

DESIGN AND FABRICATION OF MULTI TOUCH SCREEN
KEYBOARD TABLE

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BORANG PENGESAHAN STATUS TESIS

JUDUL

**DESIGN AND FABRICATION OF MULTI TOUCH
SCREEN KEYBOARD TABLE**

SESI PENGAJIAN: **2011/2012**

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DESIGN AND FABRICATION OF MULTI TOUCH SCREEN KEYBOARD
TABLE

AHMAD AIMAN BIN AZMI

Report submitted in fulfilment of the requirements for the award of the Diploma in
Mechanical Engineering

Faculty of Mechanical Engineering
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DECEMBER 2011

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and in my opinion this project is satisfactory in terms of scope and quality for the award of Diploma in Mechanical Engineering.

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Position :

Date :

STUDENT'S DECLARATION

I hereby declare that this report titled “Design and Fabrication of Multi Touch Screen Keyboard Table” and the result from my research are based on the references that have been used in order to complete it. I hereby declare that the work in this chapter is my own except for quotations and summaries which have been duly acknowledged. The report has not been accepted for any diploma and is not concurrently submitted for award of other diploma.

Signature :

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CHAPTER 1

INTRODUCTION

1.1 Background

Multi touch screen Keyboard Table (MTKT) is a generation of computer we used nowadays. As we all know, normal computer used mouse and keyboard as their input, but with MTKT we can interact with the computer by the touch of our finger. The moment we touch the screen, the computer will interact with them to produce input to our computer. Moreover, with MTKT the users can have multiple touches or inputs on the same computer. It will make it easier for the user to have a conversation and interacting with the computer on the same time.

MTKT can be in many different sizes but it must be in suitable to fit a LCD projector and an IR webcam. For some of the products, MTKT is built in standard sizes to make the user easier to use it also as a table. The size is an important factor when building MTKT because it will some space in the room.

The mechanism to construct the touch screen is by reflecting the IR light to the webcam at the bottom of the table. The Frustrated Total Internal Reflection (FTIR) is used. FTIR happen when the IR light trapped into the acrylic and it only reflect in the acrylic. When someone touches the acrylic, the light will bounce back to the IR webcam below the acrylic.

1.2 Problem Statement

Nowadays many people find it hard using mouse and the keyboard while using the computer at the same time. It also limits the user to interact with the computer by one click at a time. Some computers maybe consume too much space for it. Besides that, the conventional keyboard cannot long lasting and it is not suitable for extreme user such as gamers. Although the conventional keyboard is not so expensive, the broken of it may cause people to lay much money to buy the new ones when they are malfunction or broken. Besides that, the designs of multi touch that has been in the market consume too much space and not practical and also the weight is huge and hard to portable.

1.3 Project Objective

To design and fabricate Multi Touch Screen Keyboard Table (MTKT) for multipurpose usage.

1.4 Project Scope

- To test the software for multi touches.
- To fabricate (MTKT) using various manufacturing process.
- To compare ideas with past developers and products.
- To design a new table for multipurpose uses of keyboard

1.5 Thesis outline

1. Chapter II will present about literature review and the history of multi touch screen.
2. Chapter III will discuss about methodology of the project.
3. Chapter IV will discuss about the result and discussion of the project.
4. Chapter V will includes the conclusion of the project.

CHAPTER 2

LITERATURE REVIEW

2.1 History of Multi-touch

The use of touch screen technology to control electronic devices pre-dates multi-touch technology and the personal computer. Early synthesizer and electronic instrument builders like Hugh Le Caine and Bob Moog experimented with using touch-sensitive capacitance sensors to control the sounds made by their instruments. IBM began building the first touch screens in the late 1960s, and, in 1972, Control Data released the PLATO IV computer, a terminal used for educational purposes that employed single-touch points in a 16x16 array as its user interface.

One of the early implementations of mutual capacitance touch screen technology was developed at CERN in 1977 based on their capacitance touch screens developed in 1972 by Danish electronics engineer Bent Stumpe. This technology was used to develop a new type of human machine interface (HMI) for the control room of the Super Proton Synchrotron particle accelerator.

Multi-touch technology began in 1982, when the University of Toronto's Input Research Group developed the first human-input multi-touch system. The system used a frosted-glass panel with a camera placed behind the glass. When a finger or several fingers pressed on the glass, the camera would detect the action as one or more black spots on an otherwise white background, allowing it to be registered as an input. Since the size of a dot was dependent on pressure (how hard the person was pressing on the glass), the system was somewhat pressure-sensitive as well.

In 1983, Bell Labs at Murray Hill published a comprehensive discussion of touch-screen based interfaces. In 1984, Bell Labs engineered a touch screen that could change images with more than one hand. In 1985, the University of Toronto group including Bill Buxton developed a multi-touch tablet that used capacitance rather than bulky camera-based optical sensing systems.

Various companies expanded upon these inventions in the beginning of the twenty-first century. The company Fingerworks developed various multi-touch technologies between 1999 and 2005, including Touchstream keyboards and the iGesture Pad. Several studies of this technology were published in the early 2000s by Alan Hedge, professor of human factors and ergonomics at Cornell University. Apple acquired Fingerworks and its multi-touch technology in 2005. Mainstream exposure to multi-touch technology occurred in 2007 when the iPhone gained popularity, with Apple stating they 'invented multi touch' as part of the iPhone announcement however both the function and the term predate the announcement or patent requests, except for such area of application as capacitive mobile screens, which did not exist before Fingerworks/Apple's technology (Apple filed patents for in 2005-2007 and was awarded with in 2009-2010). Publication and demonstration using the term Multi-touch by Jefferson Y. Han in 2005 predates these, but Apple did give multi-touch wider exposure through its association with their new product and were the first to introduce multi-touch on a mobile device. Microsoft's table-top touch platform Microsoft Surface, which started development in 2001, interacts with both the users touch and their electronic devices. Similarly, in 2001, Mitsubishi Electric Research Laboratories (MERL) began development of a multi-touch, multi-user system called DiamondTouch, also based on capacitance but able to differentiate between multiple simultaneous users (or rather, the chairs in which each user is seated or the floorpad the user is standing on); the Diamondtouch became a commercial product in 2008.

Small-scale touch devices are rapidly becoming commonplace, with the number of touch screen telephones expected to increase from 200,000 shipped in 2006 to 21 million in 2012

2.2 Introduction

Lots of effort had been done to maximize our hand usage to control digital objects. The results we can see now are touch pad, ATM machines, and as the latest, tablet PC and Smartphone. Many revolutions had happen since 1985, when the first multi touch tablets were proposed by Lee, Buxton and Smith. Since that time, many people continue to develop the technology of multi touch screen and the design of this product. The types of input to this multi touch display are various, whether it is a direct input, gestural input, symbolic or hand measurement to specify the input or command.

Nowadays, lot of multi touch gadgets use lot of effort and very complex design, thus it will increase the cost of making the device. Figure 2.1 shows the example of conventional keyboard of computer, this design is still uses nowadays and figure 2.2 shows the next generation of the keyboard called the silicone keyboard and the silicone keyboard took the market place with its colourful and attractive design, this keyboard is not so expensive but it is quite not practical because it is not fireproof and easy to damage.



Figure 2.1: Conventional keyboard



Figure 2.2: Silicone keyboard

2.3 Early Edition of Multi Touch Screen

One of the early implementations of mutual capacitance touch screen technology was developed by the human in 1977 ago. After an innovations to another innovations, human came out with various types of designs that implement the technology of multi touch screen.

2.3.1 Touchpad

Touch tablets that can sense more than a single point of contact was first propose by Lee, Buxton, and Smith in 1985. They used digitizer as their main component at the touchpad. The proposal was made at University of Toronto the place where they are doing their work. Figure 2.1 shows that the early model of touchpad that had been used. This first model uses a heat sensor to indicate present of heat from the finger.



Figure 2.3 First Touchpad

The purpose of their proposal is to search the method for multi touch can be done in the same time at the same thing. Their digitizer is composed of an array of capacitive proximity sensors where the finger and the sensor act as two plates of capacitors. Since capacitance is inversely proportional to the distance between the plates, robust contact detection can be accomplished by simply selecting an appropriate threshold.

The resolution of the digitizer can be enhanced beyond the physical resolution of the sensor matrix by interpolating data from neighboring groups of sensors, the touchpad also approximate pressure sensing by monitoring the increase in capacitance as the fingertip flattens against its surfaces. This proposal made the breaking point for the revolution of the multi touch screen. Since then, many type of touch pad had been commercialized. For example, Touch Stream and iGesture touchpads by FingerWorks

2.3.2 Vision-Based System

Vision based can be roughly classified as “direct” system, where the camera are aimed at the users hand, and “indirect” system, where the cameras are aimed at a touch-surface that produces a change in the image when touched by a finger or object.

One of the earliest direct vision based system for whole hand interaction is Krueger’s Videoplace. Myron Krueger who is a computer genius has started the research of from 1969 until 1974. The system captures an image of the users, who stand in front of a plain background. It segments the image and displays it as a silhouette in real time. The moving silhouette can then be used to interact with digital objects and animated characters. Figure 2.4 and 2.5 show that the user displayed the function of vision-based system. The digital images produced by this system is projected to the infrared layout screen.



Figure 2.4 Input From the User



Figure 2.5 Digital Image Produced

2.4 Technology

There are various of technologies related on how to improve the multi touch screen. Some of the technologies costs billion of money that had been laboured from big companies such as Microsoft Corp. and Apple Corp. They are competing to come out with the most valiant and reliable software of multi touch technology such as Frustrated Total Internal Reflection (FTIR)

FTIR is a name used by the multi touch community to describe an optical multi-touch methodology developed by Jeff Han. The phrase actually refers to the well known underlying optical phenomenon underlying Han's method. Total Internal Reflection describes a condition present in certain material when light enters one material from another material with high refractive index, at an angle of incidence greater than the specific angle. The specific angle at which this occurs depends on the refractive indexes of both materials, and is known as the critical angle, which can be calculated mathematically using Snell's Law.

When this happens, no refraction occurs in the material, and the light beam is totally reflected. Han's method uses this to great effect, flooding the inside of a piece of acrylic with infrared light by trapping the light rays within the acrylic using the principle of Total Internal Reflection. When the user comes into contact with the surface, the light rays are said to be frustrated, since they can now pass through into the contact material (usually skin), and the reflection is no longer total at that point. This frustrated light is scattered downwards towards an infrared webcam, capable of picking these blobs up and relaying them to the tracking software.

Figure 2.6 shows that when the user put his hand on the screen, the infrared lights will be reflected by the finger and went down, then the webcam that act like a sensor will detect the present of the light and then it will trap the light. Data will be sent to the computer inside the table below and it will interpreted the data and gives the output

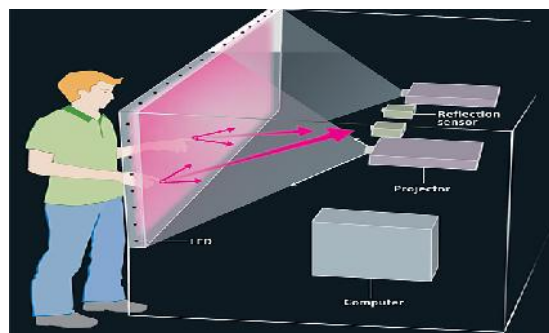


Figure 2.6: The projector will project the images to the acrylic surface (screen)

Figure 2.7 shows the finger that touched the acrylic surface, the IR inside the frame will project the infrared light, when the light hit the finger, it will reflect to the sensors. The acrylic surface is covered with pressure-sensitive polymer. The function is to increase the total surface area contact of the hand and it will increase the efficiency of the acrylic surface.

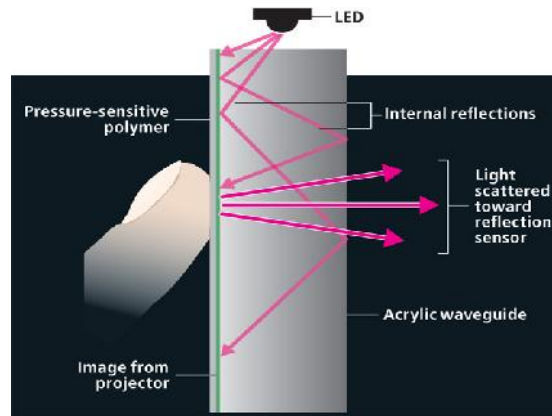


Figure 2.7: Finger will reflect the light from IR and go to the sensor.

Figure 2.8 shows how the FTIR mechanisms work. By flooding the inside of a piece of acrylic with infrared light by trapping the light rays within the acrylic using the principle of Total Internal Reflection. When the user comes into contact with the surface, the light rays are said to be frustrated, since they can now pass through into the contact material (usually skin), and the reflection is no longer total at that point.

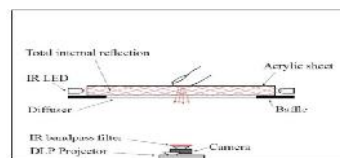


Figure 2.8 FTIR mechanisms

Figure 2.9 shows that the blobs from the fingers had been detected by the webcam sensor by using the FTIR software.

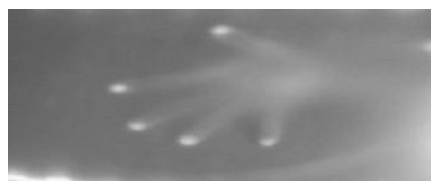


Figure 2.9 Blobs from fingers

2.5 Types of Multi Touch Screen

The figures 2.6, 2.7 and 2.8 shows that the design of multi touch screen design table that are already in the market, however, the sizes and designs had indicated some disadvantages such as the sizes are quite large and many of them cannot move freely because of its weight.

2.5.1 Open Table Style

Figure 2.10 shows an example of multi touch screen table. The advantages of this design are it is very simple and can be portable. The disadvantages of this table are it is quite heavy and difficult to be mobilized. Besides that, the design is too open and the electronic components can be exposed with the accidentally poured of water that can damage them.



Figure 2.10: Open-table Style

2.5.2 Vertical-block Style

Figure 2.11 shows the multi touch screen that is designed in a vertical-block style. One of the benefits of this design is it can increase the user interface between the user and the screen, and the disadvantage is it is too heavy and cannot be moved freely.



Figure 2.11: Vertical-block Style

2.5.3 Combination of table and board Style

Figure 2.12 shows the recent design that had been improved from the previous two designs. This design is more simple and lightweight and it can be portable. But, this design is quite not durable because it is made of plastic to reduce its weight. In the other hand, it is not suitable for extreme uses.



Figure 2.12: Multi Touch Screen Table

2.5.4 Bend Desk

Bend desk is a prototype interactive display that takes the digital workspace from the screen to the desktop by the media computing group at RWTH Aachen University. While a typical work setup combines a flat desktop with a vertical computer screen, bend desk combines the two into one single unit. Bend desk is a vision for a future workspace that allows continuous interaction between both areas. Using multi-touch technology, the display curves from a horizontal plane to a vertical plane. This workspace can be used to display digital content and interact with it directly using multi-touch gestures and manipulation.

Advantages

- Very large working surface.
- Ergonomic for the user.
- Can be used as table.

Disadvantages

- Cannot move freely.
- Limited to small number of person.
- Large space consumption.

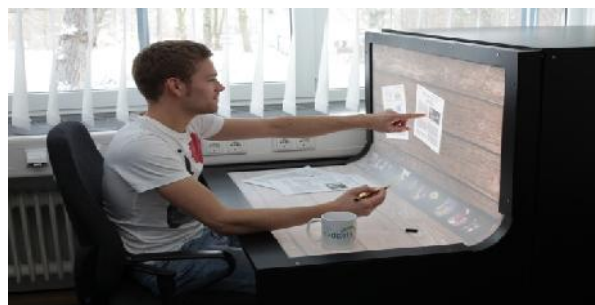


Figure 2.13 Bend Desk

2.5.5 Multi Touch Television

Similar to other multi touch product but has wider screen. The projector and the computer were located in the box of the multi touch. The project use FTIR technology. Then it combined with speaker and can work as normal computer.

Advantages

- Large wide screen.
- Build in speakers.
- Nice and attractive new design.

Disadvantages

- The design is not suitable for long usage.
- Can consume too much space



Figure 2.14: Multi Touch Television

2.5.6 Multi touch Mini

A Multitouch Mini, MTmini for short, is a cheap, small, portable multitouch pad. It can be used for all different purposes including: drawing, OS navigation, multitouch operation, games, entertainment, experimentation, and more. I created the Multitouch Mini to show people how something that seems complicated or 'magical' can be made simply and at low cost. The MTmini uses the "Front Diffused Illumination" multitouch technique, with normal ambient light (infrared not required or needed) and a normal off-the-shelf webcam (IR filter can still be in place).

Advantages

- Portable.
- Very light weight.
- Less space consumption.

Disadvantage

- Too small to fit the image.
- Less aesthetic value.
- Limited user.



Figure 2.15: MT Mini

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, we will discuss about the methods of designing and fabricating process from the beginning and the finishing process of MTKT. There are various process included in completing the MTKT and through this chapter, I will stated all the process happens. In designing and fabricating of this Multi touch screen, a flow of methods were used in completing the project. First of all, a project planning was constructed and were charted out. These chart will function as the guideline to be followed so that, the final model meets the requirement and time.

3.2 Flowchart

The flow chart starts with the introduction. This is where the first plan of work is constructed. The supervisor explains the scope of the project and requested for understanding of the project and makes some finding about the project. Student makes project synopsis, objective, scopes, problem statement and work planning.

Then the problem statement is following down the steps. Here problem are generated by the observing and research on the project.

Next the literature review of the project is done thoroughly to get the better understanding of this project. The literature review covered all the aspects regarding the build of MTKT. Student gets the information via internet and books. Additional information comes from lecturer and other student.

After the literature review was done, few raw sketching were done to fulfill the objective and the problem statement of the project. Four sketches were made with 3-dimensional and clear understanding. Sketching is done to make a clear view for designing process after this. After all the sketches are prepared, a comparison among the sketches is made to give the advantage and this advantage for the sketches. This is to make sure the best sketches will be produced.

Pugh analysis is made to get the scoring between the sketches. By using this method, the student can see more easily and clearly compared to comparison. Every criterion will be given a weight and the scoring is made based on the criteria. The score is then multiplied by the weight of the criteria to get the score. The best is chose among the highest total score. Then the actual project design is made based on the chosen sketches. The design is made by using SolidWorks 2010 software. The design is made part by part and is assembled by using the same software. Then 2D drawing is made with dimension and scale.

The next step is fabrication process. All the fabricating works are made in the lab and utilize all the tool and equipment in the lab. The first step is getting the material from the FKM store. Plywoods is used as the main frame of the model. Then, then it is cut into 4 pieces to be joining as the wall of the table. After that a thick wood is used as the based and the level of the model. The joining process of the product is using rivet, bolt and nut, so drilling process is needed before the joining process is made.

As all the parts had been joined together, it comes to the result and discussion section. In this section, the report and the product are shown and tested. The draft report and the entire related article are handed over to the supervisor for checking. For the conclusion, all the recommendations are stated to get the best quality product. The project and the report is also checked to make sure no mistake and flaw in the end report.

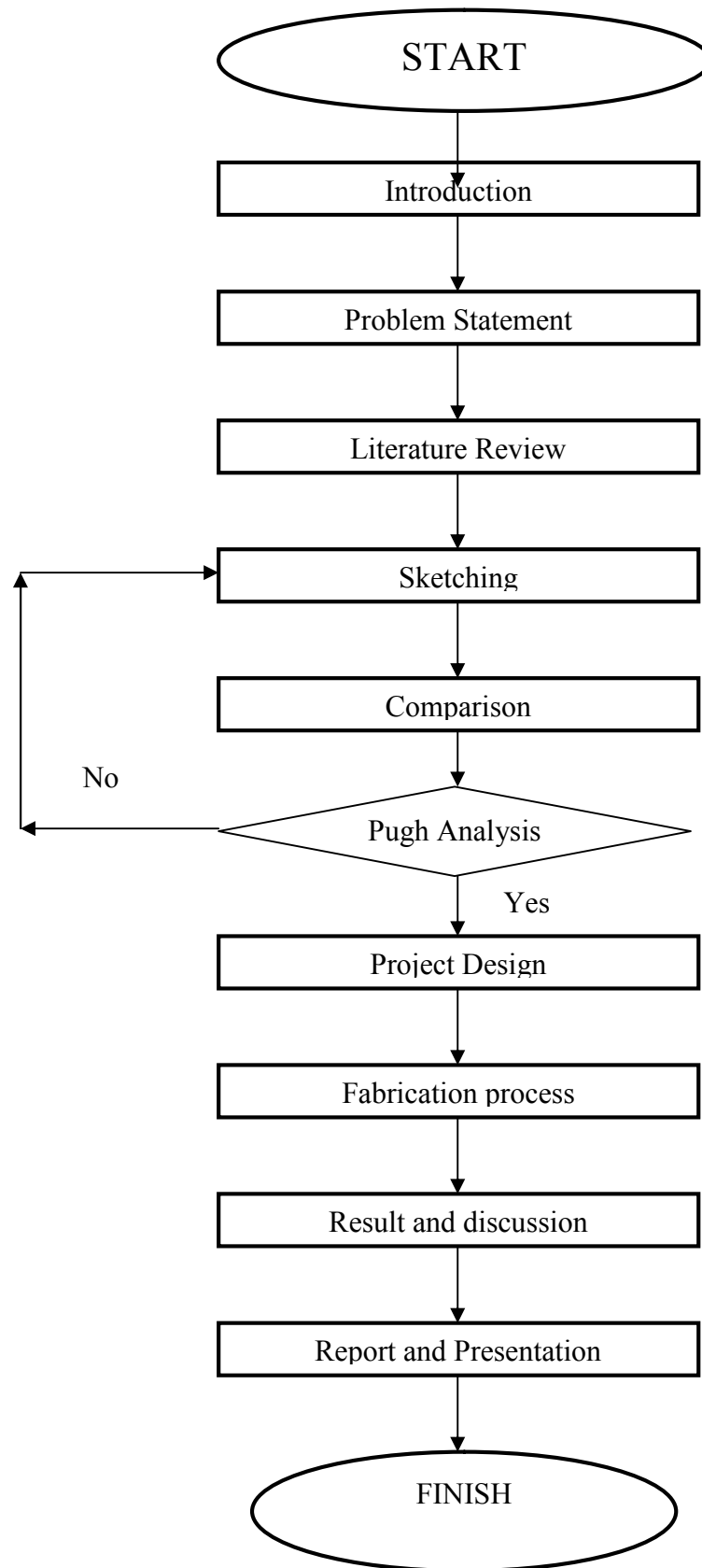


Figure 3.1: Flow Chart

3.3 Sketching

I had come out with 4 sketches that had been designed based on the previous design in the market and I had improved on its sizes and design to make the designs more attractive and have commercial values. The 4 sketches were made based on the ideal concept and as followed:

3.3.1 Concept 1

This is the basic design of multi touch screen. The top of the table is the main screen and consist of 4 legs. it has sharp edges and not suitable for children. The table is made up of perspec and it has two doors for putting of compartments and components.

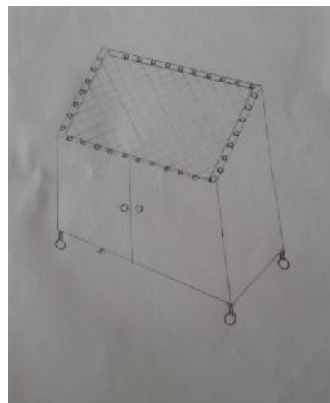


Figure 3.2: Concept 1

3.3.2 Concept 2

This concept is larger than the first concept. Can be made as an table. The bend part is also the screen for multi touch. It is open-table style and the components of electronics are exposed to the surrounding. It is not portable and not practical for people who made a lot of movements of their personal computer.

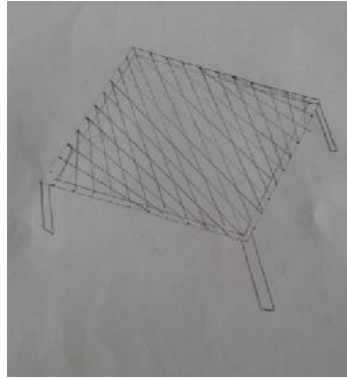


Figure 3.3: Concept 2

3.3.3 Concept 3

The third concept only consists of the screen. It has larger screen and stand on the back part of the concepts. This design has no edges and suitable for children's use. The body is made up of plywood and it will use complex fabricating processes. It has two doors for open close and to put the components inside. It is not portable.

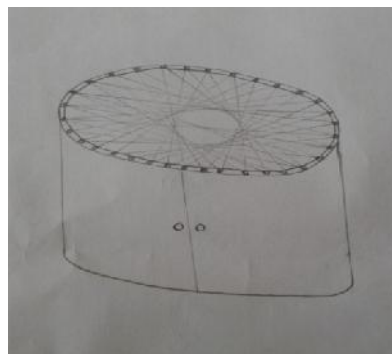


Figure 3.4: Concept 3

3.3.4 Concept 4

The last concept of this project is made for more use other than multi touch screen. It can be more useful than other concepts. It is portable and has no sharp-edges. It is made up of plywood and it has a single door for close and opening. It also has large compartment space.



Figure 3.5: Concept 4

3.4 Concept Selection and Comparison

Concept selection and comparison are made to select the best concept among the entire concepts given. The concepts are compared by using screening and scoring process. The comparison is based on reasonable criteria all as called as matrix. The four given concept is the best among all the concept generated and pass the screening process. This process is so complex and all the criterias given must be analyzed to all the concepts and must be accurate so that the chosen concept will be the best to be chosen to proceed.

3.4.1 Screening Process

Table 3.1: Screening Process of the Concepts

Matrix\Concepts	Concept 1	Concept 2	Concept 3	Concept 4
Comfort	+	o	+	+
Durability	o	+	+	+
Easy to Use	+	o	+	+
Production Cost	+	+	o	o
Portable	+	+	+	+
User limit	o	-	0	o
Easy to fabricate	o	+	0	+
Simplicity of design	+	-	o	+
Strength	o	+	-	o
Total (+)	5	5	4	6
Total (-)	0	2	1	0
Total Score	5	3	3	6
Rank	2	3	4	1

Through the screening process in table 3.6, concept 4 get the highest scores and first ranking. the sum of all + makes the concept 4 get the highest score compared to other concepts.

3.4.2 Scoring Process

Pugh analysis is made after the screening process to select the concept as the best concept. The method is same as the screening process but this time the criteria is weighted and total score are calculated in the end.

Table 3.2: Scoring Process of the Concepts

Matrix\Concepts	Weight (%)	Concept 1	Concept 2	Concept 3	Concept 4
Comfort	10	1	3	2	4
Durability	10	2	4	1	3
Easy to Use	10	1	1	2	3
Production Cost	10	4	2	1	3
Portable	15	2	3	3	4
User limit	20	1	3	3	2
Easy to fabricate	10	2	1	1	4
Simplicity of design	5	4	2	2	3
Strength	20	2	2	3	2
Total score (%)	110	210	265	245	325
Rank		4	2	3	1

1 = Excellent 2 = Very good 3 = Good 4 = Okay

3.5 Solidworks Design

Then after the concept had been chose, the sketch of concept 4 is converted into 3D drawing by using SolidWorks 2010 software. The design is made part by part and assembles to the correct way by using this software. Then a 2D sketch will be generated to get the clear view about the model. Part by part view was shown as follows:

3.5.1 Part 1

This part is the main part of the frame. Almost 90 percent of the desk body is made by this part. Figure 3.8 shows that the plywood drawing from the SolidWork according to its colour and dimension.

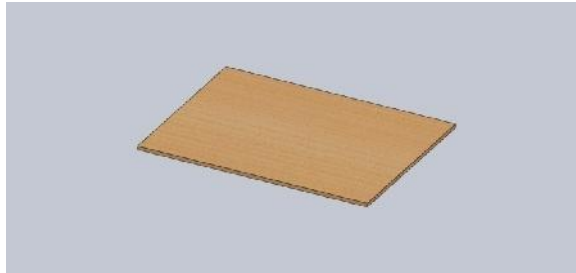


Figure 3.6: Plywood

3.5.2 Part 2

The top part of the table is made from acrylic. Figure 4.0 is the drawing of acrylic by using SolidWork. Figure 3.9 shows the drawing of acrylic according to its dimensions.

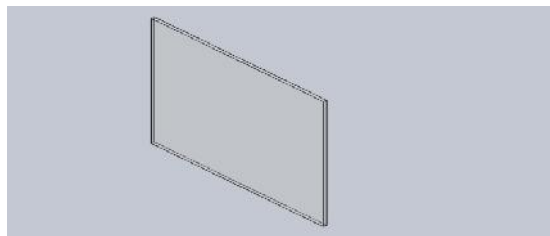


Figure 3.7: Acrylic

3.5.3 Part 3

This part is to hold the IR LED along the acrylic. The figure 3.10 below shows the drawing of the frames by using SolidWork according to its dimension and shapes.

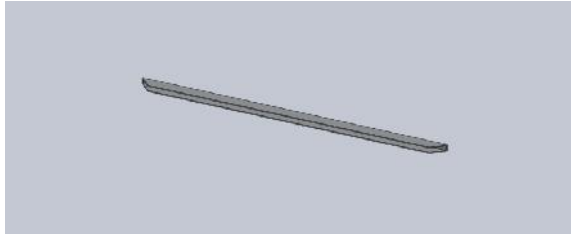


Figure 3.8: Aluminum Frame

3.5.4 Assembly View

This is the final assembly of the project which shown the last product of this project. After all the concepts went through the screening process and Pugh analysis. The number 4 concept design is chose. The figures 3.11, 3.12, 3.13, 3.14 and 3.15 shows the drawing of the MTKT from assembly view, cutting view, front view, top view and side view respectively according to its dimensions.

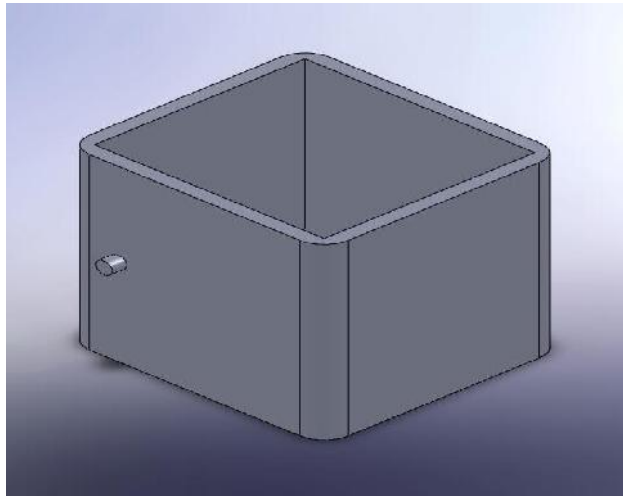


Figure 3.9: Assembly View

3.5.5 Cutting view

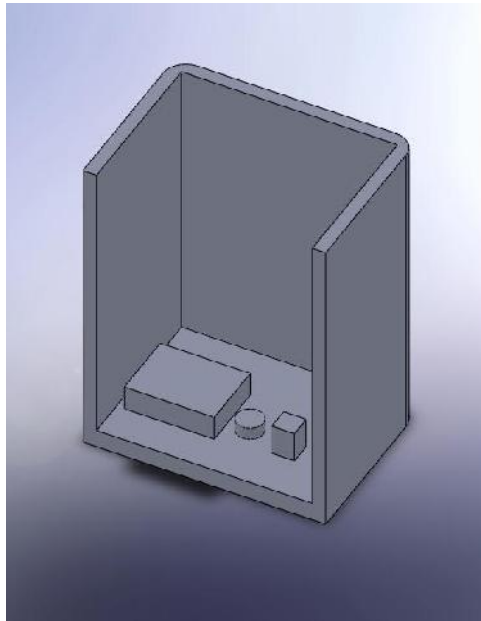


Figure 3.10: Cutting View

3.5.5 Front view

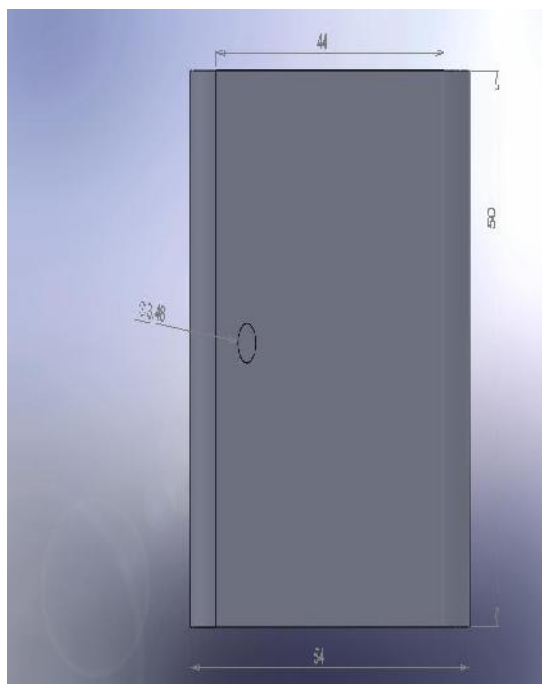


Figure 3.11: Front View

3.5.7 Top view

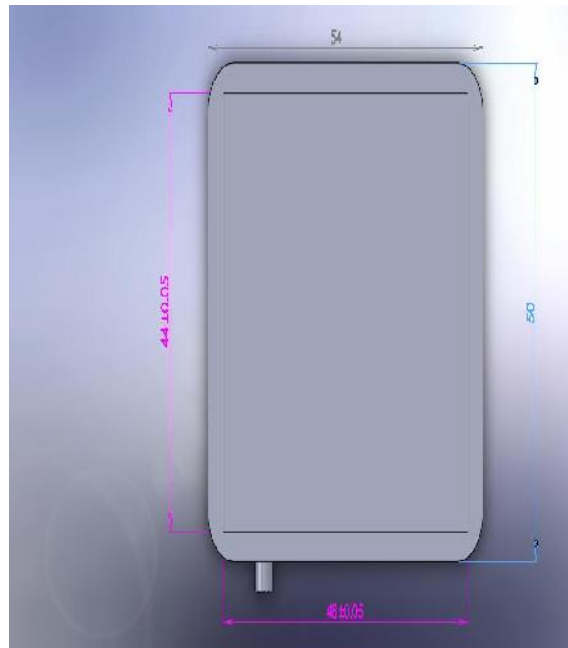


Figure 3.12: Top View

3.5.8 Side view

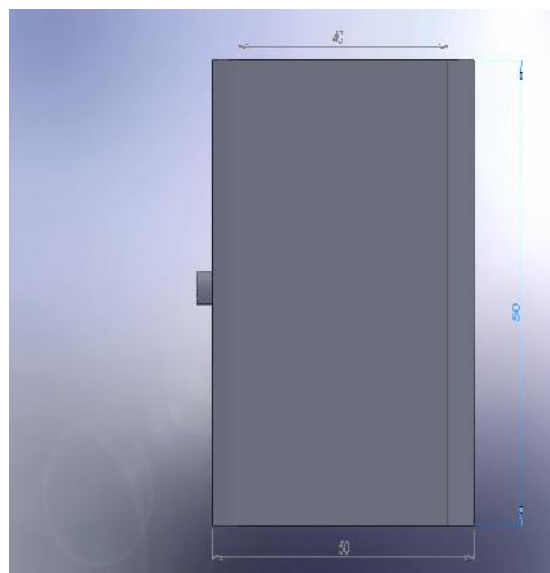


Figure 3.13: Side View

3.6 Bill of Materials

In this section, the list of material and its size are shown for reference. The material can be found in the FKM store or in hardware. Some of them are bought from the hardware shop as shown in Table 3.8.

Table 3.3: Bill of Materials

No	Description	Quantity
1	Plywoods	4 Sheet
2	Acrylic (500mm x500mm x 80mm)	1 Sheet
3	Brasso (metal polish)	1 Bottle
4	Silicon rubber	1 Bottle
5	Tracing paper	1 Sheet
6	Wood	1 Sheet
7	IR LED	30 Pieces
8	Resistor	10 Pieces
9	12V DC adapter	1 Set
10	Webcam	1 Set

3.7 Fabrication Process

In this section, all the fabrication process will be explain thoroughly. The fabrication processes are made in one of the lab in FKM. All the materials selected in section 3.6 of this report are used to make this project. The project is fabricated based on the design made earlier and using various fabricating methods. The method used to fabricate the product such as, cutting, grinding, drilling and more other methods.

In order to make the project to be finished and tested, the process of fabricating must be used. The fabrication process starts with dimensioning and ends with assembly process. The process involve in this project are as followed.

- **Collecting material**

Firstly, the material used is collected at FKM store. There are various types of materials there and the plywoods are collected there. The other materials were bought from hardware nearby.

- **Measuring and marking**

Next, all the materials are measured and marked according to the dimension from the design earlier. Measuring tape is used to measure the correct measurement according to the dimensions specified in final drawing.

- **Cutting**

After the materials are measure and marked, the cutting process will be done. The material is cut based on the mark on the material earlier. Many tools were used in this process such as hand saw, and floor cutting disk.

- **Drilling**

Then the drilling process is done in order to join the parts of the product using nut and bolt. The drill point is mark before using center punch and drilled using hand drill and table drill.



Figure 3.14: Drilling Machine

- **Grinding and finishing**

This process is to remove the bur and unnecessary part from the material. Hand grinder and file is use in this process.

- **Joining**

This process where the frame of the product is joined together using nut and bolt. The wrench is used to tighten the screw. Figure 4.4 shows that two parts of aluminium frames in a process to be joined. While doing this process, I must make sure that the wires and IRs are in the right position to avoid them from exit from its hole and then it can make the process more complex.



Figure 3.15: Joining of aluminium frame

- **Wiring**

This is the process when the IR LED is put into the acrylic frame used. The LED is connected using solder metal. The figure 4.5 shows that the wiring process that is done and I had finished this process in a whole day.



Figure 3.16: Wiring Process

- **Pouring silicone onto the Perspex surface**

This process is done after the joining process of acrylic with the aluminium frame. This process must be done quickly to avoid the quick dry of the silicone. When the silicone dry, it will make the process of pouring difficult and it can be done perfectly. During this process, avoid of inhaling the smells from the silicone as it can damages the brain. Use of PPE is recommended for this process. Figure 4.6 below shows that the pouring process happened.



Figure 3.17: Pouring silicone onto acrylic surface

- **Final assembly**

When all the parts are done, the whole projects are assembled and finishing process is done lastly. Figure 4.7 below shows that the final assembly of the table. The table is not been placed with screen on it.



Figure 3.18: Assembled Table

3.8 Conclusion

This chapter is done to discuss the step by step procedure to start the work till the end. All the flow of this project is based on the flow chart prepared early. Throughout the project, student can be more understand how to manage to work properly. The design starts with the work planning then continue to sketch the draft of the project. All the details about the concept selection and concept generation were also covered in this chapter. The drawing and the fabrication process were also being thoroughly briefed.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

This chapter is to show the final product that has been made. Then product is then compared whether is it met the target or not. If the final product doesn't met the real target then it means there are problem faced in the production period. The entire problem also will be discussed in this chapter. If the product meet the objective of this project, so it will be tested and all the testing process will be discussed in this chapter. Lastly the discussion is about the way to overcome the problem faced in the making of the project.

4.2 Final Product

The final product is finished after undergoing the entire fabrication process. The final product is then tested if it works perfectly or not. All the processes are again being reviewed to check if there is any flaw in the process of making the product. Figure 4.8 below shows the final product of the table been assembled. This table is included with the wiring of the IRs and can function well.



Figure 4.1: Final Product

4.3 Cost Analysis

Table 4.1

Materials	Materials cost	Fabrication cost
Plywoods	The actual cost of plywood is about RM20 but this material is taken from FKM store	Plywoods as the wall and 90% covered of the table, the process to cut it into 4 pieces by using hand saw is about RM10
Acrylic	The actual cost of acrylic by dimension of 500mm x 500mm is about RM65	Acrylic as the screen and placed on the top top the table, process of cutting it into desired dimensions by using hand saw cost about RM10
Silicon rubber	The cost of a bottle of silicon rubber is RM12	Silicon rubber is poured onto screen layer and the process of pouring is about RM2
IR LED	The cost of 30 pieces of IR are about RM66	IRs are placed inside the aluminium frame and the function is to detect the present of finger, process to place the IRs is by wiring process that cost about RM20
Aluminium Frame	The cost of 2.5 metres aluminium frame is about RM20 and bought from Pekan hardware	The process of cutting the aluminium frame by using hand saw into 4 pieces of angle 45 degree each and 500mm long cost about RM10
Webcam	The cost of a high	

	quality webcam is about RM45	-
Resistor	The cost of 6 pieces resistor are about RM1.80	Resistors are placed among the IRs and the function of its are to resist high voltage and the wiring process cost about RM20
Tracing paper	The cost of tracing paper bought from stationery store near Pekan is about RM1	-
12V DC adapter	The actual cost of a power source adapter is about RM20 and this adapter is borrowed from FKM Laboratory	-
Brasso Polish	The cost of a tin of Brasso polish is about RM7	-
	Total= RM257.80	Total= RM52.00

- **Plywood**

This material is taken at FKM store, the dimensions needed is 500mm X 500mm. I prefer to choose this material because of its reasonable price, durable and have esthetic value on it.

- **Acrylic**

This material also taken at FKM store, the thickness of this material is 7mm, this thick is the minimum recommended for the IR LED to pass through it, the thicker the acrylic, the better it can function. I had looked for this material at hardwares nearby Pekan and Kuantan but the prices are quite high so I prefer to take it from FKM store. The dimension of acrylic needed is 480mm X 480mm.

- **Brasso (polish metal)**

This material is needed as the finishing process to polish the aluminium frames. This process is not compulsory but it must be done to make the aluminium looks more shiny and attractive and also commercial value.

- **Silicon rubber**

This materials is bought from hardware store near Kuantan. This material is needed to cover the acrylic surface. The estimated price for silicon rubber is RM12

- **Tracing paper**

This material also been bought at stationery store, this paper's function is to increase the vision for the sensor and to improve the brightness of the screen (acrylic).

- **IR LED**

These materials are bought at Pekan hardware. IRs are use to act as an input, the lights from IR will be detected by webcam sensor. I use 30 pieces of IRs.

- **Resistor**

Resistor is used to resist excessive voltage from the power source, it is to protect the IRs from melt and damages because of high voltage.

- **12V DC adapter**

This is the power source to operate the IRs. This material is been borrowed at Hydraulic and Pneumatic Laboratory.

- **Webcam**

Webcam is uses to act like a sensor to detect the IRs' light. This webcam at first been altered to make it capable to detect the infrared light.

4.4 Defect

In the making of the project, there are many defects can happen while the fabrication process is done. There are few flaws that have been detected at the end of this project. The defect can happen because of the human error or machine and tool error. All flaws that had been detected can be the guide to overcome the problem on next production. It also can be the way to prevent any wastage of cost and production in next time production.

Besides that, all the defects can be avoided by using the correct method or way to complete the project. When the defects occurred, we cannot stand to waste any money and efforts for the project so by taking the correct steps, we can reduce the error and increase more money value for the project in the future.

4.5 Static Analysis

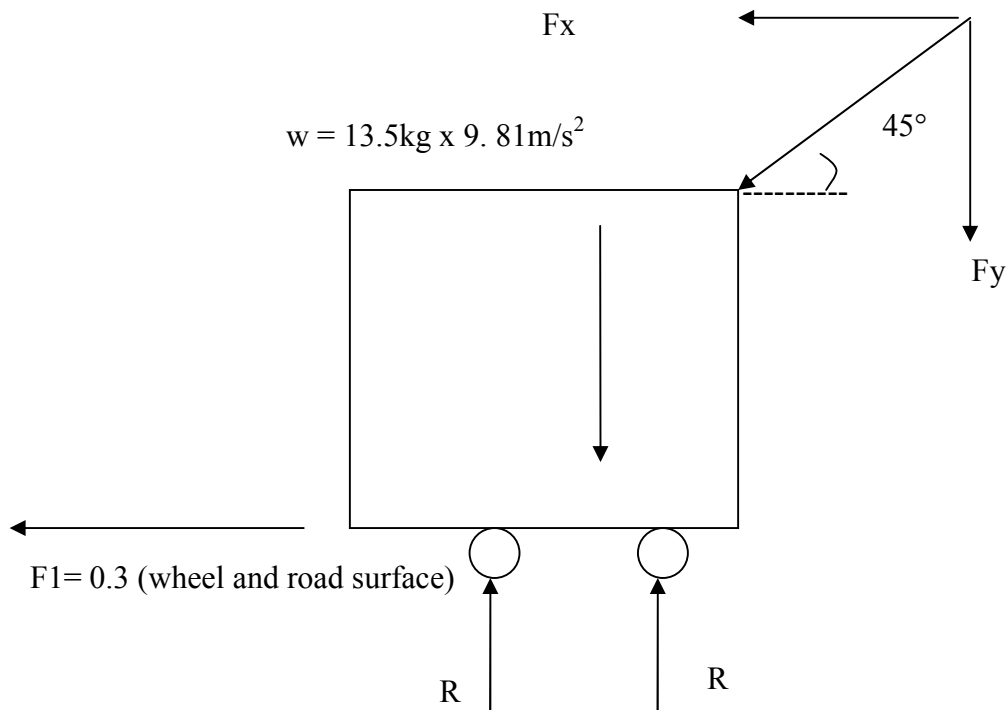


Figure 4.2: Free Body Diagram of the Table

Σf_x	$= -F_1 + P \cos 45$	Σf_y	$= R - 132.435\text{N} - P \sin 45$
0	$= -0.3\text{N} + 0.707P$	0	$= R - 0.707P - 132.435$
P	$= 0.424\text{N}$	0	$= R - 0.707(42.79) - 132.435$
P	$= 0.424(101.87)$	R	$= 30.25 + 132.435$
P	$= \mathbf{42.79\text{ N}}$	R	$= \mathbf{162.7\text{ N}}$
		R/4	$= \mathbf{40.7\text{ N for each wheel}}$

- Minimum force needed to push the table is **42.79 Newton**
- Reaction force for each wheel is 40.7 N

CHAPTER 5

CONCLUSION

5.1 Introduction

In this section, the summary of the whole project will be made in order to show the things that had been done in the entire process. This chapter also includes recommendation for the product to enhance the usage and the esthetic value of the product. Therefore, the project has accomplished the objective successfully. The project is done in 14 weeks time. The entire process of making this project is follows such as literature review, design, sketching and fabrication. The flow chart and the Gantt chart is also followed successfully. Besides that, I can conclude that the objectives of this project have been achieved successfully by its time.

5.2 Problem Faced

There are a lot of problems occurred during the making of the project. The problems can occur because of many factors and elements such as:

5.2.1 Materials Problem

The problem happen when the material that early suggested, needs to be changed. It is because the material needed for the project is not located in faculty store. So the material is change to the suitable material which is in the store. But not all the materials are in the lab, so student has to find the store nearby Pekan for the exact material. Besides that, electronic components like IR LED is very expensive and we need to wait for a long time to book them at the hardware store. It also experiencing burned and this electronic components are very limited and cannot be replaced in case of burned or damages.

5.2.2 Design Problem

There are also a few problems in this part. Because of the limited machine and tool in UMP, some of the materials need to be changed to match the limit of the tools in UMP faculty lab. It is also be a problem when the student does not have enough experience to handle designing software such as SolidWorks. The student has to learn the skill of using the software from the student that can help.

5.2.3 Fabrication Problem

There are also problem that occur in fabrication process. The problem may be caused by the limitation of the tool, type of tool in the lab and how to use the machine. At the beginning of this project. Student must know how to use all the machine involve in this project. The problem occur when student is hard to find the person in charge of the lab. Some of the student don't know where the PIC for the lab while doing their work.

5.3 Recommendation

The project must used more suitable material such all large aluminum alloy in order to make the table stronger. The size of the aluminum alloys of the frame should be 3x3 inches. Then the acrylic used must be more than 7 mm thick to make the thing more efficient. The lab should provide more functioning machine for the student to make the work easier and faster. Student should start their work earlier to make the work finish on the time. Other than that, I also experienced the faulty and malfunction of the IR LED, it is because of wiring process that had been in wrong procedures. Some of the IR melted and damaged because of mistakes while making the wiring process, because of heavy voltage and also the lack of resistance. I have to proceed with the process because the IRs are limited and thus, I cannot replace it with another good ones.

Besides that, the disadvantage of this project is, in the pouring of silicone process, the right procedure is, the silicone must be mixed with solution named

xylene but because of I cannot get the solution(xylene), I have to pour the silicone only and as the result, the end product is not according to plan but still it can be used.

5.4 Future work

For future improvement, the table should undergo more detail planning. Many thing or function can be added besides using the MTKT as a computer and lots of effort had been done to maximize our hand usage to control digital objects. Continuous improvement should be made if the project is commercialized. Nowadays many people find it hard using mouse and the keyboard while using the computer at the same time. There are many more functions of the table that can be upgraded such as, we can put the compartment to place drink glass and snack, the design also can be enhanced so that it looks more attractive and has more commercial value. Lack of times factor had limited us to be more creative on this project but the improvement can be made on this table in order to make it more practical and durable.

REFERENCES

This report is prepared bases on the following references:

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Peters, Ltd.

APPENDIX

ACTIVITIES	WEEK														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Title Selection, Scope, Objective	Actual	Actual													
Literature Review and Identify Problem		Actual	Actual	Actual	Actual										
Sketching Design And Select Final Design				Actual	Actual										
1 st Draft Summation						Actual	Actual								
Pre-Presentation								Actual							
fabrication									Actual	Actual	Actual	Actual	Actual	Actual	Actual
result and discussion												Actual	Actual	Actual	Actual
Final Presentation															Actual
Final report									Actual	Actual	Actual	Actual	Actual	Actual	Actual

 Actual

 Planning

Gantt Chart