

P2 Project Report

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CLIPPA

Designing a nail clipper for Geriatric who have trouble reaching their toe nails.

Guide: Prof. Avinash Shende

Approval Sheet

The Design Project-2, titled "Clippa" by Ashuj Chawda, Roll number 216130009, is approved in partial fulfillment of the Master's in Industrial Design Degree at the IDC School of Design, Indian Institute of Technology, Mumbai.



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Internal Examiner

Declaration

I declare that this project report submission contains my own ideas and my own work. If any pre-existing idea or work has been included, I have appropriately cited and referenced the original author(s).

I also declare that I have adhered to the principles of Academic honesty and integrity and have not misinterpreted, fabricated or plagiarized 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.

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I am indebted to Prof. Vijay Bapat for lending me his collection of nail clippers for the product study. Also, I am thankful to all the IDC faculty who have shared their valuable opinions and feedbacks that have helped me look towards the problem through various perspectives and re-think its solutions.

I would like to thank the IDC staff for their help at various workshops. A special thank goes to Malhar Pilvalkar and Aryan Gajwe who shared their user research from their personal projects that allowed me to save some time during the primary research stage.

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Abstract

Post pandemic, our lifestyles have changed which has allowed me to think about and address problems that came with the pandemic. Being quarantined at home meant staying away from loved ones and avoiding physical contact with anybody. There are situations in which the geriatric or the elderly have to stay away from their loved ones too and there are many tasks that they need to perform alone throughout the day. Nail clipping of the toe nails is one such task that can involve bending and stretching. This is almost an impossible task for the elderly, especially if he/she is obese or have back problems.

My project focuses on problem associated to nail clipping of the toe nails of the elderly and the obese, where I have explored various possibilities of the automated chipping of the nails using just the feet. The explorations involve the use of a spiral blade that chips off the extra, protruding nails of the toe fingers. The device is named **Clippa**, from the word **clipper**. Problems like disposing off the nails after chipping have also been addressed.

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1. Introduction

I have previously worked on projects involving Assistive Technology devices for people with Cerebral Palsy. So, when we had to decide a topic for the Semester project (P2), I had pitched something that could be done under the grooming field. When I later discussed with my guide and other faculty, the nails section of the grooming had not really been researched much before. I started primary research and found out that the elderly people face trouble while clipping their toe nails.

The 2019 COVID pandemic brought with it the worst case scenarios possible to the people. It highlighted the issue of the geriatric people, especially the ones living in the cities and in old age homes, or whose loved ones live away in other cities or countries. Every small task, with passing each day, felt like a burden. It made me realise that even a small task like clipping of nails could have an effect on their wellbeing.

Nail clippers design have not been intervened for a very long time while the major issues still persist-clipping toe nails without having the elderly to bend. Now, the availability of technology and the ease of manufacturing has made me re-think the possibilities of clipping nails with ease and with fun element.

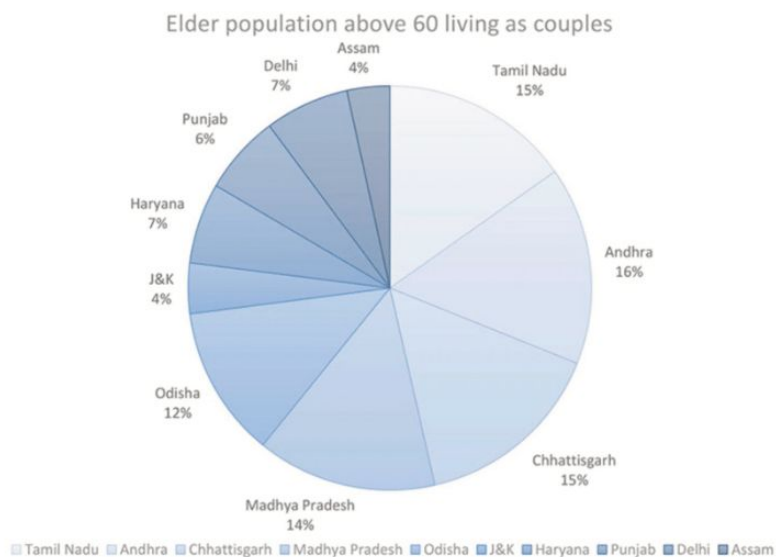
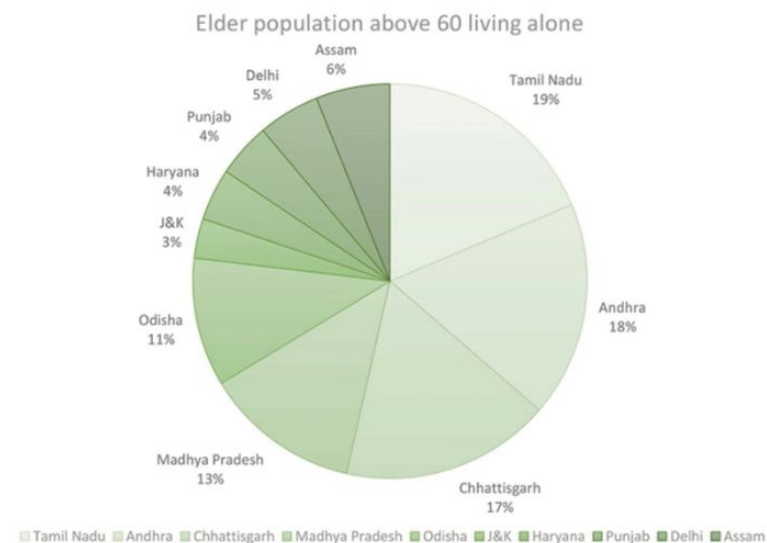


Fig. 1.1.

What do the statistics say about the elder population?

A report released by United Nations Population Fund and HelpAge India suggests that population of the elderly is expected to grow from 104 million in 2011 to 173 million by 2026. Currently, **71% of the population resides in urban areas, whereas 29% resides in rural areas.**

The pie chart on the left shows the state-wise statistics of the elderly people.

Source: Archisha Bansal, *The reason behind the rising number of old age homes in India*, eduindex.org, 2021

LIST OF OPERATIONS PERFORMED IN A DAY

- 1.Sitting up
- 2.Getting down from the bed
- 3.Walking over the level difference
- 4.Accessing basin and other areas
- 5.Climbing steps
- 6.Walking on ramps
- 7.Getting over obstacles
- 8.The movement inside the toilet.
- 9.Opening and closing of doors and windows
- 10.The movement inside the kitchen.
- 11.Performing puja.
- 12.Moving a chair or other objects

What is the condition of the elderly?

With the changing times, children move out to different cities or even different countries with the aim of gaining better living aspects leaving behind their parents for whom it is not possible to adjust with the lifestyle changes which migration brings . In some cases while the parents agree to move in with their children , in other cases it is observed that when parents age children starts to see them as a burden and a responsibility that they want to get rid off which lead them in abandoning their own parents.

Currently there are **728 old age homes in India**, with the information available for 547 homes out of which 325 homes accommodates elderly people free of cost, while 95 others charges for the accommodations while nearly 110 other homes have both free as well as pay staying facility available . Kerala , the state which has the highest literary rate in India is also reported to have the highest number of old age homes i.e. 278.

2. Design Approach

It is very important to make sure that an appropriate methodology is followed to achieve desirable results. This project involves making a healthcare product for elderly. So the output required is very critical since safety is involved.

I used a simple yet efficient method of starting with primary field study involving observing the elderly and interviewing them. Although it is advisable to follow “Shadowing” method in which we literally follow each and every step of what the user is doing right from the place of the context. In my case, it was required, but due to certain constraints, it could not be followed. But I have made sure to visit and observe the users for a certain interval of time, which is fair enough.

So, I started with the field study, continuing literature review and then again testing out products in the markets for their efficiency. Then the second stage involved narrowing down the brief to work in a particular direction and start with the ideation sketches. Finally, filtering the good ideas and concepts involving appropriate use of technology and form factor, I ended with the desirable concept.

3. Literature Study

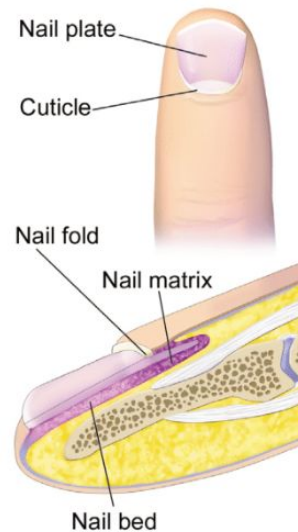


Fig. 3.1.1 Nail anatomy

3.1. About nails

A nail is a hard plate at the tip of the fingers and toes in most primates used for multiple purposes such as itching, peeling of fruits, opening and picking of objects. The fingernails and the toe nails are made up of a tough protective protien called alpha-keratin, which is a polymer.

The nail consists of the nail plate, the nail matrix and the nail bed below it and the grooves surrounding it, as shown in the figure 3.1.1 (source: Onumah, Neh; Scher, Richard K (May 2009). "Nail Surgery". eMedicine. Retrieved 10 March 2010.)

The nails come in various shapes, sizes and thicknesses as thown in the figure 3.1.2. (source: vectorstock.com)

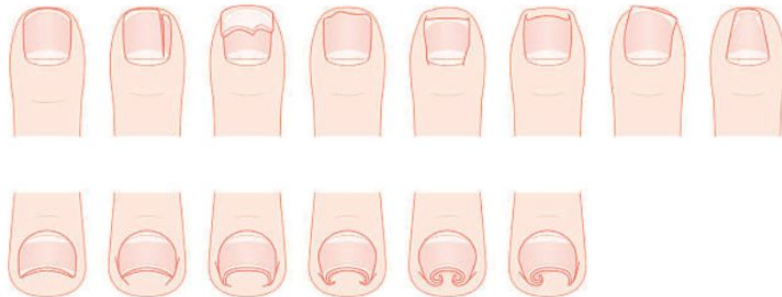


Fig. 3.1.2. Nail shapes



Fig. 3.2.1 Razor (top) and a nail cutter with bone handle (bottom) find in a grave of the Hallstatt culture (c. 6-8th Centuries BC)



Fig. 3.2.2 Roman nail clipper made of Bronze 3-4th century AD.

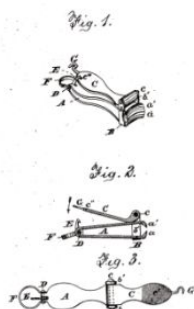


Figure 3.2.3 Fingernail clipper patent, Eugene Heim and Oelestin Matz, circa 1881. (U.S. Patent & Trademark Office)



Fig. 3.2.4. 1902 Advertisement from good housekeeping for Carter's Nail cutter, Ansonia, Connecticut

3.2. About nail clipping

Nail clipping comes under grooming, styling and conditioning to maintain hygiene and also as part of cosmetics. There are various tools involved like clipper, scissors, nail pliers and files to do the appropriate job, but most important are the clippers. Compound level based clippers are the most commonly used clippers (Fig 3.2.1)

3.2.1. History of nail clipping

Invention of nail clippers is a relatively recent invention. Earlier, people used small knives to cut or pare their nails. Descriptions of nail trimming in literature date back to the 8th Century BC (See figure 3.2.1)

Filings for finger nail clippers include in 1881, those of Eugene Heim and Celestin Matz, in 1885 by George H. Coates (See fig. 3.2.3. Source: Heim, Eugene & Matz, Celestin, "Finger-nail trimmer", issued July 26, 1881. <https://worldwide.espacenet.com/patent/search/family/002314220/publication/US244891A?q=pn%3DUS244891>), and in 1905 by Chapel S. Carter with a later patent in 1922. Around 1928, Carter was president of the company H.C. Cook, when he claimed, about 1896, the "Gem"-brand fingernail clipper was introduced (See fig 3.2.4. Source- John C. Cochran Company, 1928, *The American Exporter*).



Fig. 3.2.5 Two point Pinch



Fig. 3.2.6 Lateral Pinch



Fig. 3.2.7 Grasping Hands.

3.2.2 Nail clipping postures

There are various nail clipping postures that have been outlined below:

(a.) Two Point Pinch:

It implies placing the nail clipper above the forefinger, middle finger, ring finger and little finger, and using the thumb to press the nail clipper, where the knife edge and the exterior of the little finger are in the same direction.

(b.) Lateral Pinch:

It means placing the nail clipper on the palm and using the little finger, ring finger and middle finger to press, where the knife edge and the exterior of the little finger are in the same direction.

Grasping Hands:

It means using front thumb to press the nail clipper and the forefinger and thumb to hold the nail clipper. Performing the two-point pinch when using a nail clipper is the most frequent posture.

[Text and Image Source: Hsin-Chieh Wu, Min-Chi Chiu, Cheng-Heng Hou, 2014, Nail clipper ergonomic evaluation and redesign for the elderly, sciencedirect.com]



Fig. 3.2.8. Leg Crossed



Fig. 3.2.9. Sole-Supinated



Fig. 3.2.10. Sole-Pronated.

3.2.3 Nail clipping postures for Toe

There are various nail clipping postures for toe nails that have been outlined below:

(a.) Leg-Crossed:

This means crossing the lower leg onto the thigh of other leg to clip nails, with the leg placed horizontally.

(b.) Sole-Supinated:

This implies supinating the sole, turning aside the body to cross the elbow over the knee, and stepping the sole forward. This was the most frequent used posture when clipping toenails.

(c.) Sole-Pronated:

This means lifting up the leg, crossing the elbow on the same side over the thigh, and pronating the sole to lift the toes.

[Text & image Source: Hsin-ChiehWu, Min-Chi Chiu, Cheng-HengHou, 2014, Nail clipper ergonomic evaluation and redesign for the elderly, sciencedirect.com]



Fig. 3.3.1. Egyptian type feet



Fig. 3.3.2. Greek type



Fig. 3.3.3. Roman.

3.3. Feet types

Ancestry websites contain archaic-looking charts with foot types labeled “Greek,” “Egyptian,” “Roman,” “Celtic,” and “Germanic.”

The charts suggest that the angle of your toes reveal the region from which your ancestors originated. Other websites declare that the shape of your feet can determine your personality type.

(a.) Egyptian:

In this, the second finger is shorter than the first. It is the most common among 50-60% of people they own it. Shoemakers usually follow such a pattern to make shoe last, so they are the easiest people to find the right shoe for.

Personality: Dreamy, idealistic, impulsive and moody.

(b.) Greek:

The second finger is longer than first finger (hallux). About 15% of the population have it.

Personality: active, enthusiastic, intelligent and with great capacity for sport and to lead teams.

(c.) Roman:

same length on first and second toe. They are less frequent (5%)
Personality: not impulsive and flee from making impromptu decisions. Practical and decisive. consistent with their principles, transmit fulfillment of security requirements and they are trustworthy.

[Text & image Source: Rebecca Joy Stanborough, Can Your Foot Shape Reveal Your Personality or Your Ancestry? Learn More, Healthline, 2019.]

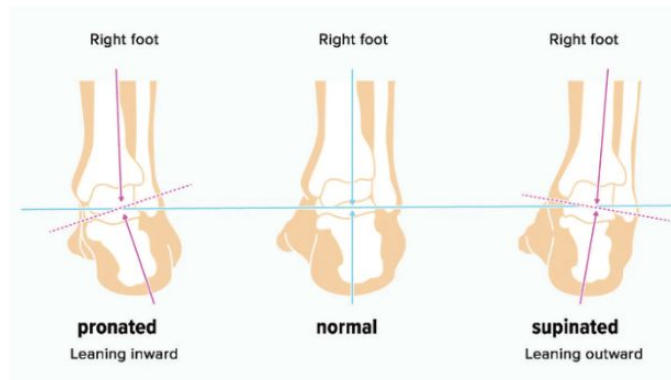


Fig. 3.4. Pronation and Supination

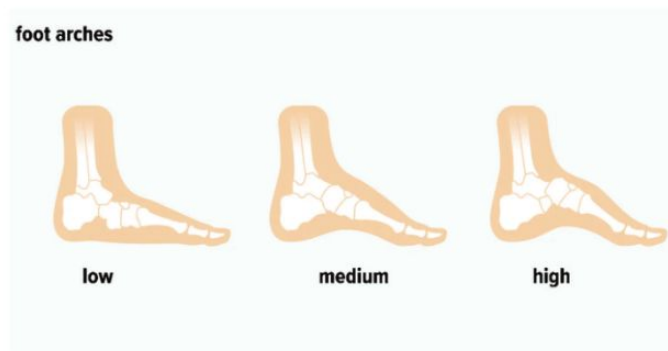


Fig. 3.5. Foot Arches

3.4. Pronation and Supination

Pronation and supination refer to the side-to-side motions your foot carries out as you move. [See fig. 3.4]

[Source - Rebecca Joy Stanborough, *Can Your Foot Shape Reveal Your Personality or Your Ancestry?* Learn More, Healthline, 2019.]

3.5. Foot Arches

One of the most noticeable ways in which feet differ from person to person is the arch. What most of us call the arch — the medial longitudinal arch — is one of three arches in the foot:

The **medial longitudinal arch** runs from the end of your heel to the ball of your foot, right down the center of your foot. The **lateral longitudinal arch** runs along the outside edge of your foot.

The **anterior transverse arch** runs from side to side, just behind the ball of your foot.

The three arches work together to help your foot absorb shock and adapt to differences in terrain as you walk or run.

[Source - Rebecca Joy Stanborough, *Can Your Foot Shape Reveal Your Personality or Your Ancestry?* Learn More, Healthline, 2019.]

4. Types of nail clippers

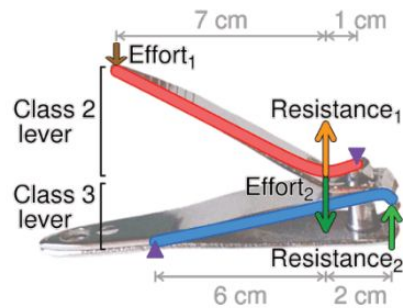


Fig. 4.1. Compound nail clipper
Image Source- Wikipedia/nailclippers



Fig. 4.2. Plier based nail clipper
Source- <https://www.amazon.co.uk/FSYSM-Clipper-Stainless-Toe-nail-Olecranon/dp/B09YD2TGJ7>



Fig. 4.3. Electric trimmer based
Source- www.adihp.com

Based upon the mechanism, there are basically 3 types of nail clippers. [See fig. 4.1., 4.2., 4.3.]

1. Compound nail clippers- This type of nail clipper has 2 compound levers - class-2 and class-3, 2 fulcrum points, 2 resistance.

2. Plier Based- Plier Based is very popular among the elderly (from interview insights mentioned later.)

3. Electric trimming based - This is the most recent development in technology, which no one has ever heard of. There is a sharp helical blade inside a cylindrical casing that rotates due to an electric DC motor connected via a gear train. I looked for this type of nail 'trimmer' at every shop, but could not find any.

5. User Ergonomics Study



Fig. 5.1. Hand-movement, line-of-sight, pain-point study.

Source- Malhar Pilvalkar, Personal project, IDC, IITB, 2022.

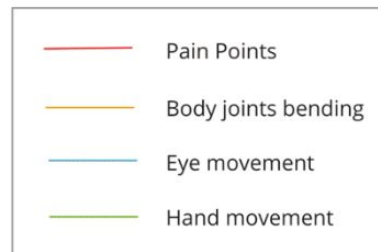


Fig. 5.2. Prioritized insights

I interviewed some elderly people (60+) and shadowed them to observe and to study ergonomic postures. The elders reside in Mumbai urban region of India. The woman shown in the picture is healthy and fit to be able to cut her own nails without any trouble in bending or reaching out to her toes.

The Figure 5.1 shows the Leg crossed, Sole Supinated and Sole-pronated postures of the toe nail clipping action. I made note of various pain points and line of sight throughout the task process. (Refer figure 5.1.). Important insights were drawn from the entire process and prioritized in a colored manner, as shown in figure.

Time motion analysis was also made as outlined on table 5.1

Actions	time in sec
Clipping one single nail	5
Clipping one nail with repeated cuts	8 to 10
Clipping all fingers of one hand	25 to 30
Switching between fingers to toes	2 to 3
Time for clipping one single toenail	5
Time for clipping all toenails of one leg	25 to 30

Table 5.1



Fig. 5.3. Respective simulation results

Head flexion	30.1°	2.0°	2.9°
Palmar flexion	15.2°	17.1°	19.1°
Wrist ulnar/radial deviation ^a	-36.6°	-24.8°	+31.9°
Torso recline	6.3°	23.5°	37.8°

Table. 5.2. Body flexions

5.1. Ergonomic simulation of nail clipping

The following paragraph is taken from the above mentioned website, wherein, the author is from Taiwan and has used JACK4.0 software to simulate the representative nail clipping postures (according to the above photographs) and analyze the joint angles of the wrist, neck and back. The purpose of computer-aided ergonomic evaluation was to understand how large the joint angle was away from the neutral position and to redesign the nail clipper for preventing the large joint angle. Fig. 5.3. shows the representative simulation results. The dimensions of virtual humans were based on **Taiwanese female adults' average anthropometric data**. The chair height was set a little lower than the average knee popliteal height of Taiwanese female adults. The typical nail clipper was also established for ergonomic simulation in the JACK virtual environment. Table 1 shows the target joint angles under representative nail clipping postures when using a traditional nail clipper. Wrist ulnar/radial deviation was about 24.8–36.6° during clipping hand nails and toenails. **In order to prevent the wrist from ulnar/radial deviation, the structure of the traditional nail clipper should be redesigned.** Therefore, a design idea of changing the cutter direction came from the simulation results. Further, it is inevitable that the torso reclined 23.5–37.8° while clipping toenails (see Table 5.2). **To design a proper pedal plate for clipping toenails may be a good idea to improve the back bending problem.**

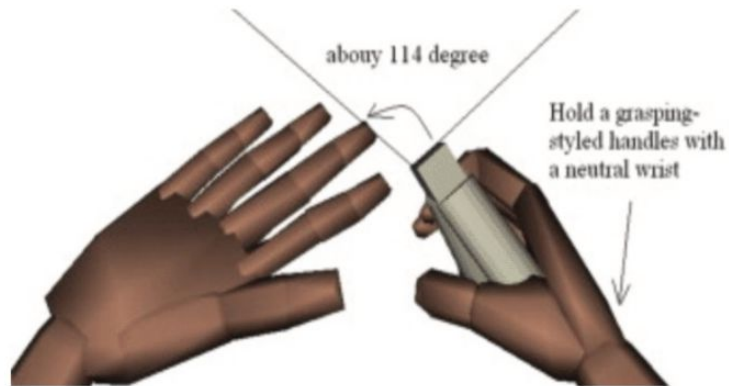


Fig. 5.4. Clipping at neutral wrist position

5.2. Deciding the right nail clipper

In order to maintain a neutral wrist, the knife angle should be 114° between the handle and normal line to the cutter edge as shown in the Figure 5.4.

Based on the above requirements, the nail clipper shown in Figure 5.5 suits best.

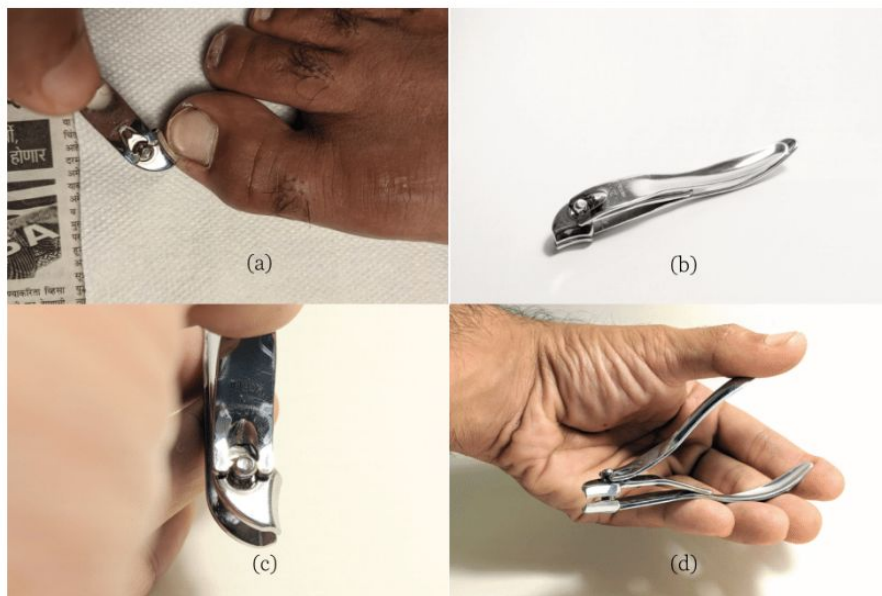


Fig. 5.5. Ideally ergonomic compound lever based clipper

6. Market Study



Fig. 6.1. Rotatable head clipper (a)



Fig. 6.1. Rotatable head clipper (b) & (c)

Based on the ergonomic study, I have tried to find other products that could be called strong competitors. Following products have been cleverly designed and smartly engineered to try best to perform the task of clipping nails.

6.1. Rotatable head clipper

This nail clipper has one arm's head acting as the washer for the upper lever arm and the lower blade head.

Pros:

The head can be rotated according to the need of the user and also the head is quite sturdy.

Cons:

User needs to change head position every time.



Fig. 6.2. Hang-nail and in-grown clipper (a)

6.2. Hang-nail and in-grown nail specialist

This nail clipper is used specifically to cut cuticles and to cut corners around the edges.

Pros

The pointy edges make sure that the job is done well.

Cons:

Not good for normal clipping.



Fig. 6.1. Rotatable head clipper (b) & Hang-nails(c)

6.3. Double sided clipper

This nail clipper has one side to perform normal clipping around the front and the other side to perform cutting action of hang-nails and in-growns.

Pros

Multi-purpose.

Cons:

Not too efficient for harder and thicker nails.



Fig. 6.3. Double sided clipper (a)

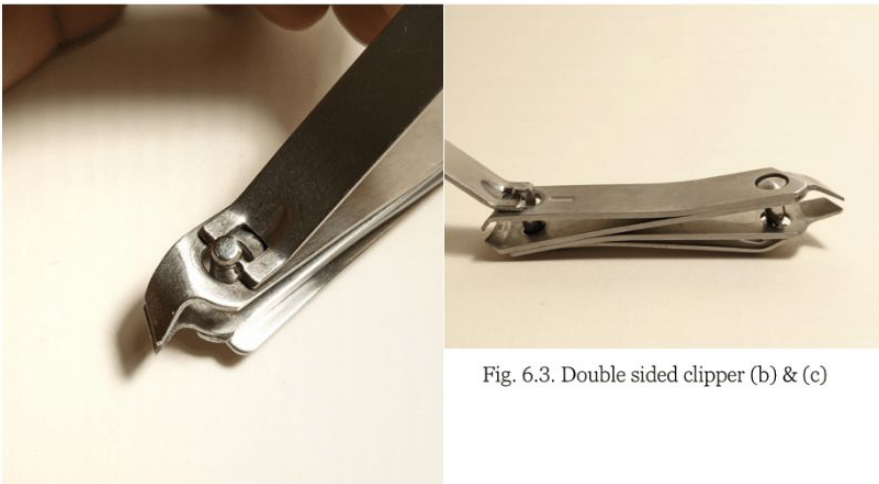


Fig. 6.3. Double sided clipper (b) & (c)

6.4. Magnifying glass attachment

The main component of this clipper is the magnifying glass attachment that can be detached easily to accomodate other clippers with ferrous metal body.

Pros

Magnetic attachment of the glass is great for people with less vision.

Cons:

Little less sturdier compared to other high end clippers.



Fig. 6.4. Magnifying glass attachment (a)



Fig. 6.4. (b) & (c)



Fig. 6.5. (a), (b), (c), (d), (e)

6.5. Japanese, well engineered, Purple clipper

When it comes to Japanese design, you know the product will be efficient in what is supposed to do. When asked amongst the elderly which nail clipper felt joyous to use, they picked this one. There is a casing of purple translucent PLA that helps in catching the nails quite efficiently.

Pros

The cutting efficiency is superb, like a butter.

Cons:

The grip could have been made to be more ergonomic. Also, it does not really solve the issue of having to bend for clipping.



Fig. 6.6. (a), (b), (c), (d), (e)

6.6. Ace Branded Nail Clipper for harder nails

Aesthetically designed, this nail clipper has a red silicone layer behind its teeth to probably catch the nail chippings.

Pros

Good looks. Good quality steel for cutting harder nails.

Cons:

Not very ergonomic

6.7. Good grip clipper

This nail clipper has an added layer of groves or treads for more grip to the user.

Pros

Extra layer of ergonomic grip helps with the stability while performing the clipping task..

Cons:

Angle of the blade is not efficient.

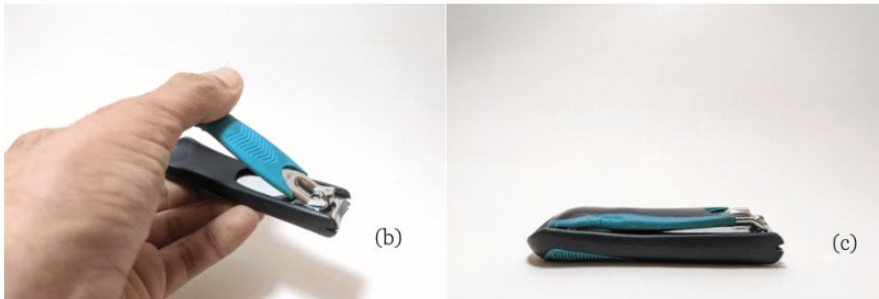


Fig. 6.7. (a), (b), (c)



Fig. 6.8. (a), (b)

6.8. Baby clipper

Imagine holding the baby in one and clipping the baby's nails with the other! This clipper has a ring around it for putting through one of any available fingers into for more support.

Pros
Sturdy

Cons:
Sometimes baby nails are very hard. It becomes little inefficient in cutting those.



Fig. 6.9. (a), (b)



6.9. Plier Based

Based on the popular opinion from the elder people, this plier based clipper does great job in clipping off the harder and thicker variable nails on the feet.

Pros

Ergonomic and effective in clipping hard and thick nails.

Cons:

Takes more time and requires a bit of effort.



6.10. Some other honorable mentions-

Here shown on the left are some nail clipper which could not be tested first hand due to unavailability. But hopefully, it helps.

Figure 6.10 shows a unique arrangement of levers in a compound based nail clipper

Figure 6.11 shows an extra link mechanism to proposedly lessen the strength required to clip nails.

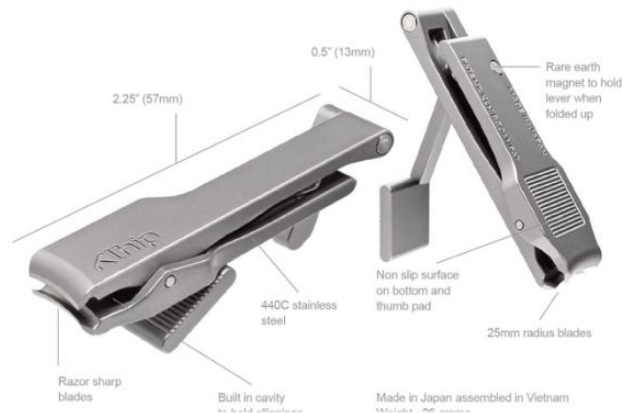


Fig. 6.10. (a), (b)



Fig. 6.11

7. INITIAL IDEATION

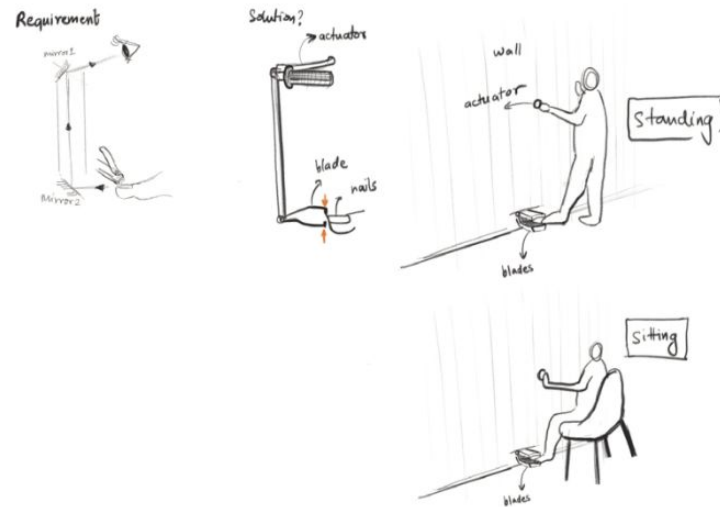


Fig. 7.1.

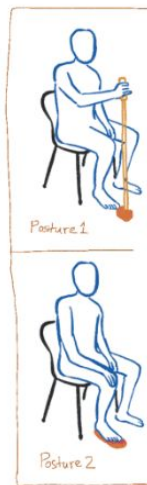


Fig. 7.2.



Fig. 7.3.

Far reach clippers

The most prior requirement for the elderly is to be able to cut toe nails without bending to avoid injury or pain.

For this, a probable solution is to use telescopic actuating mechanism to trim the nails. This includes being able to see the nails, having a good line of sight.

Figure 7.1 shows how a clipping component or the blade can be devised to get the action.

Figure 7.2 shows the comfortable seating postures to be able to clip nails.

Figure 7.3 shows existing product that have been contrapted to facilitate the required posture.

Figure 7.4 shows scan from Dev Kumar Chakraborty's book - Anthropometry Data. Here, the data is of Indian population's buttock to leg lengths in various leg postures while sitting on chair.

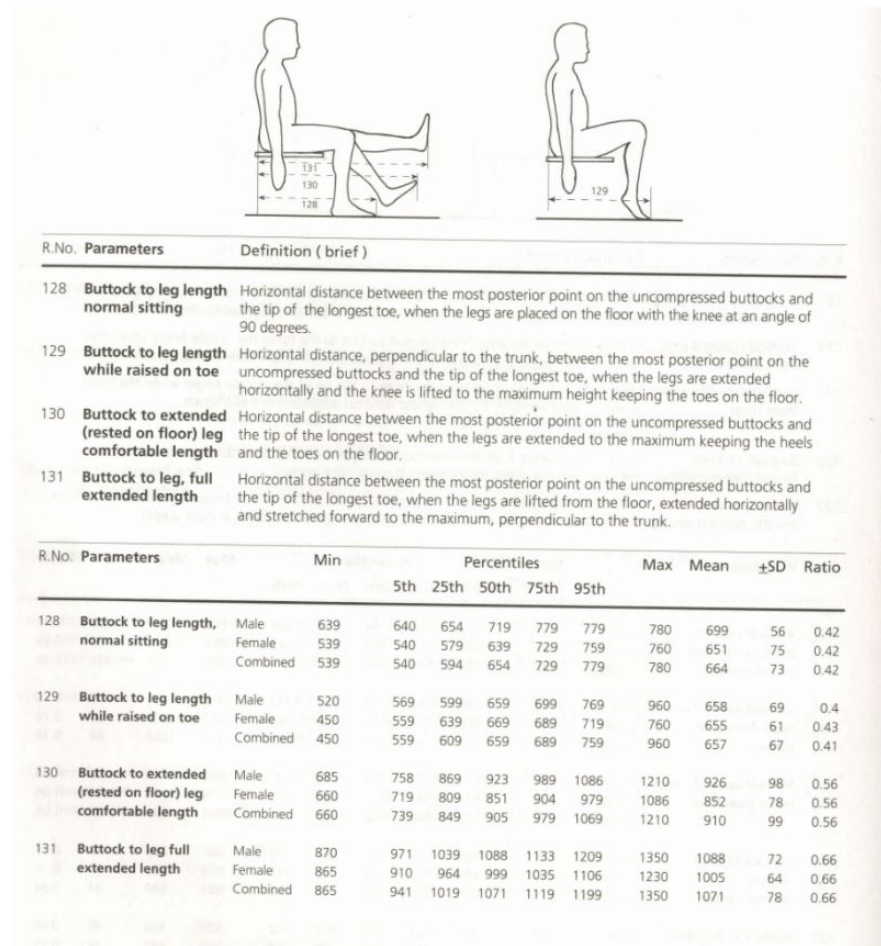


Fig. 7.4

8. Initial Mockup



Fig. 8.1. Far reach clipper mockup, (a) and (b)

I built my own far-reaching clipping mockup just to test various aspects and note down the ergonomic part. Bicycle parts have been used for this mockup wherein the clamping mechanism is accomplished by a bicycle brake and is actuated via a brake handle and braking wire. See figure 8.1 (a) & (b).

But the issue of having a stronger grip still persists.

As seen in the priority listing, all the major issues still persist(see Fig. 8.2).

No matter how good the blade, the lever mechanism, the disposability aspect, the biggest issue or reaching the toe still exists.

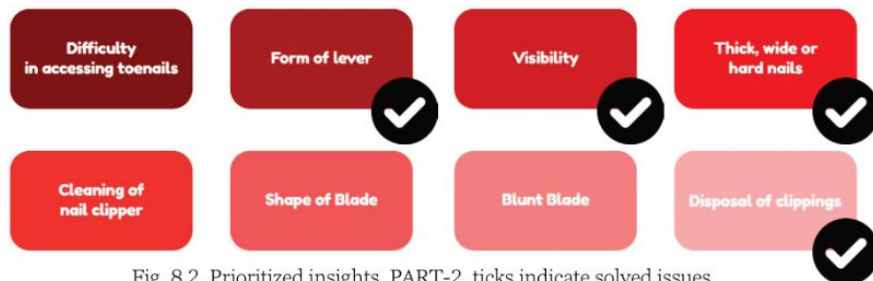


Fig. 8.2. Prioritized insights, PART-2, ticks indicate solved issues

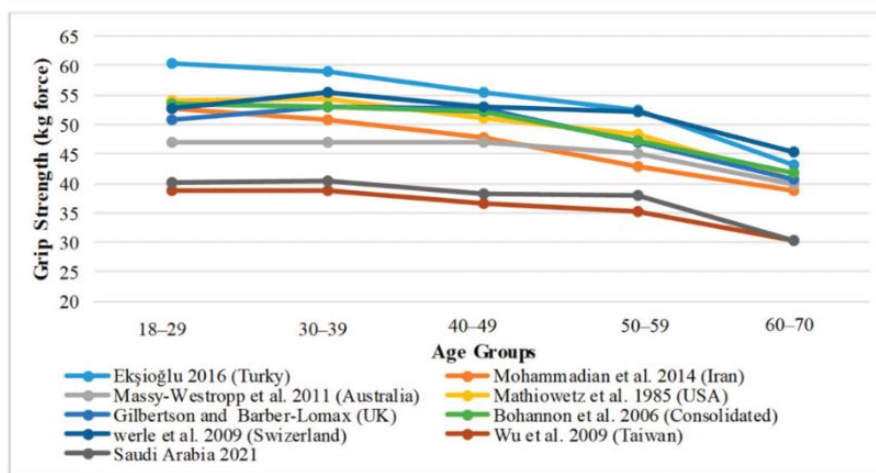


Fig. 8.1. Male, regional reports of mean grip strength by age groups

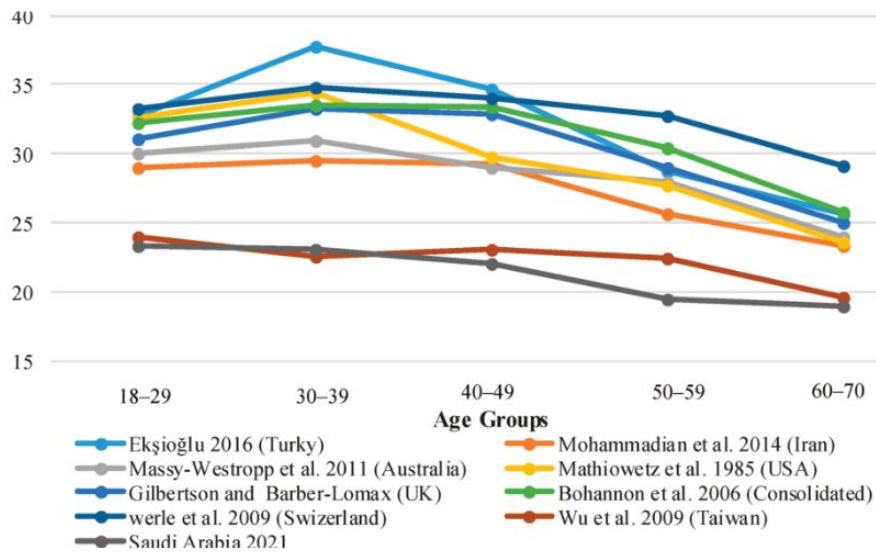


Fig. 8.2. Female, regional reports of mean grip strength by age groups

8.1. Comparison of Average Grip Strength in Saudi Arabia with Other Countries

A comparison of Saudi Arabia's average grip strength with different countries' populations according to age groups from prior studies is shown in Figure 8.1 and Figure 8.2. As can be seen, there is no significant difference in the average grip strength between Saudi Arabian adults and the Taiwanese population. On the contrary, the grip strength in other societies, such as the United States, the United Kingdom, Turkey, Iran, Switzerland, Australia, and a common database of Western countries, is significantly different in all age groups, as the population of these countries has a higher average grip strength in both sexes than the Saudi population.

In males, there was no inverse or direct relationship between grip strength and age group, while in females, the relationship is inverse, as the age increases, the grip strength decreases. The strength of the male grip increases and peaks somewhere between 30 and 39 years of age and gradually decreases until about 49 years of age and then begins to decrease significantly. This relationship is similar to what has been reported in previous studies. However, the grip strength of females tends to decrease as they get older.

9. INTERVENTION SCOPE



Fig. 9.1. Fawes electric nail trimmer

9.1. FAWES NAIL TRIMMER

Since none of the options worked well, I started exploring the electric trimmer, and it did not disappoint!

I ordered Fawes hand-held electric nail trimmer from a local supplier of Chinese products and started to test out (See Figure 9.1).

First impressions- I was little skeptical to put my nails into the blade chamber, since the thought of getting my nails stuck inside haunted me. I showed them to others and recieved the same reaction.

Usage- Once I got over my fear, I tried trimming. Initially it seemed like it was not doing much, but when I got the hang of it, it did great job of chipping nails.

Inference- There are issues with the electric nail trimmer that they are still not meant to be used by elderly. But looking at the mechanism, I felt that there is still need for a lot of innovation in this.

9.2. DISASSEMBLY- FAWES NAIL TRIMMER

I disassembled the case and started looking at the mechanism for the trimmer.

What I found was a helical blade inside a cylindrical metal casing inside of the main plastic casing. The blade rotates via a gear train connected to a DC motor which has a small battery. (See Figure 9.2.)

Looking at the internal components of the trimmer, I feel that if there was a way that the blades reach the feet

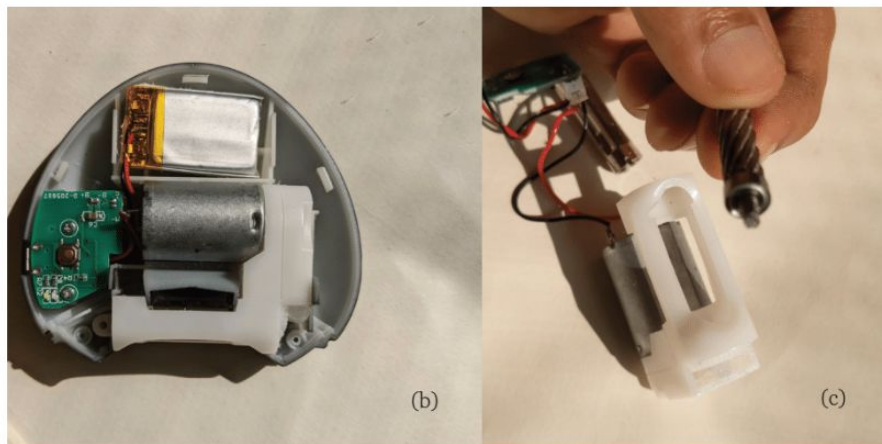
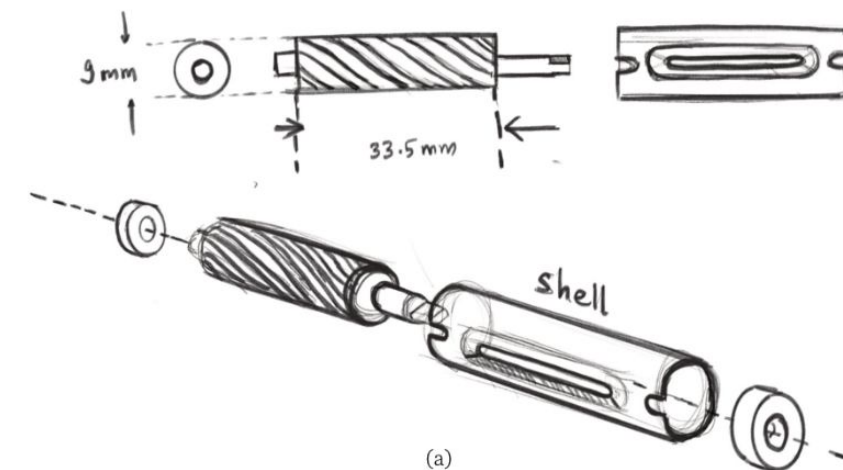


Fig. 9.2. Fawes electric nail trimmer disassembled

10. REFINED BRIEF

TO DESIGN A PRODUCT FOR ELDERLY (60+) WHO
WANTS TO TRIM NAILS WITHOUT HAVING TO BEND
DOWN AND WHICH REQUIRES NO GRASPING.

11. IDEATION- Scenario Building

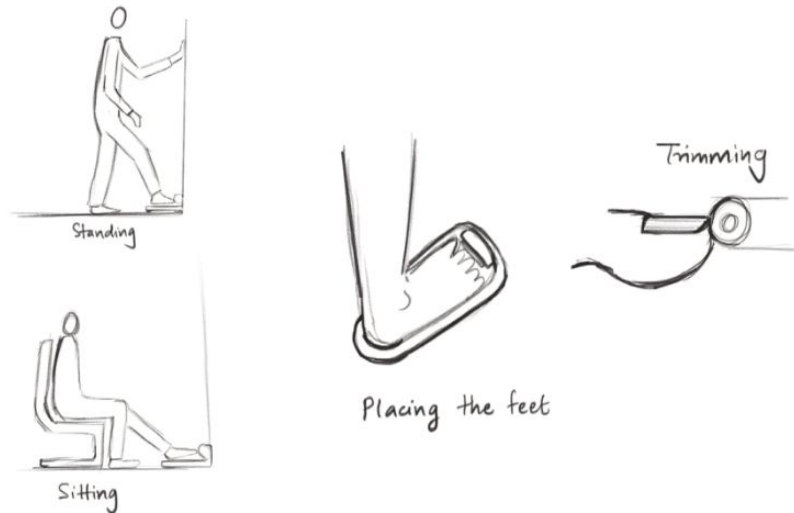


Fig. 11.1.

In order to facilitate the trimming action, the person needs to place the feet onto the trimmer blade properly without which the trimming action will not take properly.

This might require the person to sit and place the feet onto a base/platform for guiding it to the blade as shown in the Figure 11.1

Leg room

Leg room, (Fig. 40) would consist of the area in front and behind one's leg in a sitting position that would cover a distance of about 70 - 100 mm behind the heel point where the leg is resting at a 90 degree vertical position, to an area in front when the leg could be extended to the maximum, and could be rested comfortably on the floor. This extended leg distance would be around 1070 mm. So the total distance of the leg room is 70- 100 mm from behind the heel point at the back, to the point where the leg can be extended comfortably in front and rested on the floor.

The sideways leg extension must be within the span akimbo length, say at the 95th percentile which is around 950 mm in general. With allowances, it may go up to 1200 mm. Vertically, the thigh clearance height at the tibial point with raised knee on tip toe, may be of 95th percentile value, i.e. 640 mm. This leg room area must be kept free for leg movement.

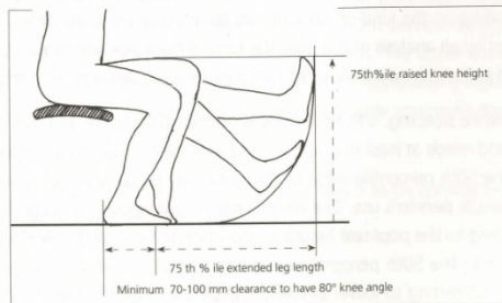


Figure 40. Free leg room.

Clearance between seat and work surface

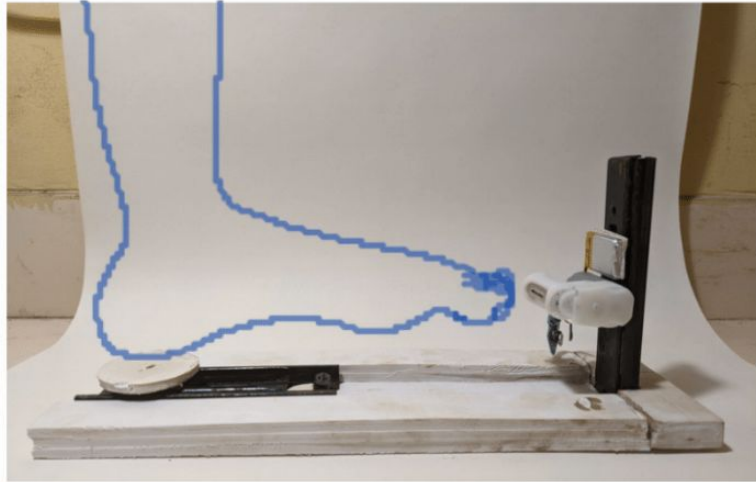
Proper clearance for movement between the edge of the seat front and the work table must be considered, to make it easier to go in front by pushing back the chair. If one uses a combined unit of seat and table with a fixed gap in between, it must ensure the $(BD-TT) + 2 + TT$, where he would also be able to stand occasionally; BD and TT stand for buttock depth and thigh thickness in standing posture respectively.

Figure- 11.2.1

Anthropometric Data

See figure 11.2.1 Source: Dev Kumar Chakraborty - Anthropometric data of Indian population.

12. Basic Apparatus Testing



Based upon the previous information, an apparatus was built to check if nail chipper will work if the person is sitting and also try that at various horizontal and vertical positions. This is shown in the Figure 12.

The module with the chipper is capable of moving vertically, while the module below the feet, under the ankle is able to slide horizontally to accommodate chipping of toe nails of different fingers of varying lengths.

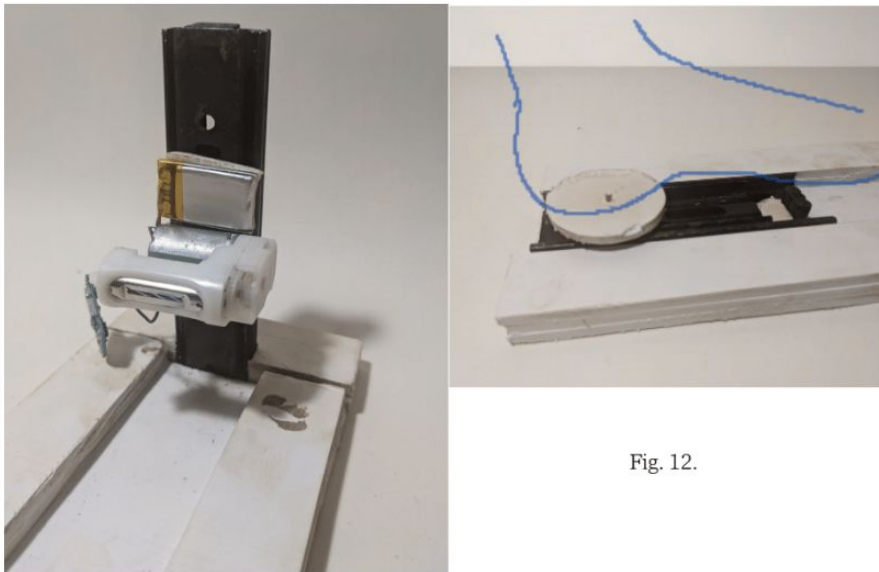


Fig. 12.

13. EXPLORATIONS

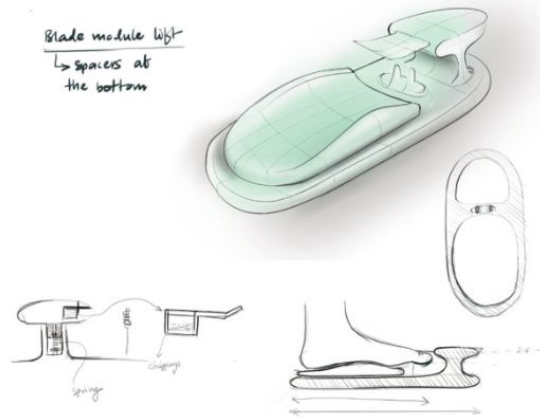


Fig. 13.1.1

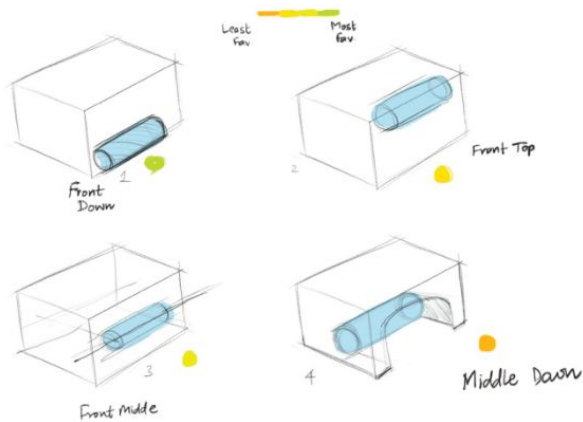


Fig. 13.1.2

13.1 Blade module

The blade module holds the blade in position and also moves in various planes, depending on the foot topology.

Some of the concepts outlined shows how the module can be made to move up and down or in an angle around the rear axis. See figure 13.1.1.

Figure 13.1.2 shows the various configurations of the blade in relation to the structure/volume of the module itself.

13. EXPLORATIONS

13.2. Base module

The following images are about some of the ideas about how the base can be developed.

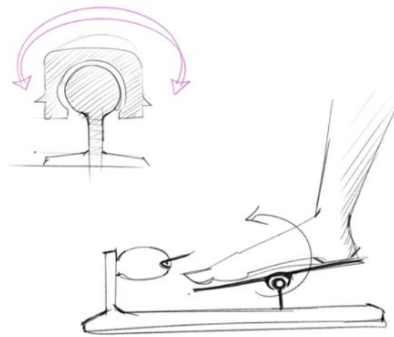
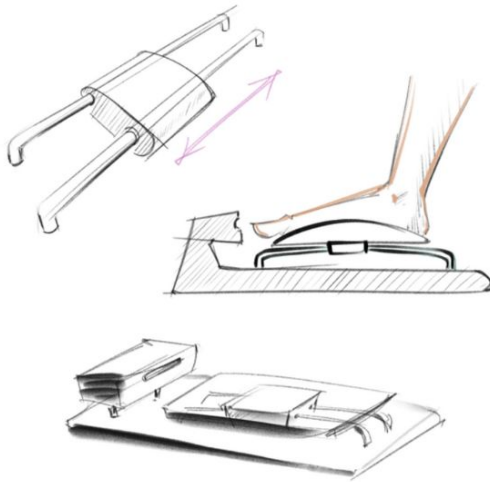
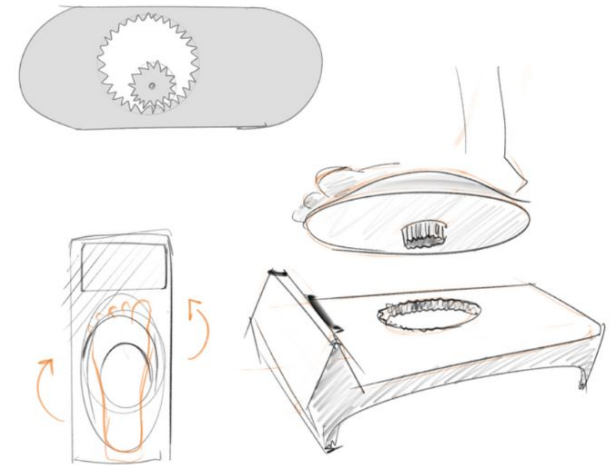


Fig. 13.2.1



13. EXPLORATIONS

BASE MODULE

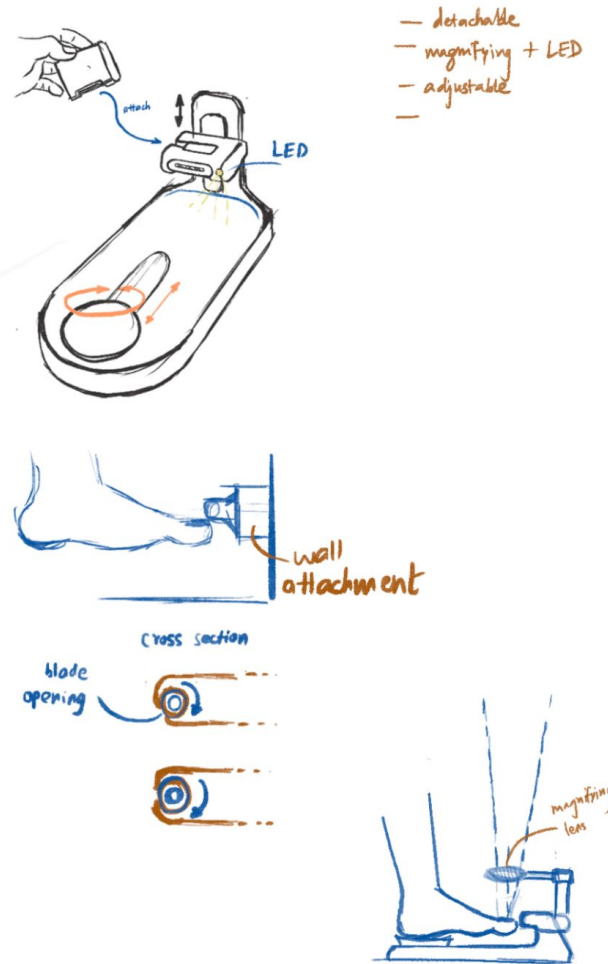
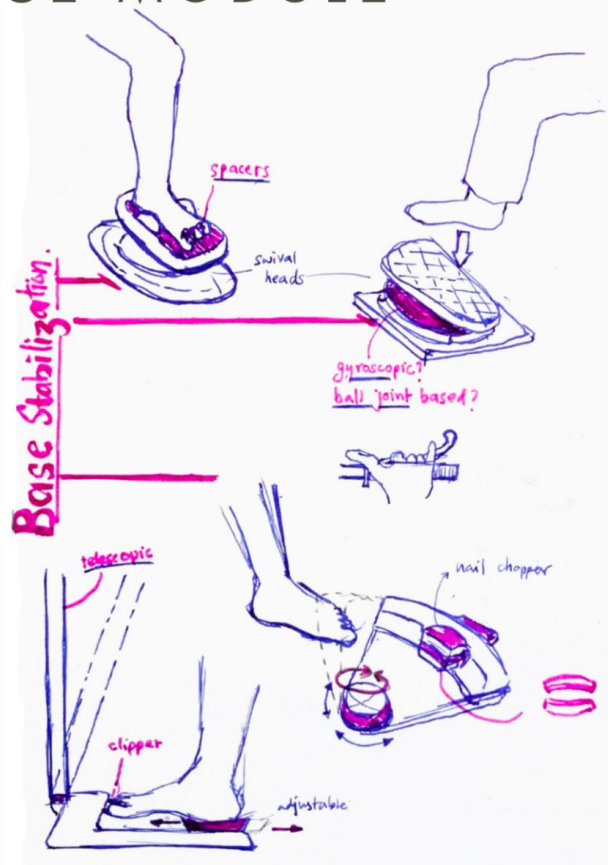


Fig. 13.2.2

13. EXPLORATIONS

13.3. Form

Exploring the form of the base is equally important to allow a more comfortable foot rest.

BASE- FORMS

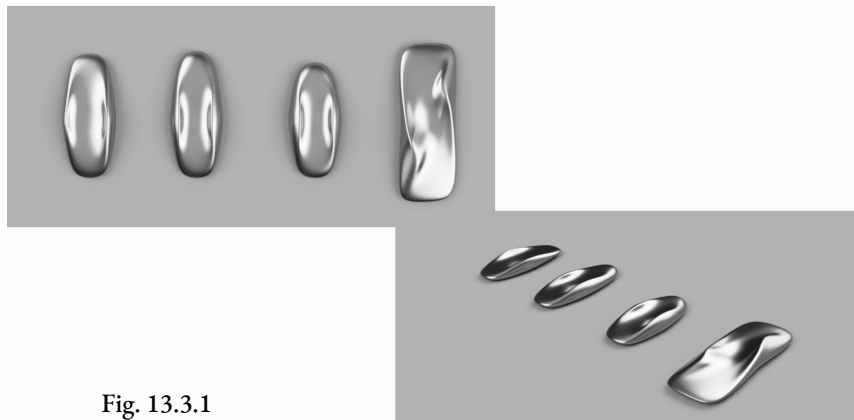


Fig. 13.3.1



14. FINAL CONCEPT

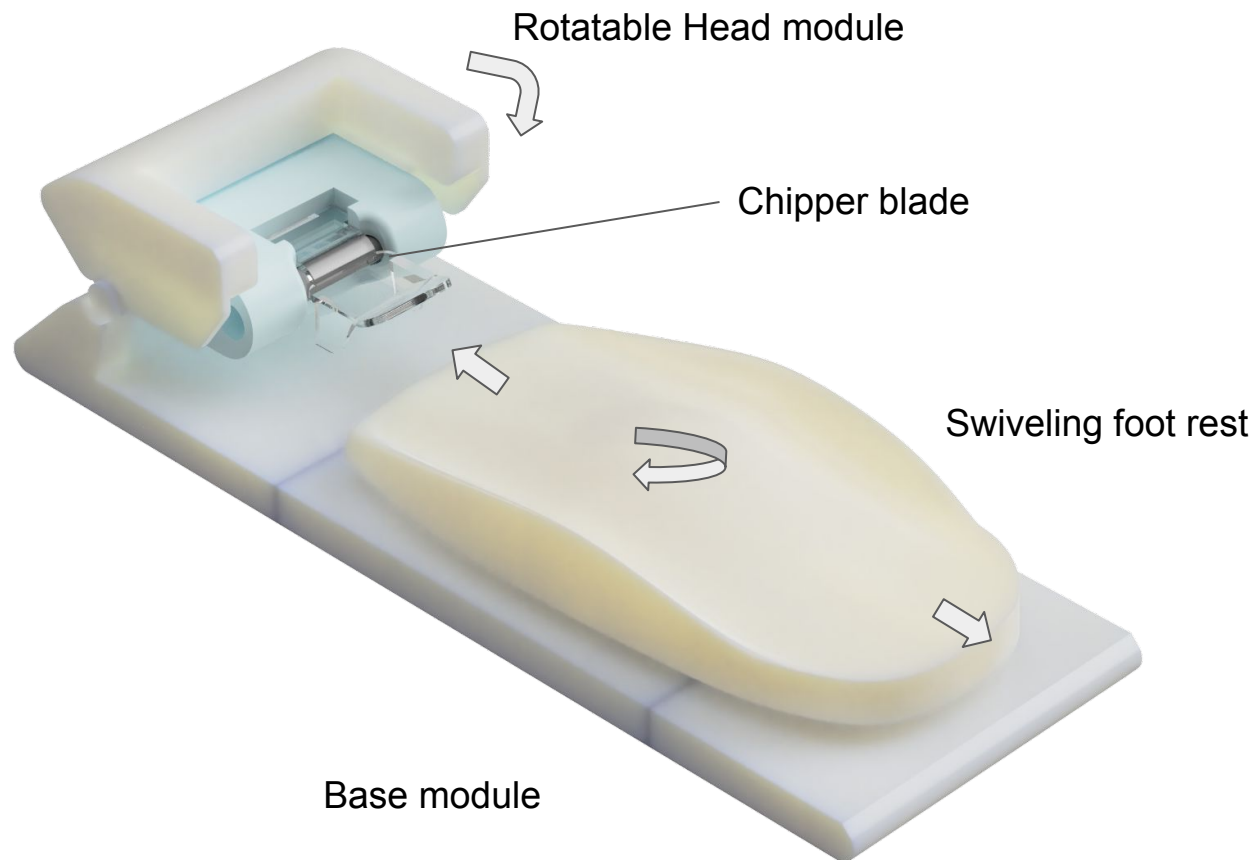
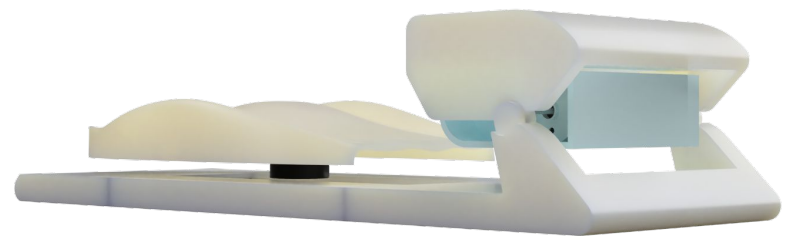


Fig. 14.1

Fig. 14.1 (a),(b),(c),(d)



(a)



(b)



(c)



(d)

14. FINAL CONCEPT - Design Drawing

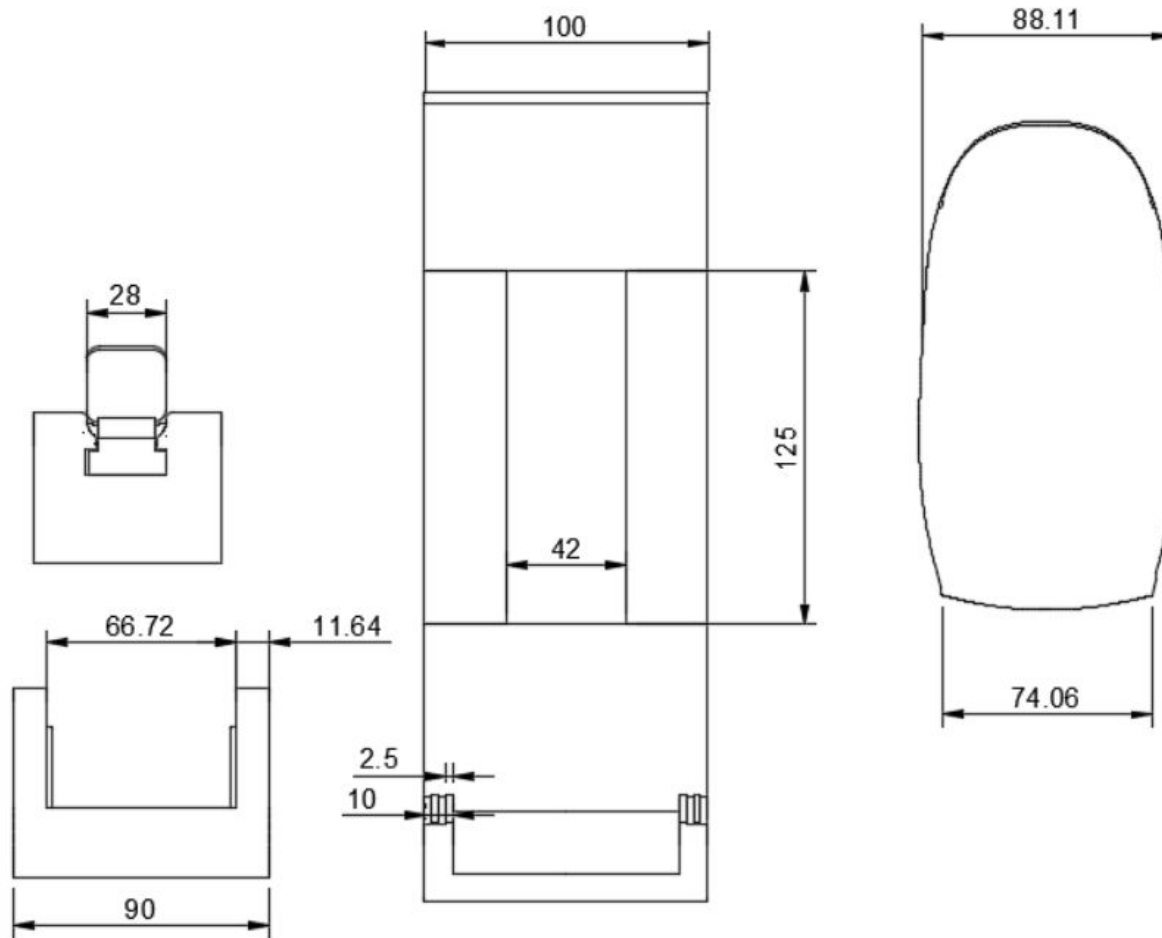


Fig. 14.3.

15. USER TESTING



Final concept was tested with various users to validate the concept and give scope to the product.



Fig. 15.1

16. CONCLUSION

After testing the concept, it was concluded that the product mechanism requires a lot of development along with the help of mechanical engineers and other professionals.

With the oncoming developments in the technology, it is quite doable and hopefully someone who decides to work in the same problem area finds this report/thesis useful to his/her time.