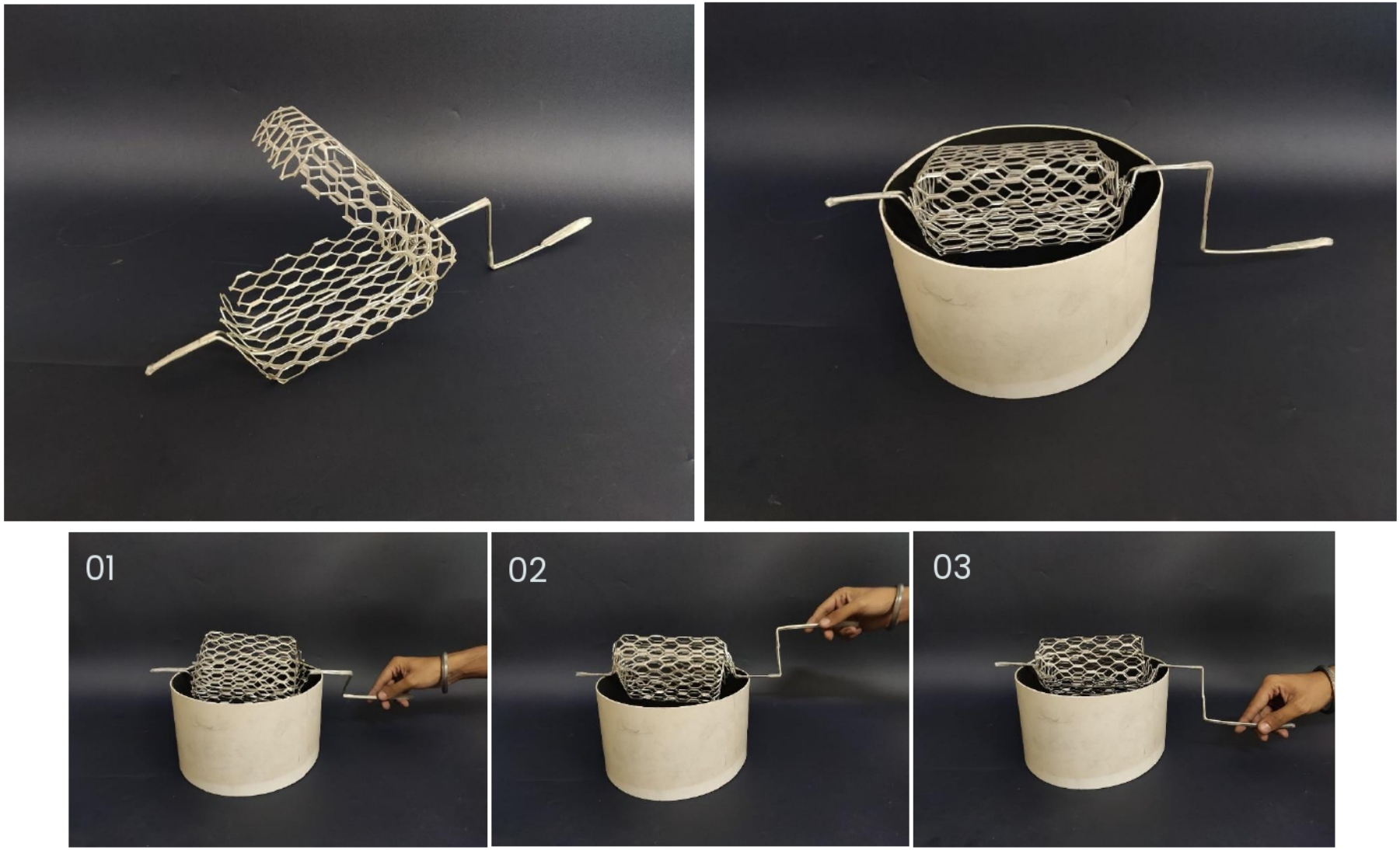


Figure 39-43: Working of mock-up 2

Mockup 3

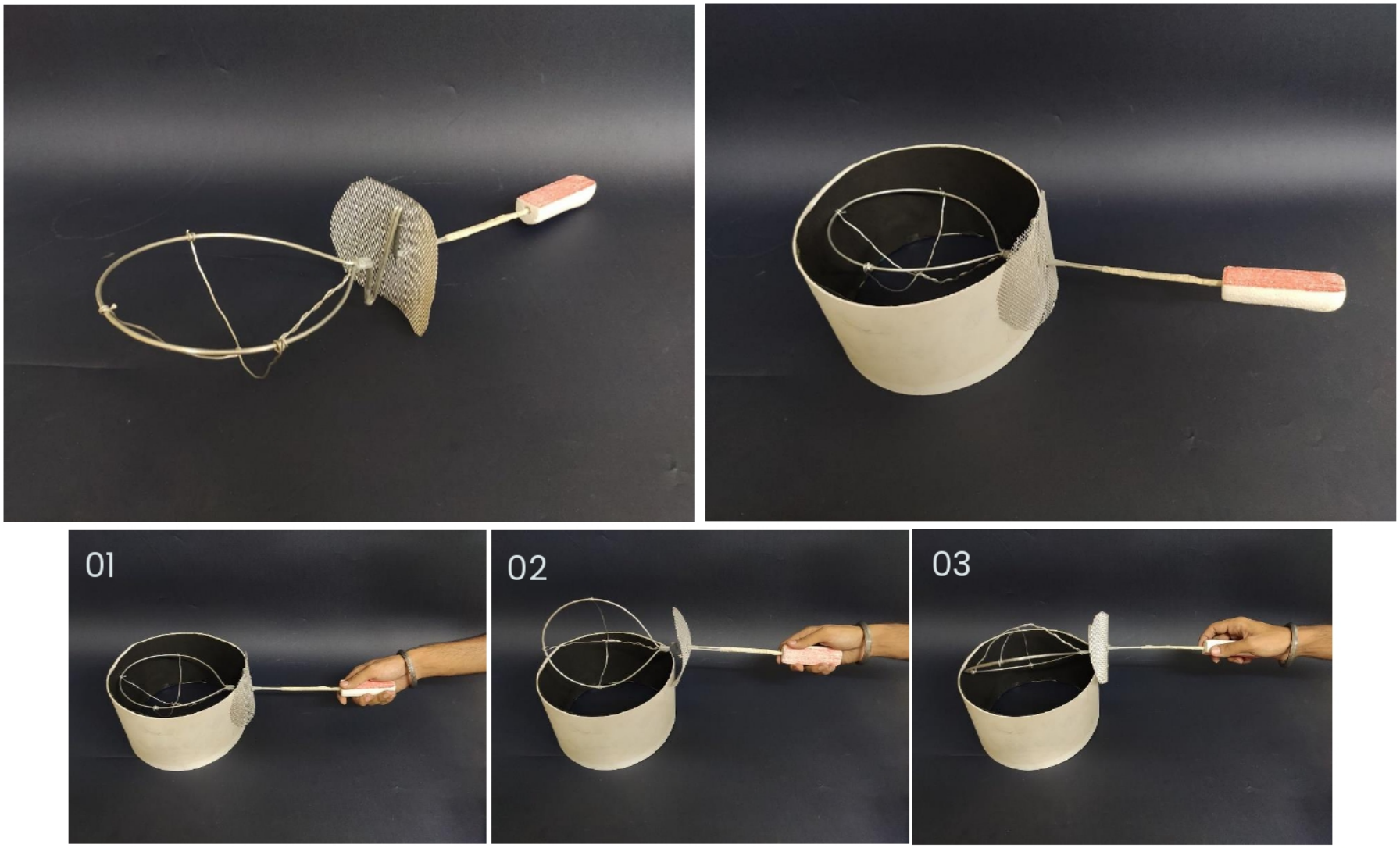


Figure 44-48: Working of mock-up 3

Mockup 4

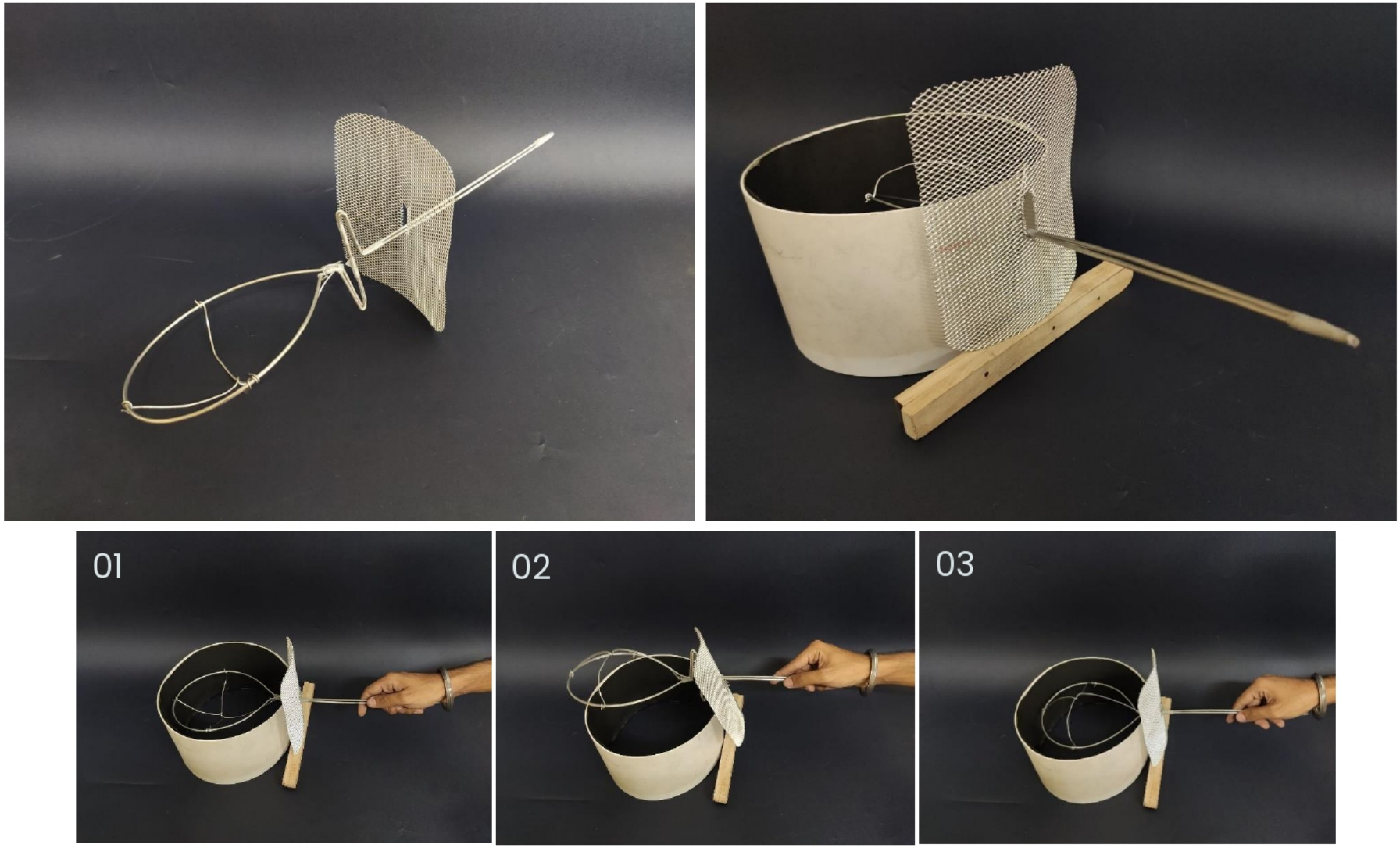


Figure 49-53: Working of mock-up 4

Mockup 5

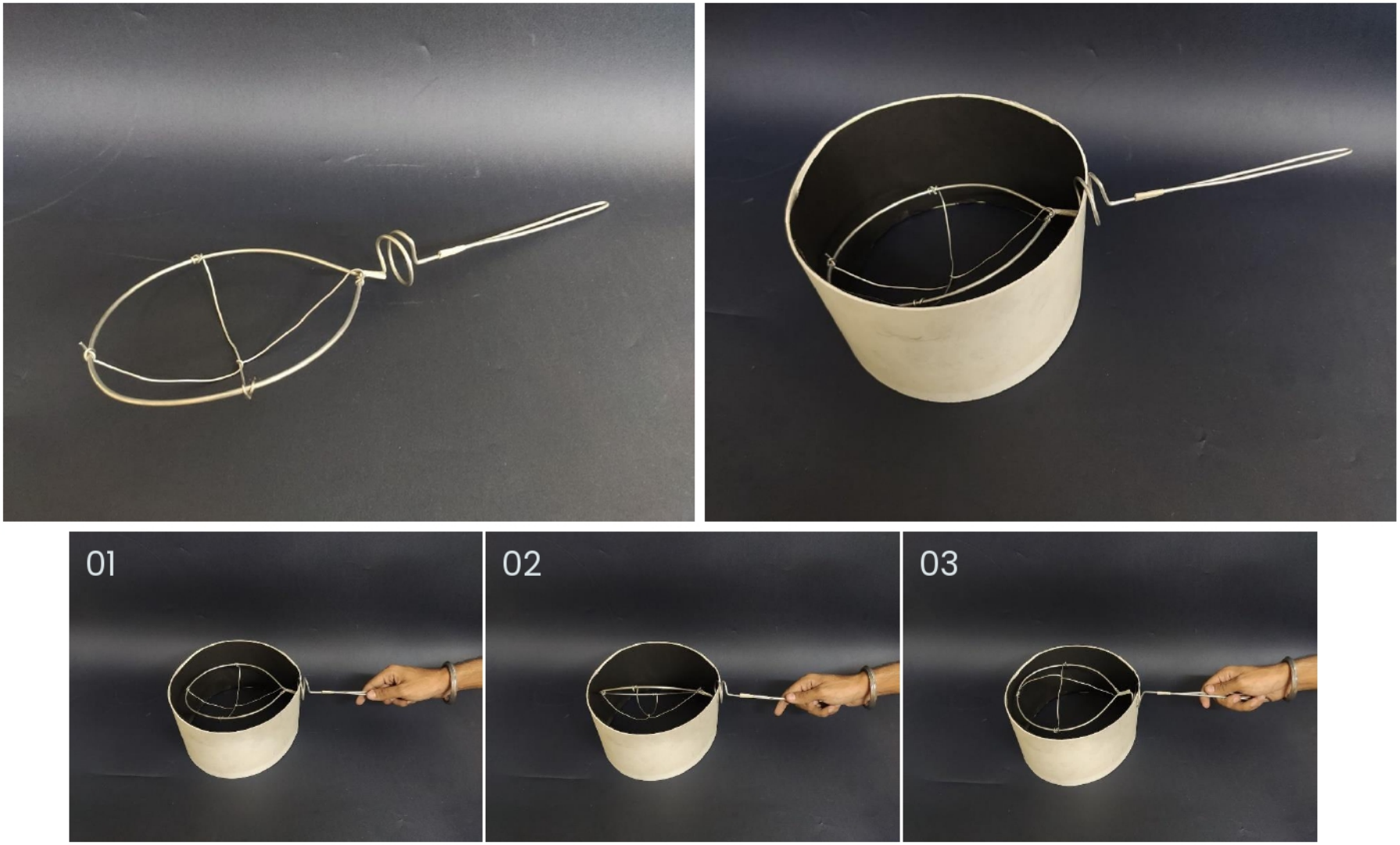


Figure 54-58: Working of mock-up 5

Mockup 6

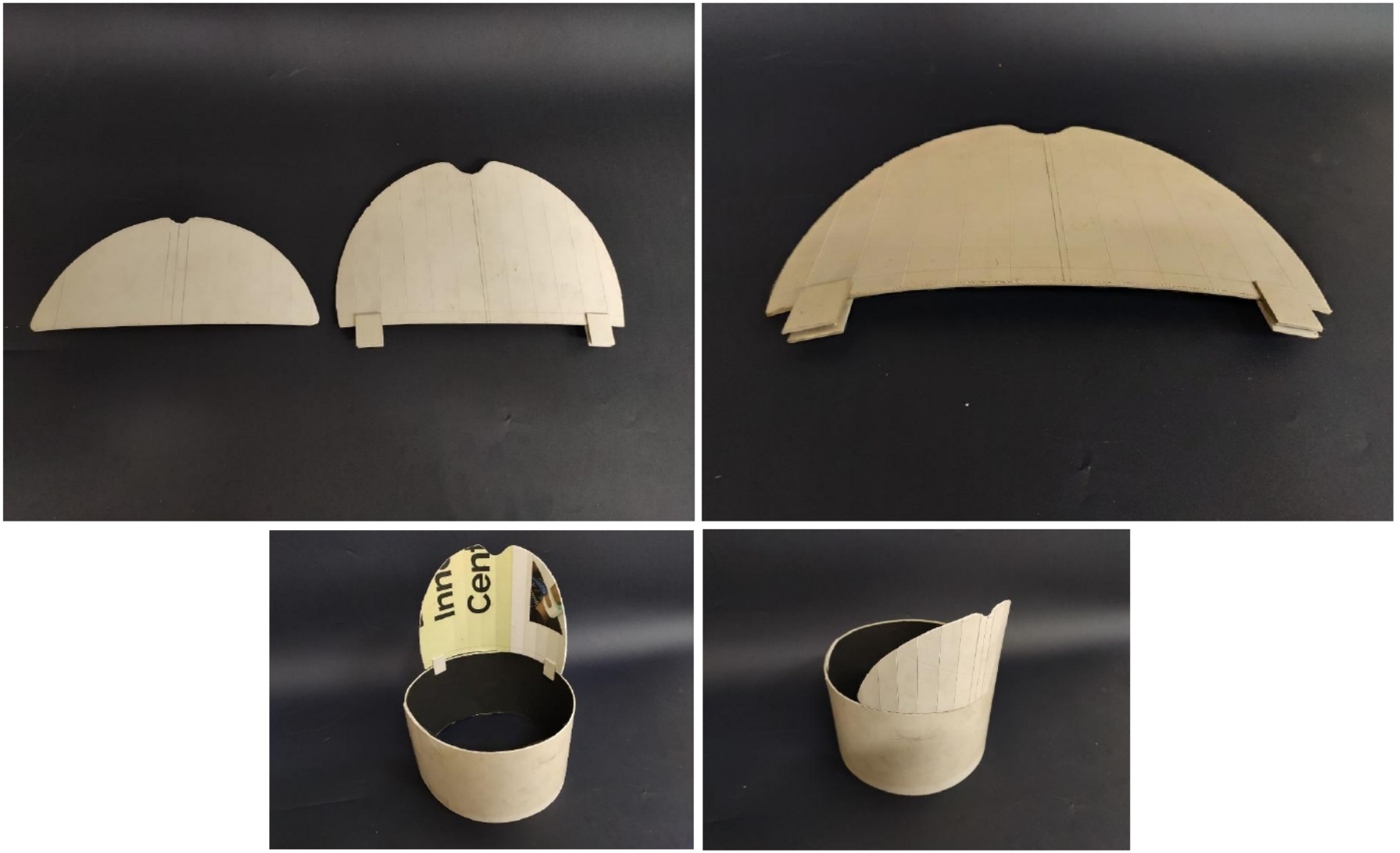


Figure 59-62: Mock-ups of splatter guard and working

9.0.2 Mockup Testing

For testing, 3 mock-ups were selected as shown in fig 63 and 2 participants were asked to perform the roleplay of using the tools with blindfold and issues were identified and noted for each mockup. This activity was done with blocked (or covered) eyes in order to generate a research perspective with regards to the elements of cooking by the blind individual and to understand the difficulties which target users may meet while deep frying.

For this process Participatory Design method is used. Participation, also called Participatory Design, is a method to ensure all users involved in the design development process, and the design results are functional and meet their demands.

Participatory Design is a design development approach which focuses on design development process rather than a design style in and of itself. Also, it is a method of creating interactive situations that are more answering to users' diverse needs. Also, Participatory Design indicates designers typically arrive at more innovative design concepts while following Participatory Design than by simply creating ideas on their own.

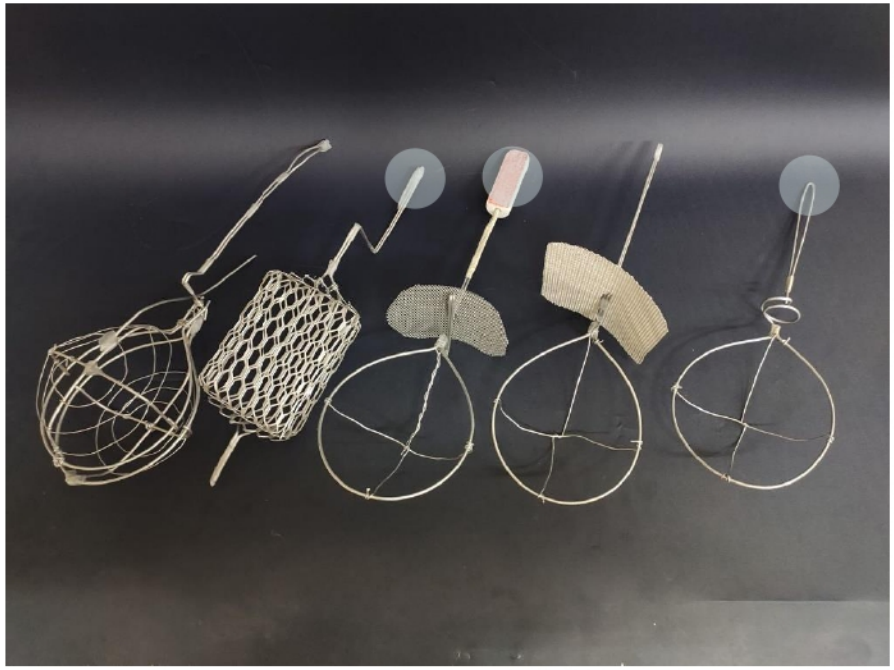
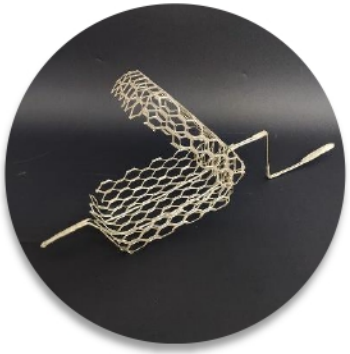


Figure 63: Selected mock-ups for testing

Testing of mockup 1 (Spinning Strainer)



Issues Identified:

- Handle orientation
- Opening hinge and putting ingredients - sideway better
- Placing strainer on vessel is difficult
- Feedback to know whether strainer is placed properly or not
- Unlocking the skimmer
- Knowing which side is up for removing cooked food
- Again putting ingredients in that skimmer for frying second batch of food
- Removing food from hot skimmer
- Spinning the spoon doesn't feel natural

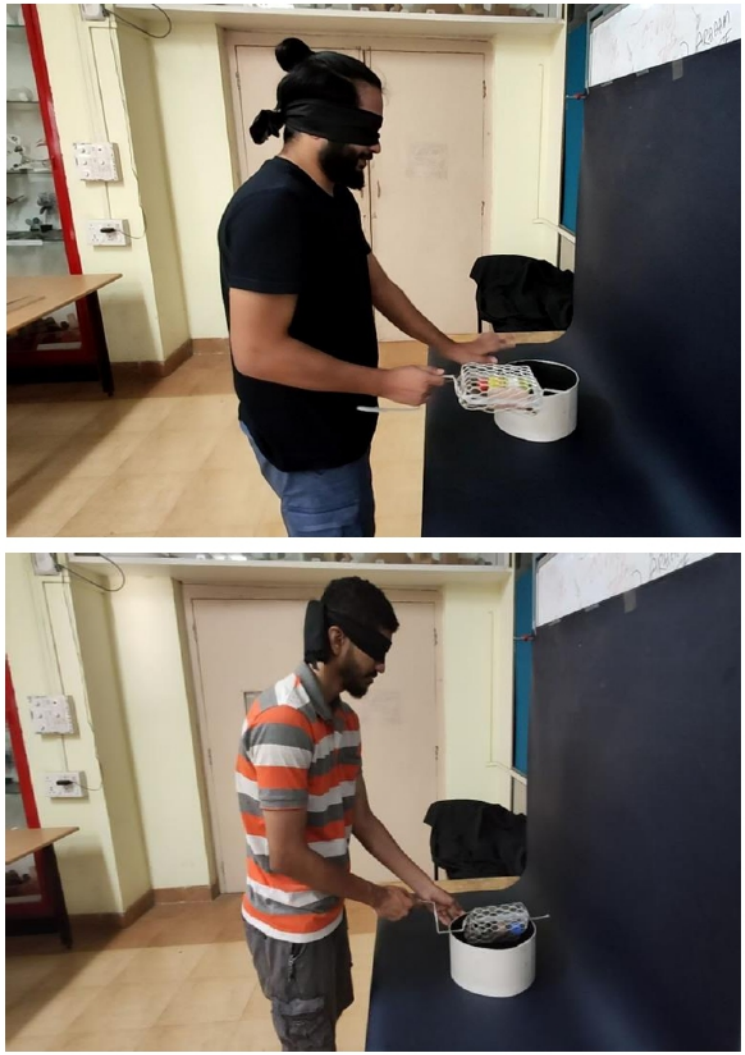


Figure 64-65: Participants testing mock-up 1

Testing of mockup 2 (Spiral Strainer)

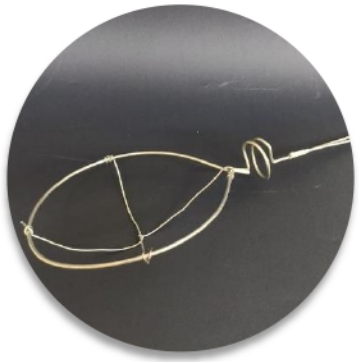


Figure 66-67: Participants testing mock-up 2

Issues Identified:

- Handle orientation
- Difficult to know where to stop
- Unstable while rotating
- Don't know which way to spin
- Positioning issues
- Tactile feedback was missing
- Spiral details creating confusion while using the strainer

Testing of mockup 3 (Zig-zag Strainer)

Figure 68-69: Participants testing mock-up 3

Issues Identified:

- Handle orientation
- Positioning over vessel
- Difficulty in guessing splatter guard location inside or outside of vessel
- Splatter guard creating confusion while using strainer
- No clue whether it is properly fixed over the vessel or not
- Tactile feedback was missing

10.0 Classification of deep frying pan

Deep-fry pans can vary based on their size, shape, and material used. There are also other specifications such as the handle length and whether the utensil is non-stick. It would help if you chose the Kadai which has most of the features you need and matches your cooking style too.

Deep-frying as the name says should be deep, so if your Kadai lacks that, you won't be able to deep-fry the food from both inner and outer areas properly. Indian deep-fried foods need that much depth and width to cook, especially in the case of dishes like samosas, vadas, or even jalebis. Though it might vary depending on the quantity.

A deep-frying pan with enough thickness and depth will also retain more heat, so your food will be less susceptible to burning.. In Indian homes generally from **1.5 litres to 5 litres** capacity of pan used and diameter of pan ranging from **24 cm to 38 cm** with depth ranging from **7 cm to 17 cm.**

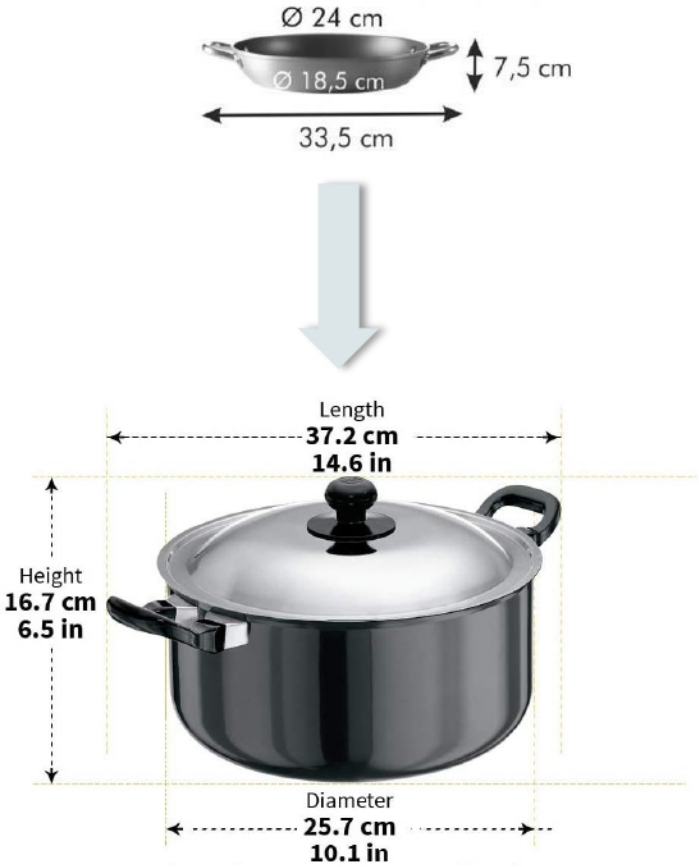


Figure 70: Dimensions of deep-frying pan

10.0.1 Deep frying temperature chart

Deep frying is done at high temperatures, usually between 350 and 375 °F. Since you're heating the oil much higher than it gets in a pan or the oven, it's super important to choose the right type of cooking fat.

Some oils are better suited for deep frying than others because they have a high smoke point—the temperature at which the oil starts to smoke and turn acrid. We like using heart-healthy oils like safflower oil and rice bran oil (which can be heated to almost 500° F). Other great choices are peanut oil, sunflower oil, or canola oil.

Some important precautions while frying would be-

- Never overcrowd the pan, which can cause the oil temperature to drop too low. Low oil temps not only take longer to cook, but they can also make your fried food taste soggy.
- Let the oil come all the way back up to temp before adding the next batch.

Following chart shows the temperature and time require to cook common deep-fried dishes in India.

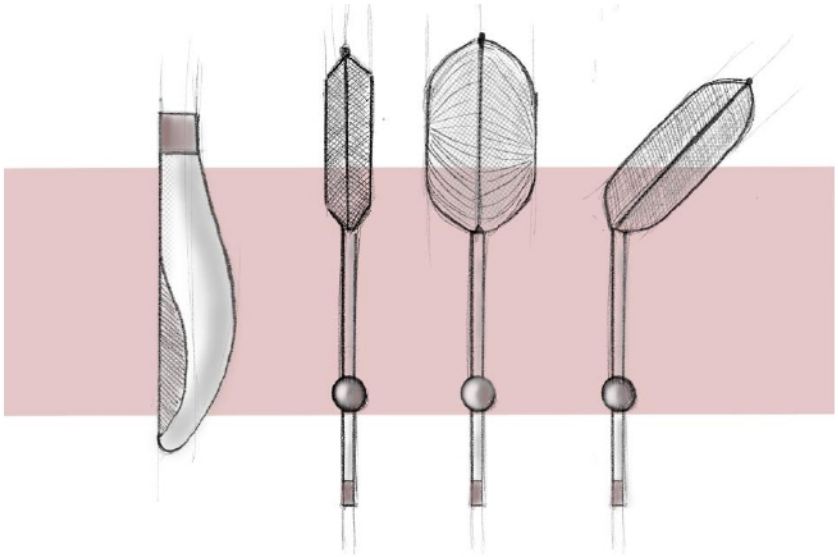
Food	Oil Temperature	Time
Puri	375 °F	1 to 2 minutes
Pakora	365 °F	4 to 6 minutes
Papad	350 °F	30 sec to 1 minutes
Potato fries	325 °F	6 to 8 minutes
Samosa	350 °F	8 to 10 minutes

Table 5: Temperature and time of deep-fried dishes

11.0 Concept Generation

Design direction 2 were selected which is “To design a set of accessories” based on the analysis of data. So, these ideations are done by taking direction 2 in consideration. From all the issues “Flipping of food” is the most challenging one and I tried to solve it here.

Ideation 1



In this ideation 3 different attachments are used for different types of foods which can be attach magnetically to handle.

Ideation 2

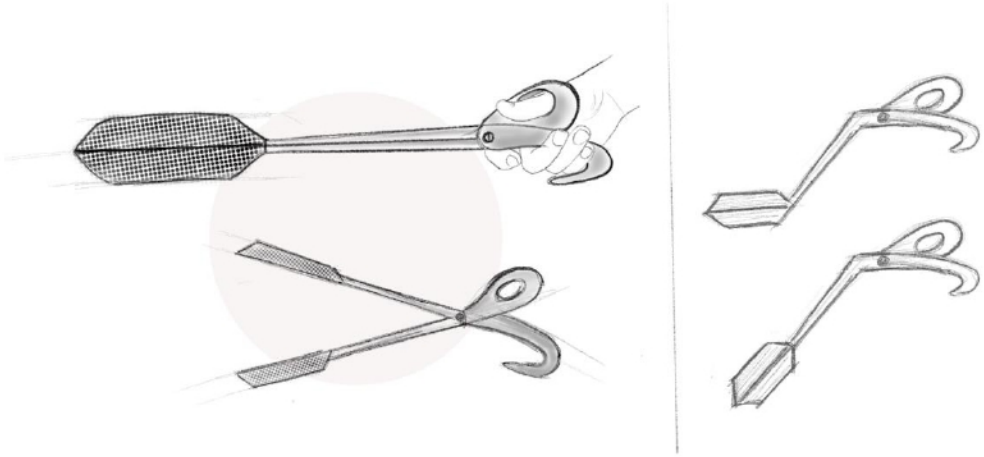


Figure 71-72: Ideations for flipping

This ideation is inspired from scissor mechanism which would help the strainer basket to open and close easily.

Concept 1 (180° Rotation)

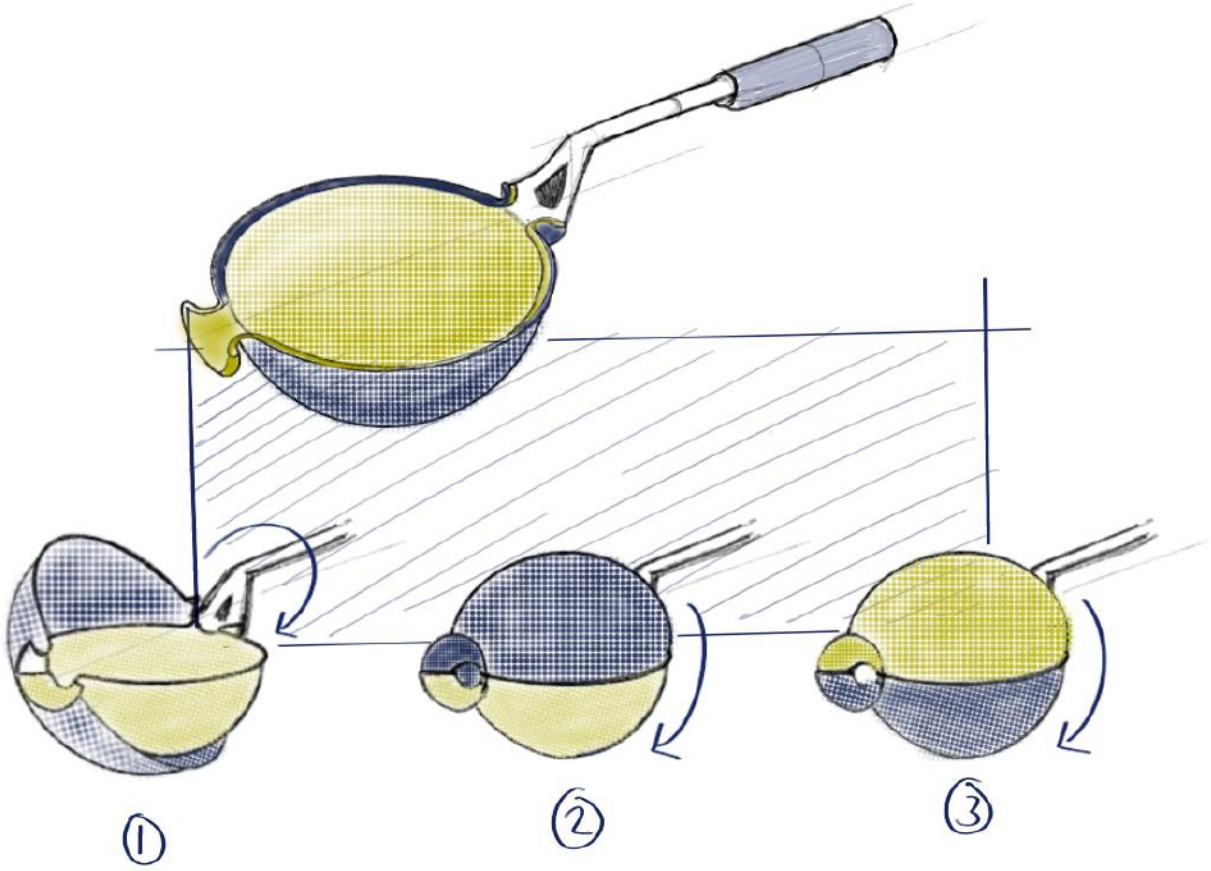


Figure 73: Components and working of Concept 1

This concept is inspired from the vegetable/fruit draining basket strainer where there are two colanders with holes for straining of oil attach with each other at one pivot support.

The handle is directly attached to the outer basket. With the rotation of 180 degree of handle the outer basket also rotate and cover the inner basket as shown in step 2 which also act as a splatter guard. If we rotate again then whole unit will get flipped to 180 degrees as shown in step 3 hence, we can achieve flipping of food cooked inside the strainer. Also, with the rotation of again 360 degrees it will come to its original position.

Concept 2 (180° Rotation)

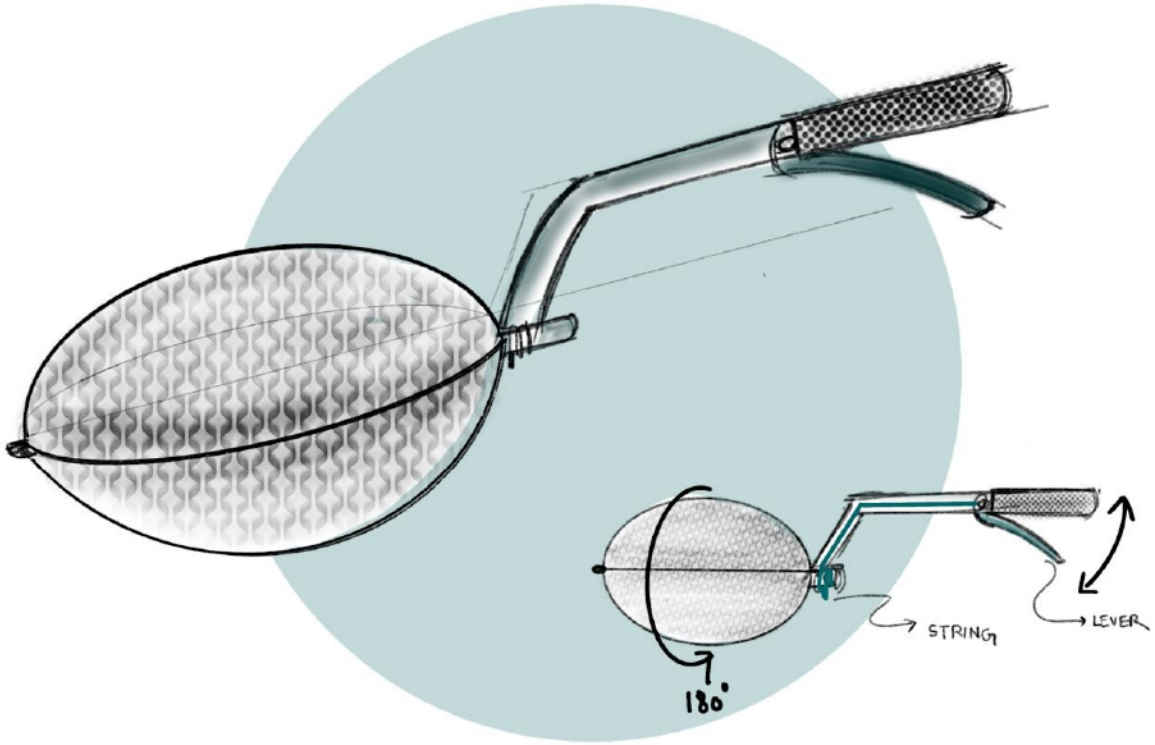


Figure 74: Components and working of Concept 2

This concept was also ideated to achieve 180-degree rotation. So, this strainer has two metal baskets connected at one pivot support.

Lever is attached to the handle which is directly connected to the basket through the metal string which is passing internally from the handle. By pressing the lever, the wire gets stretched and it will rotate the basket 180 degree. Also, the spring will be attached to the junction part of handle and basket so that basket will come to its original position when release. In this way food will get change their side.

Concept 3 (180° Rotation)

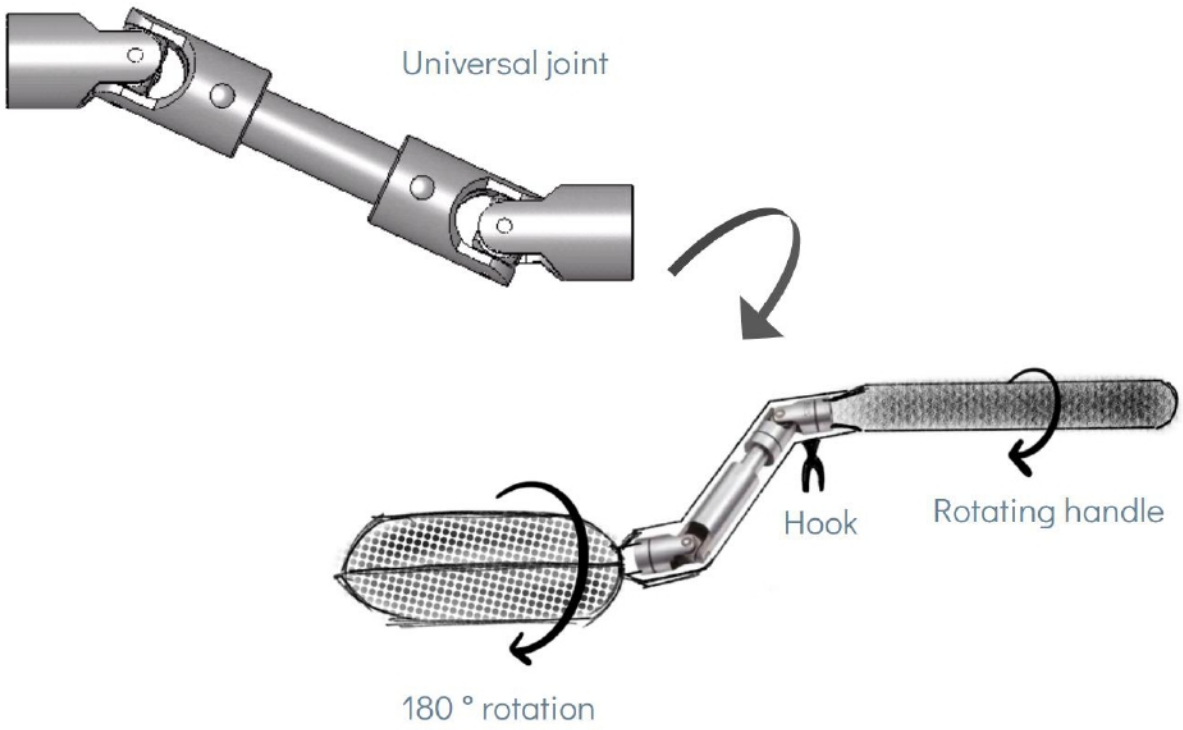


Figure 75: Components and working of Concept 3

This concept is based on the mechanism of universal joint where it is attached internally to the handle and basket.

By rotating the handle, we can achieve the rotation on basket side and it gets flipped to 180 degree. Also, hook is attached to the handle so that it can easily mount over the vessel which provides stability while rotating the handle.

Concept 4 (90° Rotation)

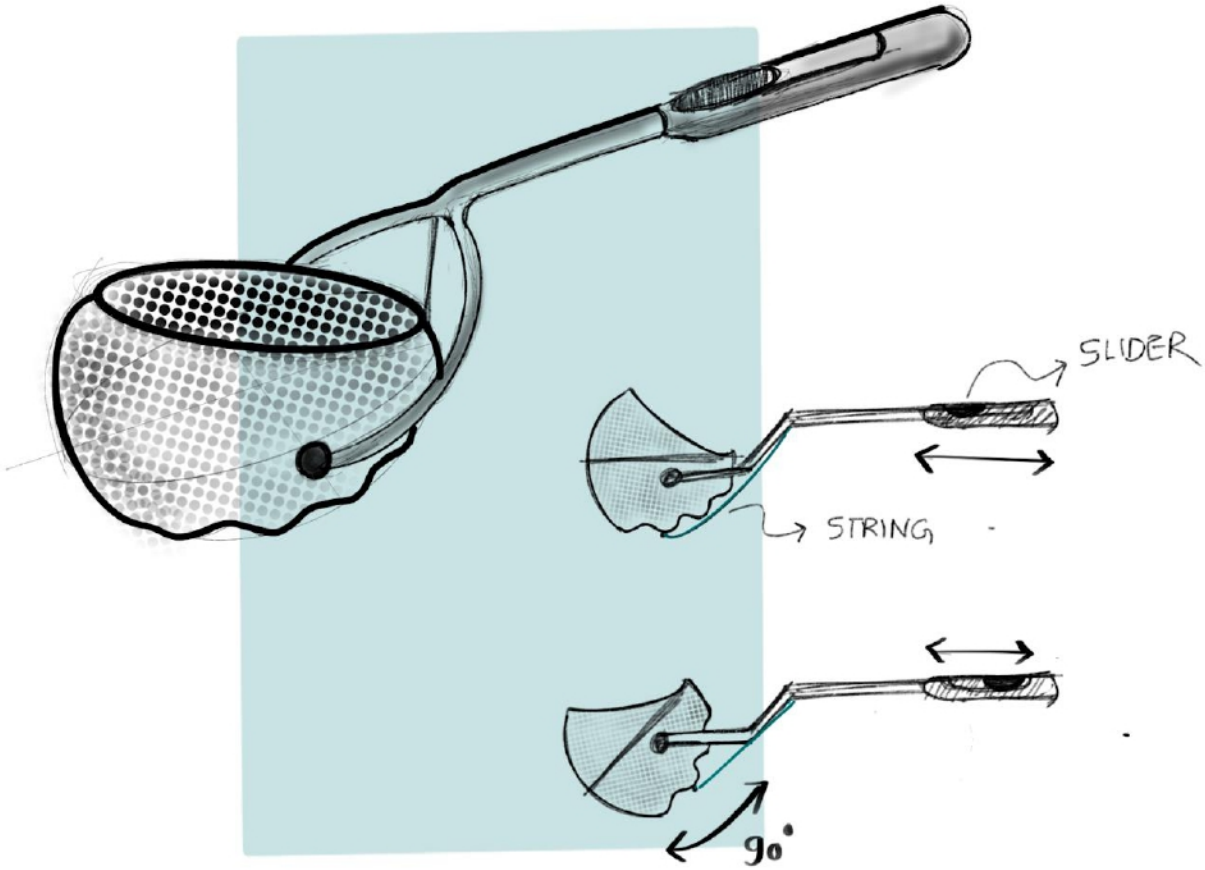


Figure 76: Components and working of Concept 4

This concept was ideated to achieve 90 degrees of rotation. The strainer has single basket which is attached to the handle part by two pivot joints. Also, to achieve the movement of the basket the metal string is attached to the basket and other end is fixed to the slider of the handle. By moving the slider forward and backward the string gets stretched and it will rotate the basket to 90 degrees.

The basket has detailing of depression on one side so that food will get surface to stuck and flip the slide just by rotation of 90 degrees. The food will get flipped and move to the other side of basket.

11.0.1 Mockup Testing 1

Three mock-ups were made from the concepts to test the mechanism for 90 degrees and 180 degrees rotation. The following figure shows the props which were used to taste the mock-ups, made from cardboard, foam and modelling clay.

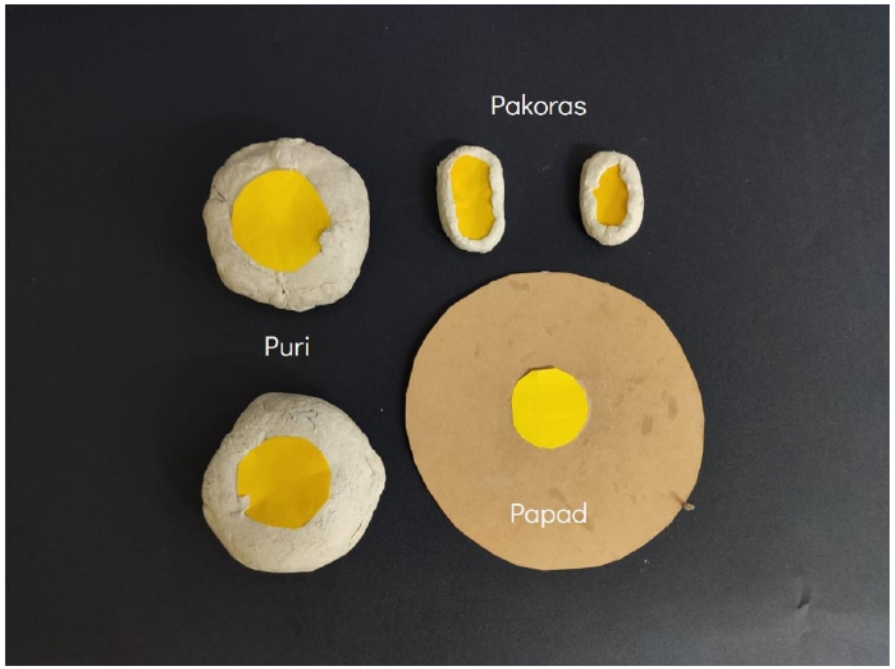


Figure 77: Props used for experiment

Figure shows the props of puri, papad and pakora which are labelled in yellow colour on one side so that the flipping can be easily identified.

Mockup 1 (90° Rotation)

This mock-up was made by modifying plastic vegetable strainer. To achieve extra friction the plastic mesh was attached to the inner basket as shown in fig. 78.

Figure 78: Image showing mock-up 1

Testing was done with 3 props as shown in fig. 79 and problems were identified.

Figure 79: Testing of mock-up with props

Observation:

- Puri and pakoras were rotating good but still bottom friction was not helping so much for flipping.
- Papad was not flipped properly.
- After rotate to 90 degree, very small surface was available.
- Gap between the two baskets should be minimum as possible.

Mockup 1.1 (90° Rotation)

This mock-up is an updated version of mockup 1 and was made by modifying plastic vegetable strainer. To achieve extra friction, modelling clay bulge applied over the plastic mesh as shown in fig. 80.

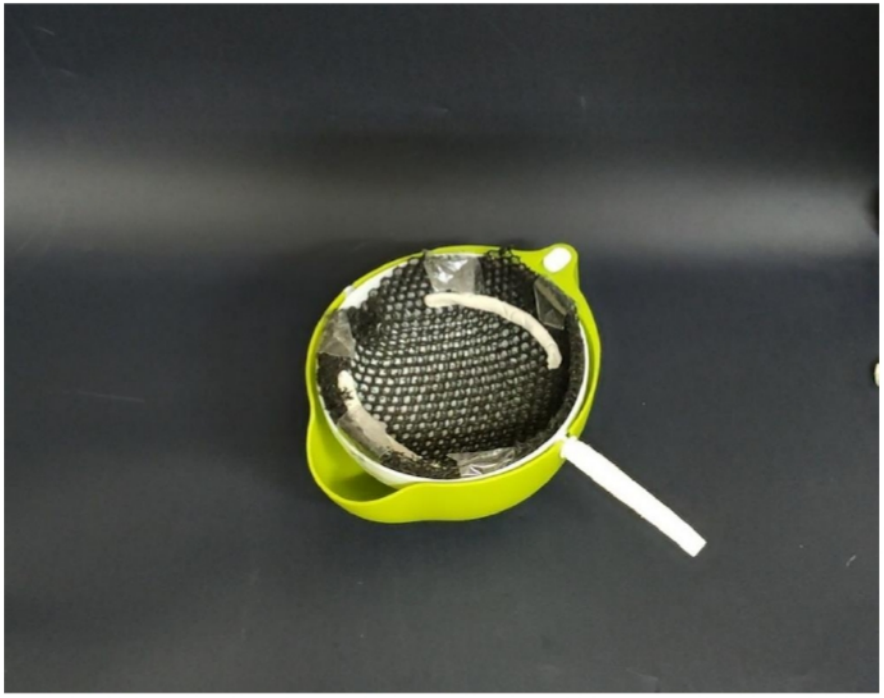


Figure 80: Image showing mock-up 1.1

Testing was done with 3 props as shown in fig. 81 and problems were identified.

Figure 81: Testing of mock-up with props

Observation:

- Puri and pakoras were rotating better than the previous mockup because of extra friction.
- Papad was flipped properly this time.
- After rotate to 90 degree, very small surface was available.
- Gap between the two baskets should be minimum as possible.

Mockup 2 (90° Rotation)

This mock-up was also made by modifying plastic vegetable strainer. To achieve extra friction the metal mesh was moulded in wavy pattern and attached to the inner basket as shown in fig. 82.

Figure 81: Image showing mock-up 2

Testing was done with 3 props as shown in fig. 83 and problems were identified.

Figure 82: Testing of mock-up with props

Observation:

- Puri and pakoras were rotating good but wavy pattern wasn't helped much.
- Papad was not flipped at all.
- After rotate to 90 degree, very small surface was available.
- Gap between the two baskets should be minimum as possible.

Mockup 2.1 (90° Rotation)

This mock-up is an updated version of mockup 2 and was made by modifying plastic vegetable strainer. To achieve extra friction, modelling clay bulge applied over the plastic mesh as shown in fig. 83.

Figure 83: Image showing mock-up 2.1

Testing was done with 3 props as shown in fig. 84 and problems were identified.

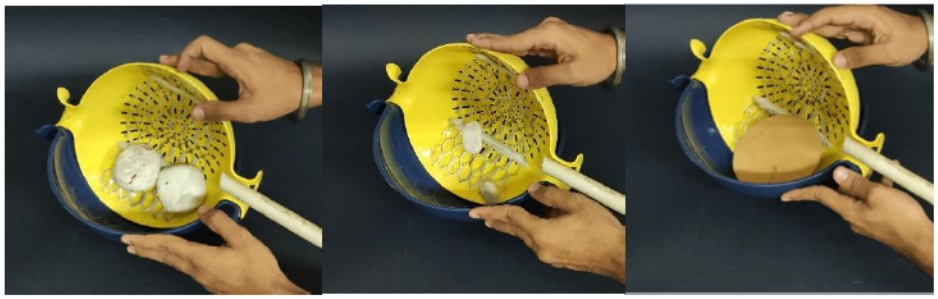


Figure 84: Testing of mock-up with props

Observation:

- Puri and pakoras were rotating better than the previous mockup because of extra friction of clay bulge.
- Papad was flipped properly this time.
- After rotate to 90 degree, very small surface was available.
- Gap between the two baskets should be minimum as possible.

Mockup 3 (180° Rotation)

This mockup was made to check the flipping of food by 180 degrees. The aluminium metal mesh was used to make a basket, aluminium wire for support and PVC pipes were used as a handle and side support. The string is attached to the nail of pivot support and passed through the PVC handle. For counteraction of basket one rubber band is attached.

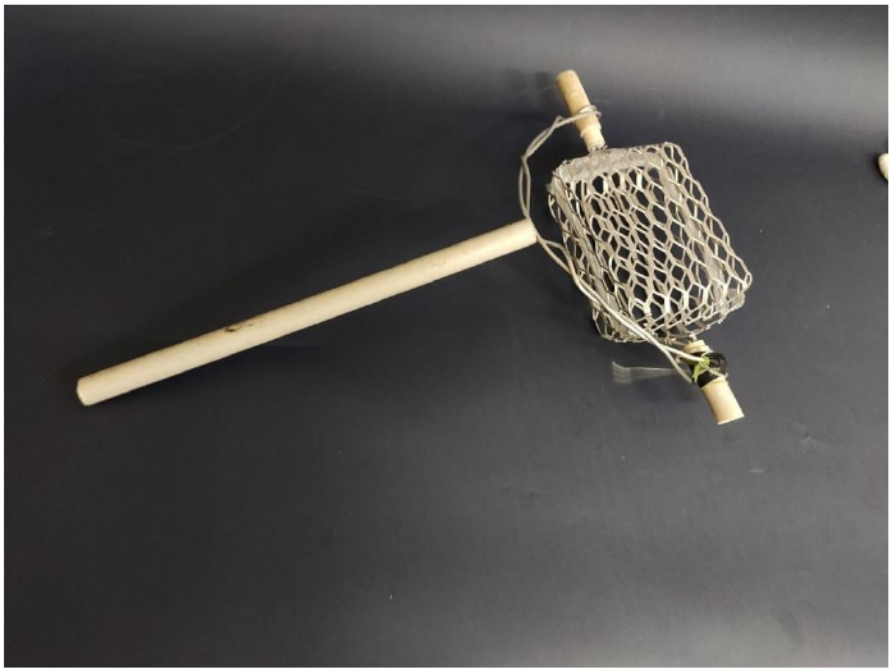


Figure 85: Image showing mock-up 3

Testing was done with some weight and without props, as shown in fig and problems were identified.

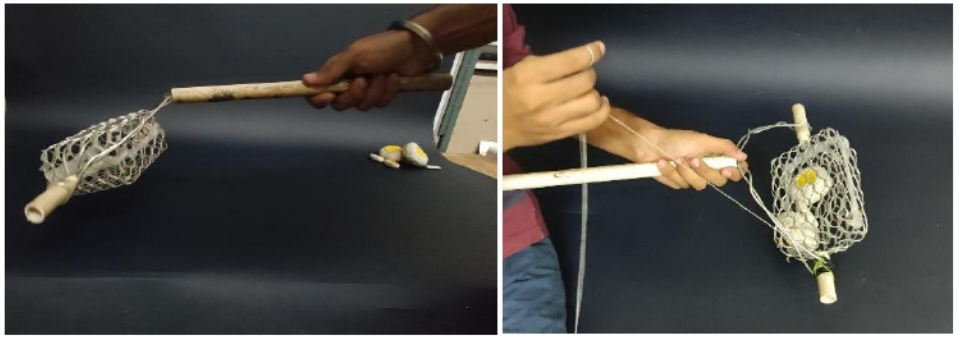


Figure 86-87: Testing of mock-up with props

Observation:

- Without any weight, it was rotating easily but still, it wasn't that smooth.
- Couldn't achieve proper 180-degree rotation.
- After adding props, it was very difficult to rotate.
- While rotating, the props were accumulating to one side.
- The position of the string should be perfect for proper rotation.

11.0.2 Mockup Testing 2

This testing was conducted to gain insights on the behaviour of props when in contact with liquid. For this experiment two mock-ups 1 and 2 were selected. A tub filled with water is used which is imitating the frying vessel and oil. The experiment was done with the two levels of oil i.e. 1/3rd and 2/3rd and issues were identified from both the mock-ups.

1/3rd level

The tub was filled with 1/3rd of water and both the mock-ups were tested with all three props. Fig 88. Showing the testing of Mockup 1 in water. Observation was done for each prop and issues were identified.

Figure 88: Testing of mock-up 1 with props in water

Mockup 2 was tested as shown in fig. 89

Figure 89: Testing of mock-up 2 with props in water

Observation:

- The props were not able to fully submerged in water because of the low level.
- Height of the mockup 1 was high because of the gap between the two baskets causing water was not touching the inner basket properly.
- In mockup 1 the mesh was not helping in flipping of props, it was sliding over it.
- Wavy bulge on mockup 2 was helping to change the side of the props and it was better than previous mockup.
- Papad wasn't flipped in both the cases as it floats on water.

2/3rd level

Now, the tub was filled with 2/3rd of water and mockup 2 was tested with all three props. Fig 90. Showing the testing of Mockup 2 in water. Observation was done for each prop and issues were identified.

Figure 90: Testing of mock-up 2 with props in 2/3rd water

Observation:

- Level of the water seems perfect as props were submerged into it.
- For extra friction the clay bump was fixed inside the basket which was helping props to flip easlily.
- In this case papad changed the side by the help of extra bulge.
- It was observed that flipping the props outside water was better than flipping it inside also it will reduce the chances of oil splattering.
- Level of the oil should be perfect while frying otherwise food won't fry properly.

12.0 Final Concept

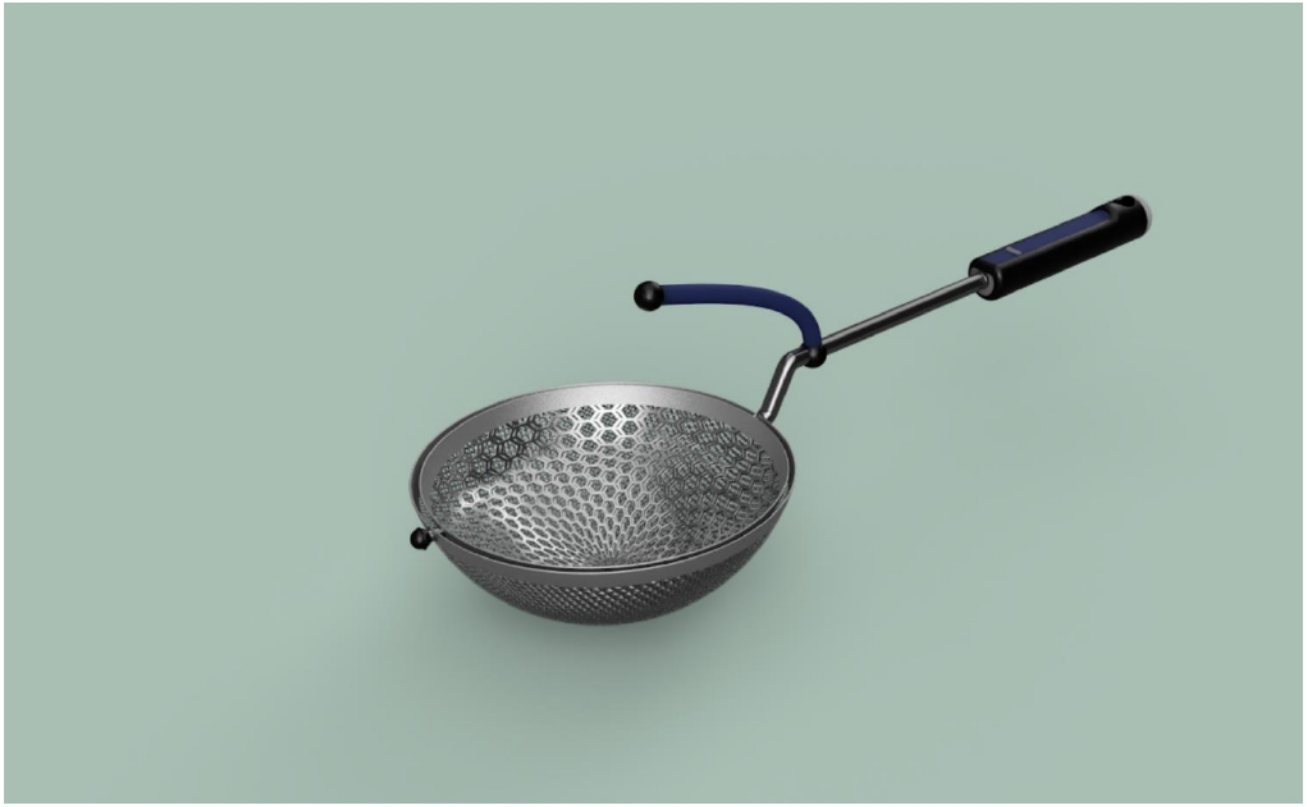


Figure 91: CAD model of final concept

This is the CAD model of final concept as shown on fig 91. In this concept there are two metal colanders with different diameter attached through the pivot support. Outer colander is detachable and can be easily attached just by snapping.

There is one reference guard for positioning of hand while putting food inside the strainer. Also, handle is magnetically attached as shown in figure so that it will prevent from any accident. Handle was designed with tactile feedback so that VIP can understand the orientation of strainer.

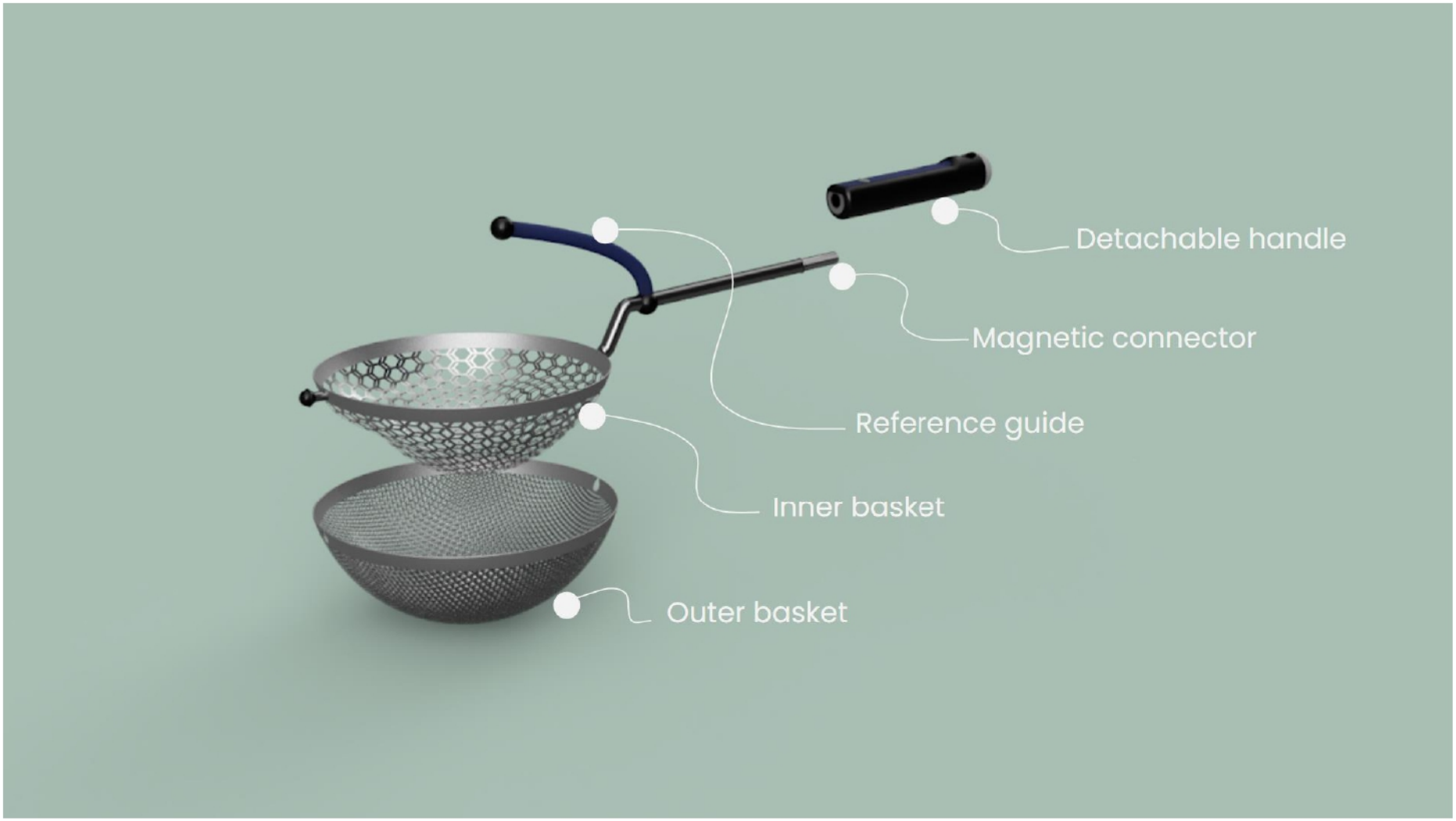


Figure 92: Exploded view and components of final concept

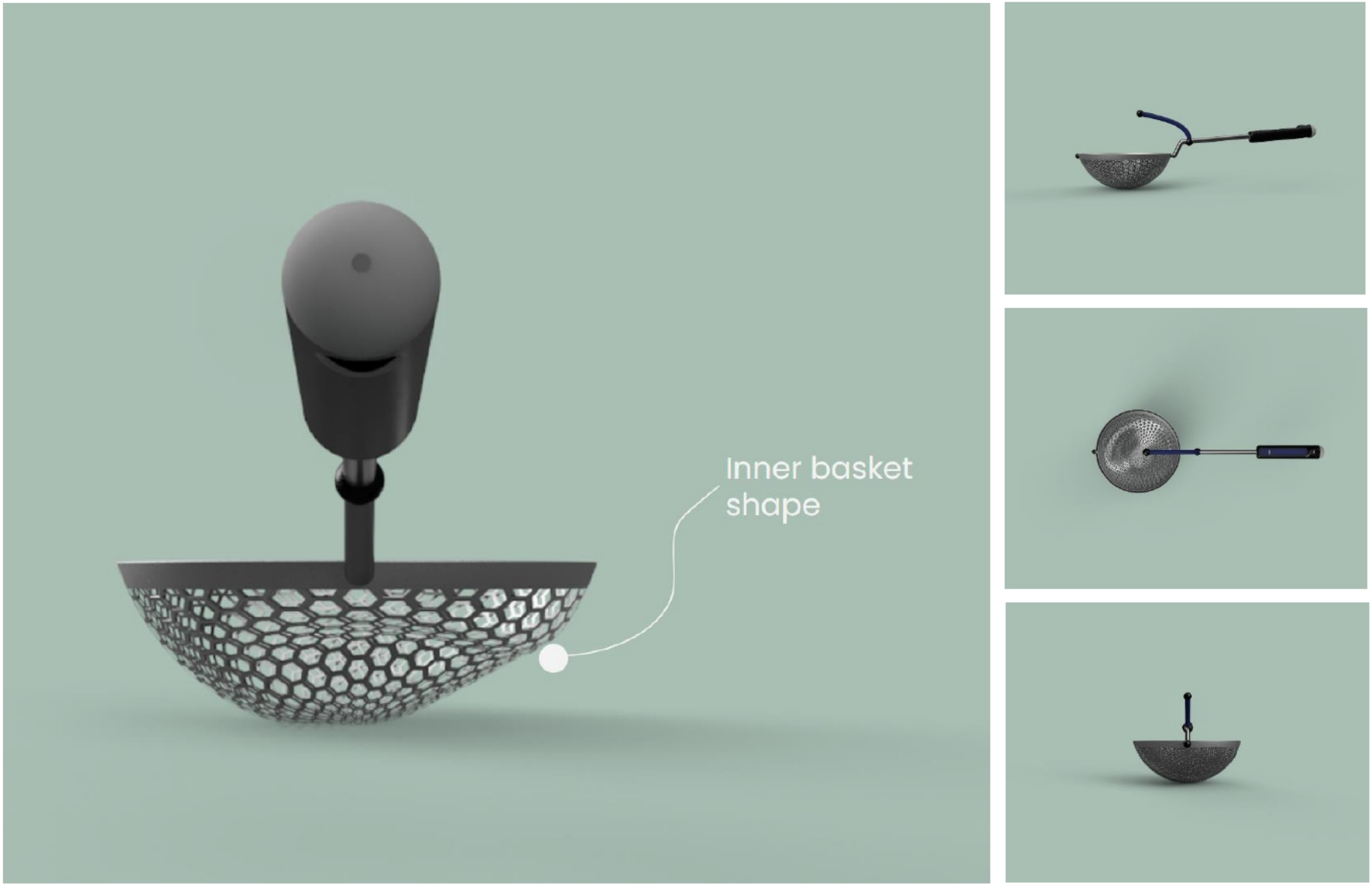


Figure 93-96: Details of final concept

12.0.1 Details

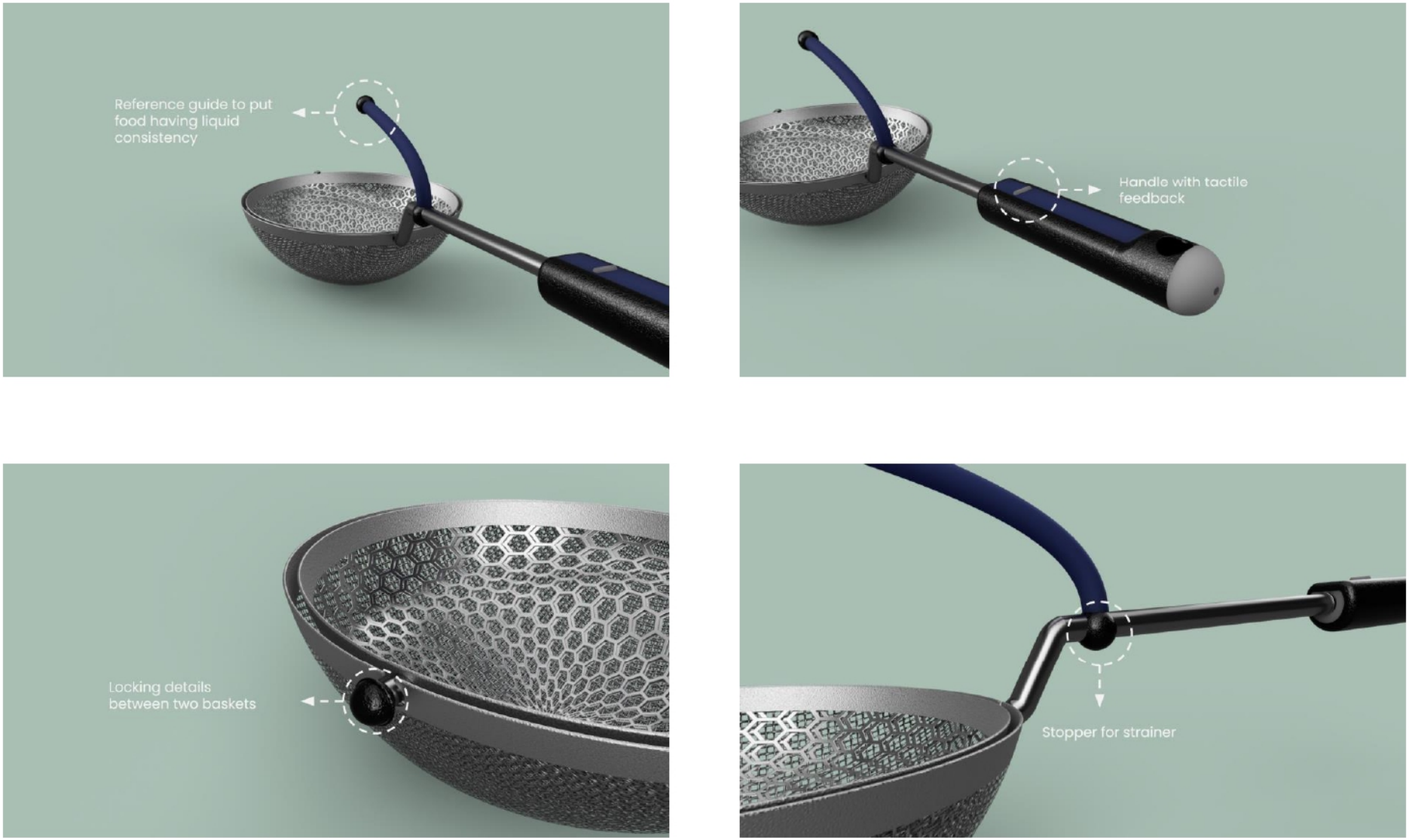


Figure 97-100: Features of final concept

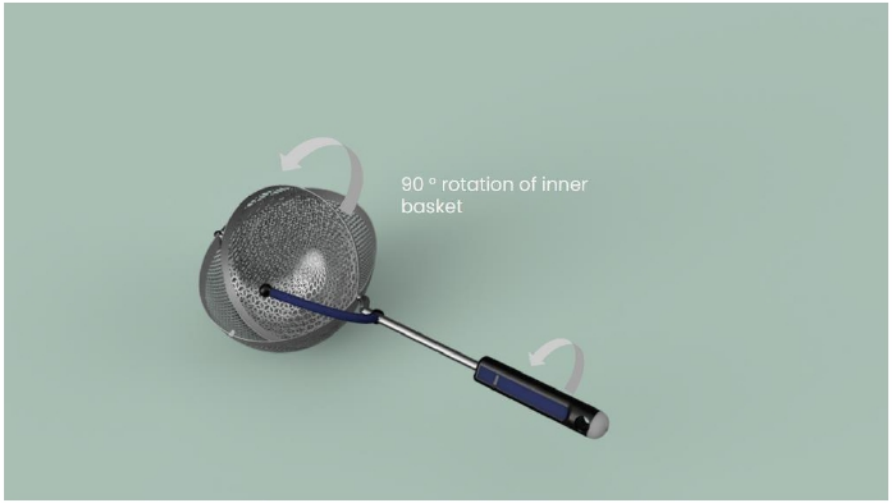


Figure 101-102: Features of final concept

As shown in images, the shape of inner basket is different. It has bulge on one side so that it can help in flipping of food. There are two types of stainless-steel mesh used in the basket, one with fine mesh and one with hexagonal perforated mesh for better drainage of oil.

The reference guard will help the VIP to put the food correctly in centre of the strainer. The handle is magnetically attached to the main body so that it can detach easily when someone accidently pulls their hands back. In this way it will maintain the safety while frying. Locking details between two baskets is very simple, easily detachable. There is one stopper on the handle bar so that it can properly fix over a vessel. Also, there is one stopper attached on an outer basket so that it will be easy when taking out food from vessel.

13.0 Revised Final Design

Figure 103: CAD model of revised final concept

This is the revised design which is universal and completely made from nylon reinforced fiberglass material. The main advantage of nylon is that it is food grade and it is heat resistant up to 225°C. There are two colanders with different diameter attached through the pivot support. Outer colander is detachable and inner colander has flat bottom so that it prevents food with liquid consistency from sticking.

There are reference guides for positioning of hand while putting food inside the strainer. Handle was designed with tactile feedback so that VIP can understand the orientation of strainer.

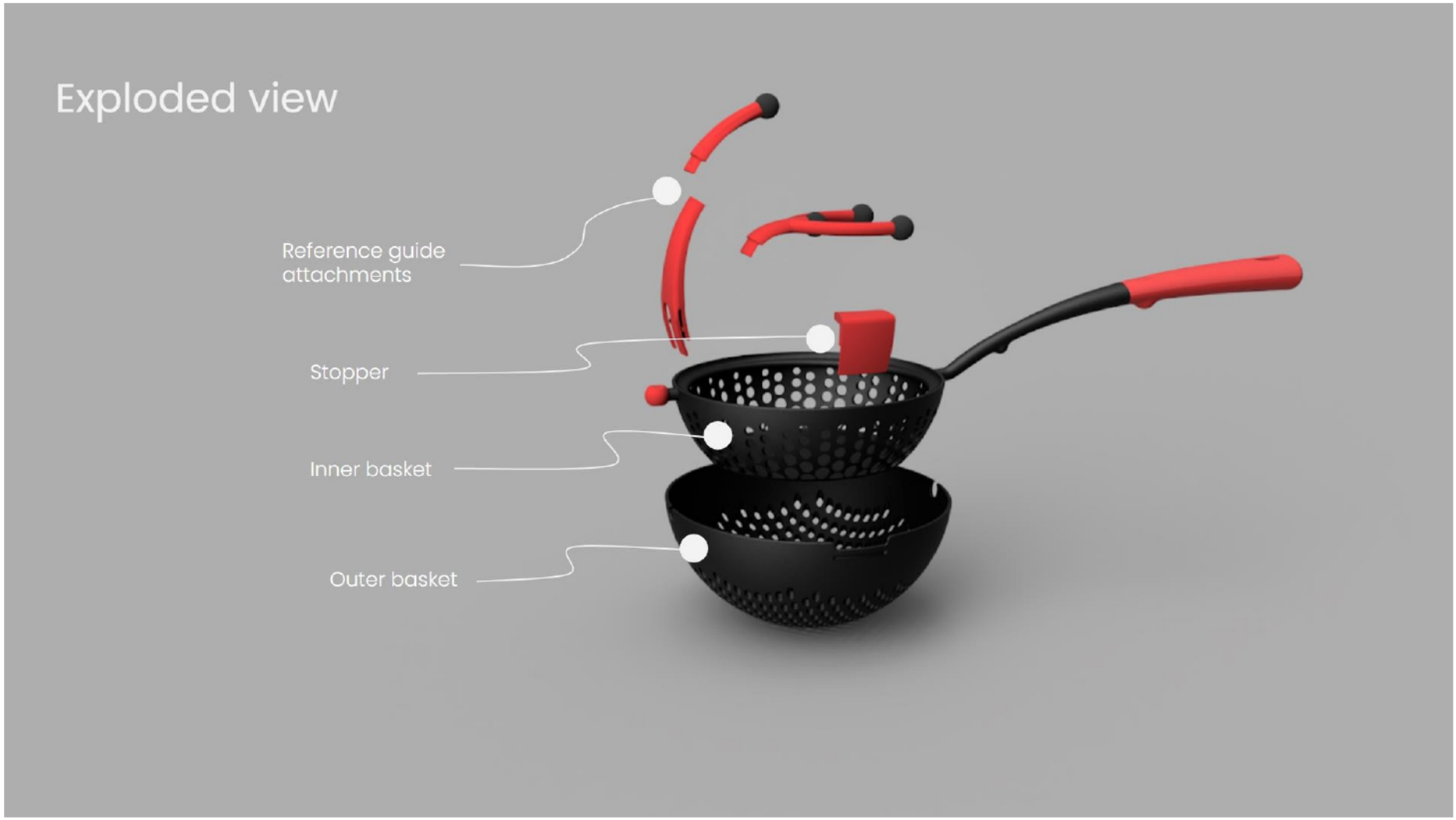


Figure 104: Exploded view and components of revised final design

Figure 105: Components of revised final design

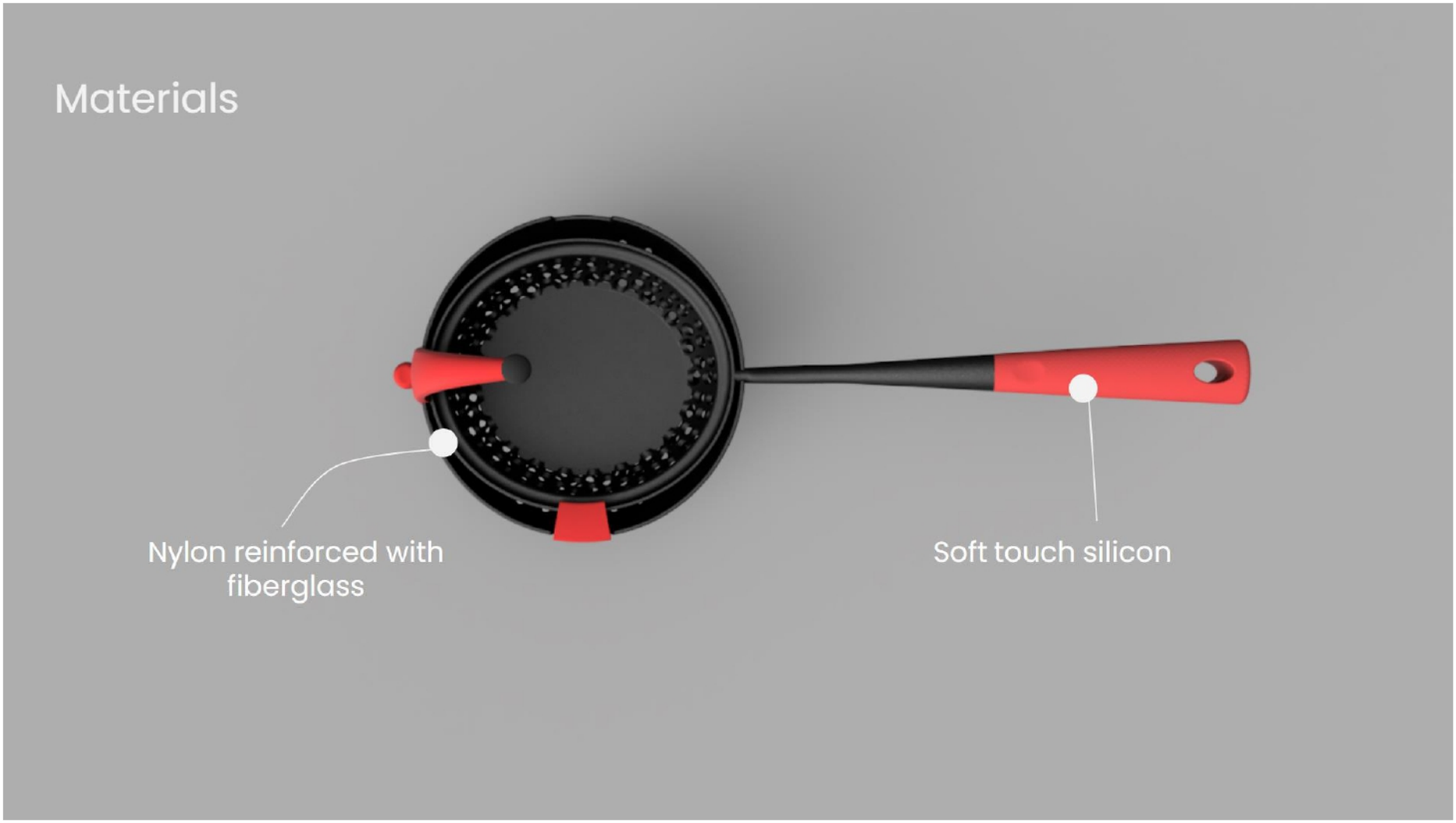


Figure 106: Materials of revised final design

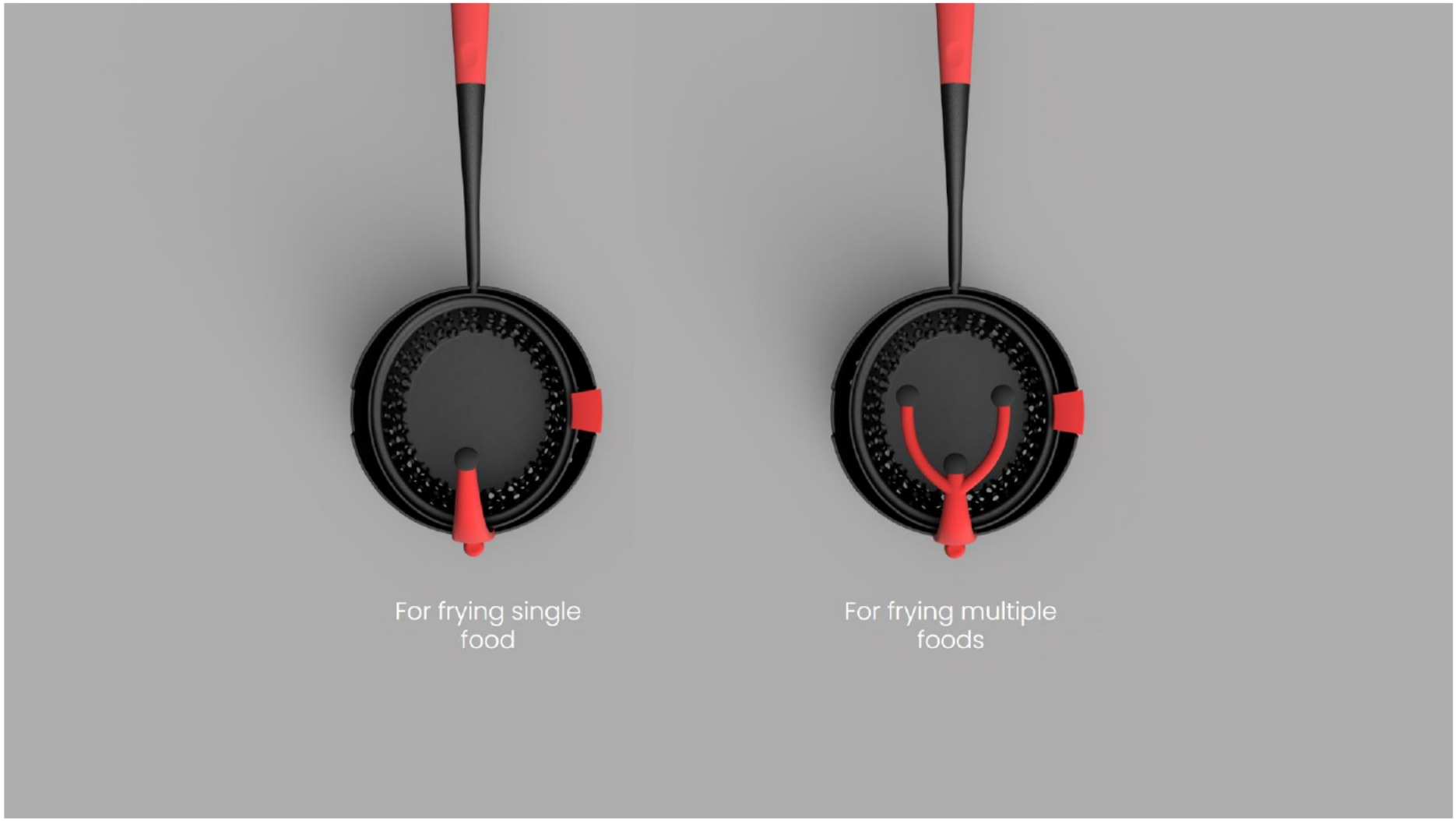


Figure 107: Function of reference guide

13.0.1 Details

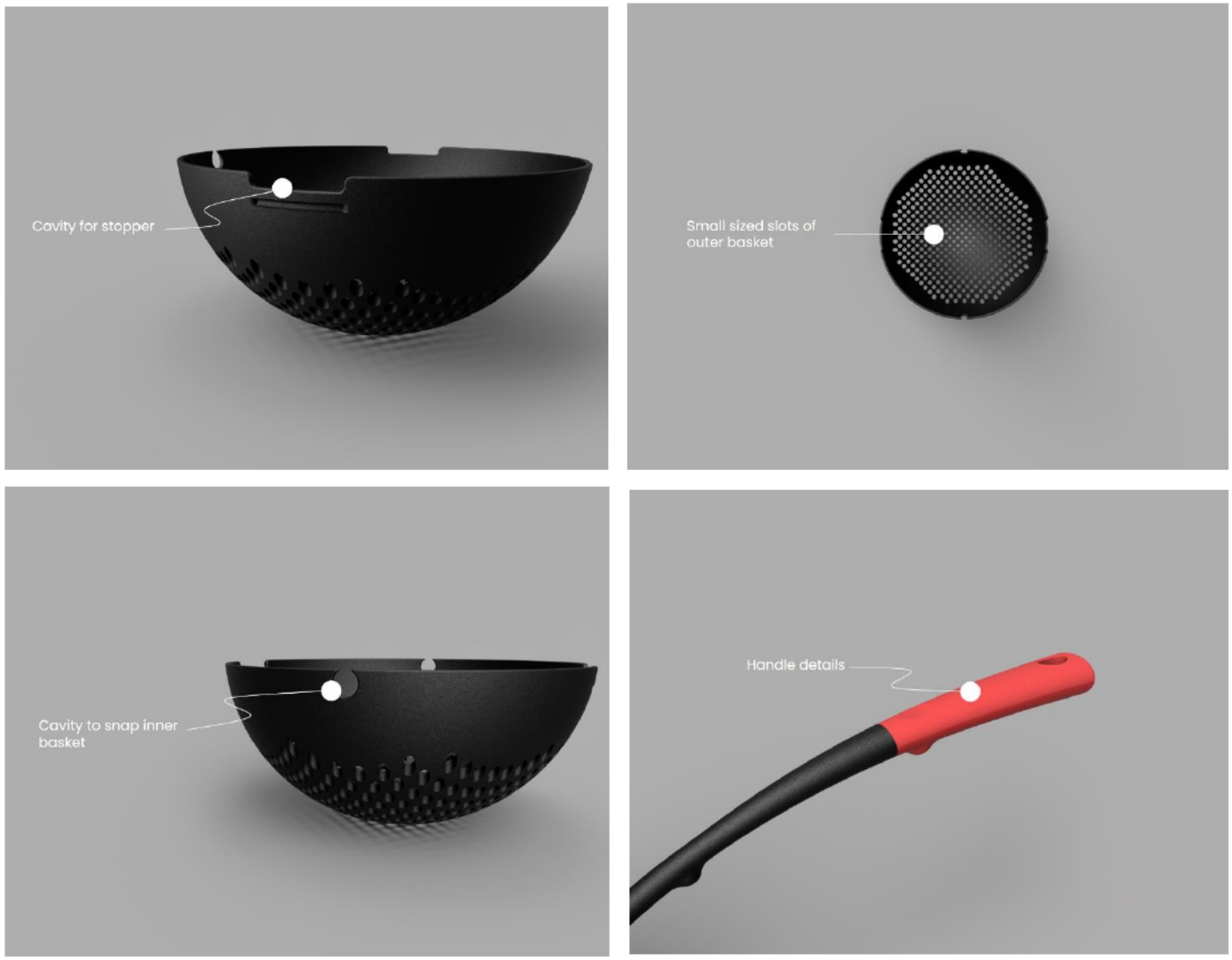


Figure108-111: Details of revised final design

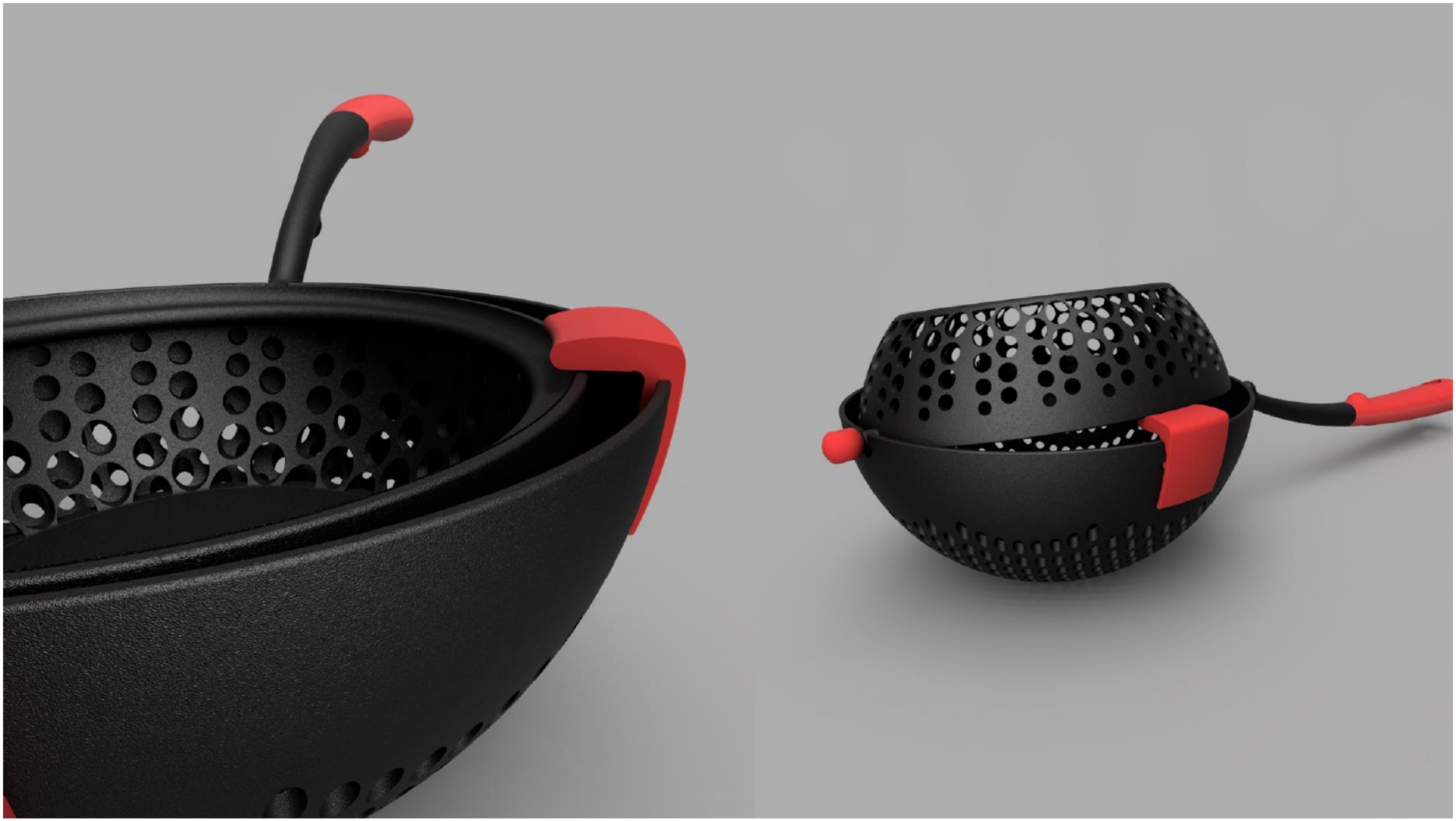


Figure 112: Details of stopper

14.0 Conclusion

The proposed design is simple and it would empower the individuals with vision impairments to perform deep frying activity independently and with confidence.

To design an aid for the visually impaired requires a deep understanding of their practices, preferences and problems. Touch and sound are the most important senses of visually impaired people and the final concept was designed by taking these parameters in consideration.

The essence of problem solving is discovering a shared problem by a target user group and identifying a method to solve the problem or refining current solutions. The objective of design is generating a better quality of life for target users, or even more specific, to create a simpler interactive relationship between users and designed items. Design should not be solely an independent activity completed by designers, true design is an interactive development process between users and designers; in other words, the design process requires collaboration to be effective.

By doing experiment with a temporary blindness, I experienced the general difficulties of the user group. A designer's responsibility is using professional design knowledge to analyse collected data when generating design concepts; a target user's responsibility is to identify the mistakes made by designers and refine possible design concepts suggested by designers based on previous research and ideation works.

15.0 References

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