

PROJECT III

Designing a peeler for those affected by Cerebral Palsy

Shankara Vigneshwaran V | 17U130016

Under the guidance of

Prof. Purba Joshi

IDC School of Design
अभिकल्प विद्यालय



IIT Bombay

Approval sheet

This is to certify that the Industrial Design Project - III (P3) titled “Designing a Peeler for those affected by Cerebral Palsy” by Shankara Vigneshwaran V is approved in partial fulfillment of the B. Des - M.Des Dual Degree at IDC, IIT Bombay.

Project Guide: Prof. Purba Joshi

Digital Signature
Purba Joshi Joshi (j09042)
25-Jul-23 03:10:41 PM

Chairperson: Prof. Anirban Guha

Internal Examiner: Prof. Avinash Shende

External Examiner: Mr. Sagnik Biswas

Declaration

I declare that this written submission represents my ideas in my own words and where other ideas or words are included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified 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 properly cited or from whom proper permission has not been taken when needed.

Acknowledgement

It is a great pleasure to have worked with Prof. Purba Joshi under their guidance to carry out the project “**Designing a peeler for those affected by Cerebral Palsy**” at IDC school of Design, IIT Bombay.

I would like to thank all my professors for their valuable guidance and feedback on the project and would like to thank every individual person who helped me through the course of the project.

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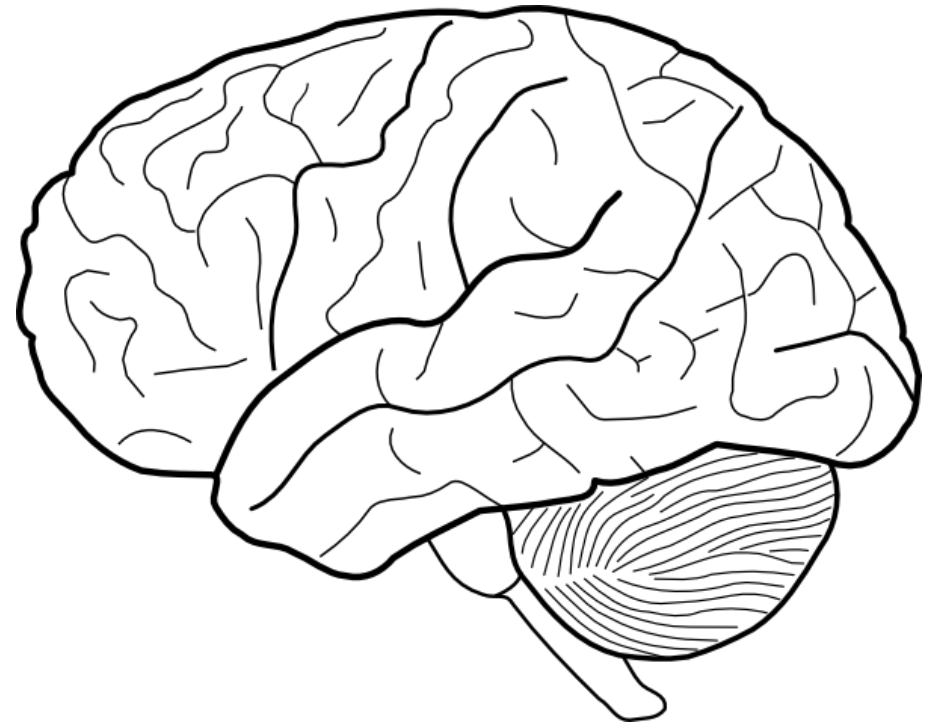
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Abstract

Cerebral Palsy is a non progressive disease caused by damage to the brain and can present itself in various ways, and is diagnosed at a very early age and the caregivers of those affected are trained to deal with the problems caused by it along with those affected leading to them being cared for almost throughout their life but most cases of cerebral palsy are under GMFCS level 2 meaning they can serve for themselves given the right tools and there has been a trend of increasing want to care for themselves among those affected by a lot of chronic illnesses, including CP. Peeling is an integral task in elevating one's cooking and most solutions for other aspects of cooking involve readymade materials or improvised shortcuts and there is a massive gap in the market for products that can help with peeling in the market of assistive care.

What is CP?

Cerebral palsy (CP) is a group of disorders that affect a person's ability to move and maintain balance and posture. CP is the most common motor disability in childhood. *Cerebral* means having to do with the brain. *Palsy* means weakness or problems with using the muscles. CP is caused by abnormal brain development or damage to the developing brain that affects a person's ability to control his or her muscles.



Symptoms

The symptoms of CP vary from person to person. A person with severe CP might need to use special equipment to be able to walk, or might not be able to walk at all and might need lifelong care. A person with mild CP, on the other hand, might walk a little awkwardly, but might not need any special help. CP does not get worse over time, though the exact symptoms can change over a person's lifetime.

All people with CP have problems with movement and posture. Many also have related conditions such as intellectual disability; seizures; problems with vision, hearing, or speech; changes in the spine (such as scoliosis); or joint problems (such as contractures).

Doctors classify CP according to the main type of movement disorder involved. Depending on which areas of the brain are affected, one or more of the following movement disorders can occur:

- Stiff muscles (spasticity)
- Uncontrollable movements (dyskinesia)
- Poor balance and coordination (ataxia)

Spastic CP

The most common type of CP is spastic CP. Spastic CP affects about 80% of people with CP.

People with spastic CP have increased muscle tone. This means their muscles are stiff and, as a result, their movements can be awkward. Spastic CP usually is described by what parts of the body are affected:

- Spastic diplegia/diparesis—In this type of CP, muscle stiffness is mainly in the legs, with the arms less affected or not affected at all. People with spastic diplegia might have difficulty walking because tight hip and leg muscles cause their legs to pull together, turn inward, and cross at the knees (also known as *scissoring*).
- Spastic hemiplegia/hemiparesis—This type of CP affects only one side of a person's body; usually the arm is more affected than the leg.
- Spastic quadriplegia/quadriparesis—Spastic quadriplegia is the most severe form of spastic CP and affects all four limbs, the trunk, and the face. People with spastic quadriparesis usually cannot walk and often have other developmental disabilities such as intellectual disability; seizures; or problems with vision, hearing, or speech.

People with dyskinetic CP have problems controlling the movement of their hands, arms, feet, and legs, making it difficult to sit and walk. The movements are uncontrollable and can be slow and writhing or rapid and jerky. Sometimes the face and tongue are affected and the person has a hard time sucking, swallowing, and talking. A person with dyskinetic CP has muscle tone that can change (varying from too tight to too loose) not only from day to day, but even during a single day.

Ataxic CP

People with ataxic CP have problems with balance and coordination. They might be unsteady when they walk. They might have a hard time with quick movements or movements that need a lot of control, like writing. They might have a hard time controlling their hands or arms when they reach for something.

Mixed CP

Some people have symptoms of more than one type of CP. The most common type of mixed CP is spastic-dyskinetic CP.

Diseases Similar to CP

Because different disorders have some of the same symptoms, other conditions may be mistaken for cerebral palsy and vice versa. For example, some misdiagnoses might involve other movement disorders such as dopa responsive dystonia, some medications might cause spastic behavior or the spinal cord might be unstable.

While these conditions can mimic each other in some aspects, they all have different treatments, so it is important that the individual is diagnosed correctly.

DRD

DRD is a genetic disorder that causes the body to not produce enough of a neurochemical called DOPA. This causes a person to have physical limitations as their body's muscle tone increases.

Symptoms of DRD are similar to cerebral palsy because the individual's muscle tone can vary throughout the day. These similar characteristics can be confused for cerebral palsy and lead to a misdiagnosis.

The main difference between cerebral palsy and DRD is that the latter is a progressive movement disorder and the former is not. This means the longer DRD is left untreated, the worse it can get.

Spinal Cord Injuries

Spinal cord injuries are not medical disorders, but their symptoms can be mistaken for one. If a child has progressive spasticity, deterioration of motor function, sensory changes and bowel movement or bladder control issues, then the doctor should look into the possibility of them having an injury to their spinal column. The spine needs to be stabilized to prevent the condition from worsening.

Side effects of medicines

Certain medications cause spastic motions as a side effect. If your child's movements seem different and they were recently put on a new drug, talk to your doctor about whether or not spastic movements are a side effect of the medication.

Muscular Dystrophy

Muscular dystrophy (MD) is a genetic disorder in which the genes for muscle proteins are damaged, causing progressive degeneration of the muscles. It can affect people at any age, but is most common in children. Assistive technologies depend on the user's range of abilities, and include head wands, mouth sticks, adaptive keyboards, voice recognition software, etc.

Multiple Sclerosis

Multiple sclerosis (MS) erodes the myelin (a layer of fatty tissue which surrounds nerve fibers), blocking nerve fibers from delivering signals from the central nervous system to the muscles of the body. Effects include tremors, weakness, numbness, unstable walking, spasticity, slurred speech, muscle stiffness, impaired memory, and occasionally paralysis. Not all individuals experience all symptoms, and an individual may experience different symptoms over time. The types of assistive technologies and devices are the same as for other motor disabilities.

Spina Bifida

Spina bifida is a congenital condition leading to motor difficulties and possibly paralysis. In some cases, fluid can accumulate in and damage the brain. Some individuals experience learning and language difficulties as a result.

ALS

Amyotrophic lateral sclerosis (ALS), also known as "Lou Gehrig's Disease," is a degenerative disease that prevents neurons from sending impulses to the muscles. The muscles weaken over time, impacting dexterity in operating a mouse or keyboard, and the condition may eventually affect the muscles required for breathing, resulting in death. Symptoms include slowness in either movement or speech.

Arthritis

Arthritis pain can interfere with the fine motor control necessary to use a keyboard or use a mouse, touchpad, or mobile device to click small links or buttons. Depending on the user's range of comfort, a user may use a trackball mouse, voice recognition software, foot pedals, or other technologies. Joint pain can cause fatigue, limiting the amount of time that the person is willing to spend on a computer maneuvering a mouse and typing on a keyboard.

Parkinson's Disease

Parkinson's disease (PD) is a disorder of the central nervous system that causes uncontrollable tremors and/or rigidity in the muscles. The condition can significantly impede mouse and keyboard use.

Occasionally the voice is affected as well, to the point that voice recognition software is not an option.

Essential Tremor

Like Parkinson's Disease, essential tremor (ET) is a nerve disorder that can result in uncontrollable tremors. Essential tremor most frequently affects the upper body, such as the hands, arms, head, and larynx (which impacts the voice).

Other disorders

Other progressive disorders that are occasionally misdiagnosed as cerebral palsy are metachromatic leukodystrophy, Pelizaeus-Merzbacher disease, and Rett syndrome. These disorders differ from cerebral palsy in that they cause breakdowns in cognitive and behavior skills, not just motor skills.

Glutaric aciduria type 1 is another genetic disorder that can be confused with cerebral palsy. It is a progressive condition that causes the child to develop chorea or make rapid and random motions. It is caused by an abnormality in the temporal area of a child's brain.

Effects of CP

Cerebral Palsy is usually diagnosed at a very early age (less than 1 year in age) and the parents of the children are also educated on the care required for those affected along with specialised education or rehabilitation services as to how they are to be taken care of throughout their lives in most severe cases

However a majority of cases of CP are less than level 2 meaning they have mild to moderate impairment of motor function and can take care of themselves but those who serve to help CP mostly focus on the more severe cases due to the population and inability to care for everyone and those affected usually just rely on the care from their parents or caretakers at home, this limits their social life and recent trends have brought more and more people bringing out their stories through online mediums to help and inspire others to defy the norms and function more actively in the society and to care for themselves which could be possible with minor interventions in everyday use items

Table III: Distribution of GMFCS level by neurological subtype

Neurological subtype	GMFCS level				
	I	II	III	IV	V
Spastic quadriplegia	3	6	11	33	32
Spastic hemiplegia	68	6	2	0	1
Spastic diplegia	31	7	13	1	0
Dyskinetic	1	2	1	7	5
Ataxic-hypotonic	4	1	2	1	1
Other	1	1	1	1	0

GMFCS, Gross Motor Function Classification System.

Table IV: Pearson χ^2 test, neurological subtypes of cerebral palsy (CP) \times GMFCS level (I-III vs IV-V)

Neurological subtype	GMFCS level		χ^2	p value
	I-III	IV-V		
Spastic quadriplegia	20	65	106.7	<0.001
Other CP	141	17		
Spastic hemiplegia	176	1	53.1	<0.001
Other CP	85	81		
Spastic diplegia	51	1	30.0	<0.001
Other CP	110	81		
Dyskinetic	4	12	13.0	0.001
Other CP	157	70		
Spastic quadriplegia or dyskinetic	24	77	139.6	<0.001
Other CP	137	5		

Increasing trend of self reliance

Student overcomes challenges of cerebral palsy with perseverance

TNN / May 24, 2022, 03:33 IST

99 PTS

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ARTICLES



Student overcomes challenges of cerebral palsy...



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In a first, Attukal temple trust gets a woman chief



Expert appraisal committee finds EIA study incomplete



Thiruvananthapuram: The inaugural function of the three-day camp organized by the [UL Space Club](#) at the Kerala Arts and Crafts Village, Kovalam, had an inspiring presence on Monday.

Man with cerebral palsy challenges stereotypes, celebrates 50 years at LewisGale Hospital Pulaski

'Anybody that's disabled needs a chance to prove themselves'

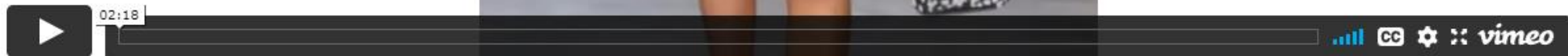


"He is an inspiration and a critical part of the hospital's operations," Sean Pressman, CEO of Lewisgale Hospital Pulaski said.



Local Teen with Cerebral Palsy Walks the Runway at L.A Fashion Week

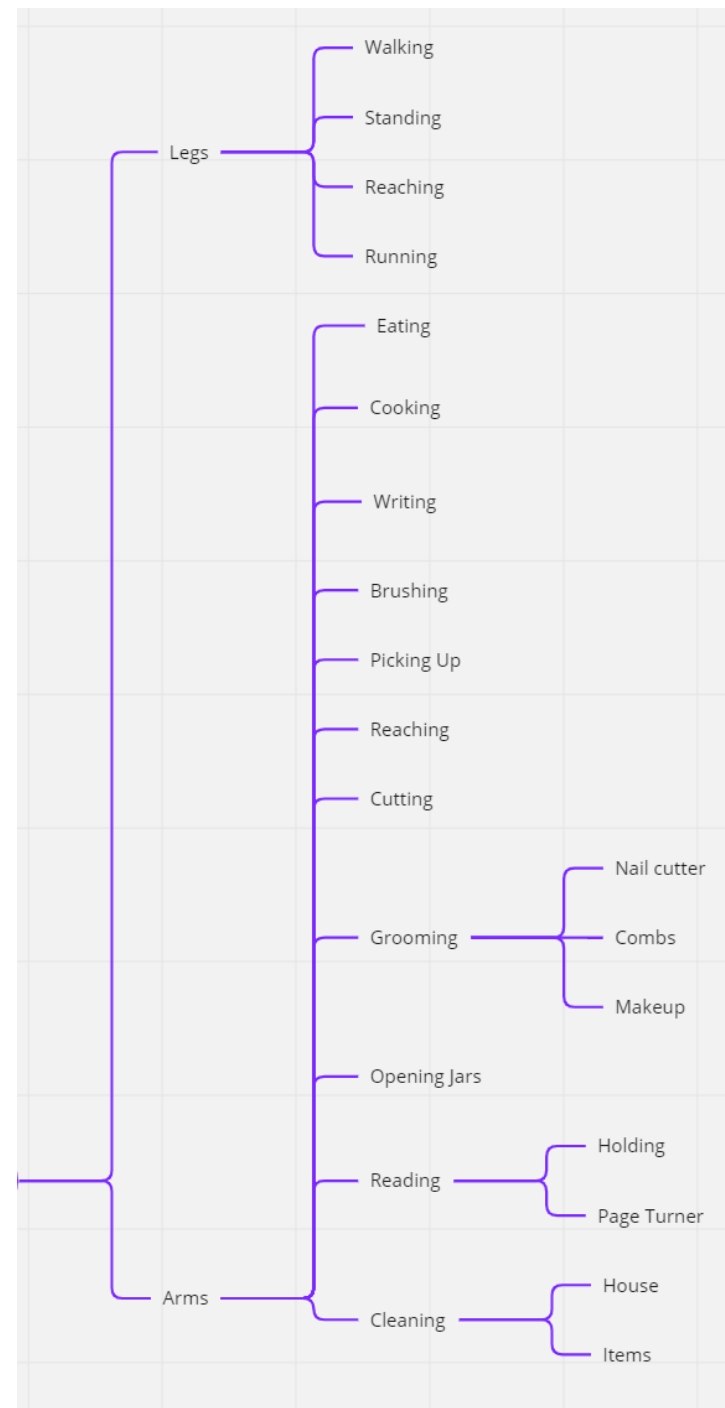
Mirror Media Group



Local Teen with Cerebral Palsy Walks the Runway at L.A Fashion Week

Actions

Among the more common everyday actions cooking and walking stand out as everyday actions that allow for more freedom and empower them



Walking/Posture aids

Walking encompasses self image like not having to be seen wearing visible crutches or having to use a wheelchair or a walking stick to get around

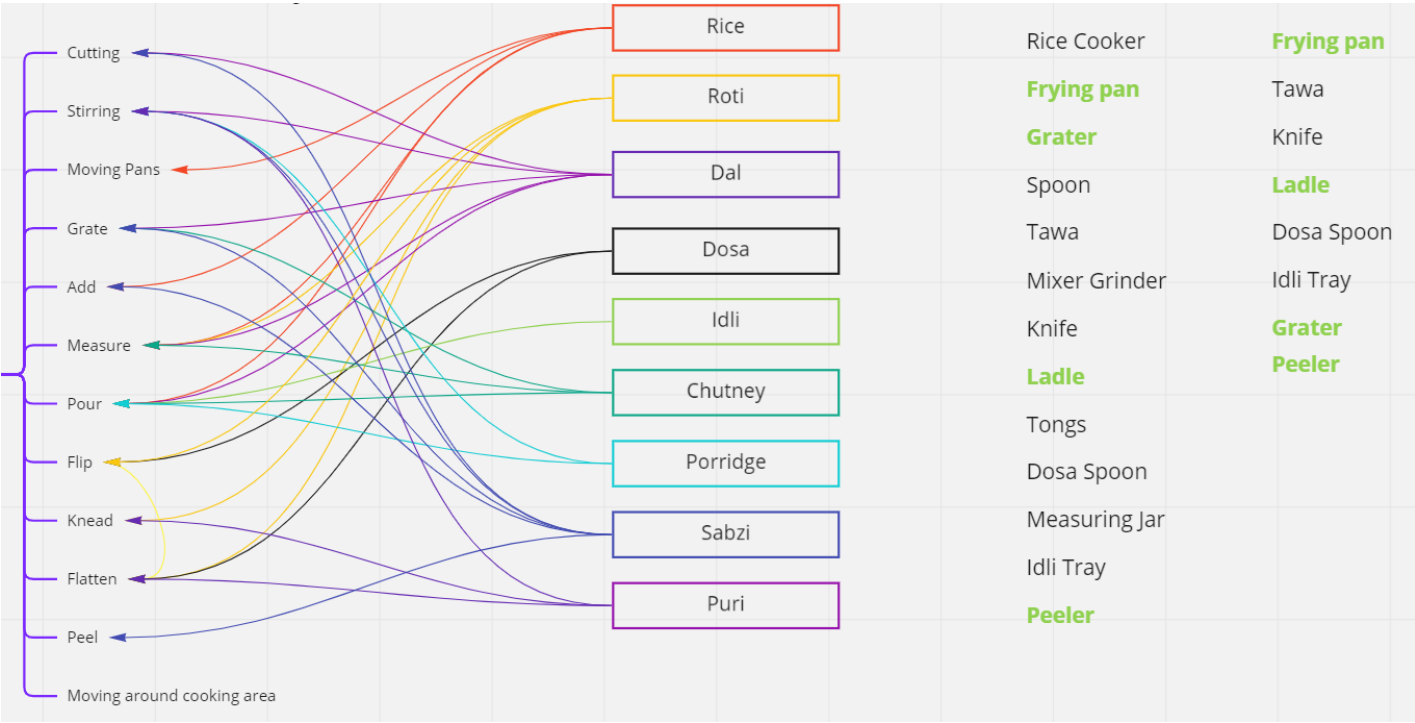
Multiple advances have been made in the field for discrete walking aids with braces available for very cheap



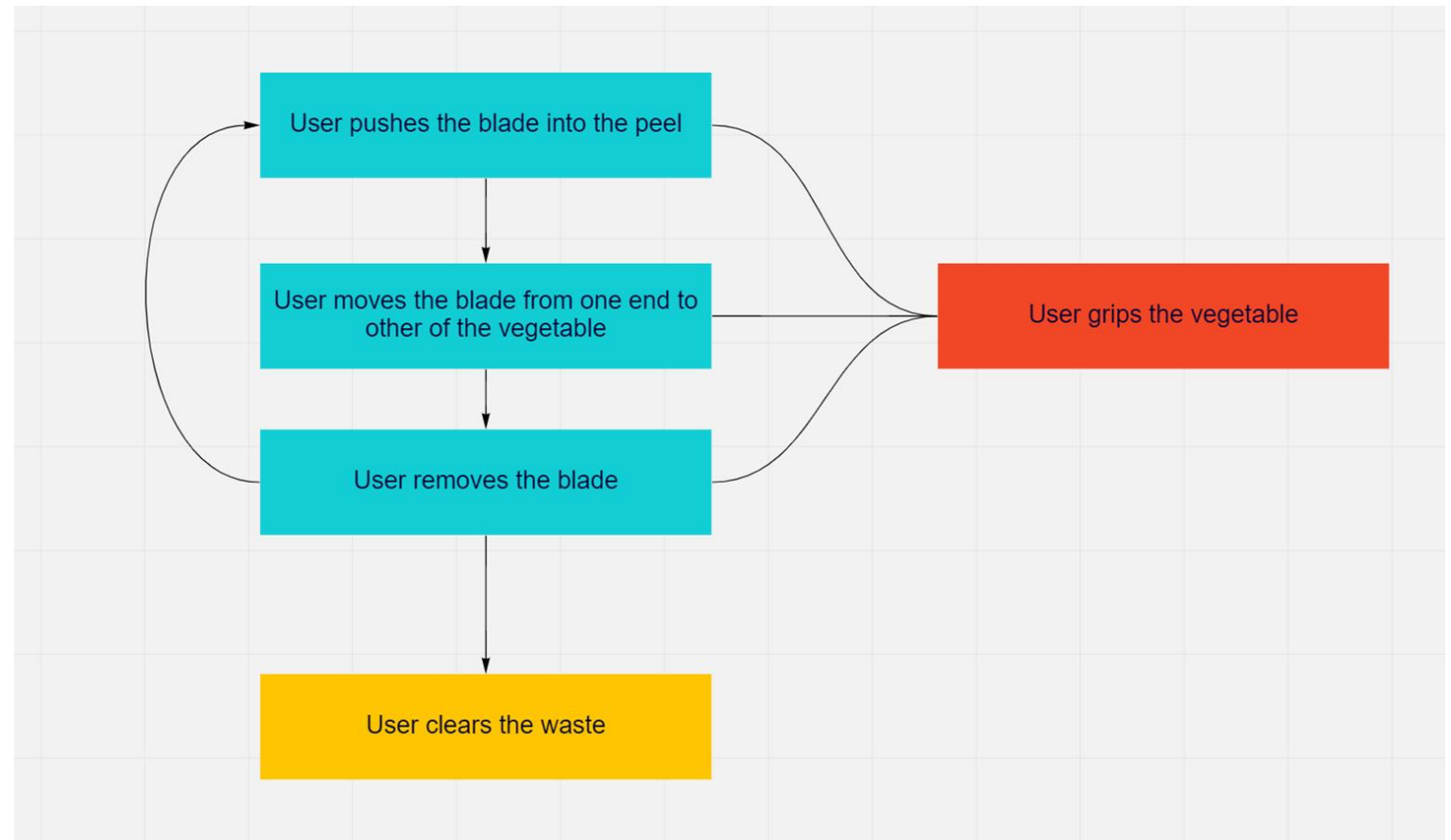
Cooking

Cooking is a more complex task encompassing multiple different actions and different devices

Peeling and grating were areas where there have been less to no developments and peeling was chosen due to it being a much more common action in Indian cuisine



The action



Products

Palm Peeler

8\$

Sits in the palm of the hand and fruit and vegetables can be peeled by running your hand over them. The single finger loop helps the peeler to stay in place.

The tip of the palm peeler has a stainless steel loop eyer for removing blemishes from vegetables.

The peeler is made from plastic with a stainless steel blade. The blade cover protects fingers and keeps the blade sharper for longer.



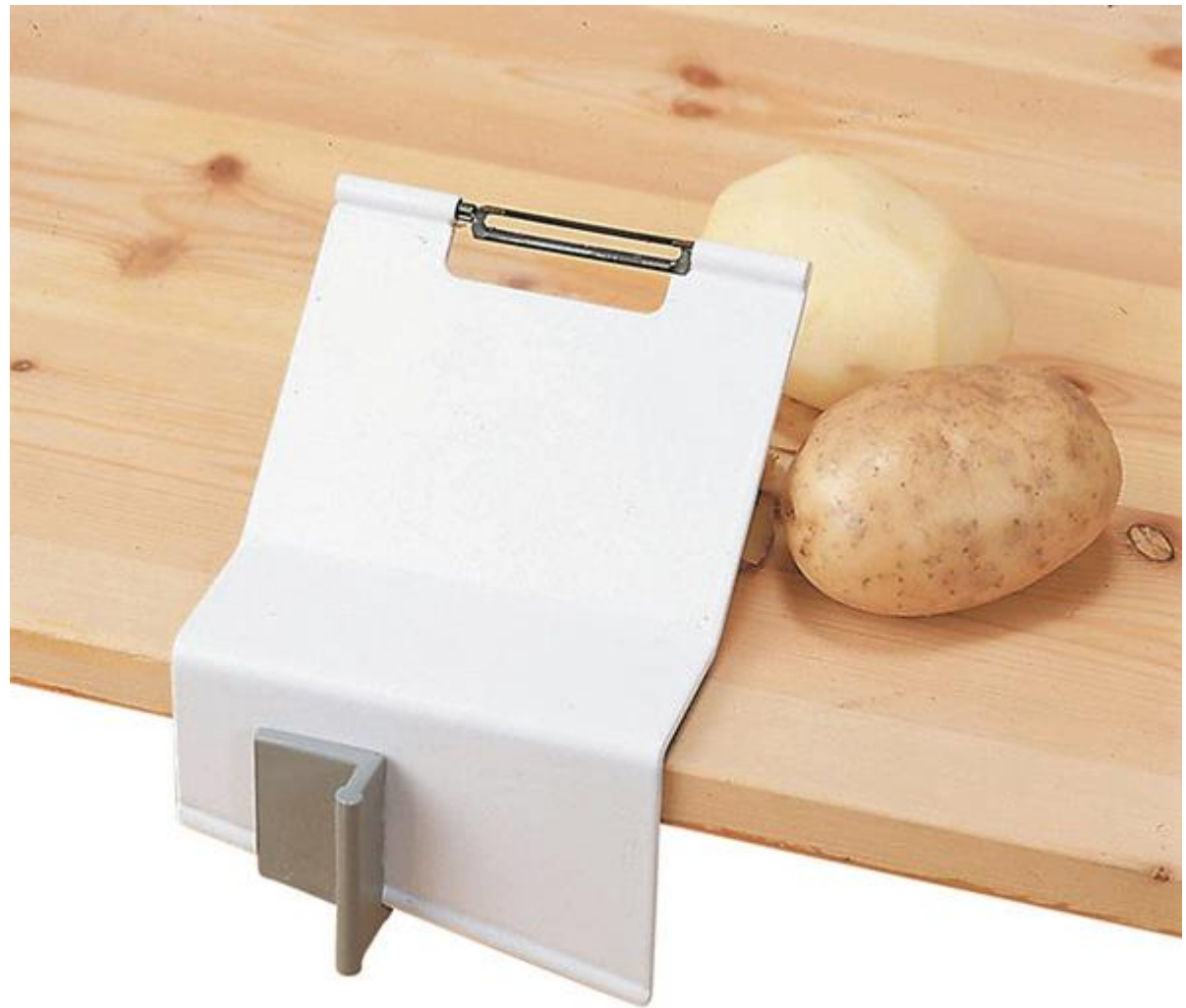
Homecraft peeler and clamp

40\$

Clamp removes the need for using one hand for support

Can be clamped onto a table or any flat surface

Inclined away from the user for safety and to ensure the waste falls on the surface



User review

Tiredness

Users are able to do the peeling action normally but tire easily due to the grip and are unable to peel enough quantity

Grip

Gripping uses a lot of energy and the current grip causes the user to tire, the direction of the blade is determined by the user and due to the lack of angular movement makes them peel in smaller patches

Pressing the blade in

Breaking the skin of the items to be peeled needs application of pressure on an angle and is hard

Gripping the item and the blade

Impaired coordination between the arms makes it harder to move the blade

Cleaning up

Cleaning the area of waste after is harder and needs other equipment

Testing

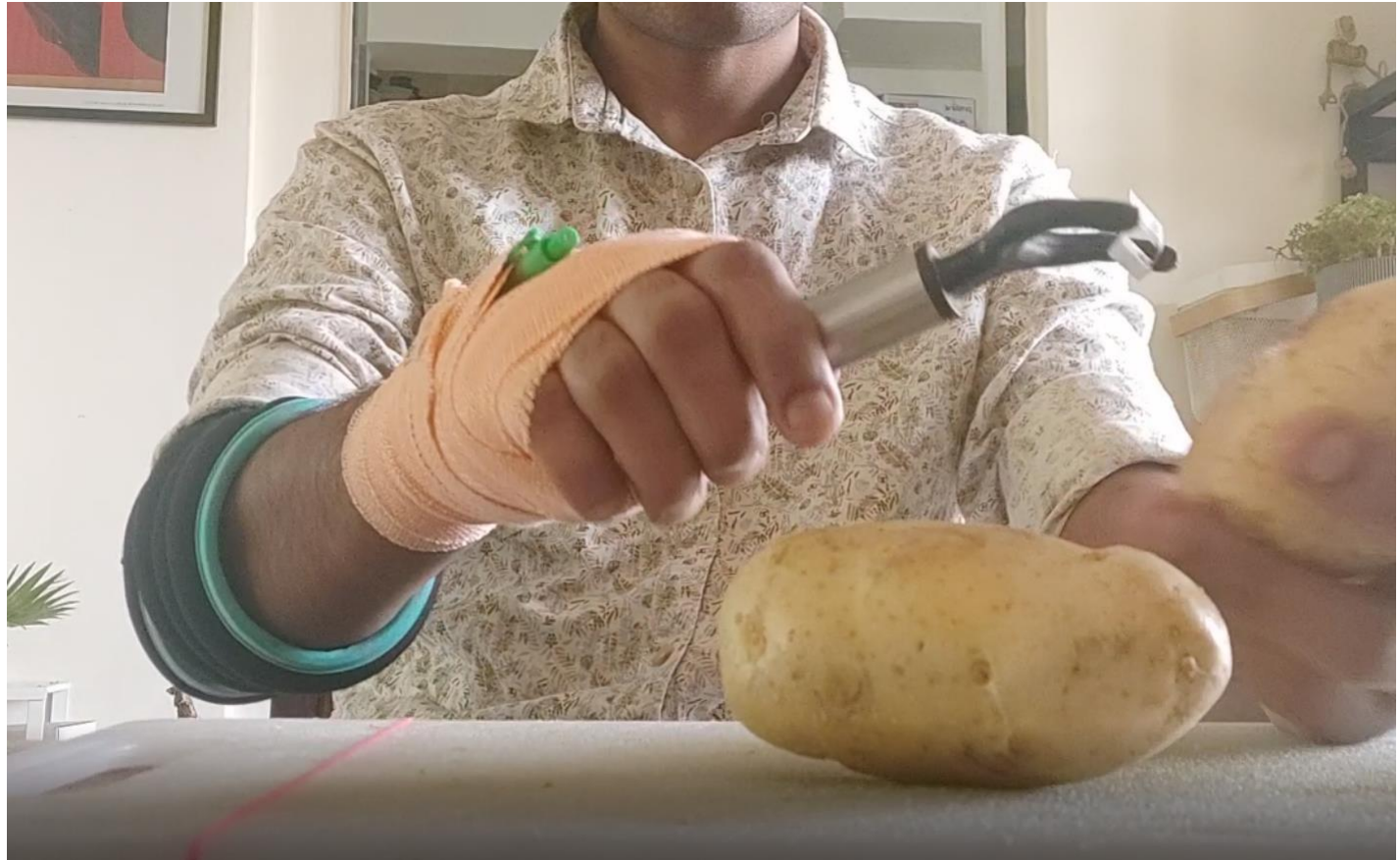
Test was done on self to try and understand the situation first hand and gain more empathy on the situation

Finger mobility was restricted using crepe bandages and weights were attached to the elbows to limit mobility and simulate weakness

Peeling in repeated strokes was easy at first but gets tiring very quickly

Getting both hands close to each other is hard

Grip is not bad while peeling but the peeler slips out often when there is nothing holding it from the other side



Design Brief

Objective:

To Design a device to facilitate independent peeling and cutting (of fruits and vegetables) for those with restricted mobility in their upper limbs.

Target Audience:

People with restricted Mobility in Arms - Any disease

People living alone or want to provide for themselves

Additional:

Different products - Cucumber, Garlic, Potato

The device can be used to supplement other similar actions

Aspects:

The device will be safe to use with no risk of the user cutting themselves

The device will separate the waste from the useful items automatically

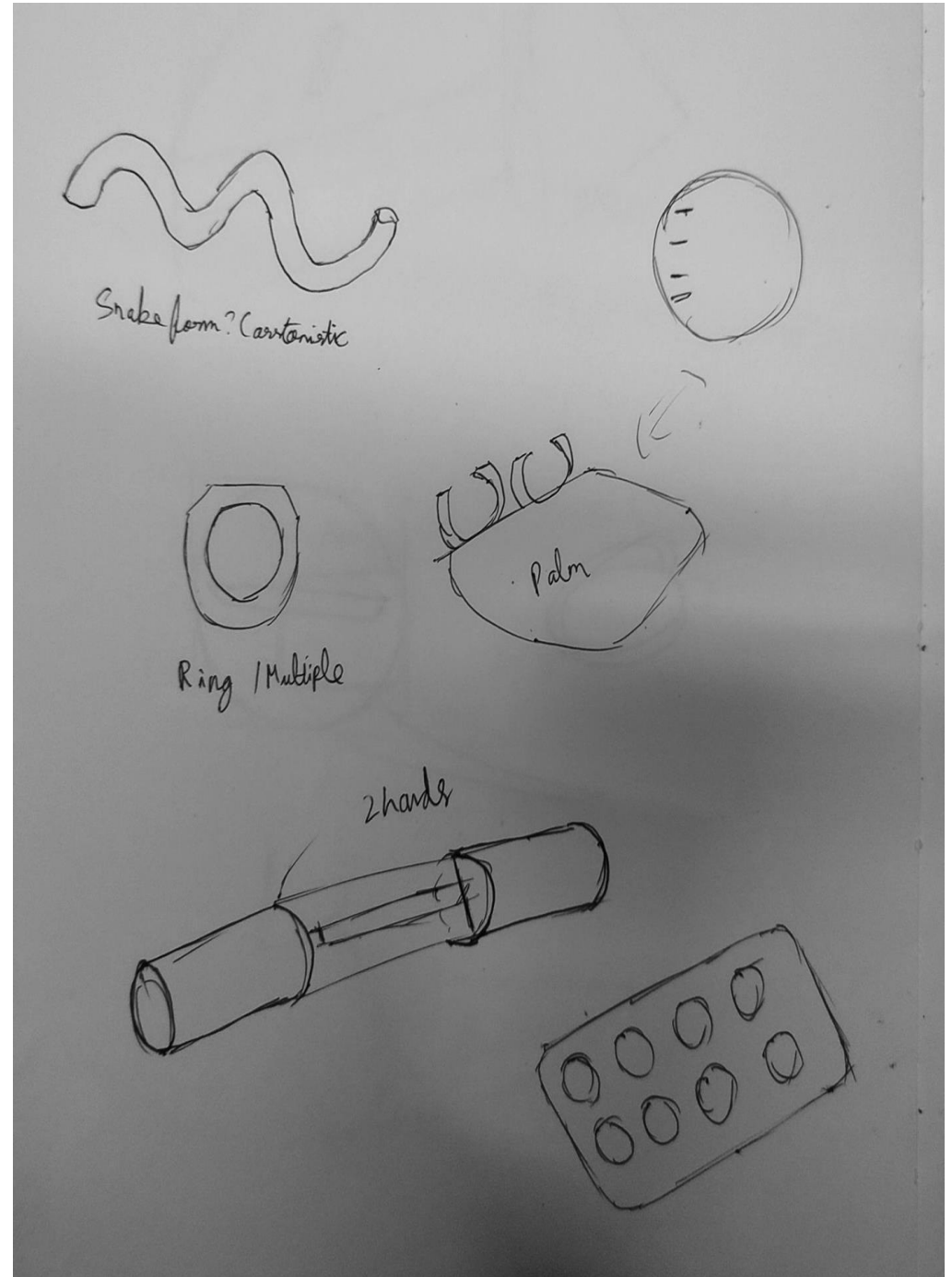
The device will be stable on it's own

The device will be easy to hold or grip

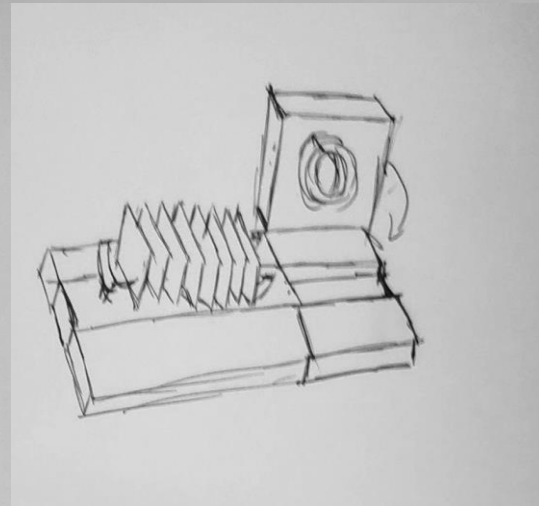
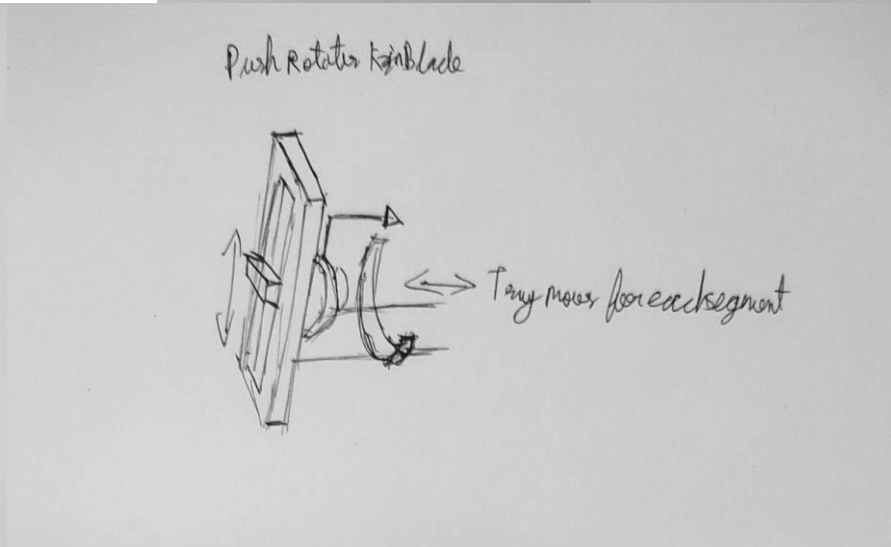
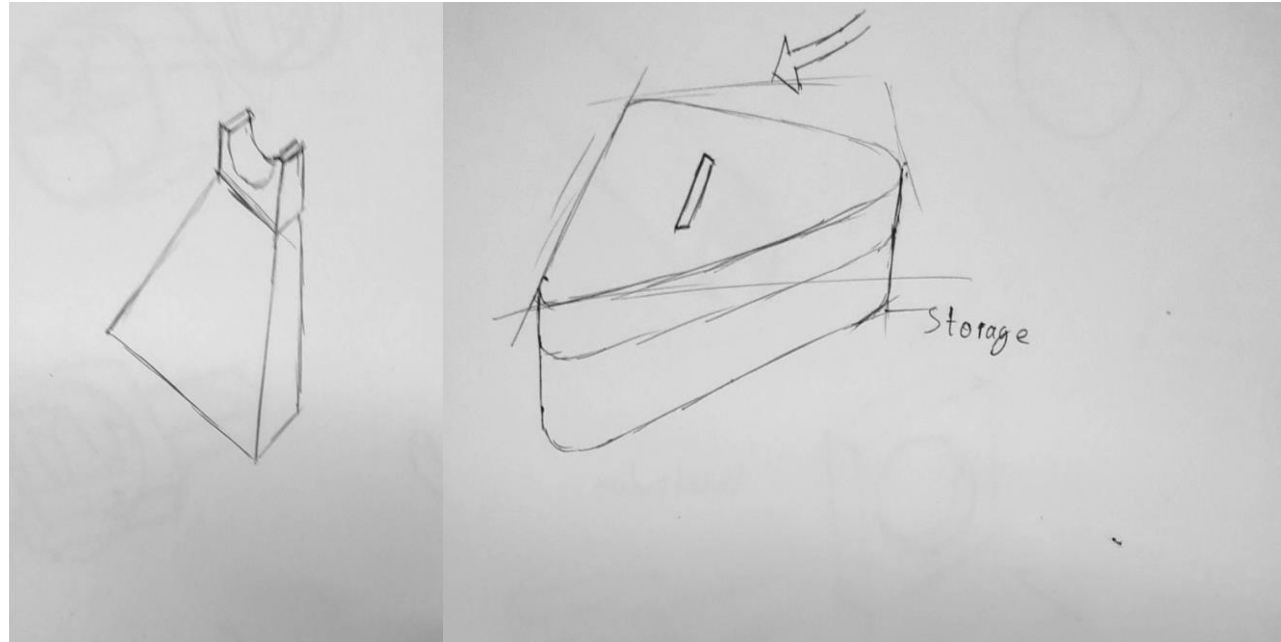
Ideations

Ideations - Directions

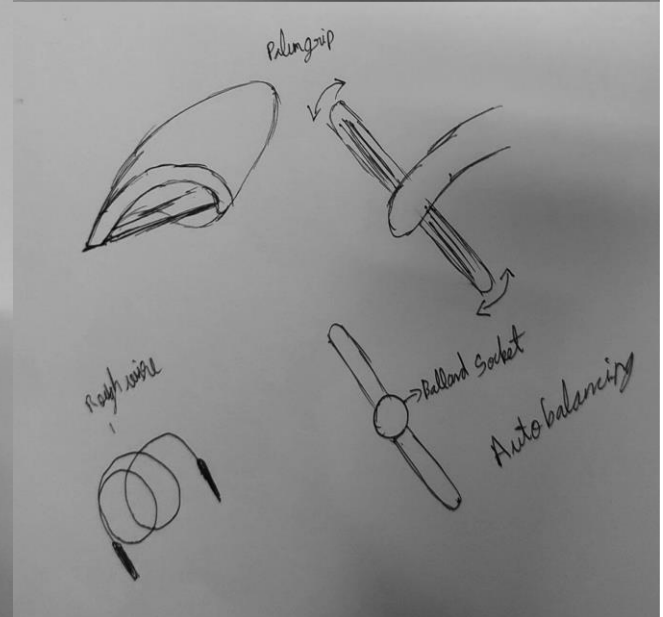
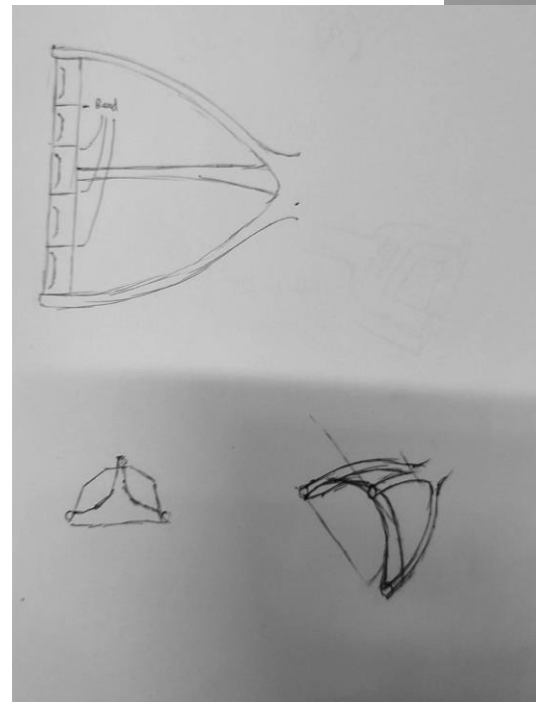
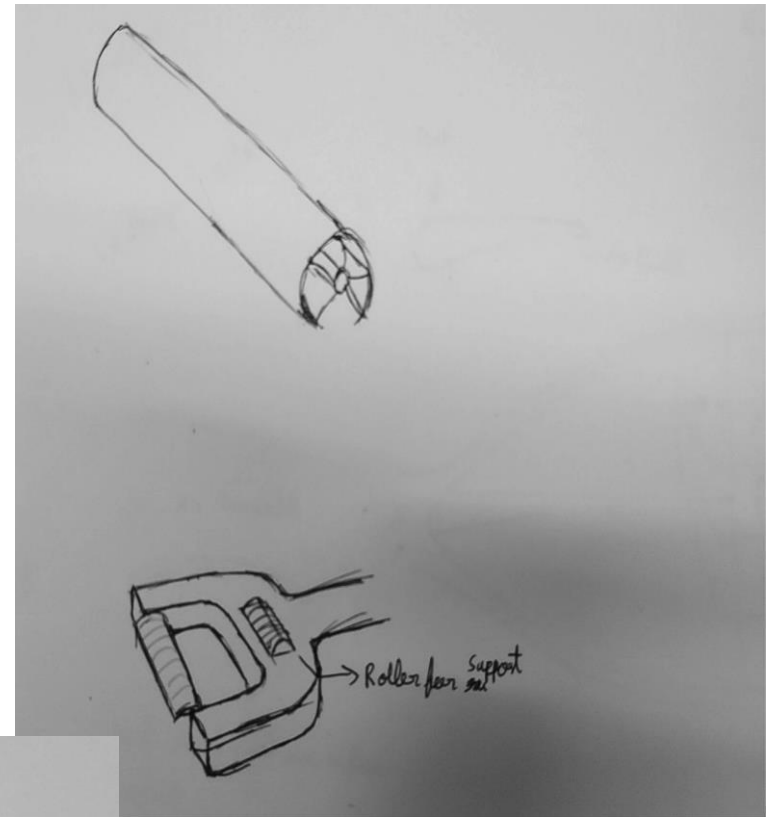
Grips



Supported at base



Modified Blades





Different textures

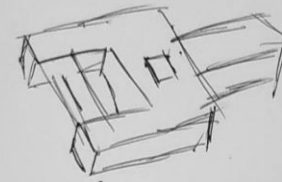
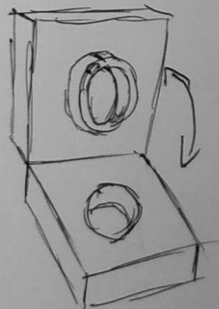


Wires

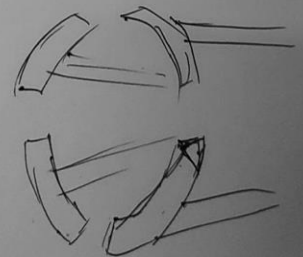
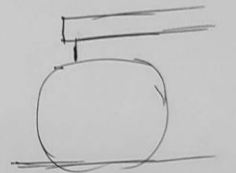


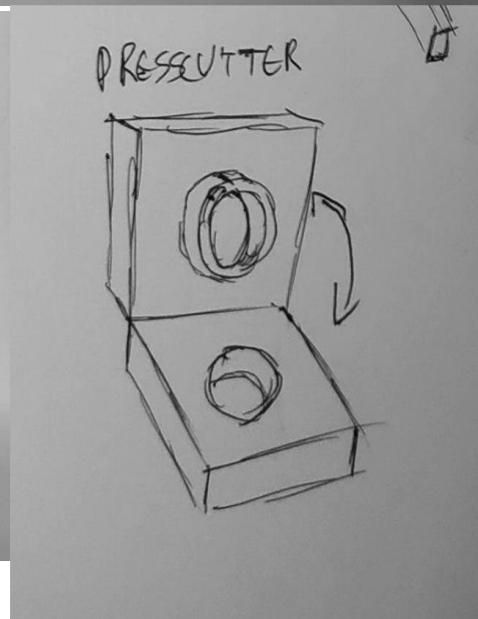
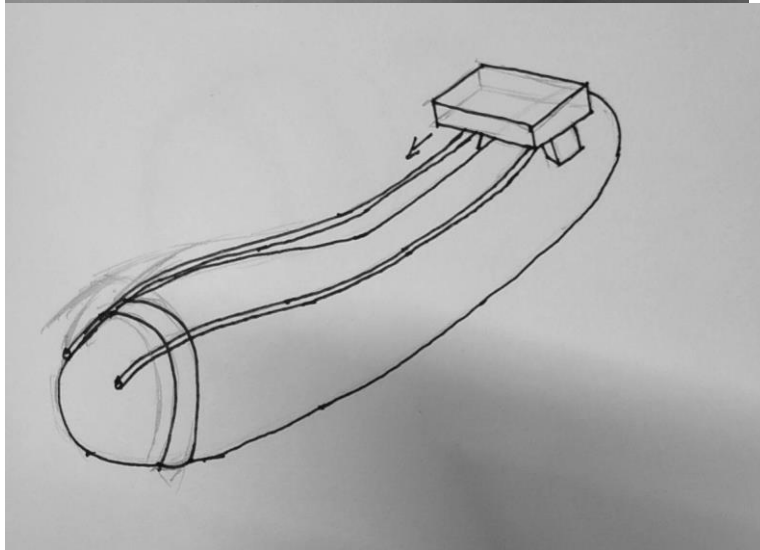
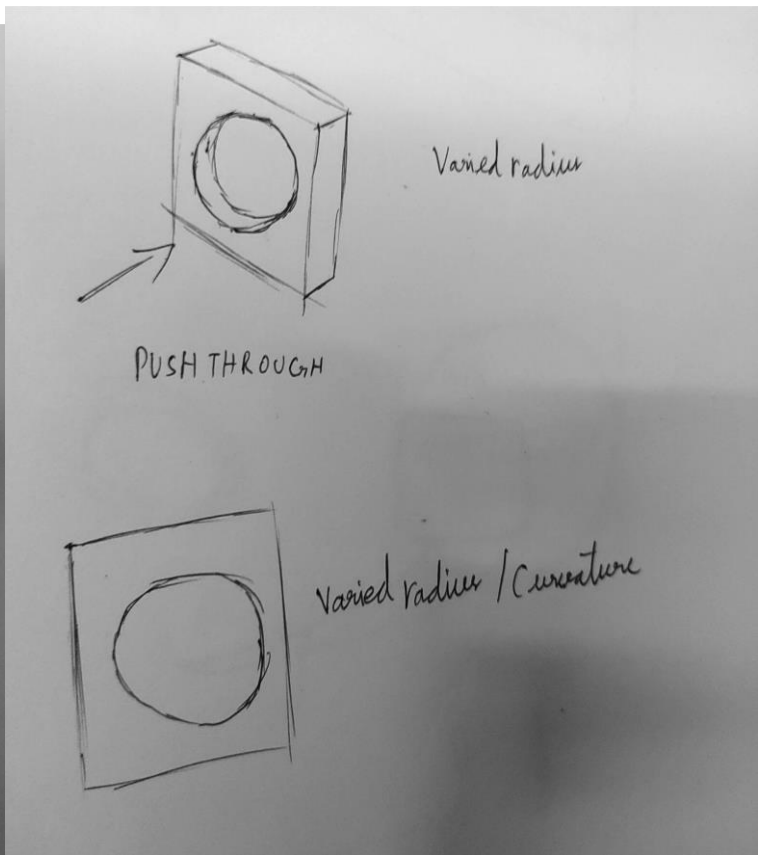
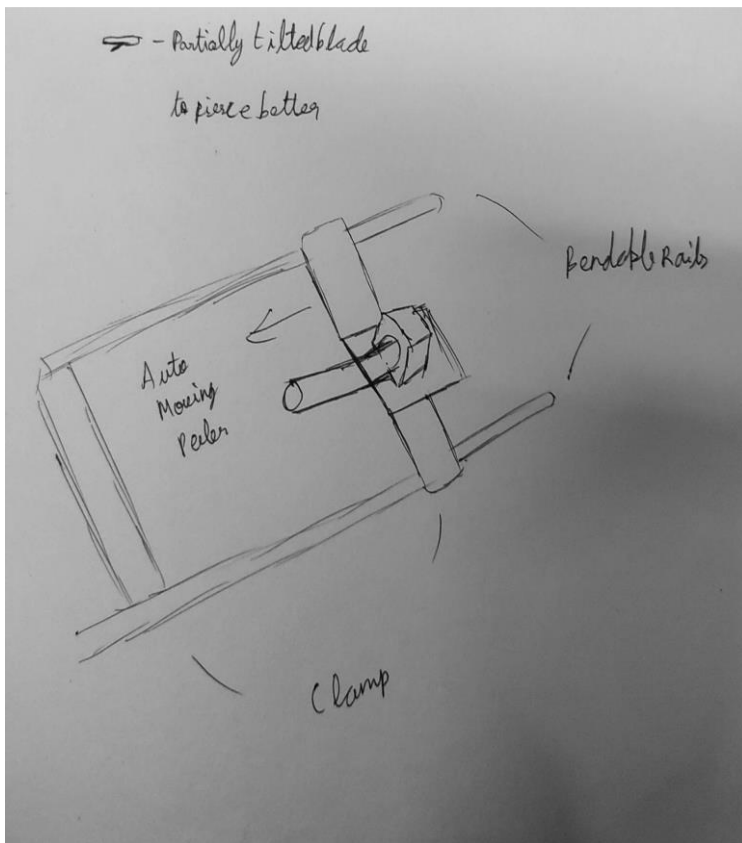
Scooper -> Potato

PRESSUTTER



→ Pull



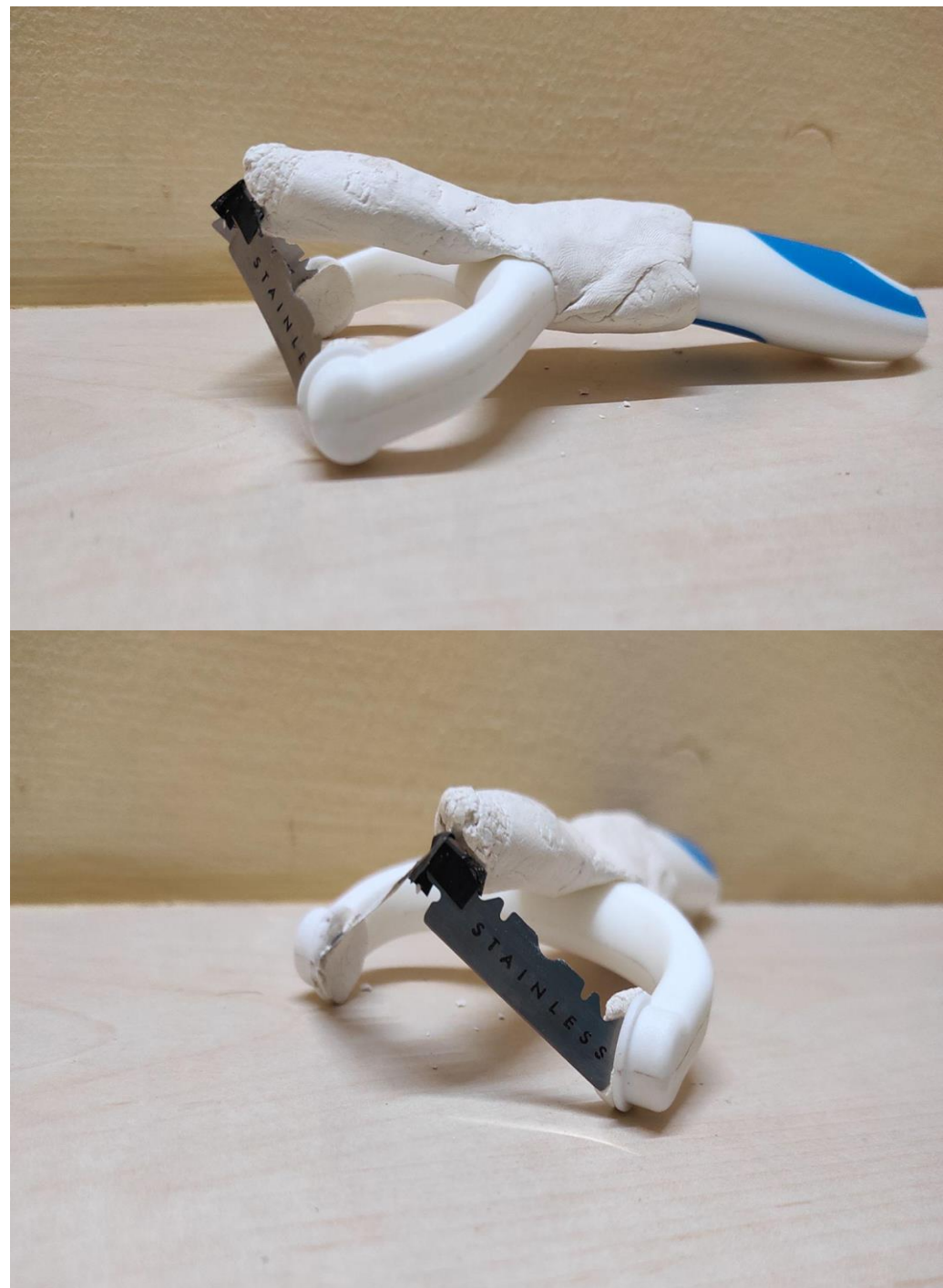


Multiple Blades

Multiple blades would increase the surface area peeled every pull

But

Having 2 blades did not mean more surface area of contact every time due to the difference in sizes of the items to be peeled and multiple blades mean the same area could be peeled more than once resulting in more wastage

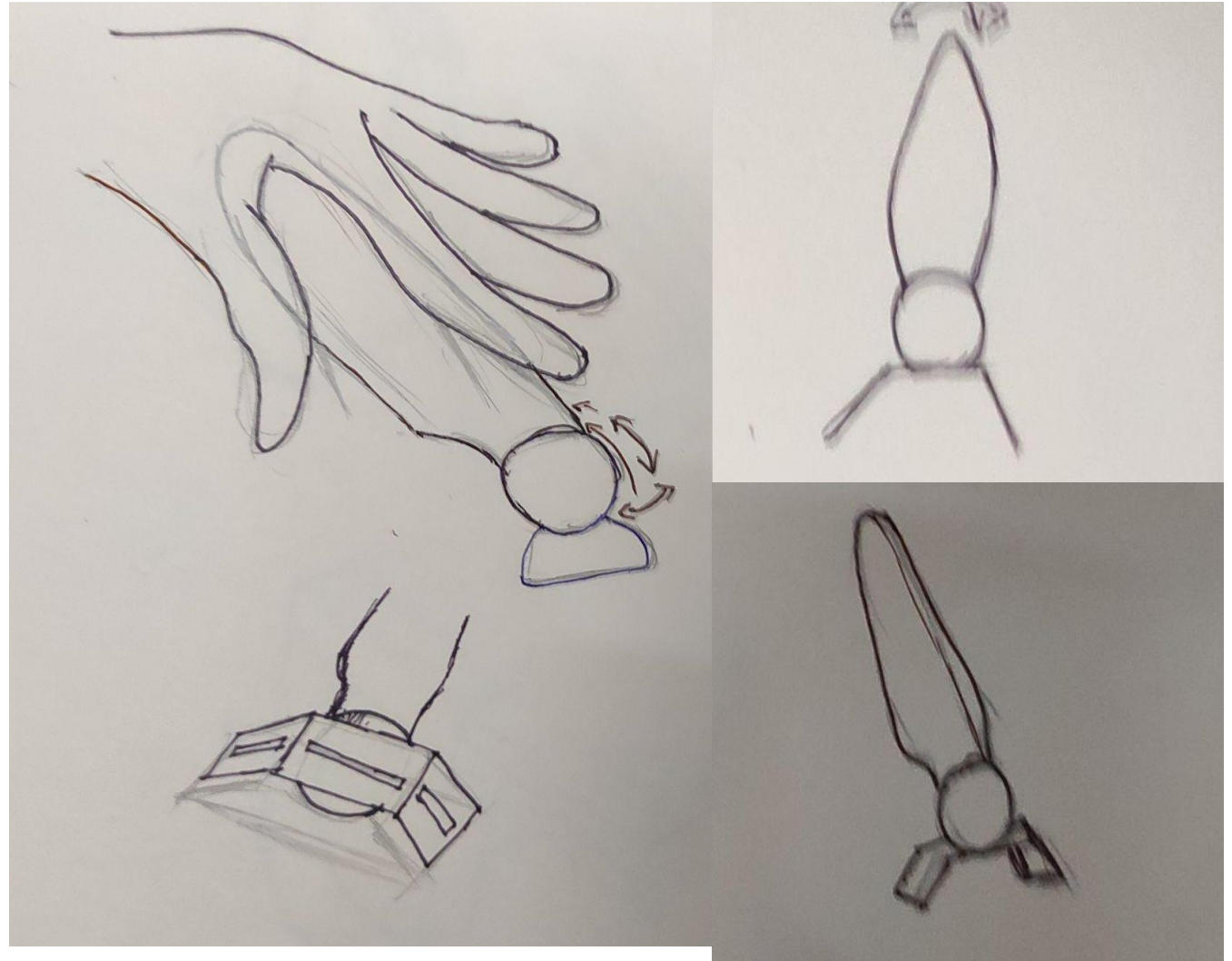


Concepts

Concept 1

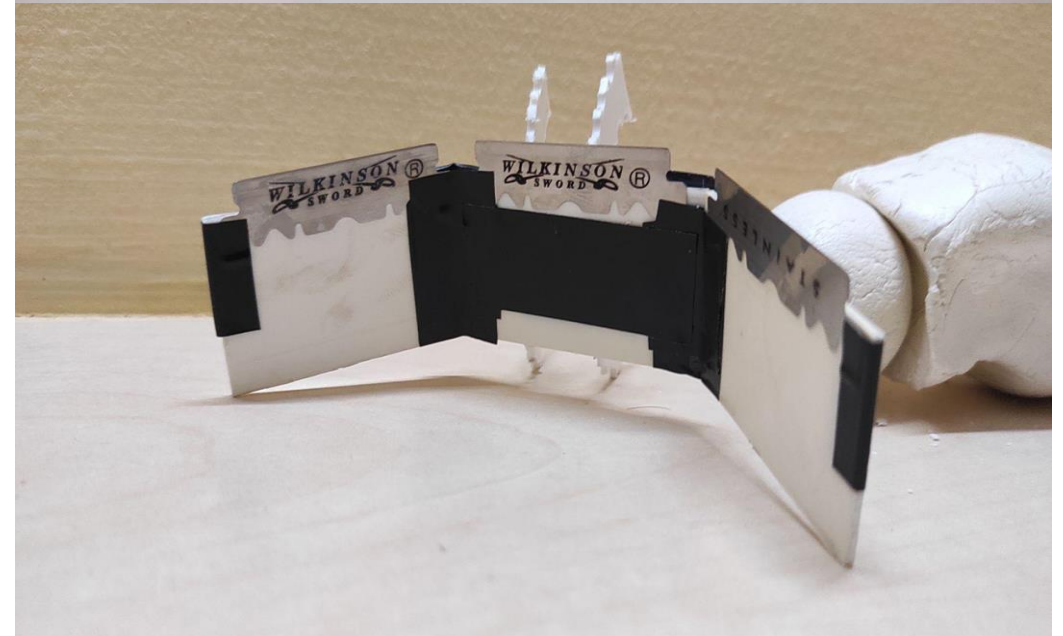
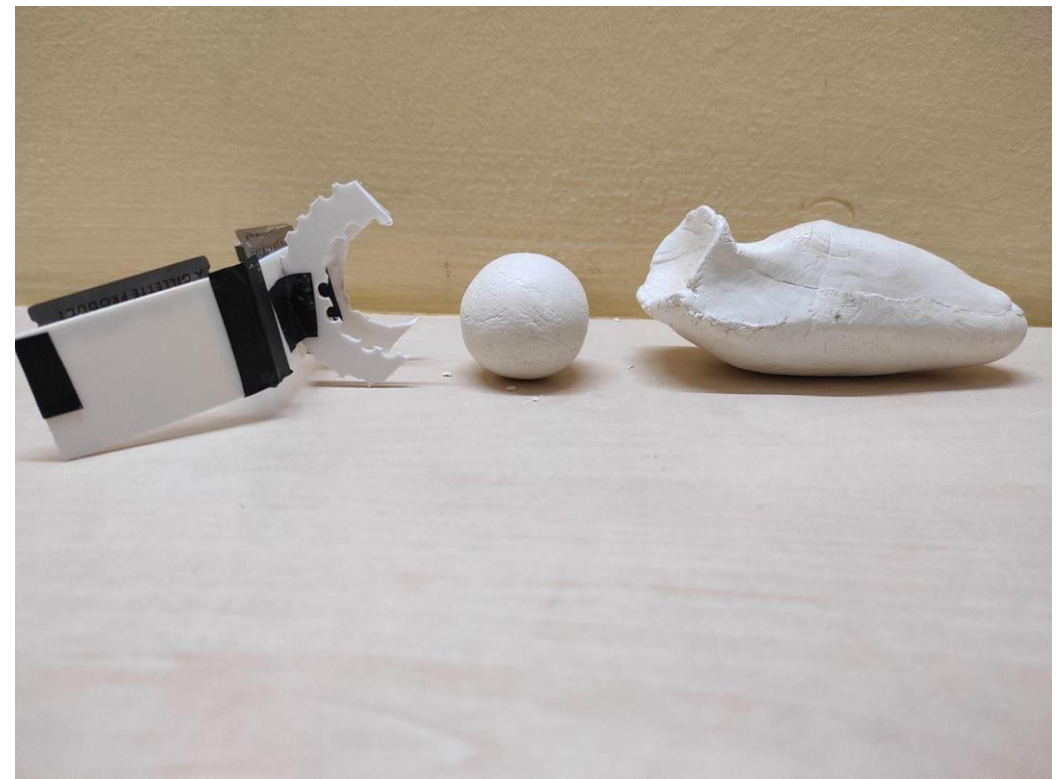
Palm can be used to hold on to items

Blade is in one position and grip can move to support ever position



The handle moves with the hand's motion while the blade is kept at level and in position

The arch shape helps keep the blade in position even when multiple blades aren't being used



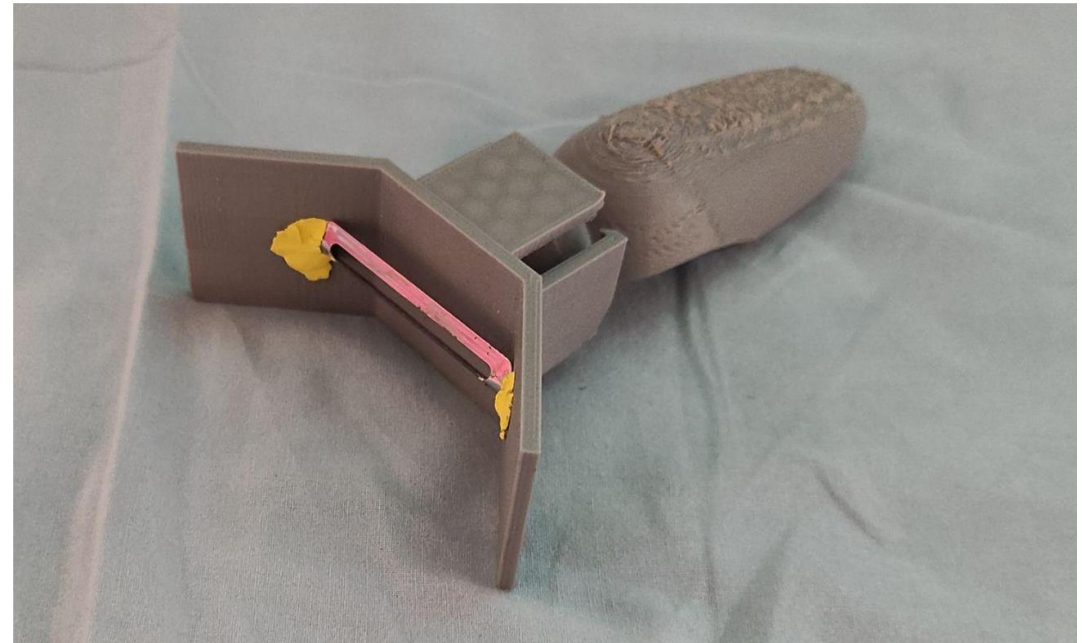
Review

The narrow gap between the blade and the surface would hold on to the peels and the user could remove them easily

But

The straight surface meant that the peeler cut through straight every time and would cut out more of the core of the item being peeled

It would also struggle to go through abnormalities on the surface (like eyes on a potato or projections on a cucumber)

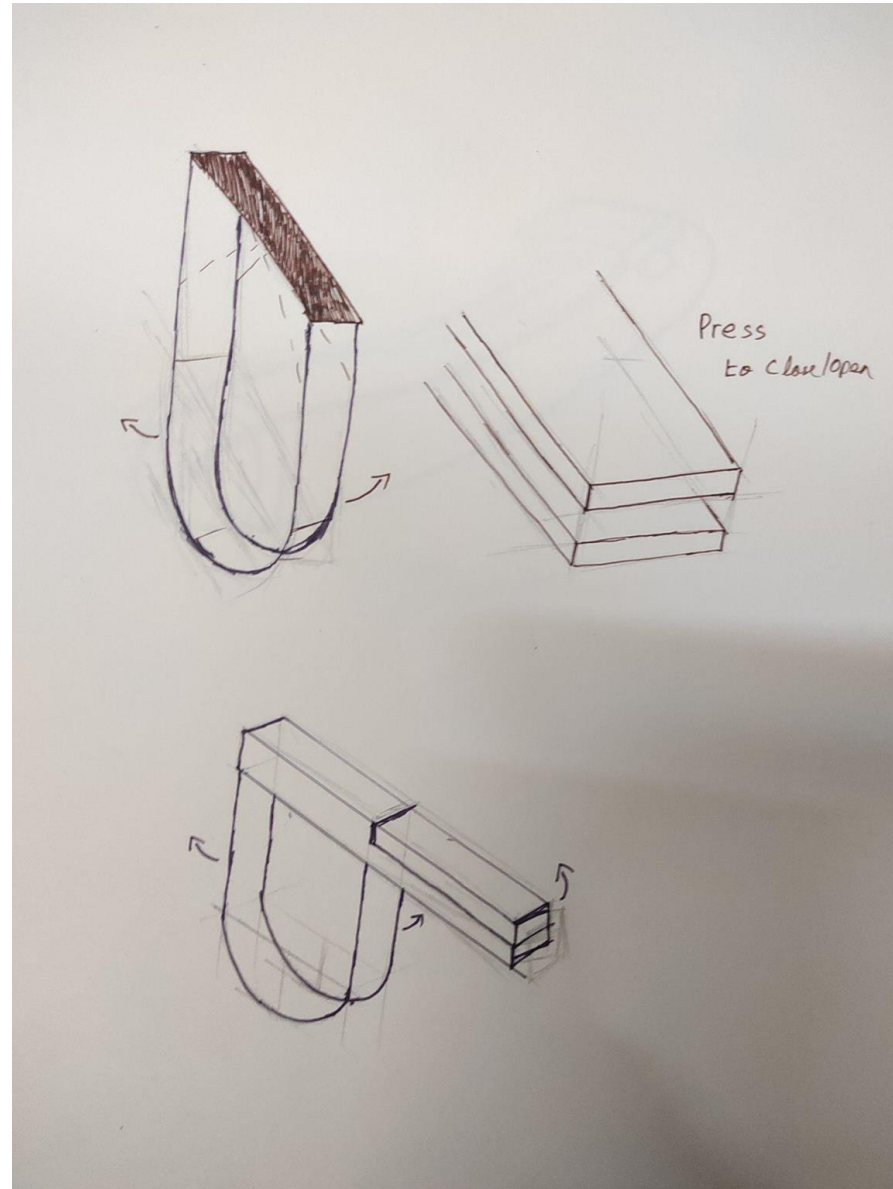


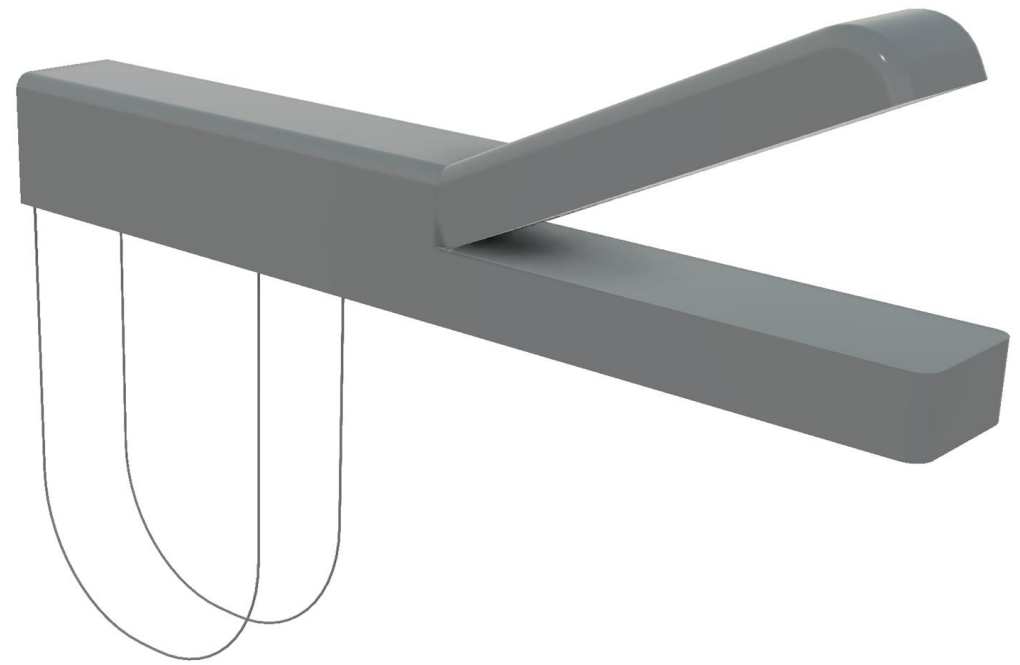
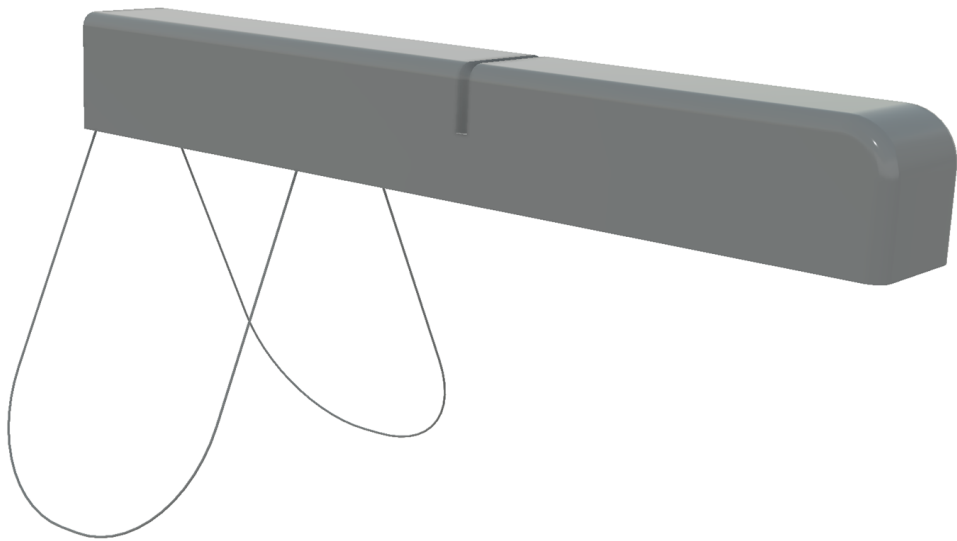
Concept 2

Similar to a kiwi scooper

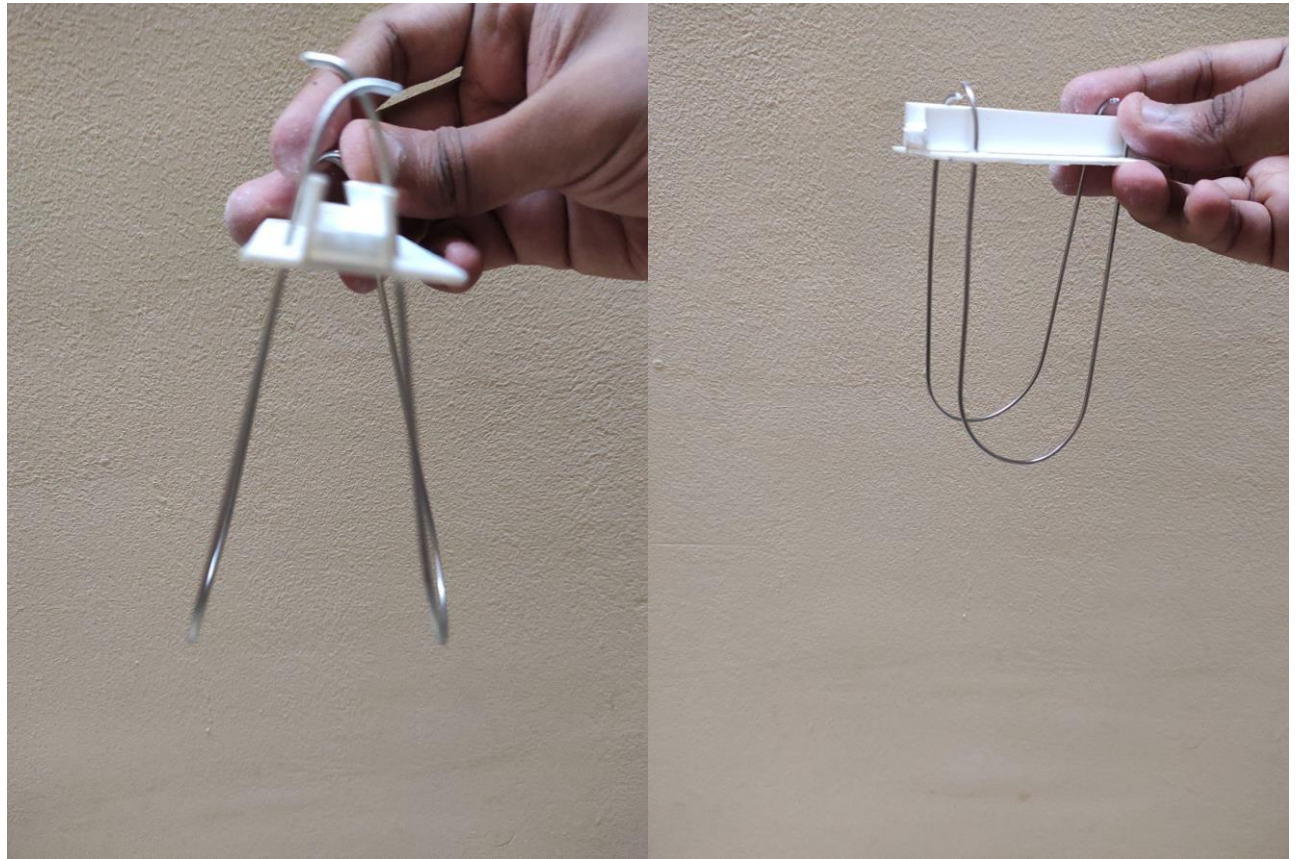
Inserted while open and scoops out the core with the flip of a button

Works with potatoes only





The peeler was tested with different wires from thick to thin but it was unable to scoop out uncooked potatoes without a sharp wire to cut through and was removed from comparison

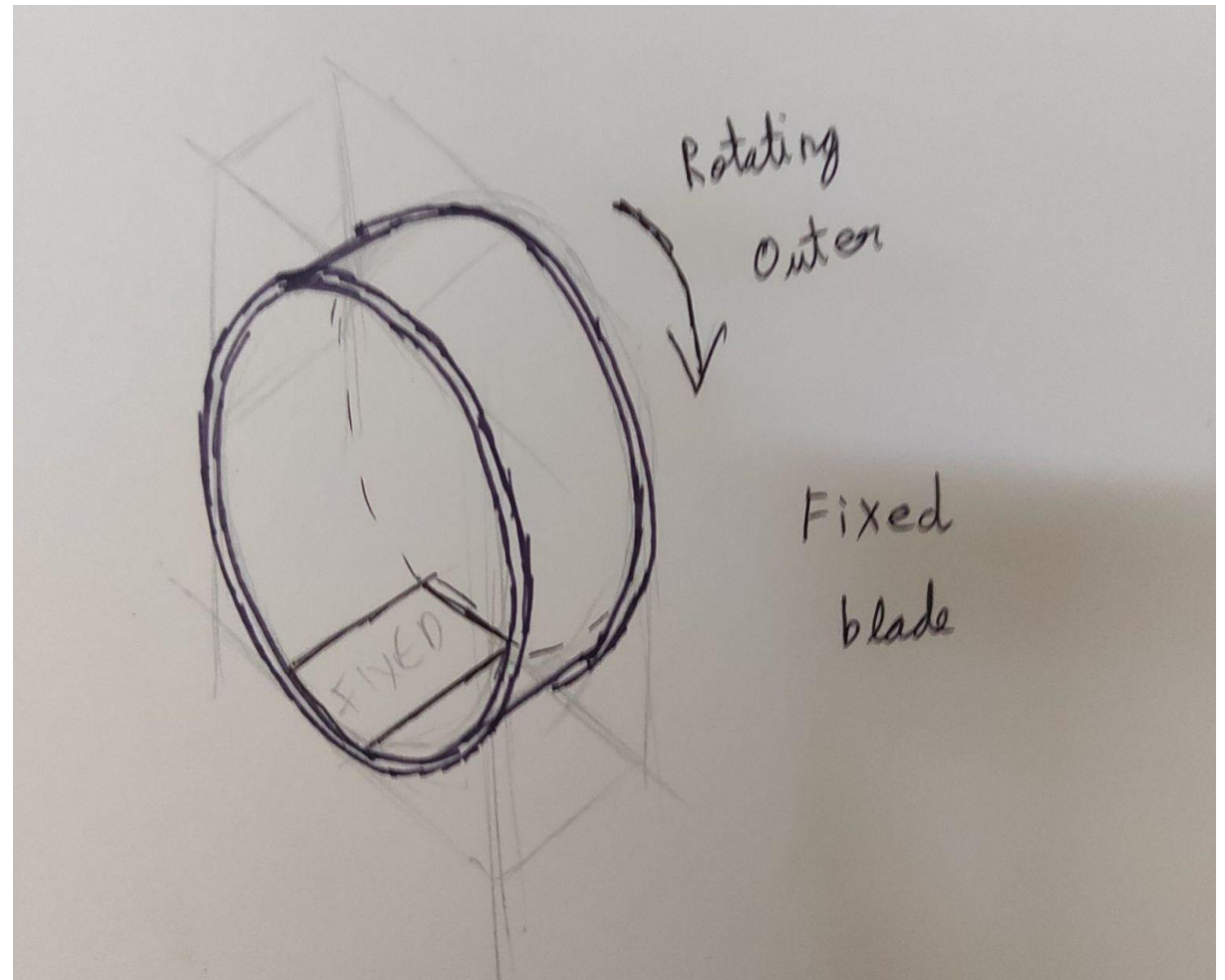


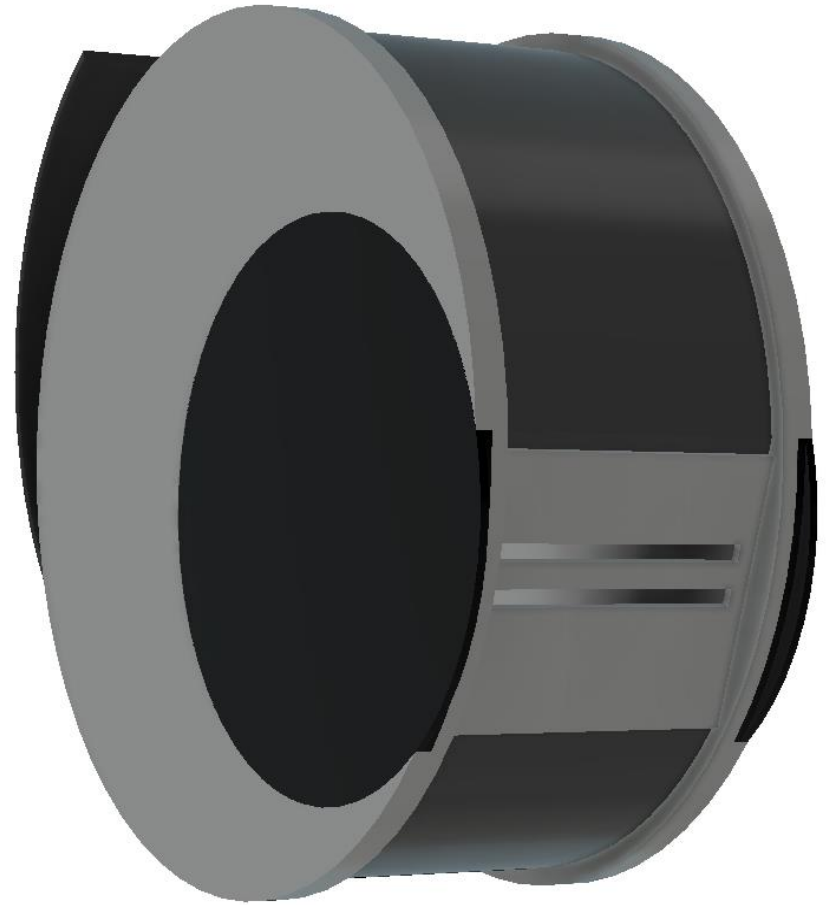
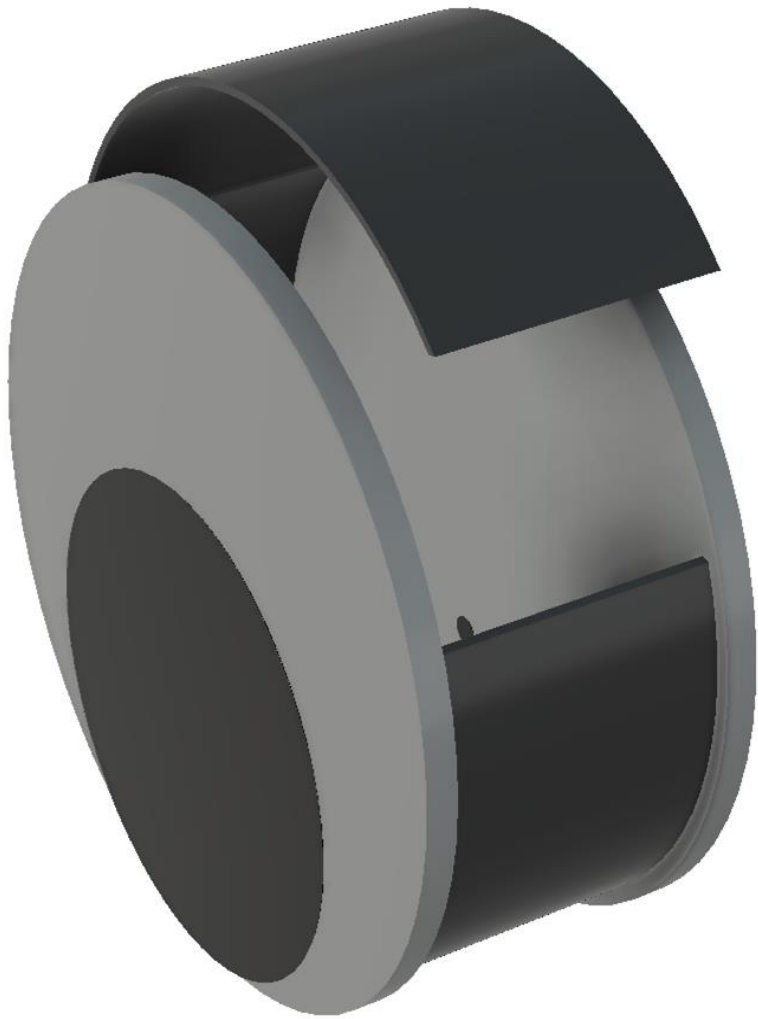
Concept 3

Rotational movement assists while peeling

Waste is auto collected in the space above the blade and can be emptied later

Very safe due to blade position



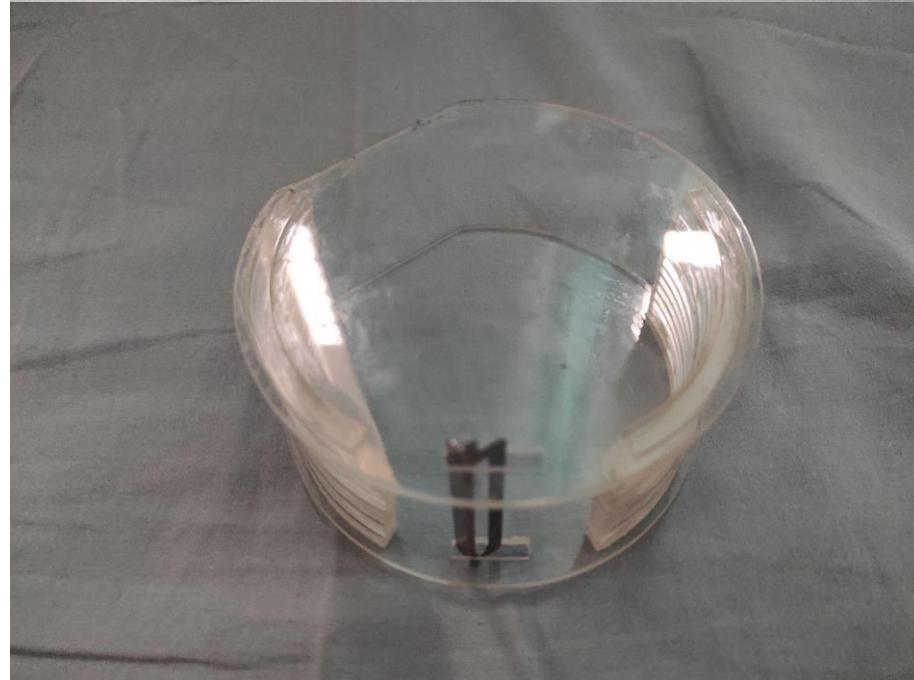
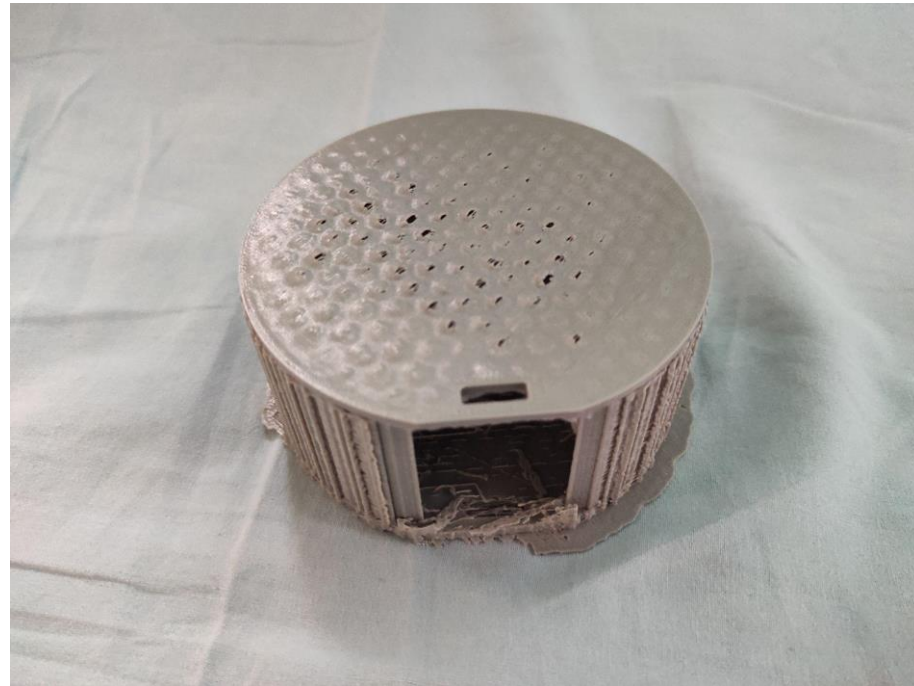


Review

Initial mockup was tested with the users and received 2 key points

- The users were unable to deduce how to move the peeler since they were unable to see the blade
- It would be nice if it could be placed on a surface instead of having to be held all the time

The transparency helped the users to see if they were to move the blade through an ascending curve or a descending curve and to see what kind of abnormalities were in the surface and move it accordingly, resulting in much more consistent peeling



Evaluation

	Speed	Tiredness	Grip	Versatility	Total
Concept 1	7	4	6	6	-17
Concept 3	6	9	9	8	-8

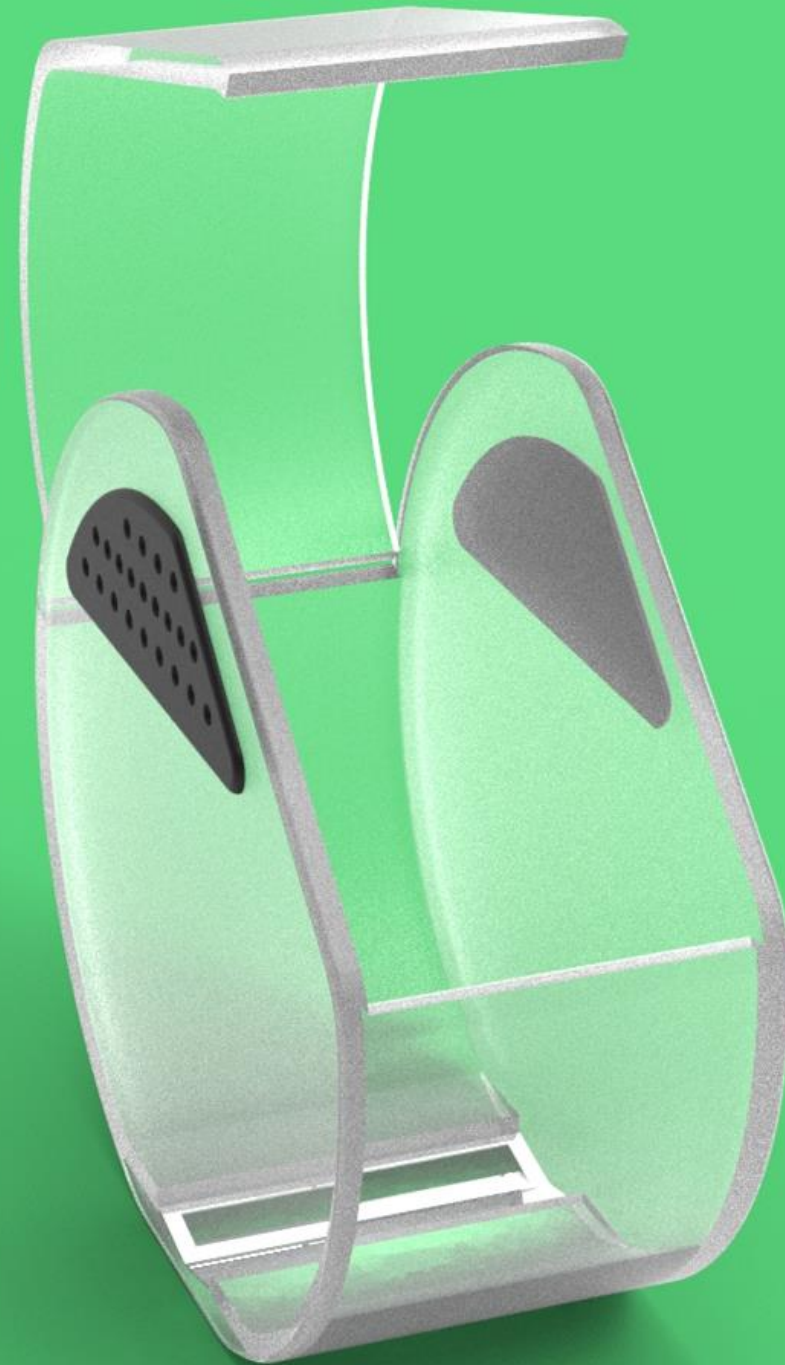
Concept 1 was faster to peel but fell short in every other category due to it mostly mimicking restricted movement itself, Concept 2 came out the clear favorite with it being much easier to hold and not having to carry it in the hand if the user is unable to

Final Concept

Lid

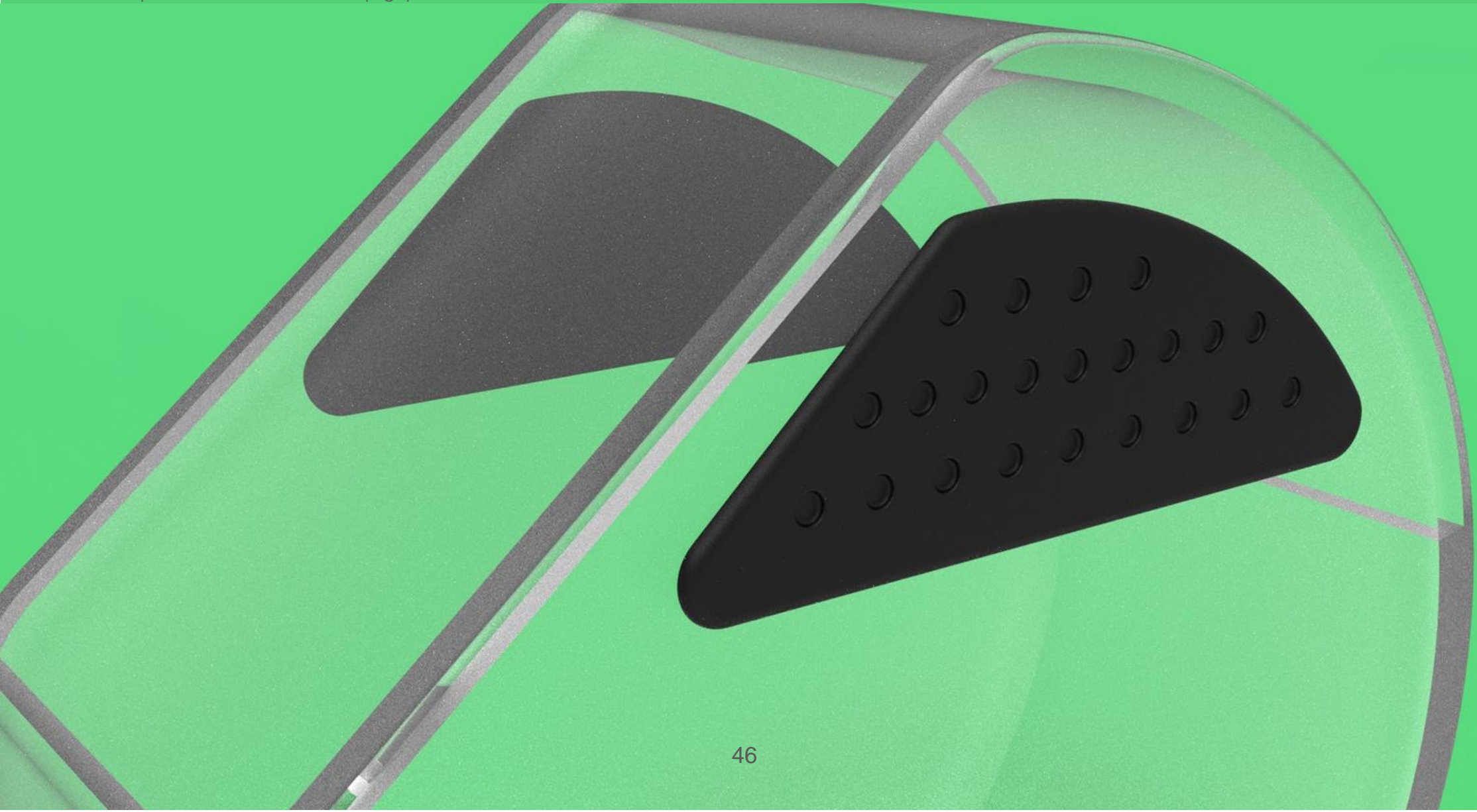
Flippable lid with a hinge attached by weak magnets will hold it place but can be opened without much force

Hinged lid removes any chance of the lid being placed in a wrong position

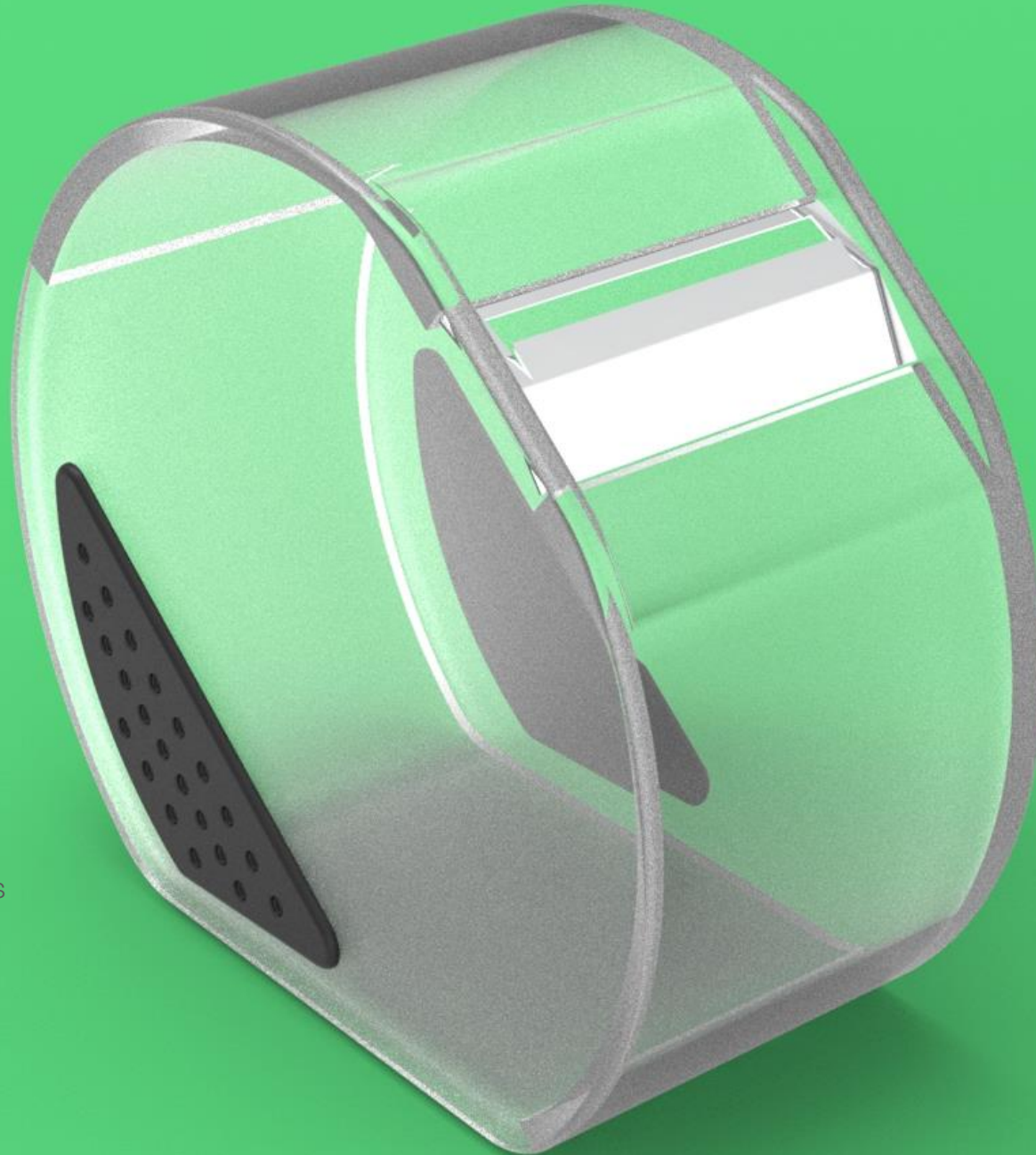


Grip

Rubber pads on each side to help grip



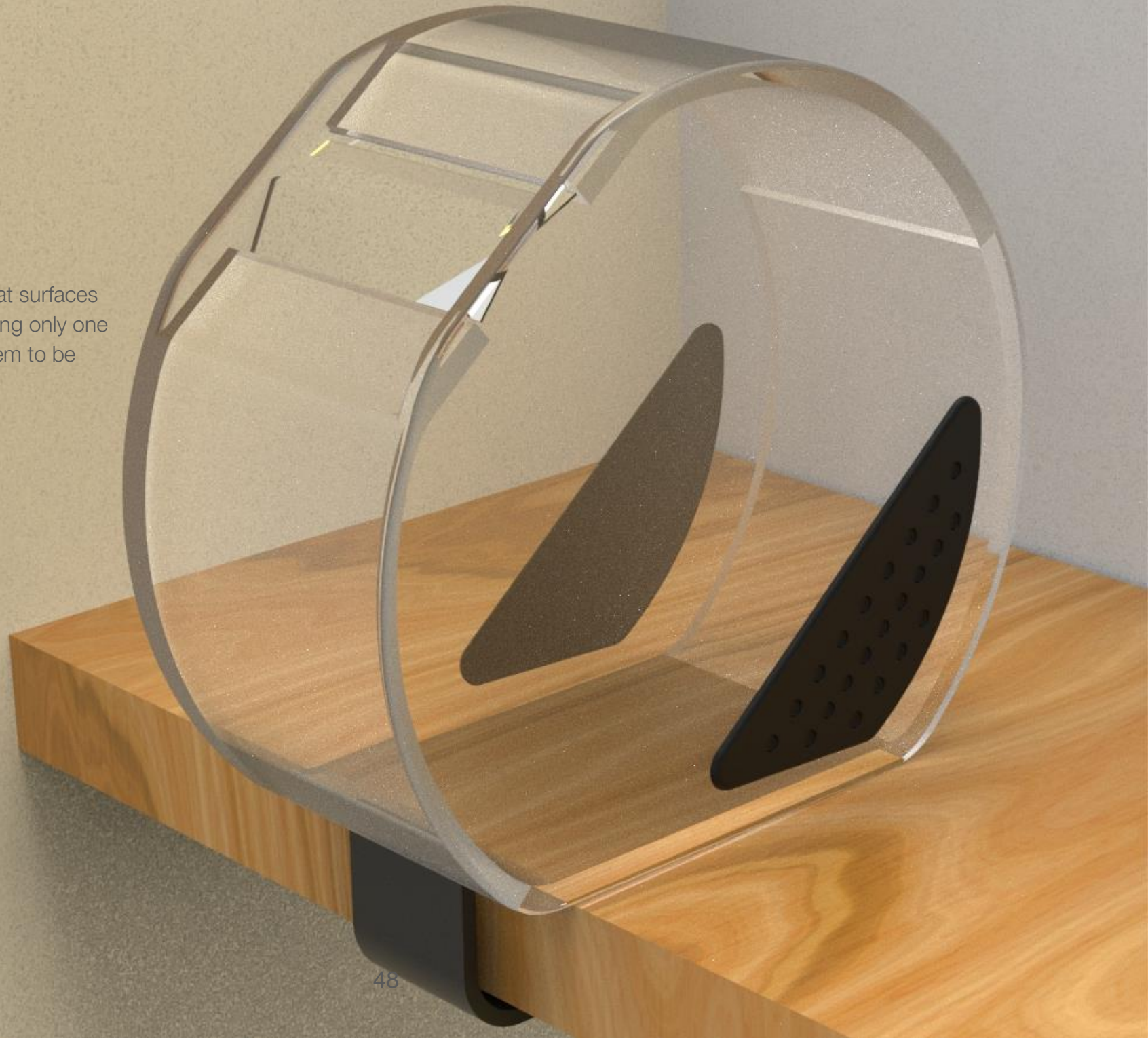
Waste storage



Waste gets stored in the body itself and has
~250 mL of space

Clamp

Clamp helps with attachment to flat surfaces so that the user can peel while using only one hand or both hands holding the item to be peeled



Anthropometry

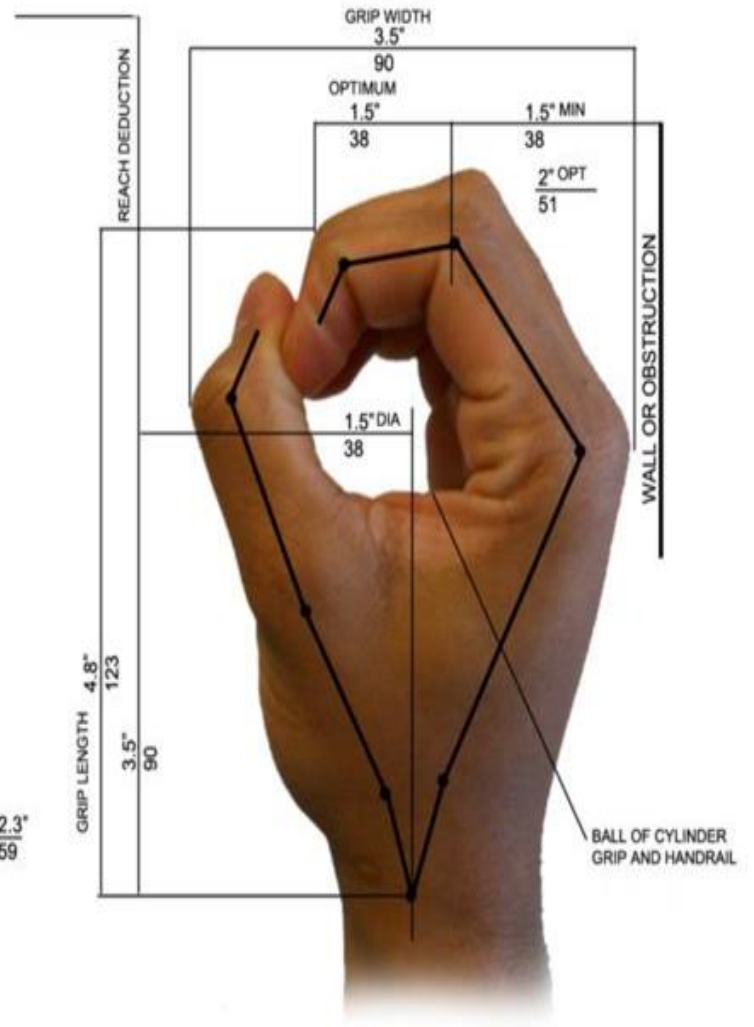
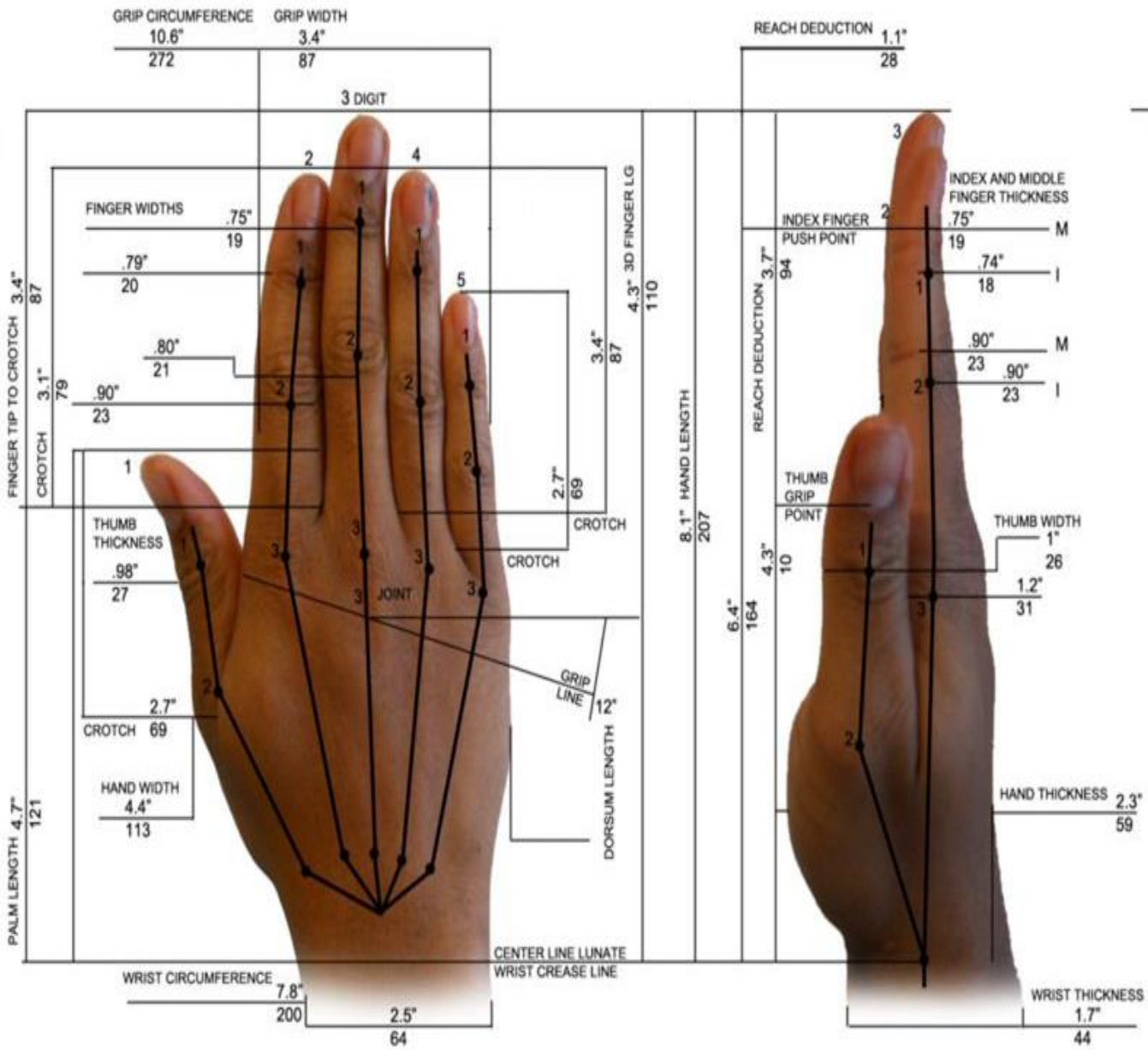
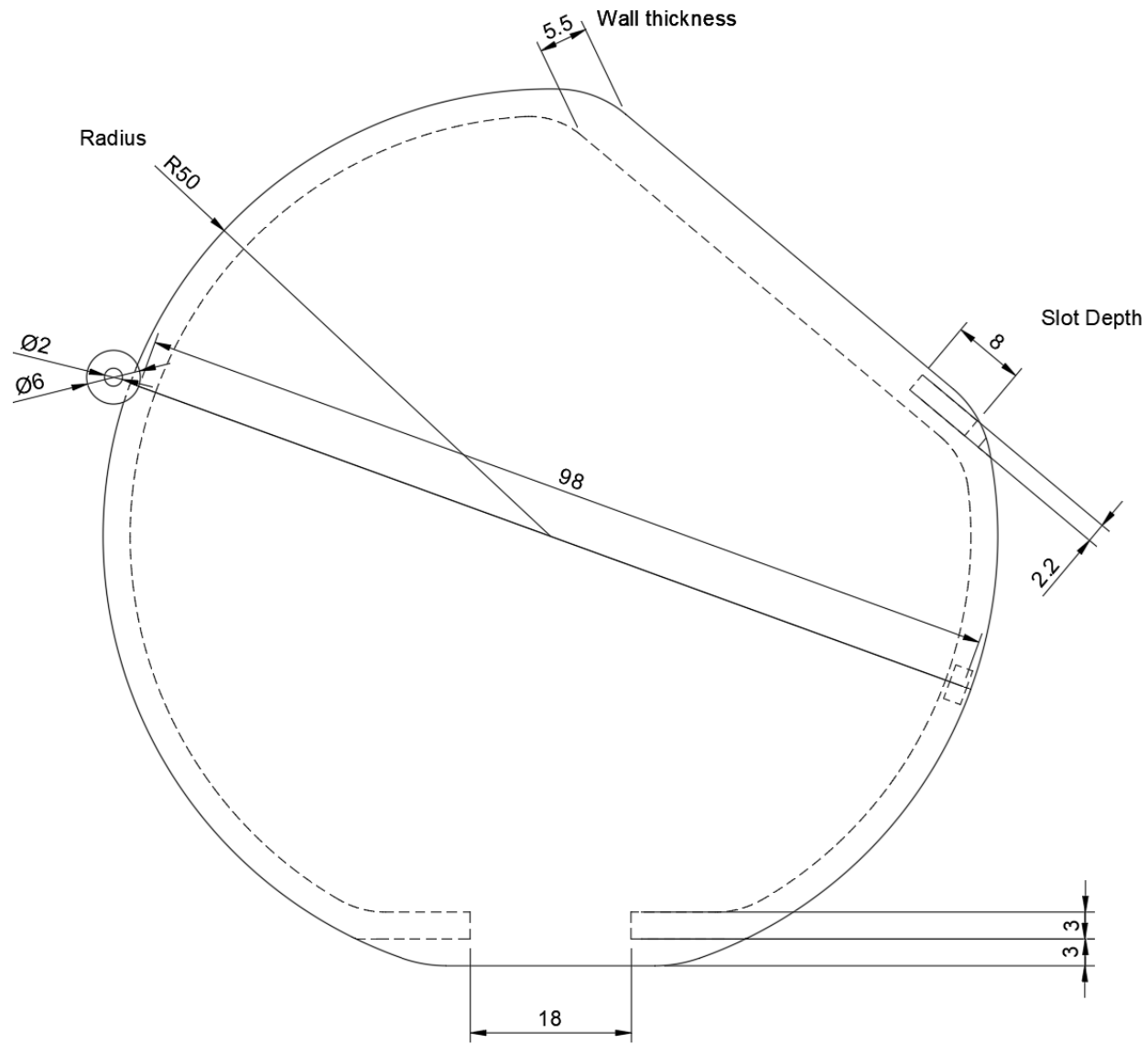
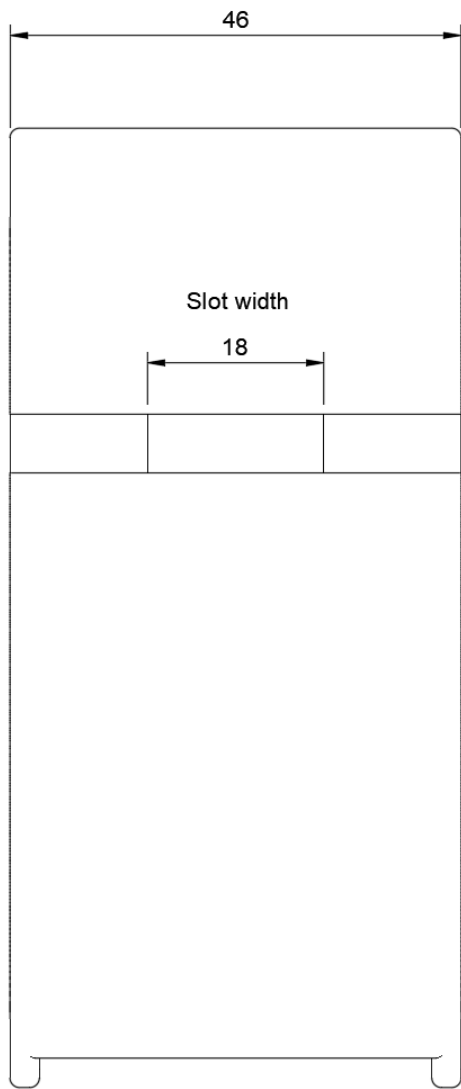
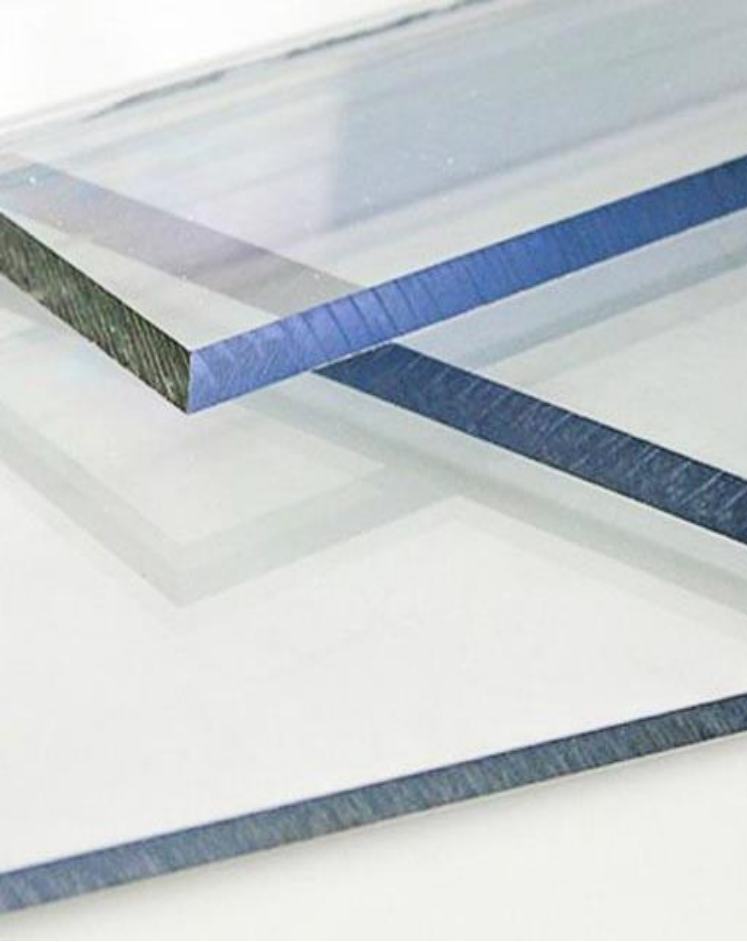


Table 2. Percentile values of hand dimensions (mm) in right and left hands.

Dimension	Percentile					
	Right hand			Left hand		
	5th percentile	50th percentile	95th percentile	5th percentile	50th percentile	95th percentile
Hand length	178.33	192.50	206.66	179.13	192.98	207.71
Palm length	99.07	110.68	119.87	99.31	110.89	121.11
Hand breadth at thumb	91.60	102.54	112.82	91.79	101.95	112.05
Hand breadth at metacarpal	79.44	87.05	96.51	78.55	86.25	95.25
Grip diameter	50.00	65.00	85.00	50.00	65.00	85.00
Fist circumference	245.00	271.00	300.00	241.0	269.00	296.50
Hand circumference	215.00	238.00	261.00	214.00	236.00	260.00
Wrist circumference	146.00	163.00	181.00	146.00	163.00	181.00
Arm length	700.00	755.00	810.00	700.00	755.00	810.00
Elbow length	431.87	468.43	504.11	433.23	466.30	503.78
Elbow flexed	235.00	270.00	311.00	236.00	268.00	310.00
Fingertip to root digit 1	49.03	57.37	70.80	47.57	56.51	70.21
Fingertip to root digit 2	63.35	72.76	79.51	63.01	73.18	80.19
Fingertip to root digit 3	69.17	79.37	87.78	68.73	79.58	87.56
Fingertip to root digit 4	62.20	73.77	81.52	61.66	72.88	80.71
Fingertip to root digit 5	50.58	59.46	67.16	49.51	59.43	65.90
Breadth of first joint of digit 1	18.65	22.08	25.17	18.60	21.50	24.59
Breadth of first joint of digit 2	17.34	20.04	22.68	16.90	19.75	22.39
Breadth of first joint of digit 3	17.26	20.00	22.30	17.00	19.64	22.05
Breadth of first joint of digit 4	16.05	18.68	21.11	15.74	18.38	21.04
Breadth of first joint of digit 5	13.95	16.98	19.24	13.62	16.58	19.41
First joint to root digit 2	39.42	47.34	53.50	38.30	47.07	53.61
First joint to root digit 3	43.10	52.55	60.34	42.56	52.13	59.33
First joint to root digit 4	38.20	46.52	53.82	37.73	46.39	53.35
First joint to root digit 5	27.71	35.12	41.51	27.37	35.20	41.55
Second joint to root digit 1	17.39	23.16	31.01	17.76	22.74	29.97
Second joint to root digit 2	19.40	24.11	27.68	19.29	23.90	28.06
Second joint to root digit 3	21.34	26.35	30.58	20.57	25.86	30.43
Second joint to root digit 4	17.40	22.75	27.18	17.40	22.43	26.84
Second joint to root digit 5	13.59	18.10	21.88	13.71	17.87	21.35



Materials



Polycarbonate

Main Body

~300 /kg of granules

1.2 g/cm³



ABS

Handles and colored parts

~100 /kg

1 - 1.05 g/cm³



Rubber

Grips

~ 500 /kg

From here on

The market for CP might be unique but products made for CP could be used in other domains as well and the peeler can have a more mainstream use where someone could peel items while sitting anywhere comfortably.

The market for CP has been filled with improvised products being manufactured in a small scale, this has led to increased prices and unavailability of the products worldwide, this is a massive hole to fill with more and more of the population being affected by locomotive illnesses including CP.

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