VM250 Final Report
Of Multi-function Smart Phone
Summer 2013

Prepared By:

Xia Fangzhou 5113709225

Sun Anqi 5113709209

Wang Kaiwen 5113709148

Lai Xingjian 5113709082

Peng Zifeng 5110809064

Undergraduate Engineers Students

Prepared for

Pro. Qi Huan

Assistant Professor, VM250 Instructor Shanghai Jiao Tong University

UM-SJTU Joint Institute

Contents

1. Abstract

This report delineates my team's design of a smart cell phone, iPeach. We start with giving a brief introduction of the overall project. Then, we list our ten customer requirements and ten engineering specifications. After that, we draw our QFD and set our PDS. Next, we talk about our innovation generating process. We generate function selections of design by targeting our clients on frequent computer users. Then, we highlight our final conceptual design， a foldable smart phone with added core function as a mouse. In the subsequent part, we discuss our recommended materials and manufacturing processes. Finally, we estimate the total cost and conclude our project.

2. Introduction

My team is assigned a project of designing iPeach, a smart phone with novel functions. After information collecting and brainstorming, we target our design on frequent computer users and decide to add the cell phone with core function as a mouse, since it will bring great convenience for our clients. The following part of the report will describe our project in detail.

3. Product Design

3.1. Problem Definitions

3.1.1. Customer Requirements (CR)

In order to attract more customers and get a greater share of market, several basic customer requirements need to be satisfied. Apart from the having the basic function of a cell phone, 10 requirements from the customers are included to increase the competitiveness of the design.

1. Additional function
2. Portability
3. High reaction speed
4. Large information storage
5. Cheapness
6. Safe and easy operation
7. Durability
8. Good appearance

9. Long time standby mode
10. Environmentally friendly

3.1.2. Engineering Specifications (ES)

In order to better satisfy the customer requirements, 10 engineering specifications are employed.

1. Geometric dimension (mm^3)
2. Weight (g)
3. Yield strength (MPa)
4. RAM size (GB)
5. Storage capacity (GB)
6. Battery capacity (mA*H)
7. Port standard (#)
8. Cost ($)
9. Number of available style (#)
10. Number of extra functions (#)

3.1.3. Quality Function Deployment Diagram and Results (QFD)

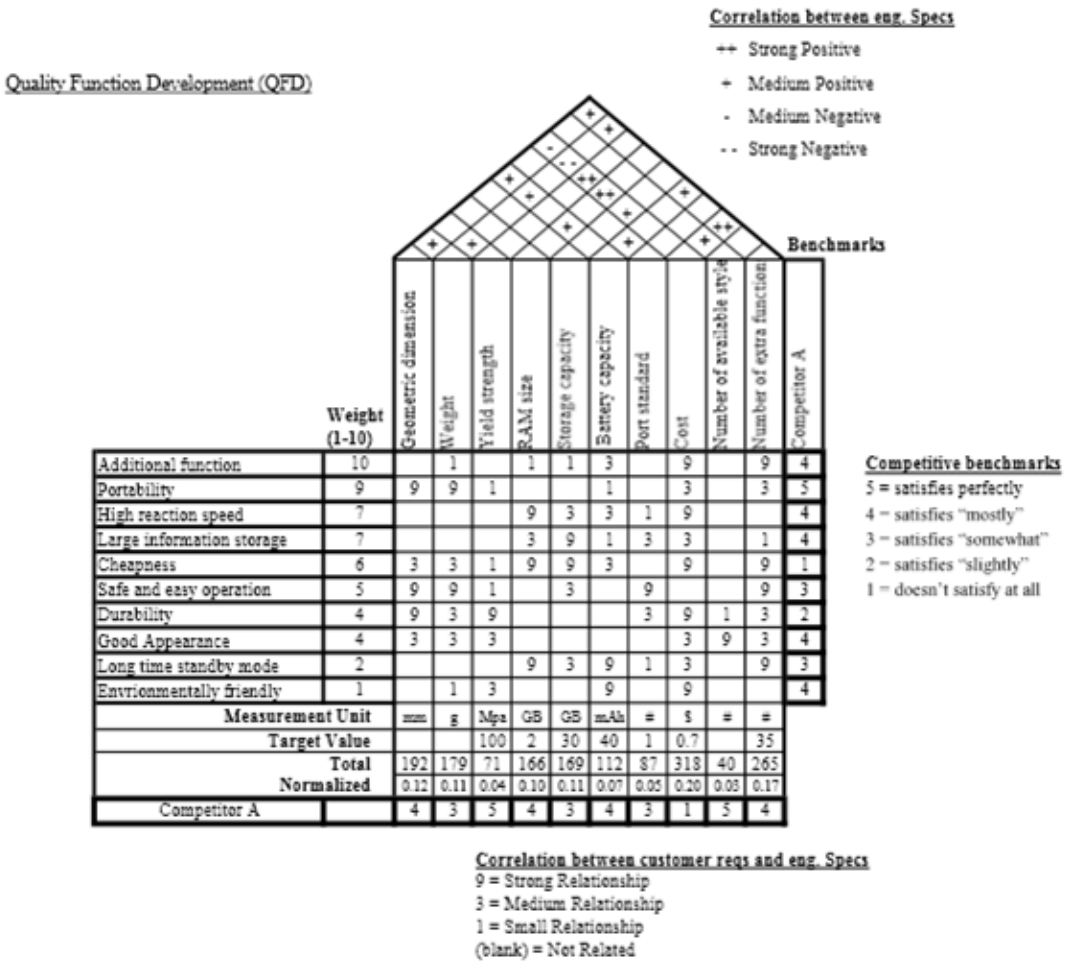


Fig.3.1.3-1 QFD

3.1.4. Product Design Specifications (PDS)

- **Performance**

  The performances of the product are as follows:

  a) It is a cell phone;

  b) It has the function of a wireless mouse.

- **Environment**

  The product can work normally in the environment ranging from -20℃ to 60℃ in temperature and 0% to 99% in relative humidity. As a cell phone, when the user is making phone calls with the product, the environment noise should be low enough for the user to hear clearly. As a wireless mouse, the environment noise does not affect the function of the product.

- **Life in service**

  The product has the functions of a cell phone. The user can make phone calls, send text messages, browse the Internet, and take photos with it. It can also carry out various software application functions, including navigation, translation, file storage, and Internet chatting.

  As a wireless mouse, the product can be connected to a computer via

Bluetooth or an external receiver.

- **Maintenance**
  The battery is very likely to have defects due to long service time or improper usage. Therefore, it should be easy to change for maintenance.
  The external receiver is a part separate with the main body of the product, so it is easy to lose. Matching external receivers should be available for maintenance.
- **Target product cost**
  Smart Phone: The average cost of a smart cell phone is about ¥1288.
  Extra Functions: The average cost of a wireless mouse is about ¥35.
  Total: The total cost should be about ¥1323.
- **Competition**
  There are no similar products found. Most of the existing similar products enable the user to move his finger on the cell phone's touch screen to control the mouse.
- **Packing**
  The packing of the product should contain enough protection material to prevent the damage from the shipping process. It should also look attractive for larger sales.
- **Shipping**
  The shipping process the product should prevent violent knock and strong electromagnetic strike that might destroy the product.
- **Manufacturing facility**
  We need the following Manufacturing facilities:
  a) CNC molding machine
  b) Stamping machine for the outer shell
  c) Circuit board making machine
  d) Welding line
  e) Assembly line
  f) Packing line
- **Product life span**
  The simple and plain style design of the product makes it hard to break. With proper use and maintenance, the expected life span of the product is 10 years.
- **Safety**
  The product should not have any sharp edges or corners. No toxic or recycling materials should be used in the parts that are directly in contact with the user. The radiation of the product should be low enough not to cause any harm to the user.
- **Installation**
  Before using, the user needs to install the battery to the product and a driving program to the computer. Other applications can be downloaded from the Internet and installed on the product at the user's wish.
- **Documentation**
  The documentation of the product includes the using instruction, the

warranty bill, and the qualifications from various testing organizations.

- **Disposal**
  Many disposed parts of the products need recycling for environmental protection and material saving purposes. The disposed battery in the product needs to be sent to specialized factories for recycling. The rare materials in the disposed main body should also be recycled for other proper use.

3.2. Concept Generation

3.2.1. Function Selection

Our first brainstorm on function selection was based on three basic multifunction design criteria:
1) Market Demand: This function should be in demand by the large populations of cell phone users.
2) Portability：The function should not increase the volume of a smart phone significantly.
3) Innovative Combination: There should not be any mature product, which has applied this combination in their design.

Based on these three criteria, we figured eight alternative additional functions for our iPeach smart phone: flash drive reader, mouse, laser pointer, PPT controller, pulse monitor, mini cosmetics case with a mirror and a comb, Swiss Army Knife and automatic induction glove.

A further screening of the functions in our second brainstorm aimed to specify the target of our customer. A collection of all these functions is meaningless, since no one will need all these eight functions at the same time. We finally targeted our customer as frequent computer users such as business people, students, and engineers. In this selection round, the pulse monitor targeting older user with health risks, the mini cosmetics case targeting the female customers and the Swiss Army Knife function targeting young male customers engaging in field work lost the election. Besides, limitation of carrying on a knife on the plane also negates the army knife function.

An automatic induction glove-like smart phone is eye-catching and many functions can be realized based on the automatic induction. However, two main reasons made us give up this design. First, wearing and removing the glove lead customer into trouble. Nobody needs a phone in their hands in every minute including washing and dining. Second, the cost and manufacturability of the design are too demanding. Deformable and elastic material not only increases the cost but also the difficulty of manufacturing. What's more, limitation of the space for chips and screens causes an infinitely extended developing cycle.

After a process of elimination, four functions remained: Flash drive reader, mouse, laser pointer and PPT controller.

Mouse function is part of our core functional features. For frequent computer users, especially the laptop users, it is annoying to bring a mouse everywhere, however, the touchpad cannot meet all their need. Especially for engineers, engineering software often require a large amount of mouse action-related event. A mouse functioned smart phone will solve this problem. As a daily carryon item, a smart phone can serve as a mouse at any time. Also, many lightweight mature designs exist in the mouse field. It greatly reduces the difficulties in design and manufacturing.

http://diy.pconline.com.cn/mouse/hq/fj/0902/1575095.html

http://img33.ddimg.cn/44/28/40078976 3-1_b.jpg

Fig. 3.2.1-1 Extra Functions

For people who give presentations or lectures frequently, our design will help them greatly. The laser pointer and PPT controller will release lecturer from the computer and control the slide at anywhere in the classroom.

Besides these functions in conjunction with a computer, we considered to reinforce functions of a smart phone when people don't have a computer in their hand. Therefore, the USB port is added at the bottom of our smart phone. Although the Bluetooth technology is popular nowadays, we need to read the content of a flash driver occasionally. Also, such a USB port added many other possibilities such as a external mobile power.

Synthesizes each kind of requirements and our targeting customers, we finally set four additional functions to our smart phone: Flash drive reader, mouse, laser pointer and PPT controller.

3.2.2. Appearance Selection

Based on the initially eight functions we designed, and the mainstream of concept cell phone, we figured out four general directions of exterior designs: wrist-mounted design, clip on design, mouse-like design and glove-like design. These four designs basically exist in concept design. They are eye-catching but they have uncertain market acceptance.

http://it.southcn.com/9/2010-05/19/content_12070864_2.htm

http://www.tektion.com/tag/future/

Fig. 3.2.2-1 Other Designs

http://it.southcn.com/9/2010-05/19/content_12070864_2.h

http://www.instructables.com/id/Making-Glove-One-a-3D-printed-wearable-cell-p

Fig.3.2.2-2 Other Designs

Three traditional handset shell designs are also taken into consideration: clamshell, candy bar and slider. These three models are abundantly practiced in the market but not so attractive.

To balance the innovation, practicality and reliability, we developed our own appearance design. We made some references to the Microsoft Arc Mouse in the

foldable aspect. Rather than the traditional clamshell design, the two sections are not tightly attached when it is closed. Then we attach a slider to the second half of the phone so that the keypad is extended to numeric model if necessary.

The streamline appearance of the outside adds the elegance and comfort level of the phone. The contraption of the inner side ensures the flexibility, practicality and novelty.

The whole appearance of our design is neither fancy for the business people, nor rigid for younger users.

3.3. Final Conceptual Design

Combining our function selections and appearance selections mentioned above, the final conceptual design is a smart phone with both clamshell and slider features.

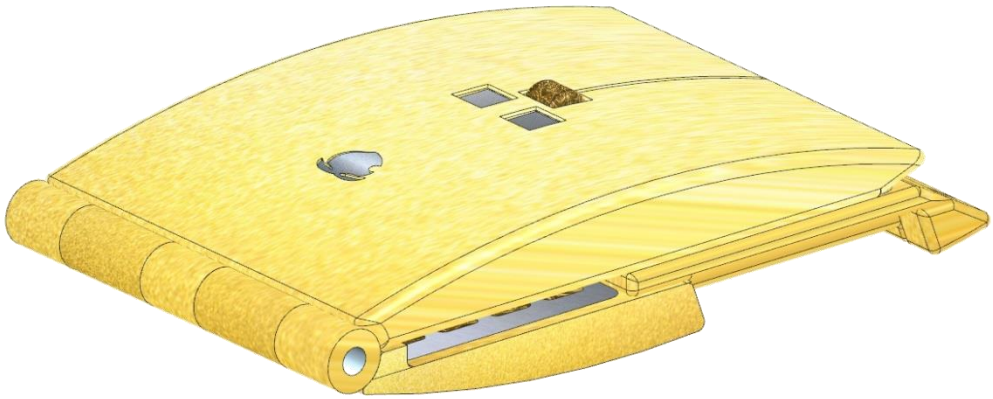


Fig.3.3- The Final Design

3.3.1. Major parts

The final design consists of two major part, the screen part and the keyboard part. For the screen part, the inner side is set to be a full-touch screen. The outer side is designed to be the mouse shell, with a rubberized plastic wheel between two standard mouse buttons. The outline of this part is an arc based on ergonomics.

Fig.3.3.1-2 The Screen Part

The keyboard part contains two layers. The function keys and the direction keys are placed on the upper layer. After sliding the upper layer keyboard, we can see the downer layer with number and character keys on it. Two parts are connected with a sliding rail.

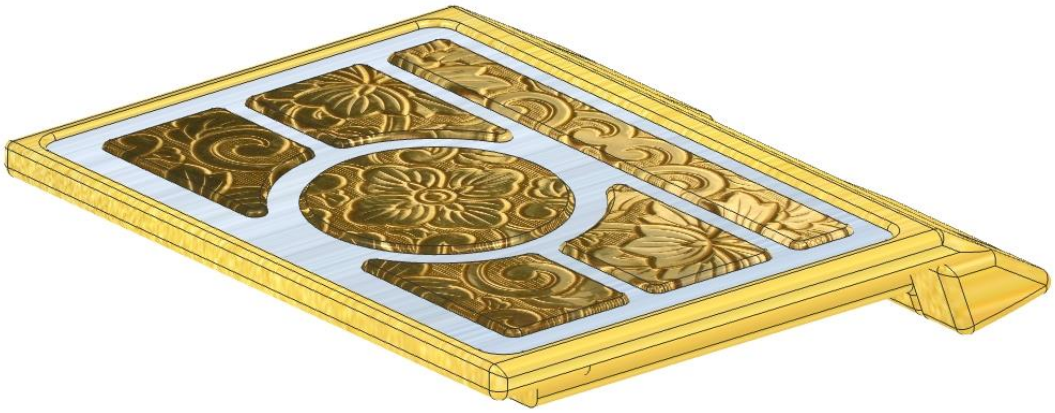


Fig.3.3.1-2 The Upper Layer with Function Keys and Direction Keys

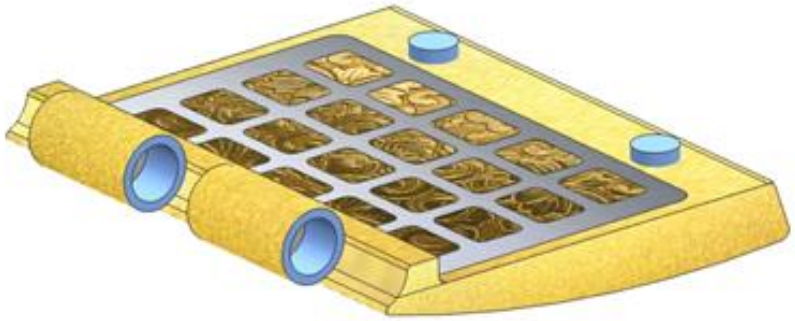


Fig.3.3.1-3 The Downer Layer

3.3.2. Function Modes

Depending on its usages, it has a special design of transformations.
According to the shape of the smart phone, it has two modes, one mouse mode and one cell phone mode.

For the mouse mode, we designed several details to abrasive resistance. Rubber blankets are placed on the contact segments. The screen is at a small angle to the support surface, which will protect the screen from scratching and misoperation.

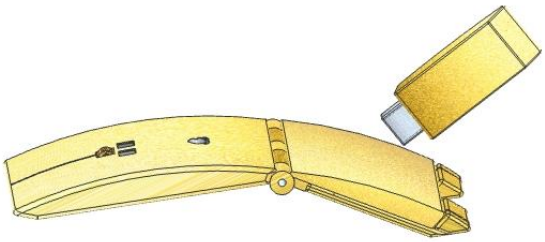


Fig.3.3.2-1 Mouse Mode

Under the cell phone mode，for touch screen users, they can directly use it without sliding out the numerical keyboard. For the keyboard users, they have optical choices. They can type on the inner keyboard when testing and dialing phone numbers and they can play games, watch videos on the upper keyboard.

What's more, the USB port is placed on the bottom of the phone. We can deal with the files in flash drive directly.

Fig.3.3.2-2 Cell Phone Mode1

Fig.3.3.2-3 Cell Phone Mode2

4. Manufacturing

When we make the design, it is indispensible to consider the manufacturing process. Since our cell phone is complicated in structure, we need to consider the manufacturing meticulously. We first mold the aluminum shells and machine their surfaces. Then, we polish and texture those surfaces. After that, we can use crystal and diamonds to cut the chamfers. (How IPhone5 Is Made, 2012)

5. Material Selection

We need to choose proper materials in order to meet customer's request and to fit design's functionality. The back of iPeach is made of anodized 6000 series aluminum, the same material applied in iPhone5, which is highly strong under stress. It can also prevent getting rusted after contacting hands. The screen is made of Gloria Glass 3, which can prevent scratching and minimize the damage of accidental falling from the height of table. (Iphone Design, 2012)

6. Cost Estimation

The basic cost of our design is estimated from two parts. The smart phone parts are based on the cost of IPHONE5 and Millet Mobile Phone. The additional function part is estimated based on the lowest cost of the components on taobao.com.

Components	Cost in CNY	Cost in USD
Smart Phone Components		
Gloria Glass 3	214.75	35
Electronic and mechanical components	192.34	31.35
8-megapixel autofocus camera	70.72	11.4
Radio and Antennas	175.06	28.53
Flash Drive	111.85	18.23356
Motherboard	87.39	14.24592
Dynamics Random Access Memory	53.03	8.6

Battery Management System and Ports	41.92	6.83
Battery	34.36	5.60
Aluminum Casing	306.5	50.00
Extra Function Components		
PPT Controller	30.00	4.90
Mouse	5.00	0.81
Total	**1322.94**	**214.74**

Table Cost Estimation of Materials

*(*Milet Smart Phone Carries Bill of Materials，2012，*)*

(iPhone4 Bill of Materials,2010)

7. Conclusion

The project of making iPeach, a smart phone with mouse function, is successfully completed by the effort of our entire team. The project involves a lot of experiences of our teammates. We searched the Internet for relevant designs, compared different materials and made selections, sketched and argued for our conceptual designs, etc. It is a big challenge for us, since most of us have never done a formal design before, but more fun is out there. We tried to apply knowledge in lectures, and learned from each other in the team. In the end, we felt we were growing up as promising engineers. This project not only provides us a chance to stretch our imagination, but also makes us learned something significant: cooperating and make a difference.

8. Reference

Christian Zibreg (2012). *How iPhone5 Is Made*. [ONLINE] Available at: http://www.idownloadblog.com/2012/09/12/how-the-iphone-5-is-made/. [Last Accessed 1 July 2013].

KEVIN KELLER (2010). *IPhone 4 Carries Bill of Materials of $187.51, According to ISuppli.*. [ONLINE] Available at: http://www.isuppli.com/Teardowns/News/Pages/iPhone-4-Carries-Bill-of-Materials-of-187-51-According-to-iSuppli.aspx. [Last Accessed 1 July 2013].

n.d.(2012). *iPhone Design*. [ONLINE] Available at: http://www.apple.com/iphone/design/. [Last Accessed 1 July 2013].

n.d. (2012). *Experts Claim That Milet Smart Phone Carries Bill of Materials Less Than 900 Yuan*. [ONLINE] Available at: http://www.iceo.com.cn/shangye/36/2012/0207/240916.shtml. [Last Accessed 1 July 2013].

9. Acknowledgement

I would like to extend my sincere gratitude to my people who give us many helpful instructions in this project. Thanks for leaning the design process and engineering drawing skills from Professor Qi Huan, and Teaching Assistant Li Hao, Xu Tianxiang, Xu Chenyu.

Appendix A: All sketches in concept design

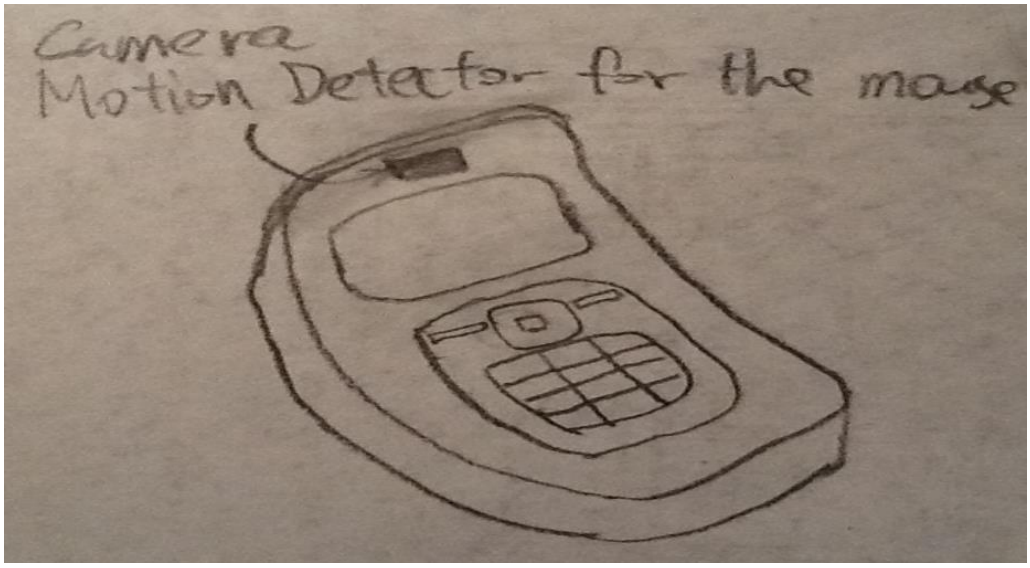


Fig.A-1 Sketch 1 by WangKaiwen

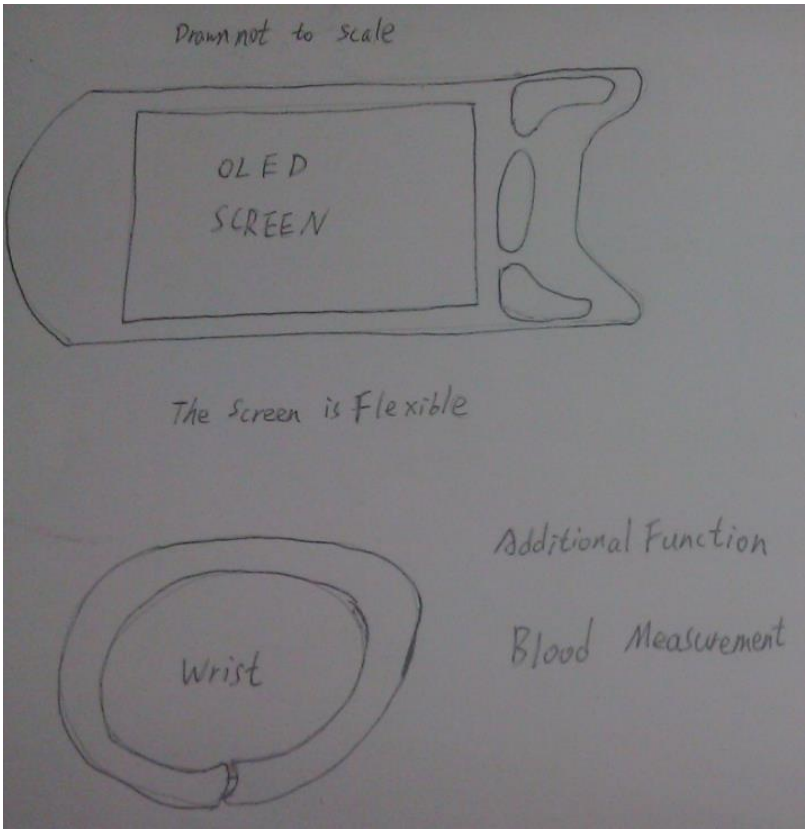


Fig.A-2 Sketch 2 by XiaFangzhou

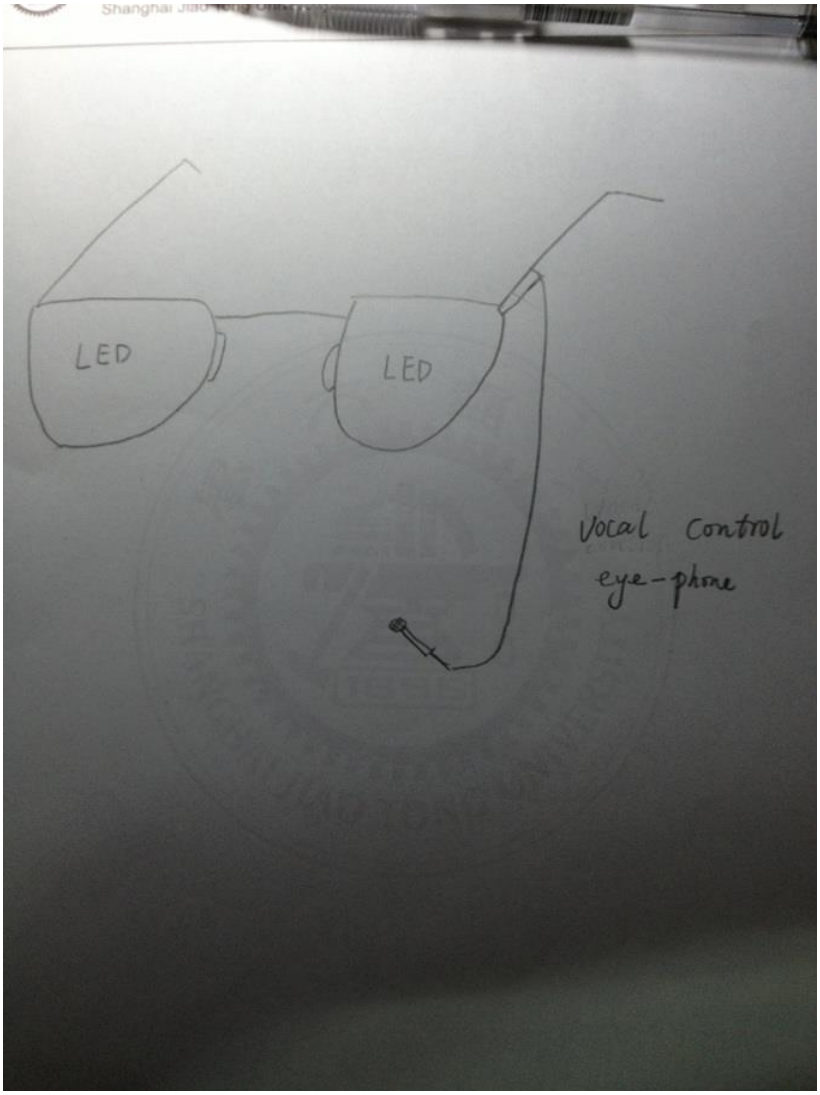


Fig.A-3 Sketch 3 by LaiXingjian

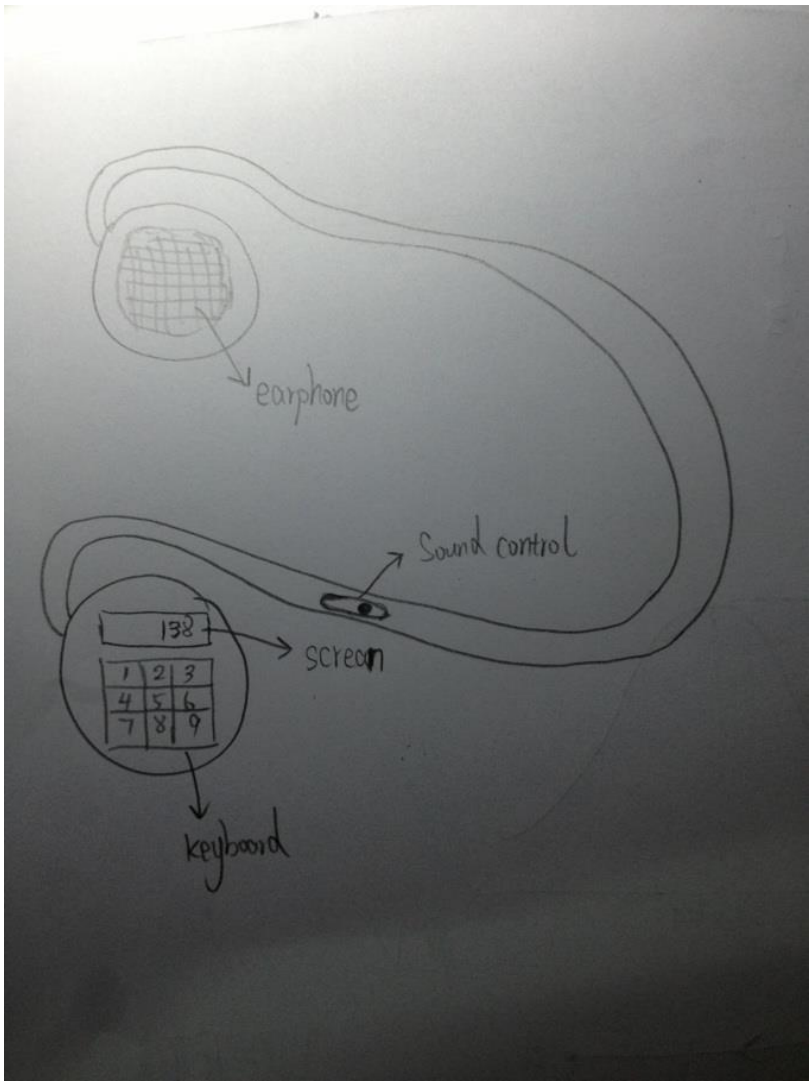


Fig.A-4 Sketch 4 by Peng Zifeng

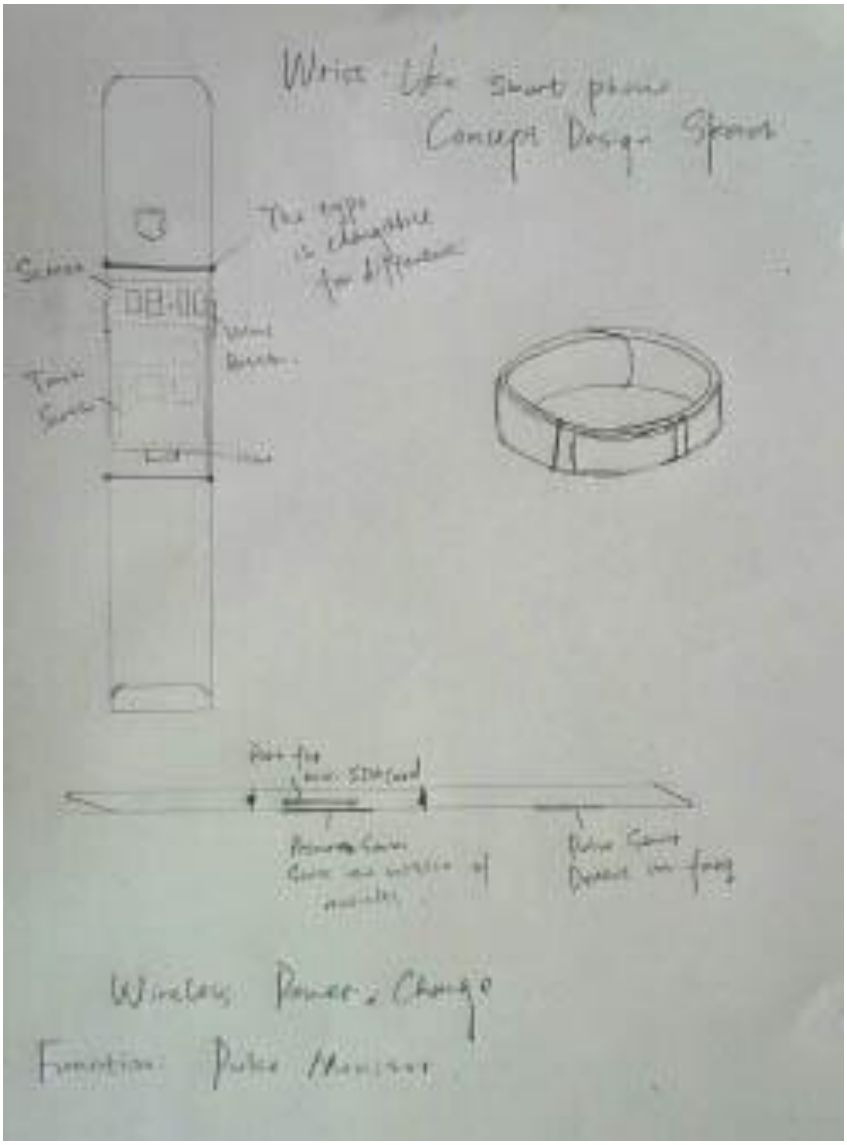


Fig.A-5 Sketch 5 by Sun Anqi

Appendix B: All Engineering Draws With UG

Fig.B-1 Cell Phone Close 3D

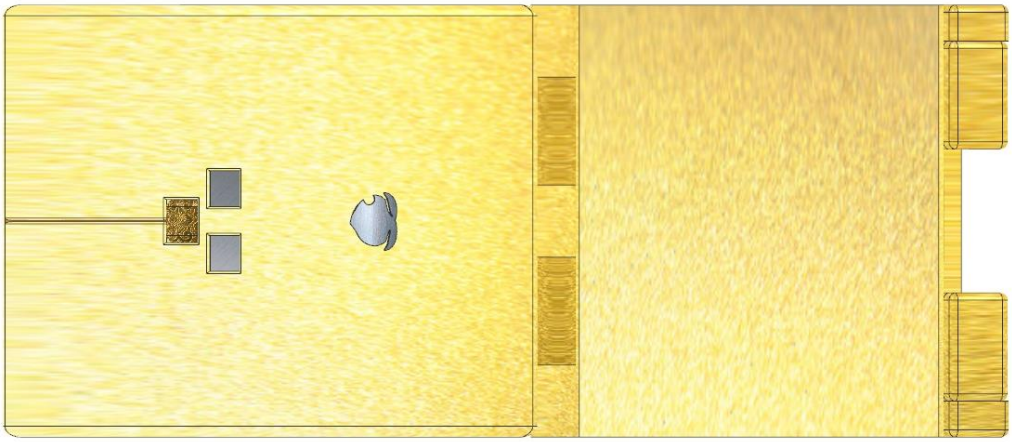


Fig.B-2 Cell Phone Mouse Form Top View

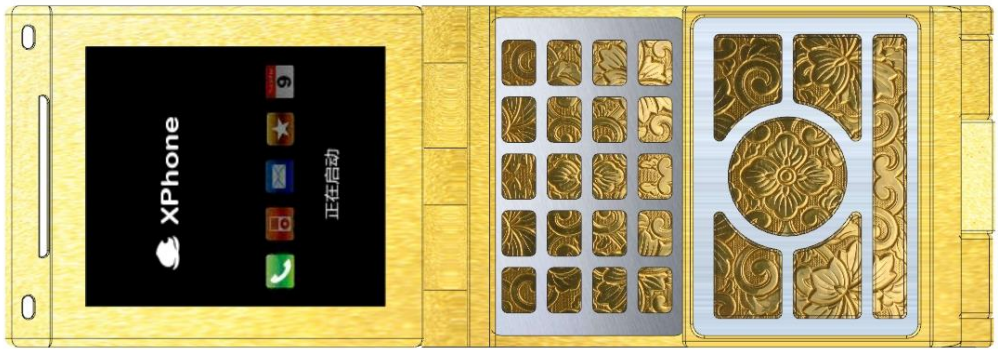


Fig.B-3　Cell Phone Open

Fig.B-4　USB

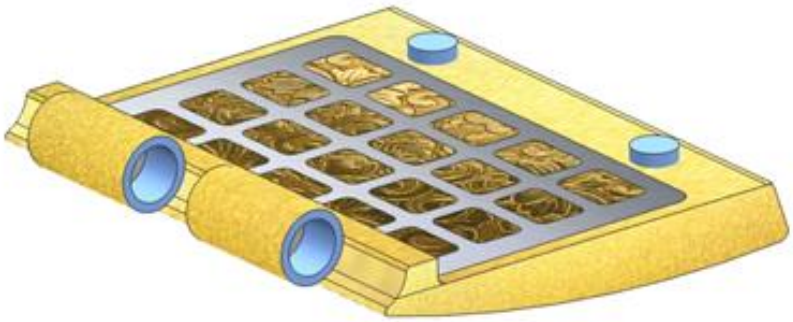


Fig.B-5 Keyboard

Fig.B-6 Screen

Appendix C: Product Design Specifications

- **Performance**
  The performances of the product are as follows:
  a) It is a cell phone;
  b) It has the function of a wireless mouse.
- **Environment**
  The product can work normally in the environment ranging from -20℃ to 60℃ in temperature and 0% to 99% in relative humidity. As a cell phone, when the user is making phone calls with the product, the environment noise should be low enough for the user to hear clearly. As a wireless mouse, the

environment noise does not affect the function of the product.

- **Life in service**

  The product has the functions of a cell phone. The user can make phone calls, send text messages, browse the internet, and take photos with it. It can also carry out various software application functions, including navigation, translation, file storage, and internet chatting.

  As a wireless mouse, the product can be connected to a computer via Bluetooth or an external receiver.

- **Maintenance**

  The battery is very likely to have defects due to long service time or improper usage. Therefore, it should be easy to change for maintenance.

  The external receiver is a part separate with the main body of the product, so it is easy to lose. Matching external receivers should be available for maintenance.

- **Target product cost**

  Cell phone: The average cost of a smart cell phone is about ¥3000.

  Wireless mouse: The average cost of a wireless mouse is about ¥300.

  Total: The total cost should be about ¥3300.

- **Manufacturing facility**

  We need the following Manufacturing facilities:

  a) CNC molding machine

  b) Stamping machine for the outer shell

  c) Circuit board making machine

  d) Welding line

  e) Assembly line

  f) Packing line

- **Size**

  Closed State (mm) $22.1 \times 100.8 \times 60$

  Mouse State (mm) $27.9 \times 143.2 \times 60$.

- **Weight**

  About 150g (guess)

- **Product life span**

  The simple and plain style design of the product makes it hard to break. With proper use and maintenance, the expected life span of the product is 10 years.

- **Safety**

  The product should not have any sharp edges or corners. No toxic or recycling materials should be used in the parts that are directly in contact with the user. The radiation of the product should be low enough not to cause any harm to the user.

- **Competition**

  There are no similar products found. Most of the existing similar products enable the user to move his finger on the cell phone’s touch screen to control the mouse.

- **Installation**

Before using, the user needs to install the battery to the product and a driving program to the computer. Other applications can be downloaded from the internet and installed on the product at the user's wish.

- **Packing**
  The packing of the product should contain enough protection material to prevent the damage from the shipping process. It should also look attractive for larger sales.
- **Shipping**
  The shipping process the product should prevent violent knock and strong electromagnetic strike that might destroy the product.
- **Disposal**
  Many disposed parts of the products need recycling for environmental protection and material saving purposes. The disposed battery in the product needs to be sent to specialized factories for recycling. The rare materials in the disposed main body should also be recycled for other proper use.
- **Patents, literature and product data**
  There is no existing patent.
- **Political and social implications**
  The product combines two commonly used electronic devices — cell phone and wireless mouse. Cell phone makes communication convenient and wireless mouse helps the user operating computer. Having both of the functions, the product will help strengthen the connections among people.
- **Legal**
  The design and manufacturing processes of the product must not violate any rules of any law, international law or local law alike.
- **Documentation**
  The documentation of the product includes the using instruction, the warranty bill, and the qualifications from various testing organizations.
- **Testing**
  The plastic used in the product mush be safe for direct contact with human body, so the related qualification, such as the PAH testing, must be obtained. To guarantee the proper work of the electronic components, the product should pass various tests in the CE test, such as the EMC test. The software functionalities also need to be tested by the software engineers.
- **Ergonomics**
  The curved surface and the keyboard of the product fit the shape of the user's hand, which makes it suitable for long time use. The latent symmetry design fits well in both hands, so it is suitable for both right-handers and left-handers.
- **Customer**
  The customer of this product can be those who travel a lot and need computer and cell phone. These travelers want to take fewer devices while satisfying their needs. The integration of cell phone and wireless mouse would make their trip easier and more enjoyable.

- **Quality reliability**

The product should pass various tests on functionality, safety, and legality. The manufacturing process should pass professional qualifications on legality, labor usage, and environmental protection. The quality of the final product and the whole process is thus guaranteed.

Appendix D: Details of Prototyped machines

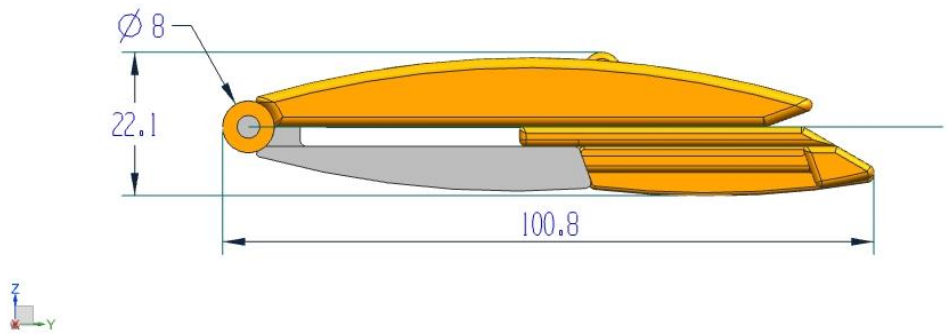


Fig.D-1 Cell Phone Close

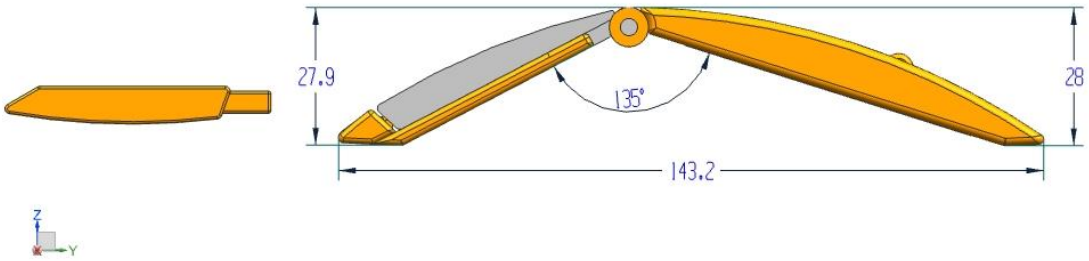


Fig.D-2 Cell Phone Mouse Form

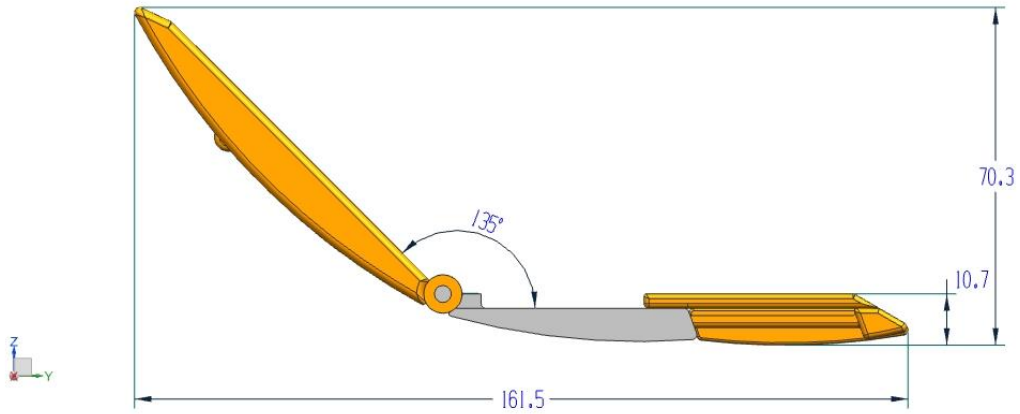


Fig.D-3 Cell Phone Open

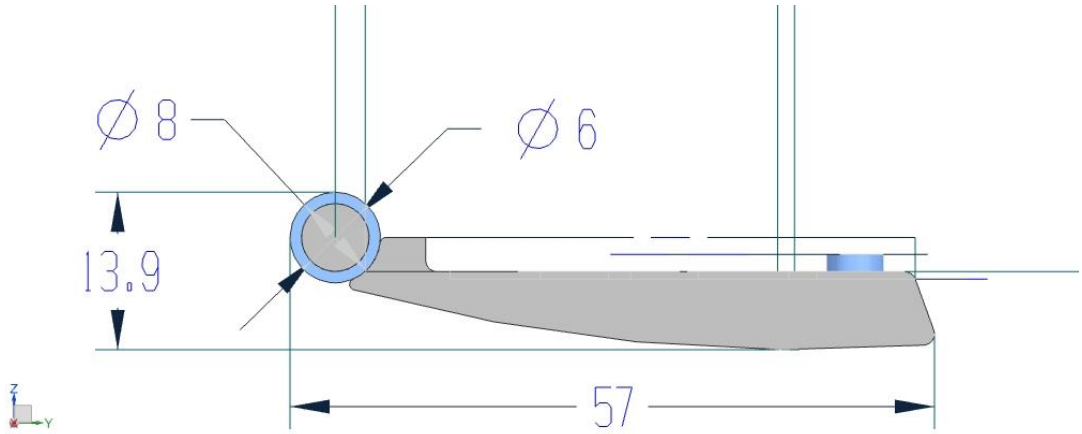


Fig.D-4 Keyboard

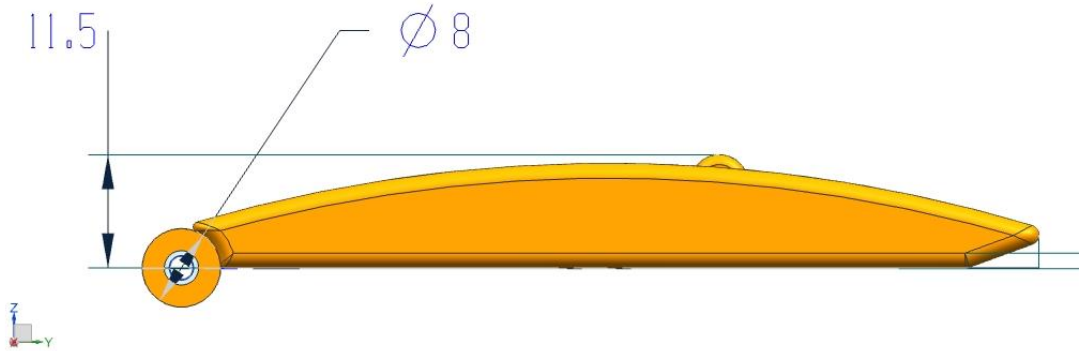


Fig.D-5 Screen

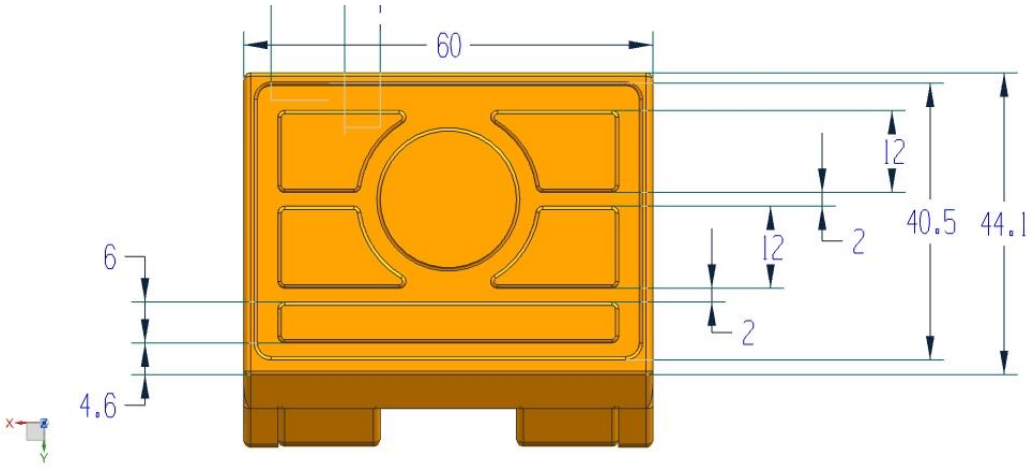


Fig.D-6 Sliding

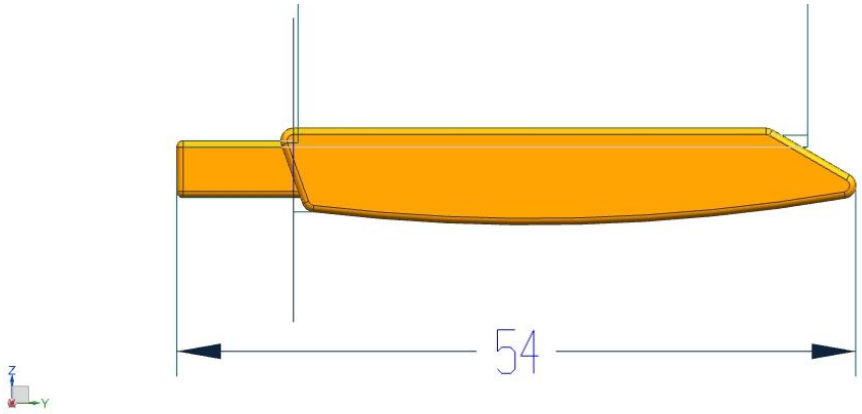


Fig.D-7 USB

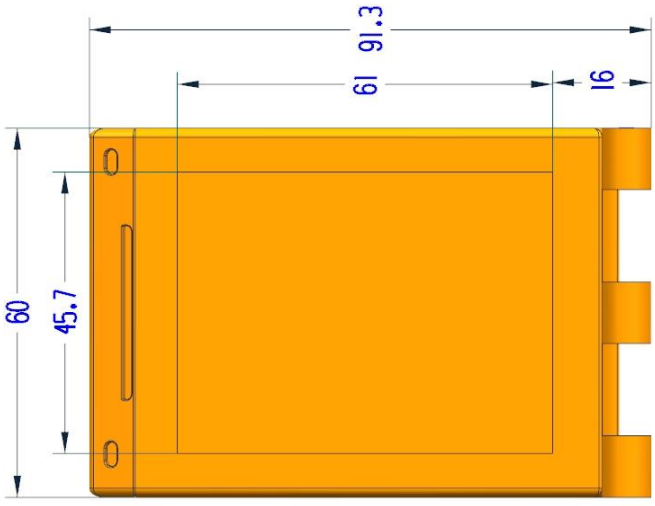
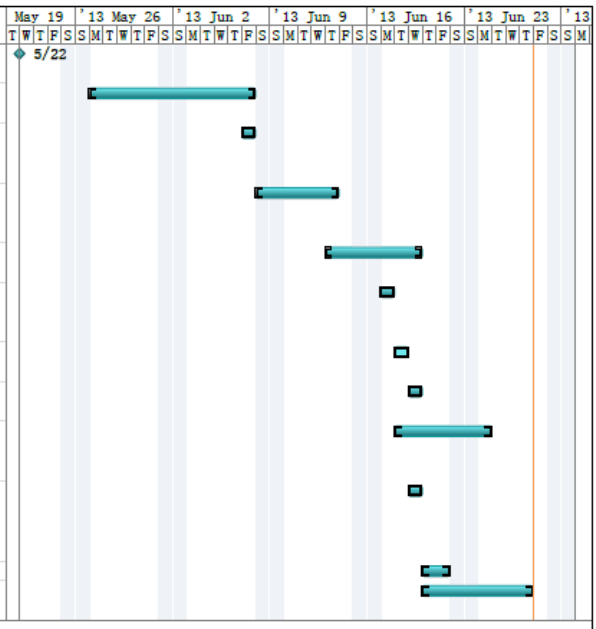


Fig.D-8 Screen

Appendix E: Gantt Chart

ID	Task Mode	Task Name	Duration	Start	Finish
1		First Project Startup	0 days	Wed 13/5/22	Wed 13/5/22
2		Master Basic CAD Techniques in UG	10 days	Mon 13/5/27	Fri 13/6/7
3		Team First Meeting for Barin Storming	1 day	Fri 13/6/7	Fri 13/6/7
4		Drangon Boat Festival Schedule Adjustment	5 days	Sat 13/6/8	Thu 13/6/13
5		Online Research for Similar Products	5 days	Thu 13/6/13	Wed 13/6/19
6		Team Meeting: Generate Concept Design	1 day	Mon 13/6/17	Mon 13/6/17
7		Identify User Requirements	1 day	Tue 13/6/18	Tue 13/6/18
8		Create QFD Chart for Project 1	1 day	Wed 13/6/19	Wed 13/6/19
9		Create Preliminary Design for Project 1 Using UG	5 days	Tue 13/6/18	Mon 13/6/24
10		Team Meeting: Concept Design Internal Overview & Divide Report Work	1 day	Wed 13/6/19	Wed 13/6/19
11		Design Modification	2 days	Thu 13/6/20	Fri 13/6/21
12		Report Section Writing	6 days	Thu 13/6/20	Thu 13/6/27



Project: Vm_250_Project_2_G
Date: Fri 13/6/28

Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Deadline
Progress

Page 1

Fig.E-1 Gantt Chart part_1

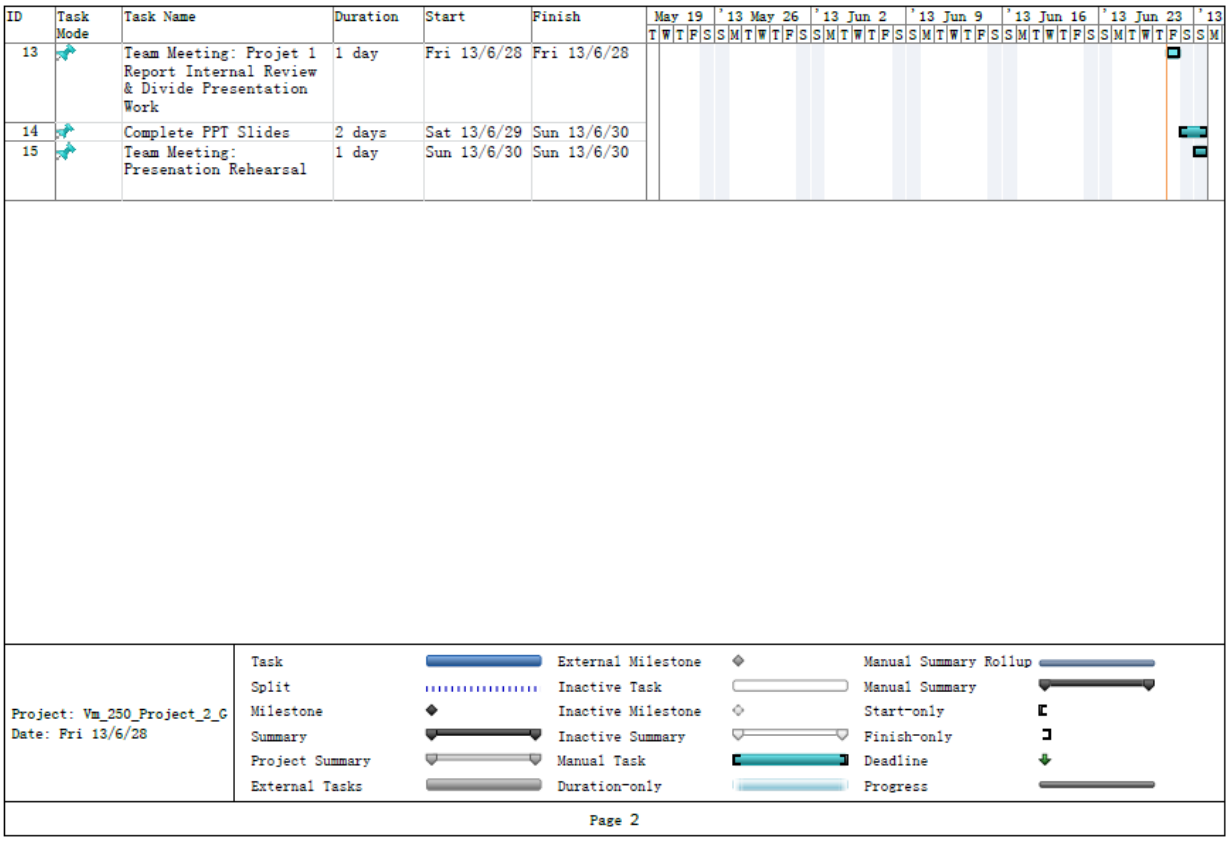


Fig.E-2 Gantt Chart part_2