

MIXit

Multi-functional food preparation appliance

Project Guide

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PROJECT 3

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Introduction

Food is an important part of cultures all across India. Due to diverse cultures, geography, soil type, vegetation; there is an assortment of cuisines in the Indian subcontinent. We Indians love our food and cooking it too. This is substantiated by the fact that Indians spend more than double the world average time in cooking (13 hours a week).

A lot of Indian food requires extensive preparation of raw material, spices, vegetable, etc... Traditional food preparation tools have been hard to work with and are painful for the user. As technology progressed, it also started coming inside kitchens in the form of various appliances. Numerous preparations are now done with appliances like grinders, food processors etc. that have reduced preparation time and reduced millions of Indian kitchen

users physical stress. Mixer grinder has become an indispensable part of modern Indian kitchen along with refrigerator in the electronic kitchen appliance category. But it is followed by plenty of other small appliances to help in food preparation.

It is relevant to explore the product category of food preparation devices and problems faced by the users. The design project hopes to come up with a quality research and insight, further complimented with a structured design development approach to deliver a design of a multi functional appliance that not only hopes to address the issues of functionality and usability but also create a unique formal language for the product to emotionally engage with the user.

Methodology

The following diagram visually showcases the approach that has been implemented in this project. The methodology includes internet and market study of food preparation devices, current trends and study of patents to get a better idea of the innovations and strategies of this industry segment. User studies involving methods like group interviews, observations as well as Do it Yourself approach were undertaken to understand the context of food preparation in real world scenarios.

A continuously evolving design brief was prepared to kickstart the design development process. Tools like morphological charts, mind mapping, fish trap model etc. were use along with concept evaluation tools to filter down concepts. The final concept is finally run through a usability testing by developing appropriate mock-up prototype, which enabled to further highlight product interface issues and refine them into the final design deliverable for P3.

Discovery Define Develop Detail

Internet study

User study

DIY

Interpreting needs

Scope & limitations

Design brief

Morphological chart

Mood board

Concept finalization

Mock-up and usability testing

Design detailing

3d Modelling

POC

Final mock-ups

Discovery

1. Internet study

- Food preparation device
- Components
- Feature-price mapping
- Product form mapping
- Trend study

2. User study

- Interviews
- Observations
- Usage scenario

3. DIY

- Using a knife
- Using manual chopper

4. Interpreting needs

Defining need statements
Revisiting need statements

Kitchen appliances

Kitchen appliances are functional appliances mostly used in kitchens to help simplify cooking processes by means of electrical and mechanical energy. As these have become indispensable part of our modern lives, these could be conveniently segmented into three categories based on their root functions. These are:

1. Food preparation (Figure 1)
2. Large kitchen appliances (Figure 2)
3. Cooking appliances (Figure 3)

Although food preparation and cooking appliances come under food processing; for the purpose of defining products within the realm of the project, we will use the term food preparation. Food preparation devices include appliances like mixer grinders, hand blenders, juicers, manual choppers, which primarily help in converting the form and composition of various food be it solid or liquid.

According to a Redseer article, Grinders, food processors and juicers take up approximately 80-85 % of food preparation appliance industry. Remaining market is occupied by hand blenders, bullet blender, mixers etc. (Figure 4)



Figure 1 Food preparation devices



Figure 2 Large kitchen appliances



Figure 3 Cooking appliances

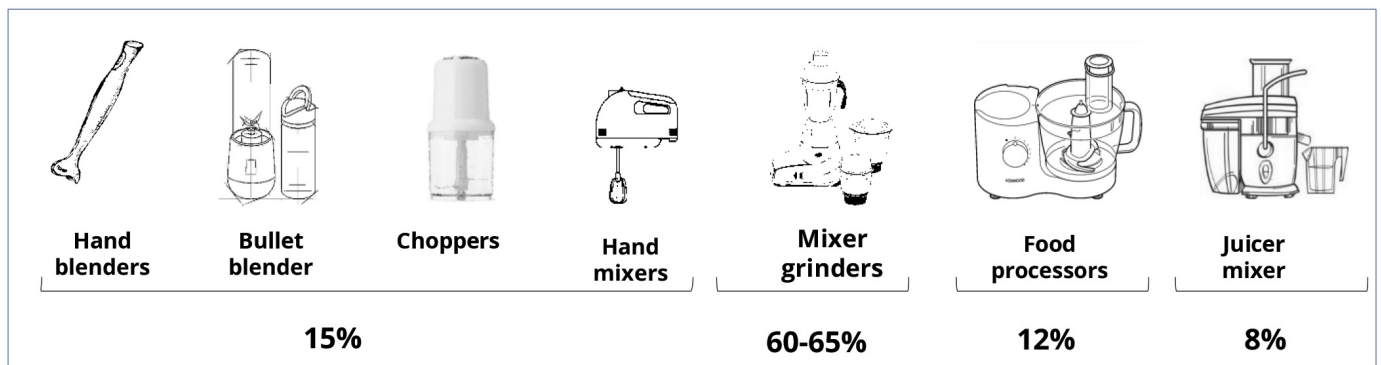


Figure 4 % share in food preparation market category

<https://redseer.com/reports/kitchen-appliances-market/>

Food preparation devices

Also called Blade grinders are food preparation appliances that make use of the rotary motion of blades of various shapes. Blender, food processor, juicer, hand blender, bullet blender, chopper, mixer, spice grinder come under the food preparation category. Let us take a closer look at these devices.

Blender/ mixer grinder/ counter blender/ mixie are name used interchangeably for countertop blenders as they grinder as well as mix food items in a closed container. Running at 10k+ rpm. Figure 5

Food processor are similar to blenders but are more versatile appliances designed for chopping, cutting, slicing, kneading. They are generally slower and bulkier than blenders. Running at 5k- rpm. Figure 6

Juicers are appliances used to extract juices. They can come as either standalone or with blenders and food processors. Figure 7

Hand blenders/ immersion blender/ stick blender are handheld blade grinders generally used to blend or puree food in regular containers. These are versatile devices which gives limited portability and more control. Figure 8



Figure 5 Mixer grinder



Figure 6 Food processor



Figure 7 juicers



Figure 8 hand blenders

Food preparation devices

Bullet blenders, personal blenders are smaller size blenders generally suited to make smoothies, chutneys in small quantities and are marketed as personal blenders for quick preparation of smoothies. Figure 9

Choppers are specific blade grinders that grind/chop vegetables. Although effective, they are limited in providing consistent cuts. Figure 10

Hand mixers, stand mixers are generally slow rotation devices used to mix, whip, whisk, beat, knead one or more items. Figure 11

Spice grinders are specific small size devices for grinding spices of different kind into varying grain size. Figure 12

Insights

1. **Mixer grinders** among the most valued items in a kitchen
2. Mixer grinders are the **most popular item** in food preparation category
3. **Bullet blenders** becoming popular due to **compact size** and marketing.
4. Other products work as secondary appliances.



Figure 9 Bullet blenders



Figure 10 Choppers



Figure 11 Hand mixers



Figure 12 spice grinders

Components

Mixer grinders are the most preferred appliance in the category and embody the core components that are to be found in all other appliances. Therefore, it is important to study and deconstruct the mixer grinder.

At the core of all these appliances is the motor that produces fast rotary motion that provides grinding, blending actions with the help of blades, disks, coupler etc. Various types of motors are commonly used are universal motors, dc motors and now days brushless dc motors as well.

It is housed in a body that provides protection and support to the motor. It also incorporates control interfaces in the form of knobs, buttons, touch interface or a combination of these.

The body also supports various jars that locks into the body and connects to the motors via couplers. There are bottle types, standard size and processor types jars that are used.

Blades are a part of jar (either permanent or removable). They come in different combinations and styles each for specialized functions.

Different type of jar lids snugly fit to the jar and enclose the food contents to be blende/mixed/grinder. They also have a 2ndary lid which helps in mixing and adding the contents without stopping the operation.

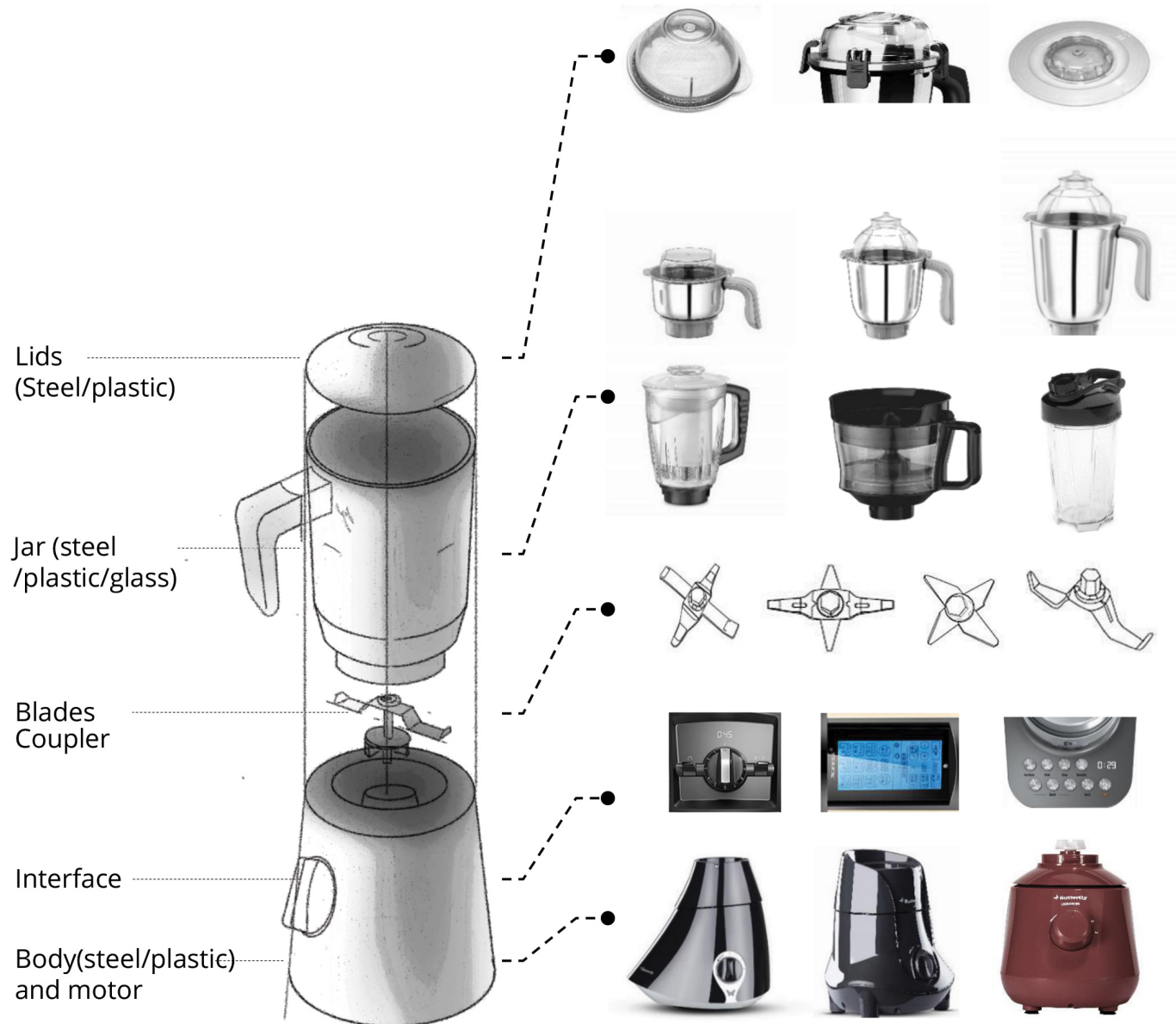
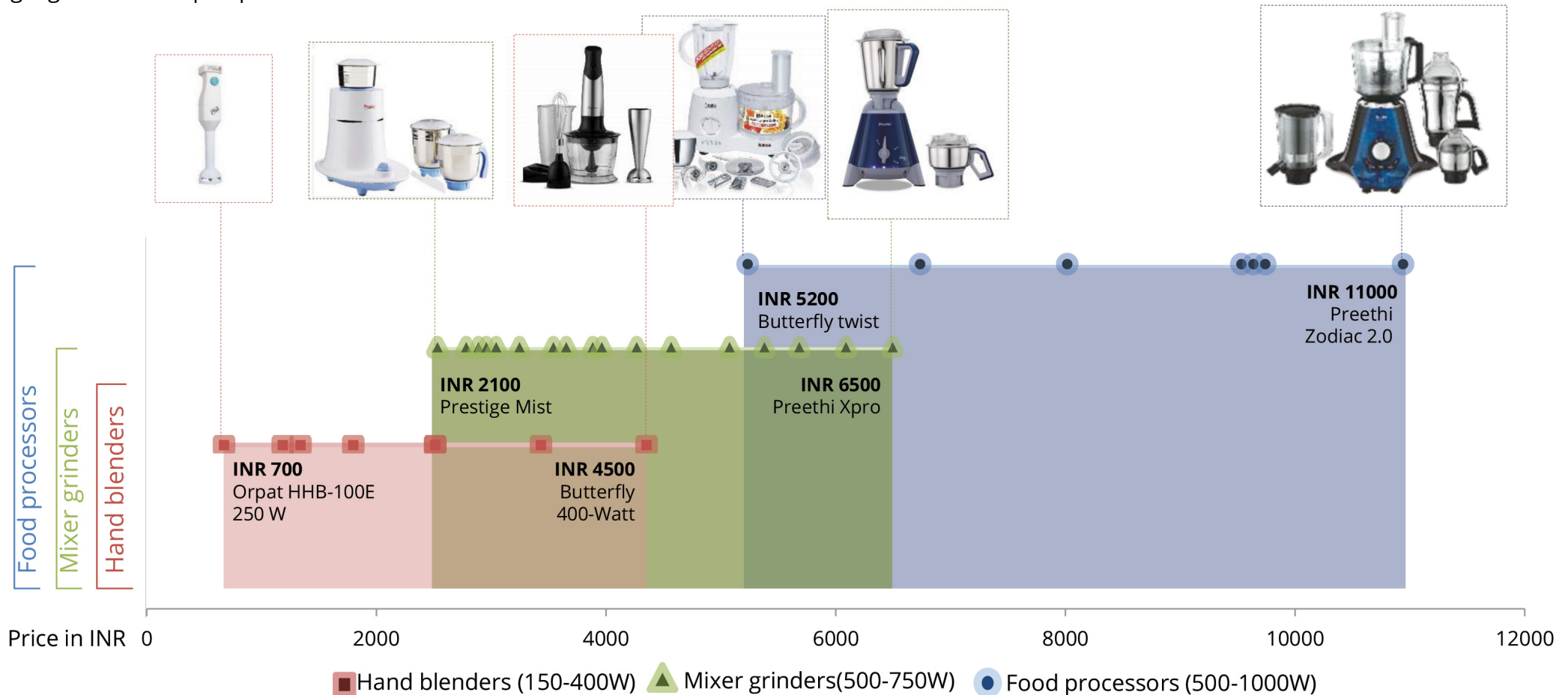


Figure 13 Components

Category mapping

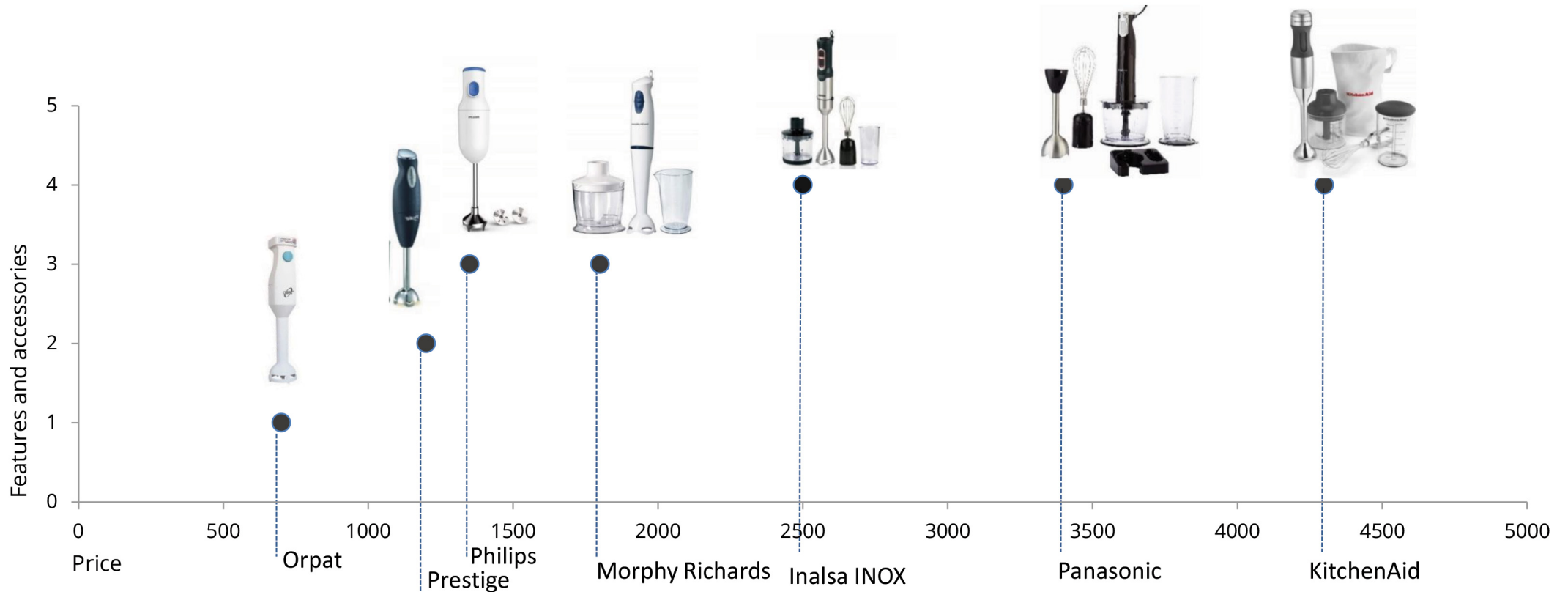
Below graph shows the placement of three relevant appliances from the food-preparation category. As one can see, there is a clear overlap of prices between the categories. **This overlap is complemented by overlap in product functions as well.**

This is a limited product mapping to highlight the overlap of prices and functions



Graph 1 Price mapping

Feature-price mapping



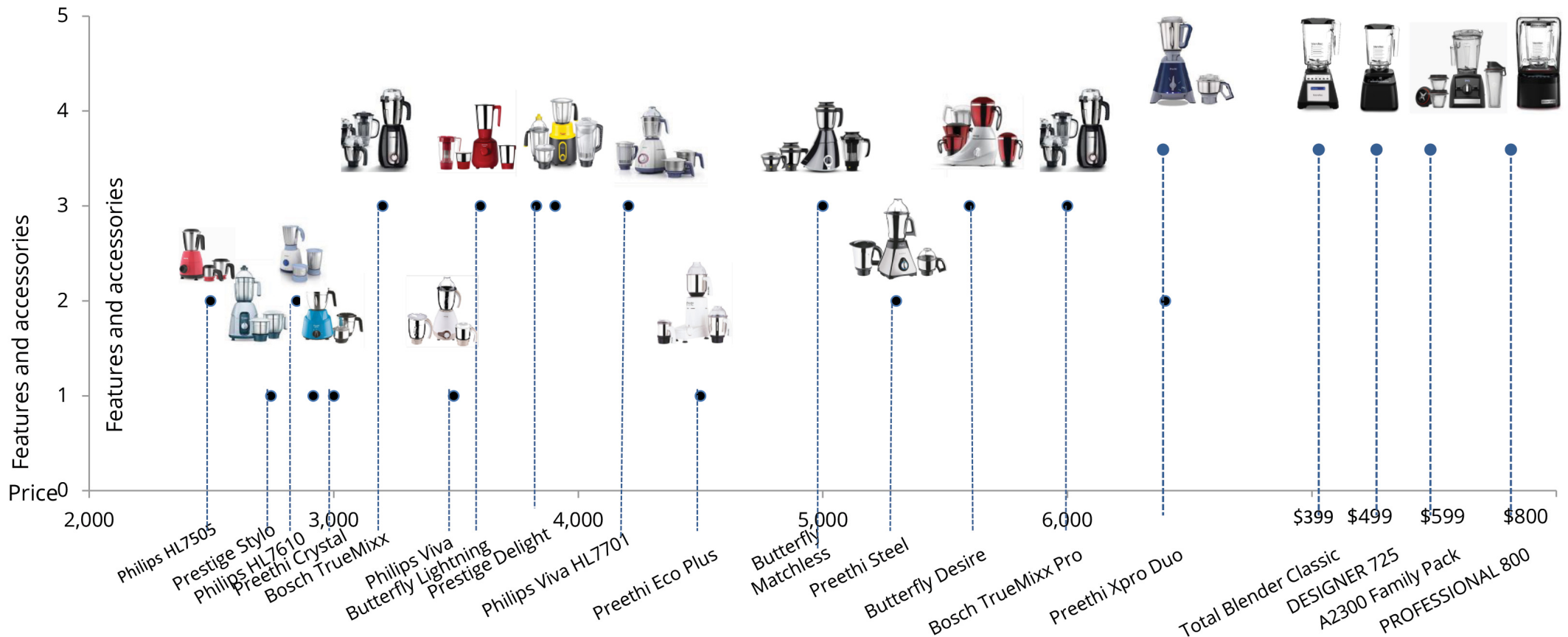
Graph 2 Hand blender feature-price mapping

Feature of hand blenders were mapped against the prices. Feature values were defined by elements that contributed to the usability of the product as well as versatility of accessories. 1 value was given to product with the basic functions. Products with ergonomic considerations was given 2 and 4 value given to products with numerous useful accessories which would help in food preparation.

Insights

1. **Hand blenders provide extended mobility and control.**
2. **Although higher end models provide higher power & enclosed jars, their usability is limited.**
3. **Cable interference during operating blender is a real problem.**

Feature-price mapping



Graph 3 Mixer blender feature-price mapping

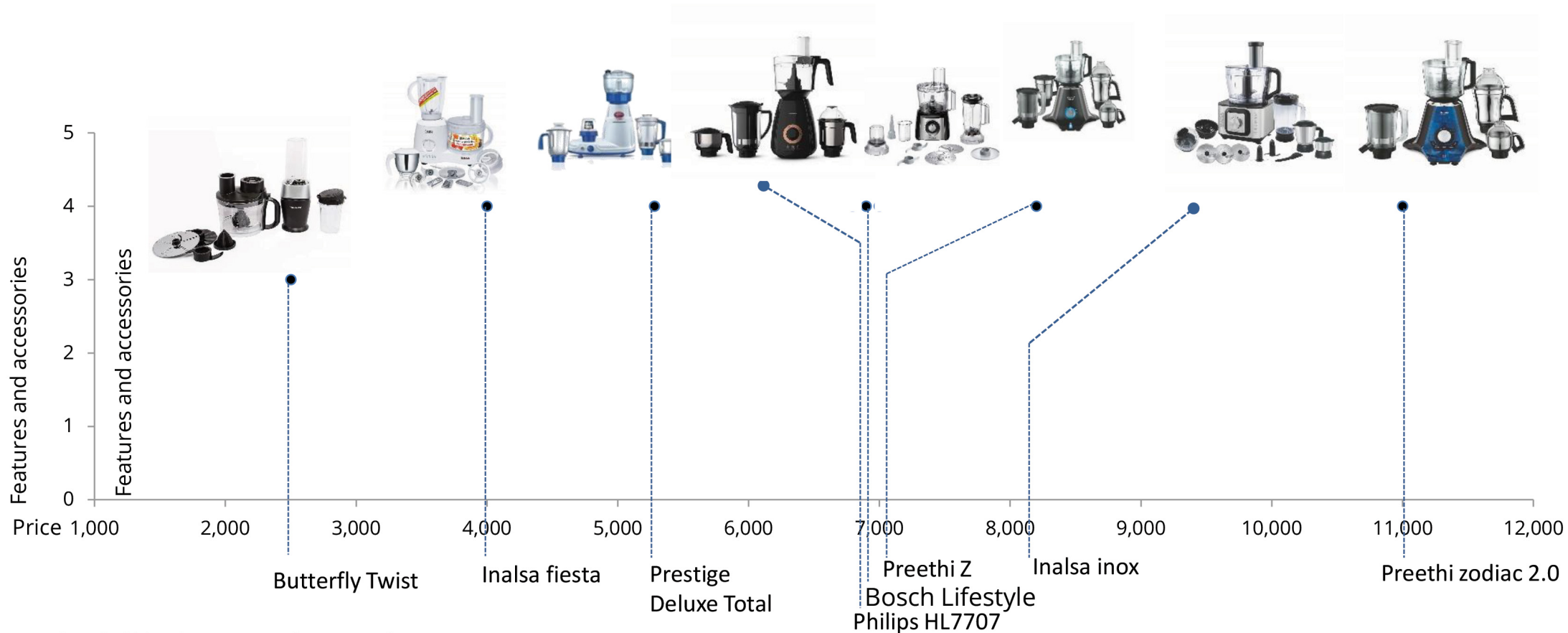
Features for mixer grinders were mapped against the prices. Feature values were defined by elements that contributed to the usability of the product as well as versatility of accessories. 1 value was given to product with the basic functions and form. Products with ergonomic considerations like better knob, improved locking features were given

2, 3 was given to products with better form element like modern & premier looks; innovative ergonomic features, added accessories and functions. 4 value given to products with higher wattage, professional grade output and novel features.

Insights

1. Plenty of options in a wide range of prices.
2. Some incorporate food processors and juicer component as well.
3. Versatile appliance but restricted mobility & control.
4. Premium models provide greater controls, high power and better material usage.

Feature-price mapping



Graph 4 Food processor feature-price mapping

Features for food processors were mapped against the prices. Feature values were defined by elements that contributed to the usability of the product as well as versatility of accessories.

Insights

1. Provide functions such as kneading, blending, grinding, cutting etc.
2. Too many functions for typical usage.
3. Adds to storage volume and cleaning efforts.
4. Generic mixer grinder processor attachments available online. Like Rio(amazon).

Form mapping



Figure 14 Forms mapping

In the food preparation industry, most of the products can be mapped under distinct form categories. These categories are tall forms, L shaped forms, Oblique forms that cannot be defined under above two categories, stick forms. Stand mixers and hand mixers have not been considered under these.

Insights

1. **Tall form appliances most bought. (amazon online data). Probably due to smaller footprint**
2. **Round and vertical forms easy to manufacture and assemble.**
3. **Button or knob style interface controls are common.**

Trend study

People around the world have been growing on the healthy eating movement. People are much more aware of global practices and adapting new ways of healthy cooking and eating. These trends are helping in the higher usage rates of appliances more than ever.

Newer innovations and concepts keep sprouting in the market. In food preparation market vacuum blending, hot food blending, magnetic drive blenders, more pre-sets, multiple devices etc. are a few well known trends.

Indian kitchens are adapting to modular concept as it provides organized, clean and space saving benefits among many others. These are becoming useful as average house footprint is reducing in metros like Mumbai and Delhi. Hence the growing trend demands for more space saving designs and modern identity.



Figure 15a From back to front: Millo magnetic blender, Oster blender with numerous controls, Philips vacuum blender, Philips hot soup blender.



Figure 15b Modular kitchen spaces

User study

Semi structured interviews with numerous users in Mumbai were conducted in following formats: group interviews and personal interviews. These were duly audio recorded after taking prior permission from the users and later transcribed. **Two group interviews** were conducted and gave insights regarding peer discussions and what motivates the user group to purchase certain type of products. **5 personal interviews** were conducted in user residences. These were complimented with basic **context observations and photograph documentation**.

One personal interview was extended and elongated observations made to better understand the user behaviour and interactions in and around food preparation devices. Other than this, few semi structured digital surveys were also conducted.



“ We would love to have more chutney jars ”

“ Manual choppers better than grinders for chopping vegetables ”

“ Hot food has to be cooled before blending ”

“ Only sometimes use food processor ”

Interviews

Two group interviews were conducted among 7-8 users in Mumbai suburban area of Kandivali. The study was conducted in the month of January. All were female and in their mid life. Everyone in the group were homemakers and mostly from the Marathi and Gujarati background. The interview was conducted in their common meeting area.

Below are customer statements segregated into appropriate categories.

Followed by interpretations of those statements into needs for developing need statements.

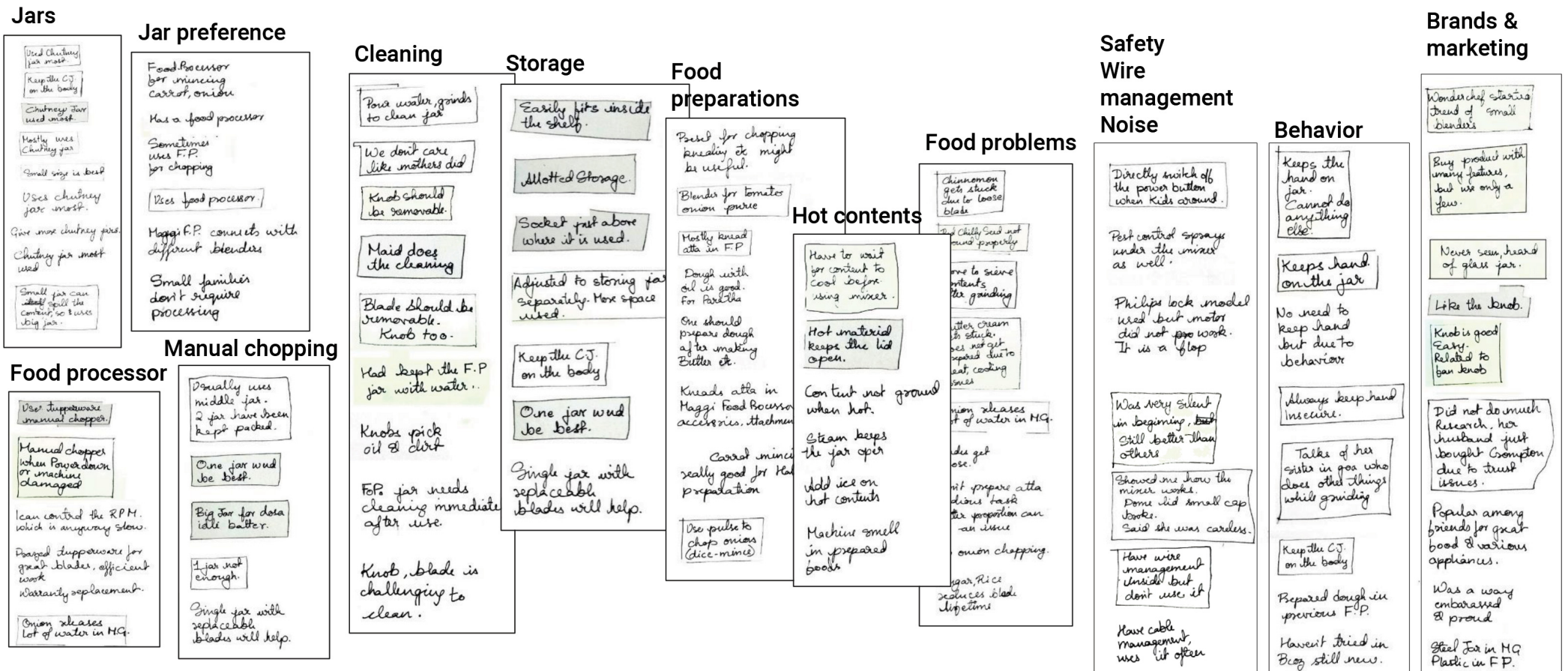


Figure 16 User statement affinity mapping

What users say ...

Below are customer points collected together on similarity basis. Followed by interpretations of those statements into needs for developing need statements. Below is a layout to read the user statements and interpreted as need statement.

Layout of the need statements

2ndry Need statement: Prepared by interpreting underlying user need from the raw statements

- Raw user statements grouped together on the basis of similar underlying need
- Xyz....
- Xyz....
- Xyz....

Appliance takes less space and is easy to store & use

- It easily fits inside the shelf height
- I have allotted storage for the mixie
- I have adjusted to jars in a different place as they require more space.
- Keep the chutney jar on the body
- Socket is just above where the mixie is kept

Mixer-grinder has removable parts for easy cleaning.

- Knob and blades challenging to clean
- Knob should be removable for cleaning
- Knobs pick oil and dirt
- Blade and knobs should be removable.

Number of jars are appropriate for usage and storage

- One jar would be best for easy storage
- Single jar with replaceable blades will really help.

It has easy steps for cleaning jars and containers

- I pour water and grind to clean the jar
- Have to keep the Food processor jar filled with water
- Food processor jar needs instant cleaning
- Maid does the cleaning
- We don't care about the products like our mothers used to do

Blade remain strong and sharp for smooth grinding and longer lifetime

- Sugar/rice grinding reduces blade lifetime
- Red chilly seed not ground properly
- Have to sieve contents after grinding

Provides good quality vegetable blending, grinding

- Blender is used for tomato onion puree
- Carrot minces really good for halwa
- Onions release lots of water
- No proper onion chopping

It has necessary presets for good usability

- Preset for chopping, kneading would be useful
- I use pulse to chop onions

Blade are tightly fixed in place

- Blades get loose overtime
- Cinnamon gets stuck due to loose blade

Food processor has limited functional quality and usability

- Kneading dough with oil is good and easy to clean
- One should make dough after making butter to use the butter milk in kneading.
- Butter/cream gets messy due to improper heating and cooling
- Don't prepare Atta . It is a tedious task and also water proportion can be an issue

Hot content is effectively handles by the appliance

- Use hand blender for hot content blending
- Content is not ground when hot
- Have to wait for content to cool before using the mixer
- Hot materials keep the lid open
- Steam keep the jar open
- I use ice to hot contents while grinding
- There is machine smell in the food.

What users say ...

Below are customer points collected together on similarity basis. Followed by interpretations of those statements into needs for developing need statements. Below is a layout to read the user statements and interpreted as need statement.

Appliance is safe to use and provides necessary child proof functions

- I directly switch off the power button when kids are playing around
- Pest control also sprays under the mixie.
- I bought Philips lock jar model for food safety but motor didn't work properly. It is a flop

Appliance has lower noise levels

- My mixie was very silent in the beginning, but gradually started making noise
- We just stop the grinding when someone calls

It has easy and intuitive wire management

- Wire management
- I have the wire management under the mixie but don't use it. Just wrap it around the body
- I do use the cable management provided on the side.
- Although portable, hand blender cable comes in between work and gets messy.

Appliance has smart idiot proof features

- While showing how the mixer works, she forgot the dome cap lid inside the grinder. When she operated, the lid broke off.

It provides stable (less vibration) functioning

- Only bcoz of behavior I keep the hand on jar
- Insecure if I don't keep hand on the jar
- I cannot do anything as I keep the hand on jar
- Vibrates if I don't put my hand on
- My sister leaves the jar and does other things

Physical control knob provides multi sensorial feedback

- Like the knob bcoz I have always seen it from olden times.

Single jar can be effective

- One jar would be best for using with mixie
- Single jar with replaceable blades will help.
- I use middle jar. Other 2 are just packed.
- I use big jar for batter preparations
- I feel one jar is not enough

Food processor jar have limited usage

- Food processor is used for pureeing carrot, onion
- I sometimes use food processor for chopping.
- Mostly knead Atta in food processor
- I have a food processor that connects with different blenders.
- Small families do not require food processor

Chutney jars are preferred but not always

- Chutney jars are the most used containers
- Give more chutney jars
- Since small jar can spill contents, therefore use bigger jar.
- Small size is best

Appliance provides good speed control for better vegetable cuts

- I use Tupperware manual chopper
- I can control the blade rotations which is any way slow
- Really like Tupperware for great blade and efficient work and longer warranty
- Onions release lot of water in the mixie, therefore I use manual chopper.

Can also function without power

- Manual chopper works when power is down or machine damaged

It has versatile functions

- I need hand blender for hot food blending
- Hand blender provides more control for small quantities
- Vegetable cutting, slicing etc. can be done in food processor

Observation

Some basic observations were made during the interviews and an extended observation of one family's usage of kitchen and appliances was performed. Below are the points from the same. As seen in the adjacent images, a lot of information data was derived from the context observation. The study helped in establishing some common patterns and helped understand user needs better.



Figure 17 Badly placed hand blender storage

Figure 17 showcase the hand blender and counter blender position. They are placed right below and above the place of socket placement due to easy reach. This was seen in other houses as well.



Figure 18a,b Redundant & underutilized features

Fig 18a Shows allocated place. Also mentioned the under utility of extra jars.

Fig 18b the redundant features like wire securing space, rather it has become regular place for the insects and a nuisance to clean.



Figure 19 Reduced shelf space

Figure 19 Another user felt satisfied with the product but indirectly lamented the shelf space taken up by multiple products.

Do it yourself: knife

It is crucial to appreciate and learn from the products that are seemingly irreplaceable. Knife is one such versatile product. One of the most used items in a kitchen world over, there is no other product like it. Cutting of vegetables, fruits and other items into various forms is an essential component of food preparation. Although there are numerous appliances trying to ease the process and to a certain extent have succeeded in doing so, quality of cuts a knife can produce have a certain artisanal quality.

A **time motion analysis** was conducted for cutting a **soft** and **hard** vegetable. **Dicing**, **mincing** and **julienne** were performed. Performing precise cutting styles seemed generally lengthier than usual vegetable cutting that happens. But the quality of these cuts and eventual usage in cooking gave amazing texture and visual appeal to the dish.

“ Precise quality cutting led to amazing visual appeal and texture while eating ”



Figure 20 Onion cutting



Figure 21 Tomato cutting

Insights

- **Versatile and neat cut quality.**
- **Has than better control although slow and takes practise.**
- **Also better for small portions.**

Do it yourself: manual chopper

As revealed in user interviews, manual chopper seemed to be quite a hit among the interviewees. Their stated reason was quick operation compared to mixer grinders. So I tried to get a hang of this product and experience the usage myself

“ The operation is quick and also leaves the vegetable dry, but the cut quality did not impress”



Figure 22 Onion cuts (knife cut chopper cut)

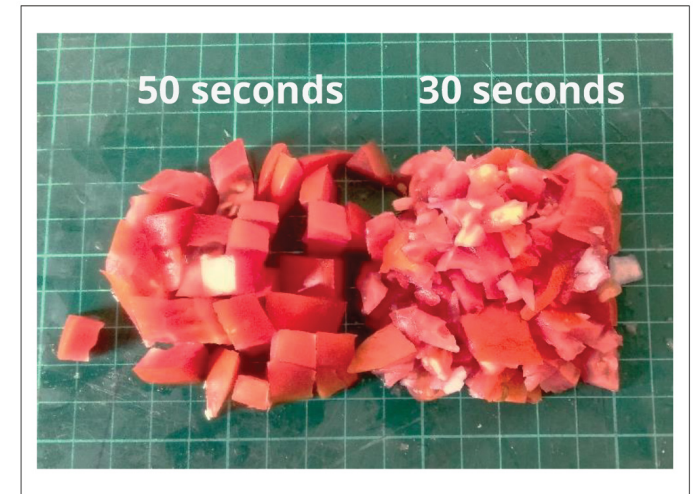


Figure 23 Tomato cuts (knife cut chopper cut)

Insights

- Compared to the appliances, there are less steps involved and it is comparatively easy to clean.
- It has better results than most blenders that puree the vegetables, but the cut quality is barely consistent.

Interpreting needs

Above mentioned user statements were interpreted and made into need statements. After creating need statements, redundant needs statements were clubbed together to form singular needs. All the statements were then clubbed together based on their similarities and a label was given, which acts as a larger umbrella need statement.

The label statements were then evaluated among each other to establish a relative importance of needs. By doing so, it became easier to look at the customer needs from the priority point of view.

Primary need statements

Appliance is easy to store and use

- Appliance takes less space and is easy to store & use
- Number of jars are appropriate for usage and storage

Appliance is easy to clean

- Mixer-grinder has removable parts for easy cleaning.
- It has easy steps for cleaning jars and containers

Appliance provides consistent and required output for longer period.

- Blade are tightly fixed in place
- Blade remain strong and sharp for smooth grinding and longer lifetime
- Food processor has limited functional quality and usability
- Provides good quality vegetable cutting blending, grinding
- It has necessary presets for good usability
- Hot content is effectively handled by the appliance

It has features to improve user behavior.

- Appliance is safe to use and provides necessary child proof functions
- Appliance has lower noise levels
- It has easy and intuitive wire management
- Appliance has idiot proof features
- It provides stable (less vibration) functioning
- Physical-digi control knob provides multi sensorial feedback

Appliance jars are optimally designed & useful in passive state.

- Single jar can be effective
- Chutney jars are preferred but not always
- Food processor jar have limited usage

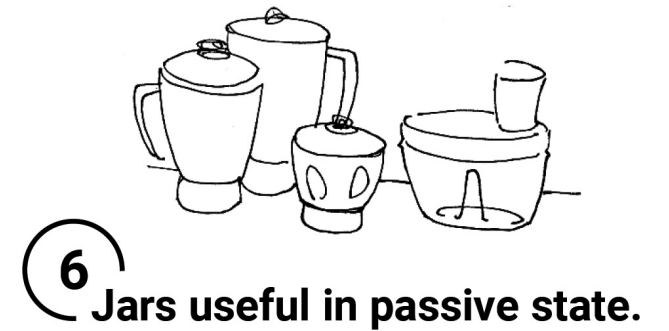
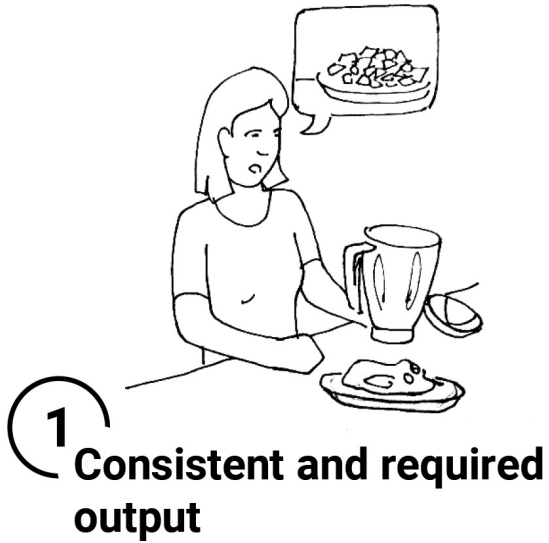
It reduces the need for supplementary food preparation products

- Appliance provides good speed control for better vegetable cuts
- Can also function without power
- It has versatile functions

Hierarchy of need statements

- 1. Appliance provides consistent and required output for longer period.**
- 2. It reduces the need for supplementary food preparation products**
- 3. Appliance is easy to clean**
- 4. Appliance is easy to store and use**
- 5. It has features to improve user behavior.**
- 6. Appliance jars are optimally designed & useful in passive state.**

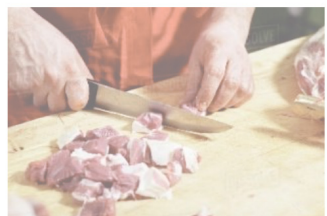
User need statements



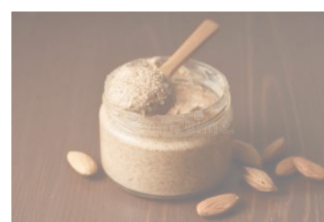
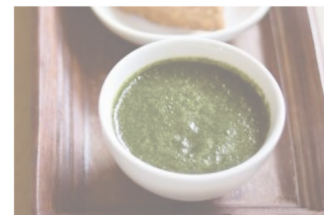
Revisiting need statements: Food preparation

Lets look at the derived need statements, probe the issues further and research what has been done to tackle these issues so far.

Hand



Mixer grinder



Hand blender



Food processor

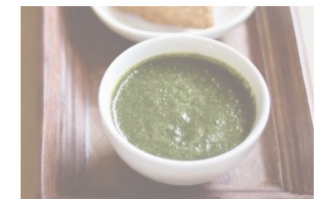


Figure 24 Issues with food preparation that require attention

Revisiting need statements: Food preparation

There are various devices that tackle the issues of food preparation like quality chopping, hot content blending, grating etc..
But ..

- **All of these have restricted functions.**
- **They end up increasing the products in the kitchen.**
- **Remain passive**

Chopping



Generic mandoline



Cookessentials electric mandoline



Kitchenaid dicer attachment

Grating



Generic blender attachment



Wise coconut scraper

Hot content



Philips SoupMaker

Figure 25 Available solutions

Revisiting need statements: Multiple devices

There are numerous appliances that we employ in our kitchens (figure 26). Mixer grinder, food processor, hand blender and chopper are some of the commonly used items. They are

- **Take more storage**
- **Remain passive**
- **Cumulatively expensive**

In figure 27, we can see the type of products employed in a typical house.

Many national and international brand and studios have come up with unique solutions, mostly by integrating food processor with hand blenders (figure 28a). One interesting concept is using a flexible shaft to extend mixer blender into a hand blender by design studio InventIndia as seen in figure 28b.



Figure 26 Commonly used products

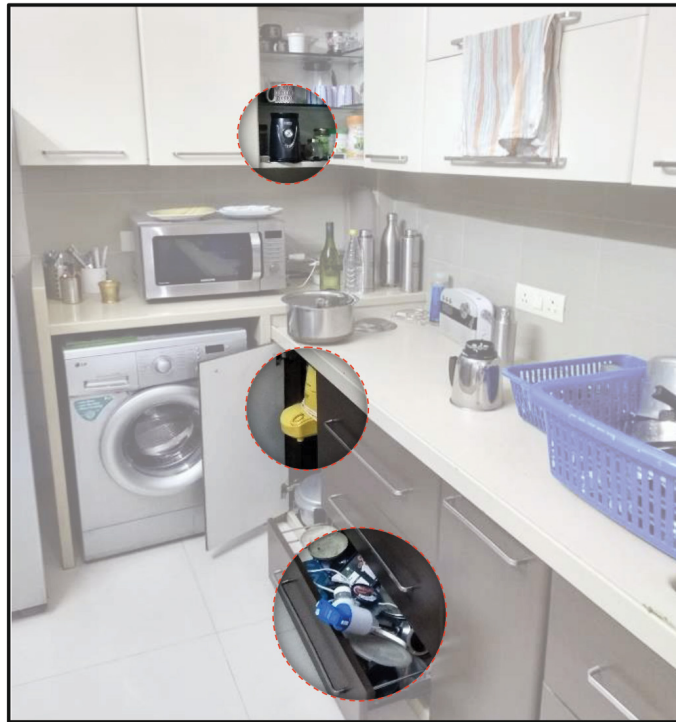


Figure 27 Multiple products in a kitchen



Figure 28, 29 Available products & concepts

Revisiting need statements: Cleaning of appliances

Cleaning of devices is a crucial step in appliance usage and leads to better hygiene. As seen in the photos above,

- **Difficult to reach places are difficult to clean and keep collecting dust.**
- **More components increase cleaning time and require immediate attention.**

There are many product like one shown in figure 30 trying to address cleaning issues. Figure 31 is a concept to clean the vegetables using blender rotation.



Figure 30 cleaning issues in existing devices



Figure 31 modular jars



Figure 32 Cleaning concepts

Revisiting need statements: Storage of appliances

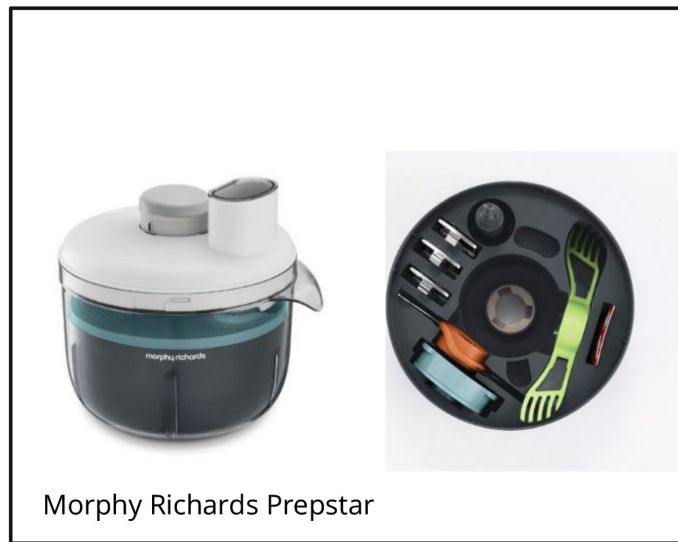
As observed during user study, city like Mumbai where small size apartments are the norm, there is a **high need to find solutions to storage problems** faced by many. At present, there are very limited devices employing compact integrated products.

Few examples shown in figure 33 have compact forms and clutter free storage.

These help in keeping the products together, safe and always available when required.



Figure 33 small storage areas



Morphy Richards Prepstar

Figure 34 Products addressing storage issues



Lakeland compact blender

Revisiting need statements: user behaviour

There are a lot of elements, factors and variables that decide user behavior around a kitchen appliance. For example, a **poor cable management coming in between work creates frustration**. Likewise, a device having **child lock protection can help ease user anxiety**. Wrapping the cable around or just keeping the jar on the base are few more examples that showcase the potential issues these behaviors can cause.

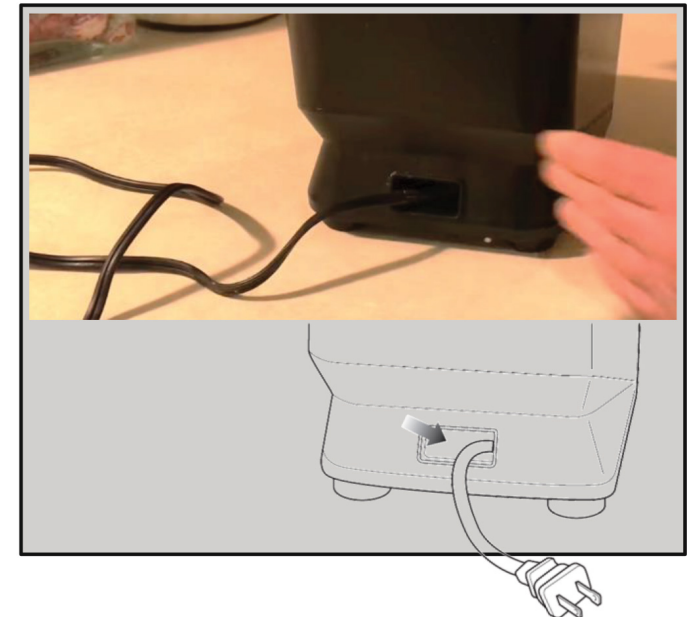
Below examples showcase improvements like adjustable interface angle, cyber-physical knob, various cable management options utilized in products.



Figure 36 User centric interface features



Figure 37 Wire management in Oster appliances



define

1. Problem identification

2. Scope & limitations

3. Design brief

Target user

Key features

Requirements

Target specifications

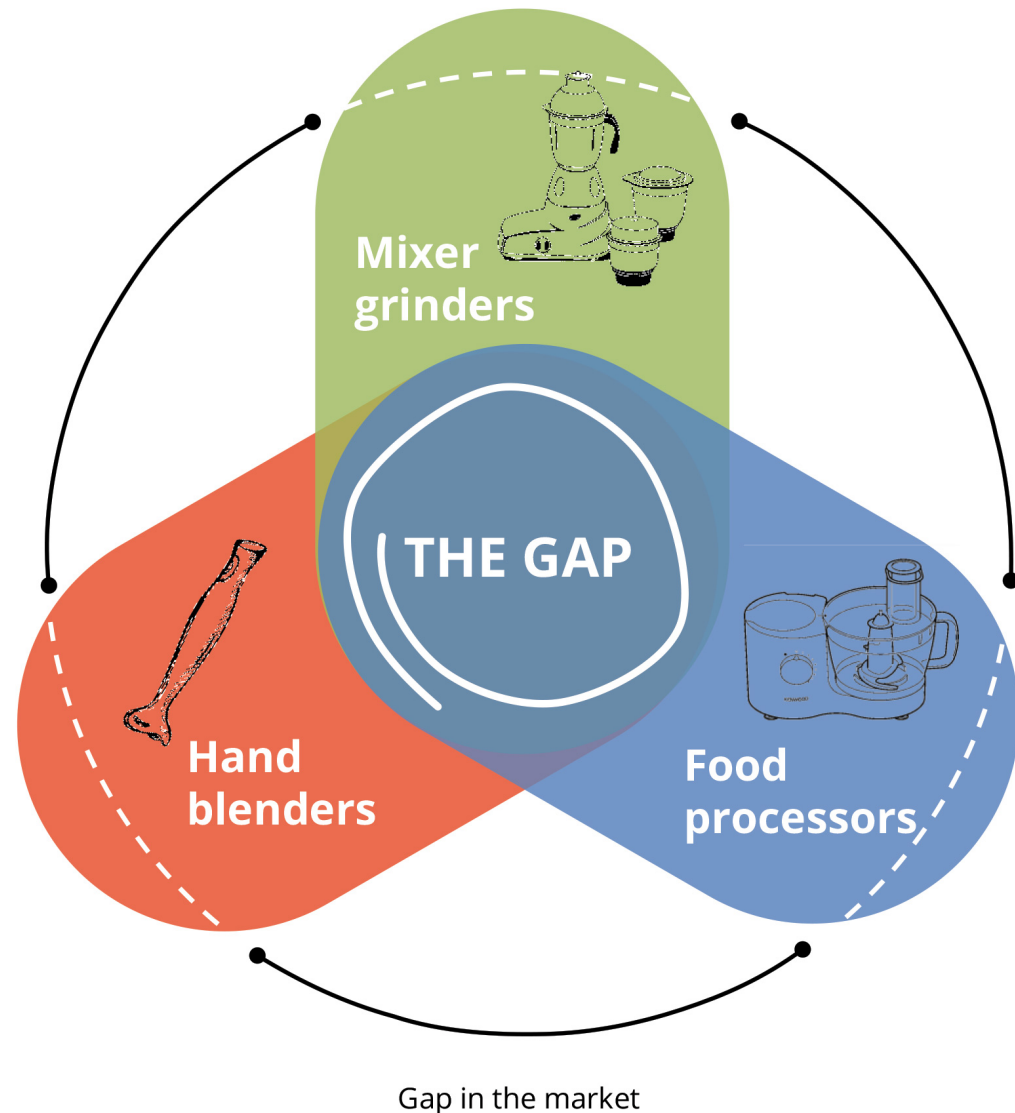
Problem identification

Owning multiple products is very common in metro cities. **Mixer grinder is the first preference** for new users, suggesting the importance and value placed in the product. It provides important functions or the lack thereof. There are **issues like handling hot items, portability, usability and output food quality with mixer grinders**. Users end up buying new devices to expand functionality.

Having multiple preparation appliances is a good way to provide specialized functionality and a great strategy for increasing company revenue. However, it's the customer who is faced by evident and latent issues. Apart from the added cost with each new appliance, these appliances eat up precious kitchen storage spaces.

“Lack of a competitive and versatile appliance appears as a crucial gap in the market”

Various devices have tried to address the beforementioned issues in parts, but there isn't one complete solution to all of these issues as per my limited research. Lack of a competitive and versatile appliance appears as a crucial gap in the market. **Hence the aim of my P3 design project is to try and develop an appliance which enables the user to have a versatile food preparation experience.**



Scope and limitations

The design project is around the small kitchen appliances used on a daily basis. As a P3 project, I have tried to explore the user experiences with these products in the kitchen context.

It is a user-driven design project where my main objective is to understand user interactions with various appliances and intervene partially at functionality level and mostly at the usability level. It involves conducting user study and market study along with other research tools in order to find insights, which could be used to define the design brief for the project. Initially the idea was to deliver a Proof of Concept and finished mock-up prototypes. But due to the ongoing COVID-19 pandemic and the lockdown, the scope has been reduced to digital concept detailing and modelling.

The existing situation dismisses the possibility of external usability testing of the concept and is limited to the realm of my place of stay.

The project is also limited in terms of the feasibility testing of the mechanical concept.

Existing technology in the product category has been used to maintain the product costing which justifies the design of the appliance for Urban middle class.

Design brief

A multi functional food preparation (blending, grinding, cutting ...) appliance for Indian homes.

Product category

Small kitchen appliance

Target user for the product

Primary users going to be the homemakers seeking a unique preparation appliance.

They primarily reside in sprawling urban centers, embracing modern living & lifestyles.

Secondary user is the helping staff/family members that will have limited exposure in operating and handling the appliance. Seeking a hassle-free easy to use appliance.

Tertiary users are people involved in assembly-disassembly of the product, seeking simplified, idiot-proof assembly design.

Key benefits of the product

- Combines **diverse food preparation functions** in one appliance.
 - Improved **management** and **storage** of the appliance.
 - Designed for **convenient cleaning**.
 - Provides a **novel product experience**, improving user behavior.
-

Design brief

Must have design requirements

1. Provides good quality cutting (chopping/dicing, slicing, shredding) , blending, grinding, grating.
 2. Handles hot and cold contents effectively.
 3. Blades remain strong & sharp for smooth grinding and longer lifetime
 4. It is easy to store & manage
 5. It has easy steps for cleaning jars and other accessories.
 6. It provides required safety against accidental usage.
-

May have design requirements

1. Interface provides intuitive and augmented control.
 2. It has intuitive wire management system.
 3. Appliance works without power.
 4. Appliance has a compact footprint.
-

Target specifications

Before the conception of design development, a basic specifications list was prepared in order to have some form of relevant guidelines.

Performance

1. Must be easy to operate
2. It should perform various functions i.e. blending, grinding, various cutting styles
3. Have cordless functions

Environment

1. Resistant to water, edible liquids, oil and vegetable/food chemicals.
2. The product should perform with temperature of the contents between 0°C to 100 °C.
3. Dust, liquid should be easily cleaned from the product.

Maintenance

1. Easily accessible for cleaning.
2. Parts require lubrication must be accessible.
3. The replacement of spare parts must be easily done.
4. Product is easy to manage and handle around the kitchen
5. Have wire management system in place

Storage

1. Does not occupy space larger than the cumulative volume of existing multiple products
2. Should easily fit in existing shelf sizes

3. Has a small footprint

Materials

1. Materials must provide durability and strength to handle preparation tasks.
2. The materials should not oxidize in any way.
3. Materials coming in direct contact with food must be food grade.
4. Materials must be resistant to oil and water

Safety

1. Have protection against accidental operation
2. The product should have protection from power surges
3. No sharp edges to be exposed
4. Materials should not conduct electricity

Ergonomics

1. Controls must be positioned at a height suitable to the user.
2. No sharp edges to be exposed
3. Preferable to make controls universal and provide multi sensorial feedback

develop

1. Morphological Chart

- Test rig
- Product functions & design parameters
- Developing Chart
- Selection of ideas
- Evaluation

2. Mood board

3. Concept finalization

- Design options
- Classification
- Detailing
- Swot Analysis
- Detailing

4. Mock-up and usability testing

- Developing a mock-up
- Usability Testing
- Insights
- Faculty comments

Chopping disk rig Test 1

Chopping features are available in many international brands but none in India. A visit to Lohar chawl, a famous appliance market in Fort area, Bombay revealed the usage of grid chopping blades in industrial machines. Therefore, a chopping disk rig was made to understand the functioning of chopping blade using a self made slicing disk blade and chopping blades.

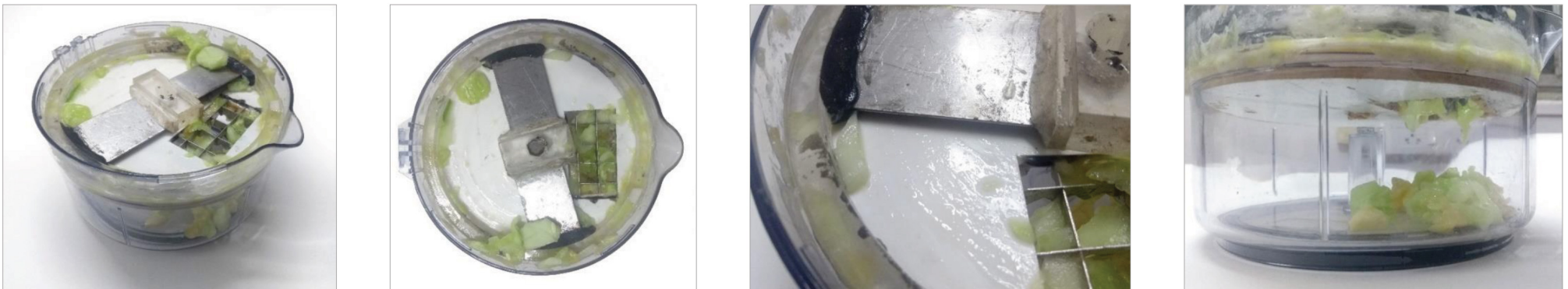


Figure 38a,b,c,d Chopping disk rig, Chopping layer and slicing layer, Gap in the slicing disk and an issue, Pulped output

Insights

It was clear that the problem of food item getting stuck in between needs to be attended. Some observations made were

- Vegetables passed through
- Also slipped through the gap.
- Got stuck in the grid chopping blade

Chopping disk rig Test 2

Chopping features are available in many international brands but none in India. A visit to Lohar chawl, a famous appliance market in Fort area, Bombay revealed the usage of grid chopping blades in industrial machines. Therefore, a chopping disk rig was made to understand the functioning of chopping blade using a self made slicing disk blade and chopping blades.



Figure 39 Chopping disk rig 2

Insights

After covering the slicing disk gap, some improvements were visible. There was a difference between standard chopper output and rig output.

The slicer disk kept lifting and the blades were not sharp enough. Although the results were not satisfying, they showed promise in the quality of cuts that came out.

Product functions

In order to make use of a morphological chart, it is important to start with an organized list of functions the desired product would do.

The product could have a single or multiple main functions. In case of my project, I listed down few main functions and later on sub functions were listed under. This was finally analyzed critically to derive at final list of product functions.

The functional list (parameters) is then used to create a chart and possible solutions for the parameters sketched out. Finally, a few conceptual solutions were created by selecting and combining one component from each parameter. These were then evaluated on the basis of the design statements presented in the brief above.

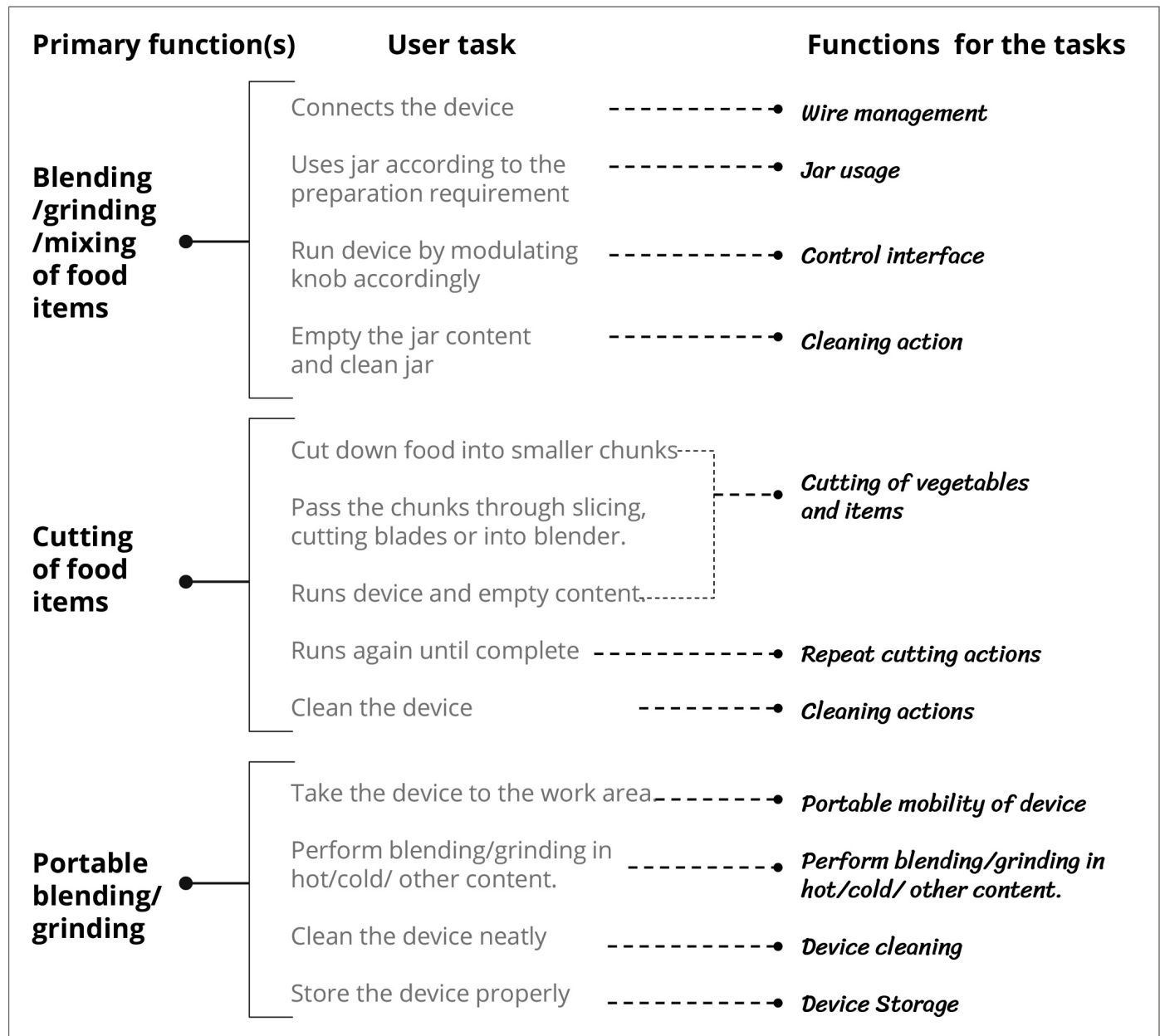


Figure 40 Elaboration of product functions

Morphological Chart





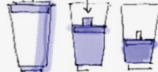




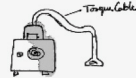











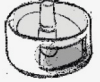


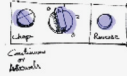




Functions ↓	Variations →						
Jar usage							
Cutting of vegetables and items							
Device body & portability							
Perform blending/grinding in hot/cold/ other content.							
Device cleaning							
Blade - Coupler							
Control interface							
Wire management							

Figure 41 Morphological chart

Morphological Chart

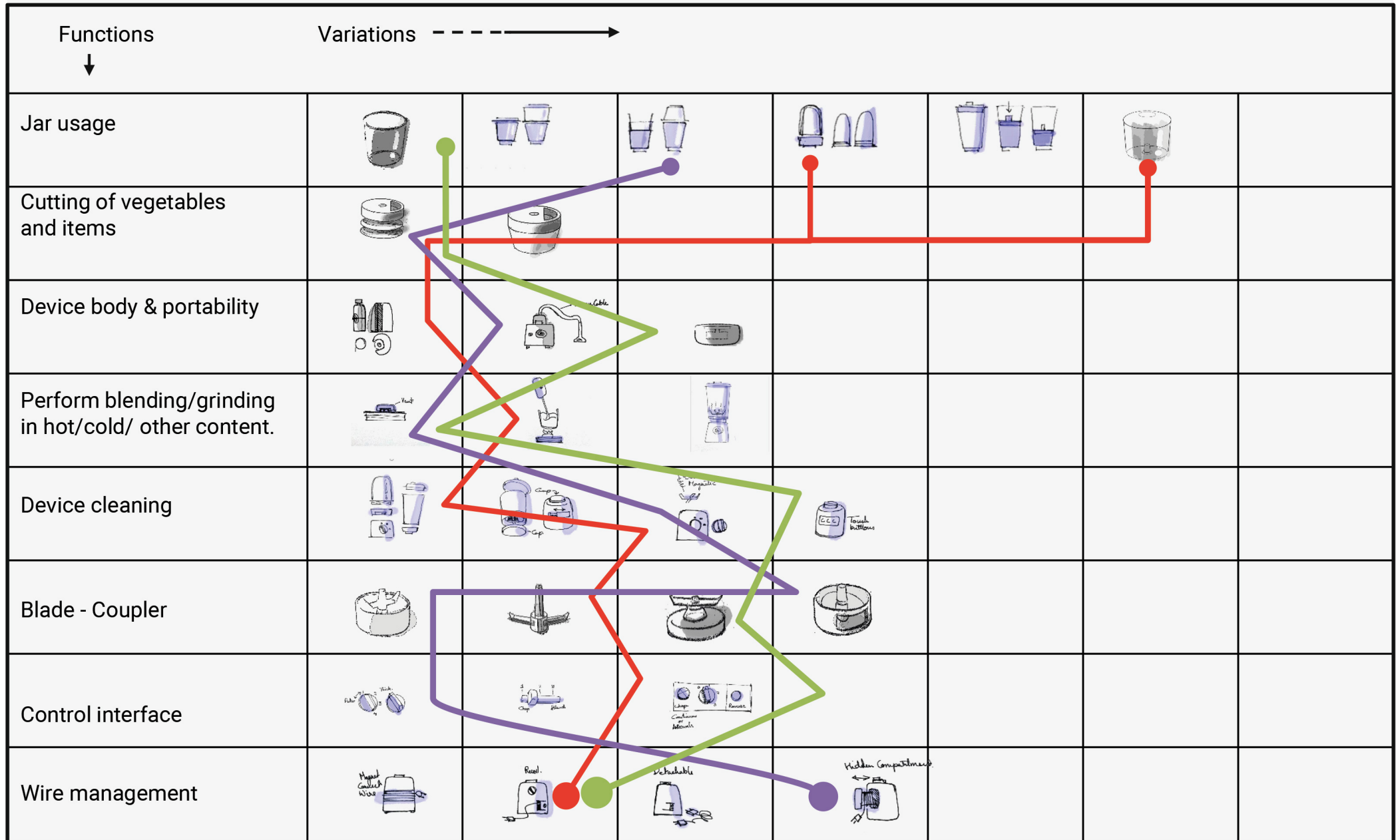
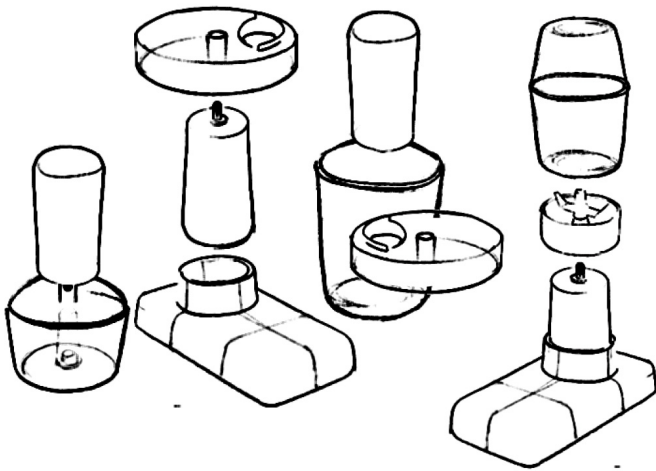


Figure 42 Developing design directions

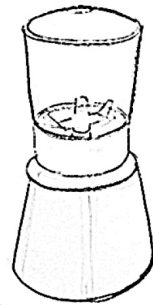
Selected ideas

The morphological chart helped in creating multiple options and through careful selection of option with the guide, below three options were finalized.

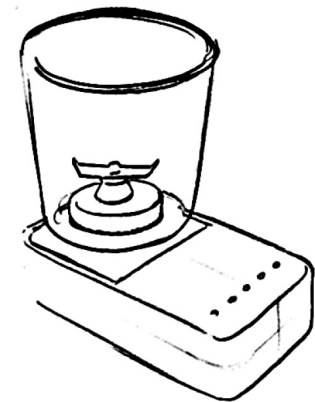
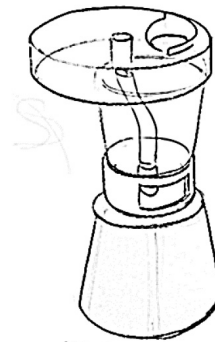
All of these incorporated existing proven technologies. Once selected, these were evaluated against the major design brief requirements.



Idea 1



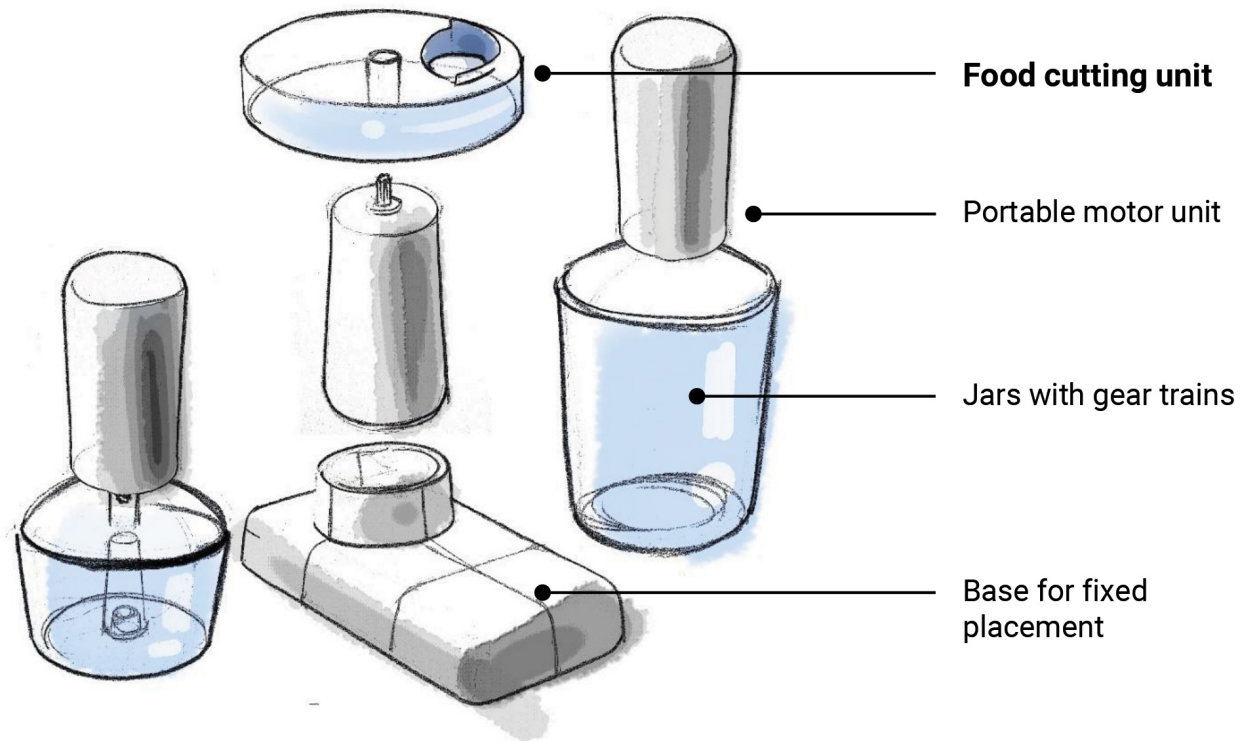
Idea 2



Idea 3

Idea 1

Direction 1 incorporates a portable hand blender with other appliance components to provide portability and stability of a counter top blender.



Positives

Chopping, dicing, slicing, grating

Surface used as cutting board, no need of extra board.

Sleek and space saving

Content directly collected on a plate

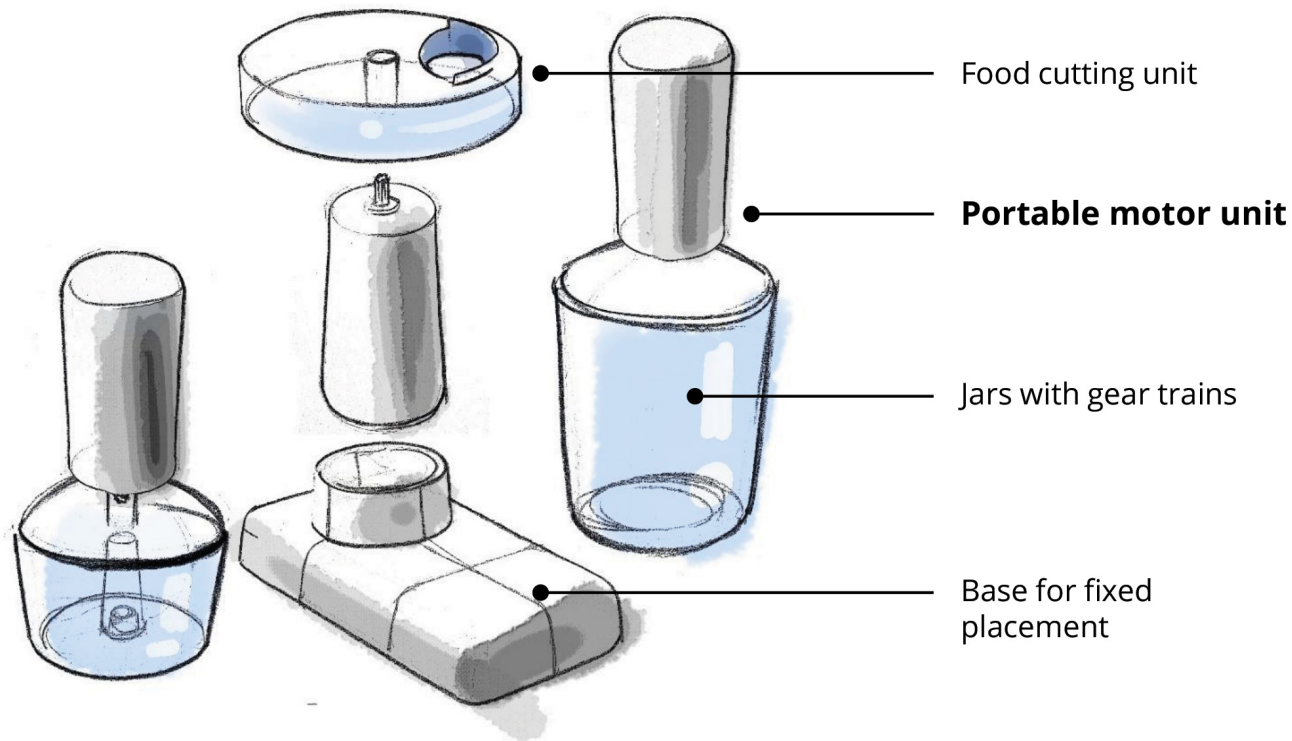
Negatives

Unstable

Figure 44 Design direction 1

Idea 1

Direction 1 incorporates a portable hand blender with other appliance components to provide portability and stability of a counter top blender.



Positives

Versatile

Compact and convenient storage

Better mobility and reach

Negatives

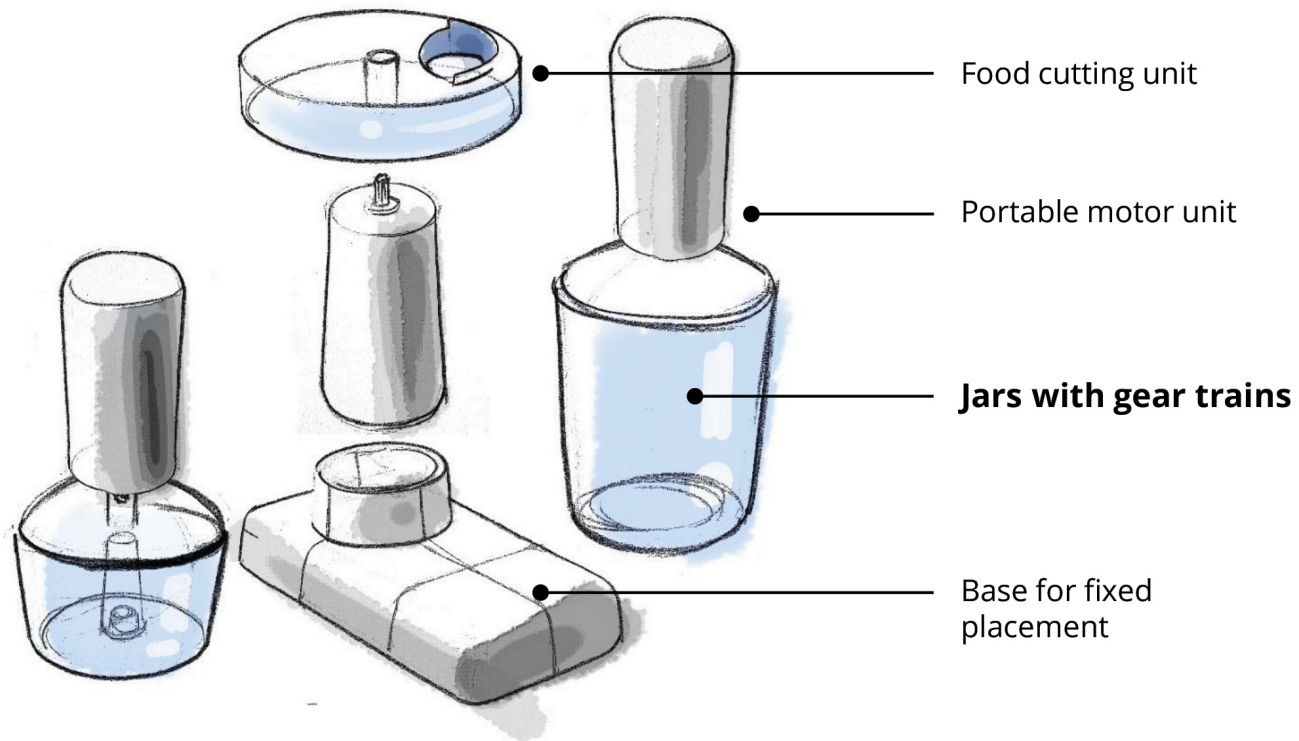
Not so stable

Gripping an issue for extended usage

Figure 44 Design direction 1

Idea 1

Direction 1 incorporates a portable hand blender with other appliance components to provide portability and stability of a counter top blender.



Positives

Speed variability

Better control on texture output

Can be used as normal containers

Convenient cleaning

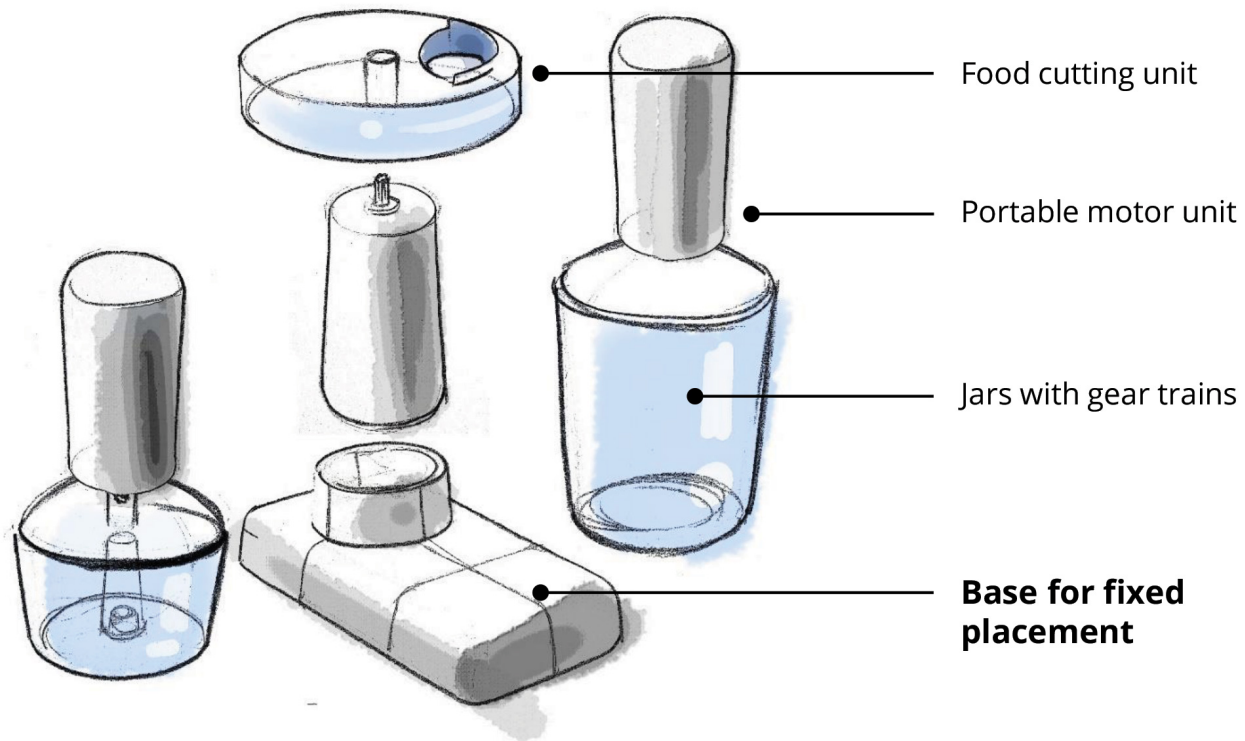
Negatives

Need active handling of the device

Figure 44 Design direction 1

Idea 1

Direction 1 incorporates a portable hand blender with other appliance components to provide portability and stability of a counter top blender.



Positives

Sleek and unassuming

Provides grip & stability

Storage for blades and motor

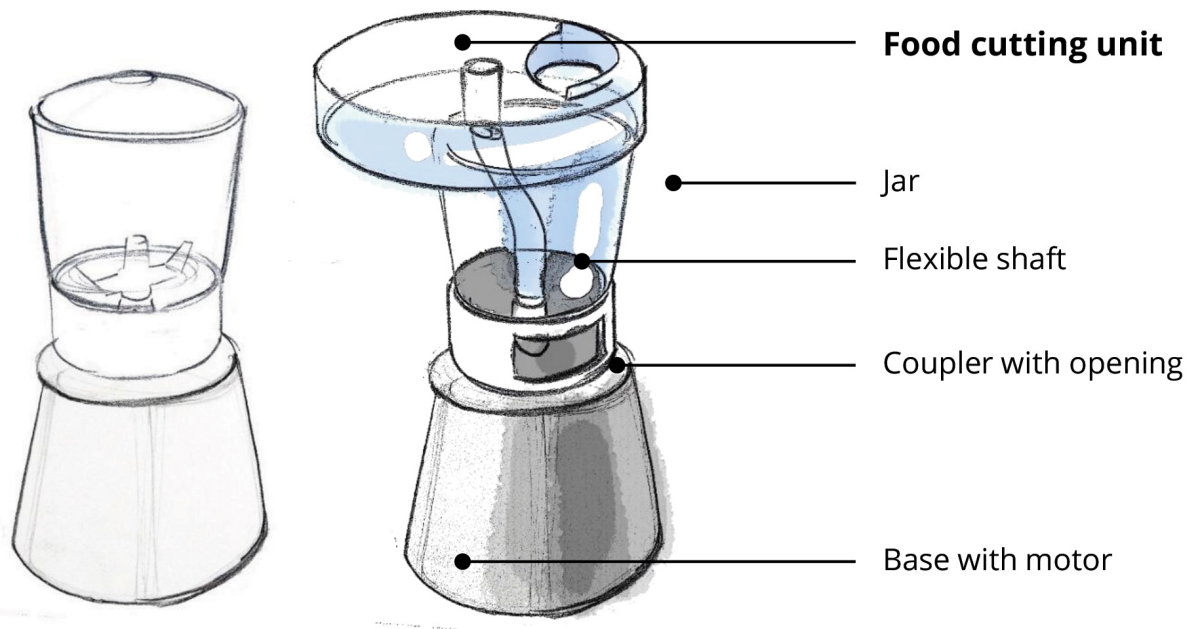
Negatives

Extra component with no passive usage

Figure 44 Design direction 1

Idea 2

Direction 2 incorporates the use of a flexible shaft to provide extended blending functions without a need for extra device.



Positives

Chopping, dicing, slicing, grating

Surface used as cutting board, no need of extra board.

Sleek and space saving

Content directly collected on a plate

Negatives

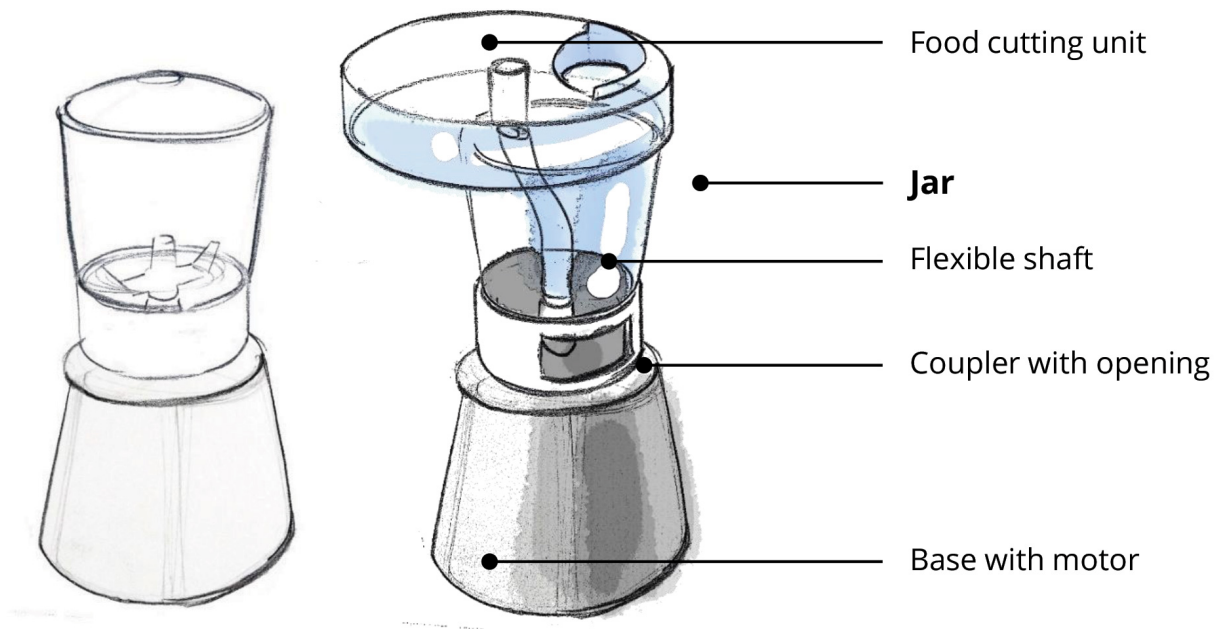
Raised height

Unstable

Figure 45 Design direction 2

Idea 2

Direction 2 incorporates the use of a flexible shaft to provide extended blending functions without a need for extra device.



Positives

Simple jar with detachable blade unit

Acts as a base for preparation unit

Negatives

No passive usage

Figure 45 Design direction 2

Idea 2

Direction 2 incorporates the use of a flexible shaft to provide extended blending functions without a need for extra device.

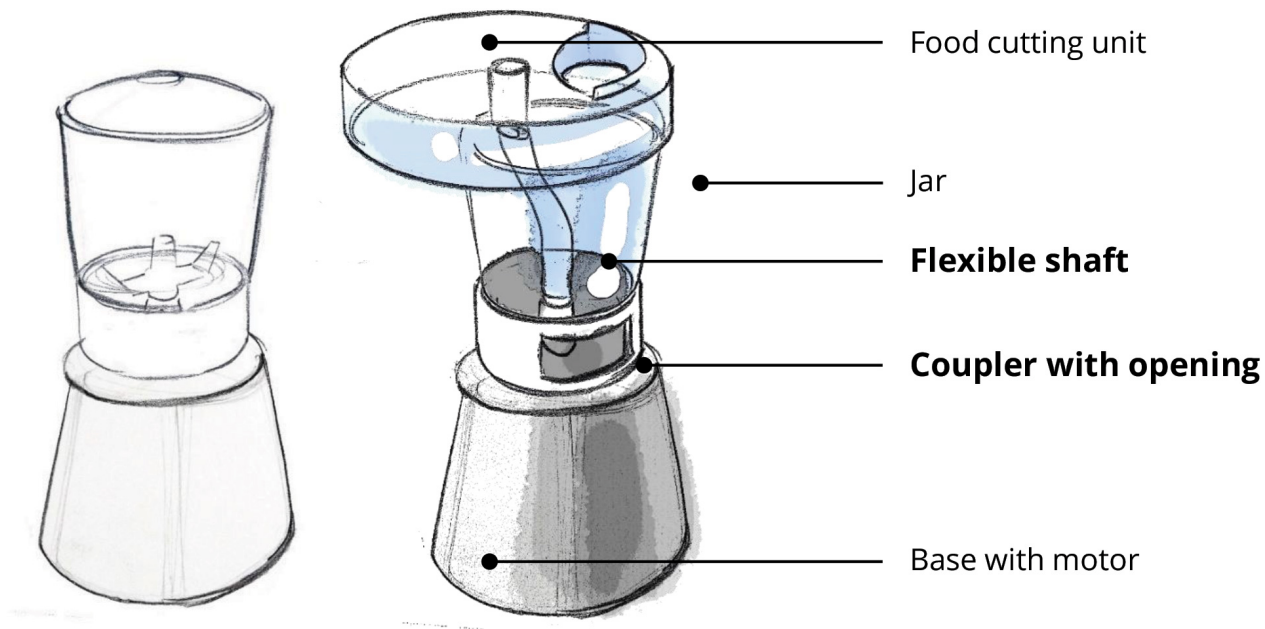


Figure 45 Design direction 2

Positives

Shifts axis of rotation

Minimizes mechanical parts

Blade unit lets the food out onto the plate

Reduces operational steps

Negatives

Requires extra cleaning

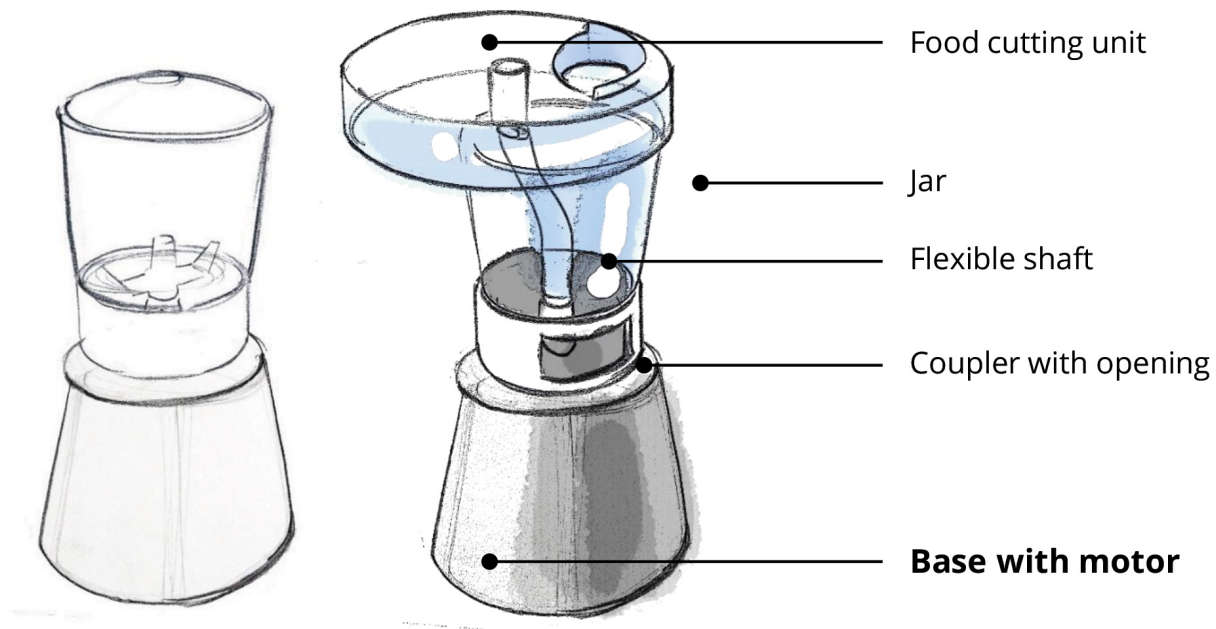
Added blade unit component

Limited functions

Problem of shaft coming in between while working

Idea 2

Direction 2 incorporates the use of a flexible shaft to provide extended blending functions without a need for extra device.



Positives

Stability

Can have higher motor power

Familiar form

Negatives

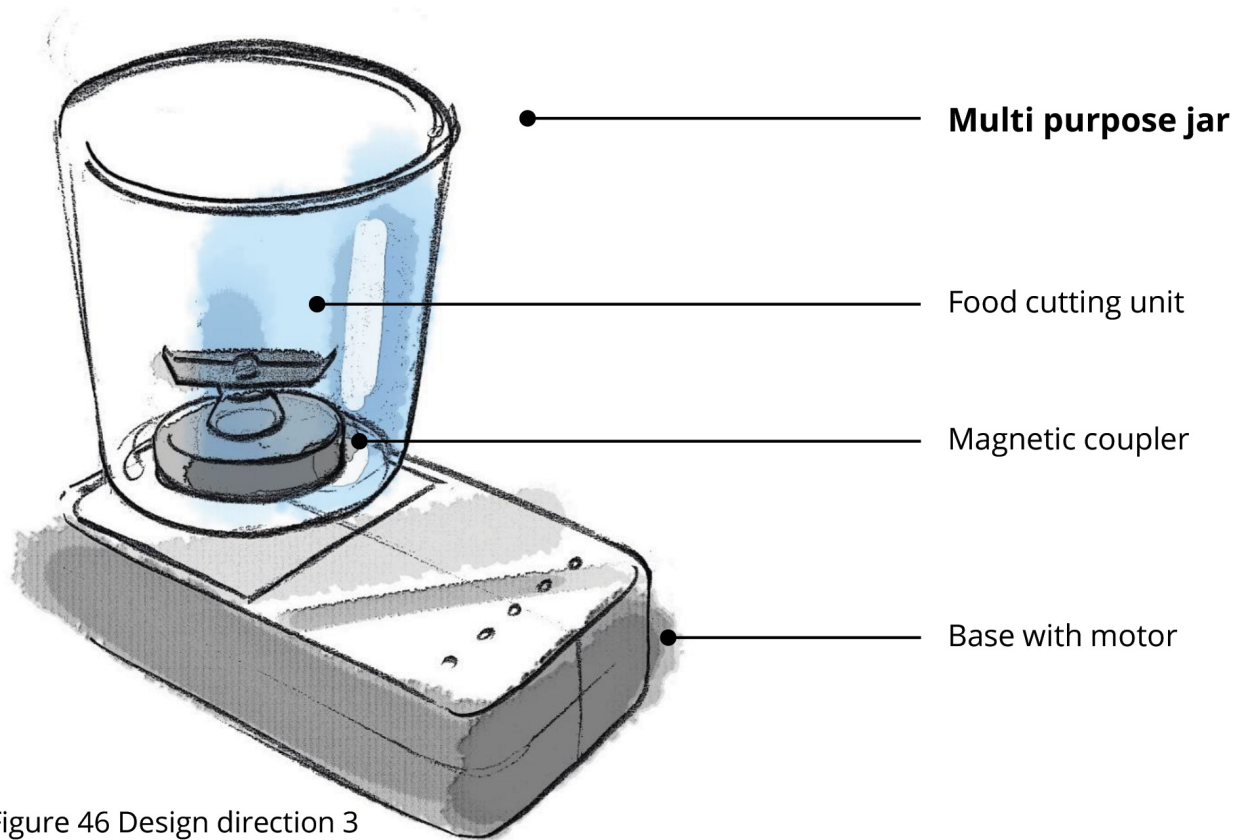
Takes up space

Reduced mobility

Figure 45 Design direction 2

Idea 3

Direction 3 uses magnetic coupling technology, providing a unique(non contact) way for transferring motion to the coupler.



Positives

Multi functional usage

Easy to clean

No fuss

Figure 46 Design direction 3

Idea 3

Direction 3 uses magnetic coupling technology, providing a unique(non contact) way for transferring motion to the coupler.

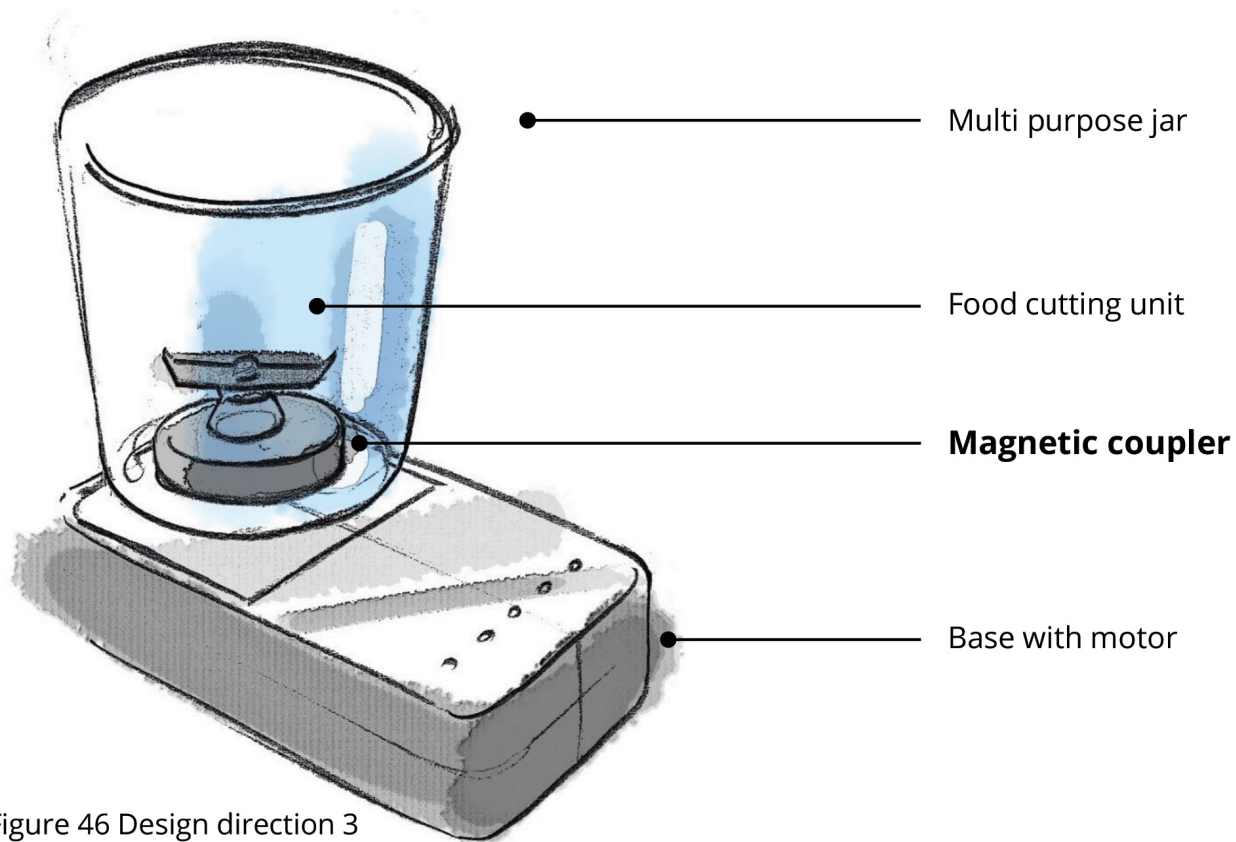


Figure 46 Design direction 3

Positives

- Highly Efficient & lower maintenance
- Easy cleaning
- Long working life
- Convenient alignment

Negatives

- Comparatively expensive
- Possible issue in case of fault

Idea 3

Direction 3 uses magnetic coupling technology, providing a unique(non contact) way for transferring motion to the coupler.

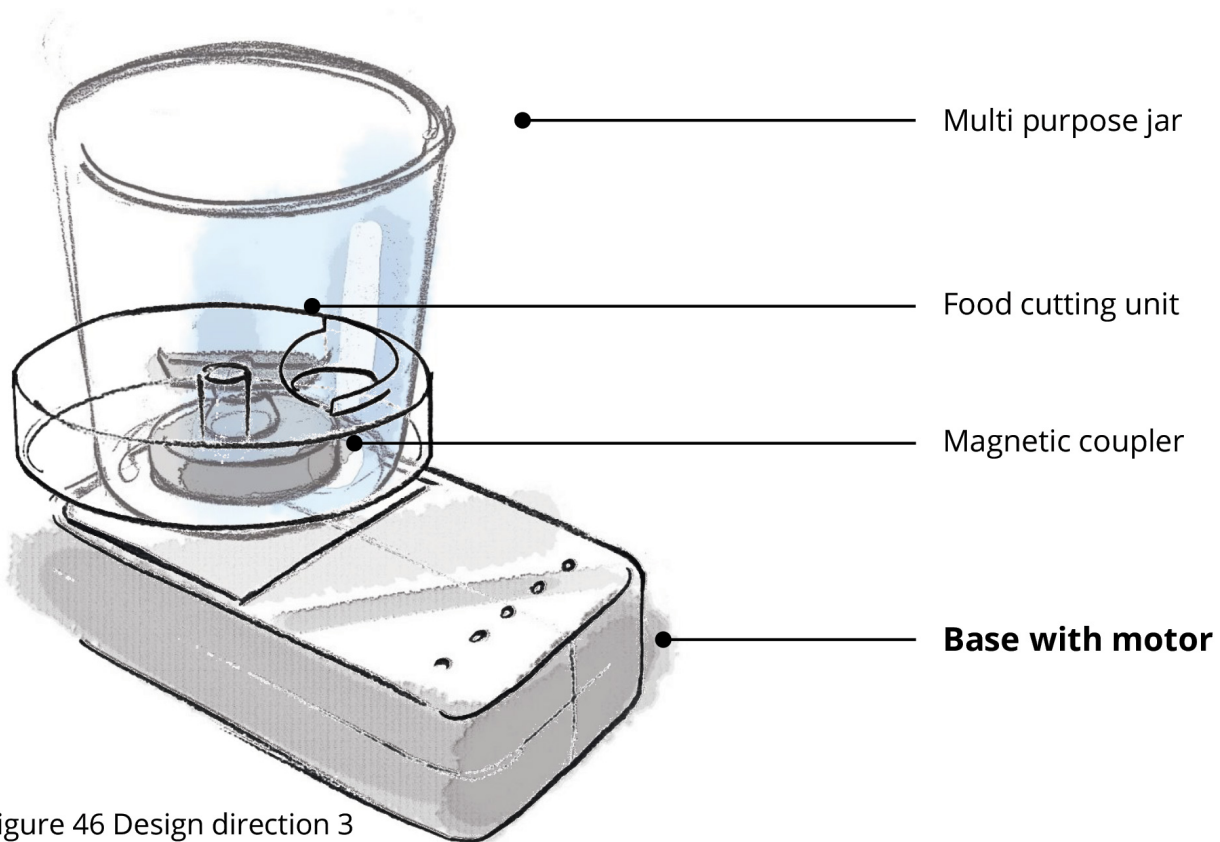


Figure 46 Design direction 3

Positives

Low height

Low noise

Creates a statement

Easy clean

Negatives

Comparatively expensive

Possible issue in case of fault

Mock-ups

Styrofoam and paper mockups were prepared to explore the handling of products.

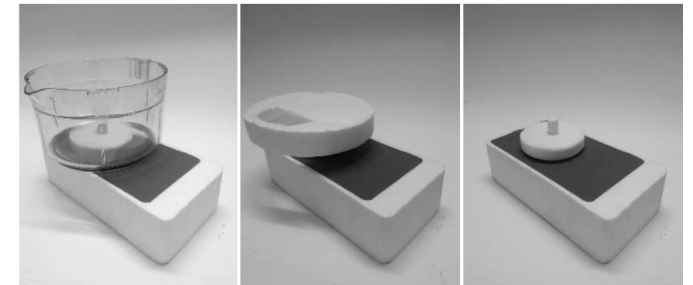
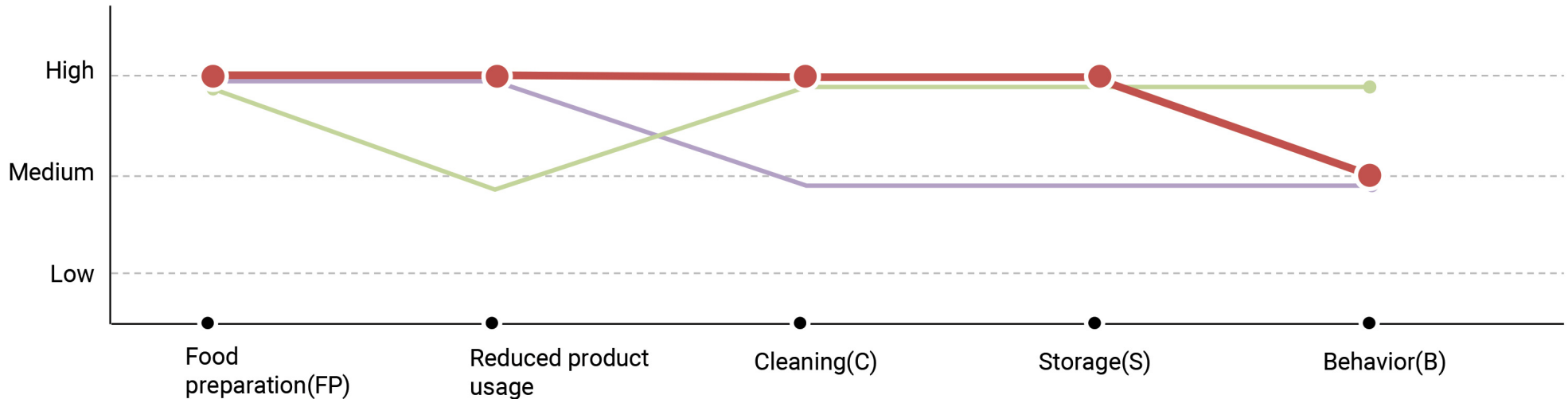
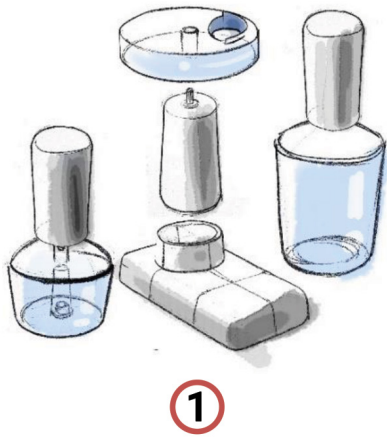


Figure 47 Mock ups of design directions

Evaluation

Based on the primary design statements, these directions were evaluated against the design brief challenges. This exercise was performed with fellow students.



Graph 5 Design direction evaluation

Mood board

Once the design direction was finalized, a mood board was constructed for form inspiration. It helped in designing the form in a certain formal direction, although it was always preceded by the functionality requirements

- **Geometric form derivatives:** Modern | Strong | Mature
- **Curved edges:** Safe | Inviting



Figure 48 Mood board

Mood board

Once the design direction was finalized, a mood board was constructed for form inspiration. It helped in designing the form in a certain formal direction, although it was always preceded by the functionality requirements

- **Simple clutter free layouts**
- **Progressive reduction**

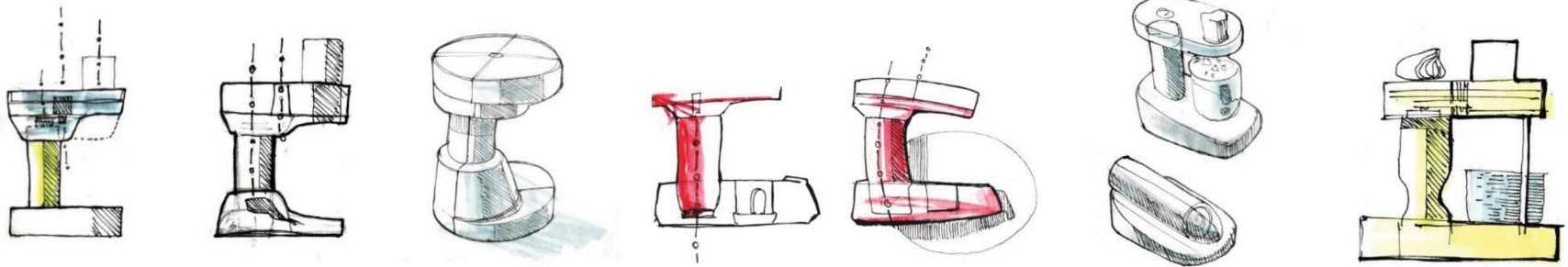


Figure 49 Mood board

Form typology

Numerous forms were sketched in the divergent stage. Later in the convergent stage these forms were categorized into two most prominent form typologies i.e.

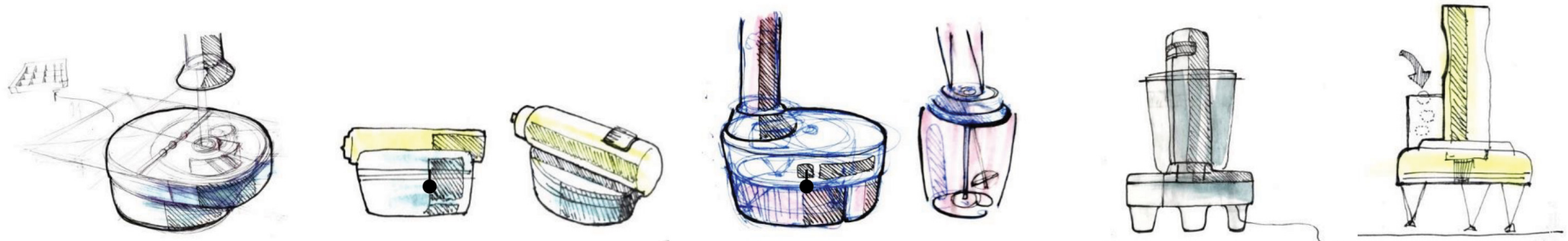
1. **Cantilevered support form**
2. **Downward blender engagement form**



1

Cantilevered support forms

External support



2

Downward blender engagement

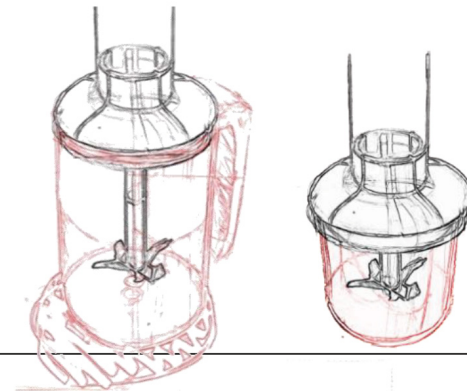
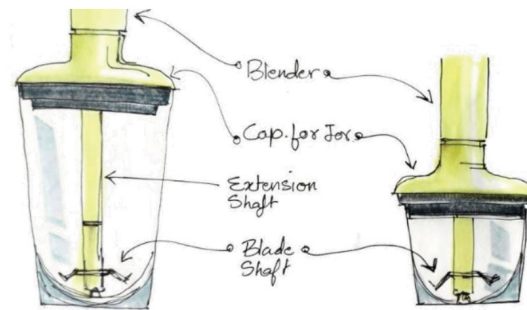
Raised form factor

Figure 51 Two form directions

Form typology

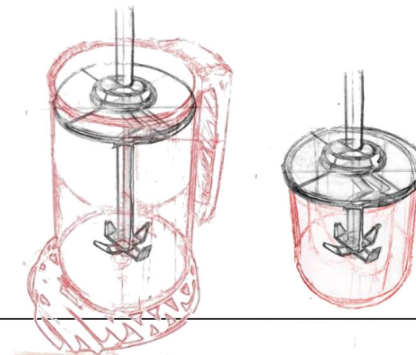
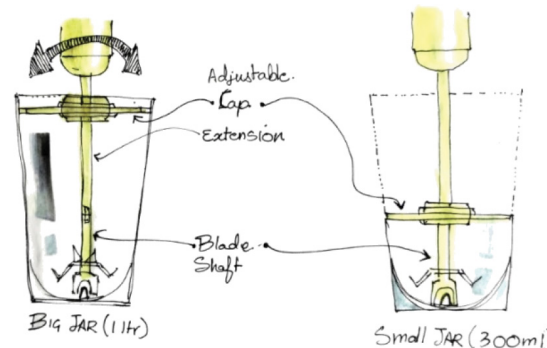
Jar and shaft forms were also explored in tandem with a handheld blender. Later in the convergent stage these forms were categorized into two most prominent form typologies i.e.

1. Fixed shaft
2. Free movement shaft



1

Fixed shaft idea



2

Free movement shaft idea

Concept 1

The two form categories were finally explored in 3d modelling tools and developed into more detailed concepts.

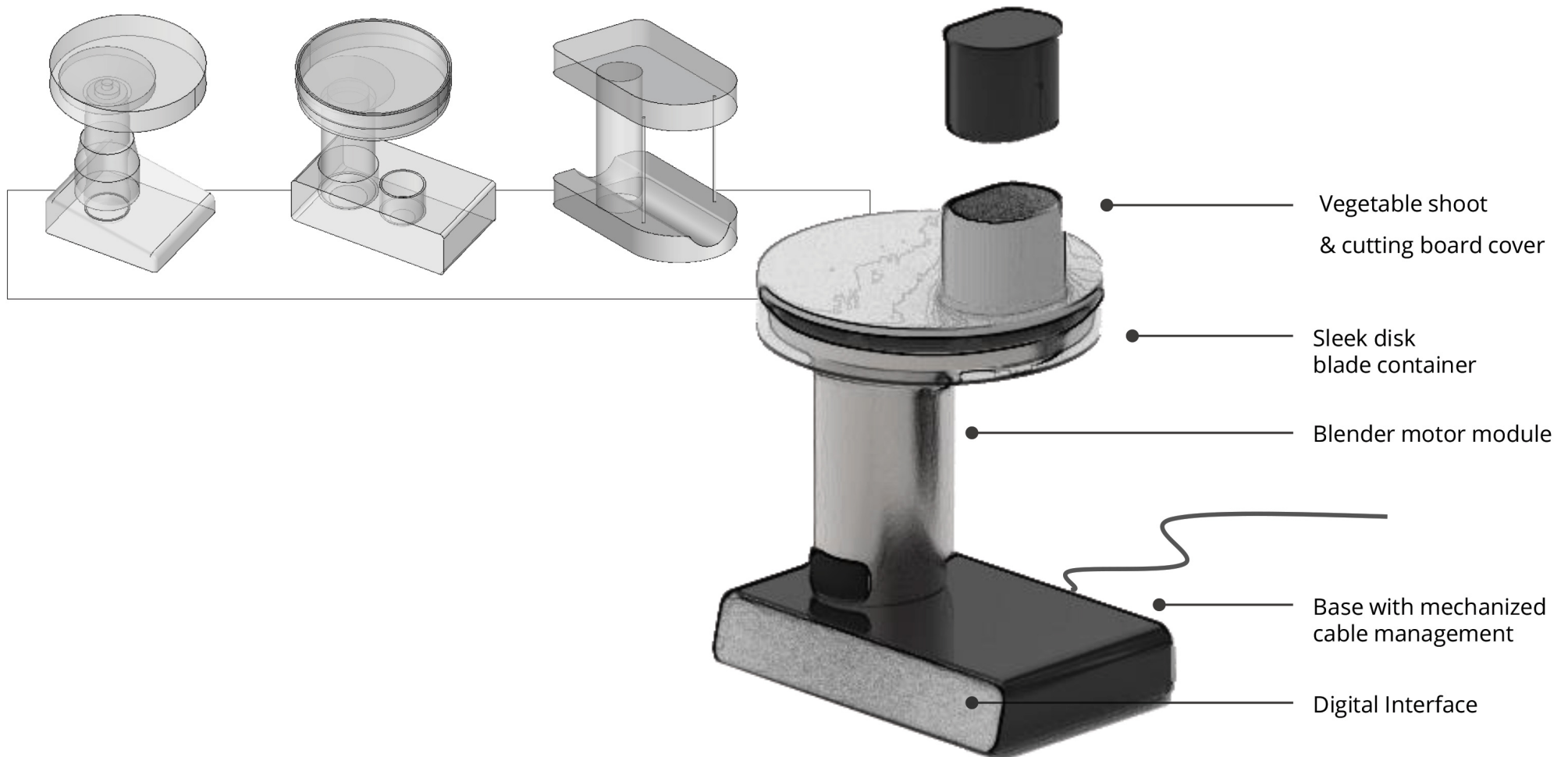


Figure 52a Concept 1

Concept 2

The two form categories were finally explored in 3d modelling tools and developed into more detailed concepts.

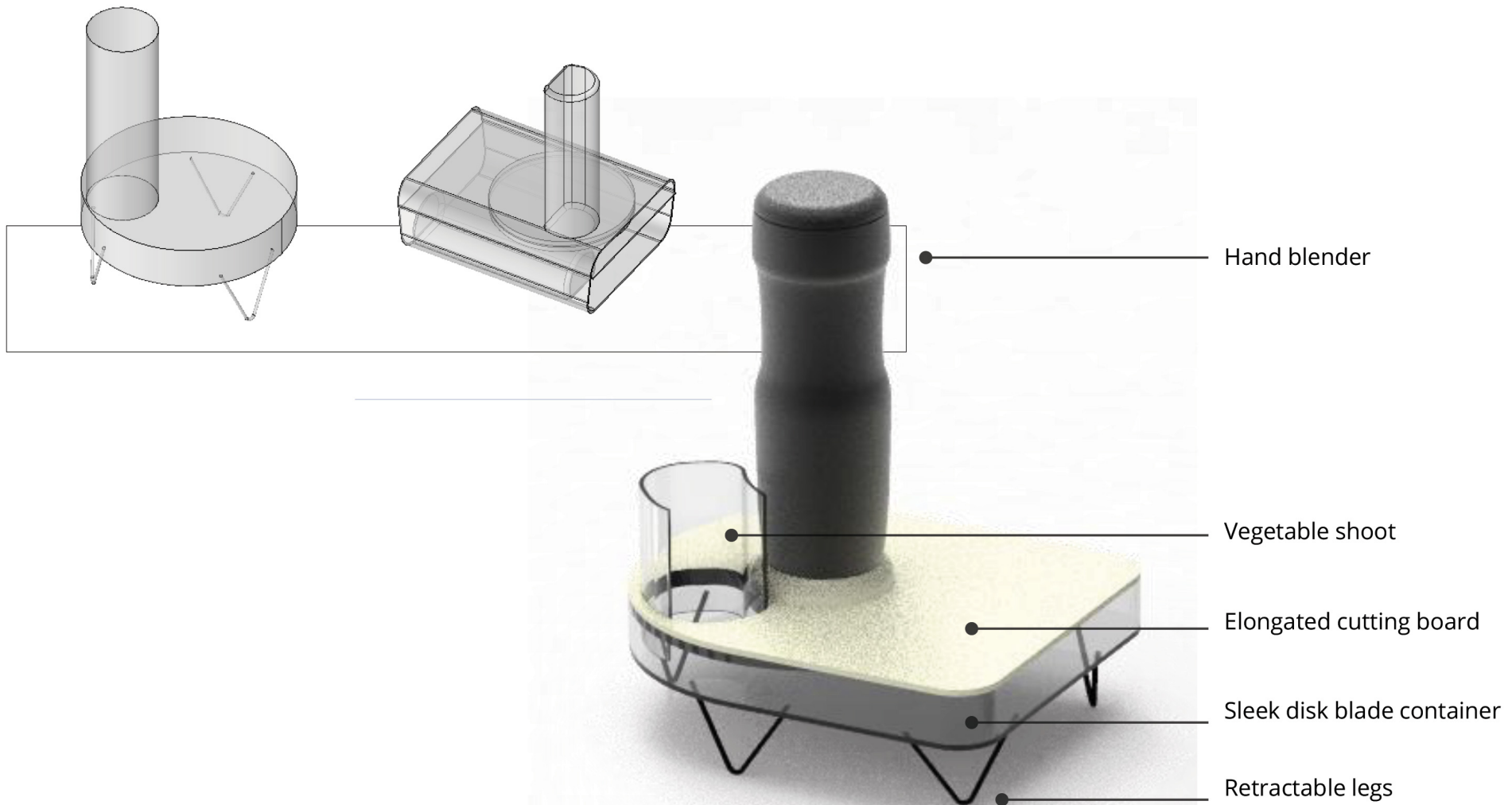


Figure 52b Concept 2

Swot analysis

The two concepts were evaluated using SWOT analysis. Concept with downward blender engagement was finalized and further developed to fulfill the brief statements prepared earlier



- Unique form factor
- Cable management
- Minimal look

- **Poor CoG**
- Storage issues
- **Redundant base**

- Base as storage
- Base can house smart functions

- **Fear of breaking the chopping container**

Strength

Weakness

Opportunity

Threat

- **Better CoG**
- **Better grip & overall stability**
- No unwanted components
- Foldable legs

- Weak leg expression
- Wire management issue

- **Underside can be used as a storage**

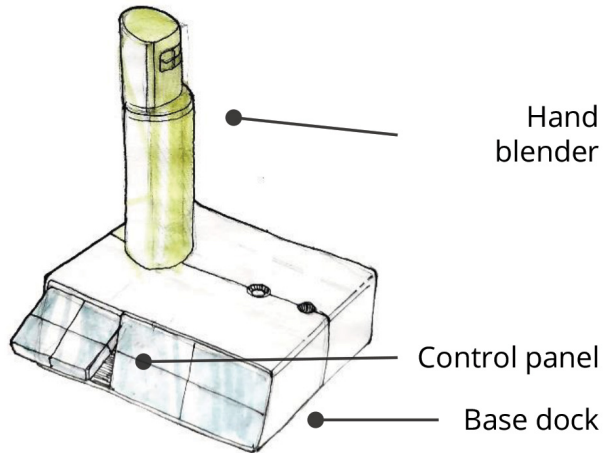
- Support legs could cause vibration and instability



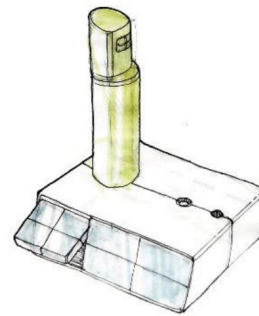
Graph 5 Swot analysis

Detailing

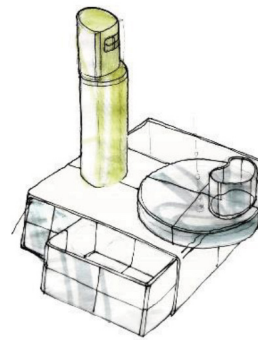
Once finalized, the concept continuously kept on refining by means of evaluation, peer and expert discussions. This page highlights the immediate formal and material development of the appliance.



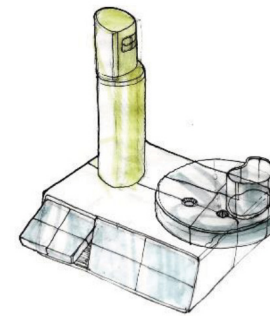
Concept refinement 1



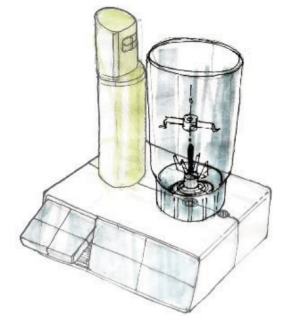
Basic configuration



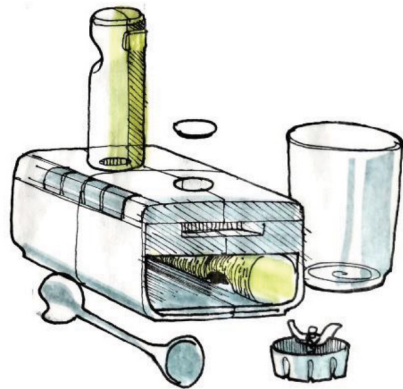
Storage for blender & other components



With chopping disk configuration



With blending jar configuration



Concept refinement 2

Functional components



Figure 54 Final concept render

1. Docking base/storage with belt drive
2. Blender & battery module
3. Blade & Coconut shredder shaft
4. Food cutting attachment/container
5. Jars: small, large & bottle form

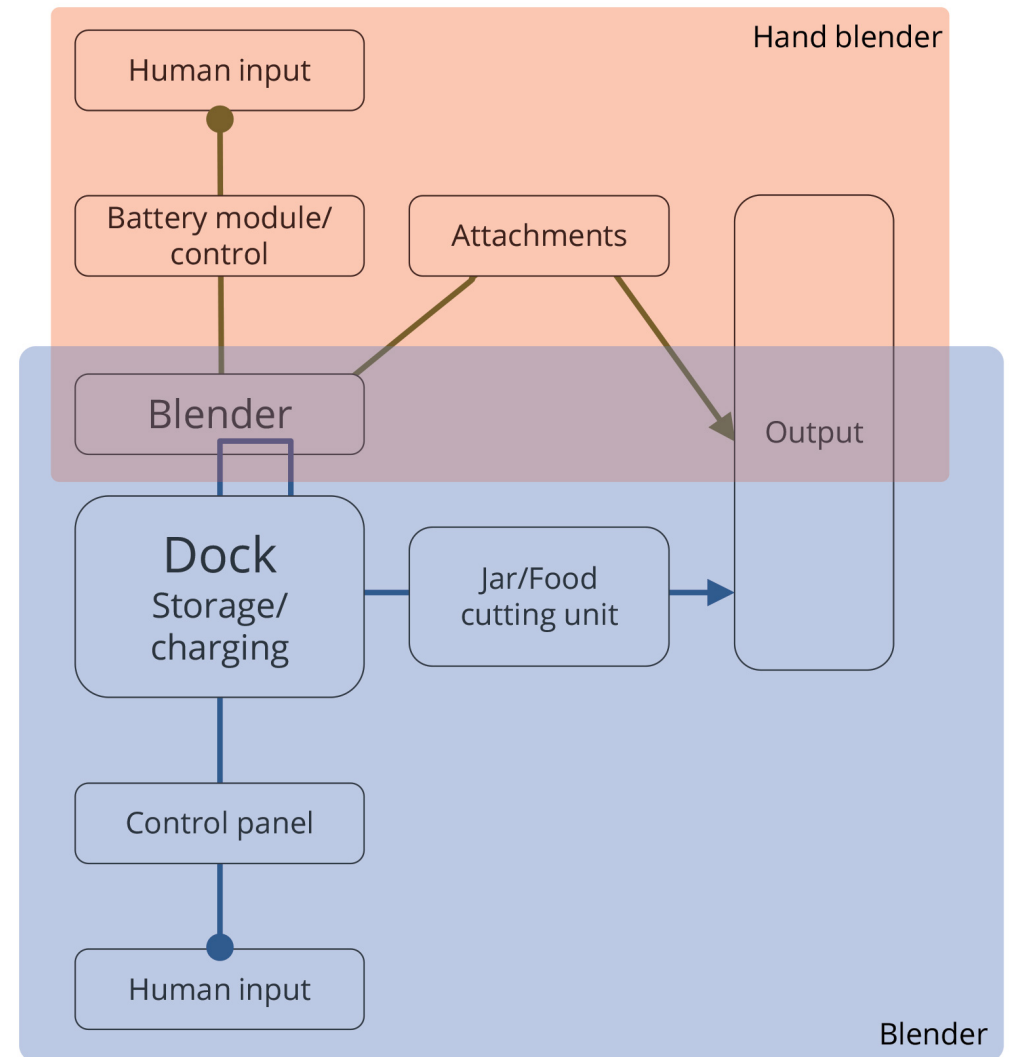
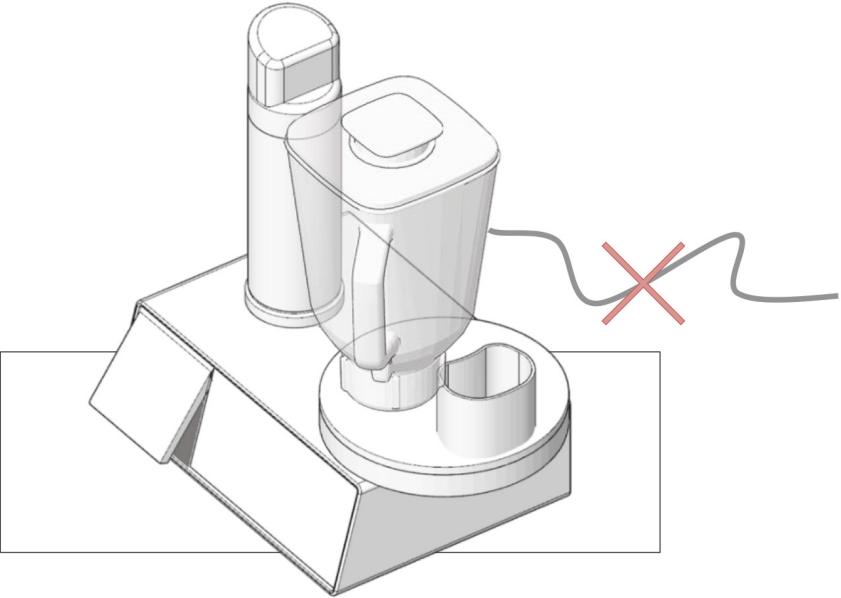


Figure 54 Block diagram

Final concept



Elegant composition & form novelty

Adaptive product interface

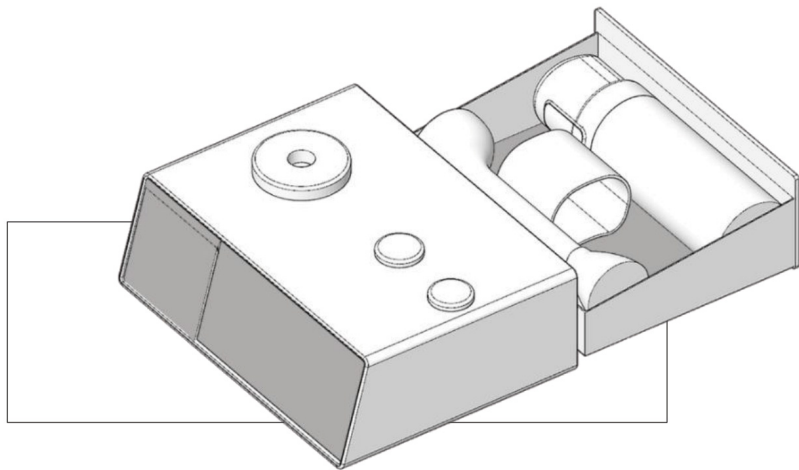
Cordless

Battery module: dock charging, removable



Figure 55 Product details

Final concept



Elegant composition & form novelty

Adaptive product interface

Cordless

Reduced clutter & effective storage

Convenient cleaning



Figure 56 Product detail 2s

Developing a mockup

In order to experience the product form, I made a mockup with whatever material I could lay my hands on. The mockup helped in understanding the obvious as well as the latent usability issues with it. I conducted a basic usability test where the user was asked to carry, hold and use the product in the most natural way possible.

Below are a few details of the mockups along with the snapshots. The following content present the issues and comments on the mockup form.

Scale: 1:1

Materials used: Paper,
Sun-board
Masking tape
Fevicol, F-bond
Paper pins

Techniques: Cutting
Folding
Pasting
Sanding

Scenario testing: Male (28 yrs)



Figure 57 Paper mock-up

Paper mockups & Experience prototyping

Usability testing was documented to showcase the comments and insights with the visuals. The user was quite natural in working with a mock-up and provided good insights.

Chopping



- Convenient height for cutting
- Skewed space for placing plates

Figure 58 Usability testing

Paper mockups & Experience prototyping

Usability testing was documented to showcase the comments and insights with the visuals. The user was quite natural in working with a mock-up and provided good insights.

Blending

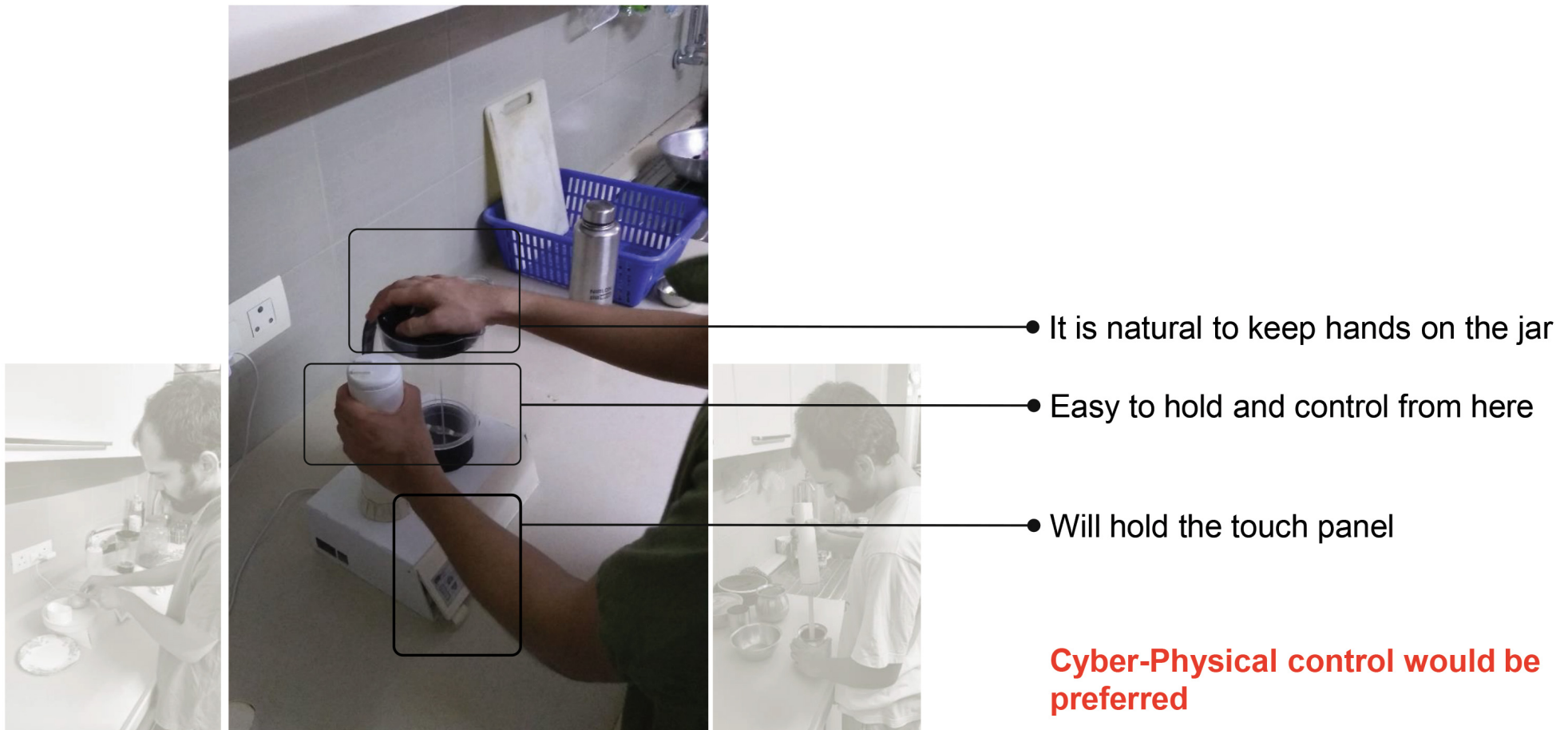
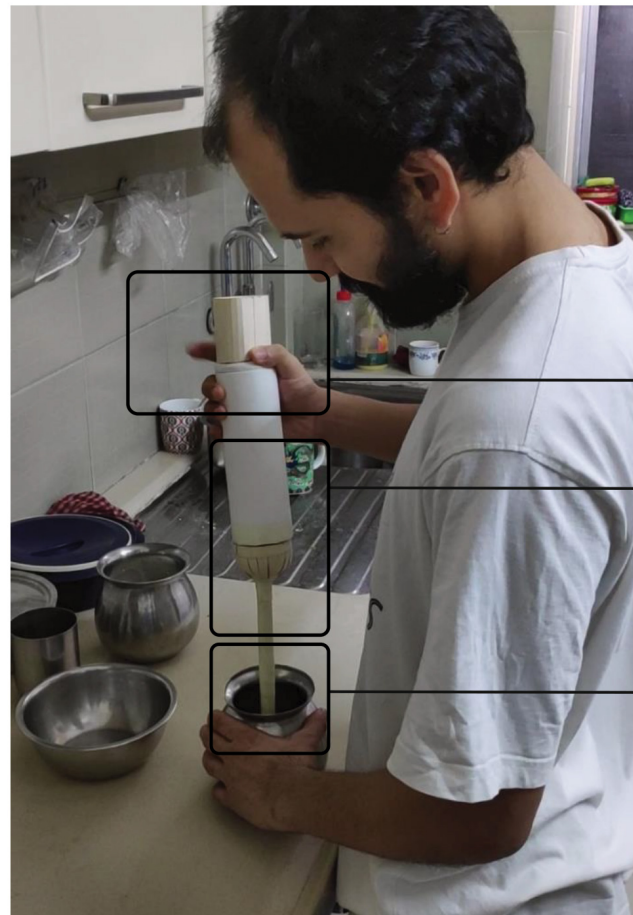


Figure 59 Usability testing 2

Paper mockups & Experience prototyping

Usability testing was documented to showcase the comments and insights with the visuals. The user was quite natural in working with a mock-up and provided good insights.

Hand blending



• Would prefer button at thumb height

• Too long

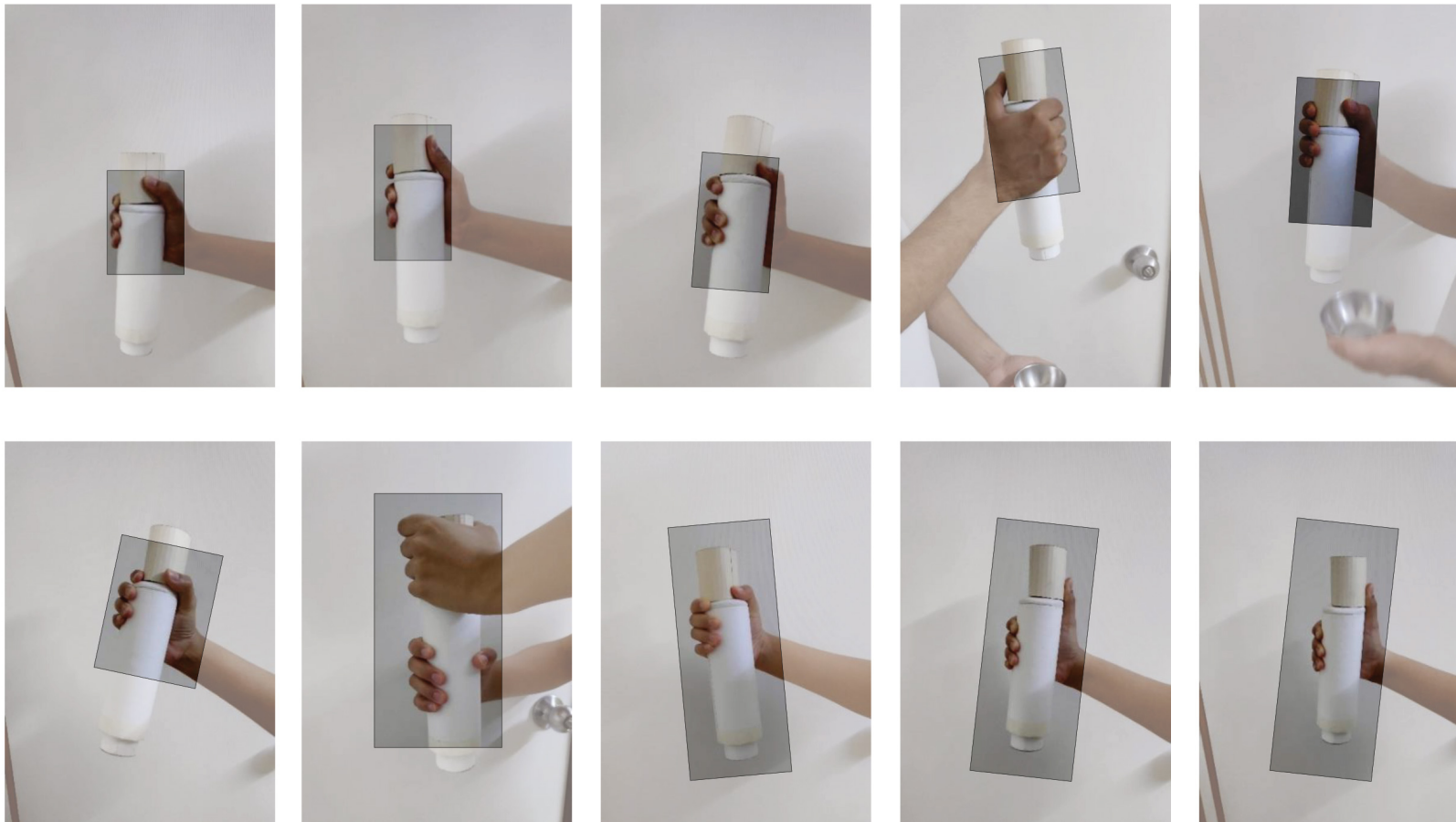
• Long shaft good for viewing

Figure 60 Usability testing 3

Paper mockups & Experience prototyping

The hand blender was tested for grip and natural finger positions to design the control form and position.

Grip study and button position marking



- Ideal button position at the junction
- Surface texture should have grip

- Downward thumb grip can be improved
- Requires both hands
- Size of battery unit good to grip

Figure 61 Hand blender holding trial with 2 users

Insights and faculty comments

Insights after usability testing

- Touch interface with **additional step of adjusting the angle** appeared extra.
- Position of plate placement is **small**.
- The **cutting surface & height** were convenient.
- Hand blender need to be better designed for optimum **button placement** and **length**.
- **Downward grip** for the thumb **and surface grip** for fingers is relevant for prolonged usage.

Faculty comments

- Food cutting could result in **splashing of the vegetables**.
- Important to keep **thumb for gripping action**. Use **index finger** for operating.
- Try to **observe** the users in the kitchen and their natural behavior.
- **Reduce** the action of pulling the storage unit and taking out the accessories.

detailing

1. Design detailing

- Design improvements
- Product specifications
- Design details
- Control interface design
- Usage scenario

2. 3d modelling

- Modelling
- Environment rendering

Improvements

After the usability test and getting faculty suggestions, I tried to address the issues that were revealed in the process. Various elements like control interface, container position, storage ideas were worked upon. More technical details were finalized and a specification list prepared.

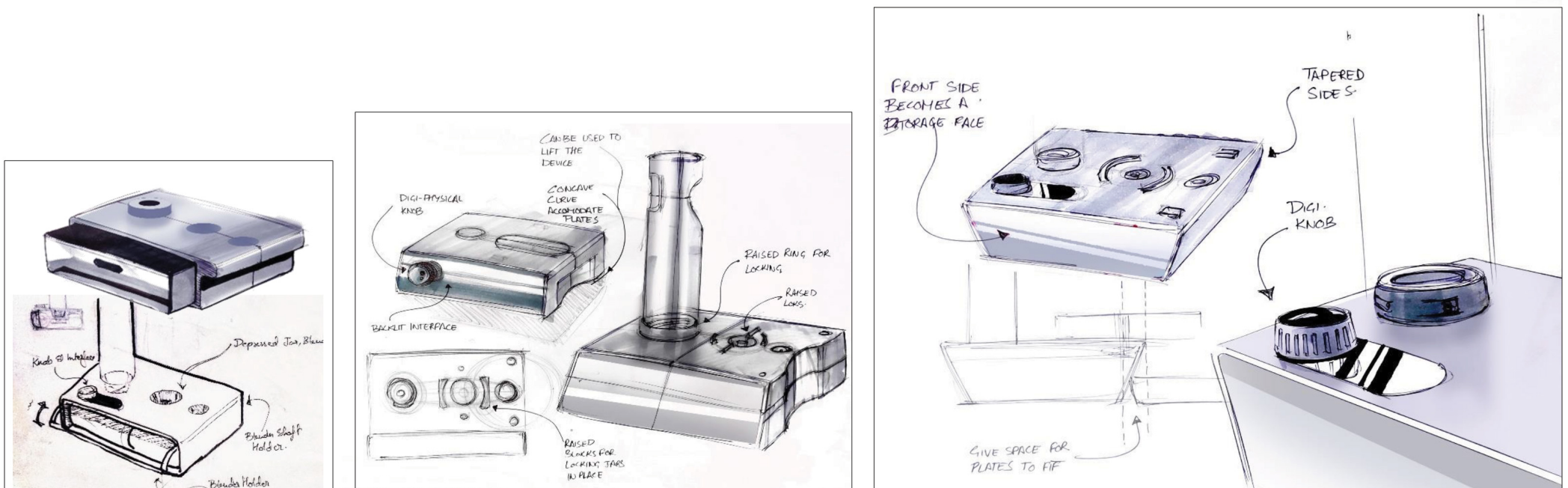


Figure 62a,b,c Form iterations to address issues like interface positioning and plate placement.

Improvements

Finalised the details for the hand blender in order to make it more usable.

- I looked into the anthropometric data of Indian hand grip, selecting the 5th percentile data, to include the smaller hand reach.
- Studied existing product forms to learn about optimum controls positions.
- A dc motor (DC751(2)XLLG-025) by Johnson Electronic was taken as a reference as it specially manufactured for hand blenders.

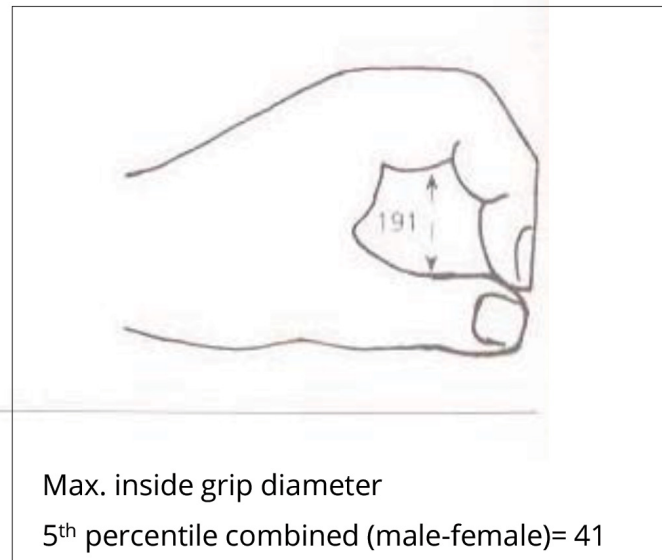


Figure 63 Grip details from Indian Anthropometric dimension by Debkumar Chakrabarti

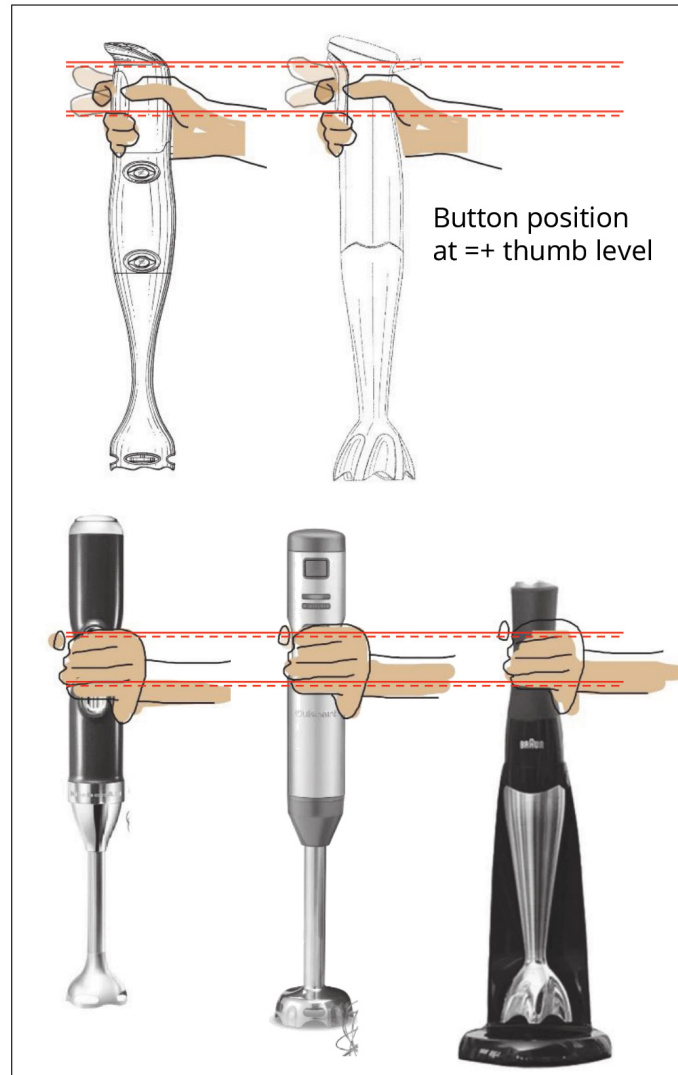


Figure 64 blender control position

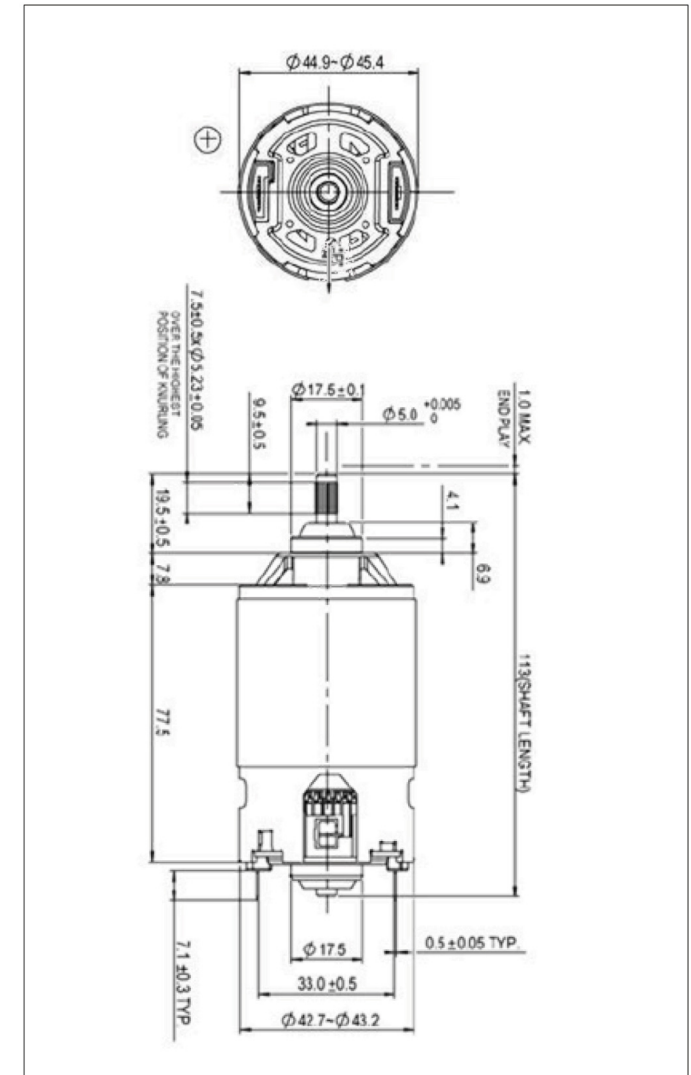


Figure 65 DC motor reference

Improvements

Hand blender forms.
Second option from left was selected for having form qualities that were more comprehensible with the overall design form.

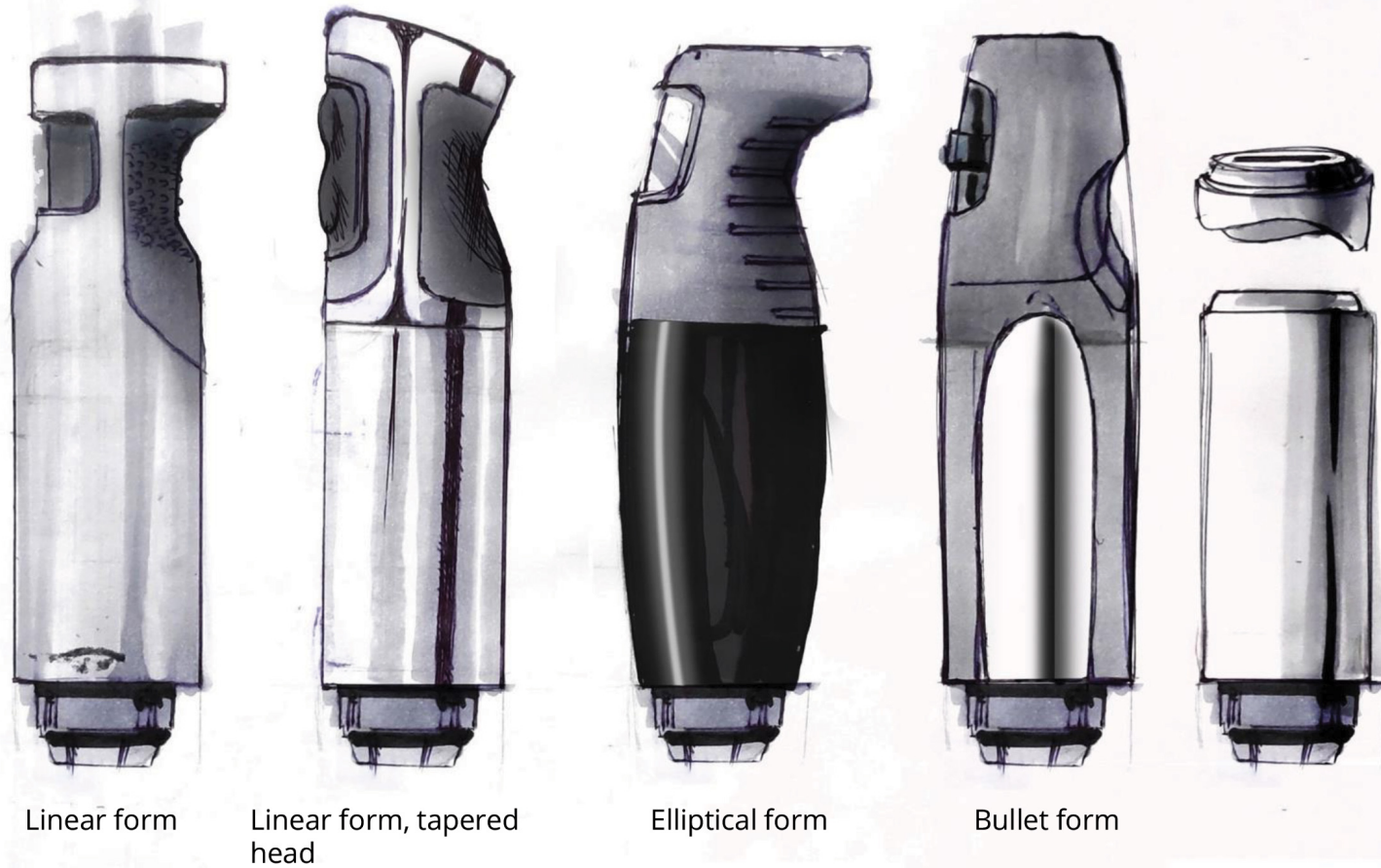


Figure 66 Design of hand blender form for better grip

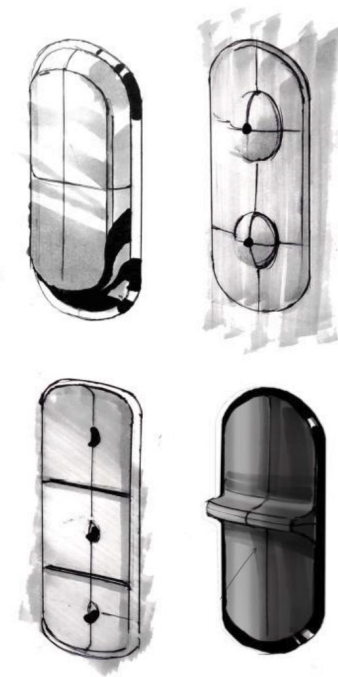


Figure 67 Control options

Product specifications

As the design is now finalized and technical details being worked around, I have tried to compile a product specification list.

Product name: **MIXit**

Category: **Small kitchen appliance**

Performance

1. Must be **easy to operate by different age group (15-65 years, provisional)**
2. It should have a **speed range of 11000 rpm to perform various functions** i.e. blending, grinding, various cutting styles
3. Should have a DC motor with **min. 500 W input power.**
4. Hand blender to work on **both ac and dc power**
5. Blender to use **12V, 7Ah+** LiPo battery (better weight/power ratio and flexible designing.)

Size

1. Appliance footprint to be **less than 300x200 mm**

Materials

1. Materials must provide durability and strength to handle preparation tasks.
2. It should be **corrosion resistant. Steel 304**
3. Materials coming in direct contact with food must be **food grade. Steel 304**
4. Polycarbonate for other components and accessories

Environment

1. Resistant to water, edible liquids, oil and vegetable/food chemicals.
2. The product should **perform** with temperature of the **food contents between 0°C to 90° C.**
3. **Dust, liquid should be easily cleaned** from the product.

Maintenance

1. **Easily accessible** for cleaning.
2. **Dust, liquid should be easily cleaned** from the product
3. Parts require lubrication must be easily accessible.
4. The replacement of **spare parts** must be **easily done.**
5. Have semi automatic **wire management system** in place

Storage

1. Does not occupy space larger than the cumulative volume of existing multiple products
2. Should easily fit in existing shelf sizes i.e. 24" deep shelves with minimum height of 8"

Safety

1. Have protection against **accidental operation**
2. It is protected from **power surges**
3. **No sharp edges** to be exposed
4. Materials in direct or possible contact with users **do not conduct electricity**

Ergonomics

1. Controls must be at a **height suitable** to positioned the user when placed over the counter
2. **No sharp edges** to be exposed
3. Preferable to make **controls universal** and provide multi sensorial feedback

Aesthetics

1. Must present an **image of robustness, reliability, and compactness.**
2. Also reflect as an **innovative and modern** product proposition.

Design details

Below is a basic view of the final design, along with the components details that come together to form a unique design proposition.

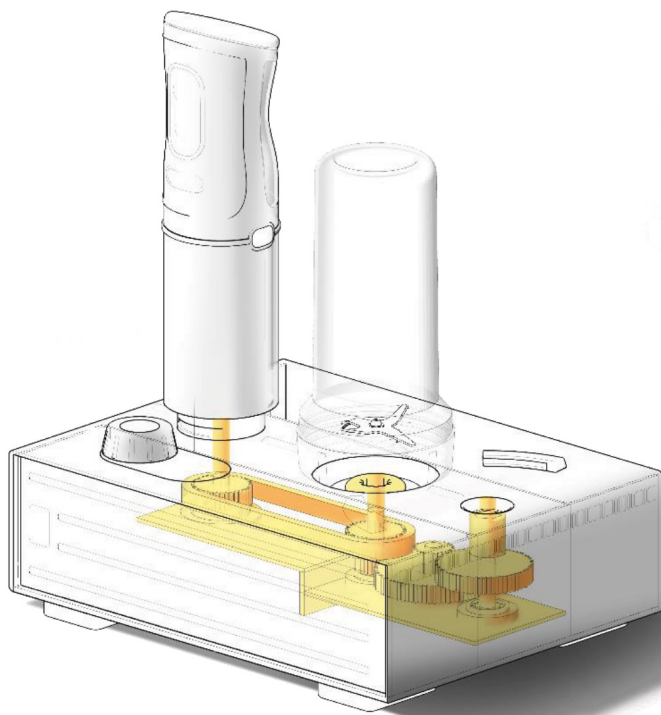


Figure 68 Basic view of the Mixit

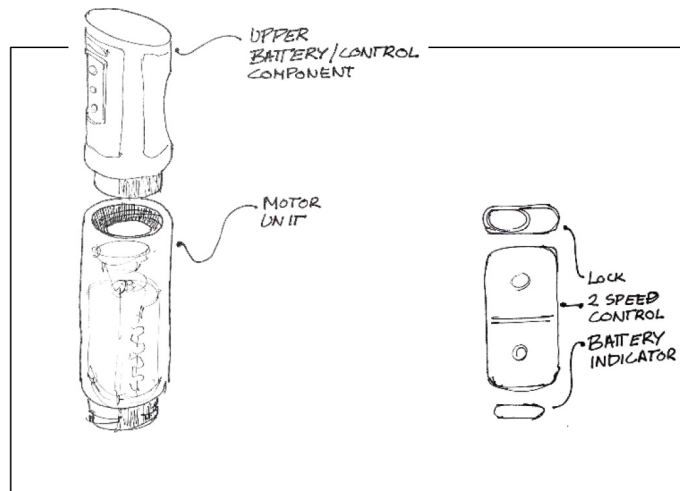


Figure 69 Blender elements

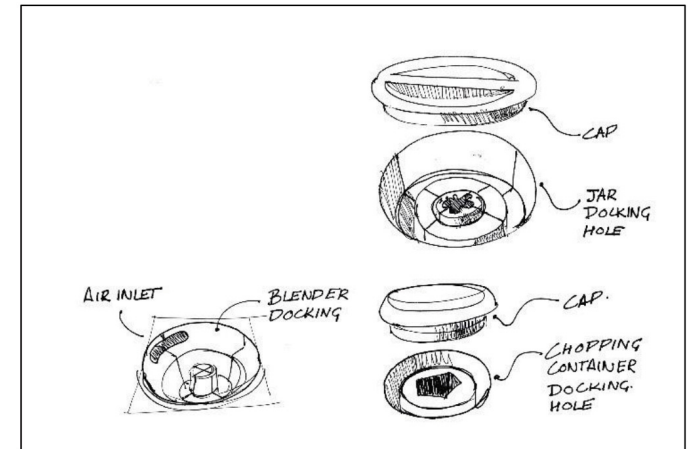


Figure 70 Docking holes on the base unit for blender, jar and cutting container

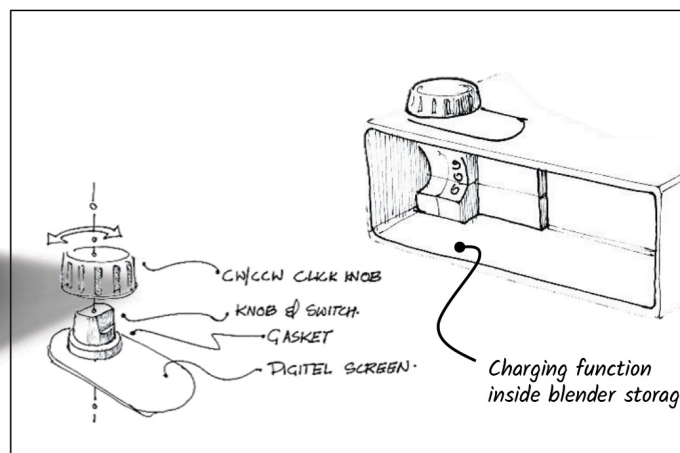


Figure 71 Charging unit and interface

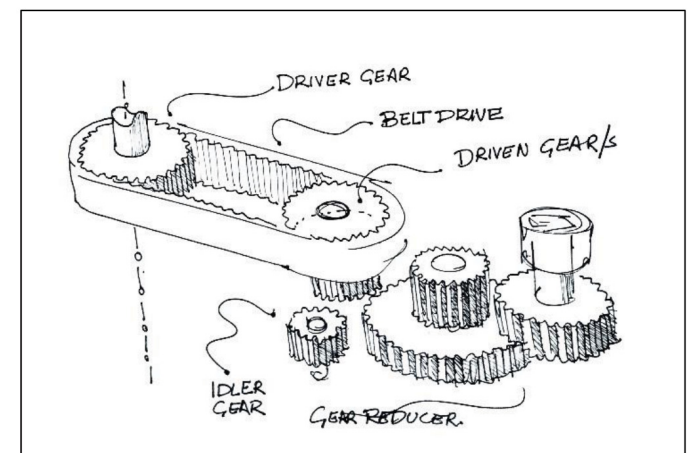


Figure 72 Gear system used for transmission.

Design details

Below is a basic view of the final design, along with the components details that come together to form a unique design proposition.

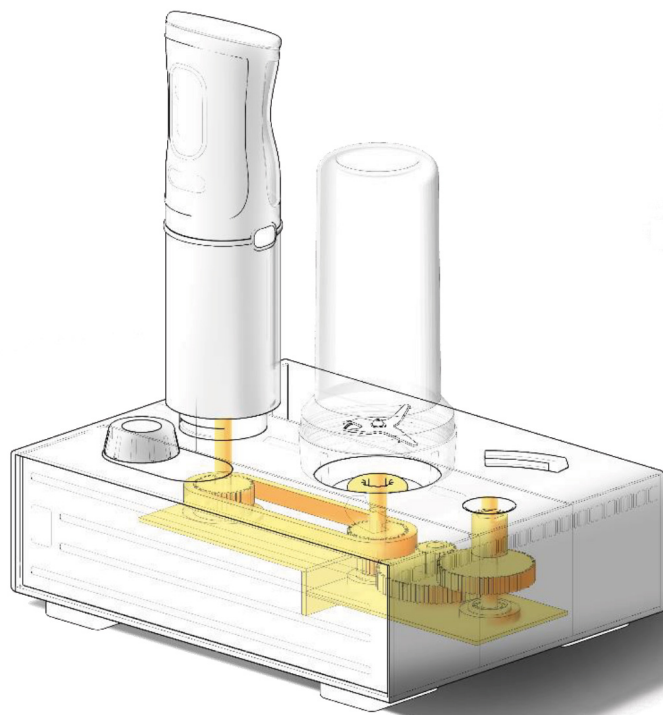


Figure 68 Basic view of the Mixit

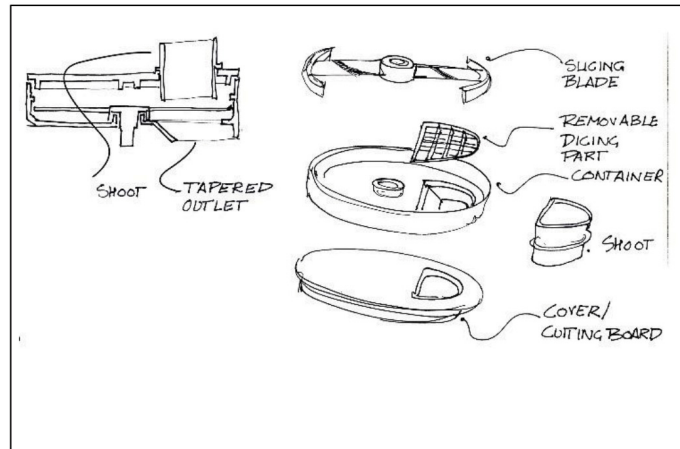


Figure 73 Cutting container system

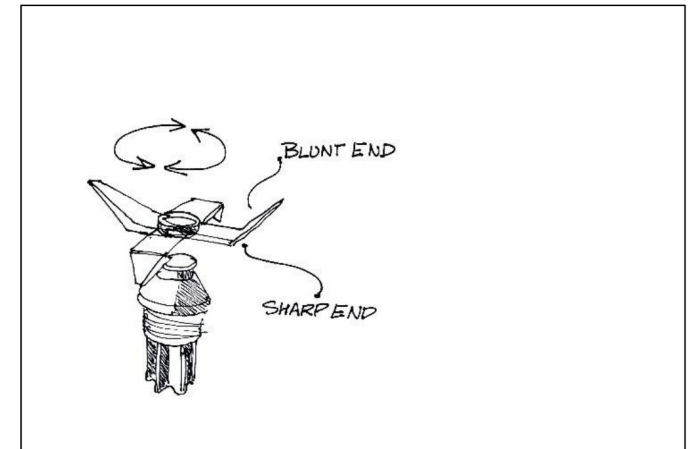


Figure 74 Reverse blade action, helps in keeping it sharp for longer

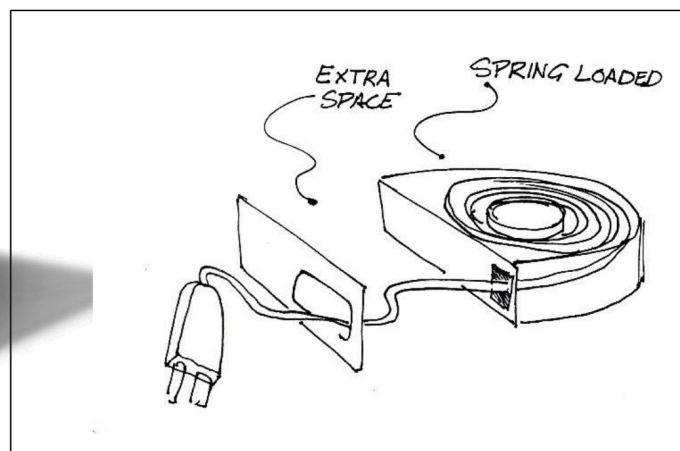


Figure 75 retractable system incorporated in wire management along with extra space to accommodate longer cable

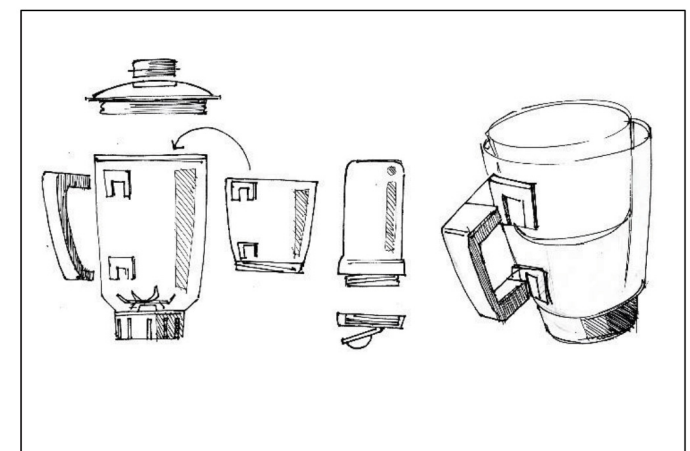


Figure 76 big jar, small jar and a bottle jar with space saving planning

Control interface design

The interface is a digital-physical interface, providing the comfort and feedback of physical control knob and digital screen to augment the operating experience. The user gets the feedback in the form of tactile breaks, sound and visual cues like corresponding speed light and screen information. Below is a simple flowchart of the blender interface

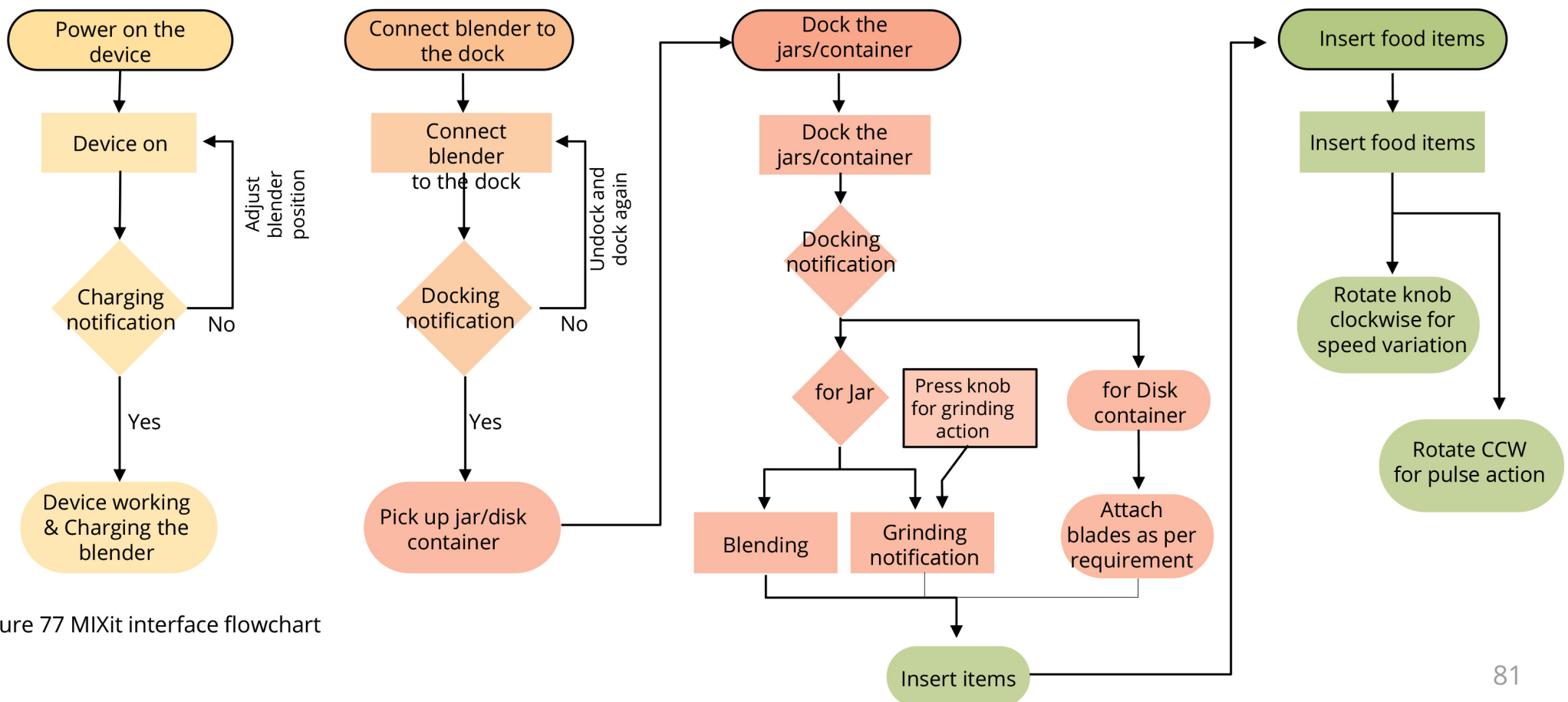
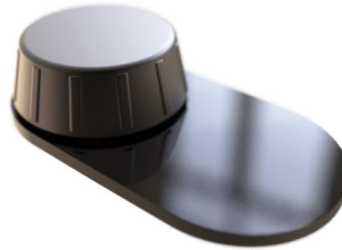


Figure 77 MIXit interface flowchart

Control interface design

The interface is a digital-physical interface, providing the comfort and feedback of physical control knob and digital screen to augment the operating experience. The user gets the feedback in the form of tactile breaks, sound and visual cues like corresponding speed light and screen information.

Below is a wireframe of the blender interface.

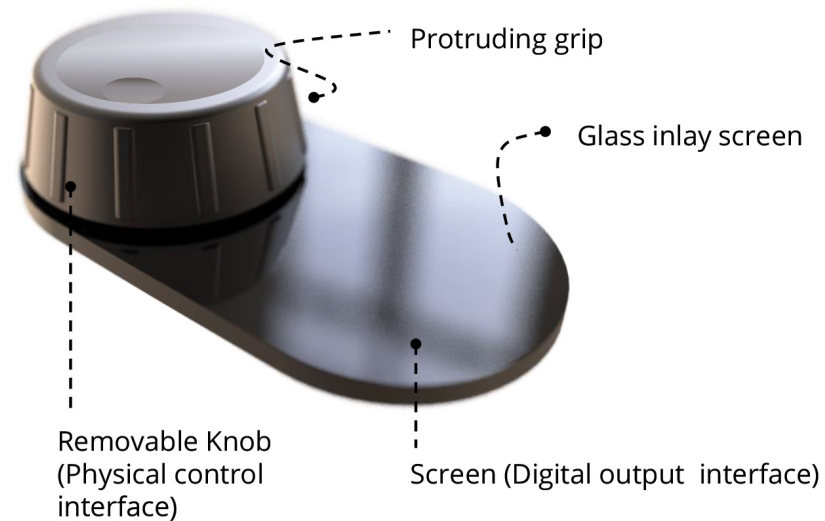


Figure 80 Perspective view of the control interface

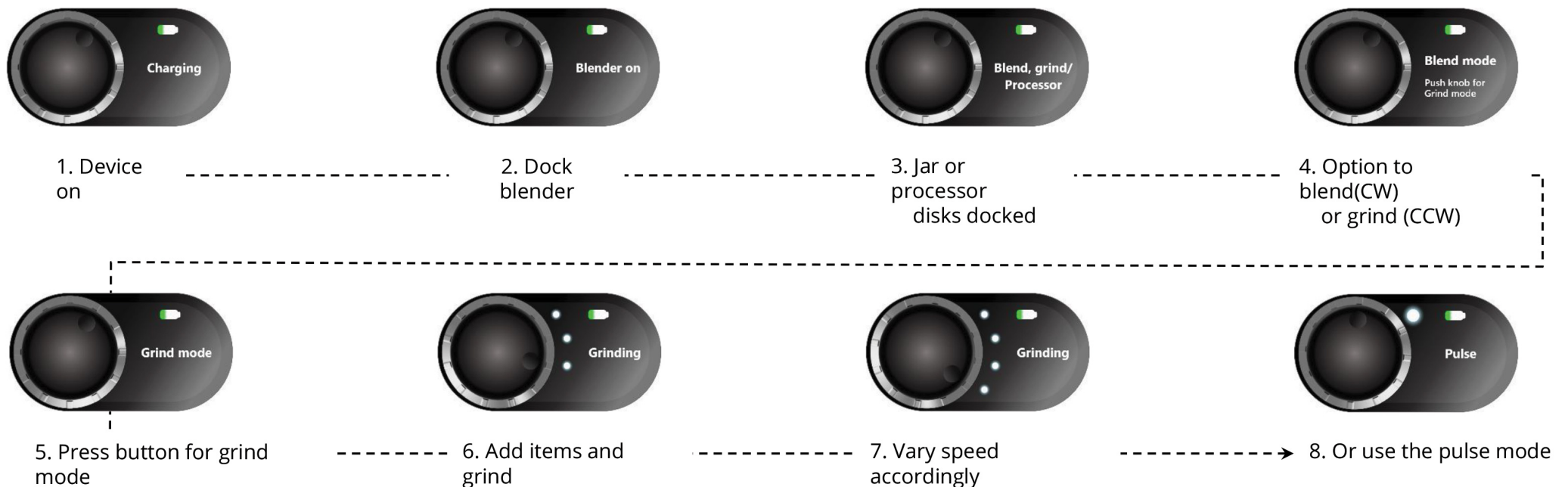


Figure 79 wireframe of MIXit interface

Derivative of **Mixie**
A mix of different functions

MIXit

Final v.2



Multi-functional

Hand blending
Counter-top blending-grinding
Food processor

Variable speed

12V DC / 24 V DC
CW-CCW rotation

Integrated storage

Blender & shaft storage

Improved usability

Better maintenance
Intuitive control interface
Ease of cleaning

Figure 81 MIXit

Derivative of **Mixie**
A mix of different functions

MIXit

Final v.2



Figure 81 MIXit

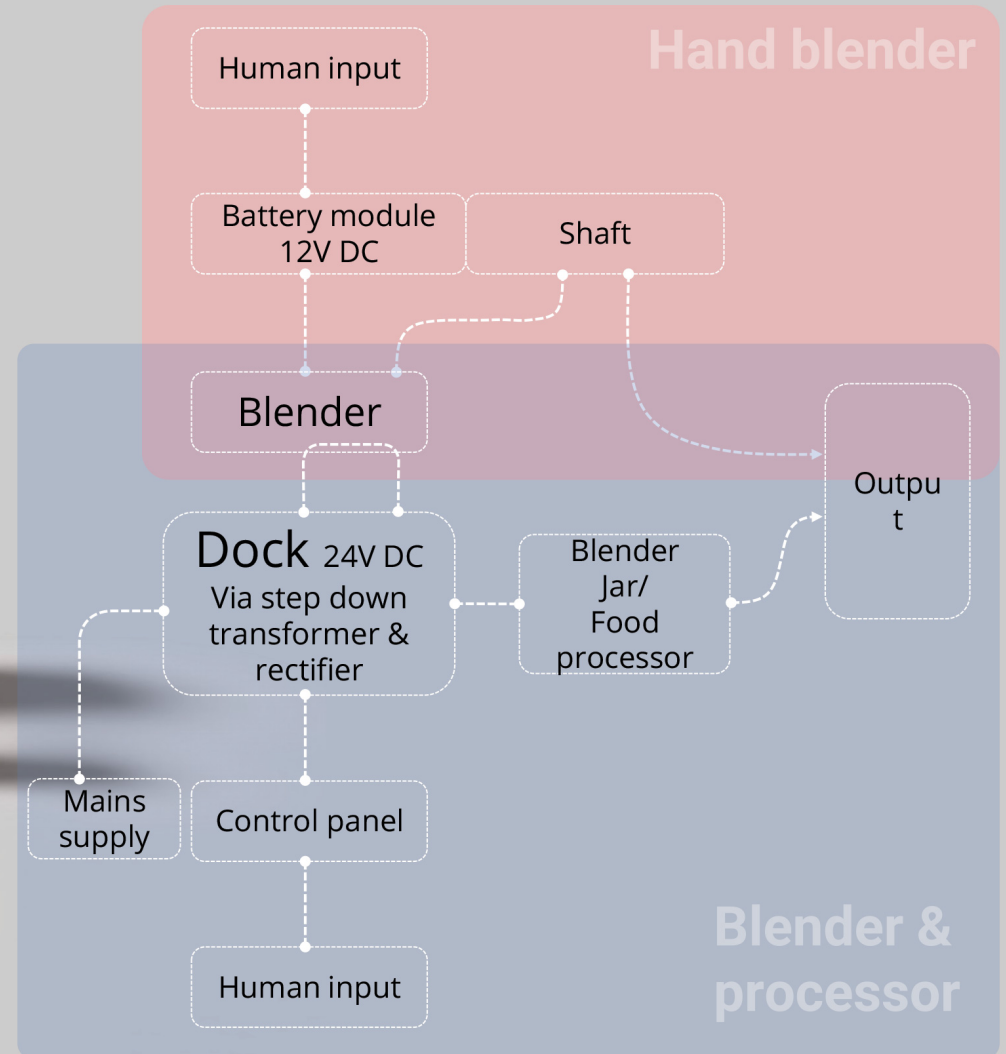
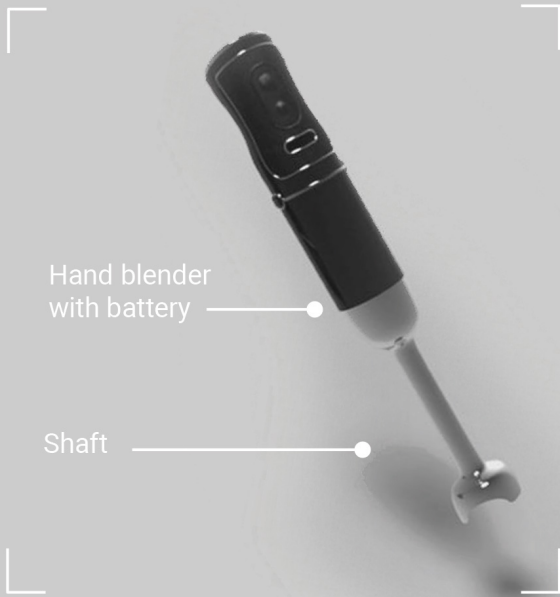


Figure 82 Block diagram

MIXit

Final v.2



Configuration 1: Hand blender

Status: Wireless
 Input: 12V DC
 5000 RPM

Works as a portable blender
 no cable fuss while working.

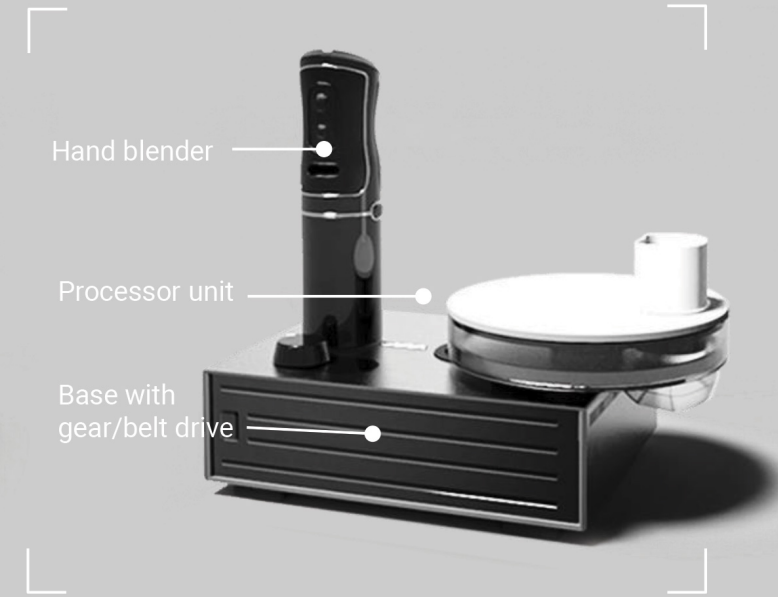
Figure 83 Different modes of MIXit



Configuration 2: Counter top blender

Status: Wired
 Input: 24V DC (From AC)
 10000 RPM

Motor runs on higher power.
 Blending: CW direction
 Grinding: CCW direction- blunt edge



Configuration 3: Food processor unit

Status: Wired
 Input: 24V DC (from AC)
 2500 RPM

Provides various cutting styles like slicing,
 chopping, grating shredding.
 A coconut scraping unit can be connected as well.

MIXit

Final v.2

MIXit

Dimensions

Base: 300x210x70 mm³
 Blender: 240X56ø
 Jar: 1.5 litre

Materials:

Tritan, PC, ABS, SS304, TPE

Processes:

Sheet forming, Casting, IM



Figure 84 Exploded view of MIXit

Storyboard

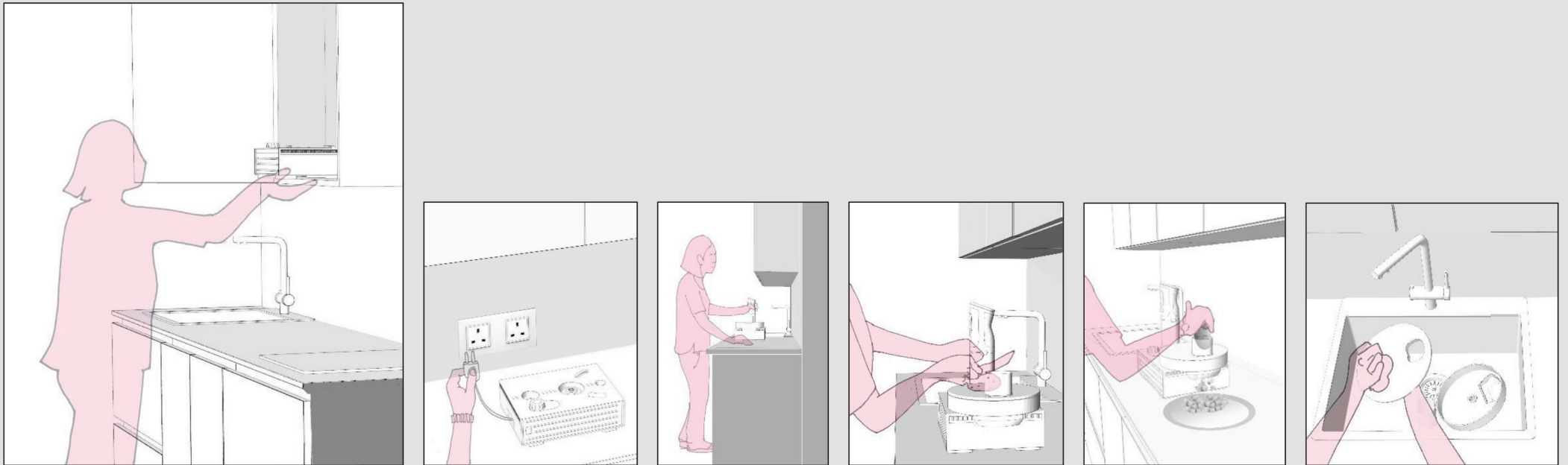


Figure 85 User takes out MIXit

Storyboard

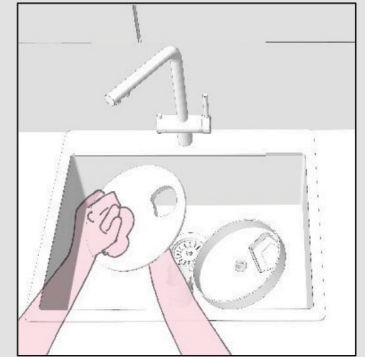
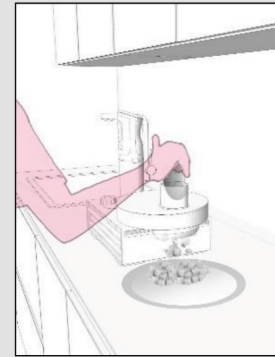
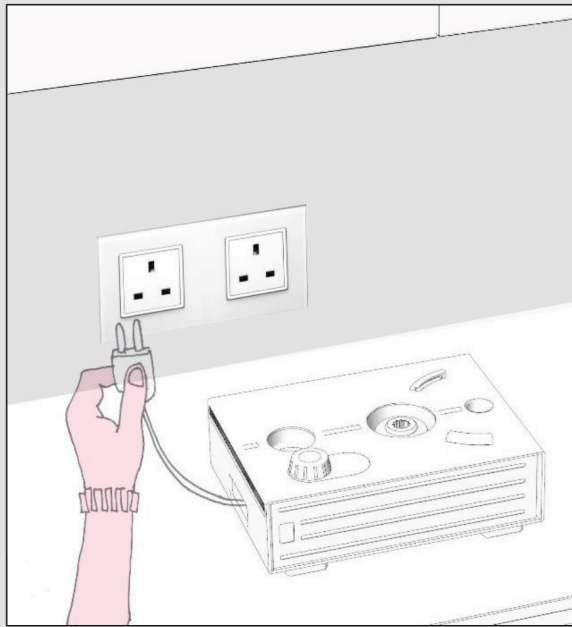


Figure 86 Pulls the retractable cable and connects to the socket

Storyboard

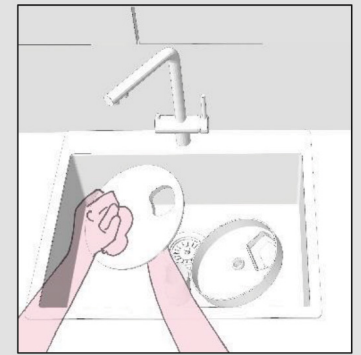
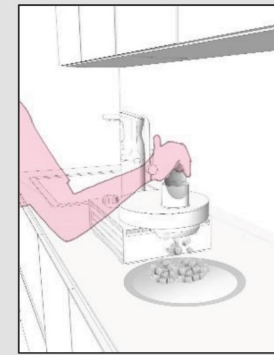
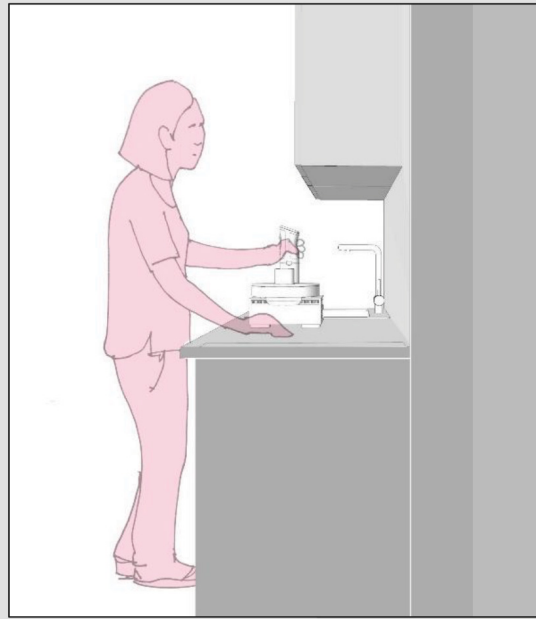
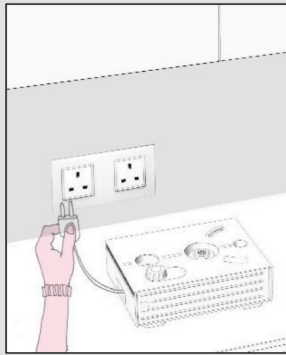
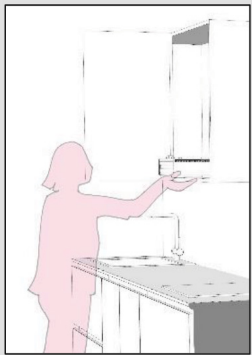


Figure 87 Takes out the blender from inside And docks it on the base

Storyboard

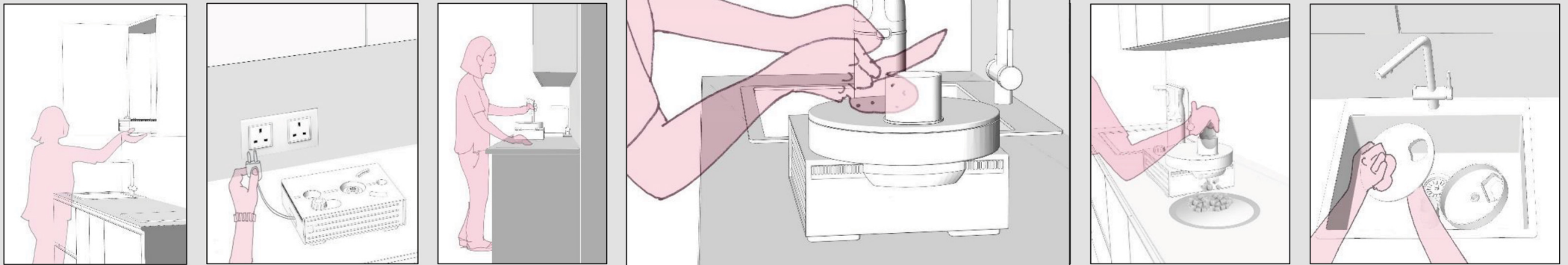


Figure 88 Connects the processor unit, slices and cuts the vegetable on it

Storyboard

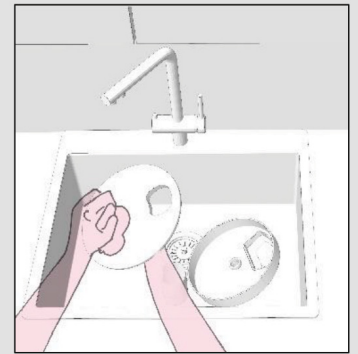
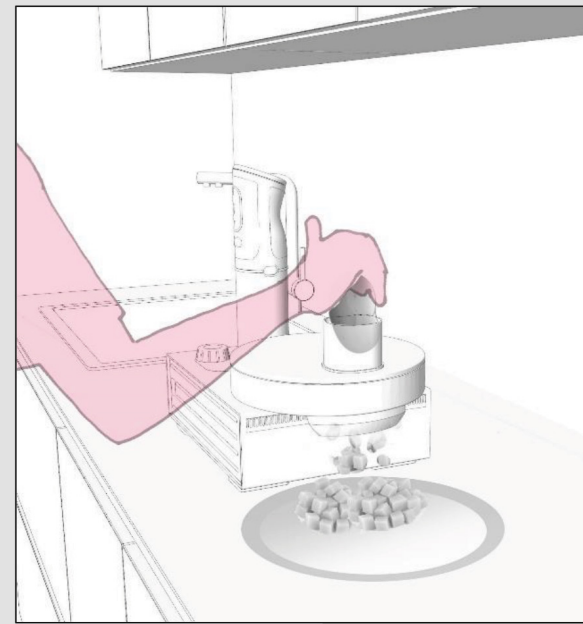
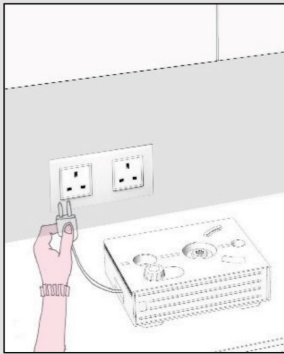
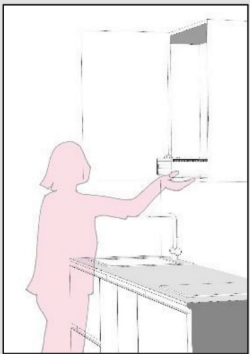


Figure 89 Places the plate, operates MIXit

Storyboard

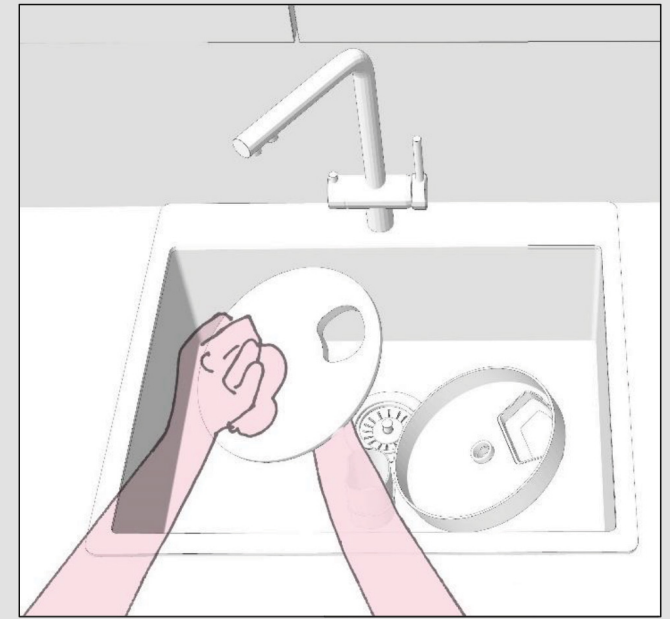
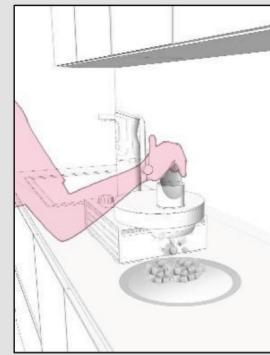
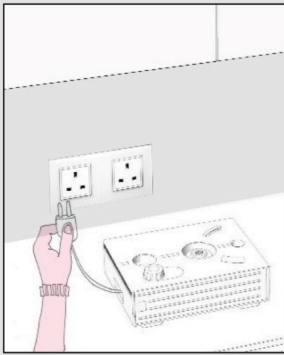
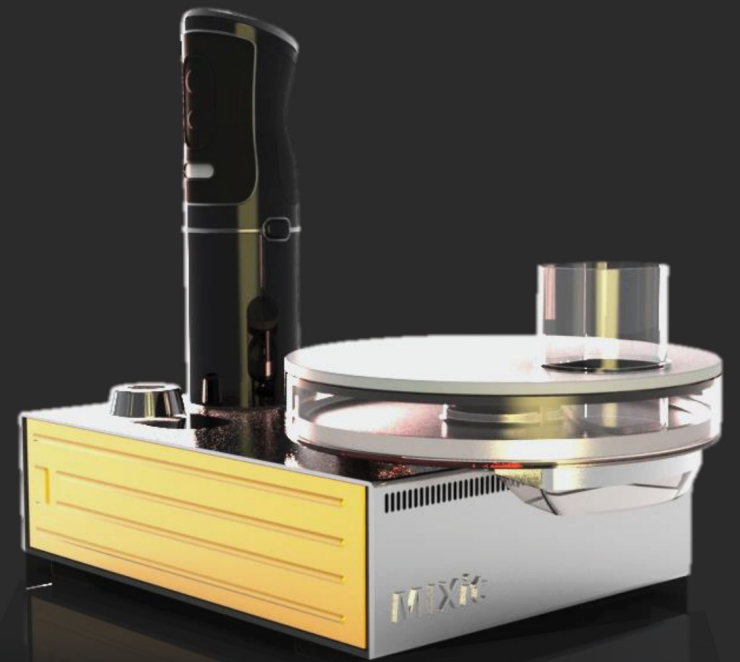
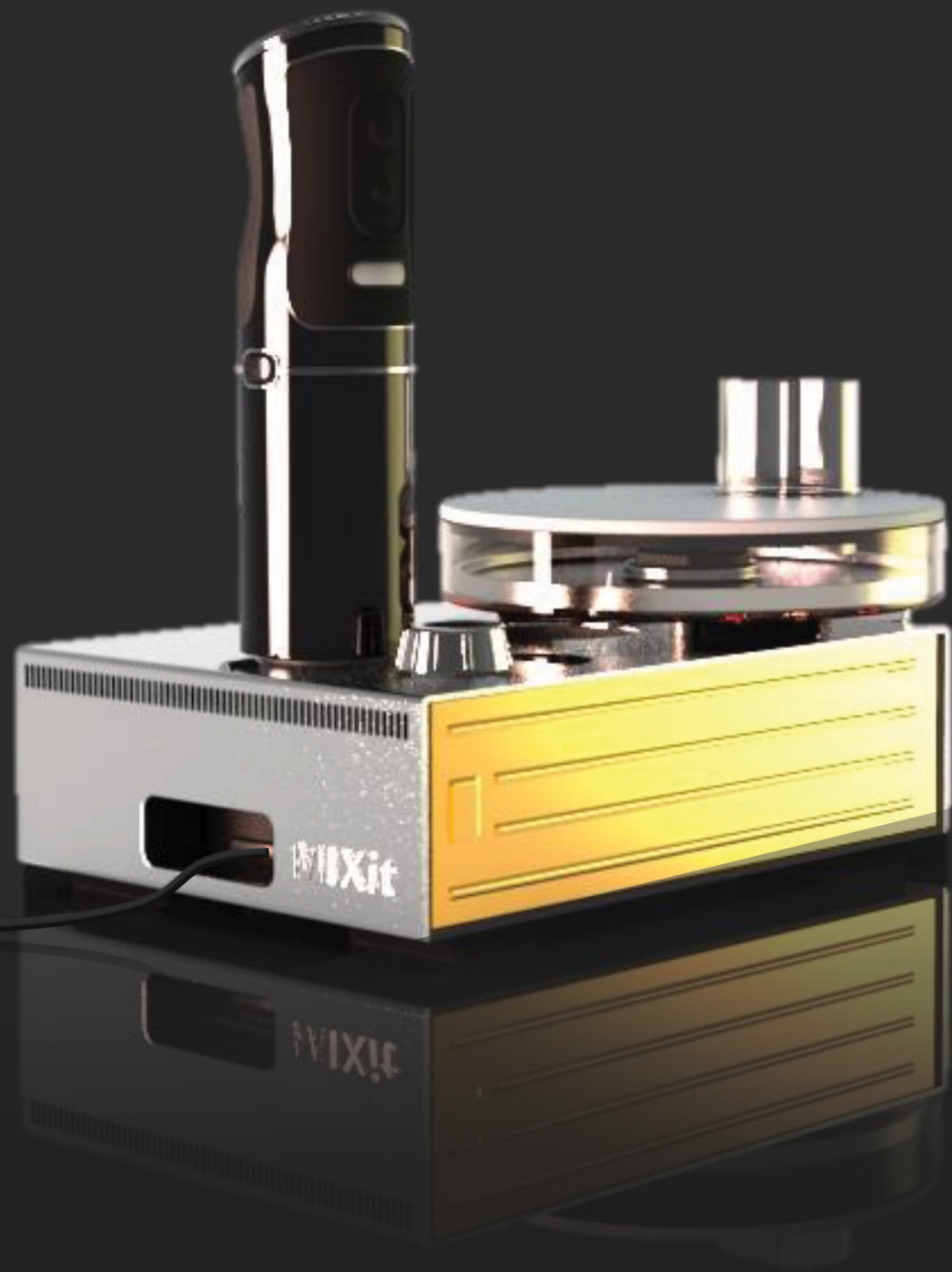


Figure 90 Less items to clean



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Thank you

