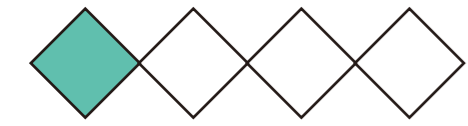# Master Major Project

Design Process Journal

Flexible Laptop

A Laptop Design to Improve Your Health Experience During Remote Work
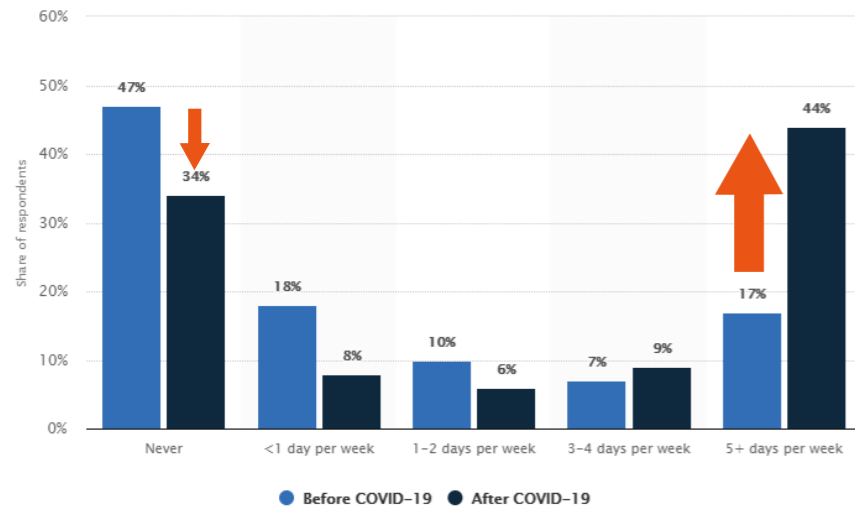
Product Design Engineering 2021

Designed by: Tongliang Huang | 695370903@qq.com | Tutor: Alieen Biagi | Nick Bell | Jon Barnes

THE GLASGOW SCHOOL OF ART

Discover

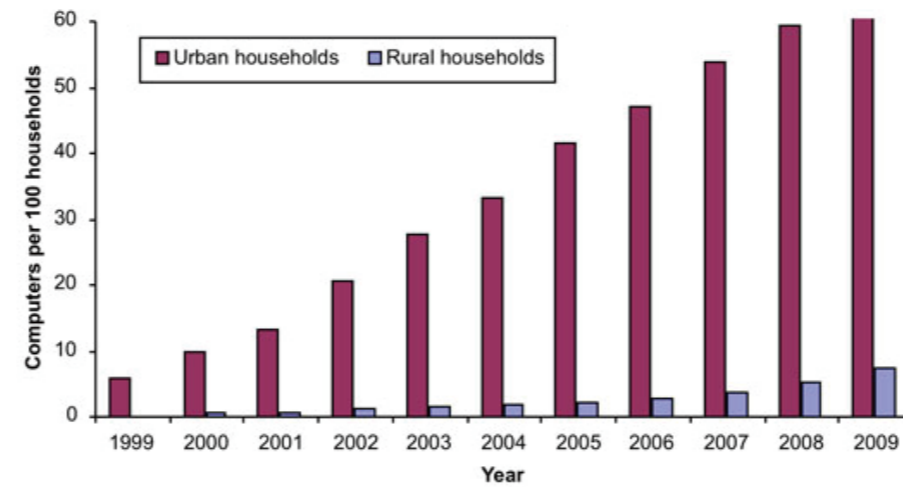## Background, Initial Research & Questionnaire

Remote Work Trends during Pandemic (1)

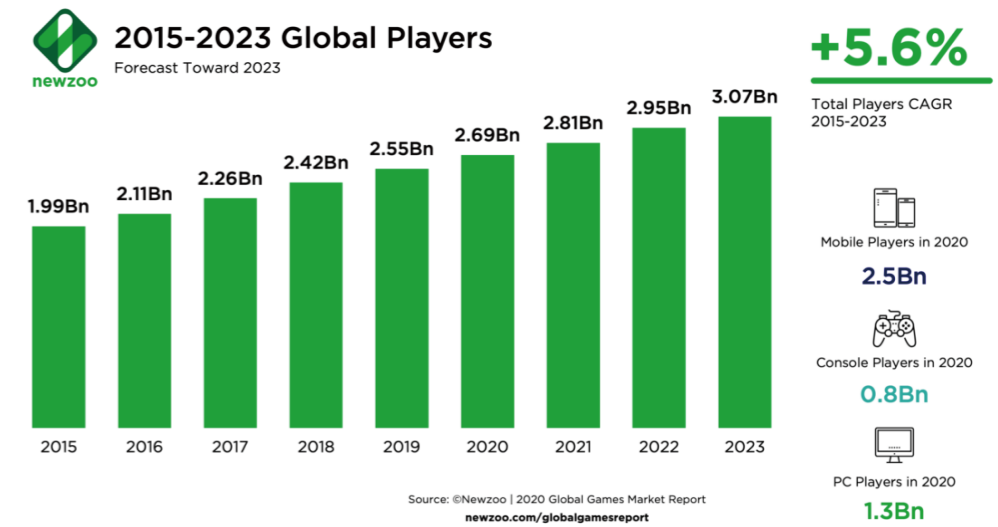More and more people are going to work at home during the pandemic.

Trend of Computer Ownership(2)

Due to the convenient of the Internet and the pandemic, people tend to use more and more computer at home.

Global Online Players Market(3)

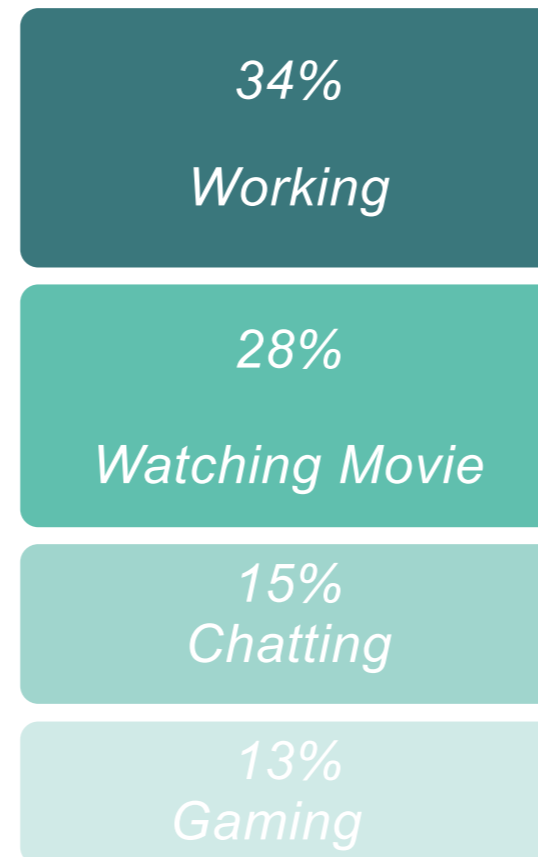More people like to have entertainment online.

newzoo

2015-2023 Global Players
Forecast Toward 2023

1.99Bn 2.11Bn 2.26Bn 2.42Bn 2.55Bn 2.69Bn 2.81Bn 2.95Bn 3.07Bn

2015 2016 2017 2018 2019 2020 2021 2022 2023

+5.6%
Total Players CAGR 2015-2023

Mobile Players in 2020
2.5Bn

Console Players in 2020
0.8Bn

PC Players in 2020
1.3Bn

Source: ©Newzoo | 2020 Global Games Market Report
newzoo.com/globalgamesreport

What People Do at Home during Pandemic?

Working

Studying

Playing Games

Sporting

Cooking

Insight

Most of remote work are related with the computer.

Result of Questionnaire (266 Participants)

Reasons of Using Computer

34% Working
28% Watching Movie
15% Chatting
13% Gaming

Time Spending on the Internet

< 1 Hour — 31% Before Pandemic / 18% After Pandemic

>4 Hour — 26% Before Pandemic / 40% After Pandemic
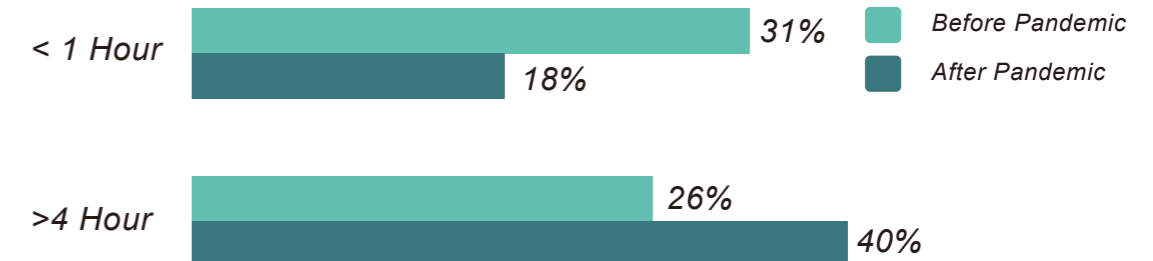
Time Spending on Sport

Once Every 5-7 Days — 20% Before Pandemic / 15% After Pandemic

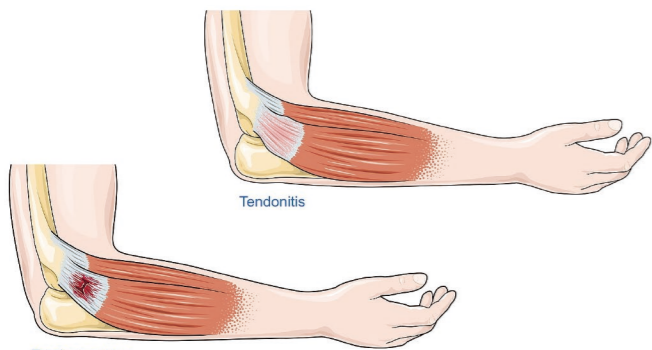Once Every 7 Days — 37% Before Pandemic / 38% After Pandemic

Insight

People spending more time with internet while the amount of sports did not change.
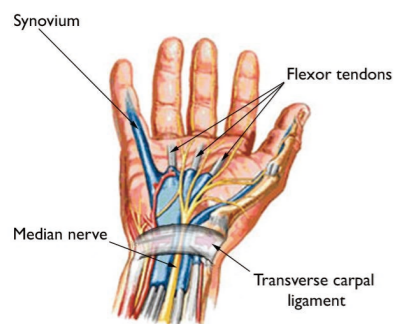
Discover

Effect & User Journey from Interview
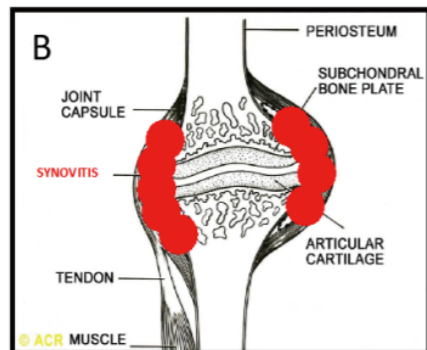
Health Issues when Using Compute for Long *(4~8)*

WRONG SITTING POSTURE

Lung Collapse Caused by Poor Posture, Sedentary and Immobility

Malnutrition and Lack of Exercise

- Photosensitive Epileptic Seizures (PSE)
- Computer Vision Syndrome (CVS)

- Tendonitis

Degenerative Disease of Spine

- Carpal Tunnel Syndrome

- Rheumatoid Arthritis Synovitis

User Journey from User Interview

Neck Bended Due to Low Position of Laptop

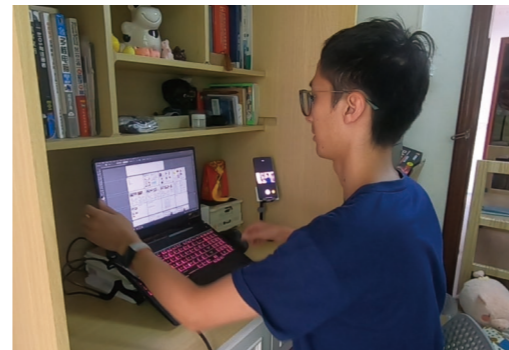a. User sits forward in order to reach the keyboard and type conveniently.

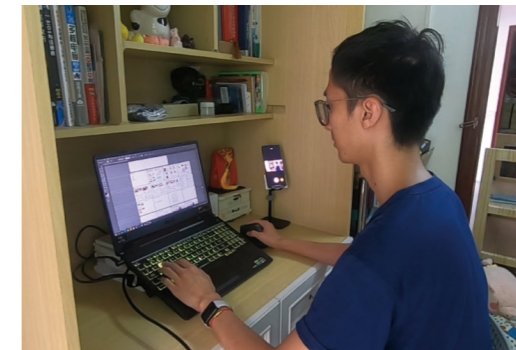b. After a period of time, user wants to sit back and have a rest. The hand is stretched.

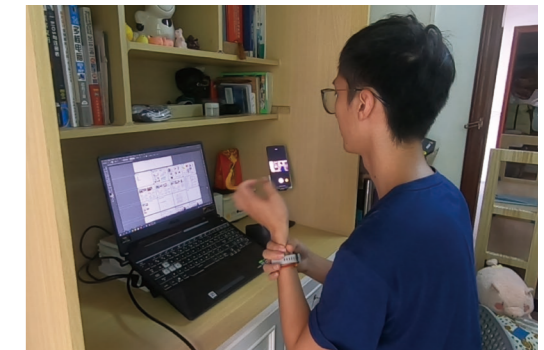c. After working for long time, user would move forward and bend his head unconsciously.

Wrist Bended Because of the Laptop Stand

d. User puts a stand under the laptop so that he doesn't need to bend his head.

e. He bends his wrist to type on the client keyboard.

f. User relaxes his hand after a long period of time.

No Space for Storying the Keyboard

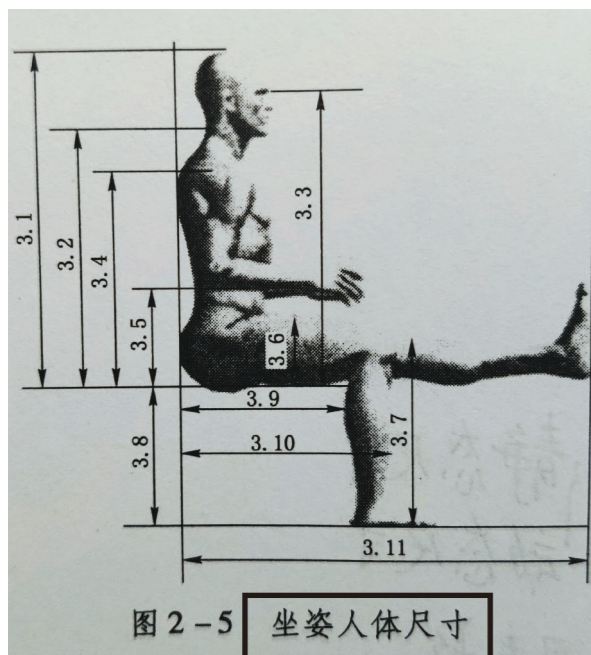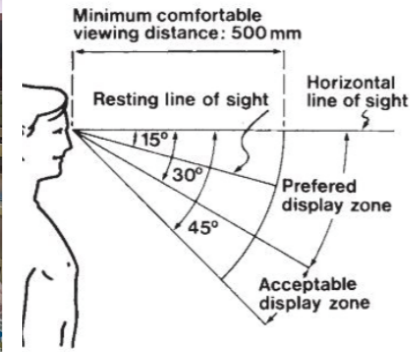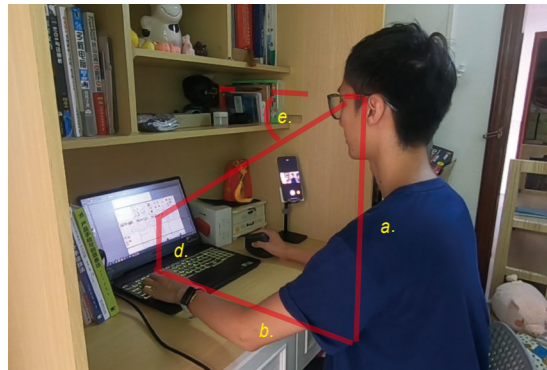g. User buys an extra keyboard so that he could type conveniently.

h. User puts away the keyboard when he want to do paper work in the desk.

i. The desk is small that he couldn't keep the keyboard on the desk.

Discover — Problem Analysis, Market Research & Evaluation
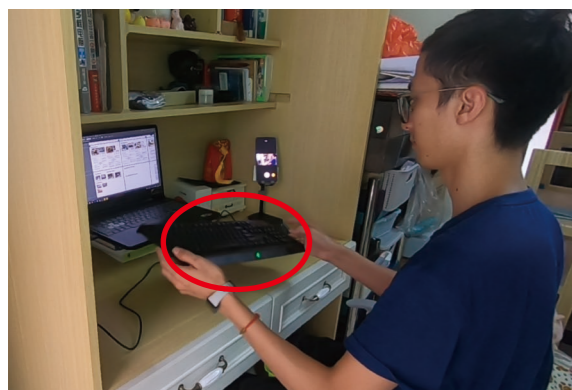
Problem 1: Viewing Angle (9~10)
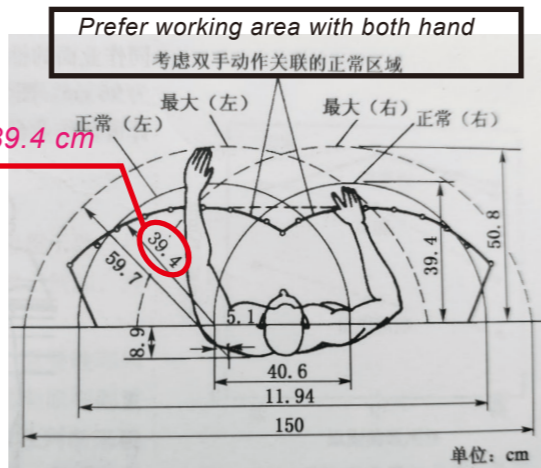

图 2-5 坐姿人体尺寸
Sitting Size

- The average visual angle (e.) of male (P50): 36° (Calculation)
- About 50 percent of male are viewing laptop in just an acceptable range.

Problem 3: Space

- No space for an extra keyboard.

Problem 2: Typing Posture (11)

Prefer working area with both hand
考虑双手动作关联的正常区域
39.4 cm

- The average working distance on keyboard from hand: 475 mm (Measure distance), which is bigger than the prefer distance.
- The working angle for hand would be too big if user lift the laptop and watch the screen comfortably.

Market Research Analysis

Current Solution of Potential Customer Working in **Narrow Space**

Laptop Stand with Extra Keyboard

- Easy Mechanism to Adjust Height and Angle
- Two Keyboard that Consume Space
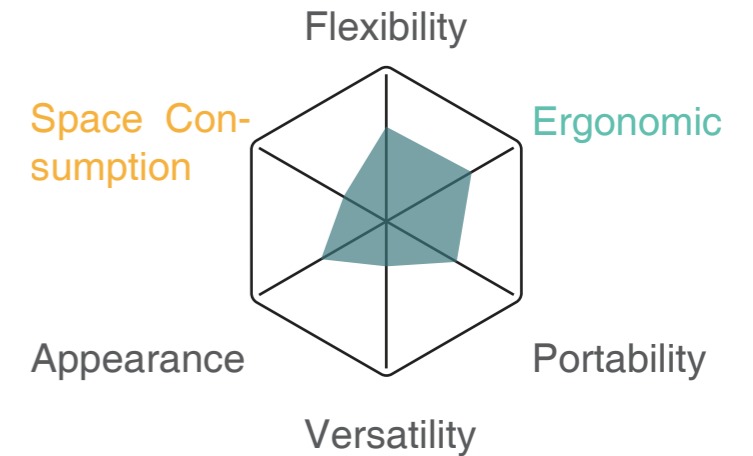
Stand with Chair

- Easy Mechanism to Adjust Height and Angle
- Difficult to Bring to Other Place

Extra Table Storage to Lift Height

- Mutifunctional
- Consume too much space

Define

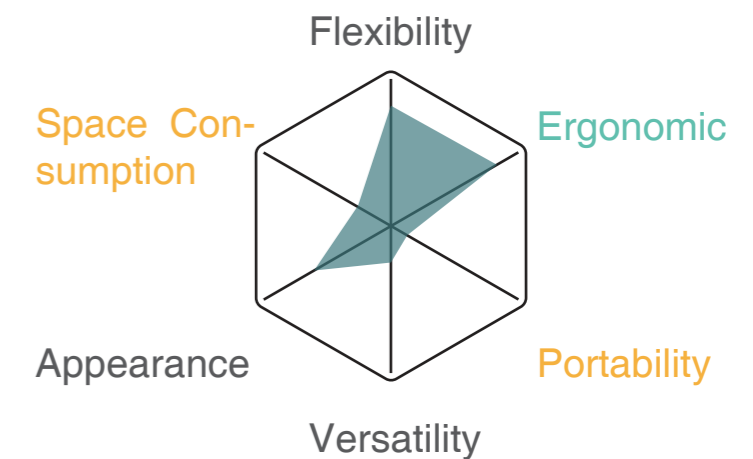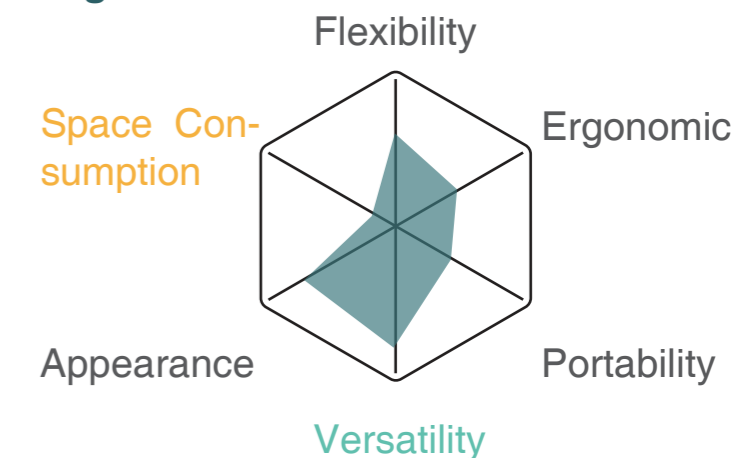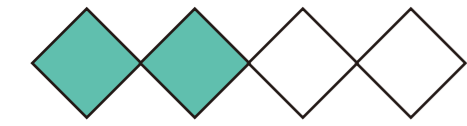## Project Brief, Requirement, & Concept Generation

Target Group

Student

Officer

The project would focus on first-time buyer such as fresher who is going study or work in a narrow space (Accommodation or etc.) They might encounter difficulties in health or space while using a laptop.

Environment

Office

Accommodation

Features

The space is crowded and wide with daily stuffs. A laptop could barely fit on the desk.

Problem Summary

- **Viewing Angle of Laptop was too large.**

- **Typing distance was too long.**

- **No space for too much devices.**

Product Requirement

- **The product should provide a healthy environment for user.**

- **The product could be space saving so that people could place it in narrow space.**

- **The product could adjust different height of people.**

Concept Generation & Evaluation

Concept 1: Desk to Store Laptop and Daily Devices
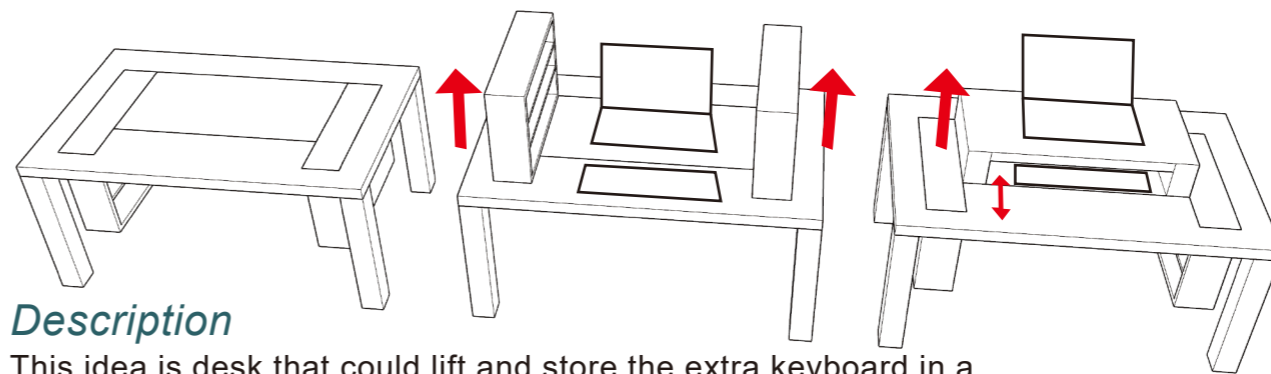
Description

This idea is desk that could lift and store the extra keyboard in a probable way. People could also store daily stuffs on both easily and reach them conveniently.

Reasons of Design:

People usually put daily stuffs on tables and seldom use drawer because they would always forget what is inside it so they need to open the draw one by one to find something. Meanwhile, the viewing angle of laptop is too large on the desk.

Result of Evaluation:

- 🟩 Could store and find stuffs easily.
- 🟧 Seldom move it because of big size and weight.
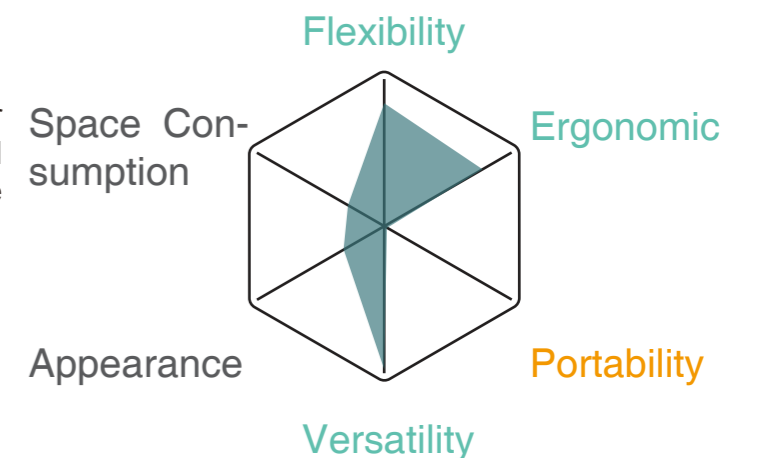
Define — Concept Generation & Evaluation

Concept 2: Laptop with Keyboard Projector

Flat Surface

Description

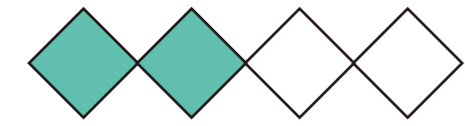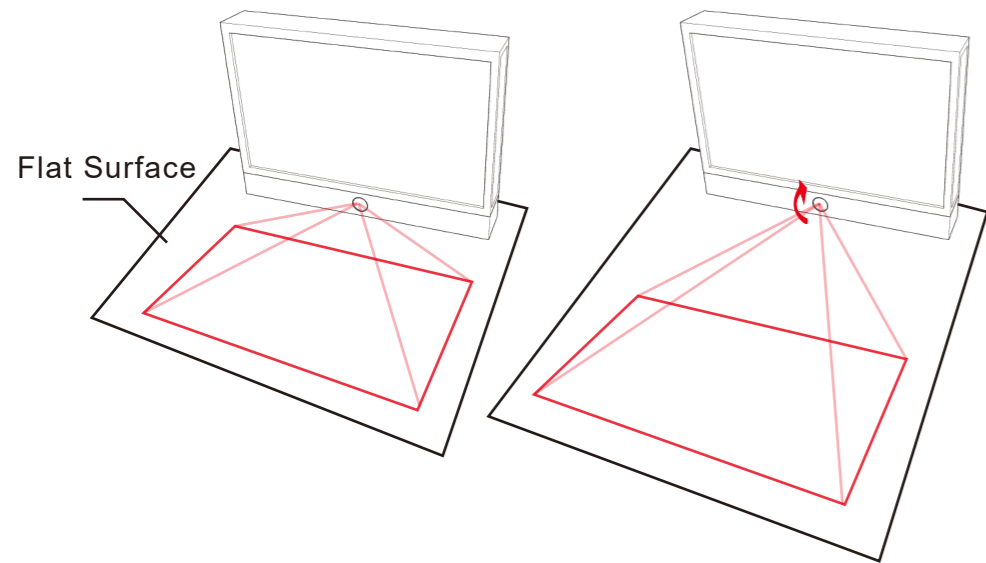This idea is about a laptop install by infrared keyboard projector. The projector could change the angle in order to adjust depth so that people could type in a prefer range. It also saves space so that people could do physical work on the keyboard.
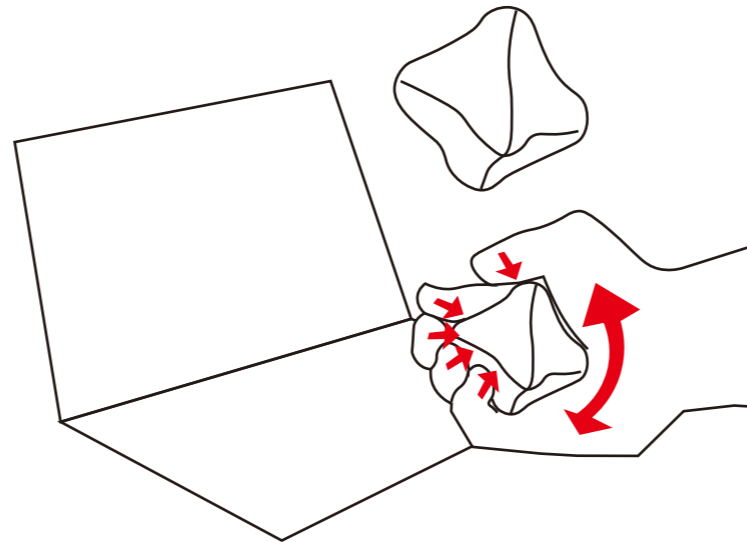
Reasons of Design:

The typing range in a narrow space would be large. Meanwhile, a physical keyboard would consume space.

Flexibility
Space Consumption
Ergonomic
Appearance
Portability
Versatility
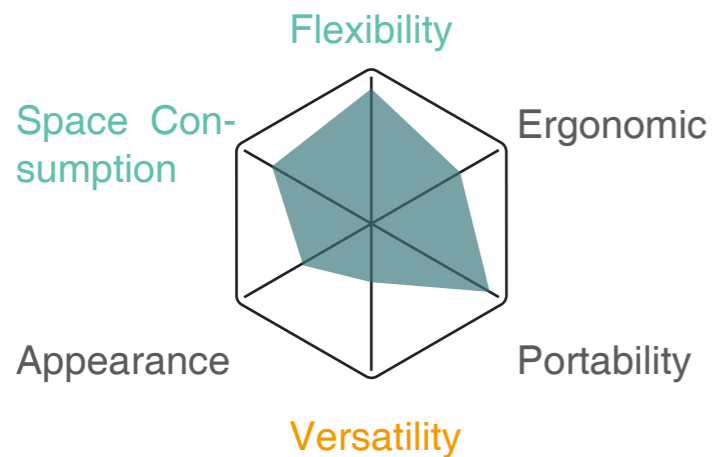
Result of Evaluation:

- Fair adjustment of typing range.
- Small size
- Using environment is restricted.

Concept 3: Hexagon Controller

Description

This idea is a hexagon controller. User could flip around the product and press it with five fingers. During each compressing, the product help relax finger as well.

Reasons of Design:

Clicking the mouse for long would cause carpal tunnel syndrome. What's more, normal mouse could only be used on the surface.

Flexibility
Space Consumption
Ergonomic
Appearance
Portability
Versatility
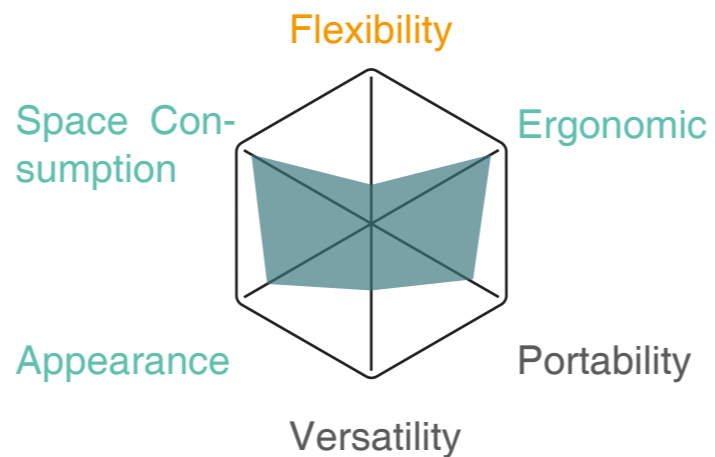
Result of Evaluation:

- Healthy to user's hands
- Small size
- Complex control

Concept 4: Voice Convertor

This is my first idea......
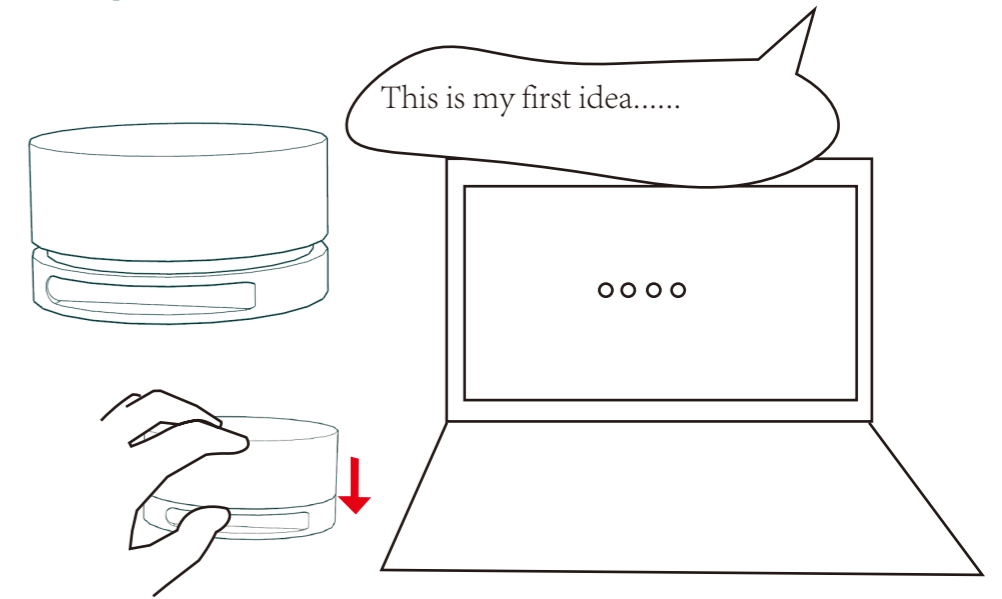
Description

This idea is a voice convertor. User could pressure the button and speak with product. Then the product could convert the voice to laptop so that people don't need to buy extra keyboard.

Reasons of Design:

Typing too long with keyboard might cause tendonitis. Meanwhile, an extra keyboard for laptop is space consuming.

Flexibility
Space Consumption
Ergonomic
Appearance
Portability
Versatility
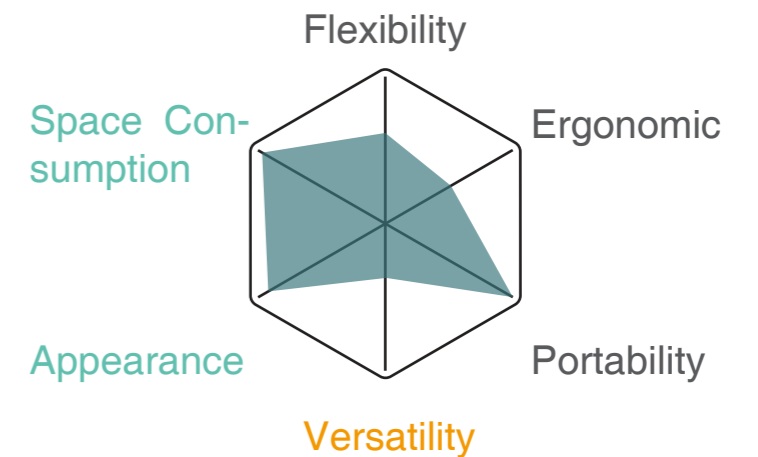
Result of Evaluation:

- Simple Appearance
- Small size
- Technique restriction

Concept Generation, Evaluation & Selection

Concept 5: Chair Clamp

Description

This idea is a chair clamp so that it remind people when they have sit in wrong posture. It also tights people's back with chair and form health habit.

Reasons of Design:

Customer's back would feel exhausted after sitting for long time and it would be bent excessively which might not good to people's health.

Result of Evaluation:

- Healthy to people's back
- Difficult to bring to everywhere because of the size and weight.
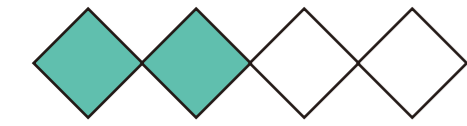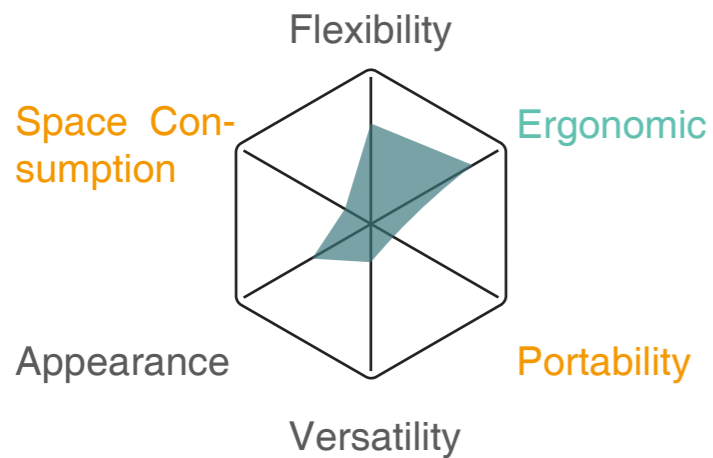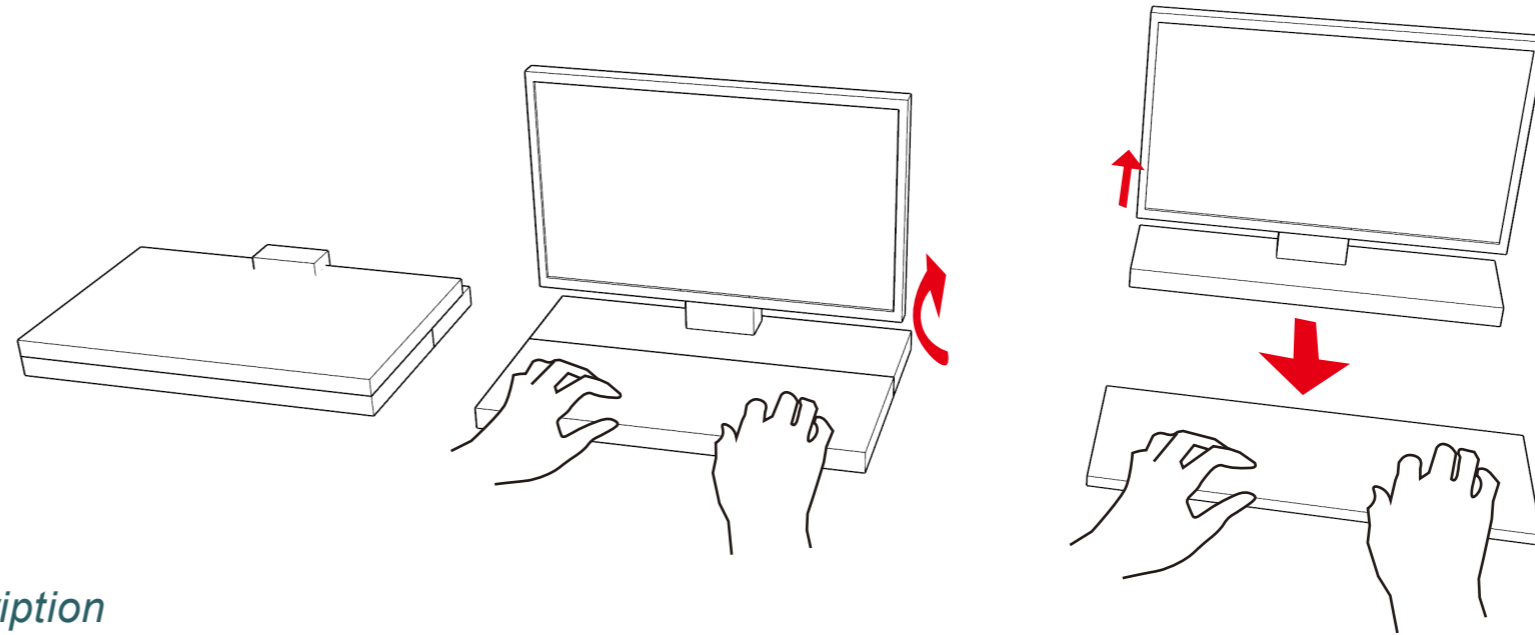
## Concept 6: Laptop with Detachable Keyboard and Liftable Monitor

Description

This Idea is a laptop with detachable keyboard and liftable monitor. User could lift the monitor at the perfect height and type in a prefer range.

Reasons of Design:

The viewing angle and typing range is too large on the desk in a narrow space,which might affect people's neck and elbow. Too much devices on the desk would be space consuming.
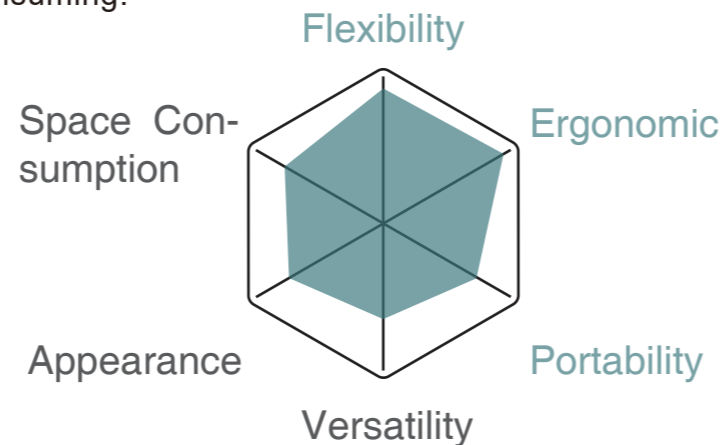
Result of Evaluation:

- Healthy for people's neck and hands
- Ability to bring everywhere
- Could be used for people with different height

Concept Selection
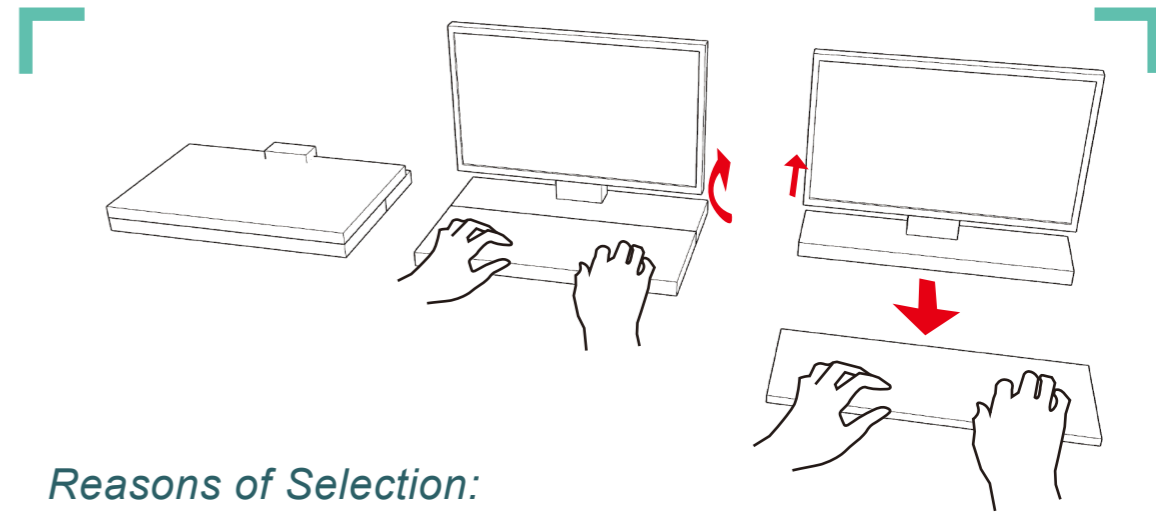
Reasons of Selection:

First, the product could protect people's health in more than one aspect. It could lift the monitor to relax the bent neck and also remove the keyboard to adjust the typing range.

Second, it is flexible to adjust different height and distance so that different people with different height or length of hands could work comfortably while sitting on the desk.

Finally, it does not consume too much space compared with normal solution in the market so that people could put it in a narrow space. It also has the ability to be brought to a remote area without caring too much devices.
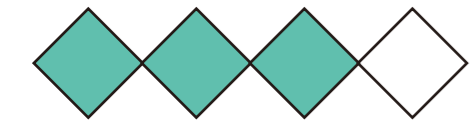
Develop

Iteration with Detailed Technique & Initial Prototype Testing

1st Iteration - Monitor with Flexible Screen (12)

Keyboard
Core Part
Monitor Lid

Screen

Feedback from User:

- Materials would be delicate and expensive.
- Feel unsafe about holding it.
- The technique would be too challenging and if I do like this I would make a flexible keyboard as well.

Summary from Comment

Cooling
Cost
Comfortability
Appearance
Strength
Maintenance

2nd Iteration - Monitor with Flipping Mechanism (13)

Screen
Core Part
Rotating Rod

Keyboard

Feedback from User:

- The structure is interesting but too complex.
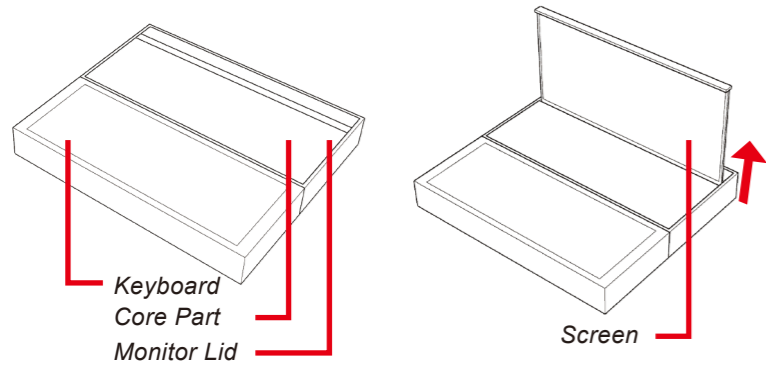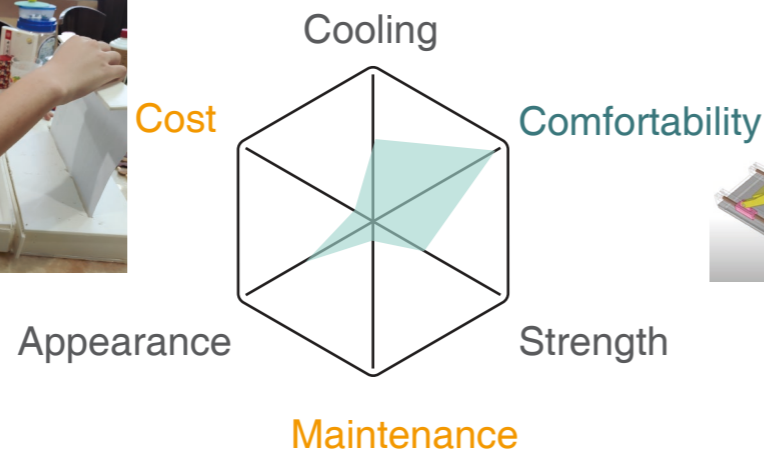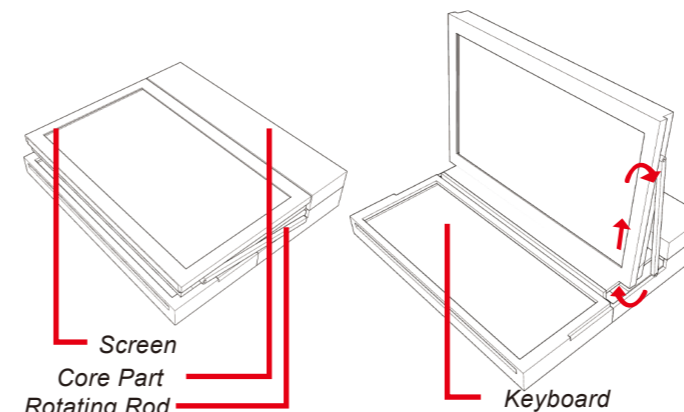- The lifting force would be big so need to lifted by two hands.
- The screen faces towards outside which would be dangerous sometimes.

Summary from Comment

Cooling
Cost
Comfortability
Appearance
Strength
Maintenance
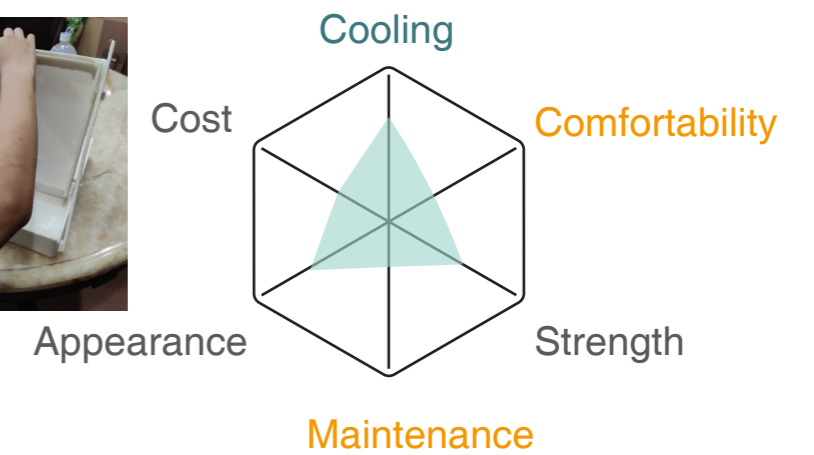
3rd - Monitor with Sliding Rod on Both Side (14)

Core Part
Hinge
Sliding Rod

Keyboard
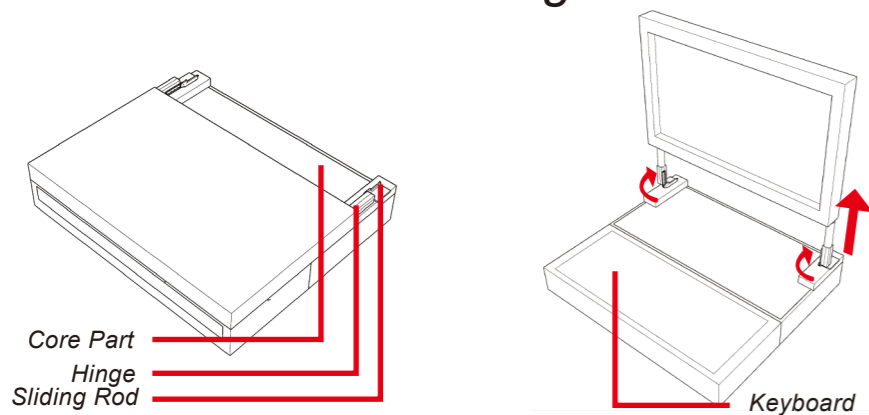
Feedback from User:

- Good to me but it would be difficult to hide the mechanism
- I couldn't lift the monitor by one hand because rods are on both side
- The lifting rod might be too thin and easy to be destoried.

Cooling
Cost
Comfortability
Appearance
Strength
Maintenance
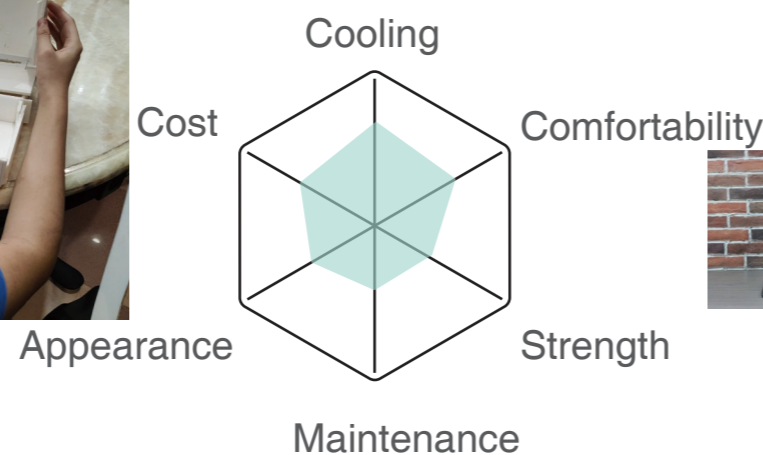
4th - Monitor with Sliding Rod in the Middle (15)

Sliding Rod
Core Part
Hinge

Keyboard
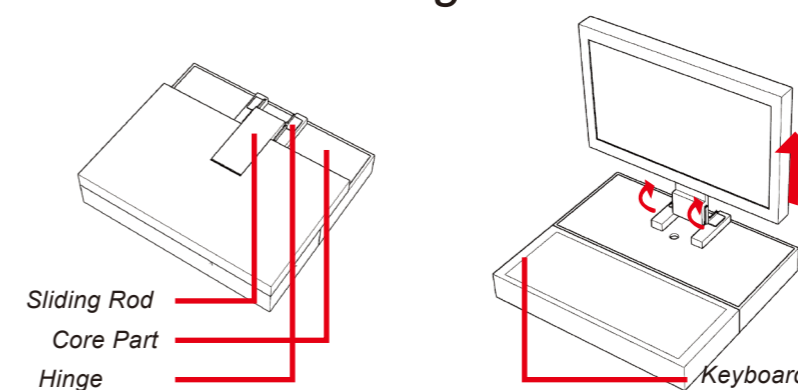
Feedback from User:

- Similar to desktop Monitor and it is smaller.
- Don't know where to lift the screen.
- Might not be probable because the screen is delicate and thin.

Cooling
Cost
Comfortability
Appearance
Strength
Maintenance
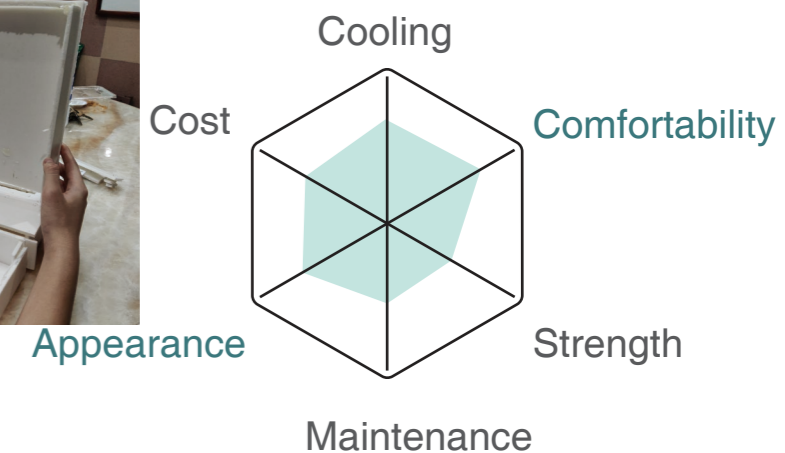
Prototyping & Testing

Final Iteration - Monitor Lifted with Sliding Rods on One Side (16)

- Core Part
- Sliding Rod
- Hinge
- Keyboard

Feedback from User:

- The strength of rod would be a consideration or the screen might be fluctuated.

- Easy Lifting force but what if I am a left-handed person?

- Sharp appearance but I am not sure that it is strong enough.

Hexagonal radar chart axes:
- Cooling
- Comfortability
- Strength
- Maintenance
- Appearance
- Cost

Concept Selection

I choose concept 5 as my final decision compared others concepts. Even through it might have difficulties in the strength of material while user unfolding and lifting the monitor , the user experience would be better than other four concept concepts because people could hold only one side of the monitor in order to lift it. Meanwhile, the laptop could have a left hand version to cat to left-hand user. The asymmetric would also be an attractive point for selling.
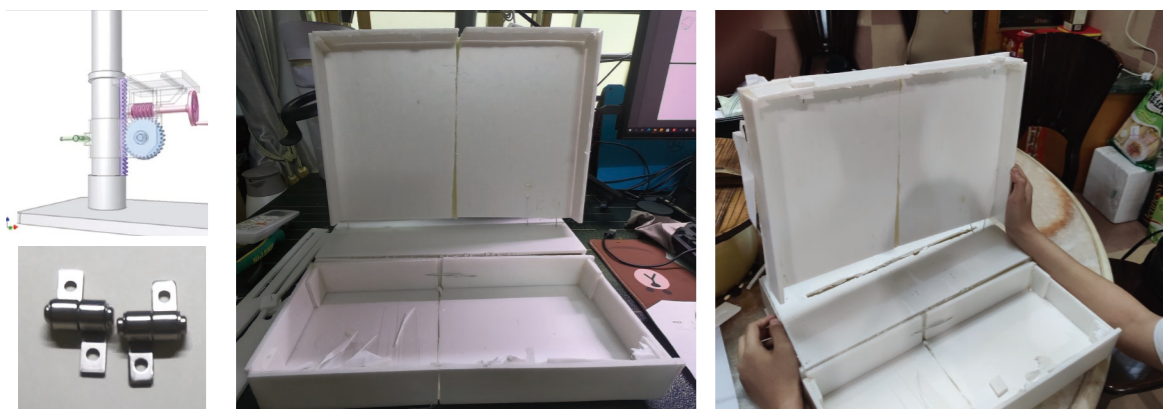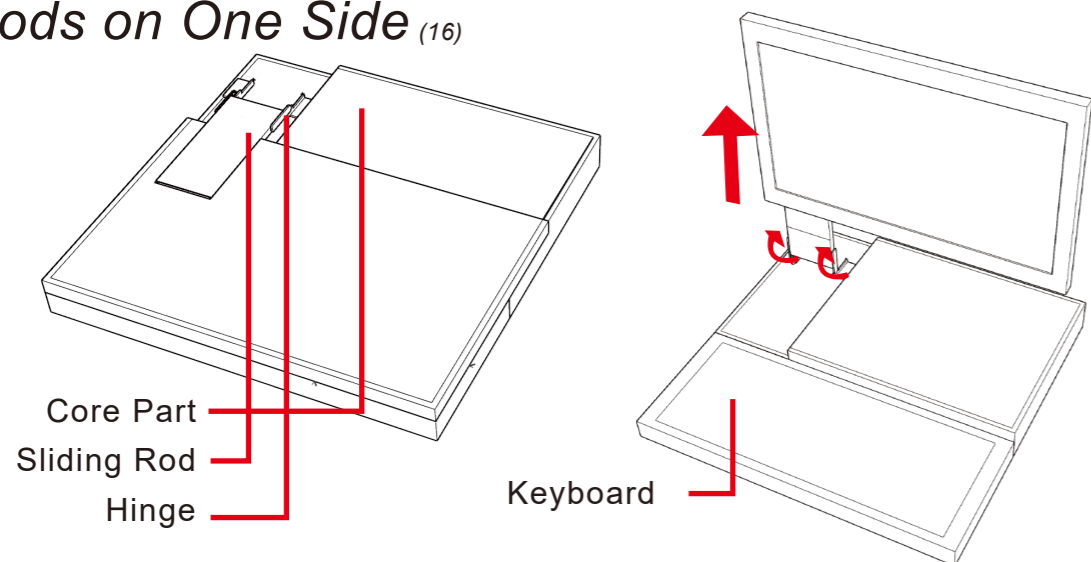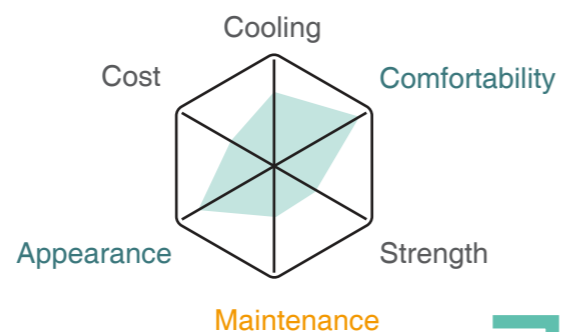
Final Prototyping

3 physical iterations with 7 virtual modelling is made to simulate the most realistic physical prototype. A rod of alloy was installed on the other side of monitor to support the monitor. It was assumed that the improper material of lifting mechanism cause the banding of monitor. the Electrical system is successfully installed with Raspberry PI 4B, a 15.6-inch monitor, a remote keyboard, and a power bank.
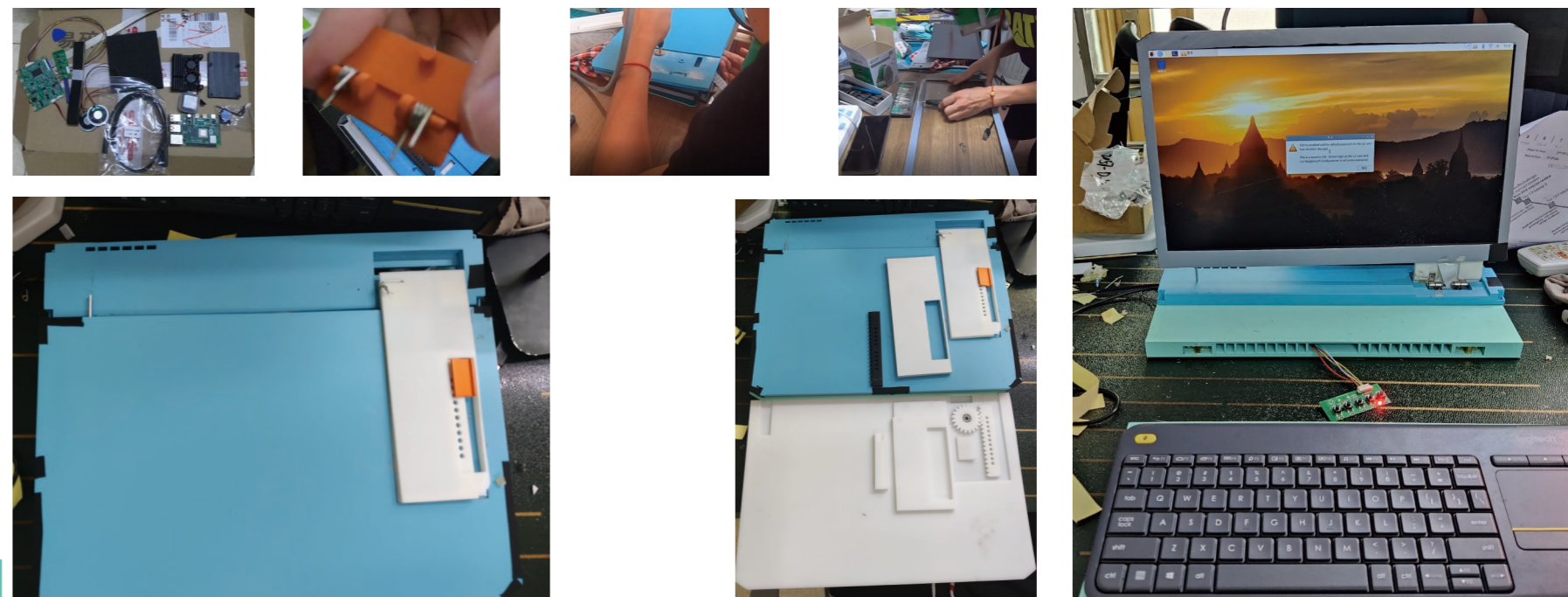
Testing

Feedback:

Former interviewees are invitied to have test and here are certain feedbacks:

- It is a design between desk-top and laptop.

- Upper face of core base could be an auxiliary screen.

- Hot plug technique could be used for upgrade of laptop.

- The removeable keyboard is interesting and save space. The mouse pad could be removeable as well.

- The lifting mechanism seem not so robust and the lifting posture could be consider as electric-mechanic system.

- Someone might like the full-size keyboard so there could be improvement on keyboard.

- The concept is great for adjustment of head but the lifting mechanism should be robust enough to support the monitor.

- More cooling holes is helpful to the performance of laptop.

- The cable socket could be on one side so that there would not be too much wires around the table.

- The core base might be too small to store the circuit board if I want to have a better performance of laptop.
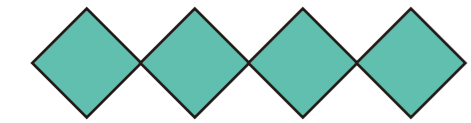
Deliver

3D Model Layout & Specification

Labels: Back Shell, Screen, Front Shell, Screen Hinge, Remote Keyboard, Clip, Roller, Shell, Shell, Rack & Pinion, PCB, Female Hinge, Upper Shell, Core Base

Female Hinge
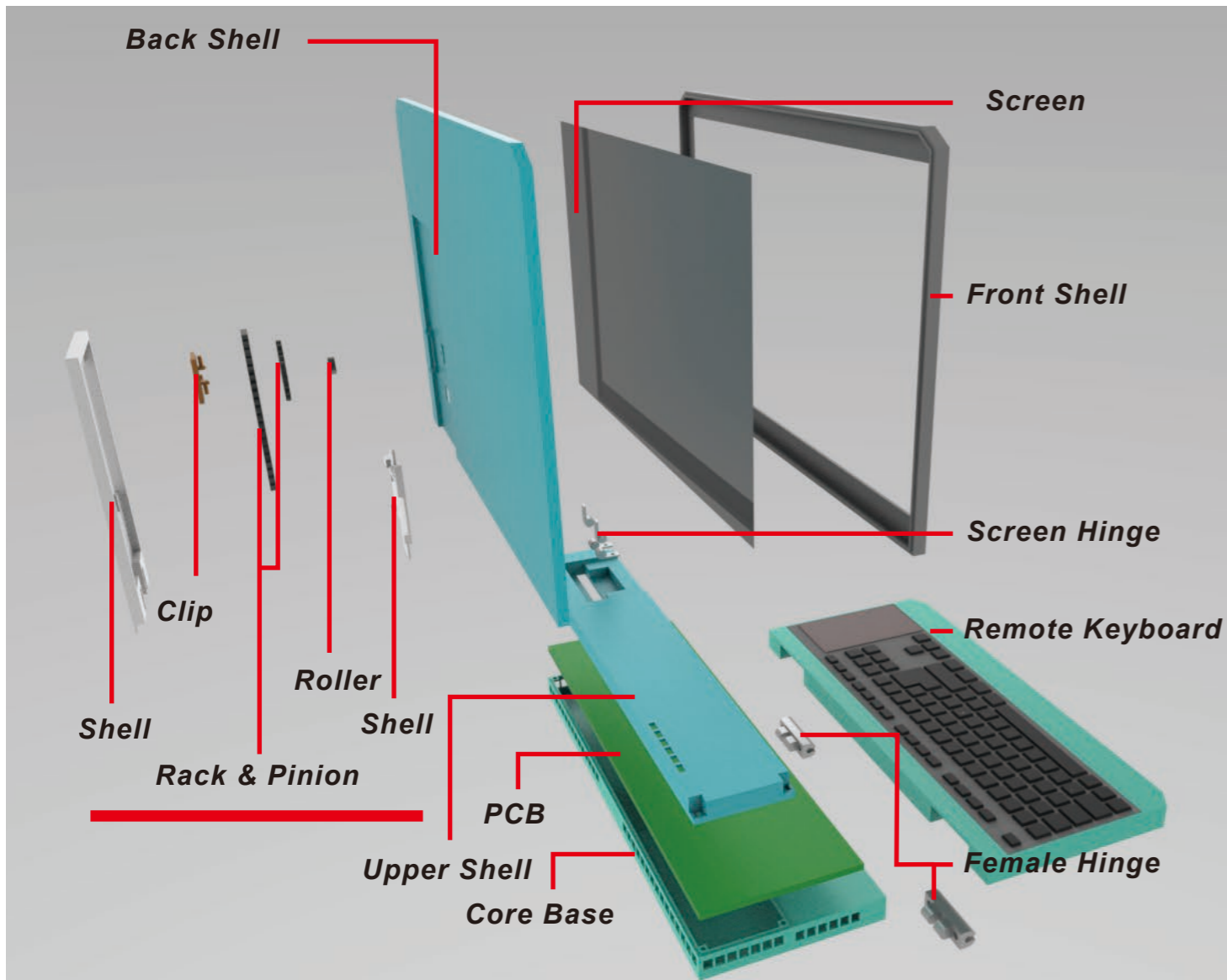
The product dimension is 365 X 295 X 31 mm and weight 1.97kg. The monitor could rotate at most 100° and could lift the height at most 60mm. Most of material would be made in ABS and aluminium to keep the light weight.

Lifting Mechanism (17~18)

The monitor could be lifted at most 60 mm high so the viewing angle for 50% male in China would be 31% which is close to perfect region.

■ Rack & Pinion:

The rack is fixed with back white shell while the pinion is installed with the back shell of monitor. The lifting part depends on the translation of rack and white shell.

■ Ball Bearing:

It Provides a fluent rotation of pinion to improve user experience.

■ Clip with Spring:

A clip would lock a rack which would stop the screen from moving up and down. It would be installed 2 spring to enhance pressing experience. The specification of spring is:

Wire Diameter: 0.8 mm	Angle: 15 °
Outer Diameter: 5 mm	Number of Coil: 3

Core Base & Upper Shell:

To Store the electric component. The cooling performance would improve because the upper face and front face could be used for cooling as well. Two male hinges are installed in the front face of core base.

Remote Modular Keyboard:

The remote keyboard could connect with the core base with female hinges and wireless connection of 2.4GHz frequency rate. The hinges could also work as stand so that people could adjust the angle of typing. The keyboard could link the base with wire to increase the reaction speed. Different types of keyboard could be chosed to connected with the mainboard. There could be PCB in the keyboard and connect with the mainboard with wireless HDMI as well.

31.00mm
295.00 mm
365.00 mm
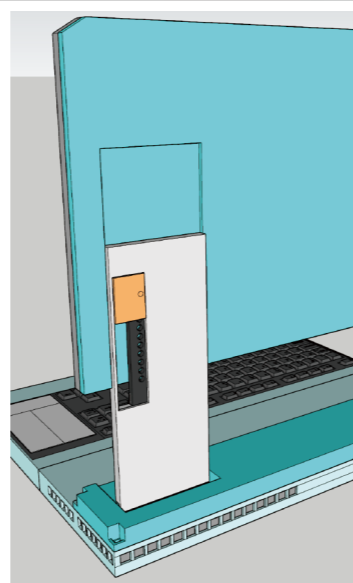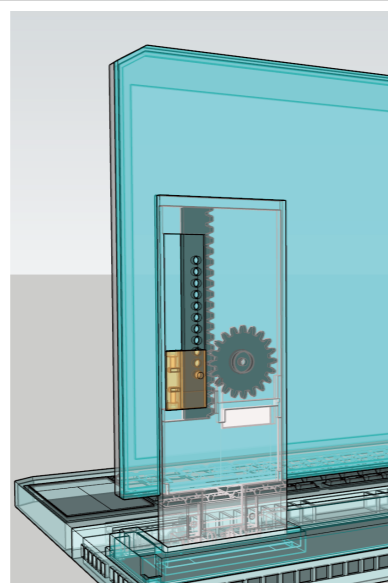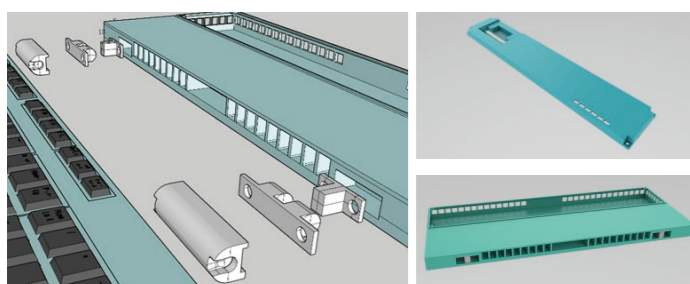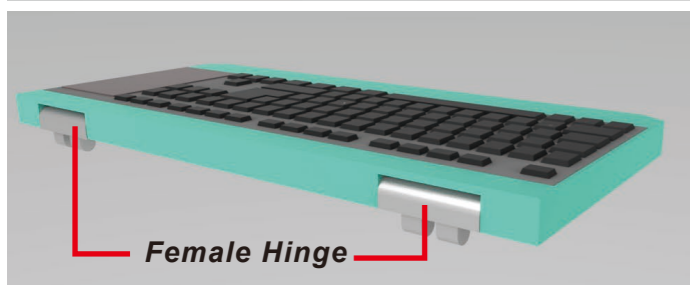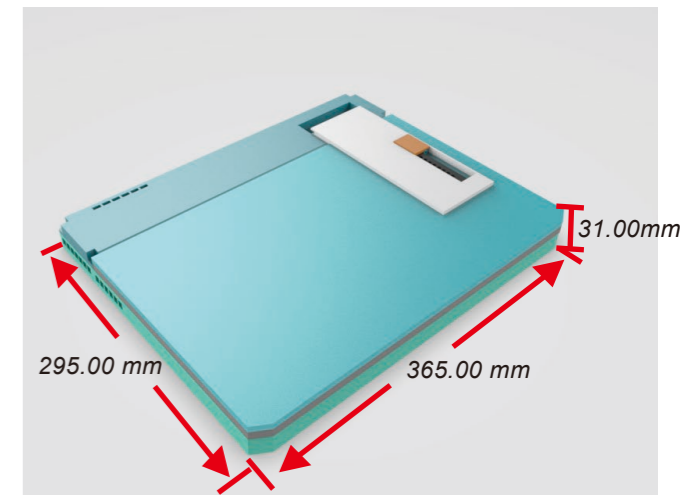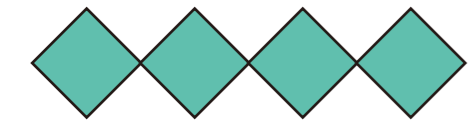
Deliver Developed User Journey

Developed User Journey
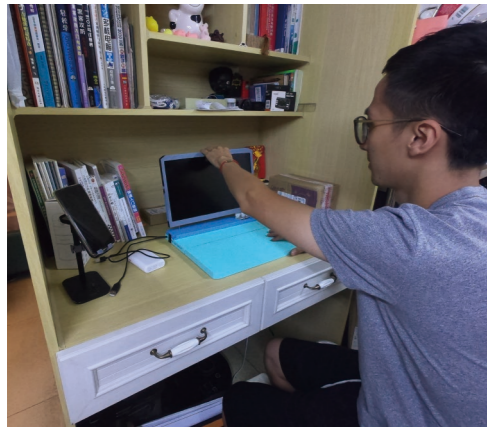
Previous Issues

a. Unfold the monitor

b. Separate the keyboard

c. Type in a comfortable range

i. Wrist was exhausted if the monitor is lifted with a stand

d. Neck is exhausted

e. Lift the monitor

f. Work in a comfortable visual angle

ii. Monitor sits too low and neck is tired

g. Want to do paper work

h. Install the keyboard

i. Grap the book

j. Work normally

iii. No space for paper work

Reflection *Future Work & Reference*

Future Work *(17-18)*

First, due to the lack of software technique and time limit, it was difficult to do the fluid analysis on the cooling performance of the base. But compared with the normal laptop, the amount of cooling holes was larger.

Second, due to the remote study out of campus, there was no chance to have access to the studio, only 3D printing was suitable for me to get a prototype with good surface. Meanwhile, while make an order online to print the prototype, it took around 3 days of shipment. Therefore, the cost of prototyping would be high and the amount of iteration would not be enough. The drawback of asymmetric layout was that it might fluctuate to support the monitor and a middle layout with the clip on the side might be more suitable.

The size of PCB main board would be 112.6 X 361.0 mm. It would be smaller than that in a normal 15.6-inch laptop but since there is a upper shell, there is opportunities to make a multilayer design of PCB. Meanwhile, there could be PCB inside the keyboard and connect with the Monitor with wireless HDMI technique (Linus, 2021) . The type of keyboard could also be change to 103 keys, 87 keys, or even a electrical drawing board. In this case, people could have a comprehensive experience on the laptop. What's more, the upper face of core base could be an auxiliary screen. A modular mouse could also be separated from the keyboard so that people do not need to buy another one. Hot plug technique could be used to upgrade the hardware so that the product could be more environmentally friendly.

In the future, more iteration of prototype should be done with suitable materials so that it could be as realistic as it can. The room below the keyboard was not available and there would be more space below the upper shell. Therefore, Multilayer PCB would be applicable for the project because it has the advantages of saving spaces, high capacity, high speed and etc. (Benefits of Multilayer Printed Circuit Boards | Blog, 2017)

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