Everyday cookware designed for better handling.

Submitted in partial fulfilments of the requirements
of the degree of

Master of Design

by

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P2 Project Report of

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Guidance by Prof. B.K. Chakravarthy

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I would like to thank Sarthak Rao for getting me his jacket when he didn't need to.

project approval

This is to certify that the Industrial Design Project entitled “Everyday cookware designed for better handling” by Snehdeep Singh Pabla is approved for partial fulfillment for the Master of Design degree in Industrial Design.

Prof. BK Chakravarthy (Project Guide)

Chairperson 

Internal Examiner 

External Examiner 

project abstract

This project is an attempt to redesign the three most commonly used utensils in order to improve their handling and usage. The project started with re-searching about inclusive design and how to remove systems of exclusion from the cooking spaces. This involved how people who are not abled body feel excluded on various levels. I interviewed peoplle from over the country, age groups, occupations and ableness in order to understand their cooking habits and preferences. The insights gained from these in-terviews were then categorized and prioritzed. Ideas were generated by using these newfound insights in order to create design concepts. These Concepts were then prototpyed and tested in order to create the final designs.

contents

Introduction

The utensils we use everyday leave a lot to be desired in terms of handling and handelability. In kitchens we often encounter badly designed and manufactured utensils. Why are they badly designed? Because the parts we interact the most are often found broken, loose, melted or missing. The utensils we use at home seem to break down with the lightest of moderate use. Making them unusable from a safety and perspective.

These unreliable handles often causes worry, spills, mishaps and at worse injuries.

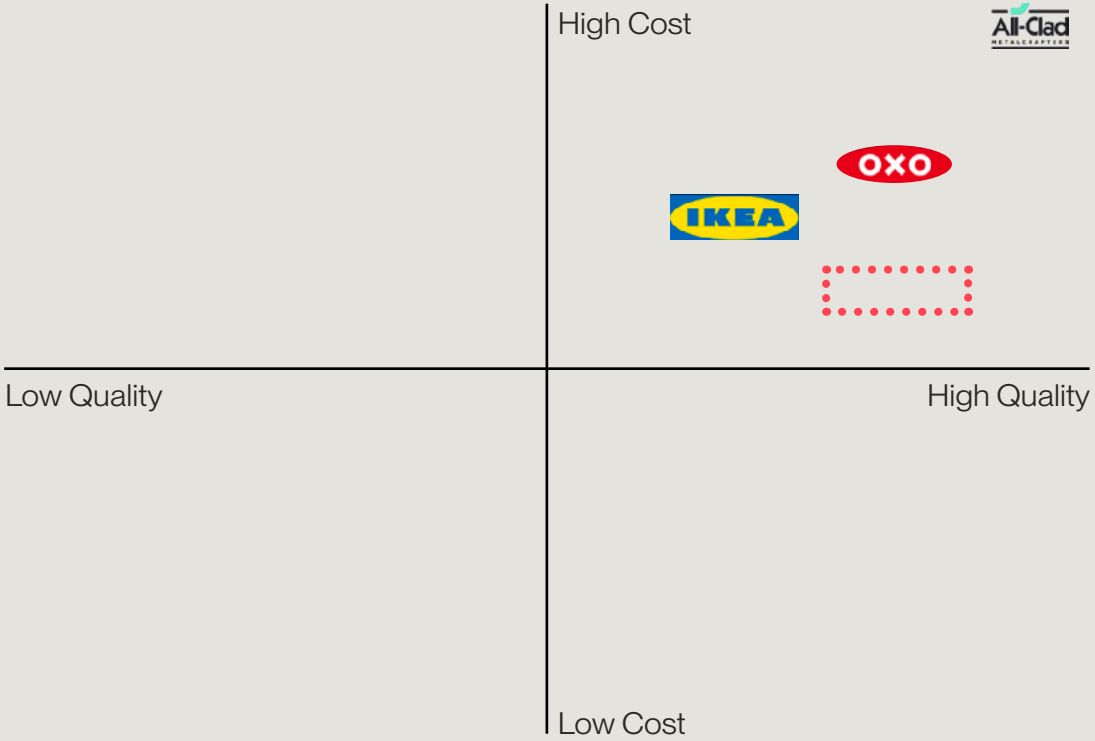
The objective was to improve the handleability of everyday cookware we use the most.

The Context

To design a 3 piece universal cookware range with a focus on handles and handling.

A Flat-pan/ Tawa
A Saucepan
A Kadai

For the company context, we took the cookware and kitchen equipment manufacturer Wonderchef. They make a wide variety of products ranging from low price to high ranges.



thinking inclusively

Being inclusive begins with a change of mindset. Designing inclusively only begins when one can think and consider the problems othr people face while going about their lives.

Before doing that, one must consider their own permanent, temporary and situational disabilities that prevent themselves from interacting with society. The privileged views that society can and must be only designed for the people who are fully-abled because it's difficult to make changes for the few. This mindset creates mental barriers which makes people of different ableness looked down up and feel alienated, even subconsciously,

According to the **World Health Organization** *(2)*:

Disability as context dependent
"Disability is not just a health problem. It is a complex phenomenon, reflecting the interaction between features of a person's body and features of the society in which he or she lives."

Disability as personal attribute
"In the conetxt of health experience, a disability is any restriction or lack of ability (resulting from an impairment) to perform an activity i nthe manner or within the ranfe considered nromal for a human being."

Types of Exclusion:

1. Temporary: Short term injury or contexts which effect the way people interact with the world around them

.

2. **Situational**: Context dependent on the various conditions people find themseles in their day to day

lives.

By recognising exclusion and its source, products can be improved which impoves the lives of people who face exclusion. By making a poduct better for people with permanent disabilities it also helps with **temporary** and **situational** disabilitiies.

Benefits of Inclusive Design *(1)*:

1. Increased access
2. Reduced friction
3. More emotional context

The impact of inclusive design is more than just the products that people use. It's also a shift in our mindset, methods, and behaviors. What we design is a byproduct of how we design. Measuring the benefits includes measuring the shift in our culture and ourselves.

How Cooking Culture excludes people with disabilities

An interview study which took place in New Jersey found that people with cognitive and physical disabilities encountered structural and attitudinal discrimination that makes cooking and shopping less accessible. This discrimination leads to people facing **food insecurity.**
People with physical and mental disabilities who are dependent on their community for daily living find it incredibly challenging to go out and shop and do other tasks independently. The level of assistance required relies heavily on the accessibilities provided in the local area and community.

These barriers occur throughout the food acquisition and preparation process. Which are:

1. Barriers in the Stores:

Supermarkets are supposed to comply with their local or national disabilities accessbility standards but many do not. But the primary grocery and food sources tend to be the local small stores which tend to not comply at all.

Source:
United States Census Bureau, Limbs for Life Foundation, Amputee Coalition, MedicineHealth.com, CDC.gov, Disability Statistics Center at the UCSF

Figure 1

2. Barriers in Social Attitudes

People tend to view pre-cut and prepped ingredients as “lazy” and “something for rich people” and tend not to purchase them. Which leads to stores not stocking them or selling them at a premium. Disabled people tend not to be seen as the primary shoppers at a store and end up being overlooked.
Many people tend to view them as being unable to cook at all. Disabled are often not taught cooking and other vital tasks as they’re either seen too dangerous or complicated to attempt.

3. Barriers in the Kitchen

A regular kitchen tends to be full of barriers. Ergonomic, position and height of countertops, no wheel chair compliance, and most importantly the need to be agile and move around a lot without needing any supports which lead to hazardous situations. Converting a kitchen into something more accessible takes time and money, which makes it something people rarely attempt.

4. Barriers in traditional food media

People who attempt to learn cooking through various food media like books, TV and the internet tend to face issues there as well. Presenters tend to move through steps too quickly, which can be disorienting for people with cognitive disabilities. Adapted kitchen and tools rarely get shown off and pre-cut and pre-prepped ingrediens tend to be looked down upon by professionals as something unclean and/or second rate.

What is cookware?

Cookware are equipment which are used in the preparation of food, particularly the cooking of the food itself. Cookware are usually kept on or inside a heat source. Common heat sources are gas stove, induction stove or range cook-tops and ovens. In rural areas open stoves made of clay are used in which the fuel tends to be cow dung cakes and//or wood.

Cookware come in a great variety of form, material and surface textures, depending on its specialty or general use case.

Cookware Components

Work End:

a heatable food container/vessel, the component that should eat up.

Human End:
a handle, varies in form and material depending on the cookware, the component that should not heat up.

Cookware types

There are many types and subtypes of cookware. Differences amongst them depends on:

1. Cuisine.
2. Level of expertise.
3. The amount of people to cook for.
4. Types of food like, curries, breads, or solids.

The commonly used types of cookware are:

Fry pan/Skillet/Tawa

Fry pan, skillet or a Tawa is an Indian essential. Incredibly versatile, an. These pans are designed with a flat bottom and curved sides, making them a perfect choice for turning foods over or simmering with oils.

What differentiates the three?

Fry pan usually refers to a flat pan with straight, vertical sides. The straight sides allow them to hold in liquids without accidental spills and are adequate for shallow frying, poaching and pan-frying. A fry pan allow for a larger cooking surface as almost all of the diameter of the pan can be used for cooking.

While a skillet is a pan with shorter, curved sides. The wider sides allow convinient stirring, moving and flipping around the ingredients. It also helps in sliding off the finished dish off the pan easily. The actual cooking surface of the pan is usually less because fo the curved sides.

A Tawa is a pan with no sides at all. They're used for making rotis, dosas and other flat-breads or their equivalent. The lack of sides allow for the usage of metal spatulas and other tools to remove the breads from the pan. In case of a roti tawa the base is curved.

Sauce Pan

The Sauce Pan has a rounded bottom and tall, straight sides. This means that they are a very versatile cookware choice, and can be used when making all kinds of sauces and soups. These pans can be used with or without a lid to control evaporation, which is why sauce pans are a go-to in any kitchen. A sauce pan is also ideal for many other uses - from reheating leftovers and preparing grains, to boiling eggs or noodles

Wok

Woks have high, sloping sides, and are a popular all-purpose Asian pan. They are traditionally 14 inches in diameter and made of carbon steel. These pans have a hot cooking surface on the bottom, while being cooler up the sides. On top of that, being able to move the ingredients around the pan gives one great control and versatility over the temperature. Woks are perfect for stir frying, steaming and deep frying.

Woks are rarely used in Indian kitchens as they tend to be very heavy and primarily was dishes require a lot of stir fry and being cooked at high temperatures while Indian cooking tends to be slow and stew-like in their methods.

Sauté Pan

The Sauté Pan is meant for sautéing, which translates into being able to fry food while moving it around quickly in the pan, all while covered with a lid. Sauté pans are similar to fry pans when it comes to

the design, they too have a flat bottom, however the main difference between fry and sauté pans is that instead of having rounded sides, sauté pans have straight sides. Seeing as they are deeper than a fry pan, sauté pans can be used for multiple uses in addition to sautéing.

Kadai

This cookware utensil is the most important one that is required for most of Indian cooking. Mostly used to cook assortment of curries and other dry vegetable and meat dishes. The highly curved sides allow

for deep frying as well as cooking curries without spillage. The handles are reserved for only moving the cookware while pouring and prepping to cook and are not like a wok. Traditionally made with cast iron.

Indian Sauce pot

Known as Patila or Tope, this type of sauce pot is widely used in India. Usually used to boil milk, cook rice and other grains. It's used for its large capacity to hold large volumes of liquid. It is usually handled

by using a caliper or a towel as it doesn't have any handles to handle it with. The short lip provide some anchorage for a towel or a lid to stay stable on the top.

Griddle/Grill Pan

A Griddle is a piece of cookware that has a large, flat or ridged surface. With a fairly small amount of oil it can be used to cook breakfast foods such as pancakes, hash browns and eggs. It can be square

or round, but usually does not have the longer handle of a fry pan. Griddles or Grill Pans that offer a small ridged surface are perfect when you are trying to create those perfect grill marks.

Dutch Oven

The Dutch Oven is a larger vessel designed for slow-cooking generous volumes of stews, braised meats or pot roast. Dutch Ovens are usually round in shape and are made out of cast iron. Most Dutch

Ovens have a pair of short handles, in order to make lifting safe and easy.

Pressure Cooker

Pressure Cookers give you the choice of having a quick-release option, taking even less time to finish a meal and without wasting water to cool things down. Their lids completely seal the pot, while the liquid is

boiling inside. Steam then builds the pressure, which results in higher cooking temperatures and shorter cooking times. A Pressure Cooker with a detachable pressure regulator can adjust the pressure to low.

market research

I conducted both in-store study and an online study of various brands, ranging from affordable to the high-end professional cooking equipment. There is a wide variety of cookware available in the market, but most of them tend to serve very different needs and suitable for different kinds of foods, cooking styles and cuisines.

The various kinds of mainstream cookware materials are:

Aluminium

Pros:
1. Excellent thermal conductivity
2. Light-weight.
3. Cheap and affordable.
4. Doesn't take a lot of time to heat up.

Cons:
1. Poor mallard reaction browning.
2. Aluminium as a material is not soft and that

durable.
3. Metal utensils scratch it very easily.
4. Acidic foods cause it to stain.
5. Not induction compatible.
6. High heat deformation rate.

Social stigma:

The popular belief amogst the general populace is that aluminium is not very healthy and safe to cook in aluminium. There is some truth to this as adicidc foods such as tomatoes, vinegar and citrus can lead to aluminium leeching into the food that;s being cooked.

But the amount of said leaching, according to canada.ca is around 1-2mgs daily. *(5)* The World Health Organization estimates ha adults can consume more than 50mgs of alumnium daily without harm.

Cast Iron

Pros:
1. Great flavours and crusting due to extensive mallard reactions.
2. Lasts a literal lifetime (probably even more) when taken care of properly.
3. Can be used in the oven, smoker, gas stove and in basically any condition.

Cons:
1. Needs regular seasoning, which can be a bit difficult if the user is uncomfortable with it.
2. Needs special care to preserve said seasoning.
3. Very heavy.
4. Will rust if not seasoned properly.
5. Not beginner friendly.

Hard Anodized Aluminum.

An alternaive to regular aluminium cookware

Pros:

1. Very difficult to scratch due to anodized layer.
2. Corossion resistant.

3. Salt resistant.
4. Doesn't leach alumunium

Cons:

1. Must avoid high heat due to nickel fumes.
2. Require high maintenance.
3. Can be a health risk when or if the aluminium gets exposed.
4. Not completely non stick as they claim.
5. Better for liquids or food which don't stick to the pan.

Stainless Steel

Pros:
1. Non reactive and very chemically stable.
2. Corrossion resistant because of its non reactive nature.
3. Oven safe if the handle id made of metal.
4. Dishwasher safe.
5. Very good browning.

Cons:
1. Foods stick very easily to the pan.
2. A bit heavy but not as heavy as cast iron
3. Can leach nickel and chromium into acidic food when scratched but very limited amounts of it.

4. Can stain, but the stains are largely removable if washed properly.
5. Can be a bit expensive for 5ply.

Ceramics and Enameled Ceramics

Pros:
1. Synthetic chemicals free.
2. As good as non-stick pans.
3. Lightweight
4. Easy to clean.
5. Can be heated up to 400-450c.
6. Easy to clean

Cons:
1. Lower quality porcelain enamel may have a thinner coating that may crack and chip easily.
2. Using them for a log period of time in one go cann melt the enamel coating.

Enameled Cast Iron

Pros:
1. No seasoning required, which also means no rusting.
2. No seasoning required.

3. Look more stylish and pleasing.
4. Easy to care for.
5. The coating is chemically safe.
6. Food doesn't stick.

Cons:
1. Enamel coating can be a bit weak and can chip off if scratched.
2. Dopping it can be extremely dangerous.
3. The lighter interior colour darkens over time.

Wonderchef

Wonderchef sells cookware of most leading categories, included die cast aluminium. During the store visit and online resarch i found that while there are wide ranging designs in each proeuct category, it is difficult to decide why one should choose one over the other.

Key insights from the wonderchef products:

Gaudy

Very bright an unsightly colour choices for the coatings and plastics. Bright and really vibrant colours which don't suit the interiors of the kitchen space. Bright primary colours, in a very weird sticky finish, it doesn't look good brand new, it won't age well either.
The store manager mentioned that all colourrs sell equally. So there is a market for these bright colours.

But, should they be offered by companies in the first place?

Questionable Design Decisions

It is highly unclear why one particular handle design or any other design decision was made for that one product. Why was it not used throughout the product range or category? What makes one handle better for one stainless steel pan but not the other one. It makes it more confusing to purchase products if the changes are so drastic from one product to another.

Arbitrary design decisions are not only confusing or the buyer, but also confusing to evaluate. Products in similar price ranges have different treatments applied to them.

Take the cast iron pans in figures for example, the cast iron griddle has a handle which to flat and has to gripping surfaces on it, despite the weight of the griddle. But flat pan on the other hand, while being light has better gripping surfaces on it, but has a very short handle around 60% of the length of the griddle's handle. Users are more likely to need a longer handle with a better grip on flat pans as they're more inclined to do flips.

Quality control

Without a doubt, Wonderchef does make some good cookware, but the quality control is not consistent amongst all the product categories. Many of the painted handles, especially in the non-stick product category tend to be a little sticky. The paint layer on them also appear to be inconsistent. In some areas and crevices with paint entirely missing.

Some of the handles weren't tight enough and moved when the product was handled, which is a minor issue as they came with screws, but it doesn't bode well for the longevity of the products.

IKEA

The global interior lifestyle brand forays into many categories with their vast experience of things. Their products tend to be homogenous, straight and without any flair or flash.

Key insights from IKEA are:

Inconsistent Design Features

Even IKEA struggles with keeping things consistent. Sometimes the inconsistencies are in the same product line. One product in the same line will have different styling and features from the other. This makes making a purchase decisions confusing. The material and form of the handle and may vary greatly.

Unclear Use Cases

It seems to be difficult to choose between pans as the features and benefits of using one pan over the other are very obscure and unclear. And especially when there are multiple products with varying features with the exact same product name.

One can say that it's up to user preference to decide which one is best for them, but novice users and people who are unfamiliar with the nitty gritty of cooking may face doubts and difficulties while making a purchase decision.

Consistent Quality

The quality of the products is quite consistent, regardless of their price range and product category. Everything appears to be designed and manufactured to a target baseline which is the same for all categories.

Too homogeneous

The IKEA products, by design fail to stand out, even amongst their own line-ups. One can stand there in the aisle and fail to notice any major difference unless looked closely.

All about handles

To assertain why the handling experience varies so much from pana to pan, I tried a wide variety of cookwaare handles.

Types of handles tested:

1. Flat pan handles
2. Sauce pan handles
3. Kadai/Wok handles

Types of materials encountered:

1. Stainless steel
2. Aluminium
3. Bakelite
4. Wood

One of the key reasons why handles leave a lot of to be desired is because of the

Flat metal handles:

Flat metal handles tend to be found in lower end cookware which are low cost. These handles are just a flat sheet of metal stamped and often spot welded or riveted to the cooking vessel. They tend to be sharp and pinching in the palm, because of their thinness. As they're made of metal, they tend to be slippery and when paired with accidental cooking oil contact they become even more of a hassle. Users often use towels to mitigate the slipperiness.

Metal Rod (with Plastics):

Even lower end cookware tend to use a metal rod. The rod is bent and either riveted or spot welded to the cooking vessel. Some handles like in the figure above, have a plastic molding added on top for extra grip or in an attempt to improve ergonomics. The thin metal rods have low grip area. In order to compensate for that, users have to apply more pressure to grip properly.

Thermoset Plastics

Thermoset plasic handles tend to come in a variety of forms. These tend to be common in mid to high end cookware ranges where the cookware is designed primarily for home use. Less ideal manufacturing can lead to cracks and breakoffs.

Wooden Handles:

While soft to the touch and versatile, wooden handles were the least likely to come across in stores during my market research. Due to manufacturing constraints, they're either turned into cylindrical handles or machined into flat wooden panels which are inserted or held by metal rods. Friction fit.

Common problems

Welding issues

Shoddy spot welding can come apart after repeated heating or just regular everyday use. This defect is problematic as it requires the user to go out to get it repaired or have some welding or soldering skills themselves.

Bakelite Break off

Bakelite handles when exposed to heat, undergo chemical reactions which cause the material to change phase. This causes changes in its chemistry, making the material weak. Repeated stress, usually along the connection/joinery areas cause the handle to break off. The breakage is irreparable and the user has to purchase a new handle or cookware all together.

Loose screws and rivets

Bakelite handles when exposed to heat, undergo chemical reactions which cause the material to change phase. This causes changes in its chemistry, making the material weak. Repeated stress, usually along the connection/joinery areas cause the handle to break off. The breakage is irreparable and the user has to purchase a new handle or cookware all together.

Joineries

Riveting

A handle is connected to a metal bracket, iron or stainless steel. The bracket is then connected to the pan using rivets. The size and quantity of the rivets depends on the cost of the cookware.

Stud Flameguard

The handle is connected to the pan using stud and flameguard. The two are then screwed to the pan, which has a welded bracket on it. This method is gets loose often but is easily remedied at home.

The flameguard can be made of aluminium or steel. Flameguard protects the handle from the flames and heat.

Spot Welded

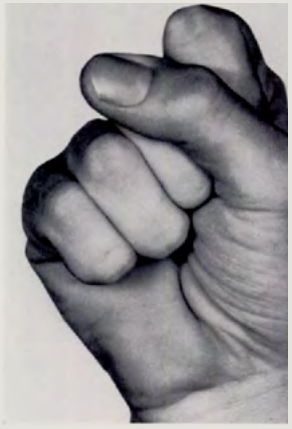
Spot welding is commonly used for metal handles such as aluminium and stainless steel. The contact area, weight and the price point of the pans determine the amount of welds. Welds allow a smooth internal cooking surface.

Grips and Ergonomics

Grips and ergonomics resarch to look into the various types of grip styles employed when handling cookware.








From Left to right:

Figure

Types of grips

The primary types of grips both power and precision grips are:

1. Hammer grip

2. Baseball batter grip
3. Precision grip (tip to tip)
4. Key grip
5. Hook grip
6. Tripod (pen) grip

But, the grips that matter for our context are:

Hammer Grip

This grip is formed by full flexion of the fingers into the palm, and flexion of the thumb, to lie outside the palm. The hammer grip is useful when considered in conjunction with the ulnocarpal joint. The ulna bone does not directly articulate with the carpals.

Power Grip/Baseball Batter grip

This is another form of grip that relies on the diagonal shaped palmar gutter in which an object lies. Thenar and hypothenar eminences provide the borders to this gutter. Two hands tightly grip the handle of the bat, with the thumb lying parallel outside the gripped hand. When a baseball bat is used to hit a ball, the entire arm works as a unit. If we imagine a baseball batter at the mound, he stands with his elbows and knees bent, and the bat held behind his head, ready to be swung forwards to strike the ball.

Hook Grip

The thumb is not involved in this grip. The other fingers are flexed, and usually carrying a weight, e.g. shopping bags. The corresponding metacarpophalangeal joints are flexed, with the proximal and distal interphalangeal joints also flexed to create a hook.

Grips in pans

While using pans, for larger gross movements, like moving the pan itself around or while trying to stabilize it users deploy the power/hammer grip (figure).

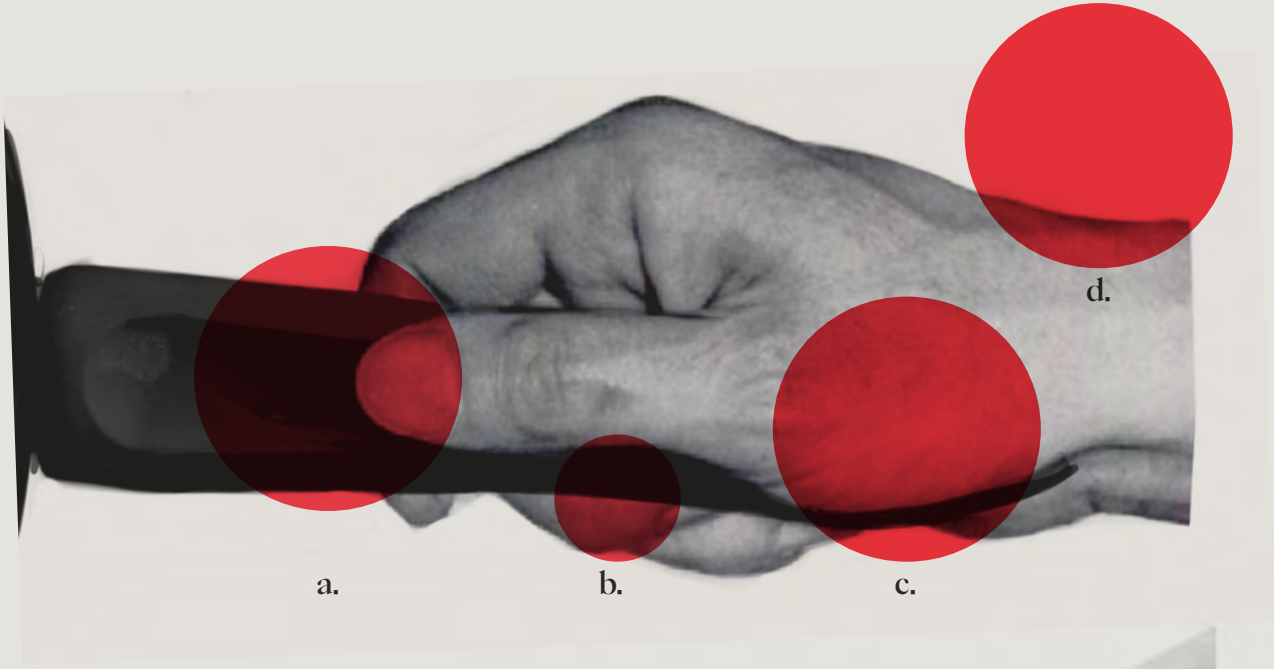
For more precise movement while pouring things out and attempting to flip an omelette, users shift to a combination of a baseball batter grip and a precision grip. Allowing for finer wrist movments for tossing. For a saucepot with side grips, users tend to either

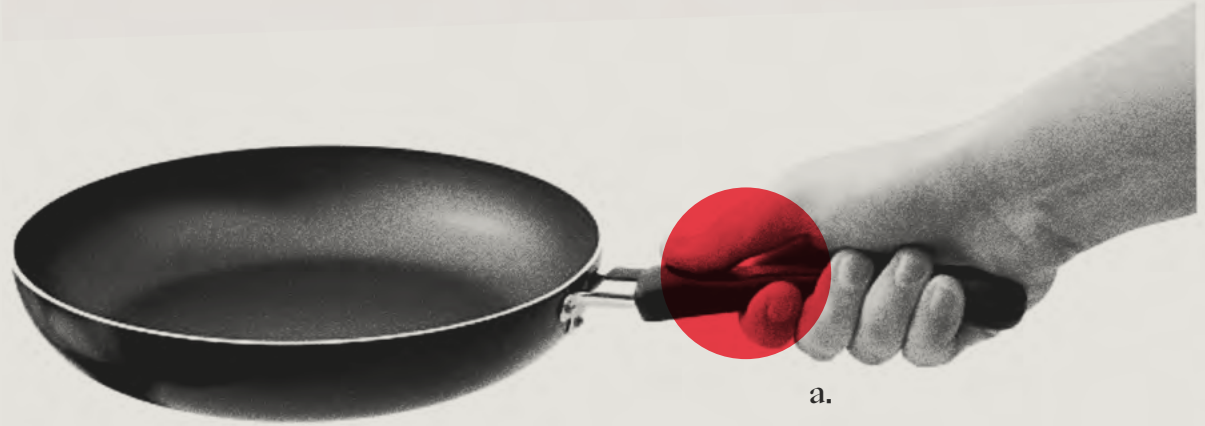
Pressure/Heat map of grip

Pressure/heat map of various grip types allows us to figure out where the problem/pain points are and ho it effects the grips of the users and vice versa.

Heat points:

hook or power grip, depending on the weight of the pot. (FIGUR)





a. The resting place for the thumb can often cause issues, especially if the surface is convex.

b. The diameter of the handle: if the diameter of the handle is too large it causes the hands to not perfectly grip the around the handle. Causing users to not have a confident grip on the vessel.

c. The end of the handle: Users, especially those with small hands, tend to also use the palm for additional grip and support. Flatter handles with imperfect contact with the handle doesn't allow for a proper grip.

d. The wrist: If the handle doesn't provide a proper grip the most of the weight and support has to come from the wrist. This adds additional strain to the wrist.

e. Distance from heat source: Some side handles are really close to the heat source, to the point that heat burns become inevitable. Some hand dancing is required to get the potions correct.

f. Handle curvature: Some handle curvatures and other dimensions are too tight to be useful for people with larger hands. Their fingers tend to be in uncomfortable positions.

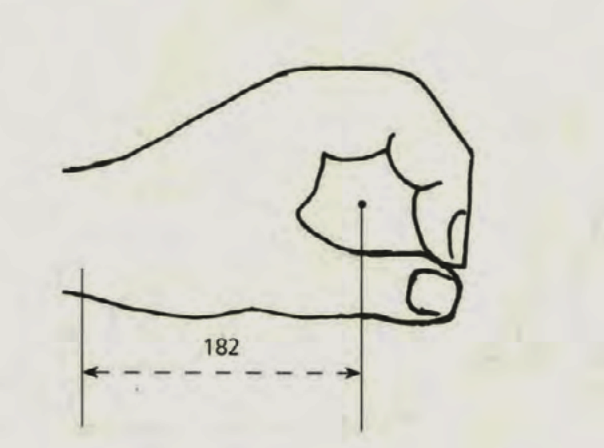
These pain points are also made worse by handle designs which seem to be completely random and made using arbitrary design decisions. The rationalization of which seem difficult to parse.

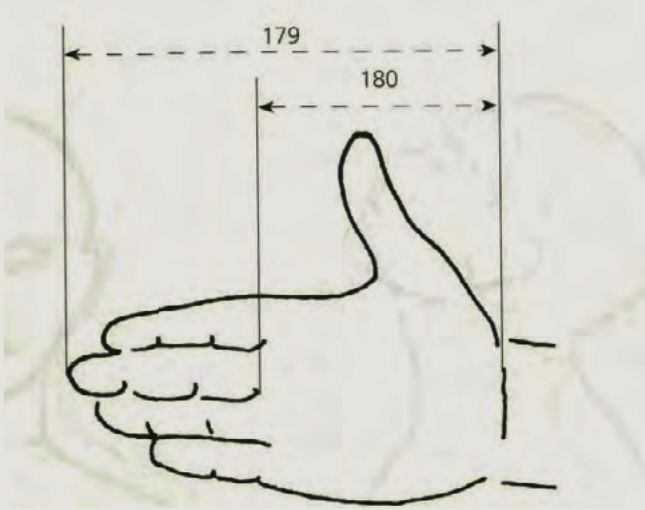
Indian Anthropometry

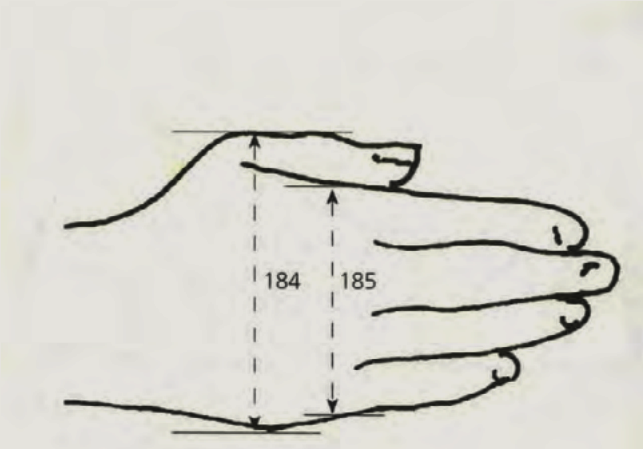
To make rational design decisions, I looked into the Indian anthropometry standards. All design decisions were to be made keeping these standards in mind.

All dimensions were taken according to design for the 5th percentile of people:

180: Palm Length:	**84**
182. Hand Grip Length:	**40**
183. Hand Grip Breadth:	**51**
184. Hand breadth with thumb:	**75**
191. Grip inside diameter	**41**







e.

A study of hands.

To undestand how a variety of users handle pans I made a clay handle to understand the pressure and grip paterns. I enlisted participants, both female and male and a variety of hand sizes. From old to young with small to big hands.

I also included myself in the study as a stand-in for a person with motor and limb disability to see how varied my pressure points are.

I acquired cookware with thin metal handles upon which I could apply a layer of clay. This ensures the utensil can be handled without the handle breaking off. This eay the users could actually pick up the cookware, with weights added to them to simulate a fulll cooking load.

10 participants

Hand lengths ranging from

Ages: 21-52

It was observed that most people have 2 distinct grip styles with minor variations amongst both, for both the kadai with short handles and pans with long handle.

Position 1 in pans is used the the handle is parallel to the user, in which they have to use a power grip to lift the pan up.

In Position 2, when the handle is perpendicular to the user, they employ a hammer grip to carefully lift the cookware up.

In case of kadais, it was observed that to stay away from the heat of the pan the users user Position 1, where they're carefully lifting up the pans in a position where most of the weight of the pan is handled by their fingers. And the thumb is used for stability. Position 2 led the user's hand to touch the hot area of the kadai which could lead to serious

Typical Position 1 - Pans

Typical Position 2 - Pans

Typical Position 1 - Kadai

Typical Position 2 - Kadai

burn injuries.

1. 181
2. 201
3. 174
4. 169
5. 167
6. 209
7. 205
8. 212
9. 166
10. 171

175 mean





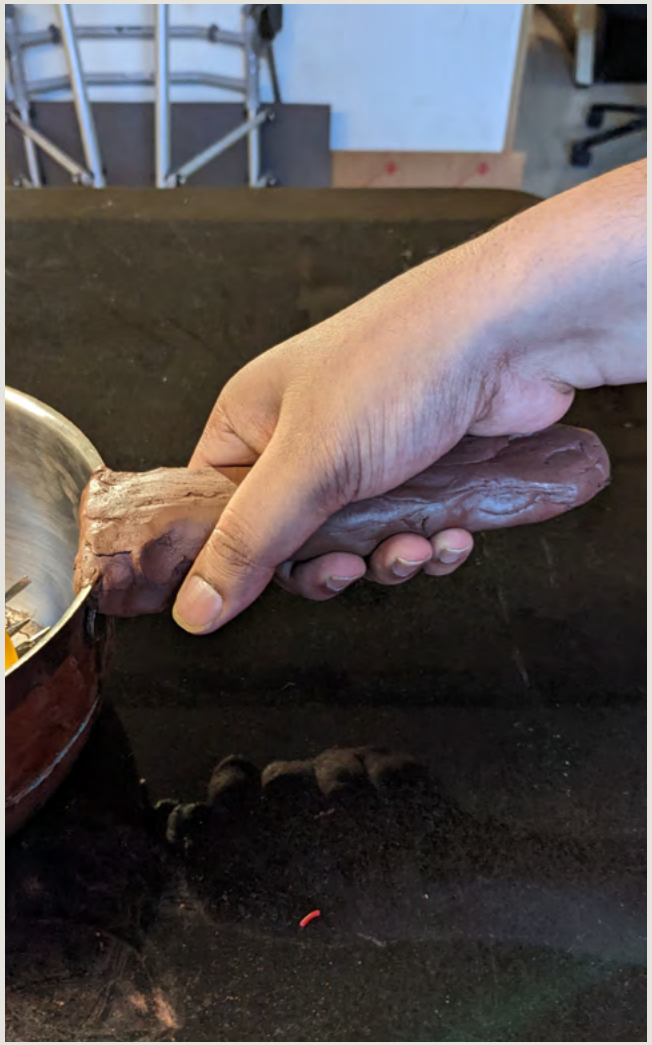



Position of the thumb

In Position 2, it was observed that the position of the thumb varied somewhat. While most users (7 out of 10) used their thumbs to wrap around the handle on the top, 3 users used their thumb to gain additional grip in the middle of the handle.

They all began with wrapping their thumb around the handle first, but then they moved their thumb to the middle of the handle to better their grip potential while they began to lift the vessel up.

The wrap-around of the fingers was dependent on the size of the users' fingers. They were observed to be largely in he same area. The more inexperienced users tend to grip the handle closer to the hot metal. This may also occur due to the weight of the pan being simulated and being cold.



Left vs. Right hand

The grips used by the users were largely the same regardless of which hand they were using. They were mirrored, despite the small difference in hand sizes.

But 4 users said they were able to grip better with their dominant hands. They were able to grip tighter and achieve are firmer grip which allowed them to be more confident in their handling.

In case of the kadai where both hands have to be used at the same time, because the weight is being distributed between two hands, the grip difference was not as apparent to these users.

Kadai Grips

While handling the kadai, users found that the handle was too close to the heat source and in an unsimulated scenario they would be not be able to use Position 2. And that they would only use Position 1 comfortably.

In Position 1, most of the weight of the the cookware is handled by the finders below. Users commenetd that they would be able to list the kadai up without using more than two fingers. But as this one was weighted, they had to use 3. The thumb was mostly there to provoide stabilization and they were not gripping tightly with it.

An atypical third position was observed by a single user who grip the handle with palm, wrapping their thumb and fingers around from belowm essentially using a power grip to pick it up.

Typical Position 1 - Kadai

Typical Position 2 - Kadai

Atypical Position 1 - Kadai

people and their thoughts

For better context I interviewed people of various ages, ableness, genders who came from all over the country and some international.

After taking the interviews and getting information about how and what they tend to cook.

The information was then sorted and insights were categorized into Norman's Three Levels.

To keep things brief, I've listed only the major/key insights form each interview and a compilation of all the insights afterwards.

Interviewer's insights

Finding opinionated people who are opinionated enough about their cookware and other utensils is a challenging affair. Most people, especially old ones tend not to divulge into things as they're very used to the bad design of their tools. They have long since adapted to them and hence they don't find if challenging.

Newcomers and young adults however, tend to be very opinionated. Fortunately, I cam across a few in my research who provided great insights into all areas of usage.

As it is India, 9 out of 11 people I interviewed were female and the primary cooks of their home.

I was also able to find insights from Nayanika Dey's study from earlier in 2022 about one handed cooking in homes.

Here are some key insights from each interview:

11 people from 8 states. Ages 24-82

User 1 - 51 yo female

1. Perception of teflon and non-stick being bad is quite strong.
2. Switched to ceramic because of its non sticky-ness and because she likes it more than non stick.
3. Has been using the same ceramic pan for 3 years.
4. Uses a gas stove. Has no plans of using induction.
5. Also uses a hard anodized kadai and an iron one for deep frying.

Users 2 and 3 - 26 and 21 yo females

1. Cooks quite a lot of eggs and stuff. The egg gets stuck on the rivets inside.
2. The wall angle of the pan can be a bit too steep.
3. Uses Teflon pans because it's cheap. But they're layer gets worn out quite easily.
4. They are using a metal spatula as they don't have all the equipment yet.
5 The handles are loose and wobbly because of lose screws. Even after tightening them often, they get loose. Spills happen quite often.
10. The saucepan/kadai becomes the eating vessel quite often.
11. Using induction currently and it's a chore to clean the pan. Some spill happens often.

User 4 - 31 yo female

1. Cooks both veg and non-veg, although she doesn't like he egg smell which lingers on in her cookware after she cooks them.
2. Has a small kitchen and a lot of pans, faces storage space issues. Uses her oven or wall hooks to store them.
4. Likes cast iron pans but doesn't like their weight.
5. Her partner is paranoid about new cooking technology so they generally avoid new fancy and high-tech stuff.
6. Eggs and curries tend to stick and burn around the rivets on the inside of certain pans.
9. Less steep internal angles are easier to clean for her.

"this probably isn't the best way... changing the habit will prove more tedious than its worth."

User 5 - 24 yo male

1. Uses stainless steel pans, cast iron and teflon non stick.
2. Handles get loose because of loose screw and comes off.

3. Finds stacking to be difficult with a long handle.
4. Sometimes, he'll just eat in the pan. Uses a metal spoon which also scrapes off the teflon coating.
5. Bought the non-stick pan because it was cheap.
6. Cleans it with scotch-brite, the green one. After a while the teflon layer came off.

User 6 - 22 yo female

1. Does not cook as frequently as she used to.
2. Considers cooking as a hobby.
3. She is left-handed but does not face any difficulties while cooking.
4. For her, the entire system and layout of the kitchen matters more to her than the utensils.
5. Attributes most kitchen mess-ups to her own user errors rather than a problem with the cookware.

"why does the govt. allow... bad products to be sold?"

User 7 - 44 yo female

1. Has strong aversion from handles. Finds that they get in her way more often than they are useful.
2. Most of her utensils she uses do not have handles. She doesn't use the ones that have handles, even though she owns a few of them.
3. Cooks 3 times a do, everyday. A mix of South and North Indian cuisines.
4. The only handle she can't avoid is the cooker handle. And she hates it.
5. She'll use calipers or a towel to move the cookware.
6. Spills happen more often than usual as she has to use alternate means of handling utensils.
7. Understands that "this probably isn't the best way to about things in the kitchen but has gotten really used to it that changing the habit will prove more tedious than its worth."
8. Says that her cast iron dosa tawa doesn't rust but photographs show otherwise.

User 8 - 49 yo female

1. Handles often break, when they break off instead of getting them repaired she'll keep using them as is.
2. If it completely falls off she'll switch to using towels.
3. Doesn't use non-stick (Teflon) cookware any more because of all the stigma around it.
4. Doesn't want to use alumnium because of the stigma around it.
5. Wants the manufacturers to be regulated.
6. Would like to have healthier products advertised, "why does the govt. allow companies to sell bad products?"

User 9 - 82 yo female w arthritis

1. Has to often sit while cooking.
2. Finds it really difficult to lift pans up. She takes support from the cooking shelf to lit them up.
3. Because of the weight issues, she only cooks a small portion.
4. Avoids cooking altogether when she's alone. Because it hurts too much.
5. Regular and consistent food intake is difficult to maintain when she's alone.

User 10- 24 yo male w limb deficiency

1. Finds cleaning large cookware challenging. As they tend to slip, especially when they're soapy
2. As one of his hands doesn't have a thumb, he finds tasks requiring to use both hands at the same time quite challenging.
3. Often finds himself in a bind because, most

cookware is mostly designed for right handed people and the spouts tend to follow that language.
4. Spills can happen quite often because of lack of a let handed spout.
5. Has to almost always use powerr grips to grip everything.
6. Stabilizing an unstable (especially large cookware is quite challenging)

User 11 - 52 yo female

1. As she has a small kitchen, she often stores utensils by stacking them. Long handles come in the way of properly stacking things.
2. Likes to use a cloth even on the handle. According to her, it provides her a better grip.

Generational Differences

There's a quite the difference between the views of people of different generations. Here are the major differing view points:

Material Paranoia:

Older people showed more aversion to trying to cook with newer materials like enameled ceramics and cast-iron. They stated that due to non-stick and then aluminium, the hot new material technologies of their time ended up being harmful. They don't experiment with new technologies for the sake of their and their family's health.

Opinions:

In the study, the older the user, the few opinions and especially the finer details were expressed. People younger than 35 had many more opinions about both the good and the bad about cookware. This could be due to many aspects, cultural, economic and/or social. Younger participants were well engrossed into the current market leaders in food and cooking sector and showed more passion towards everyday cooking. While older people who have been at it for much longer, seemed to do it out of obligation rather than passion.

Purchase Habits:

Younger people tend to go shopping for specific things. Specific handles, material technology, brands etc. While older people bought anything which suffices.

Norman's Three Levels

Dan Norman's Three Levels of Design. Each of these levels or dimensions, while heavily connected and interwoven in the emotional system, influences design in its own specific. The three levels being:

Visceral

"Concerns itself with appearances". This level of design refers to the perceptible qualities of the object and how they make the user/observer feel.

Behavioral

"...has to do with the pleasure and effectiveness of use." Behavioural design is probably more often referred to as usability, but the two terms essentially refer to the practical and functional aspects of a product or anything usable we are capable of using in our environment.

Reflective

These levels or dimensions interweave and interconnect in the emotional design system, but influence design in its own specific way.

All the interviews ere crambled and then sorted into the theree levels to get common and deeper insights as a collective.

Visceral

Pan Burn Marks

Pan burn marks are something which are inevitable. But as most interviewees were either working and/ or are the primary homemakers, they do not have the time or the energy to deal with them properly. Hence they tend to accumulate a lot on the pans. To the point, where they almost look like soot.

Black Exterior Preferred

To hide those pesky stains, users prefered utensils with black exteriors. This preference tends to contradict their opinions of not wanting to use non-stick and aluminium cookware. The only options remaining for them to use are stainless steel and

cast-iron. Stainless steel cannot be black on the outside and cast-iron skillets or cookpots were rarely or never used by them.

Non-Stick Aversion

A very strong aversion to non-stick was observed amongst the users interviewed. All of them had heard and read the news and articles which detailed the health risks associated with Teflon. Even then,

the people who tend to use them out of necessity or as an intermediate measure didn't follow the proper usage instructions. Metal spatula use was quite apparent on their worn out pans.

Behavioral

Major insights:

Space Issues:

Problems arising due to the small are of the kitchen and their house.

Non-ideal behavior:

Non ideal behaviour becomes the norm even if the user knows it's not the right way to do things.

Wobbly and spill:

Wobbly handles add to the probability of a spill.

Weight, ideal?:

Weight of the pan adds to the stability but negatively impacts advanced cooking motions like wok flipping.

Shelf-support:

Old people tend to take support from the shelf when lifting things up if they're too heavy.

Meal avoidance:

Old people with a great deal of pain avoid prepping and cooking.

Minor insights:

Cleaning

The interior curvature of the pan also effects the cleaning.
Food sticking is a big issue in stainless steel pans.
Cleaning the bottom is a difficult task if it has induction ridges.
Purchasing and keeping dedicated equipment for maintenance is difficult.
Stains from various veggies and minerals

Manufacturing

Rusting issue with cast iron.
Improper seasoning.
All the Teflon coated pans in the study had significant damage from wear.
Food sticking is a big issue in stainless steel pans.
Washing cast iron is difficult.
Rivets causes issues while cooking eggs.

Heat Source:

Different behavior for different heat sources.
Because of flat induction it's easier to keep it steady.
Deep frying is rare.

Reflective

Paranoia

People feel paranoid about nee material technologies and hence about them and stick to basics stainless steel and cast iron.

“why purchase new technology when the old one is working fine?”

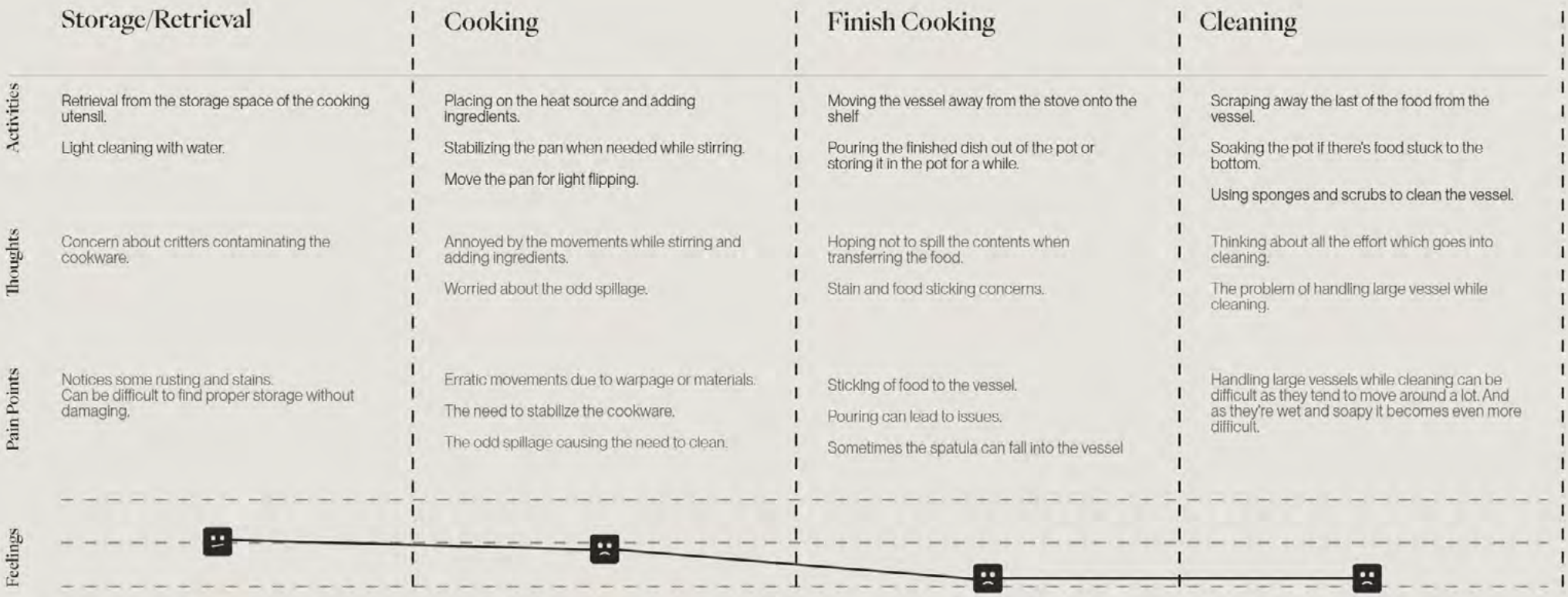
“Contaminants”

A few cooks view eggs and other non veg items as “contaminants” which contaminate the next veg dish they’ll be cooking.
Any sticky, even cooked, leftovers are not desirable.

Bad Practices

Most cooks were aware of all the bad practices they were applying in the kitchen such as using metal spatulas on a Teflon pan, letting cast iron get wet and other undesirable practices but they still tend to keep doing the same.

User experience mapping



visual & formal tensions

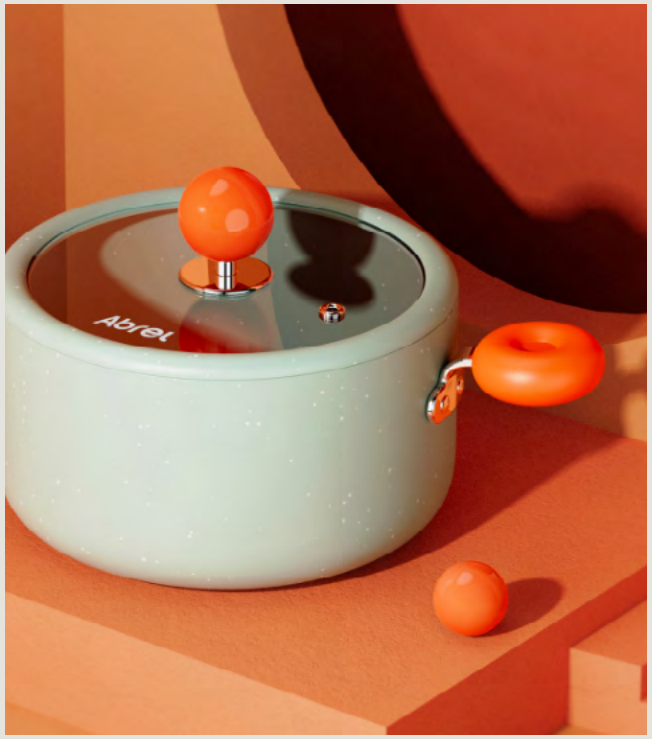
Tensions is an exercise which aims to find the right balance of two extreme styles. The styles deployed here were chosen after the resarch was done and a pattern was observed.

These tensions need not only visual, but may also apply to the usability aspects of everything.

These tensions are then employed in the final design forms

Form Characteristics

The characteristics of the form are vital as that's the first contact of the customer with the product. It should set the correct expectations as to what experience they should be expecting when they finally use the product.



Playful — Professional

Learning Curve

Defining the learning curve of a utensil is an important factor in deciding who will be able to cook with it.
While cooking is a skill which takes time to develop, the time can be shortened by using the right utsensils.

Here, non-stick is the easiest as it allows for lower number of mistakes, while cast-iron is time, money and effort investment and takes considerable care.

A learning curve on the easiest side was chosen. As the research showed people do not want non-stick cookware, the learning curve won't be the easiest it can be.

Easy
(non-stick)

Difficult
(cast-iron)

Product Feel

Product feel or outlook will define its abstract quality of being used as a strict tool, or will the user connect to it as more like a lifestyle accessory.

This can be tried to be accompllished by careful use of materials, colours and form.

The end product should feel like a lifestyle accessory.

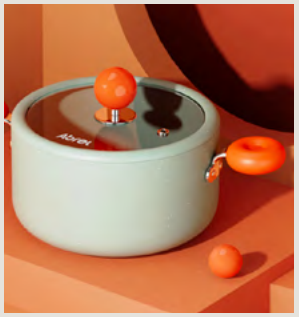
Tool — Lifestyle Accessory

Styling outlook

Strictly for the visual styling of the product, it is determine how homely or clinical the product should be visusally. Using warm homely colours or bare metal and metallic finishes which give the products a professional look.

Clinical — Homely

Overview



Playful

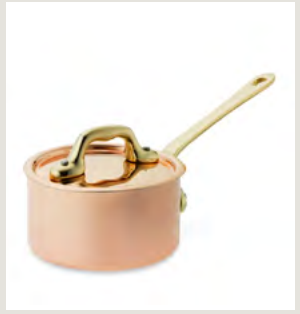
Professional

Tool

Lifestyle
Accesosry

Easy
(non-stick)

Difficult
(cast-iron)



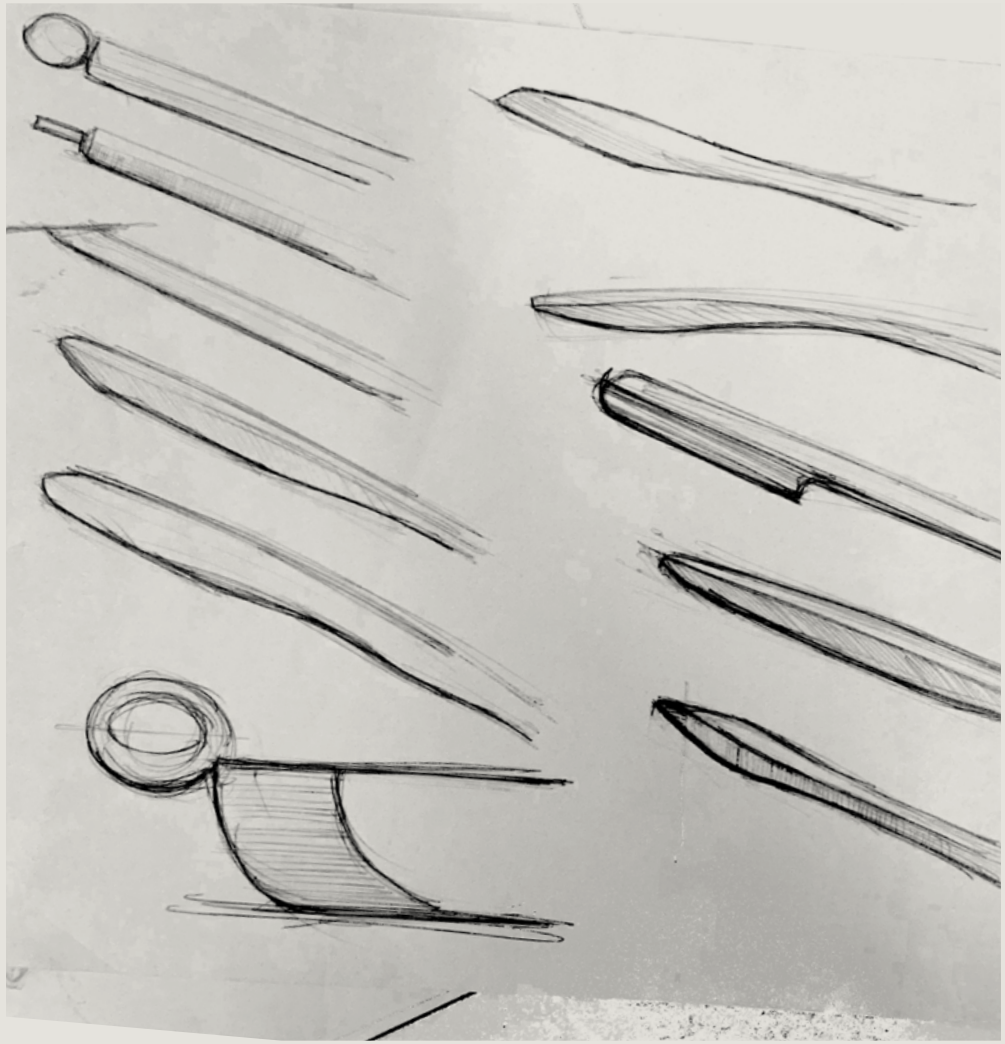
Clinical

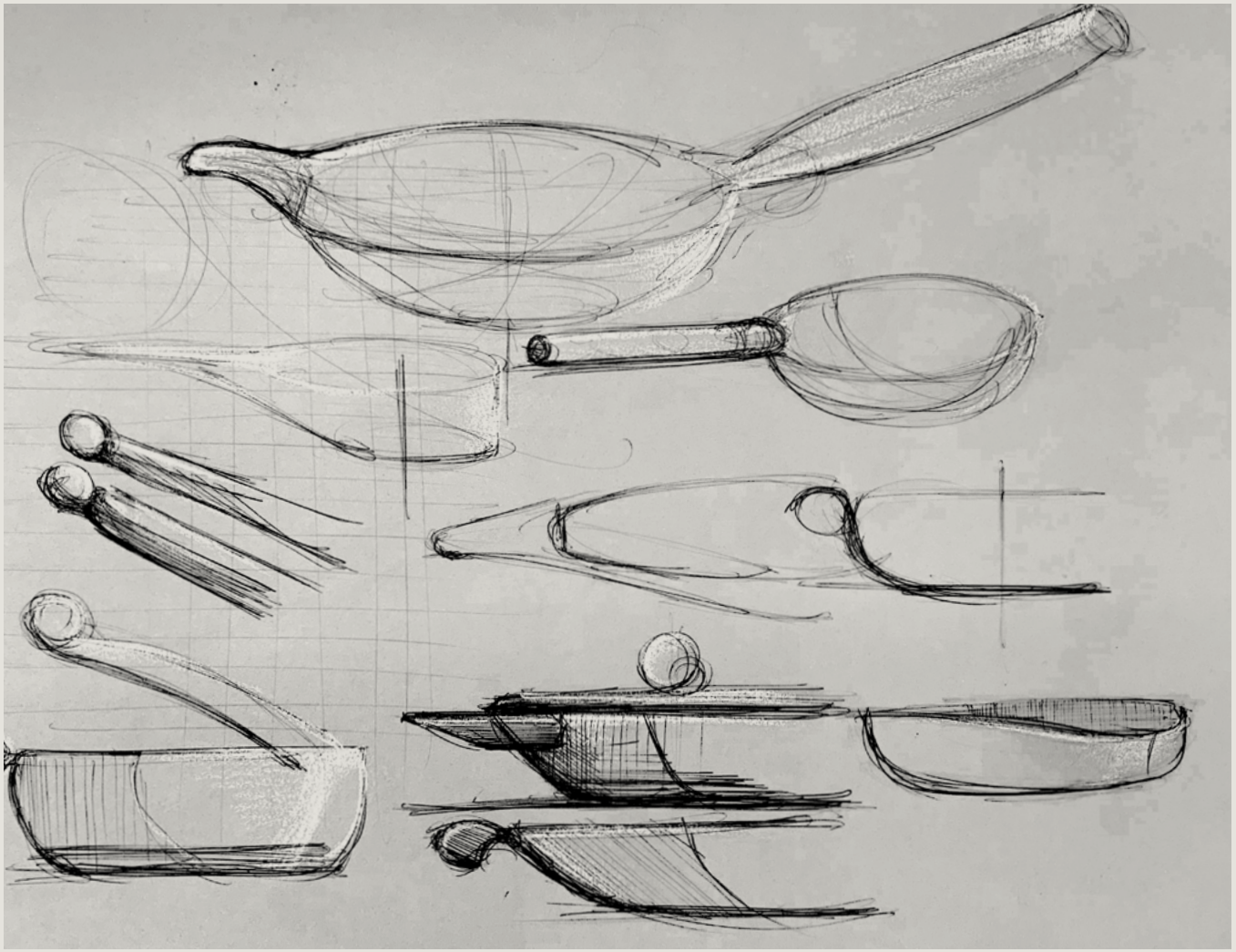
Homely

sketching ideas

I started sketching out my thoughts and ideas by considering various handle types. Proper (safe) hand placement and manipulation of the vessel was the priority.

Without eliminating any thoughts i tried various alternative materials such as loops , integrated yet removable handles.

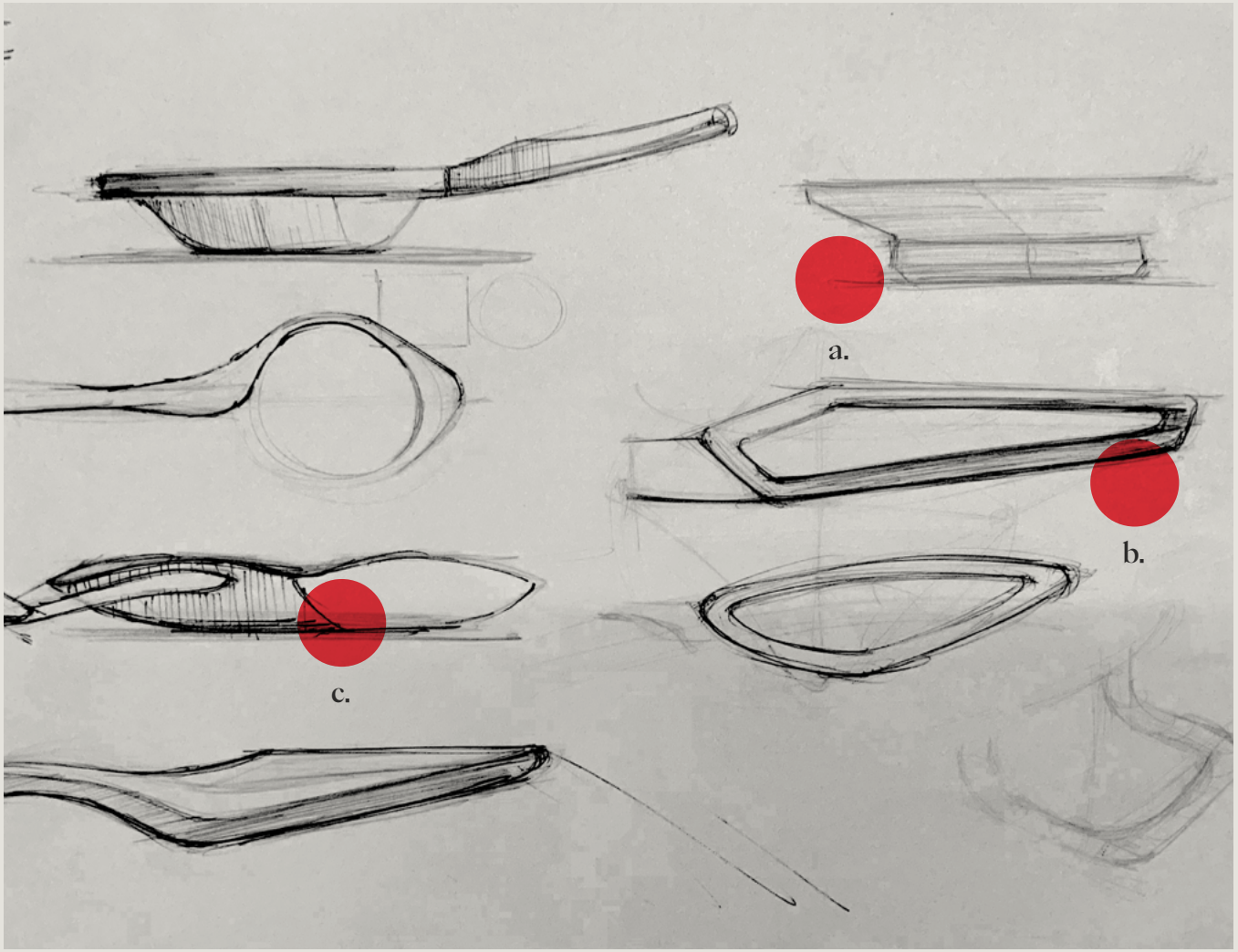




After thinking and sketching out a bunch of handles, I moved on to thinking about what the vessels themselves would look like.

I began by moving by playing around with the placement of the pouring spout to frankly, positions they shouldn't be in the first place. But as a holds barred exploration they worked into figuring what the final design should not be.

At this stage, no material and manufacturing constraints were considered.

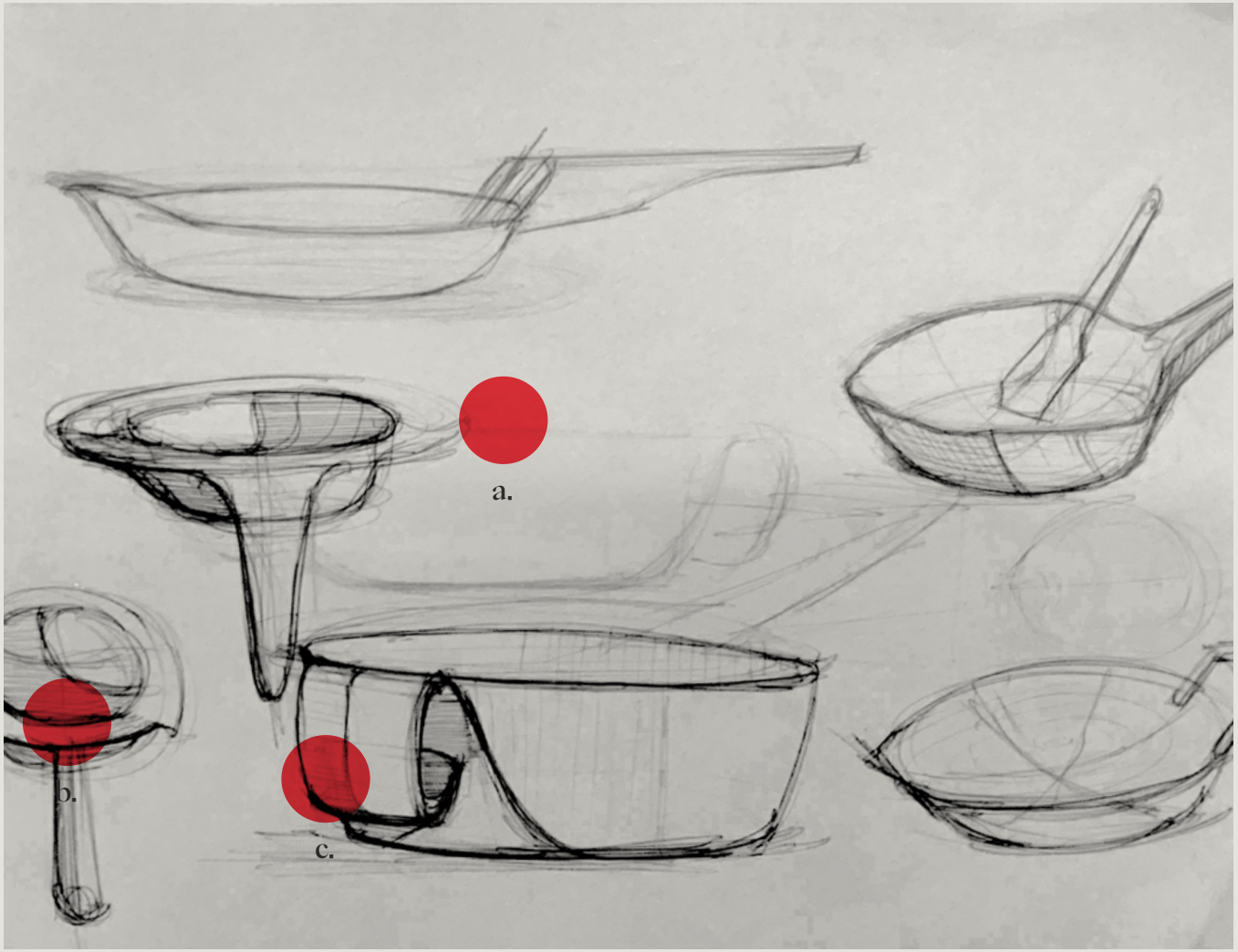


Details:

a. A flat base on a curved tawa.

b. A handle with a gap in the middle to allow for more gripping opportunities, allowing for both smaller and bigger hands to move around the handle to find the perfect grip.

c. Curved top edges to allow for the food to be poured out more easily and also act as a place to hold the spatulas.



Here's a collection of saucepans with alternate lips and handles:

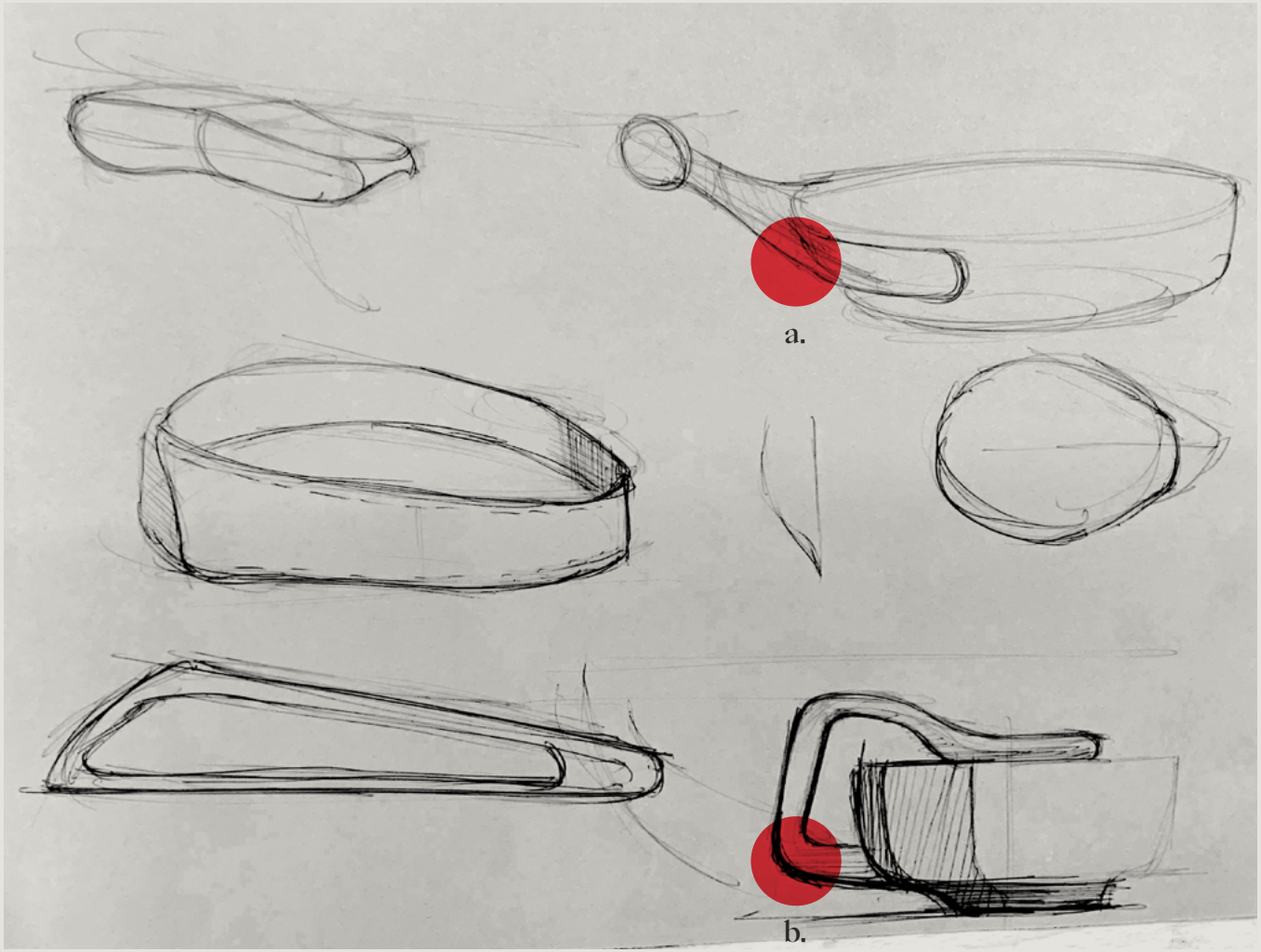
a. Larger than usual lip on the pan which allows for better handling of the vessel while it's being washed. The lip also extends into the handle. This design would only work as a cast-iron pan.

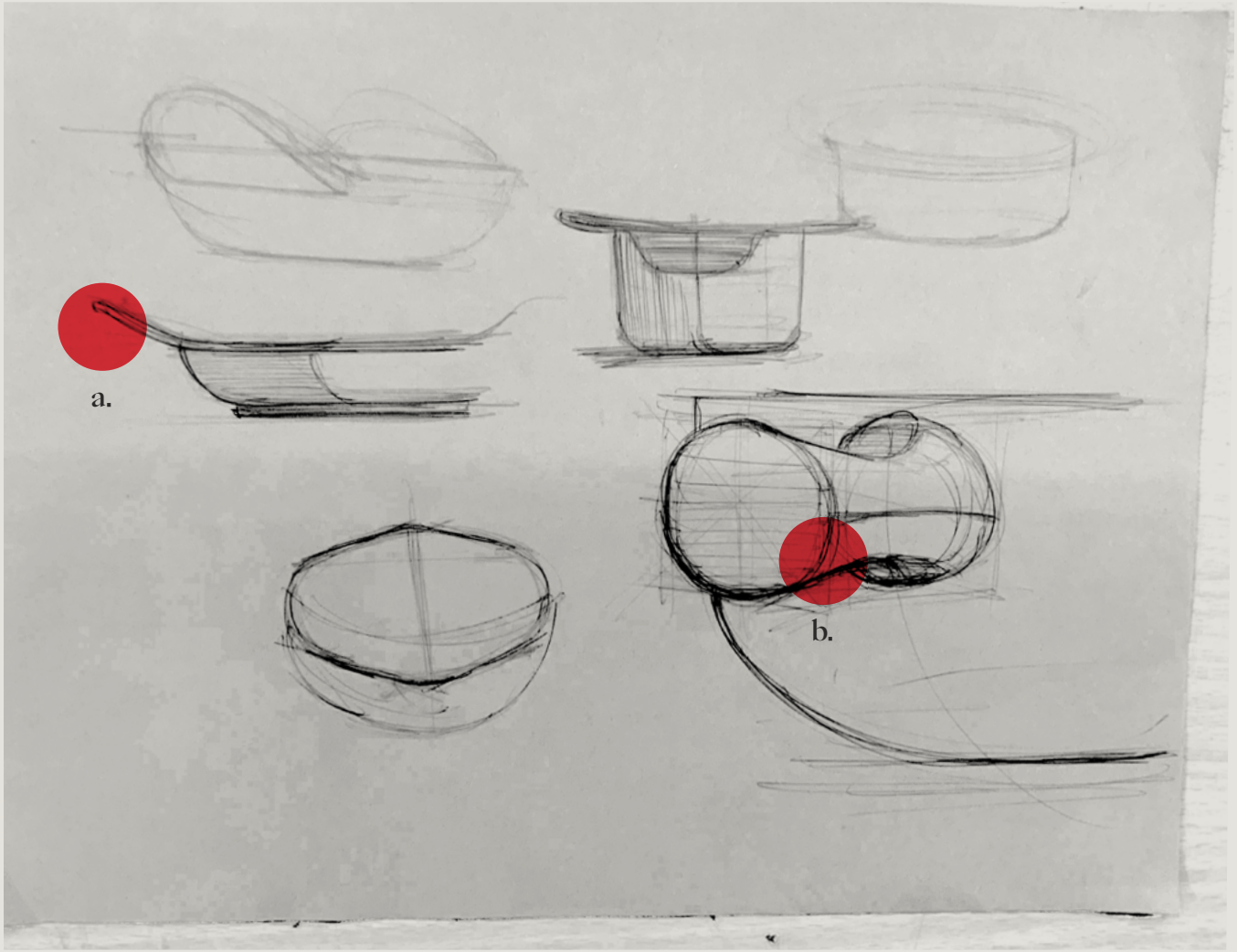
b. Another variation of a., in which the lip does not go all the way around to the handle.

c. An unconventional handle design, in which the user will slide their hands in and support the vessel with the exterior of the hands rather than actively gripping them.

a. Handle whose welds go up to the sides of the pan to increase the surface area of the welds and the grip.

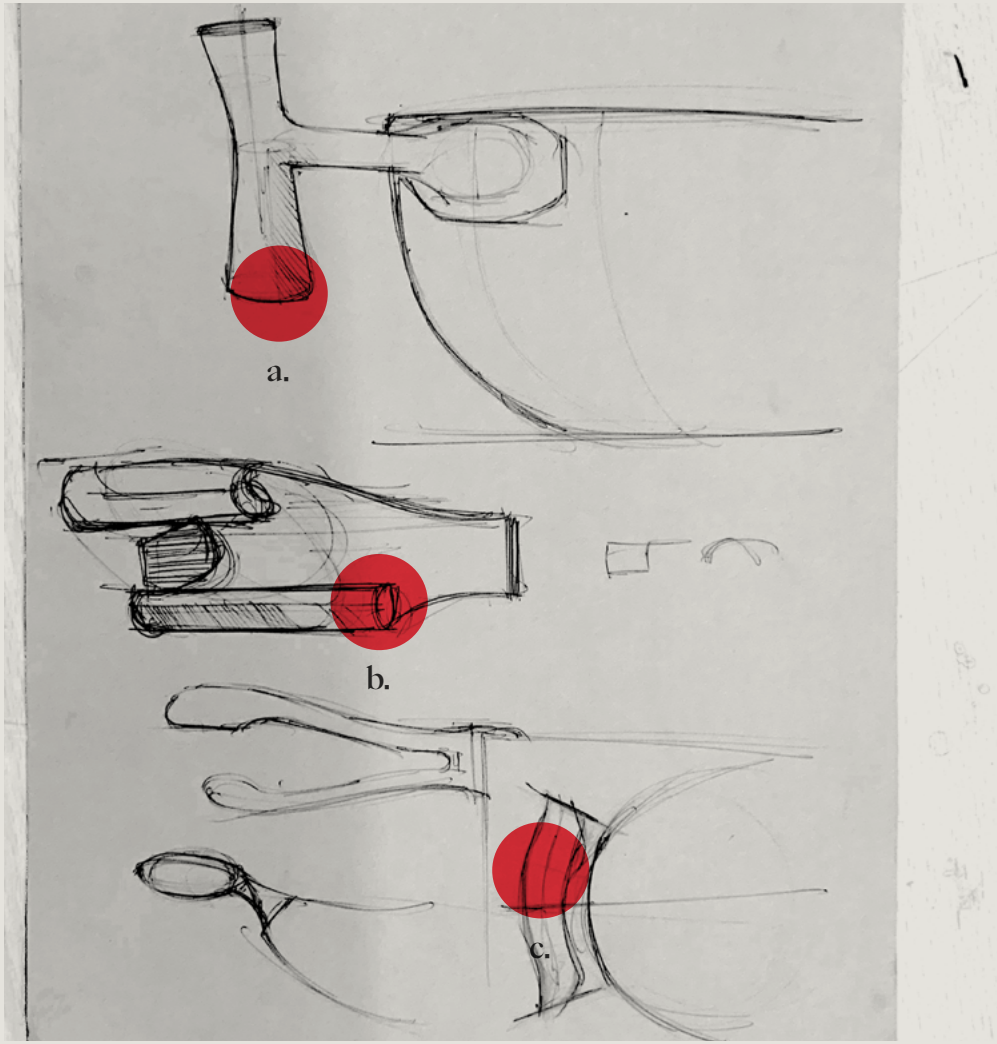
b. A handle which goes up to the top rim on both sides. which enables the user to use it like a kettle shifting the weight load (theoretically) to the arms of the user rather than cause pain in the wrists. The shorter and dense base which contours inside which lowers the center of gravity.





a. Very high handles which are connected to the top edge of the pan rather than the sides of vessel. The flat base helps steady the pan on the shelf rather than wobble around because of the curve of the interior of the vessel.

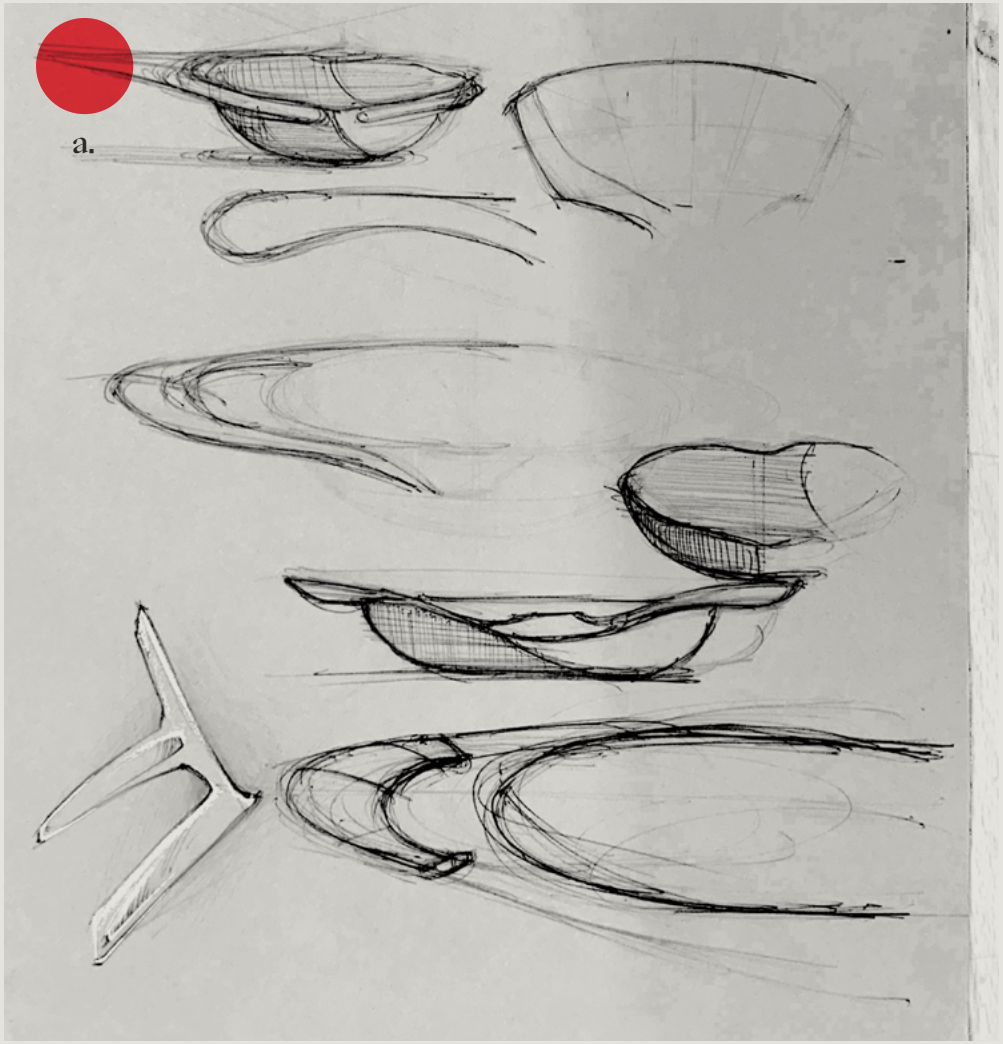
b. An alternate handle design which uses a nubbin like handle rather than the paddle type handles which are currently used. The handle provides a different type of grip where the user can wrap their hands around it or just lift them up from the bottom.



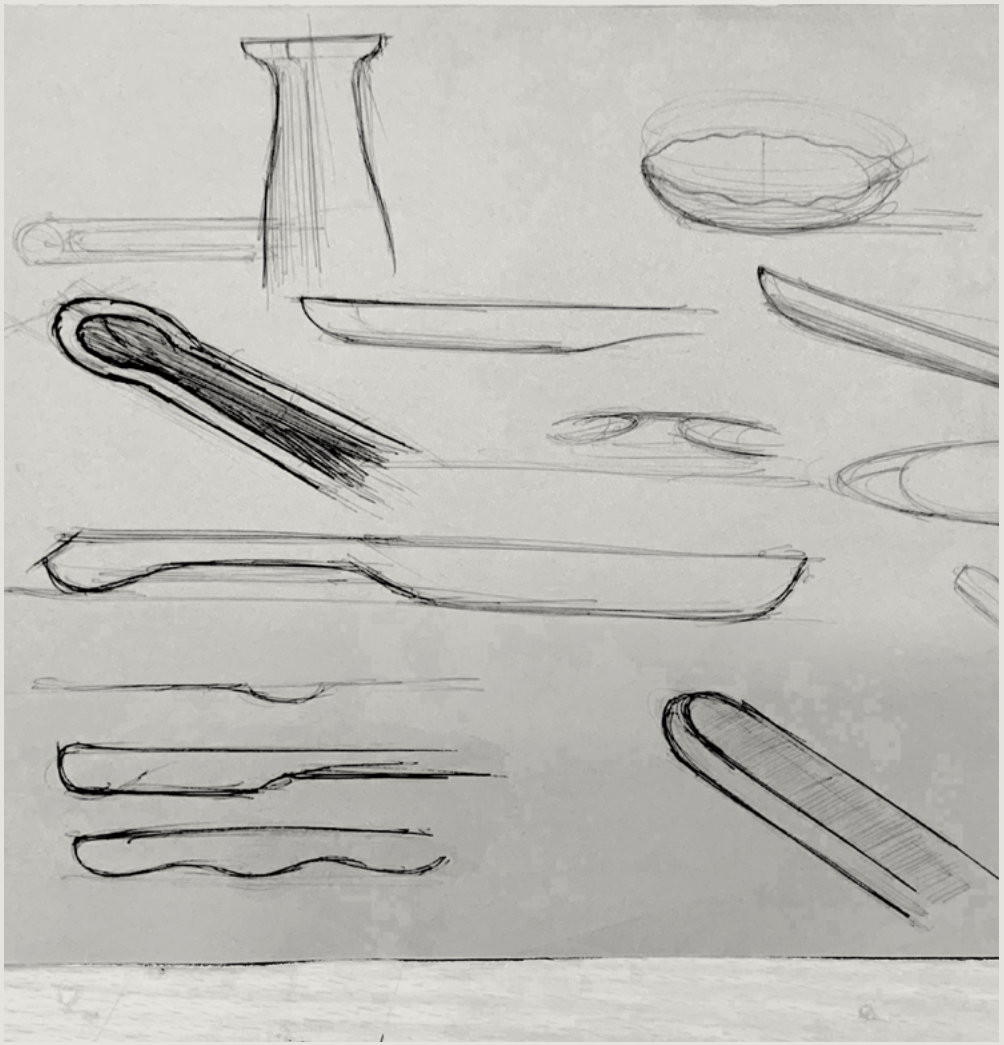
a. A vertical handle style, providing two different places/positions/types of grips.

b. A wider and double flanged side handle which allows a user to use their palm or a closed fist to allow to lift the pan up, while also allowing a regular grip style. To keep the hand away from direct heat and the hot vessel.

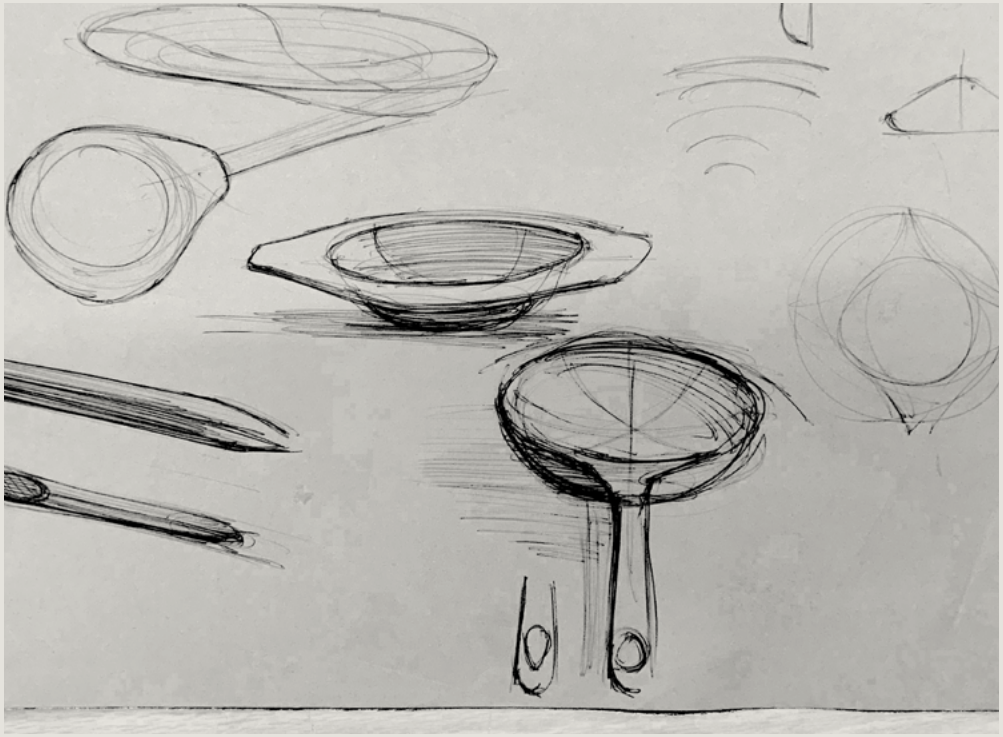
c. A handle with a wider radial area which gives the user more area to handle the vessel from.



a. An almost wrap around handle which goes around the pan providing more handling opportunities rather than keeping them limited to only the sides.



Some more handle types with balancing forms and integrated side handles.



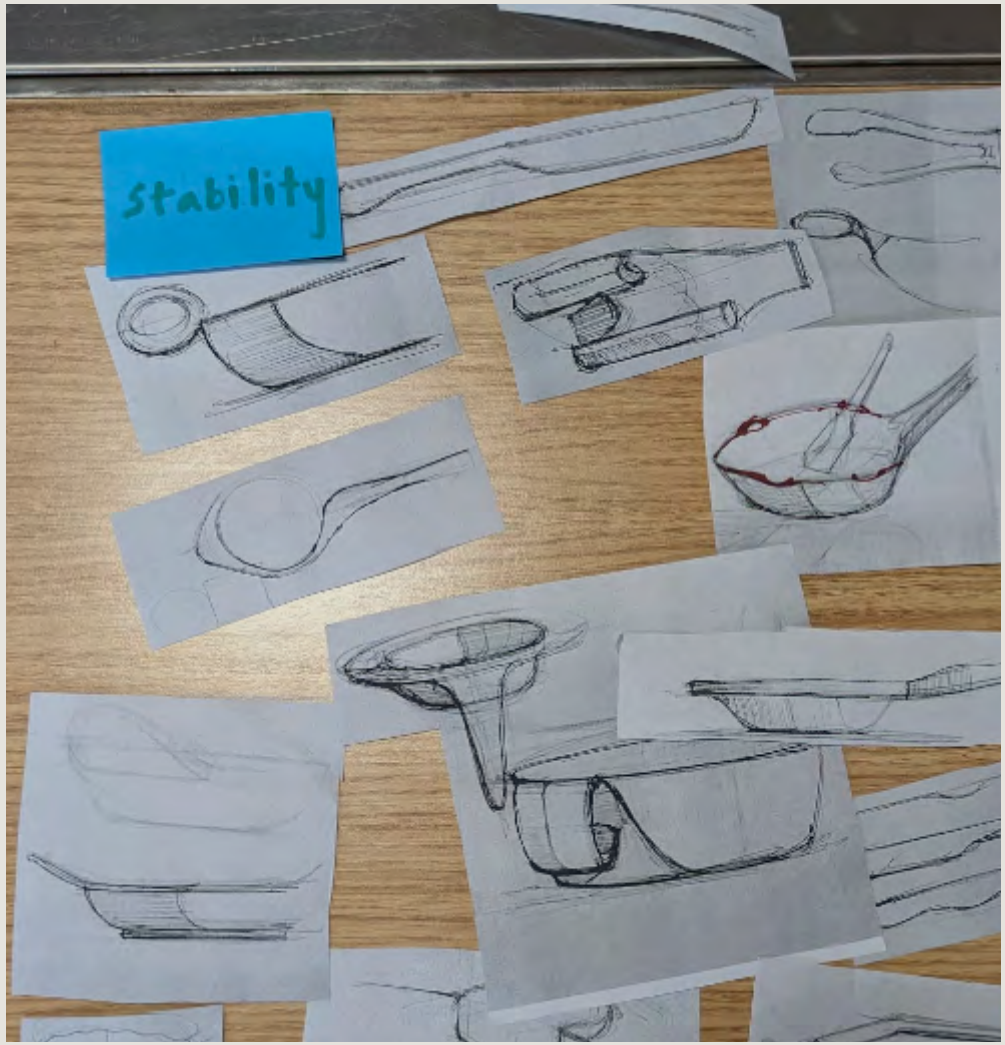
Clustering ideas

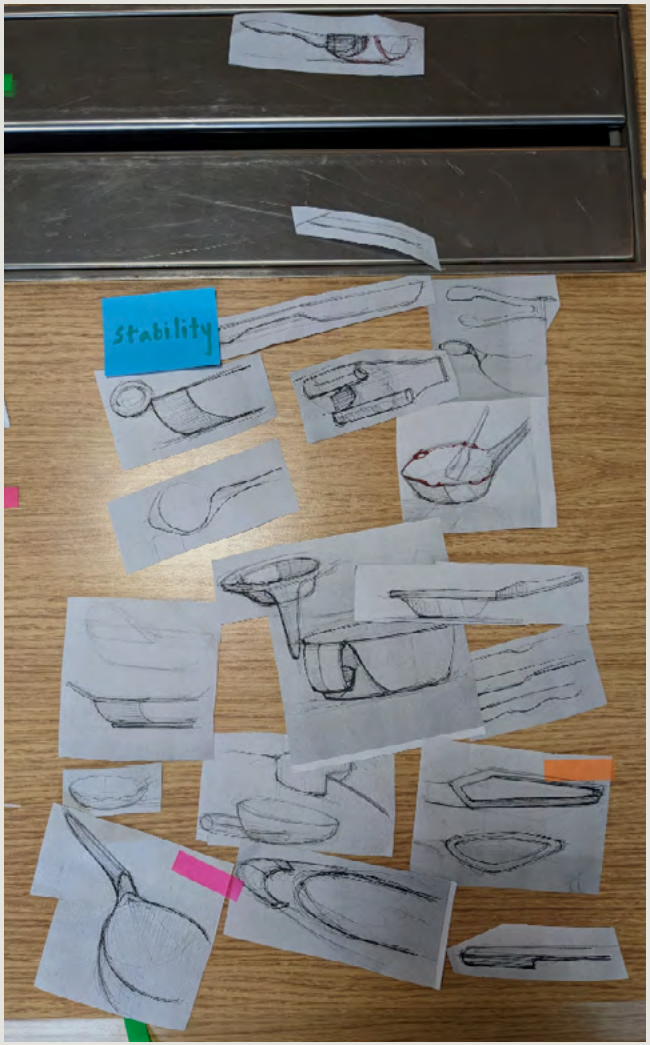
After initial sketching, the ideas were then clustered to find out the common threads amongst them. The threads were the reason the design idea was thought of.

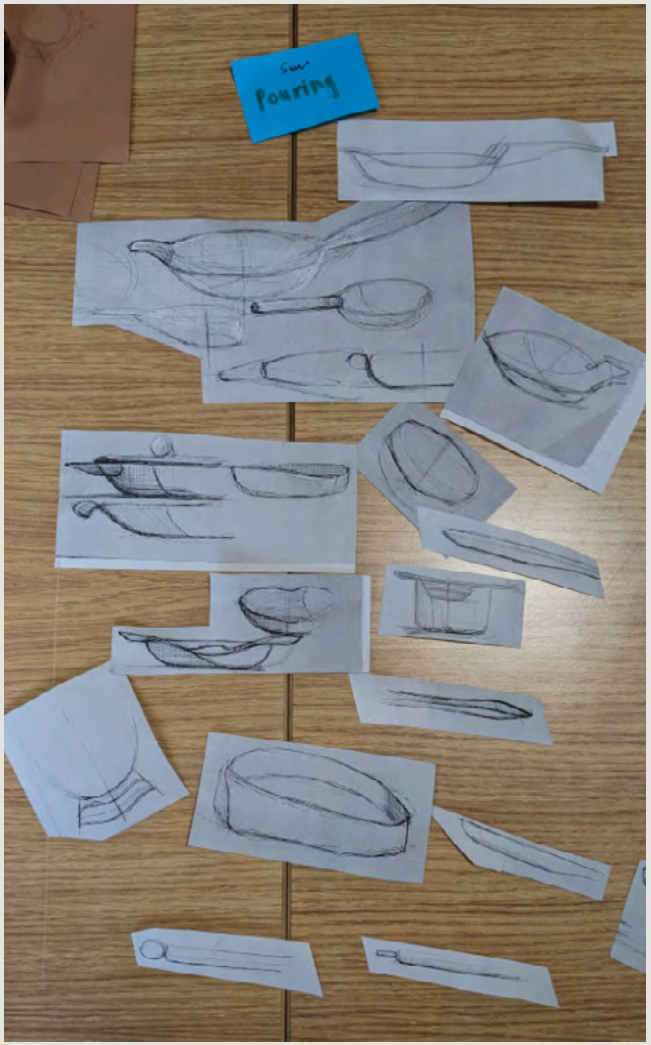
The 3 main clustering groups created were:

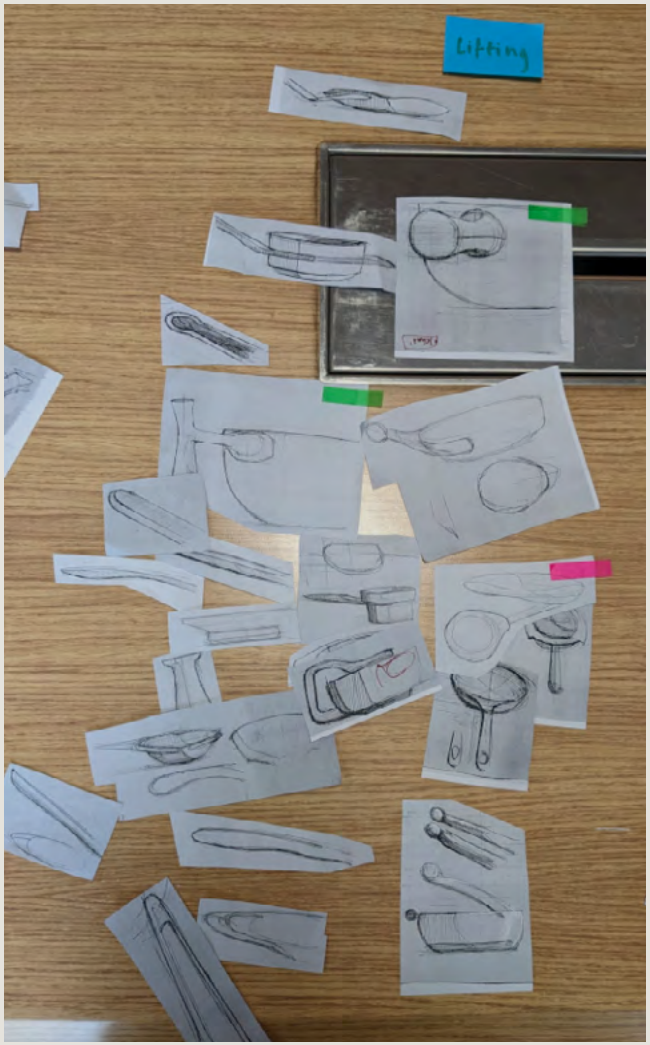
1. Stability.
2. Ease of pouring.
3. Ease of lifting.

Out of each group one champion idea was selected and which led to the creation of product concepts.




Stability


Pouring


Lifting

Prelim concepts

Tensions is an exercise which aims to find the right balance of two extreme styles. The styles deployed here were chosen after the resarch was done and a pattern was observed.

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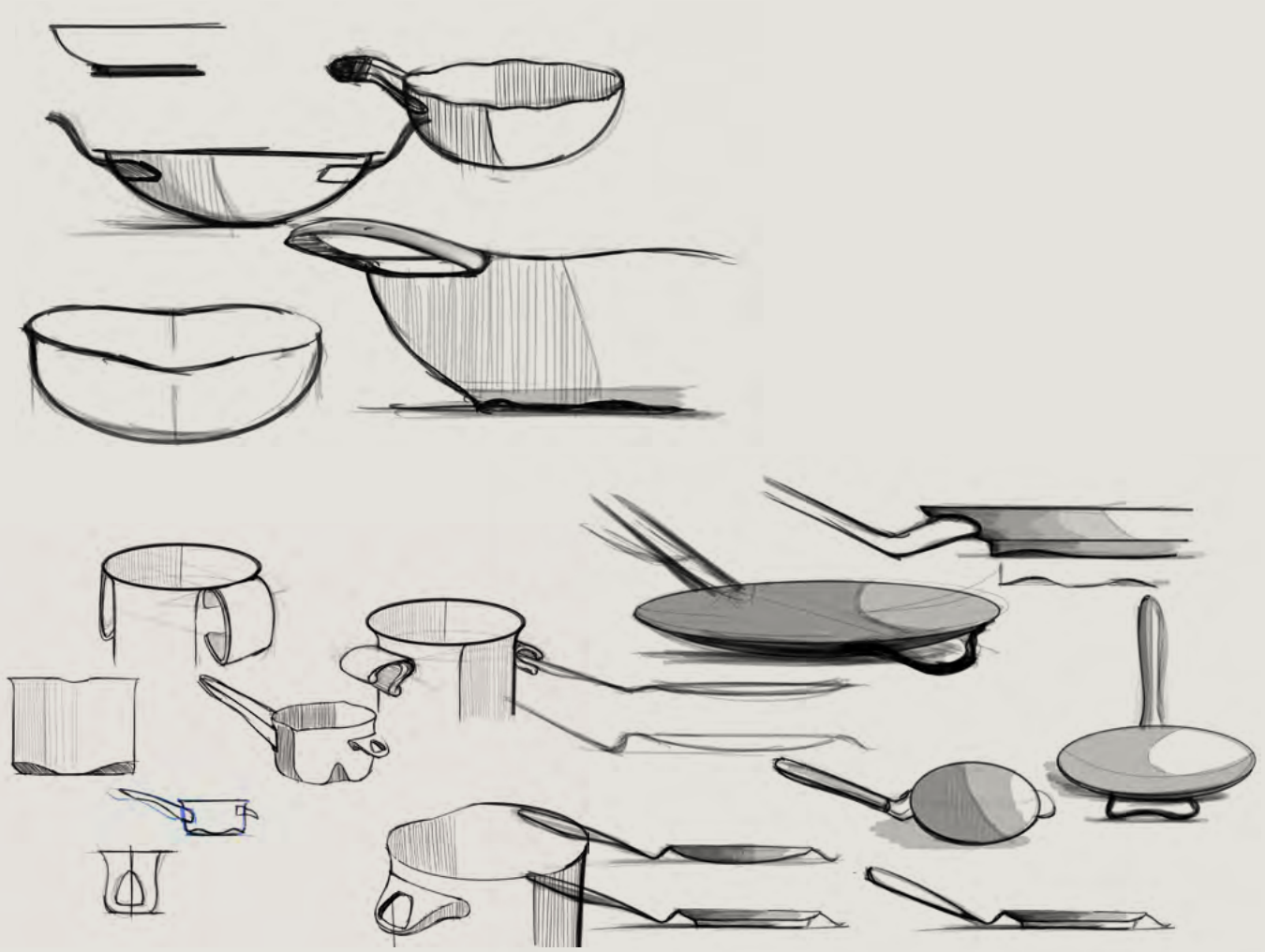
These tensions are then employed in the final design forms



Tawa

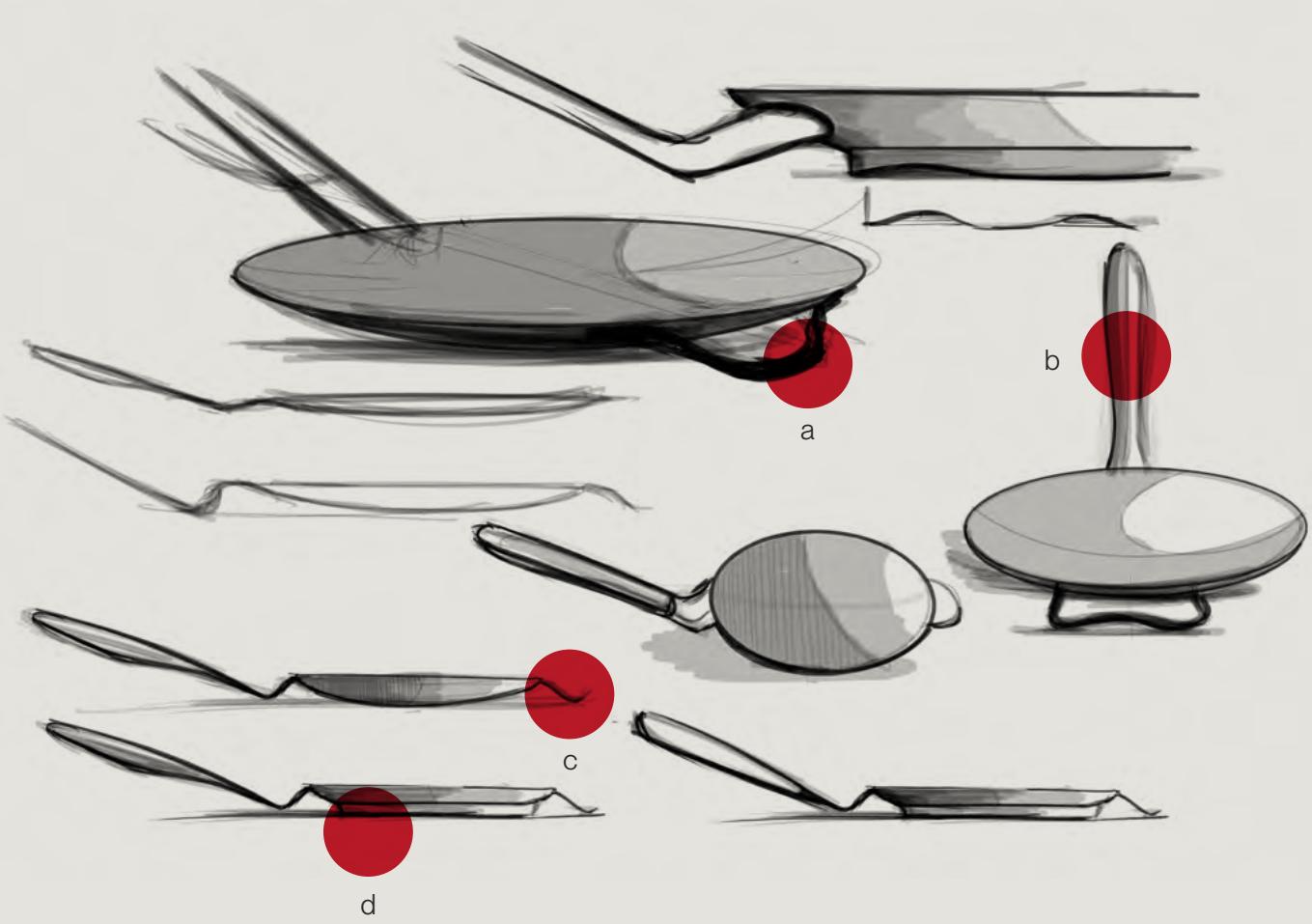
Concept details:

a. Balancing side handle which stabliizes the pan.

b. An ergonomic, full size handle, rather than a wire handle.

c. A small lip to help lift the pan up from the cooking surface when it's resting.

d. Flat base, which helps to cook on induction and helps stabilize the pan.



Saucepan

Concept details:

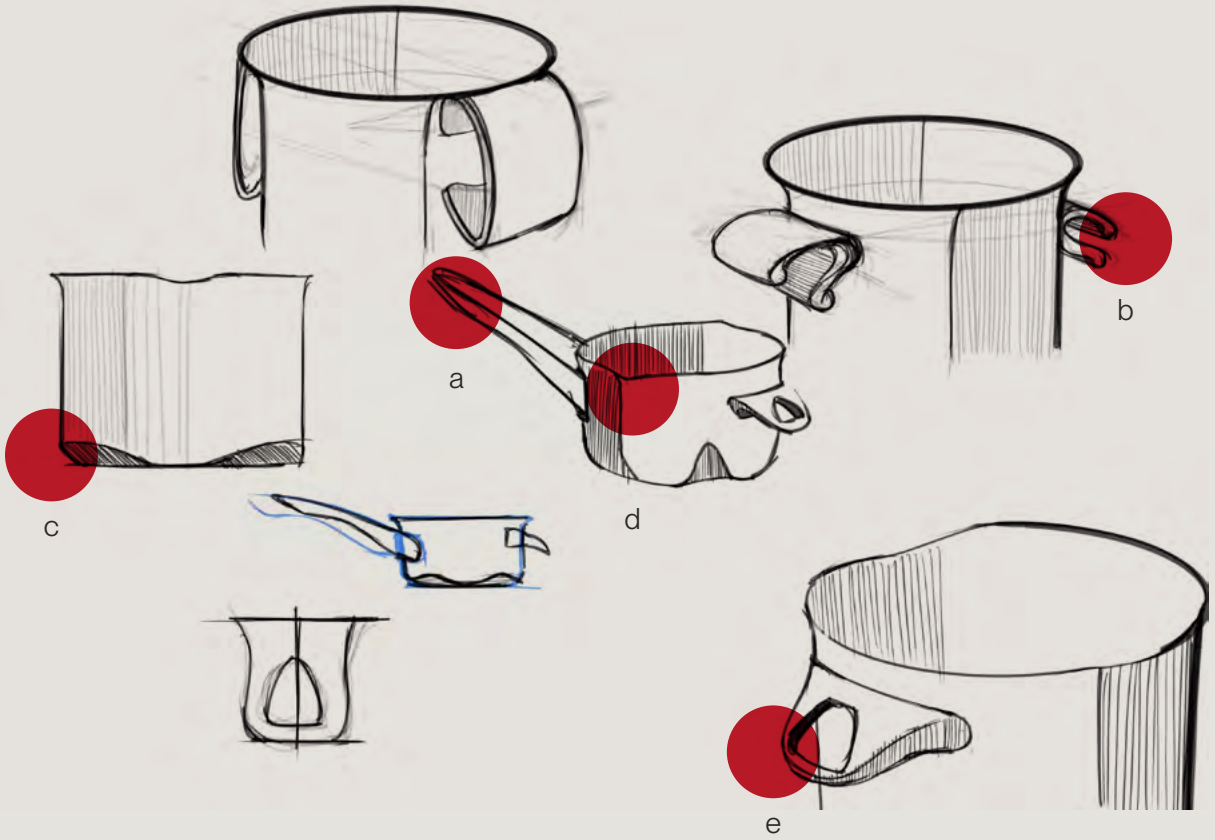
a. Ergonomic handle

b. A new alternative handle design, where the ser can slide their hands in to pick them up.

c. Ridges at the bottom of the pan which help stabilize the pan on the gas stove.

d. Spouts on both the ends of the pan. For both left and right handed users.

e. A more traditional handle version if the other one doesnt work out.



Kadai

Concept details:

a. Ergonomic handle

b. A new alternative handle design, where the ser can slide their hands in to pick them up.

c. Ridges at the bottom of the pan which help stabilize the pan on the gas stove.

d. Spouts on both the ends of the pan. For both left and right handed users.

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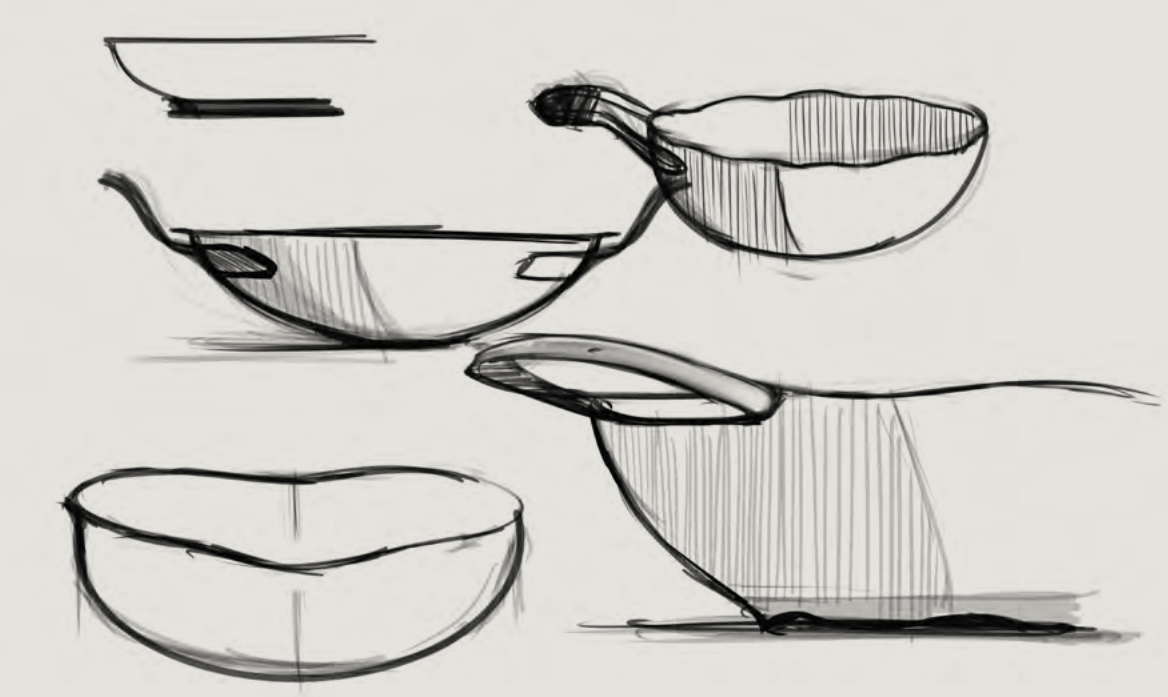

Prototypes

Prototypes were created using foam, 3D printing and cardboard, using the proper materials where necessary. 1/5th scale models of the cookware were made to get a representation of the form and

I started out with quick mock-ups of handles in foam to get an understanding of how the handles feel like when they're in the hand. translating sketches into proper and precise foam models is a big challenge.

After making a few foam models I shifted gears to translate them into handles with precise dimensions. Dimensions were necessary to get a better sense of what works and what does not. I got recommendations from people with various handsizes to gather their insights.

I started modelling with very organic curves without a lot of thought into how it would be manufactured.

I kept experimenting with various cross seections, both formally and dimensionally.

Handle Sets

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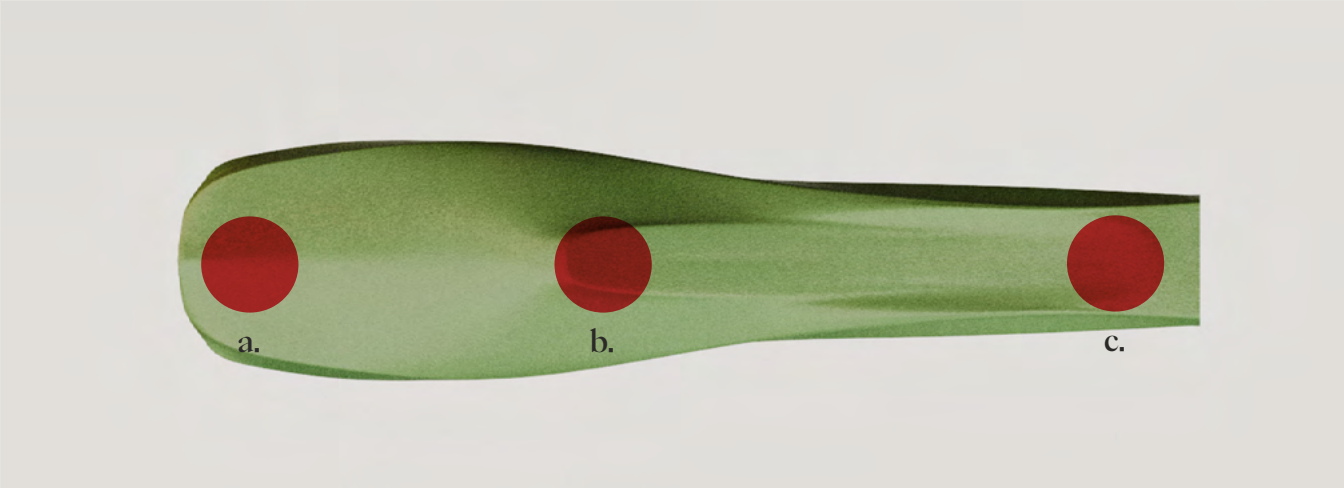
After making a few foam models I shifted gears to translate them into handles with precise dimensions. Dimensions were necessary to get a better sense of what works and what does not. I got recommendations from people with various handsizes to gather their insights.

Each iteration of the handle was made and altered according to informal user feedback.

Handle **a.**



The initial handle was designed in organically after the initial thermocol mockups.

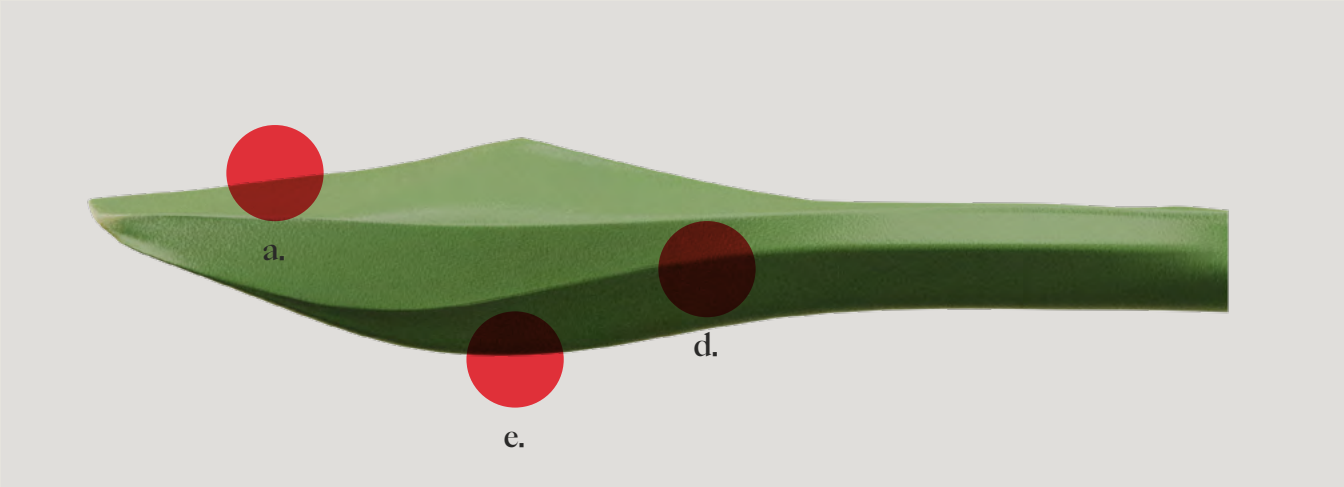
a. The palm-rest area to provide the palm to get a better grip of the handle using the sculpted counters of the inside of the palm. The wider grip area helps to balance the weight of the pan better.

b. The

c. The concave surface allows the tumb to get a proper grip on the using a hammer style grip on the handle for tighter movement control.

d. The flat sides allow the thumbs to rest on the handle when the uangle is being held in Position 2.

e. The conved surface on the bottom aalso allows for the insides of the paml to grip it, like a ball in the users hand in Position 2.



Handle Evolution

Prototypes were created using foam, 3D printing and cardboard, using the proper materials where necessary. 1/5th scale models of the cookware were made to get a representation of the form and

I started out with quick mock-ups of handles in foam to get an understanding of how the handles feel like when they're in the hand. translating sketches into proper and precise foam models is a big challenge.

After making a few foam models I shifted gears to translate them into handles with precise dimensions. Dimensions were necessary to get a better sense of what works and what does not. I got recommendations from people with various handsizes to gather their insights.

Each iteration of the handle was made and altered according to informal user feedback.

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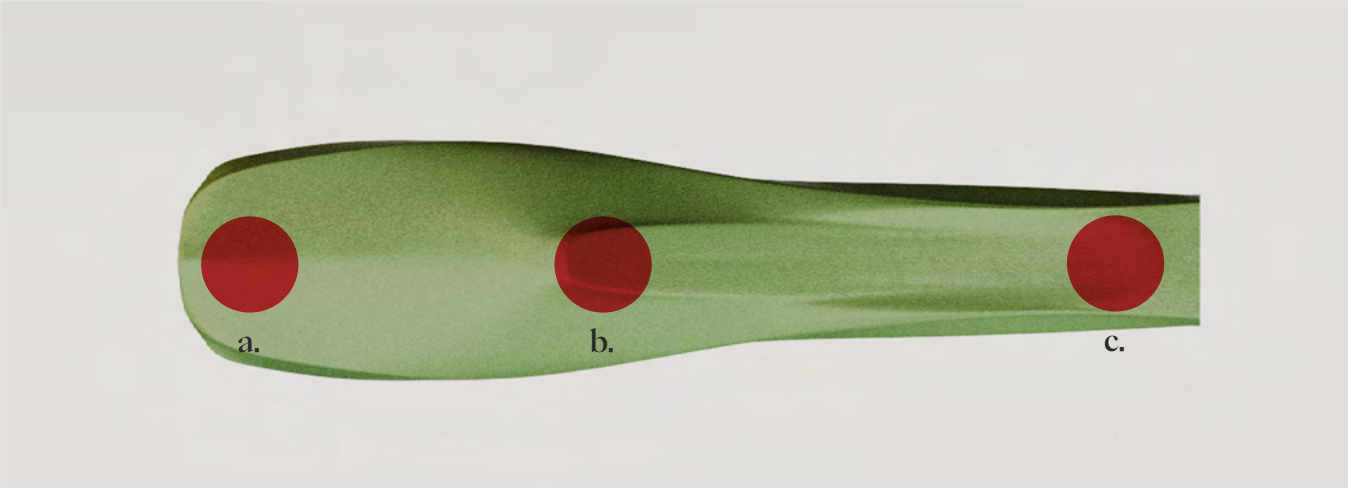
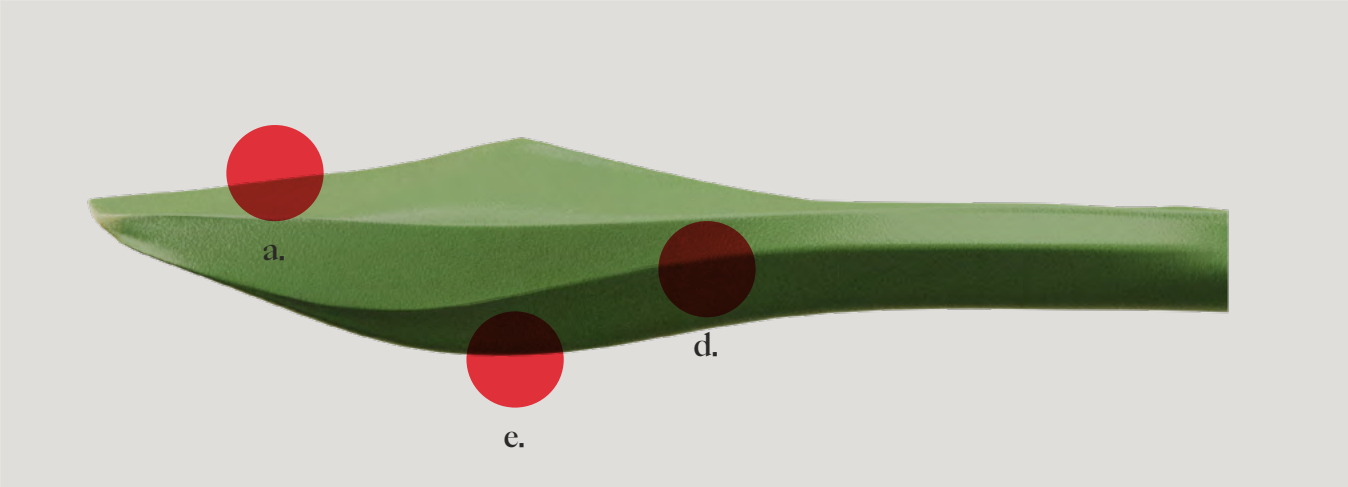


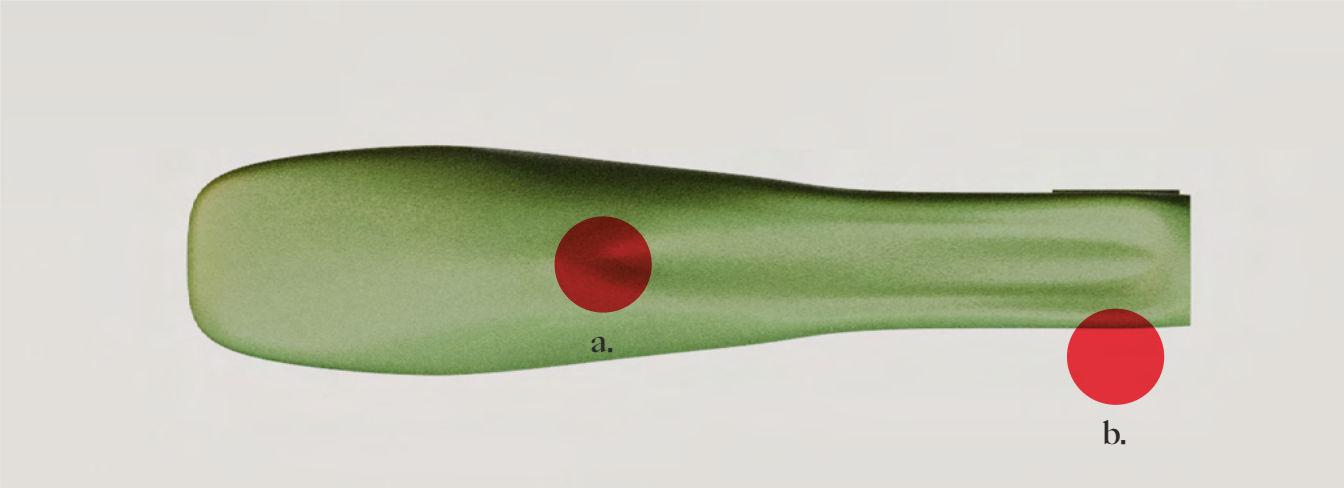


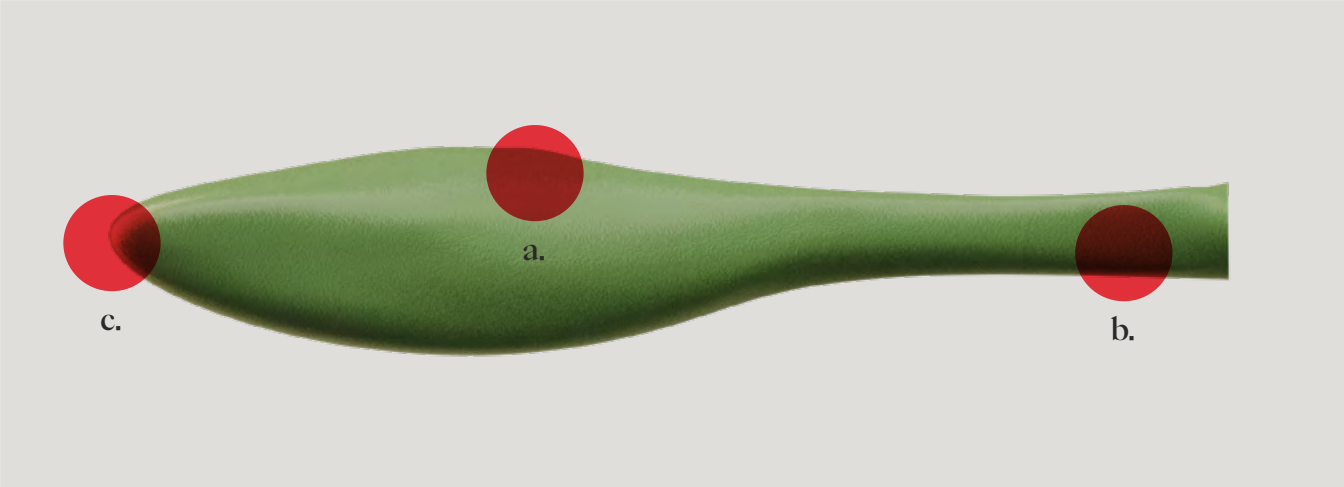
Handle **b.**

a. The users felt that the edges of handle a. could be smoothened out to provide a better feel in the hand.

b. An extra edge was added near the front edge of the handle to provide extra grip surface are for the thumb.

c. The end of the handle was contoured more smoothy so that it doesn't pinch or poke on the inside of the plam as it did in handle a.





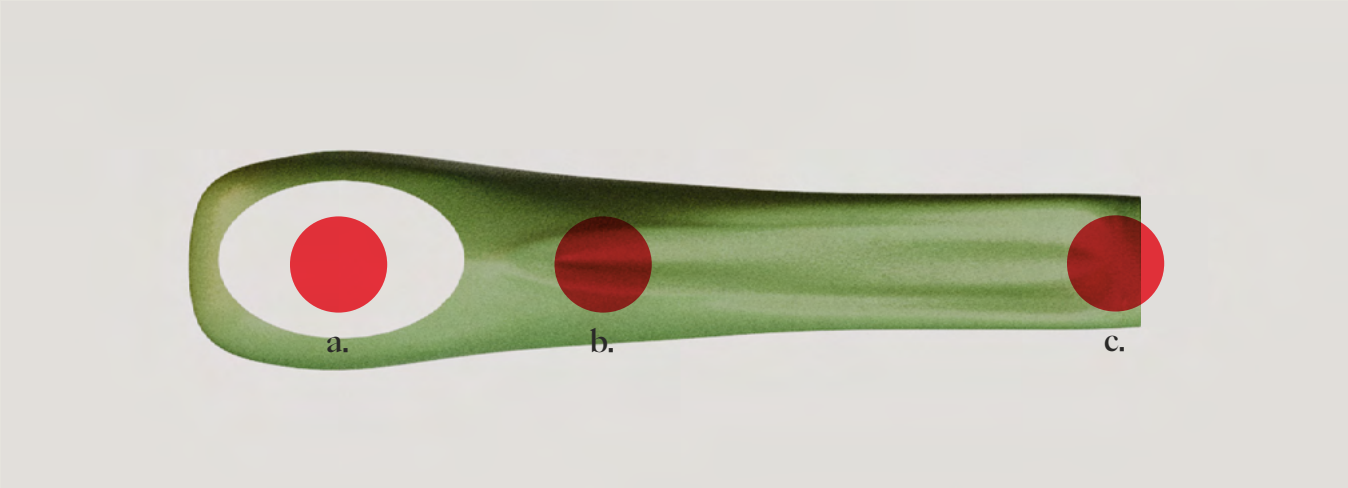
Handle **c.**

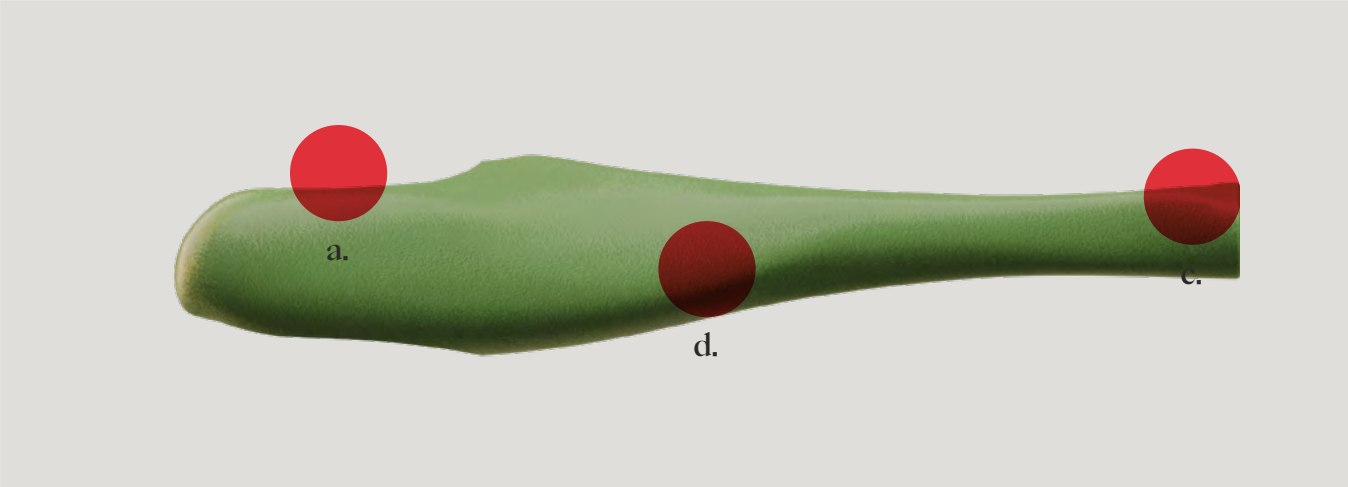
After further rounds of feedback I decided to add the hole for hanging the vessel.

a. A pretty big hook-hole so that the hanging of multiple pans and vessles on the same hook won't be ay problem. Users felt like the edges around the hole pinched their palm when gripped tightly.

b. The position of the palm curve was moved in a bit and its height reduced to allow for a less obtrusive transition for the hand. But the users felt like the lack of a proper palm grip because of the thru-hole reduced their confidence of the grip.

c. The sides of the handle are more circular in its cross-section than before. Allowing the users to wrap their hands around easily.





Handle **d.**

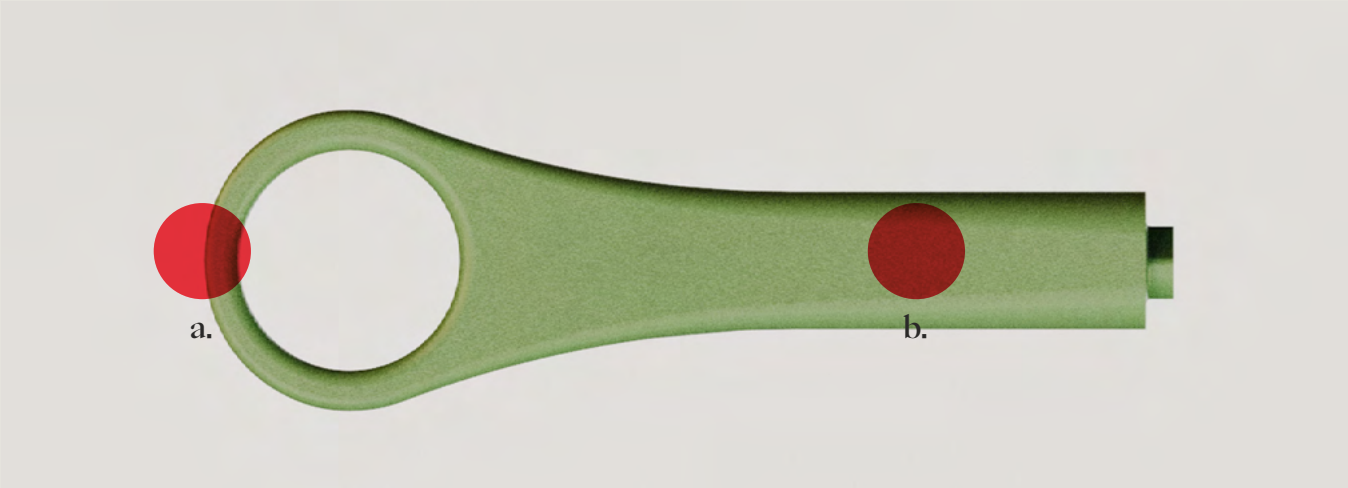
For handle d. I went into a more geometric direction to see how that fares with the users. This would allow me to gauge whether the more organic designs and curvy form of the handle is needed or not.

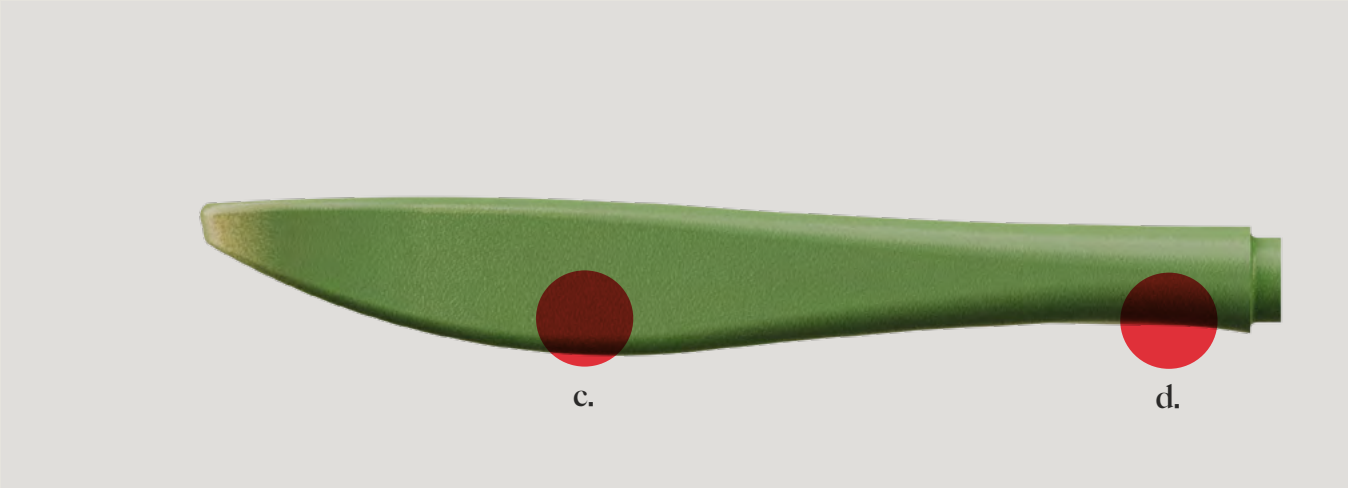
a. I retained the thru-hole but turned it into a circular loop. To give it a more geometric form and allow for an even internal hanging surface.

b. Instead of having curvilinear sides, the surfaces are all flat. This didn't test well with users, they found the flat sides to not conform to the way their fingers wanted to wrap around for a proper grip.

c. The convex surface to allow the fingers to wrap around was retained. The flat top which didn't test well with users. They felt that the curved surface of the other handles allowed for a better grip.

d. A slight curve to allow the user to get a grip on right at the edge of the end of the handle. user testing testing revealed that the angle and the size of the portion is not enough to make a difference.





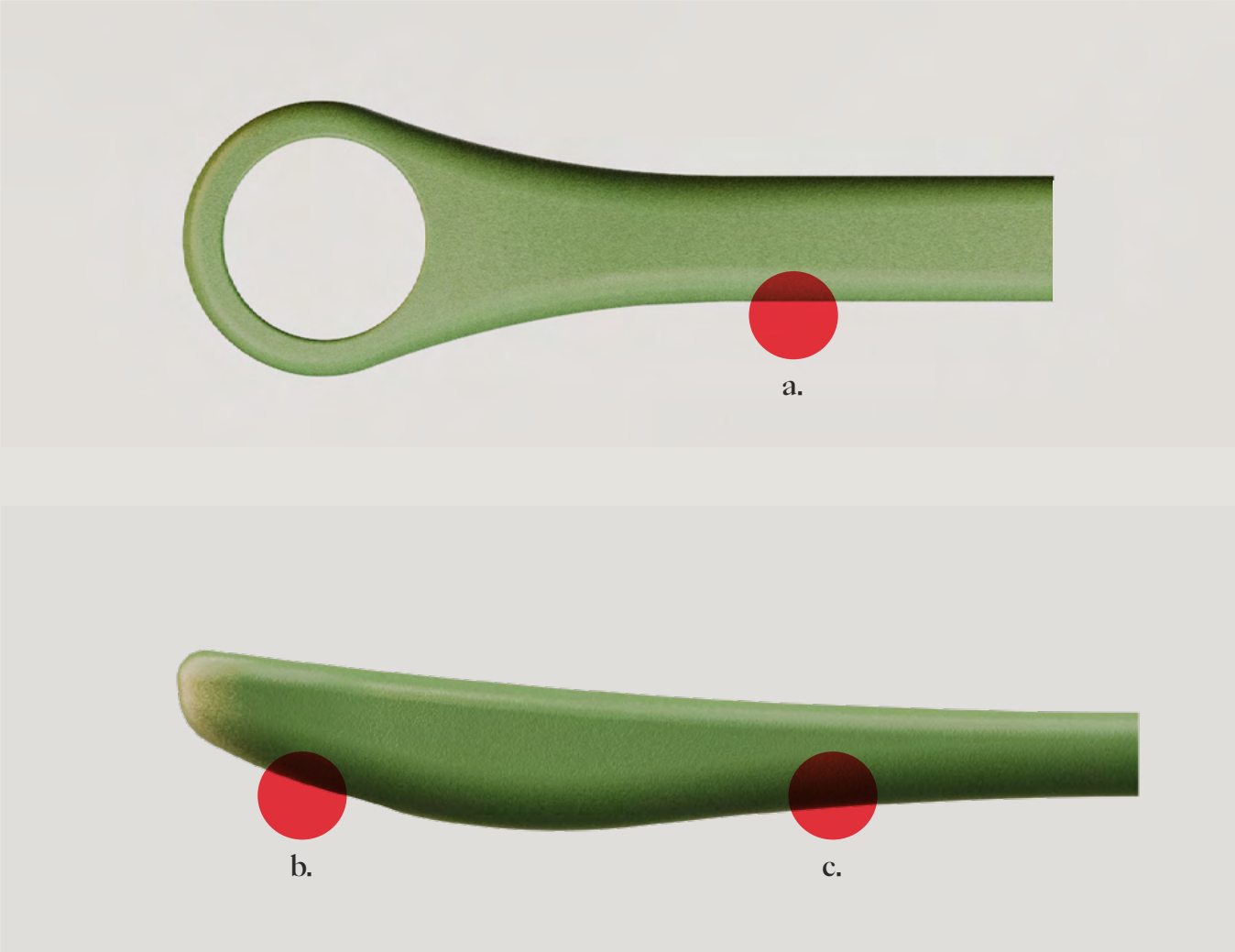
Handle **e.**

A small revision on handle d. making it more curvilinear.

a. The sides of the handle were changed to contoured rather than being flat. Users felt the this changed felt more accomodating to their handes but their fingers could not find a proper place to rest upon.

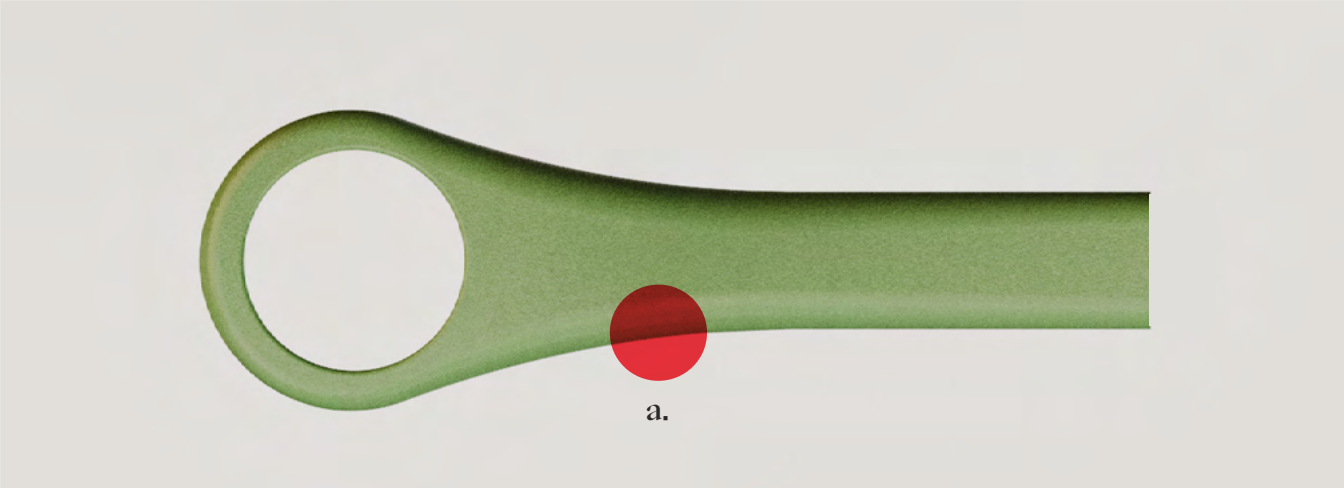
b. The cross section of the handle bends upwards. This changed was not liked by any users. They felt like it fought against the grip of their hand rather than act with it.

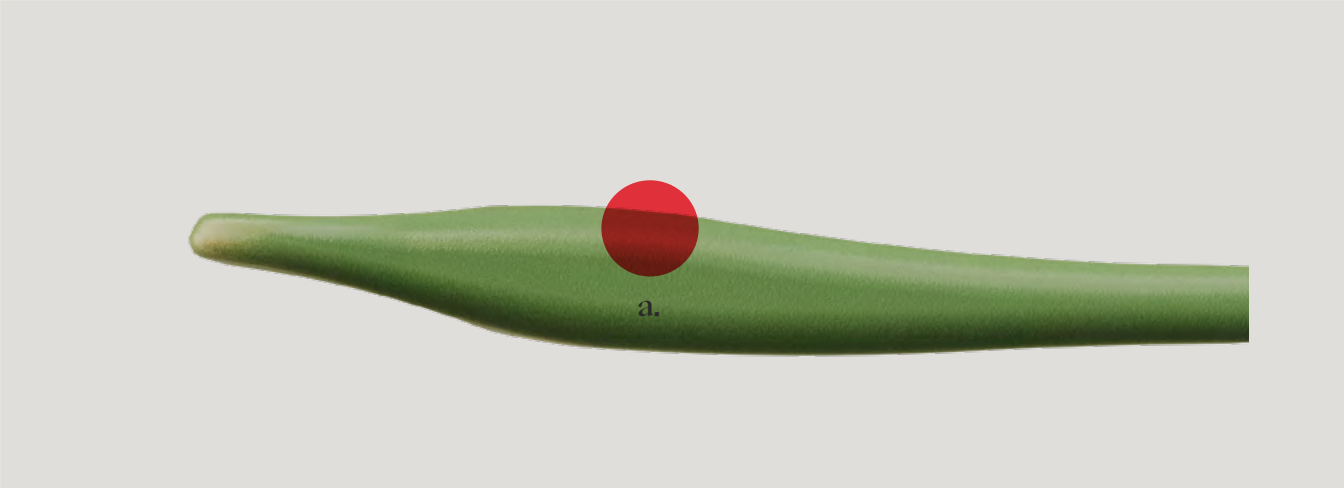
c. The curvature from the sides continued towards the bottom of the handle and till the other side, forming a continuous bend.



Handle f.

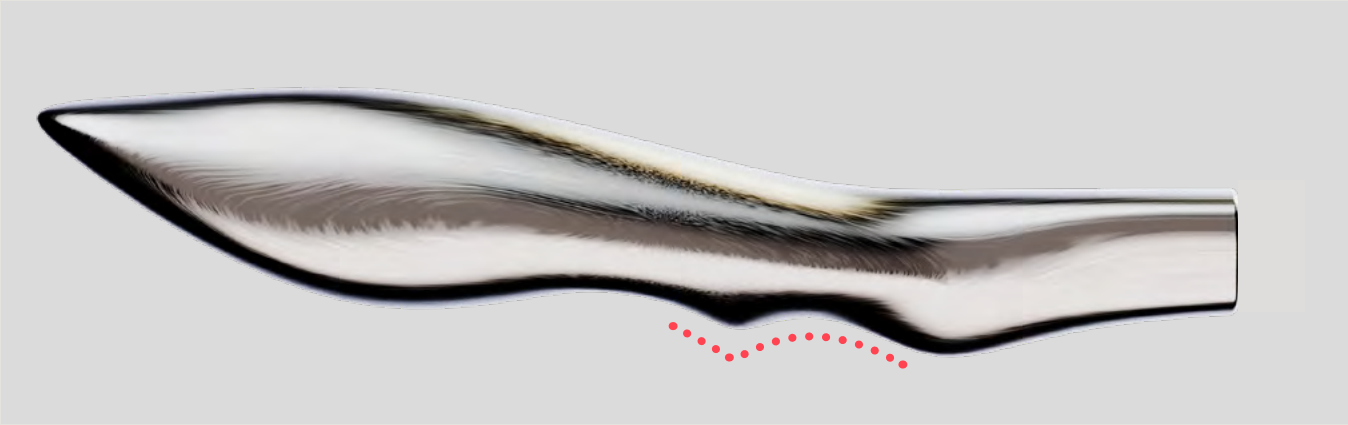
For handle d. I went into a more geometric direction to see how that fares with the users. This would allow me to gauge whether the more organic designs and curvy form of the handle is needed or not.





Handle 3

For handle d. I went into a more geometric direction to see how that fares with the users. This would allow me to gauge whether the more organic designs and curvy form of the handle is needed or not.

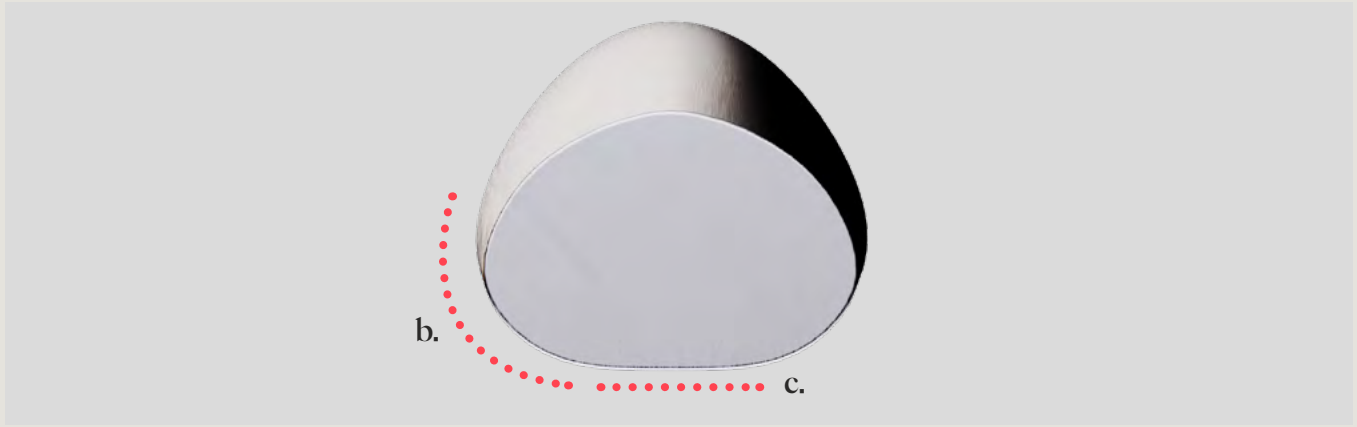


The finger contours.

Users felt that the contours of the handle made their fingers to not be able to grip the tip and sides of the handle effectively. Add to that the flat bottom surface and the highly contoured top surface pulled their hands to the side of the handle.

They felt that holding it upside down gave them a much better feel in the hand and a better overall grip.

They did appreciate the inclusion of “finger ridges”. People with BIGGER HANDS had no issues with the width and spacing of the finger ridges, but users with smaller hands couldn’t find a proper space to keep all their fingers properly stating that the grooves hindered them to place their fingers properly.



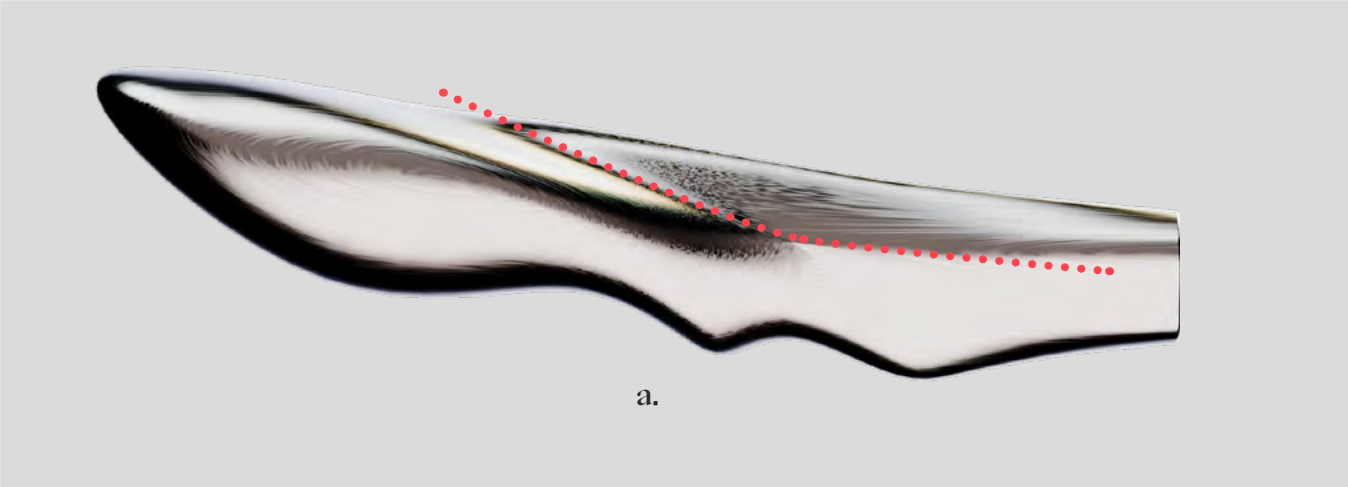
Problem areas for the palm and fingers.

Handle 3b

After taking in user feedback, the task was to improve the feel of the handle in hand by playing with the contours.

The contour was changed to being flatter on the top and more curvier and elongated towards the bottom. The palm of the hand can rest against the flatter curve while the fingers can wrap along the bottom of the handle.

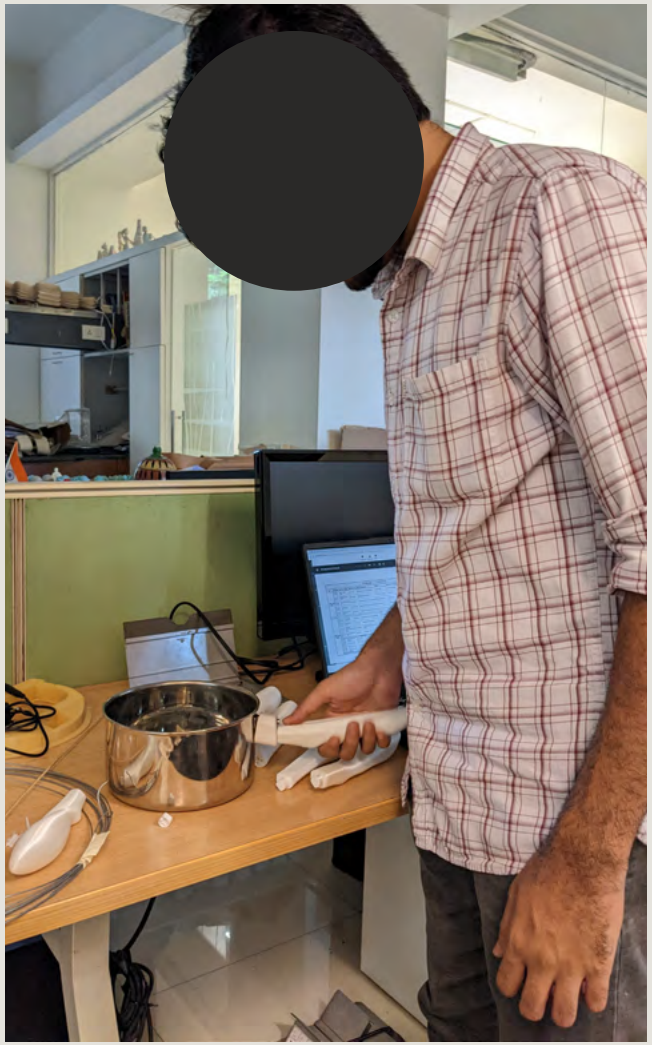
On the top, a curves to aid in resting the thumb in multiple places was also added. The problem tho became apparent when the users changed their grip to accodomodate the new curves instead of the handle following their natural gripping pattern.

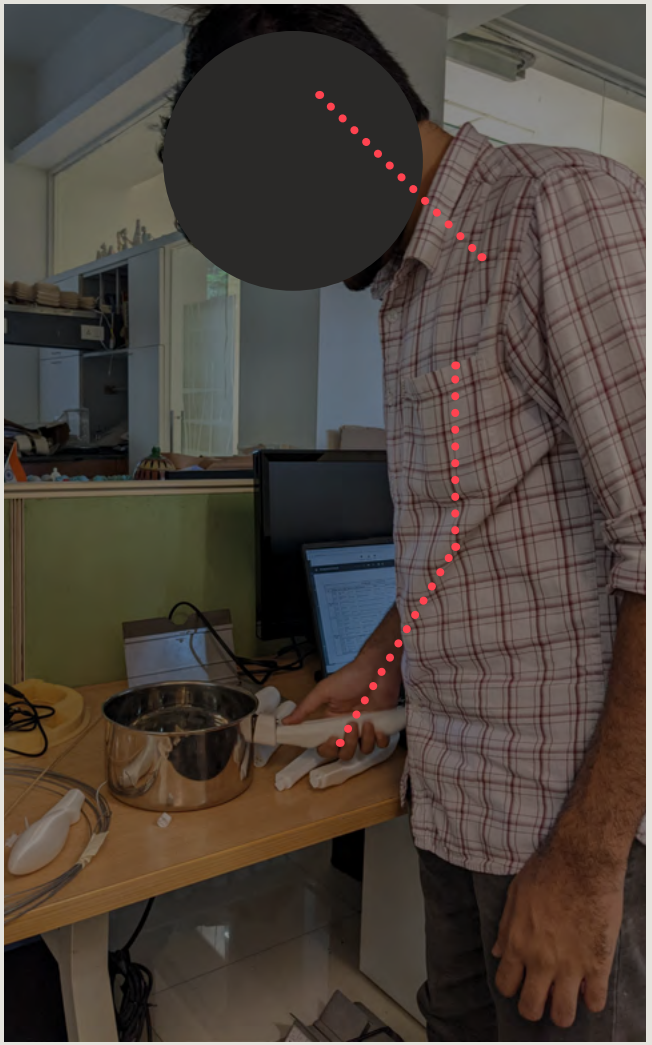


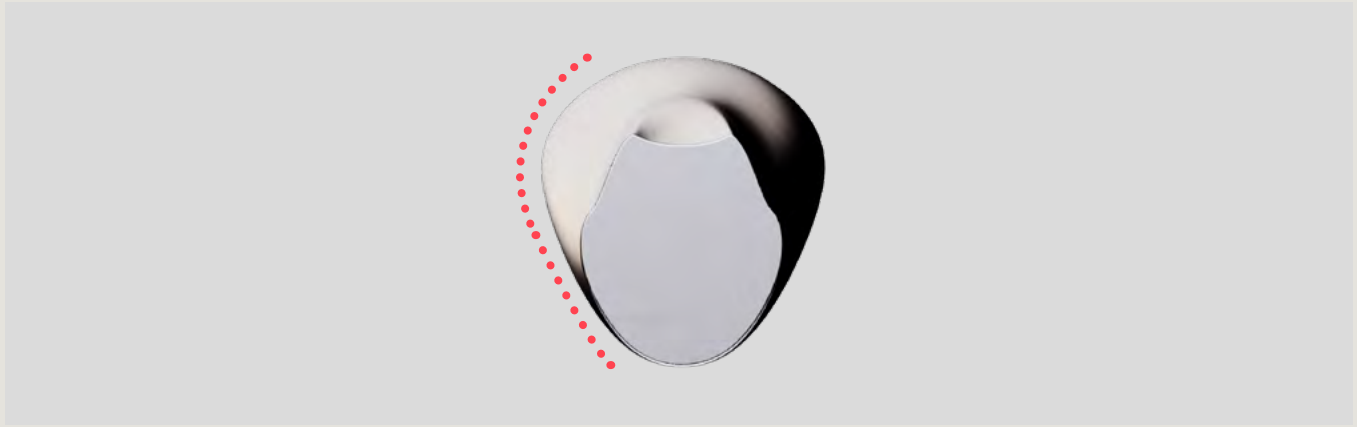
a.

Posture

It was observed that the initial handle and Handle B affected the posture of the user. The user noted that the angle and the lack of grip on the handle made them put more weight on it. The additional weight made them change their posture to lean in more.





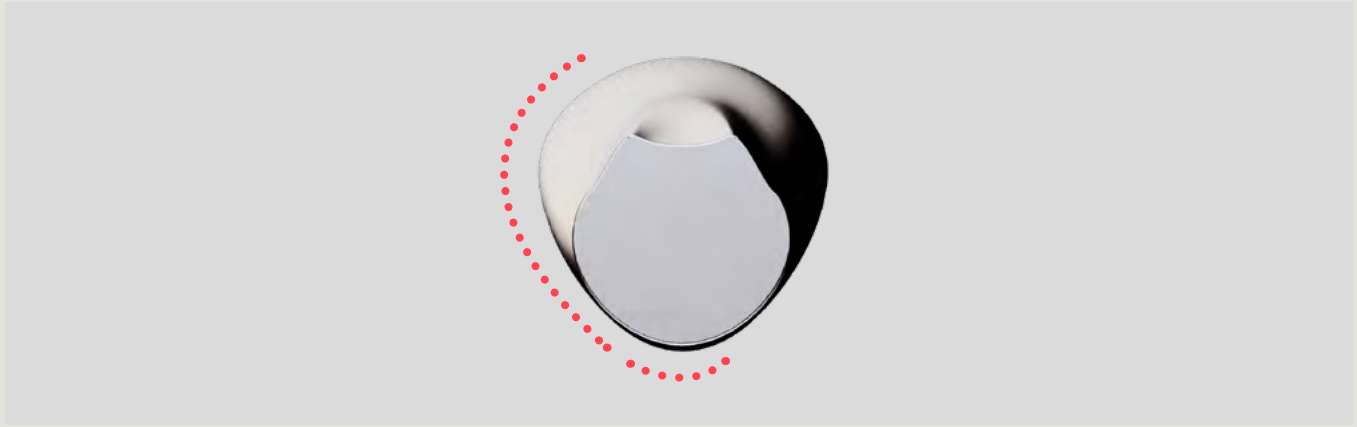


Handle 3c

As a control test, a handle variation with no finger grooves was made in order to verify their need in the design and if it actually made a difference in grip.

User testing revealed that users did feel that the finger grooves helped. The locking of the fingers in place and the additional grip control it provided felt more secure to them.

There was also a slight change in the cross-section, the height of the handle was reduced to accommodate smaller hand sizes.

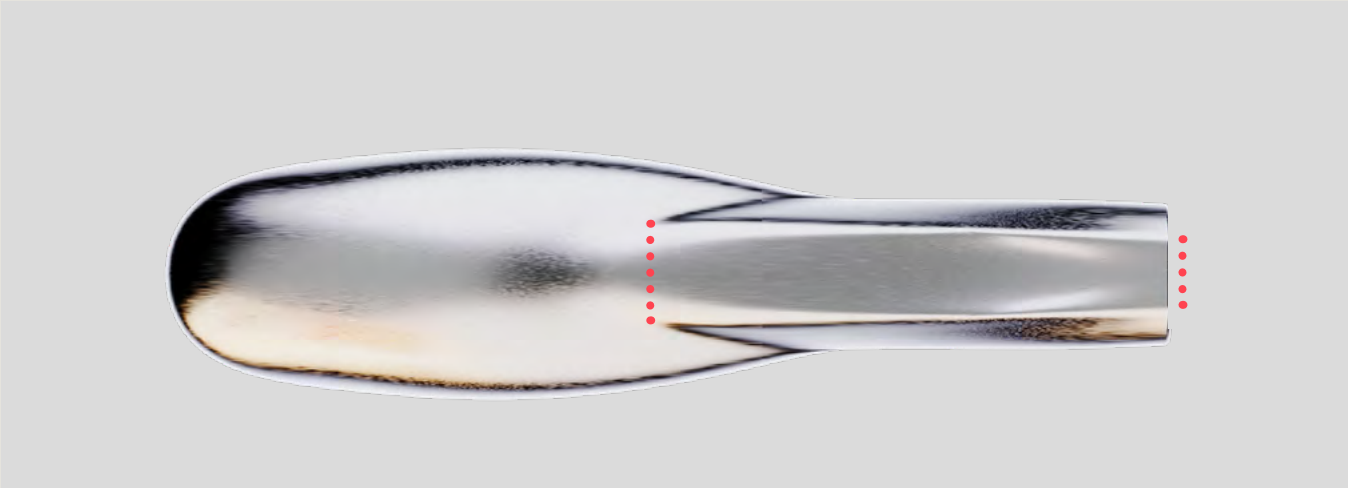


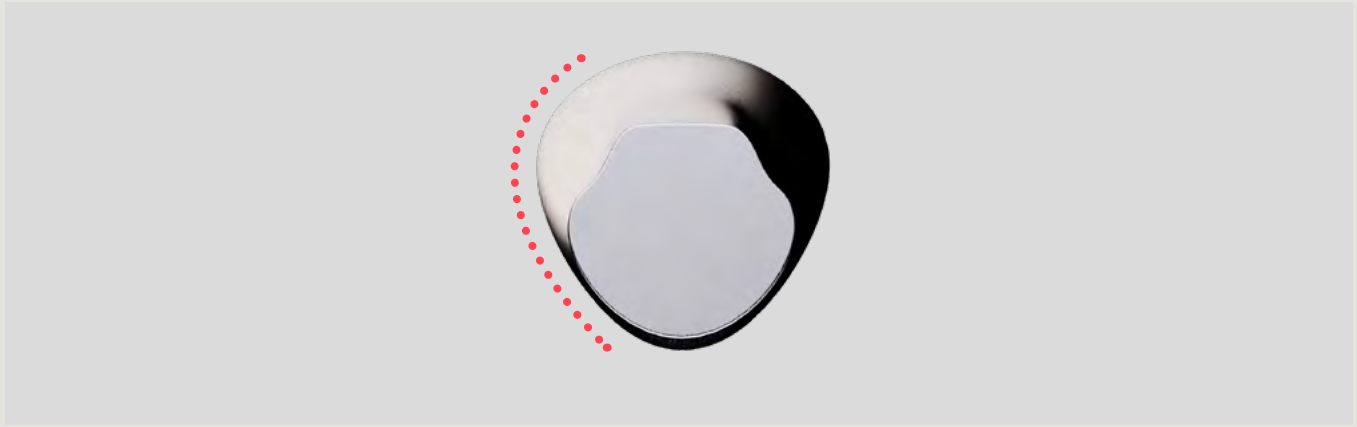
Handle 3d

According to user feedback, I added back a single finger groove. This change greatly improved user feedback. The stress they experienced on the thumb greatly diminished as they could support more of the weight with their index and middle fingers.

A slight change to the back of the handle was also made to make it rounder. This change helped more of the palm to come in contact with the handle which improved the grip.

Users with smaller hand sizes were able to rest their thumb on the top of the handle without issues but bigger thumbs like the old dimensions better, stating the thumb was able to stay on top a lot better.





Side Handle

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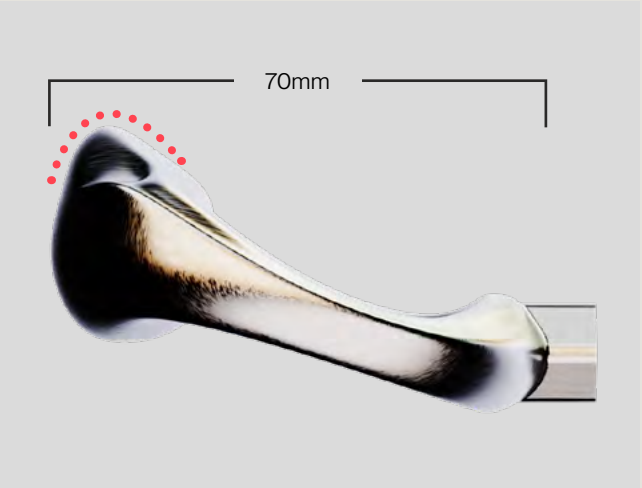
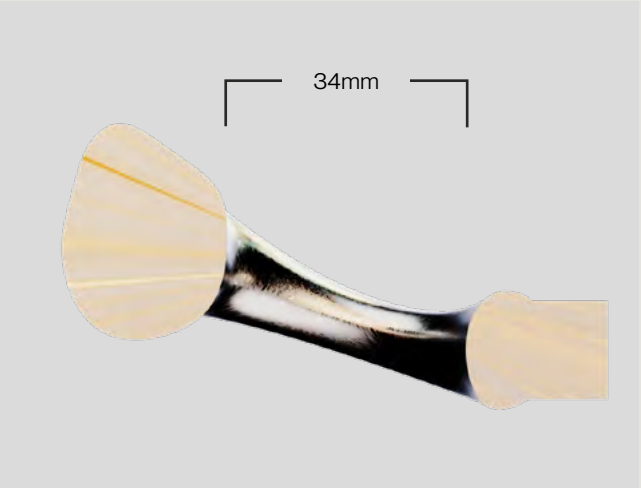
Each iteration of the handle was made and altered according to informal user feedback.

Handle 1

The first handle iteration the dimensions were too small for even the smallest of hands. The gap dimensions for 34mm bunched up the fingers too much.

The curves on the top of the handle, especially the one in the middle was suggested by the users to be smoothened out and reduced in height.





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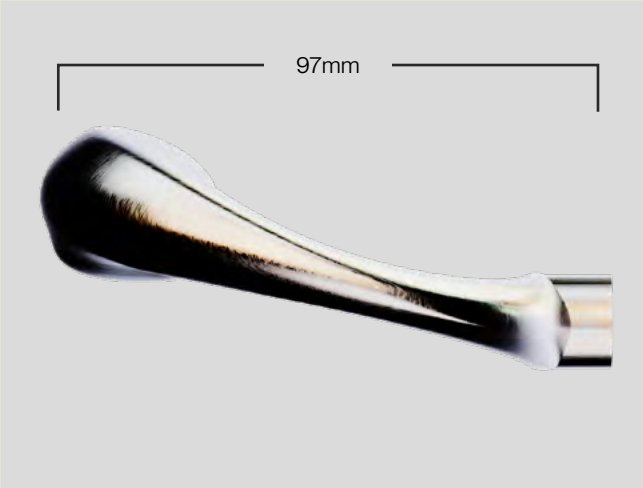
The curves on the top of the handle, especially the one in the middle was suggested by the users to be smoothened out and reduced in height.

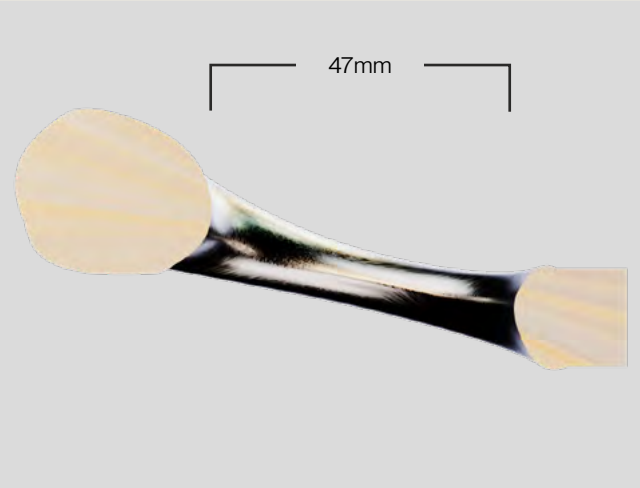
Handle 2

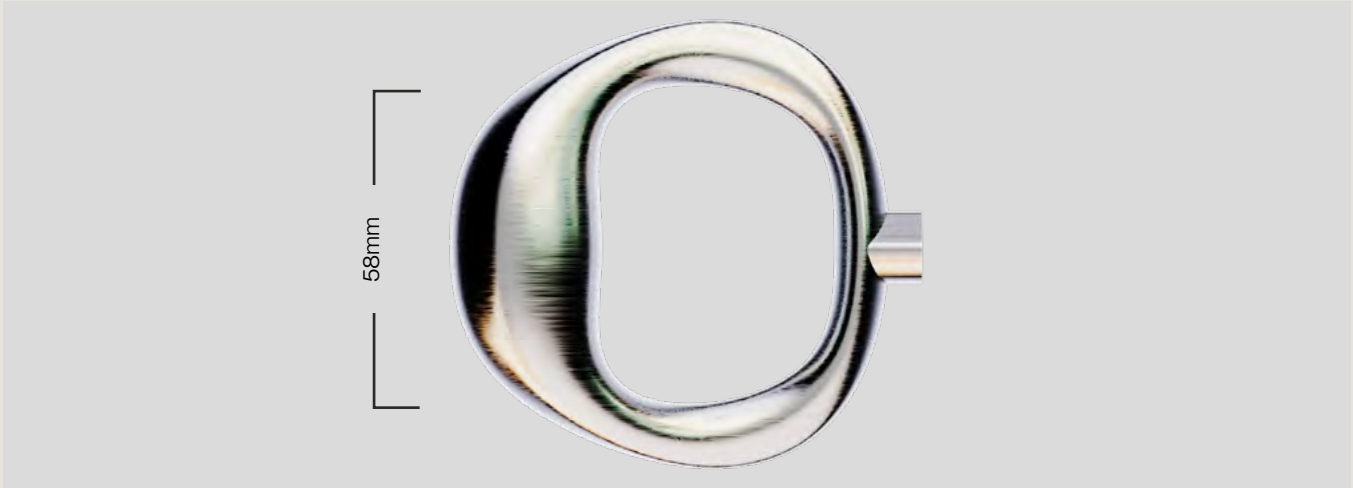
According to user feedback, the dimensions were altered and the internal grip dimension was increased to 47mm.

The top handle curve was flattened to remove the grooves. User commented that improved dimensions helped but they felt that the handle gave them a better grip while it was upside down.

Users with bigger hands felt that their palms pinched in a little pinched by the edges of the handle because its angular curvature.

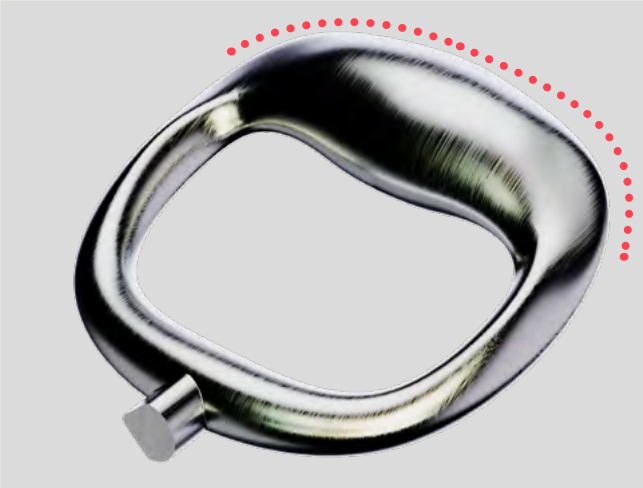


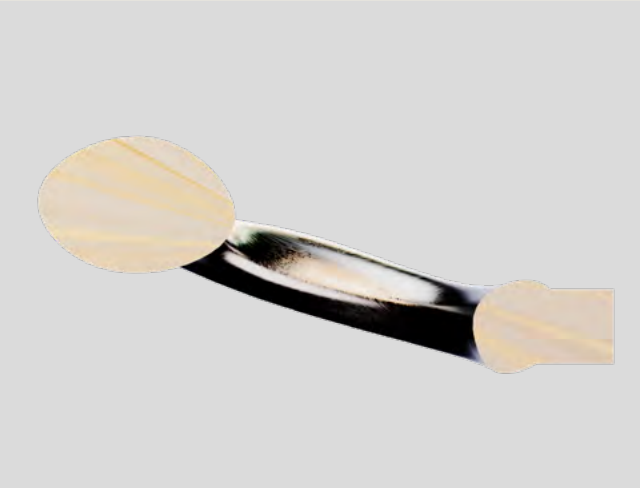



58mm

Handle 3

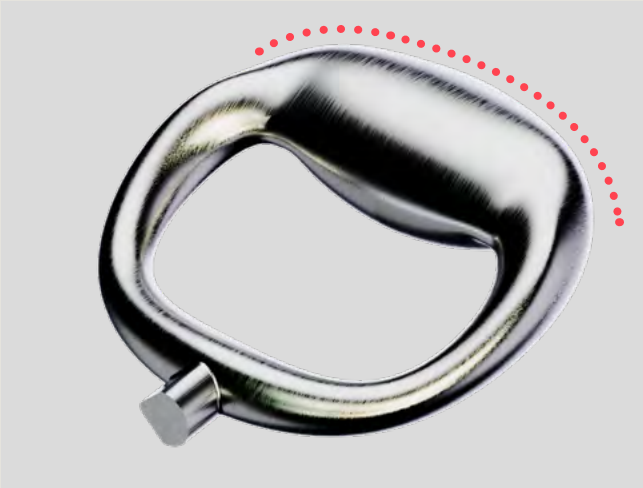
In iteration 3 tried an even flatter top curvature and a more curved bottom. The flat





Grip test with a cable.

Handle 4



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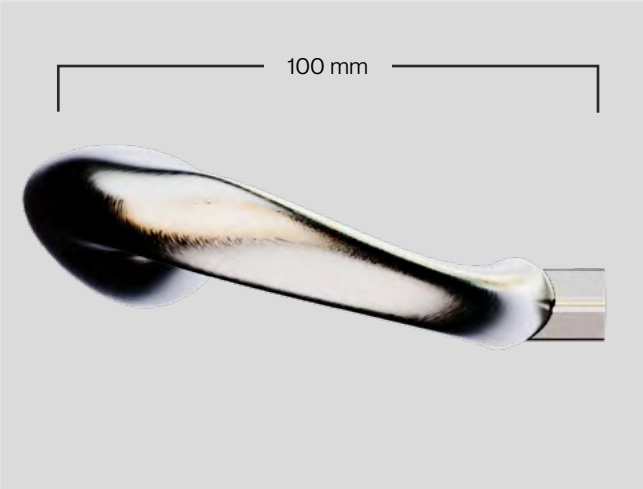
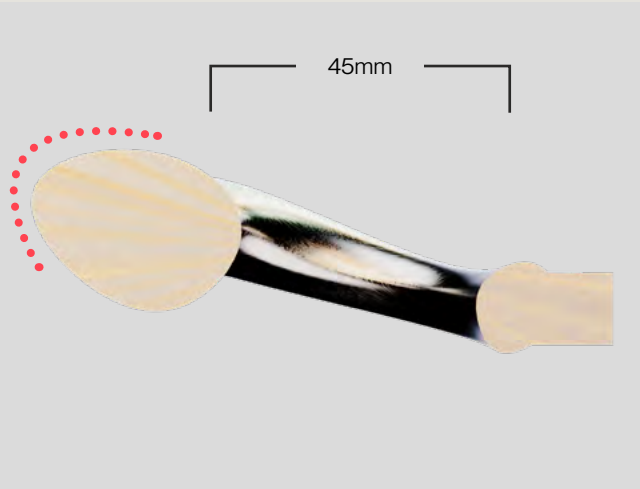




Conclusion and Feedback

The jury remarked and commended the iterative design process which was undertaken to design the handles. Iteration and very specific and changes to design based on actual user feedback and remarks.

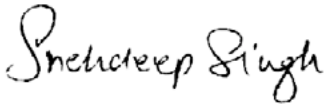
The jury understood the challenges and the shortcomings in the design based on those challenges. Challenges of a small not that diverse user group and the limited time scope.

The panel felt that more focues could've been given on the manufacturability and the design optimization based on the material chosen. The cocnerns of weight because of the selected materials were valid and should've been thought of while designing. The off balance weight will cause the end product to be much heavier than desiered and the weight off-balance will throw people off. This could've been solved by makin ga bent sheet-metal design instead of a casted one.

Declaration

I declare that this written submission represents my ideas in my own words and where others' opinions or words have been included, I have adequately cited & referenced the sources. I also declare that I have adhered to all principles of academic honesty & integrity & have not misrepresented or fabricated any idea/data/fact/source in my submission.

I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been appropriately cited or from whom proper permission has not been taken when needed.



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