

Assistive Touch Stylus for People with Tremors

Project Guide: Purba Joshi

Submitted by

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Approval

This is to certify that Industrial Design Project III (P3) entitled "Assistive Touch Stylus for People with Tremors" by Vasa Padmanabham is approved in partial fulfillment of the Master's Degree of Industrial Design at IDC, Indian Institute of Technology, Bombay.

Signature of the Project Guide:

Digital Signature
Purba Joshi Joshi (i09042)
08-Aug-24 10:11:45 PM

Signature of the Chairperson:



Signature of the Internal Examiner:



Signature of the External Examiner:



Date: 28-06-2024

Declaration

I, declare that this written report represents my ideas in my own words, and where others' ideas or words have been 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 falsified, misinterpreted or fabricated any idea, data, facts or source in my submission.

I understand that any violation of the above will be caused for disciplinary action by the Institute and can also evoke penal action from the source, from which proper permission has not been taken or improperly been cited.

Signature: 

Name of the student: Vasa Padmanabham

Roll No.: 22m2221

Date: 15-06-24

Abstract

The project "Enhanced Mobile phone Accessibility for Tremor-Related Conditions" focuses on the development of a mobile pointing device, specifically a stylus, designed for individuals suffering from tremors due to neurological conditions like Ataxia and Parkinson's disease. These individuals often confront unique challenges in daily activities, which affect their autonomy and overall quality of life. The severity of their tremors significantly influences their lifestyle and ability to perform everyday tasks.

Mobile phones are crucial in modern society, serving not only as tools for calling, information sharing, and entertainment but also as vital products for personal management and economic earnings. However, for those with tremors, the simple act of using a mobile phone can be fraught with difficulties. This project seeks to understand these specific challenges thoroughly and to devise supportive design solutions that enhance the usability of mobile devices for this demographic.

The main objective of this initiative is to improve mobile phone accessibility, enabling users to interact with digital screens more effectively despite hand tremors. The design of the stylus incorporates fundamental scientific principles aimed at counteracting involuntary movements. Collaboration with neurologists and patient advocacy groups ensures that the design process is deeply rooted in the practical needs and preferences of end-users. The expected result is a product that significantly improves mobile phone interaction for users with tremor-related conditions, thereby boosting their independence and enhancing their quality of life.

Through innovative design and thoughtful integration of technology, this project aims to bridge the gap between digital accessibility and neurological diversity, offering a tangible solution that could transform daily interactions with technology for many individuals.

Acknowledgment

I would like to express my heartfelt gratitude to our guide, Prof. Purba Joshi for her assistance and guidance throughout the project.

I would like to express my gratitude to my IDC colleagues, Shubham, Piyush, Aditya, Vedang, Sukhadev, Ritik and Sagar for their valuable time and contribution regarding the process of this project and grateful for all the instructors of Industrial Design for their assistance, advice and Suggestions.

Special Thanks to Swara Mahajan for being the part of this process and unwavering support.

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01 Introduction

Introduction

Background:

Back in my hometown of Visakhapatnam, my uncle came to me and sat beside me, trembling. It was a great difficulty for him to align himself with the sofa and gradually sit on it. It was unfortunate to see him in that condition, struggling even to hold a glass firmly and drink water from it. This was the first time I witnessed and learned about this disorder, which I understood to be a neurological disorder that results in tremors.

What are Tremors?

Tremors are rhythmic, involuntary movements of part of the body or the entire body. They can significantly impact various aspects of a person's life, affecting both physical and emotional wellbeing. Tremors can make it difficult to perform tasks like signing documents, threading a needle, or drinking a glass of water and can impair overall coordination and balance.



Introduction

They can be intermittent or constant, and there are several causes, including
Neurological Disorders: Conditions like Parkinson's disease, ataxia, and others
Essential Tremors: Shaking that is most noticeable during activities.

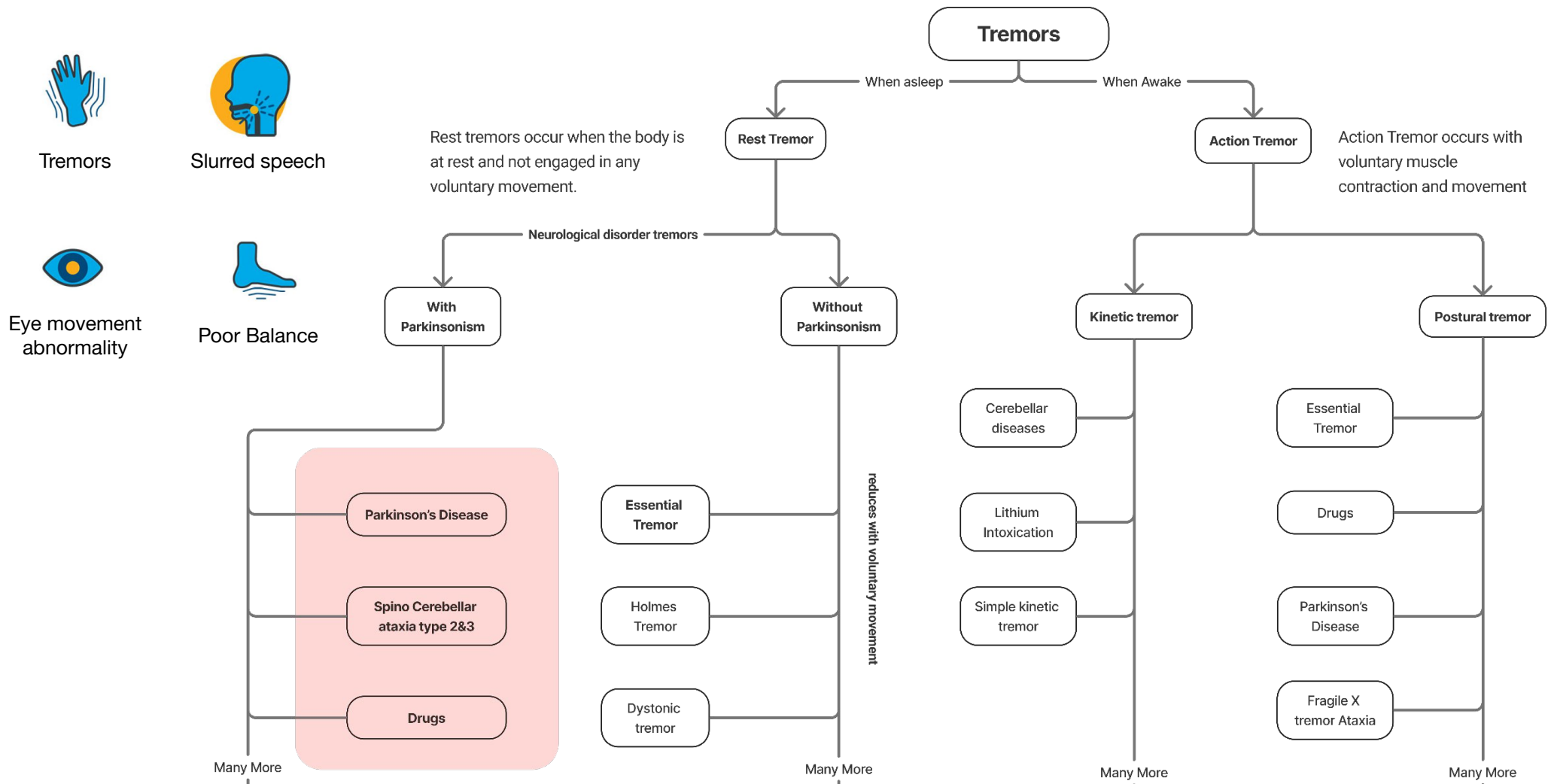
Other causes include caffeine consumption, Some are chronic and some are one temporary conditions like stress, anxiety, and involuntary muscle jerks or twitches. Treatment for tremors varies depending on the type and severity and may include medications, lifestyle changes, or surgery in severe cases. Consulting a healthcare professional is crucial for proper management and treatment.

Tremors affect over 10 million people worldwide, with variations based on age, gender, and geographical location. In India, as in many parts of the world, older adults are more commonly affected. However, due to genetic factors, young adults can also experience tremors and chronic conditions. Consulting a healthcare professional is crucial for proper management and treatment.



Types of tremors

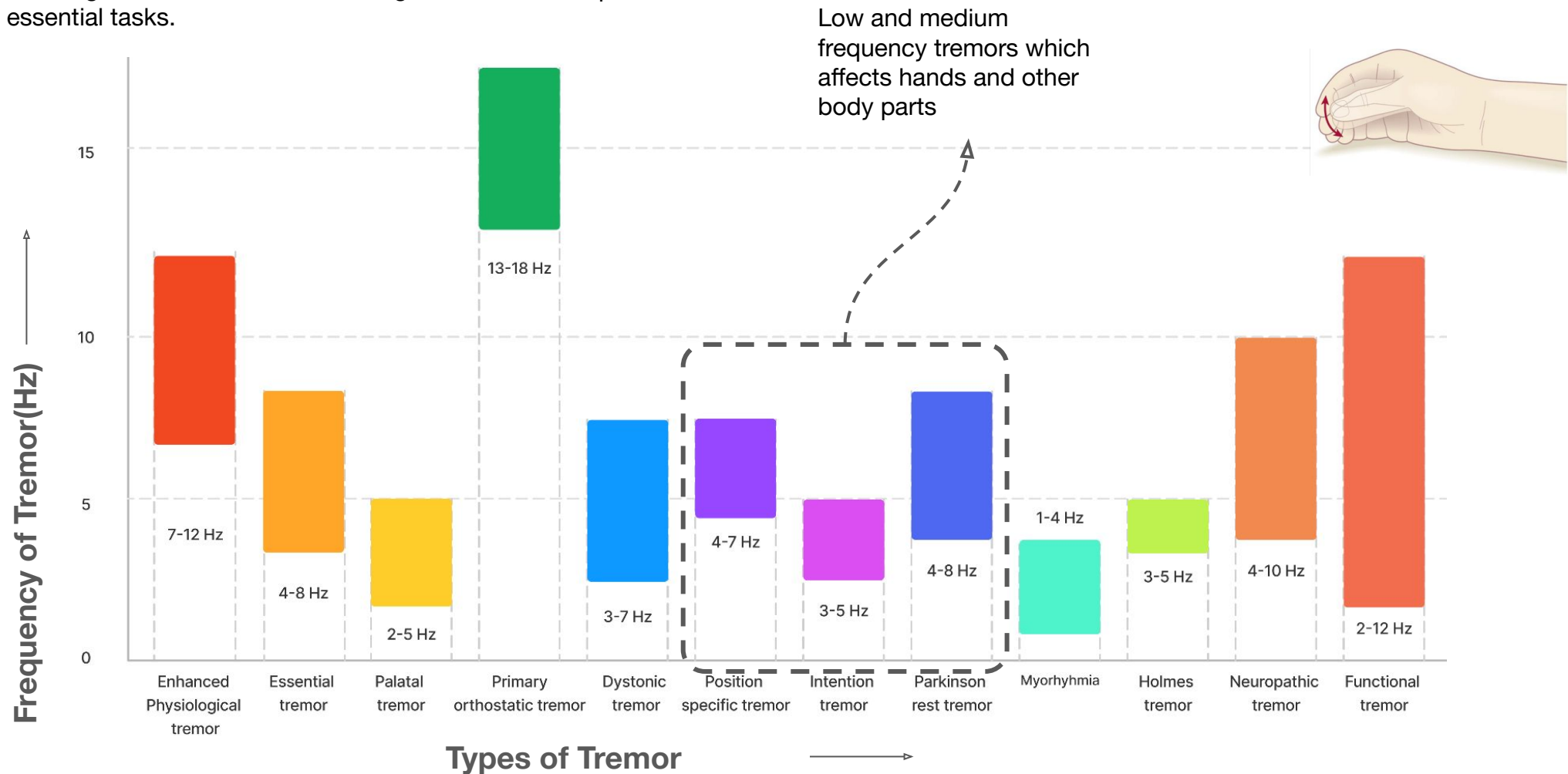
As highlighted in the flowchart on the right, neurological tremors can vary in their presentation and underlying causes. Here are some common symptoms of tremors associated with neurological disorders:



Examples of tremors

The tremors mentioned are chronic and can occur both at rest and during activities. These tremors present daily challenges for the individual, making it difficult to complete essential tasks.

Frequency of a tremor refers to the number of oscillations or cycles per unit of time.



02 Understanding Users

Activity by user

Swara M

Bhandup, Mumbai

Age: 38

Status: Married

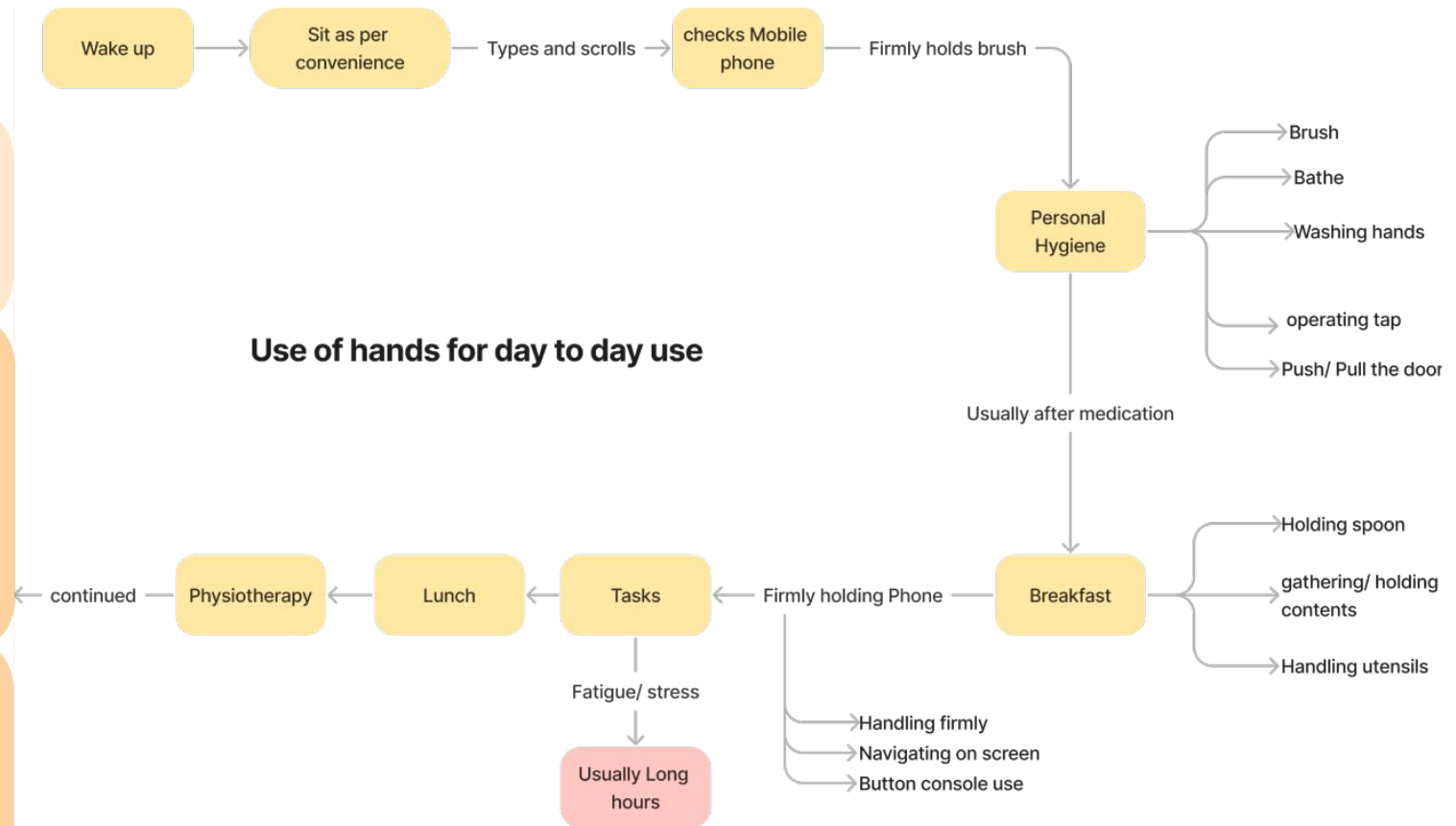
Profession: Freelance Finance

Personal Life

Swara is an accomplished individual who has achieved significant milestones both personally and professionally at a young age. She holds a MA and has been honored with national awards for her contributions to society.

Challenges

Swara faced a major health challenge when she was diagnosed with ataxia, a genetic condition, at a young age. This experience has added a layer of resilience and determination to her character. She works as a freelance financial advisor and manages her therapies from home. Despite her condition, she actively assists her mother with daily tasks.



This activity chart outlines her morning to lunchtime routine, detailing how the user manages daily tasks while coping with hand tremors. It highlights her use of hands for various activities, despite the challenges posed by her condition.

Activity Analysis-1

Here are some key insights I've gathered from the activity analysis.

Needs proper posture help getting up from bed.	Firm grip for the phone to check updates	Gait walk to get away from seat/ Bed	Lacks muscle coordination	Has difficulty gripping any object.	Firm grip for bathroom fixtures for holding.
Experiences finger stiffness.	Finds brushing teeth a tedious task	Finds brushing teeth a tedious task	Motorized Toothbrush is better	Eye coordination is not proper.	Dressing up require someones assistance
Back always needs support to balance.	Suffers from back pain due to weak muscles.	Every activity is slow and time-consuming.	Uses a large cup with a small quantity of liquid.	Experiences painful tremors.	Support from another person for transferring
Firm grip for Spoon and utensils	All fingers take grip	Strain while getting up from the Chair	Stress gives tremors	Avoids buttons and zippers in dressing	More physical rest and less Mental strain needed
Can't write anything due to wrist issues.	Less talk time on phone	Voice text transferring	6 hrs screen time average	Timely medication	Physiotherapy is necessary

Problems faced due to tremor

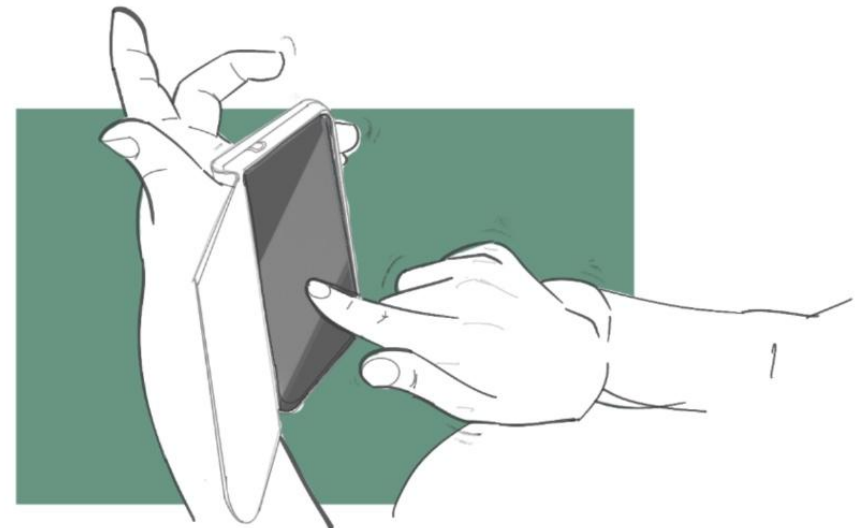


Loose finger control, stiff grips and rigid palm posture

During a tremor, the fingers become stiff, and all fingers attempt to hold the product.



Wider arms and a trembling grip on the glass

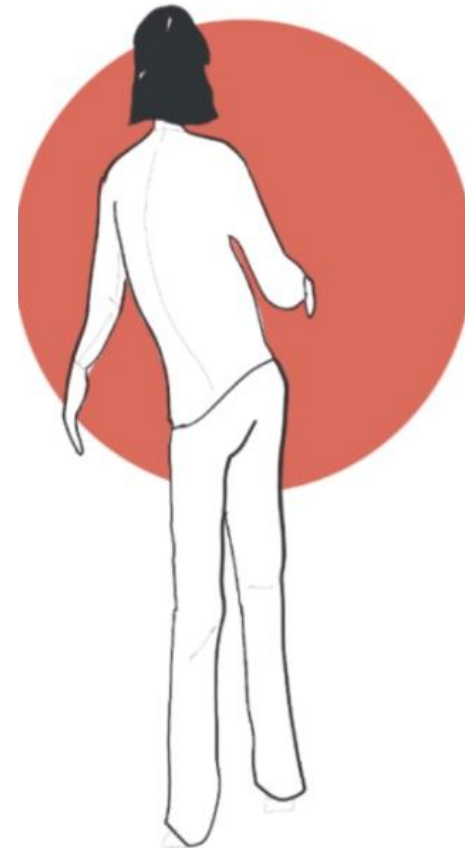


When holding a phone, the fingers stretch outwards to maintain balance.

Problems faced due to tremor



Shoulders and fingers stretched
outwards while using Phone



Gait Instability

Design opportunities

After considering insights from Swara's activity analysis and some visual depictions, here are some design opportunities:

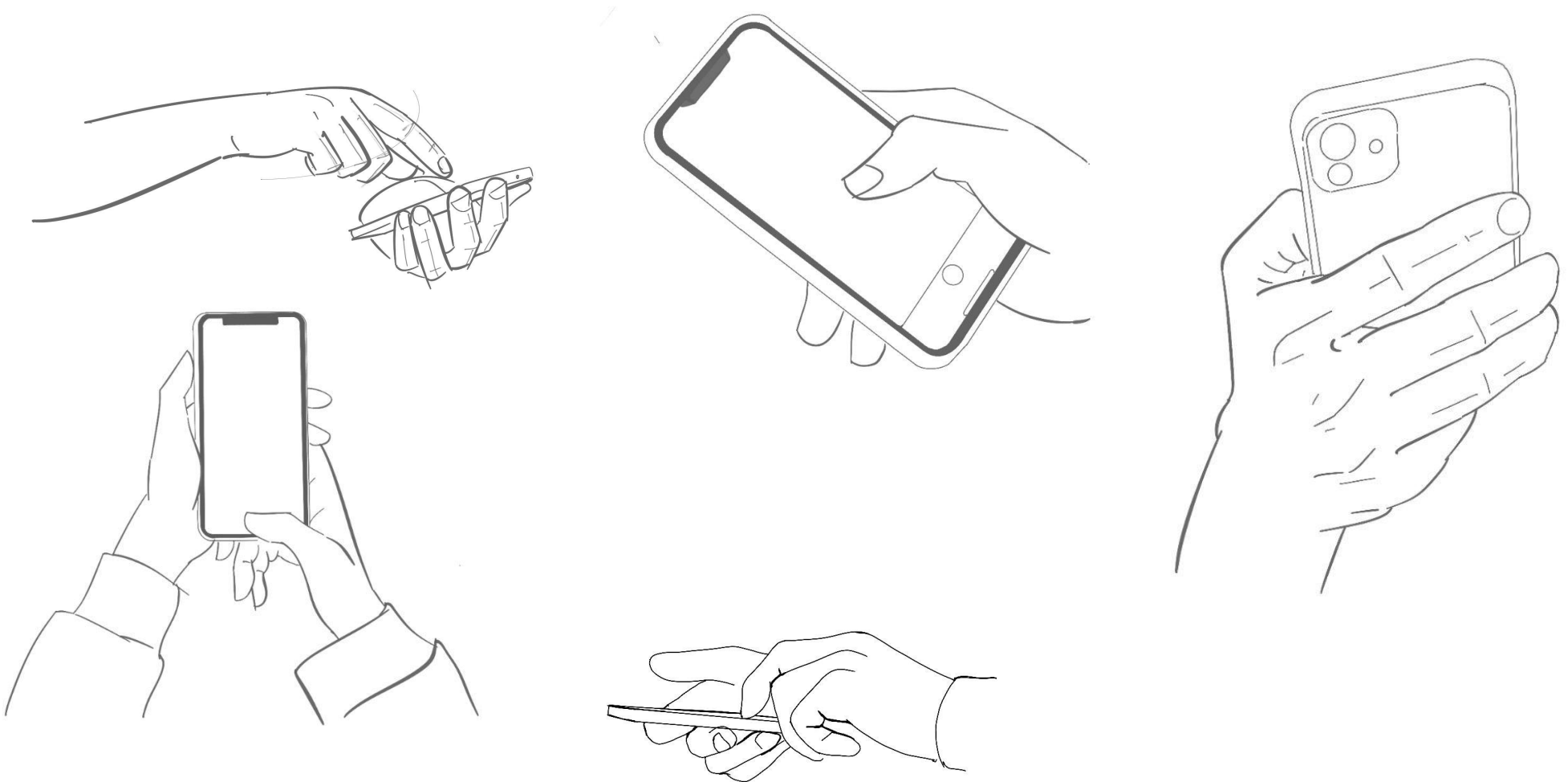
1. Assistive eating aid for balance and stability
2. Walking assistive aid for home use
3. Hand tremor stabilizing device for performing tasks
4. Assistive device for using a phone
5. Assistive aid for providing a stable sitting posture

I selected the assistive device for using a phone because:

- **Multiple Task Usage:** Smartphones are essential for daily life, including business calls, freelance support, learning, and entertainment.
- **High Impact:** An assistive device for phone use can significantly enhance independence and quality of life.
- **Continuous Interaction:** Phone usage is frequent and requires continuous interaction, making stabilization crucial.
- **Current Market Gap:** There are fewer effective solutions available for assisting individuals with tremors specifically for phone usage.

Phone usage understanding

Understanding how People try using their Phones

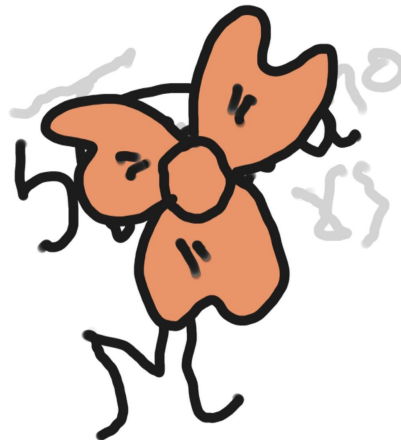
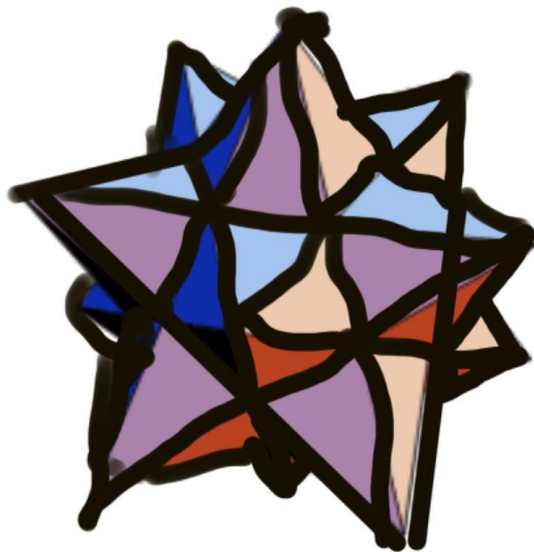
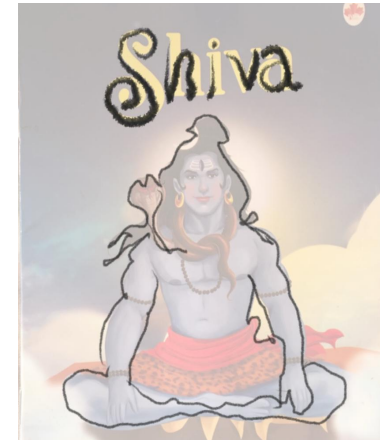


Activity-2

The task to identify the use of mobile phones in daily use so tried to make Swara sketch on iPad using Apple pencil to sketch



Swara's
Swara's
in a very
way



These are some Illustrations made by swara while having tremors

Key Insights from Activity Analysis-2

Circular grip is tough	Good grip is when all fingers hold the pencil firmly	Rolling products makes things bit uncomfortable to hold	Broader and wider and heavier grip needed
Pressure on tip is to harsh while using pencil	Screen can deflect with pressure	Pencil tip should be even closer to holding part	Point tip glides on screen
Glide on screen needs practice	Screen guard needed	More possible accidental touch	Rigorous tremor shakes screen
Lacks precision	Touch to draw arcs and curves	loose tip makes sketch clumsy	Cant use long enough
Tremor lessens grip of object	Palm covers screen makes lesser visible	Greater learning curve	Vision imbalance
Larger icon	Pinch and zoom is tough on sceen	Rotation and other interactions are not easy	Firm grip at base needed



Key insights

“Tip is more pointed than circular”

The tip of the product ensures that users can trace a path on the screen while seeing what is beneath the tip, though the vision and the traced line might not align perfectly. A rounded or cylindrical tip can provide more accuracy than a pointed tip.

Narrow grip

As the fingers hold the pencil they stiffen and feel tough to roll over the pencil and hold they make a firm grip. Either a rubber or any grip can make the grip feel good.

Heavier Mass

More the mass, more there is a belief in stability. Mass itself can reduce the lot of tremor effect on the product.

Non Glide and roll

Pencils have the tendency to roll away when they are slightly moved out of their position.

03 Mechanisms study

Techniques and Mechanisms

Tuned mass damping (TMD):

This is a technique used in various engineering fields to mitigate vibrations in structures. Traditionally applied in buildings, bridges, and other large-scale constructions.

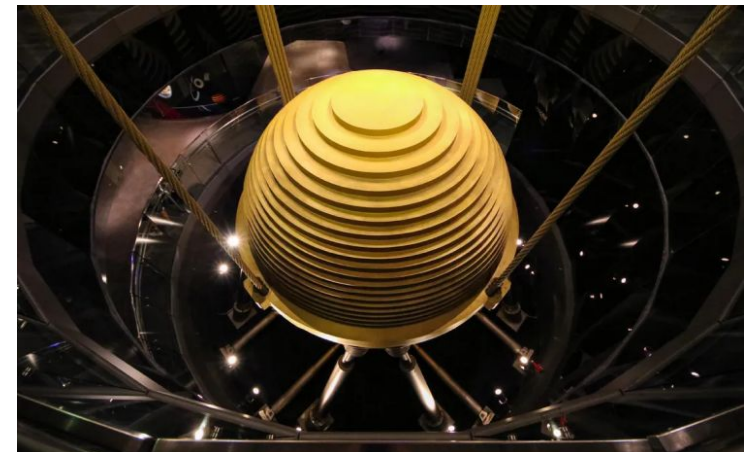
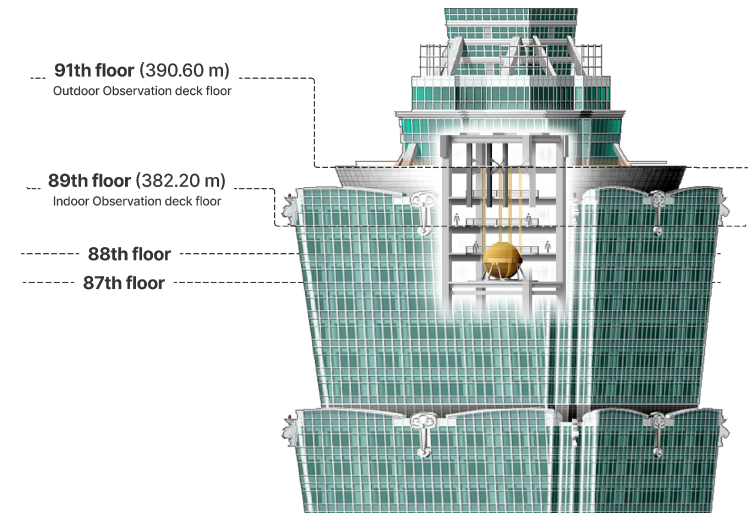
TMD work by adding a secondary mass to a primary structure. This secondary mass is connected to the structure via a spring and damper system. The mass-spring-damper system is tuned to the specific frequency of vibrations in the primary structure, effectively absorbing and dissipating the vibrational energy.

Primary Structure: The object or system experiencing undesirable vibrations.

Secondary Mass: A mass that moves out of phase with the primary structure vibrations.

Spring and Damper connects the secondary mass to the primary structure, allowing energy transfer and dissipation.

For example: Taipei 101 skyscraper employs a massive tuned mass damper of 660 metric tons to mitigate wind-induced vibrations.



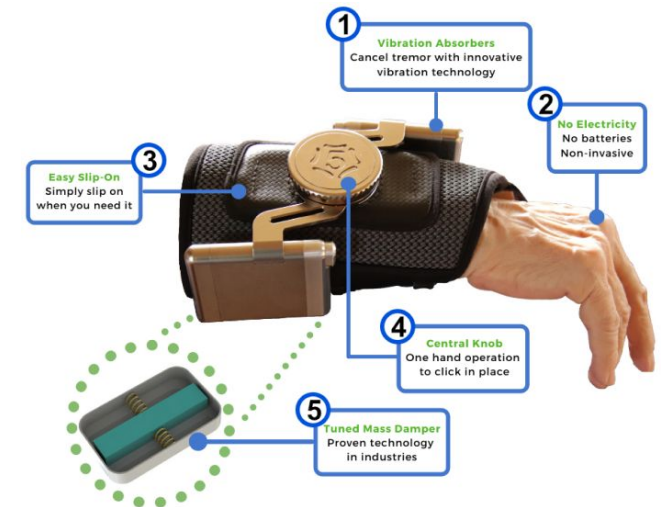
Tuned mass damping

TMD in Medical devices:

The application of TMD in medical devices, particularly for controlling tremors in patients, is an emerging field.

There are a few products and technologies designed to help manage tremors

Tremelo: This is a non-invasive hand stabilizer that straps onto the arm of a person suffering from tremors. It has sets of tuned mass dampers in each of two enclosures, which rapidly shift the weights inside to counter the motion of the wearer's tremors. The device has already shown success in 36 trial patients by limiting the amount of tremors the user experiences.



Vibrations mechanism

Liftware: This product's selection of stabilizing and leveling handles and attachments are designed to help people with hand tremor retain dignity, confidence, and independence while consuming food with spoon.



Vibration
Stabilizing



Connect
Attachment



Rechargeable



Stabilizing Technology: Advanced sensors, motors, and an onboard computer actively detect and counteract your tremors

Vibrations mechanism

 LIFTWARE



VILIM BALL

The VILIM ball helps reduce hand tremors, though its effectiveness varies by individual. Studies have shown that it typically reduces hand shaking by up to 50%. The residual effect lasts between 15 minutes to 4 hours on average, based on data from over 300 testers



Vibrations mechanism

WALK

WALK reduces freezing of gait, slowness and falls in Parkinson's Disease. It uses muscle stimulation to improve coordination while walking. Through onboard sensors, WALK collects data and tracks symptoms that may lead to falls, enabling individuals to stay active in their everyday lives without stigma or the fear of falls



Vibrating Gloves for Parkinson's

These adaptive counteracting vibrating gloves help users manage tremors and control their hands while performing precision tasks. As shown in the image on the right, the gloves ensure tasks requiring precision are completed accurately and without falling apart.

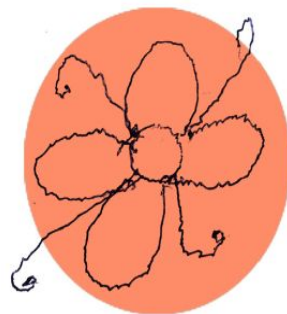


Vibrations mechanism

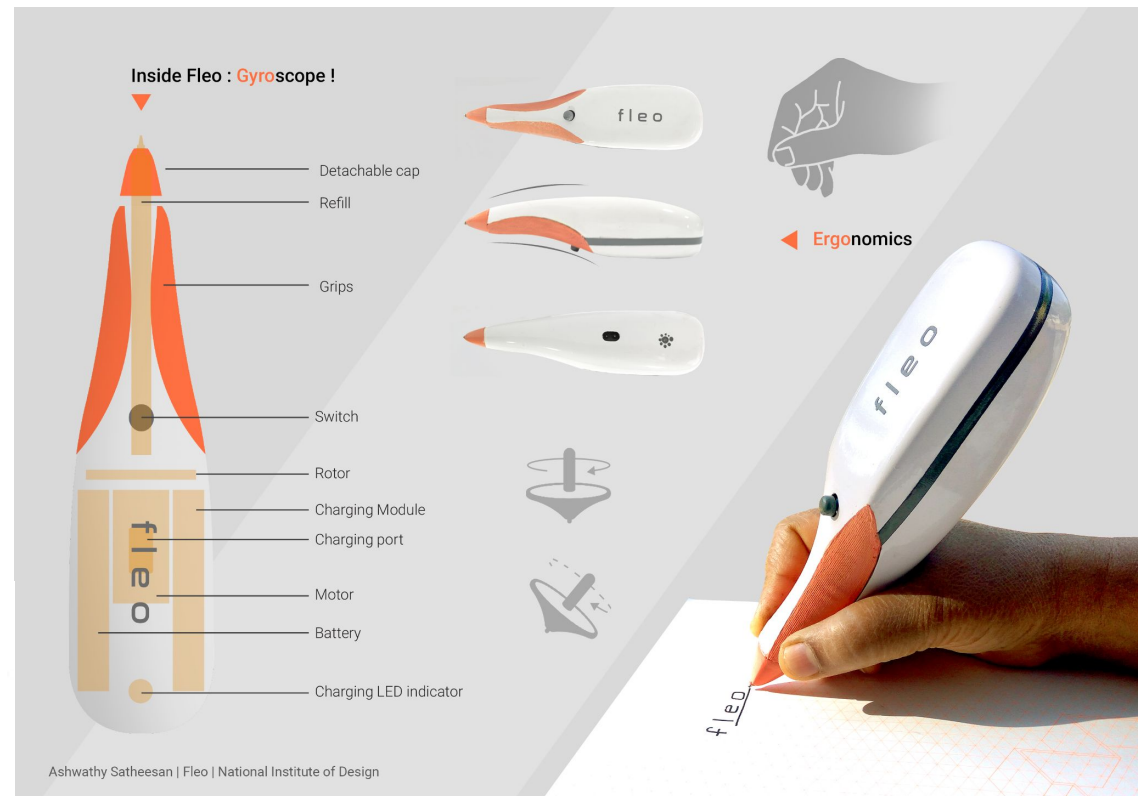
FLEO

Ashwathy Satheesan a graduate student from NID which utilizes gyroscopic principles to stabilize and reduce tremor impacts, facilitating a more confident and efficient writing/drawing.

This is a part of inspirational idea.



Handwritten text in Devanagari script: "पुष्पिनी" (Puspani) and "पुष्पिनी" (Puspani).



Magnetism

SteadyScrib

A wide-gripped pen with magnets is designed to negate the effects of shaking and tremors. A flat MS plate embedded in a pad helps the user write as others do. A heavier magnetic cover shell, at least 18mm in diameter, makes the pen incline and glide smoothly on paper through magnetic attraction.



Other designs for Tremor sensitive



04 Designing the Product

Design Objective

To Design a **product to assist “touch” interaction while using and holding smartphone**(android Phones) for patients suffering the tremors.

Target Users

Individuals with Tremors(chronic neurological tremors) with necessary cognitive abilities to use Mobile phone.

Brief

To design a Smartphone input device for users suffering from tremors. The device should ease user navigation for the patients by engaging gross motor skills and other types of tremors a. It should make use of the most easily achievable movements to trigger the control elements

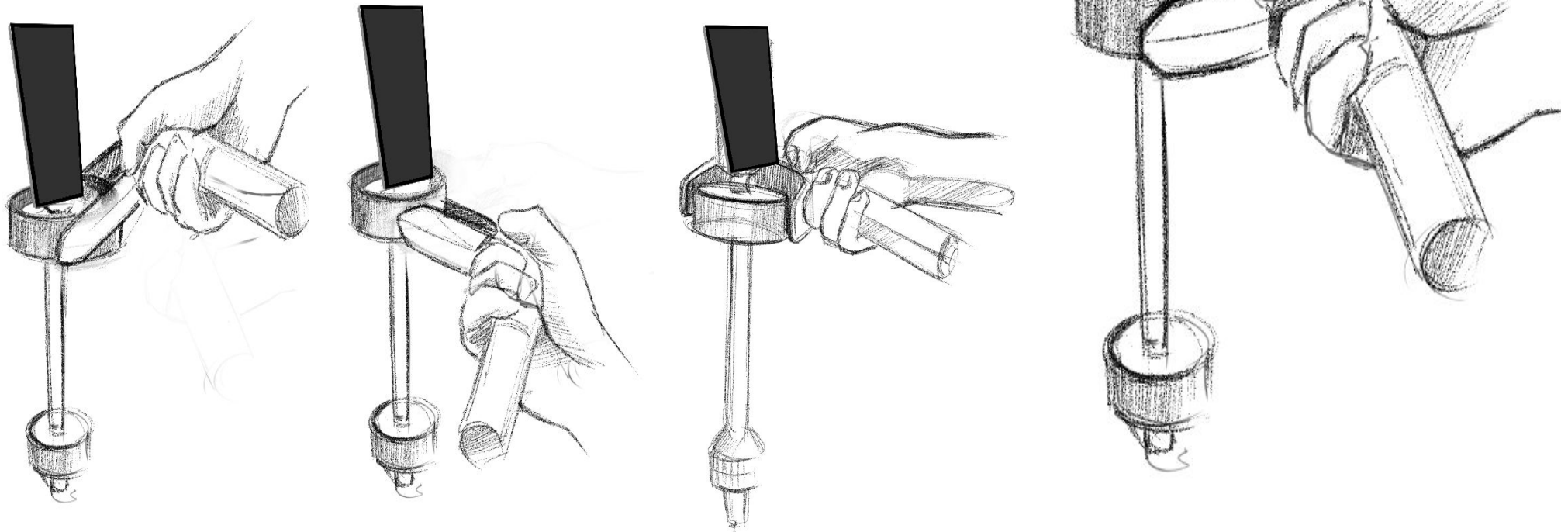
Ideations Concept 1

Concept 1- Weighted Gimbal

Gyroscopic Design with rotor and ball at the center with a L angle to hold the mobile phone firm at its place

The Pull of Gravitation and the axis bearing keep the phone steady

As per the insights the product is bit heavy and may provide solution for tremors



Ideations Concept 1

Concept 1- Weighted Gimbal

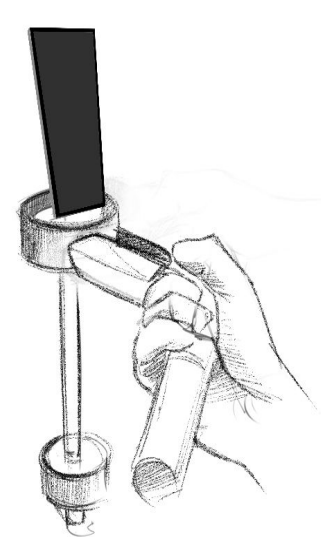
Pros

Fine balance of weight and phone

Any axis rotation

Balance due to central weight

Balance of phone at same place



Cons

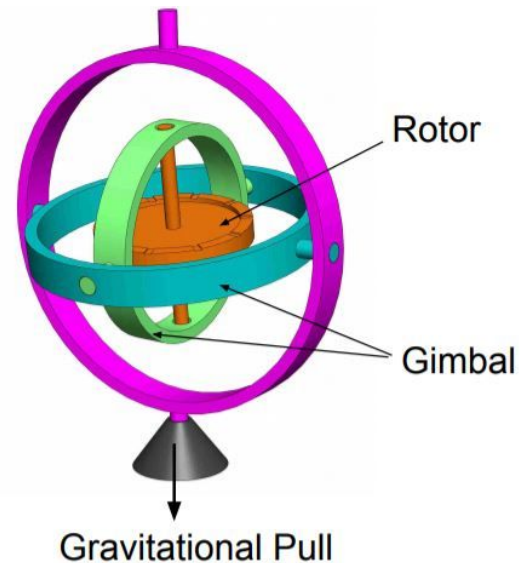
Fine balance of Motoskills

Does not satisfy vision tremor

Heavy and more tedious to carry and hold

Single handle

No support of tremors and vision imbalance



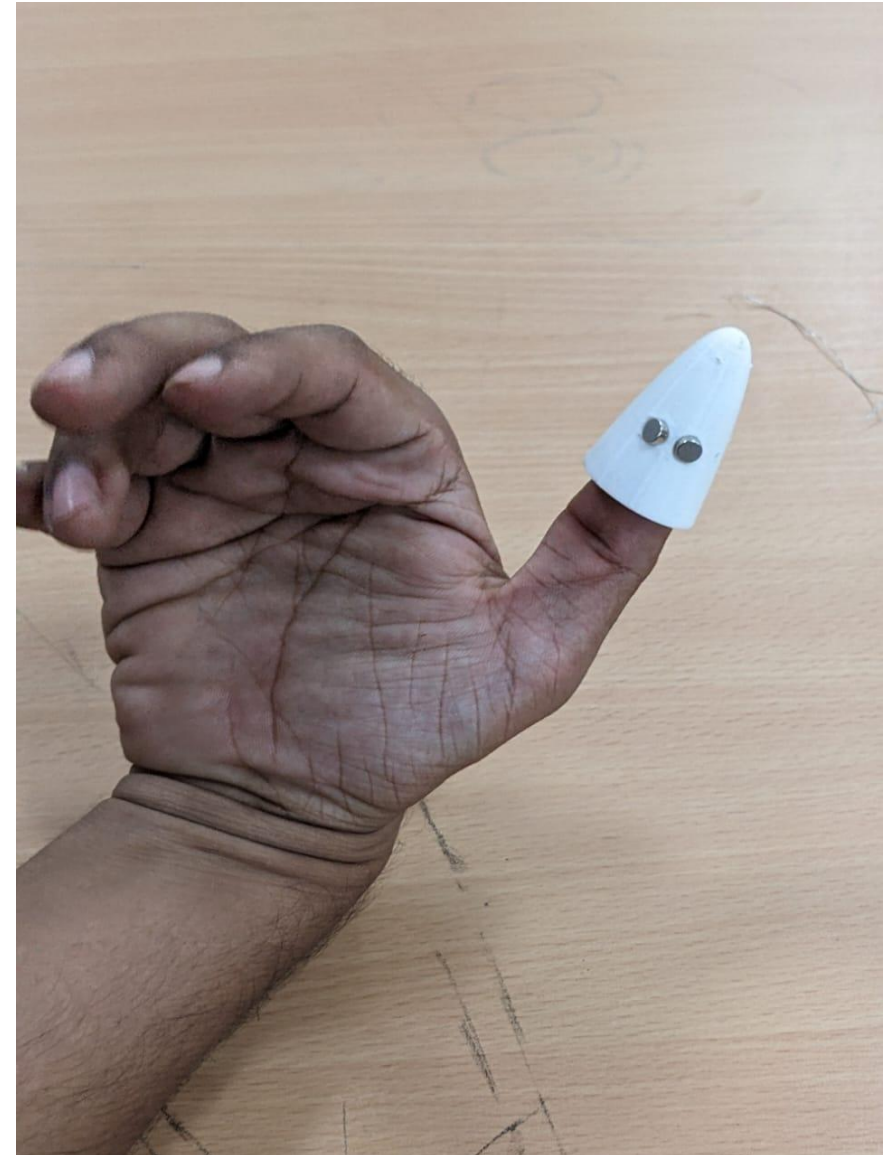
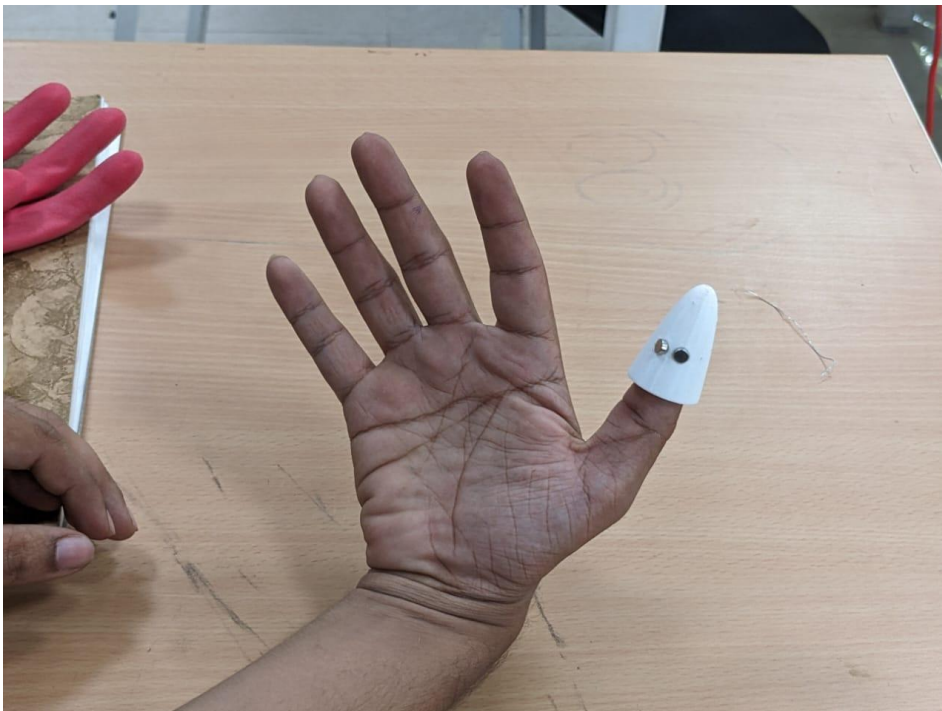
Ideations Concept 2

Concept 2- Finger touch Magnets

Features

Magnets have the capability to send signals

Fingers can send signals easily



Ideations Concept 2

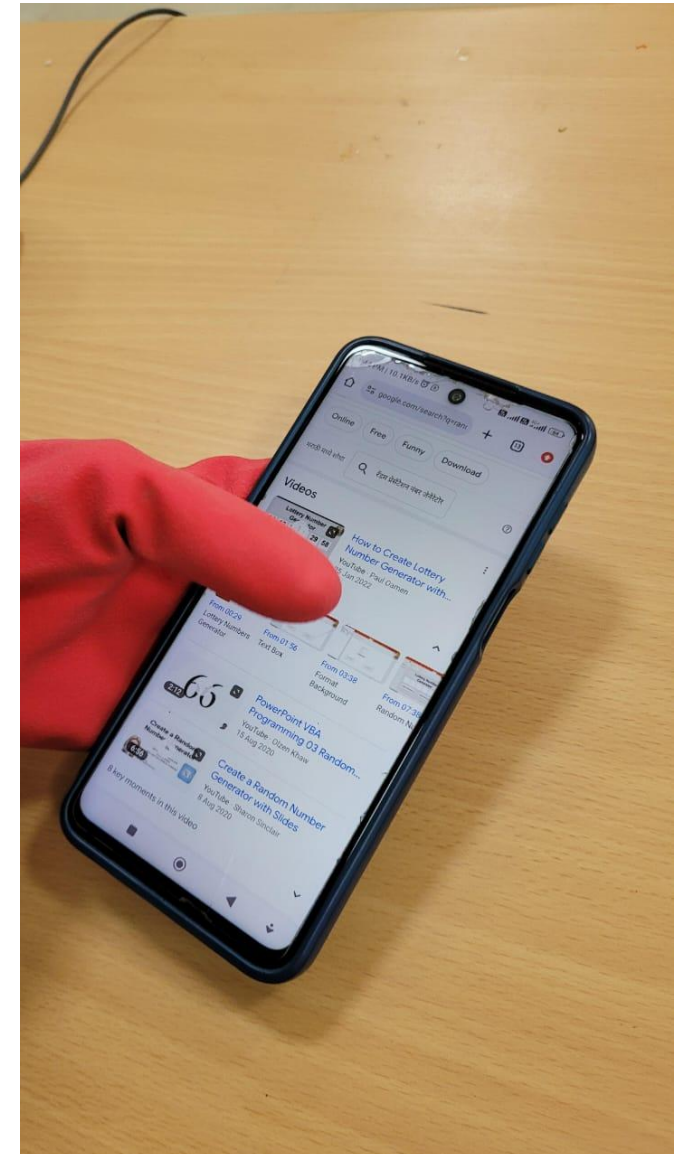
Concept 2- Finger touch Magnets

Pros

- Fine interaction with phone
- Quick access just like phone
- Quick reaction time

Cons

- Fine balance of Motoskills
- Does not satisfy finger tremor
- Wearable on fingers
- Single handle
- No support of tremors and vision imbalance



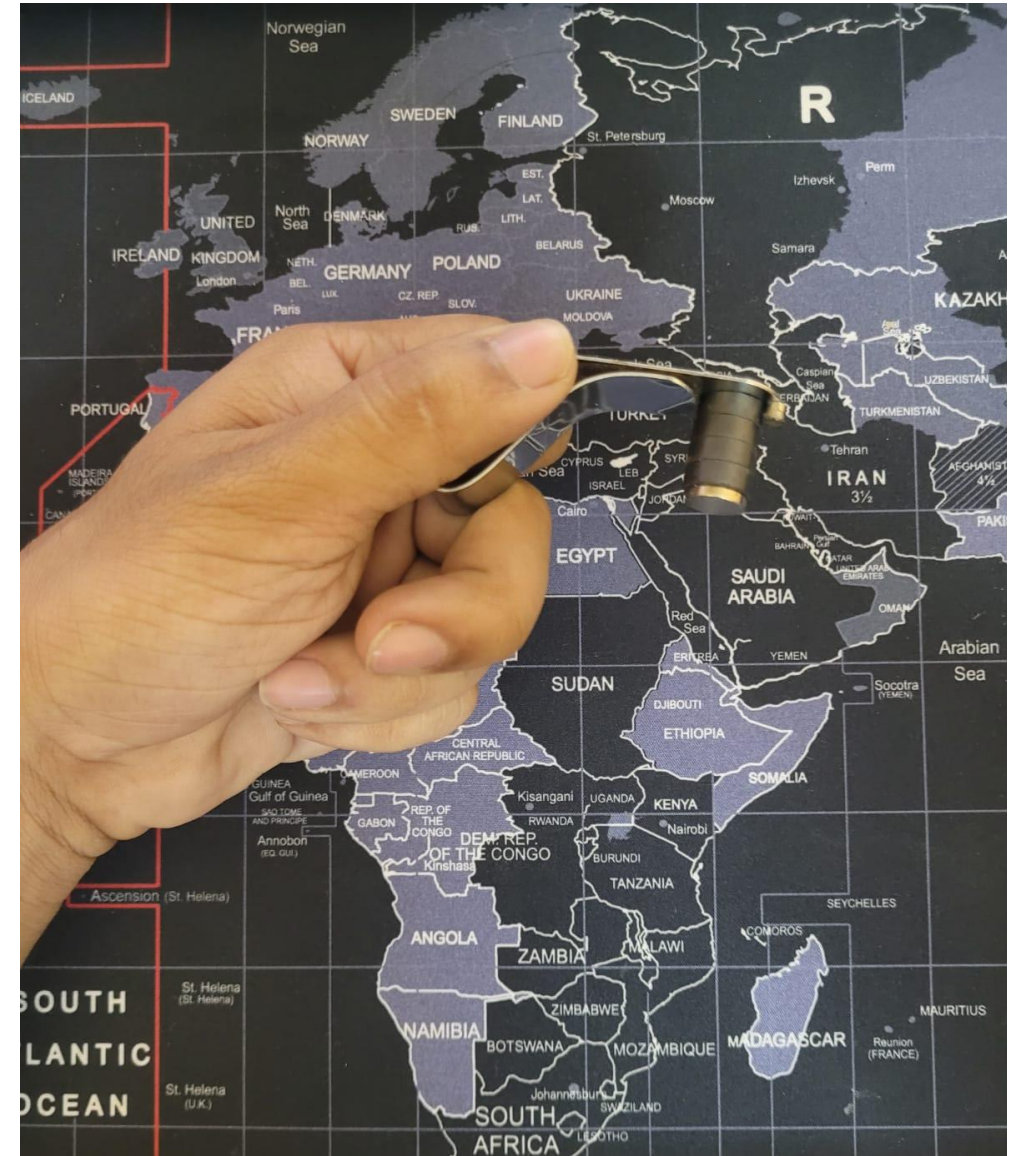
Ideations Concept 3

Concept 3- Anchor support to use

Features

Magnets have the capability to send signals from metal to screen

An anchor shape to hold the product firmly in between the fingers



Ideations Concept 3

Concept 3- Anchor support to use

Pros

- Fine interaction with phone
- Quick access just like phone
- Quick reaction time

Cons

- Fine balance of Motoskills
- Does not satisfy finger tremor
- Wearable on fingers
- Single handle
- No support of tremors and vision imbalance



User Testing

Pros

Magnets a set to touch easily

Tiny and powerful

Heavy when used and makes Tremor user to pull with force

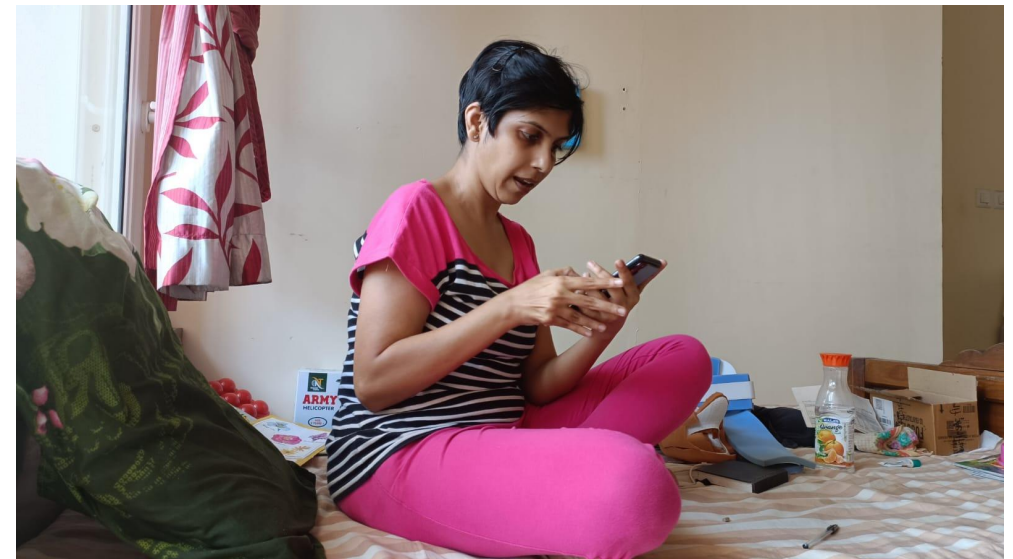
Easy learning curve

Cons

Polarity of Magnets

Pull force is sometimes too much for the user

Brittle in nature



Ideations

Final Concept

This idea combines the use of Magnets and the phenomenon of Concept 01 and Concept 2

The idea is to combine Pen as product and include TMD



Final Ideation

Theme

The product pen is a handy tool which can be held in hand while working.

The product consists of mass on top and the tip of magnet at the base

The Magnet as tip is the Tool's point of contact with the screen



Final Ideation

Mass damping experiment

The phenomenon of mass damping works on the principle of adding a heavier mass on an elastic product or a structure which takes tremor.

This force will reduce the tremors and improve stability

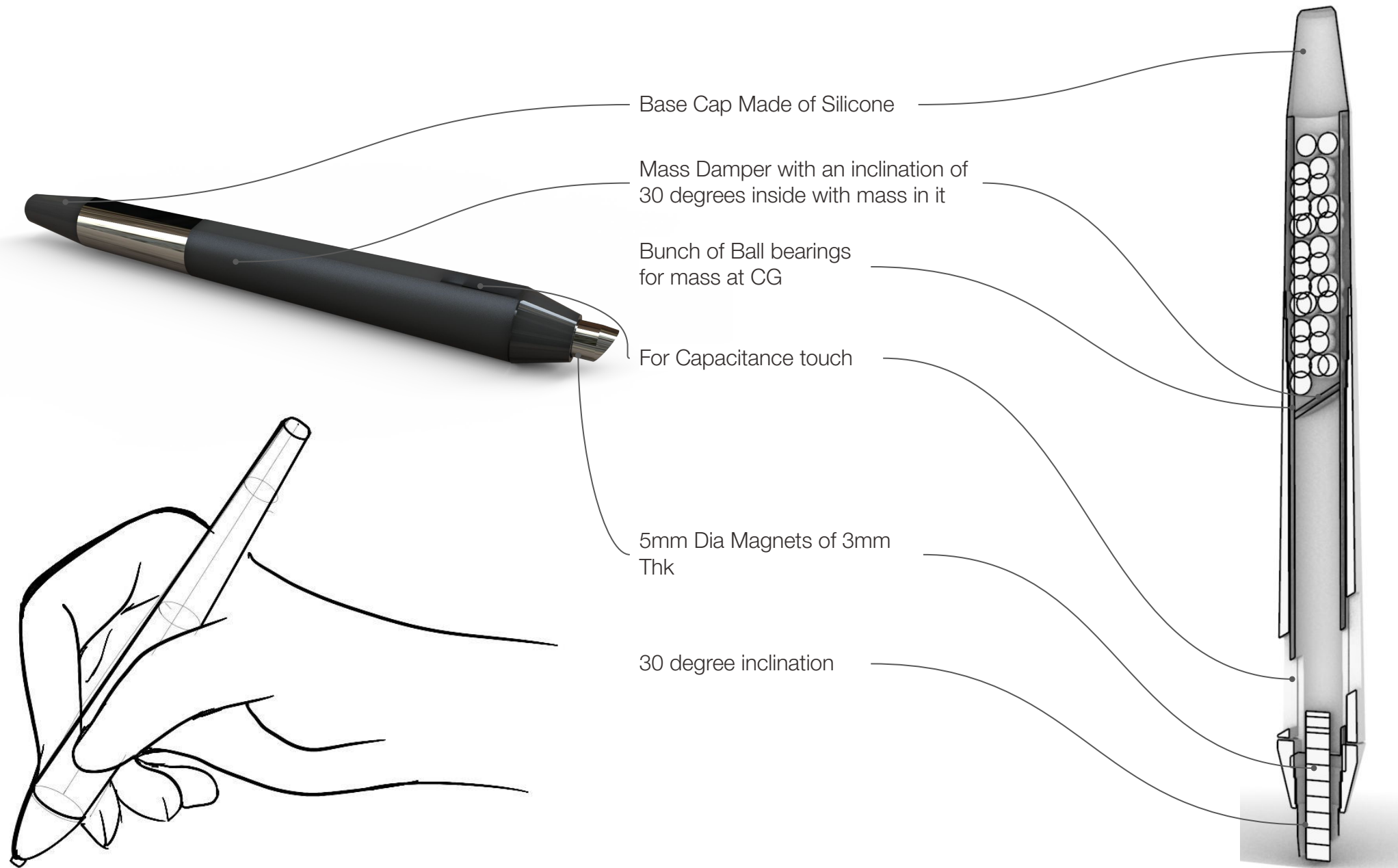


Masses on top of structure to reduce the damping of the



The incline position of the base replicates the hand and mass damping is only possible when the masses are normal to the ground

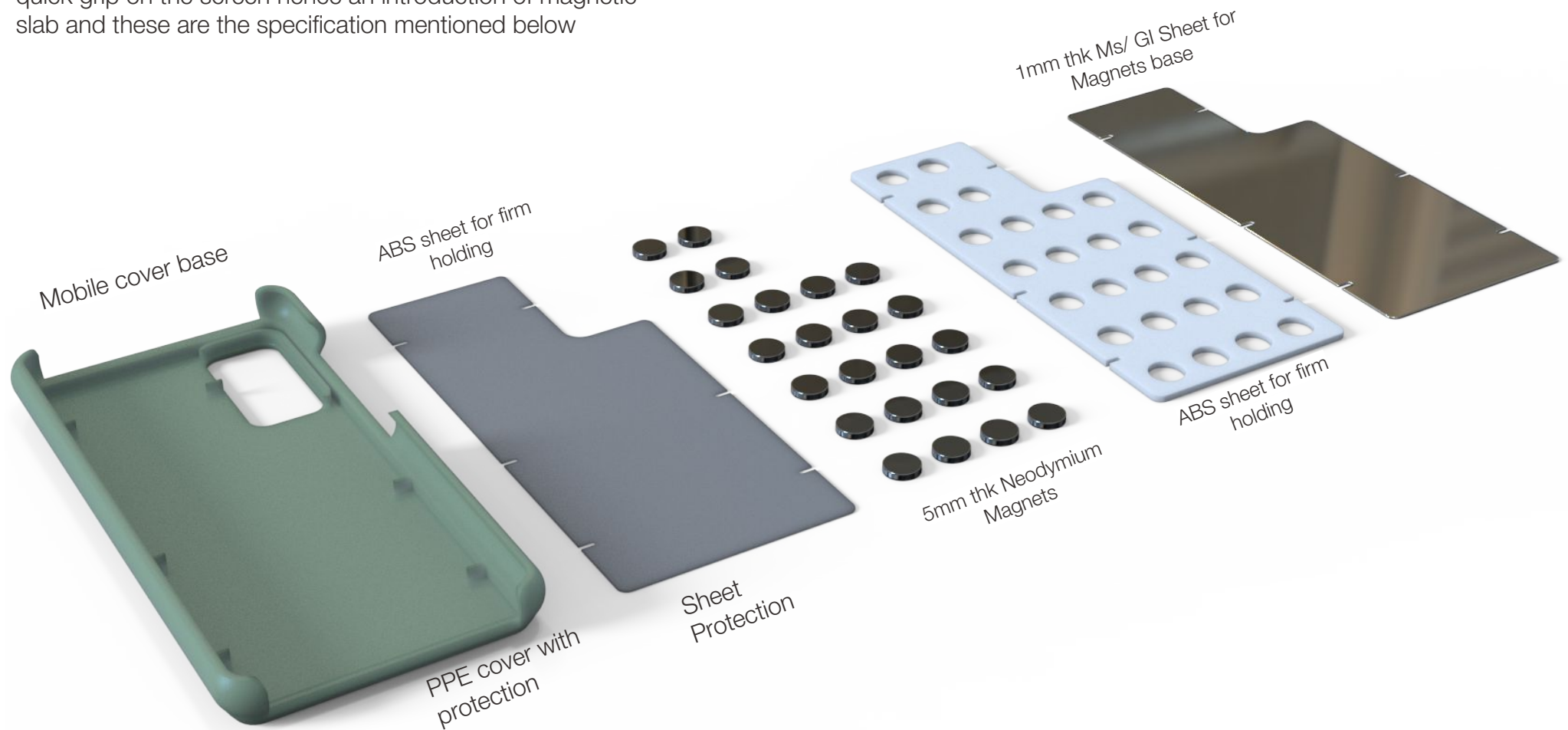
Concept 3 Magnetic Stylus



Magnetic Slab and cover

Introducing Magnetic slab

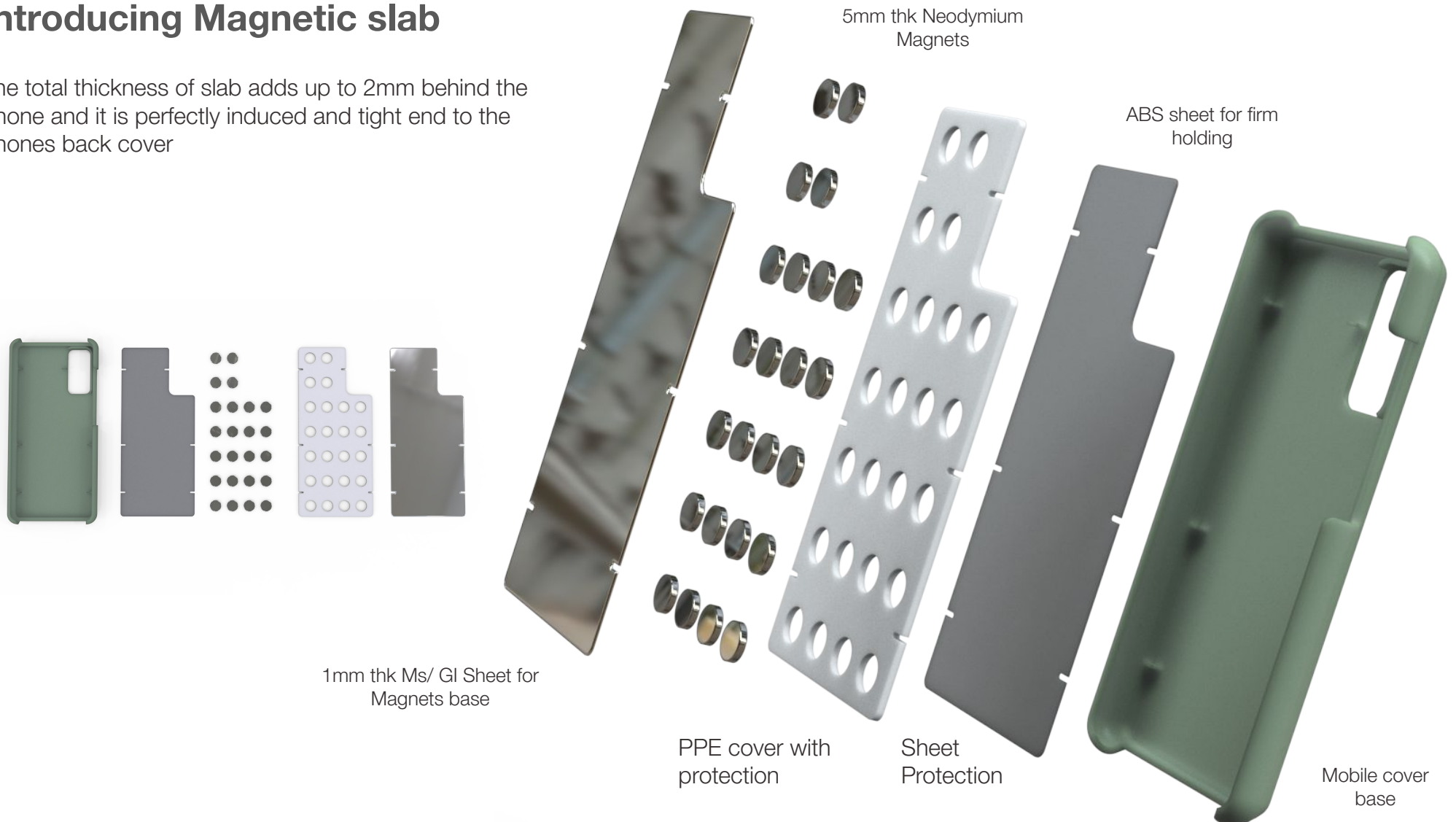
After the use of Magnets as stylus on the screen there is no quick grip on the screen hence an introduction of magnetic slab and these are the specification mentioned below



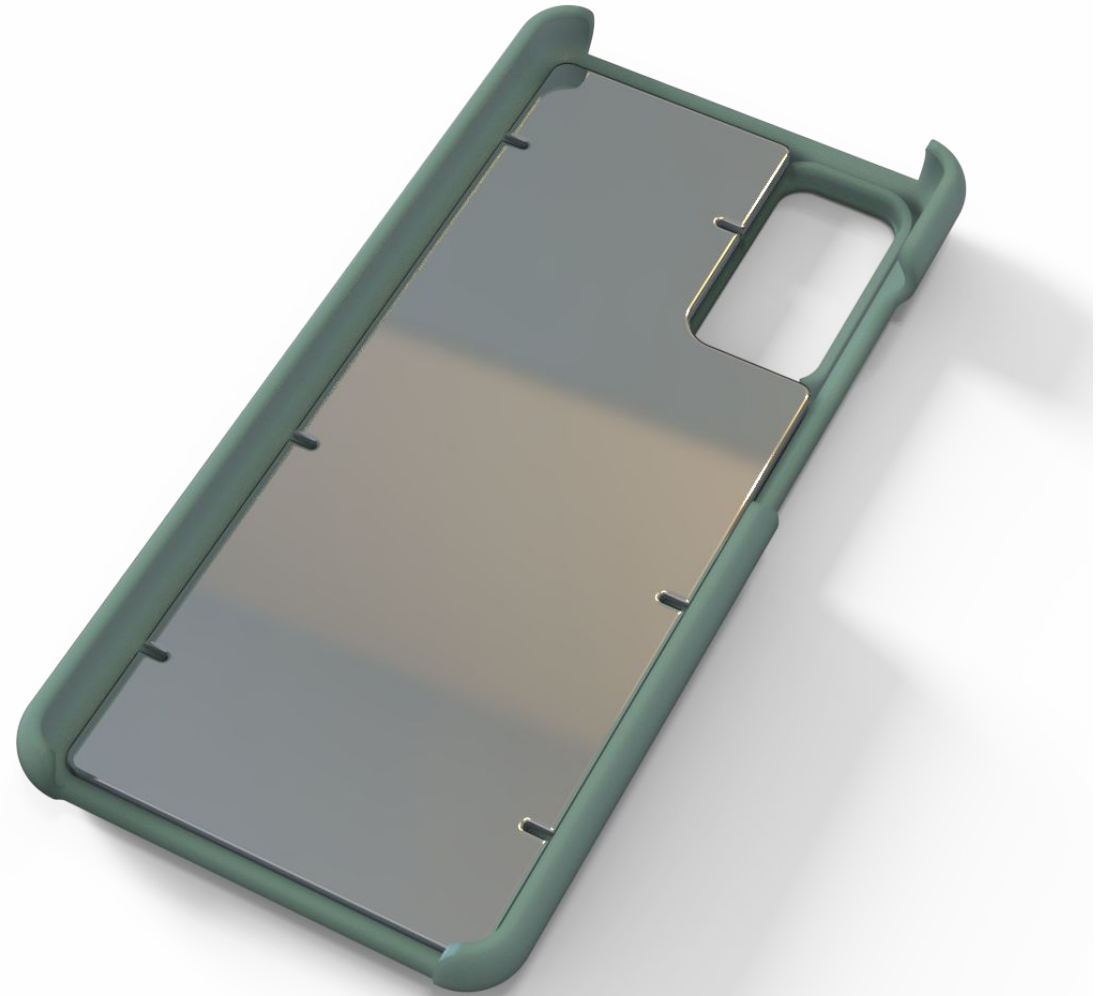
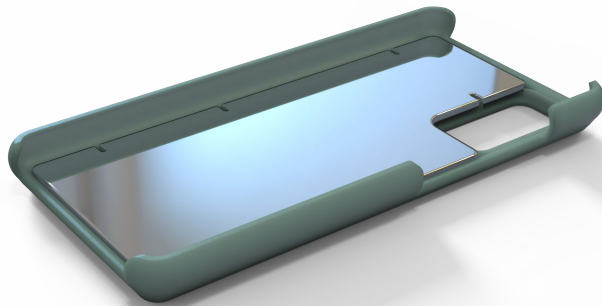
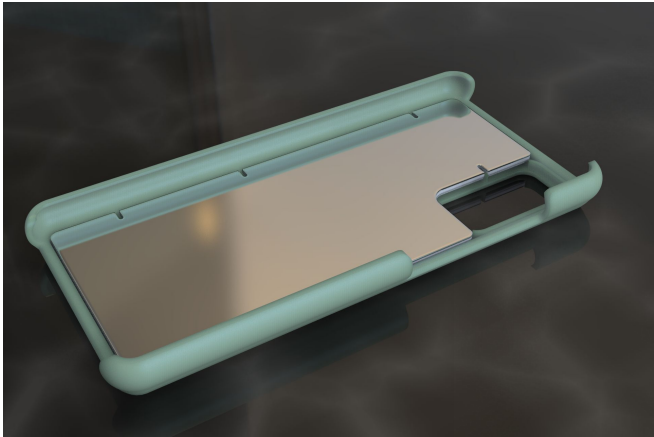
Magnetic Slab and cover

Introducing Magnetic slab

The total thickness of slab adds up to 2mm behind the phone and it is perfectly induced and tight end to the phones back cover



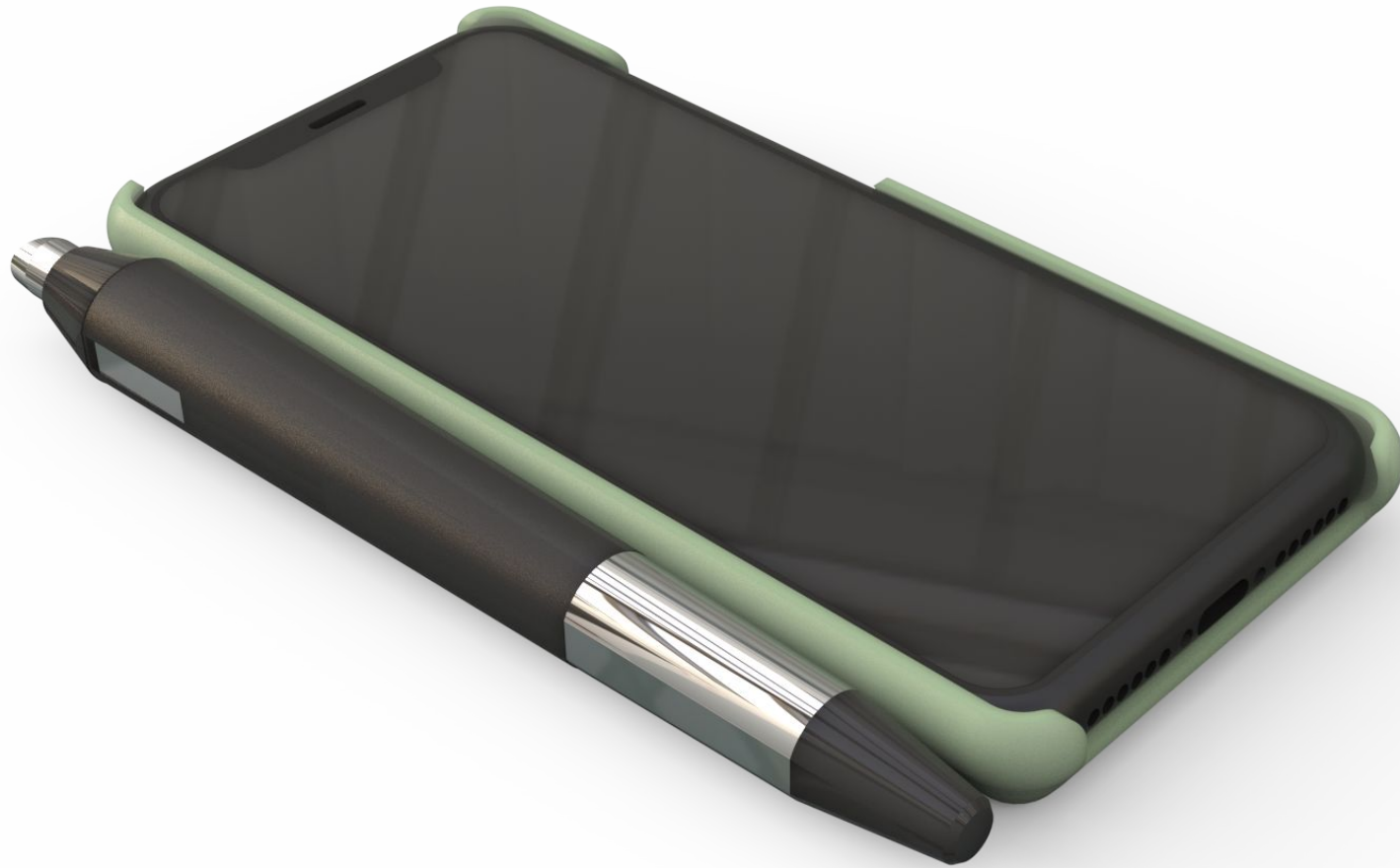
Magnetic Slab and cover



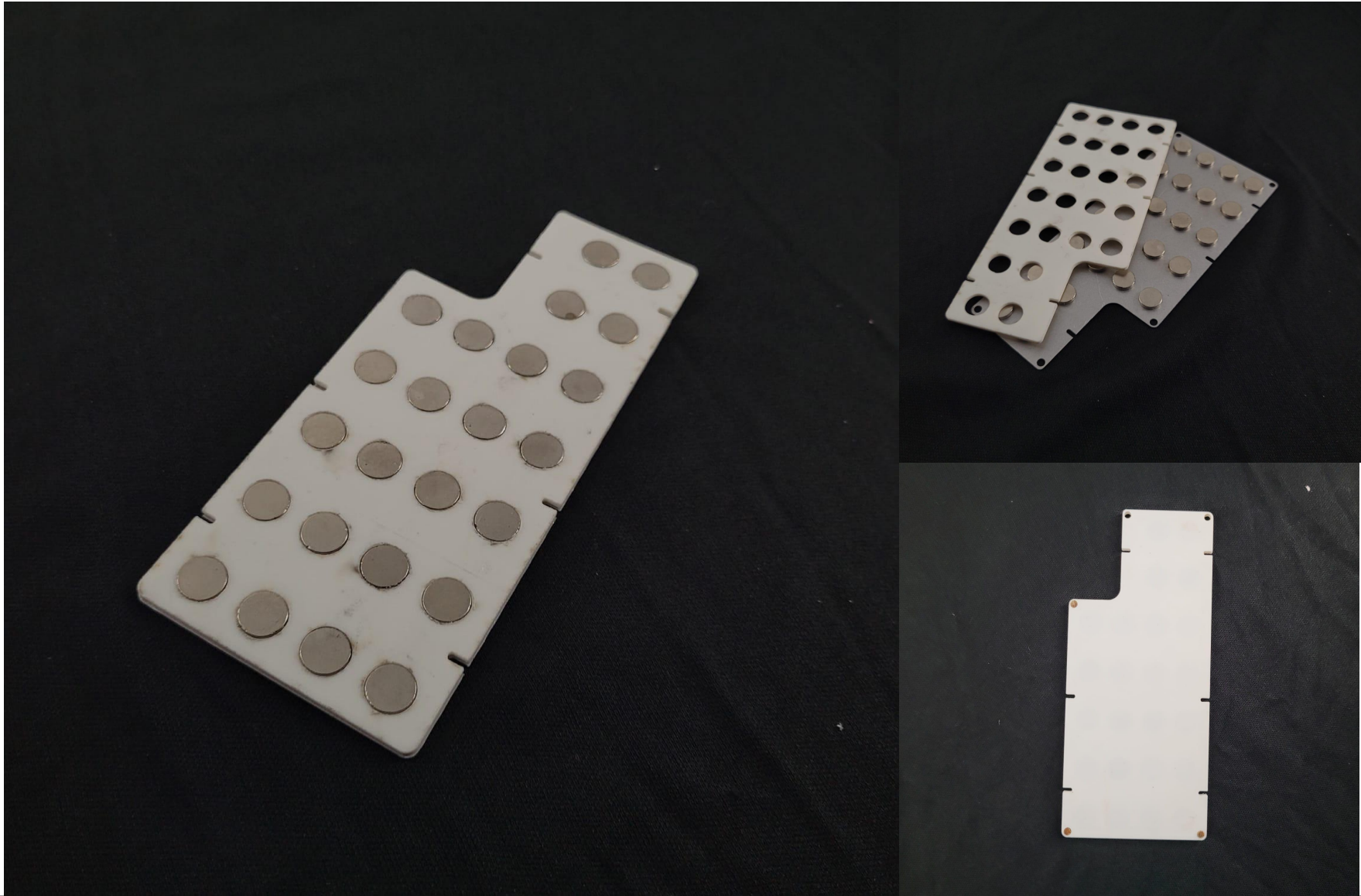
Mobile cover and interaction with stylus



Magnetic Slab and cover



Model images of magnetic slab



Model images



References

1. <https://medlineplus.gov/tremor.html>
2. [Tuned mass damping](#)
3. [Tremelo](#)
4. [Liftware](#)
5. <https://www.betterbrainandbody.com/vilim-ball>
6. <https://www.jamesdysonaward.org/en-NZ/2019/project/fleo>

Thank you