DESIGN AND FABRICATE THE NEW GENERATION OF WORKING TABLE

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TENG BOON WUN	DIPLOMA IN MECHANICAL ENGINEERING	2011	UMP

UNIVERSITI MALAYSIA PAHANG

BORANG PENGESAHAN STATUS TESIS

JUDUL: DESIGN AND FABRICATE THE NEW GENERATION OF WORKING TABLE

SESI PENGAJIAN: 2011/2012

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TENG BOON WUN

Report submitted in partial fulfillment of the requirements for the award of Diploma in Mechanical Engineering

Faculty of Mechanical Engineering

UNIVERSITI MALAYSIA PAHANG

DECEMBER 2011

SUPERVISOR'S DECLARATION

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

Signature:
Name of Supervisor: AT-TASNEEM BINTI MOHD AMIN
Position: LECTURER
Date: 9th JANUARY 2012

STUDENT DECLARATION

I hereby declare that the work in this report is my own except for quotations and summaries which have been duly acknowledged. The report has not been accepted for any degree and is not concurrently submitted for award of other degree.

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Name: TENG BOON WUN
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ACKNOWLEDGEMENTS

Firstly, I am very appreciate to God in guiding me to finish my project successfully. Although some problems arose but I still manage to overcome it. Besides that, I am very grateful and thankful to my supervisor, Miss At-Tasneem binti Mohd Amin for her valuable guidance, continuous encouragement and support in the making of this project. Regarding this aspect, she has periodically providing significant advises and knowledge which in turn benefits to me.

Other than that, I would like to thanks to lab instructors that helping me throughout the fabrication process. They generously provide their practical knowledge which is very useful. Accordingly, problems in fabrication stage are able to solve easily.

Moreover, I am sincerely to express my appreciation to all my friends that accompany me and help me in various ways in accomplish my project. Their encouragement and comfort provided are really mentally helping.

Last but not least, special thanks to my parents in providing important information regarding the location for purchasing need items for project. They are really helpful in making the progress of project even smoother. Not forget to express my gratitude to anyone who has directly or indirectly helping me in anyways or any methods to allow the accomplishment of the project. Finally, I am hereby sincerely thankful again to everyone who aid me in completing this project.

ABSTRACT

Working table provide spaces for people to carry out variety of task. Based on market survey, there are various types of working tables. It is designed either to meet a specific task or designed to meet multipurpose task. Most of the working table can be used by more than 1 user, however, it is occupy space or vice versa. Few sketches on a new working table have been supported the requirements. Later, concept finalization is established which able to meet all the requirements. Solid work with dimension of actual product is designed. Zinc sheet metal and wood are chosen as the main materials in fabricate the prototype of the working table. Next, marking process, shearing and bending process, drilling process and joining process has undergone. The prototype design working table with the dimension scale of 1:2 is portable with the existence of castors and functional with the foldable table top and installment of whiteboard that act as the medium for dropping down information. Finally, finishing process is carried out to make the working table look more attractive. After that, analyses of stress and displacement have been carried out. The maximum load for the table top supporting mechanism and the storage compartments shelve are 330N and 550N respectively. From comparison study, actual design and prototype design are functional and equip with variety of criteria.

ABSTRAK

Meja kerja memberi ruang kepada pengguna untuk melaksanakan pelbagai tugasan. Berdasarkan kaji selidik pasaran, terdapat pelbagai jenis meja kerja di pasaran. Meja kerja boleh direka bentuk khusus untuk sejenis tugas ataupun boleh direka bentuk untuk pelbagai tugasan. Kebanyakkan meja kerja yang digunakan oleh lebih daripada seorang pengguna akan memerlukan ruang yang banyak atau sebaliknya. Beberapa lakaran tentang meja kerja baru telah dikemukakan untuk memenuhi kriteria yang dikehendaki. Selepas itu, konsep terakhir telah dipilih bagi memenuhi kriteria tersebut. "Solid Work" telah digunakan untuk mereka bentuk meja kerja selari dengan dimensi yang ditetapkan. Lapisan logam Zink dan kayu telah dipilih sebagai bahan utama dalam proses pembuatan prototaip. Seterusnya, proses menanda, proses ricihan, proses lenturan, proses pengerudian dan proses penyambungan telah dijalankan. Prototaip meja kerja dengan skala dimensi 1:2 yang dihasilkan adalah mudah alih dengan kewujudan roda dan berfungsi pelbagai dengan adanya meja yang boleh dilipat dan juga papan putih yang boleh dijadikan sebagai tempat untuk mencatat nota. Akhirnya, proses kemasan telah dijalankan supaya meja kerja kelihatan menarik. Selepas itu, analisis berkenaan dengan dan jarak telah dilaksanakan. Daripada itu, maxima beban untuk meja atas sokongan mekanisme dan rak ruangan menyimpan masing- masing adalah 330N dan 550N. Daripada kajian perbezaan yang didapati, reka bentuk sebenar dan reka bentuk prototaip mempunyai berbagai fungsi dan kriteria.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Working table is a type of furniture that able to carry out variety of task based on intended use. It comes in various shapes, sizes, heights and materials. Problems arise due to several factors which are the table occupied space, only a single user is applicable for a table, difficult to move the table from one location to another, and exposed storage compartments may result in falling off of things. So, the problems are meant to be solved based on the objective which is to produce a functional working table. The scope are set such that the working table to be designed is allow for more than 1 user, the size of the table will not occupy space, the table is easy to move around, and additional medium for dropping information is provided.

1.2 BACKGROUND

Table is a piece of furniture consisting of a flat top supported on one or more legs. Working is defined as functioning or able to function. [3] Thus, working table is a type of furniture with flat top supported by legs that able to function for various working task. Working table is derived from work table. Initially, work tables were small tables designed to hold sewing materials and implements and provide a convenient work place for women who sewed. They appeared during the 18^{th} century and were popular throughout the 19^{th} century. Most examples of work tables have rectangular tops, sometimes with folding leaves, and usually one or more drawers fitted with partitions. [1] Table comes in variety of materials, shapes, and heights that depends on their origin, style, and intended use. Tables can be freestanding or

designed for placement against a wall. Table tops can be in virtually any shape such as rectangular, square, round and oval shapes. Working tables are then further divided into several types due to their specific functions. They are drafting table or drawing table and workbench. Both drafting and drawing table is a work table with adjustable top, while workbench is a strong work table for a carpenter or mechanic. [2] Other than that, the height for a working table is ranging from 60 cm to 85 cm.

1.3 PROBLEM STATEMENT

Normally, working tables are designed to suit only a user at a time. However, if the working table is able to use by more than one user, it will indirectly causing the size of the working table to enlarge and subsequently become space occupying. Other than that, working tables are mostly hard to move because it is always carried along with many things in the storage cabinet. Furthermore, if users put heavy things on the table, the table will be even difficult to move. Besides that, storage compartment for tables are sometimes exposed, so while enabling it to move, the exposed storage compartment will result in falling of things when vibration occur due to moving motion.

1.4 OBJECTIVE

The objective of this project is to design, fabricate and analyze a functional working table.

1.5 SCOPE

Firstly, the working table is suitable to locate in most of the places such as at home, office, crafting room, etc. Other than that, the working table is able to reduce space occupied when it is not in used. The working table has large working surface which manage to fit more than 1 user. Besides that, writing medium for dropping down short notes or information is available to increase the functionality of working table. Finally, the working table should be commercialized so that it will suit the criteria of common target customer.

CHAPTER 2

LITERATURE STUDY

2.1 INTRODUCTION

In this chapter, literature review on types of working tables are listed provided along with the relevant information. There are 5 types of working tables which are workshop table, drafting table, office table, craft table and L-shaped office table. Workshop table is mainly used in industry or laboratory which poses with high loading capacity. Drafting table is usually used by drafter to carry out their task on drawing plan such as building constructions, machines' internal system, or even electrical circuits. Office table and L-shaped office table are normally being seen in offices as they are designed for office usage. Craft table is mainly use for carry out DIY work such as sewing. However, it can also be used for study purpose. Other than that, 4 types of materials are identified be used in the making of working tables. These are including iron metal, stainless steel, steel metal and laminated wood composite. Iron metal is relatively cheaper than other material that poses the same properties but it is heavy in weight and will tend to rust. So, iron metal will rust throughout time. Stainless steel is totally the opposite of iron metal as it has higher strength, corrosion resistance and expensive. Steel metal is the combination of iron metal and carbon metal. Higher content of carbon percentage will result in stronger strength of the steel metal, however it is still more ductile if compare with iron. Nowadays, steel becomes widely used in almost every field especially in construction of roads and skyscrapers. Laminated composites wood is a man-made wood which consists of combination of a few composite with adhesives. This laminated composite wood has variety of thickness, sizes and grades. Thus, different type of laminated composite woods will apply in different type of application. One of

the examples for laminated composite wood is plywood that could be used in the manufacturing of furniture.

2.2 TYPES OF WORKING TABLES

2.2.1 Workshop Table

Workshop table is mainly made from iron metal while the table top of it is made from stainless steel. Besides that, this table is mainly manufacture using the light metal working method. Other than that, it has a loading capacity as high as 1000kg. The price for this table is RM1225. Moreover, it has a height of 1410mm, length of 1400mm and width of 750mm. [4]

Based on the description above, it is noticeable that the loading capacity for this product is very high because it is made from metal. Although having large loading capacity, metal will result in increasing of weight. Without any aid in portability aspect, this product is hard to lift or move and it only can place at a fixed position. Figure 2.1 shows the image of workshop table.

Figure 2.1: Workshop Table
Source: http://www.alibaba.com

2.2.2 Drafting Table

This drafting table has a weight of 760 kg and with a price of RM2809.The center of the table is act as the housing for CAD monitoring, thus users are able to refer to the monitor when carry out drafting task. Besides this, it is able to fit 2 users since it has 2 table top. It's dimension is consists of 914mm in height, 609mm in width, and 1524mm in length. [5]

The main specialty for this drafting table is that the table top can be adjusted based on the comfortableness angle of each user. This design of table top is ergonomic and user friendly. Moreover, it is able to fit 2 users at a time. However, the height of this product which is 914mm is relatively higher. So, while purchasing of this item, the height of the chair have to be match with its height. Figure 2.2 shows the image of drafting table.

Figure 2.2: Drafting Table
Source: http://www.furniture-online.com

2.2.3 Office Table

This office table is made from cold rolled sheet metal. Its storage compartment is designed with locking device. The price for this type of table is RM525. It consists of dimension with height of 750mm, width of 600mm, and length of 1000mm. [4]

Locking device helps in secure the personal items of the users. Besides that, the price is relatively cheaper. However, there are only 4 round contact points at the base of the office table with the floor. This shows that the stability for this product is low. Figure 2.3 shows the image of office table.

Figure 2.3: Office Table
Source: http://www.alibaba.com

2.2.4 Craft Table

This craft table designed to has 3 bin storage compartments, 9 shelf bookcases with 6 adjustable shelves. It is made from stain resistant laminated wood composites. The main purpose for this table is for studying, crafting, and sewing. It has a dimension of 978mm in height, 1397mm in length, and 1041mm in width. It has a weight of 352 kg only. The price of it is RM 1900. [6]

Storage compartment for this product is many and flexible since the shelves in it are adjustable. Thus, users are able to change the shelves' position according to the sizes of the things to be kept. Though the space occupied is large, but it is light in weight. Rather than this, the height of the chair that used along with this product should be higher than usual because the height for this office table is 978mm. Moreover, the storage compartments are exposed. This design will probably result in falling off of things in the cabinets when the things locate inside getting compact. Besides that, it is comparatively expensive. Figure 2.4 shows the image of craft table.

Figure 2.4: Craft Table

Source: http://www.chandlercreations.compage

2.2.5 L-shaped Office Table

This table is mainly made from steel metal. The frame of it is consists of sturdy steel tubes. It is RM420 in price. The dimension of it is 750mm in height, 1800mm in length, and 1100mm in width. [4]

Based on observation, the cabinet is portable. Therefore, the things kept inside are easily accessible. Besides that, it has large working space. Figure 2.5 shows the image of L-shaped office table.

Figure 2.5: L-shaped Office Table

Source: http://www.alibaba.com

2.3 TYPES OF MATERIALS

2.3.1 Iron Metal

Iron is a shiny, bright white metal that is soft, malleable, ductile and strong. Its surface is usually discoloured by corrosion, since it combines readily with the oxygen of the air in the presence of moisture. In absolutely dry air, it does not rust. The oxide that is produced is crumble and soft, giving no protection to the base metal. Practically, it is always obtained from ores that are usually the oxides, and occasionally the carbonate, as low in sulphur and phosphorus as possible. In the field of application, iron is best known as the metal in making weapons and tools, and whose ability by means of alloys and heat treatment to suit itself to every application makes it the primary metal of technology. Iron is the most frequently encountered metal in daily life, always in the form of manufactured objects, and usually covered with a protective coating buried deep within the object. Concrete structures contain essential reinforcing iron; electrical machines, including transformers, depend on iron. Iron is an excellent and versatile material of construction- strong, tough, easily formed and worked, and very importantly, cheap compared to the alternative. Plastics give it competition, especially in products that must be manufactured at the lowest cost where strength and durability are not the primary concerns, such as modern American automobiles. Aluminum is as strong competitor where weight is a concern, as in aircraft. However, the versatility of iron carbon alloys cannot be matched in any other material. Alloys with other metals, such as nickel, chromium and manganese, give further advantages. These steels can be tailored to nearly every demand, and are not significantly challenged as materials of construction. The shortcomings of iron are its weight, and its properties to rust. [7]

2.3.2 Stainless Steel

Stainless steel is also known as steel alloy with a minimum of 10.5% chromium content by mass. Stainless does not stain, corrode, or rust as easily as ordinary steel, but it is not stain-proof. It is also called corrosion-resistant steel or CRES when the alloy type and grade are not detailed, particularly in the aviation

industry. There are different grades and surface finishes of stainless steel to suit the environment the alloy must endure. Stainless steel is used where both the properties of steel and resistance to corrosion are required. Due to its corrosion resistance and staining, low maintenance characteristics, it is an ideal material for many applications. This alloy is milled into coils, sheets, plates, bars, wire, and tubing to be used in cookware, cutlery, hardware, surgical instruments, major appliances, industrial equipment and as an automotive and aerospace structural alloy and construction material in large buildings. It is also used in jewellery and watches with 316L being the type commonly used for such applications. It can be re-finished by any jeweler and will not oxidize. [1]

2.3.3 Steel Metal

Steel is an alloy that consists mostly of iron and has carbon content between 0.2% and 2.1% by weight, depending on grade. Steel with increased carbon content can be made harder and stronger than iron, bust such steel is also less ductile than iron. In mid-19th century, steel became an inexpensive mass-produces material. Further refinement process, such as basic oxygen steelmaking (BOS), lowered the cost of production while increasing the quality of the metal. Today, steel is one of the most common materials in the world, with more than 1.3 billion tons produced annually. Steel are widely used in the construction of roads and highways, buildings, skyscrapers, and even car bodies, etc. [1]

2.3.4 Laminated Wood Composite

It is also known as engineered wood, man-made wood, or manufactured board. It includes a range of derivative wood products which are manufactured by binding the strands, particles, fibers, or veneers of wood, together with adhesives, to form the composite materials. These products are engineered to precise design specifications which are tested to meet national or international standards. Typically, laminated wood composites products are made from the same hardwoods and softwoods used to manufacture lumber. One of the examples of product made by laminated wood composites is plywood. Plywood is a wood structural panel. It also

called the original engineered wood product. Plywood is manufactured from sheets of cross-laminated veneer and bonded under heat and pressure with durable, moisture-resistant adhesives. By alternating the grain direction of the veneers from layer to layer, or “cross-orienting’”, panel strength and stiffness in both directions are maximized. Other structural wood panels include oriented strand board and structural composite panels. Laminated composites wood has similar application to solid wood products due to its several advantages such as it comes in variety of thicknesses, sizes, grades , and exposure durability classification, and making the products ideal for use in unlimited construction, industrial and home project application. However, laminated composites wood has its disadvantages as well. Some products, such as those specified for interior use, may be weaker and more prone to humidity-induced warping than equivalent solid woods. Most particle fiber-based boards are not appropriate for outdoor use because they readily soak up water. [1]

2.4 COMMON FABRICATION METHODS

2.4.1 Shearing

Shearing is also known as sheet metal cutting. It is a cutting process where piece of sheet metal is separated by applying force to cause the material to fail. Shearing force is commonly performed during cutting process. Shearing force is the amount of force required to cut or remove a piece of material through shear. The applied force must produce enough shear stress in order to exceed the ultimate shear strength of the material in order to separate the material. Ultimate shear strength is the amount of shear stress a material can sustain, measured in units of force per unit area. Shear strength is commonly expressed in megapascals (MPa) or pounds per inch (psi) of original cross section. this shearing force is applied by 2 tools, one on the above while another one below the sheet metal. The tool above the sheet will delivers a quick downward blow to the sheet metal that rests over the lower tool. A small clearance is present between the edges of the upper and lower tools, which facilitates the fracture of the material. The size of clearance is typically 2-10% of the material thickness and depends upon several factors, such as the specific shearing

process, material, and sheet thickness. [9] Figure 2.6 shows the sheared angle of shearing process.

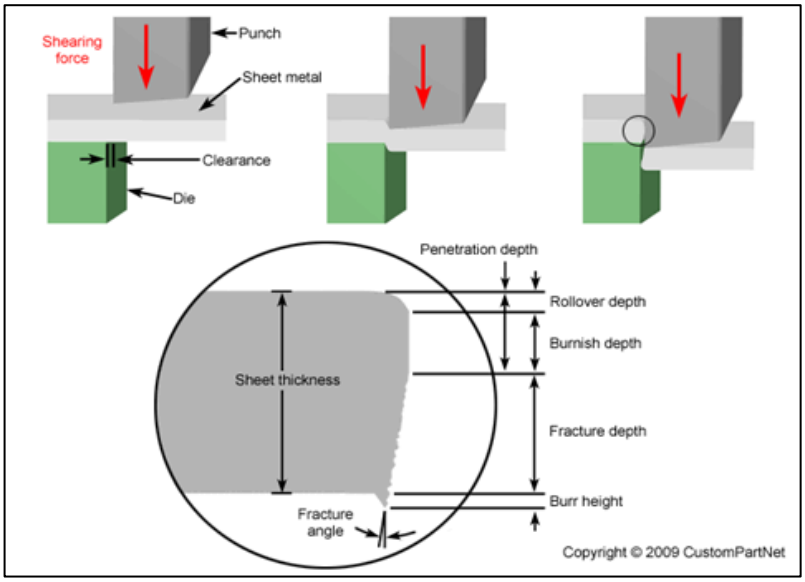


Figure 2.6: Sheared Angle

Source: http://www.custompartnet.com

2.4.2 Bending

Bending is a process where metal is deformed by plastically deforming the material and changing its shape. The material is stressed beyond the yield strength but below the ultimate tensile strength. Surface area of material will not result in obvious change. Usually, bending refers to deformation about one axis. Bending is able to produce many different shapes. During bending process, material is placed on the die, and positioned in place with stops and /or gages. It is held in place with hold-downs. The upper part of the press, the ram with the appropriately shaped punch descends and forms the v-shaped bend. Bending is done using Press Brakes. Air bending is done with the punch touching the workpiece but not bottoming in the lower cavity. Spring-back is happened when the workpiece ends up with less bend than that on the punch after the punch released. Bottoming or coining is the bending process where the punch and the workpiece bottom on the die. This makes for a

controlled angle with very little spring back. [10] Figure 2.7 shows the 2 types of bending process.

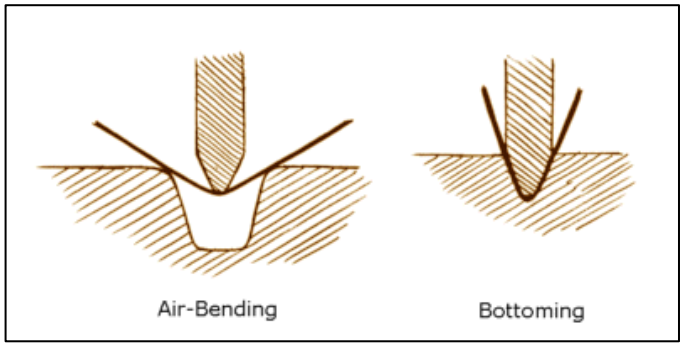


Figure 2.7: Types of Bending.
Source: http://www.efunda.com

2.4.3 Drilling

Drilling is a cutting process that uses a drill bit to cut or enlarge a hole in solid materials. The drill bit cuts by applying pressure and rotation to the workpiece, chips will then form at the cutting edges. Drilled holes are characterized by their sharp edge on the entrance side and the presence of burrs on the exit side. The mechanical properties of the workpiece may be affected by drilling as it will result in low residual stresses around the hole opening and a very thin layer of highly stressed and disturbed material on the newly formed surface. Workpiece will easily corrode at the stressed surface. Besides that, the drilled holes should perpendicular to the surface of the workpiece in order to minimize the tendency of drill bit to "walk", which causes the hole to be misplaced. Higher length-to-diameter ratio of drill bit will result in higher tendency to walk. In addition, lubricant is applied at the tip of the drill bit to prolong the tool's life. [1] Figure 2.8 shows the image of drilling machine.

Figure 2.8: Drilling Machine

Source: drilling-machine.net

2.4.4 Welding

Welding is a process that permanently joining two or more metals parts by melting both material and adding a filler material to form a pool of molten material that cools quickly to become a strong joint, with pressure sometimes used in conjunction with heat to produce the weld. Energy sources used for welding are including gas flame, an electric arc, a laser, an electron beam, friction, and ultrasound. [1] Welding joint can be made more than 100% strong, so welding joint will never fail. It is also possible for a skilled welder to add the specific material with desired characteristics to any portion of the machine parts. However, residual stress and distortion that occurred will result in damage of workpiece. Other than that, metallurgical changes will occurred in the weld filler metal during heating. Due to that, the molecular structure of base metal different from filler metal. [11] Figure 2.9 shows the classification of types of welding process.

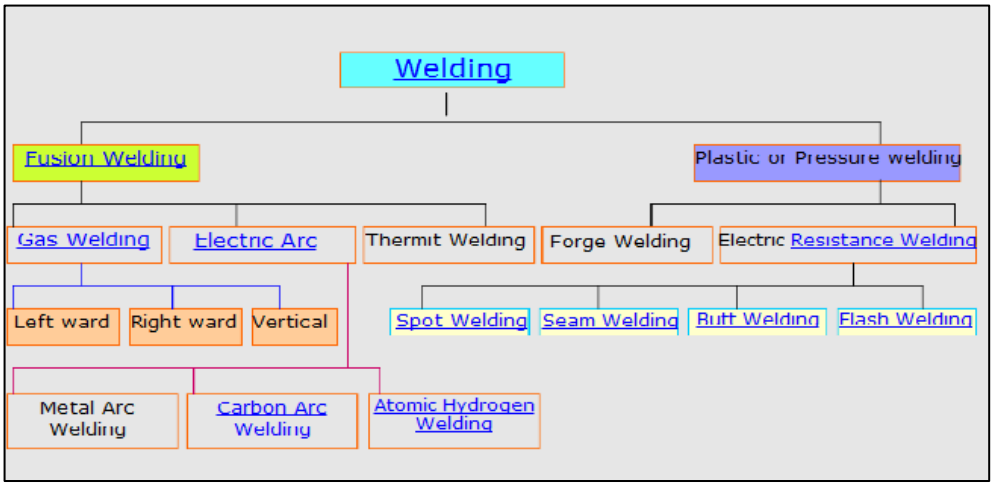


Figure 2.9: Classification of Types of Welding Process

Source: http://www.typesofwelding.net

2.4.5 Surface Finishing

Surface finishing alter the surface of an item to achieve a certain property by improving appearance, corrosion resistance, tarnish resistance, wear resistance, hardness, remove burrs and control friction. Surface finishing processes can be categorized into removing or reshaping finishing and adding or altering finishing. Example of removing or reshaping finishing is grinding. It can be done by contacting surface of rotating abrasive wheel with the surface of material to refined look and attain a desired surface feature. Figure 2.10 shows the image of hand grinder used for grinding process. Besides that, example for adding or altering finishing is painting. Paint could be in any liquid, liquefiable, or mastic composition which after application to a substrate in a thin layer is converted to an opaque solid film. It is commonly used to protect color or provide texture to the objects. [1] Figure 2.11 shows the image of spray paint used for painting.

Figure 2.10: Hand Grinder

Source: www.techno.com.my

Figure 2.11: Sray Paint

Source: www.banhoh.com

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter discuss on the flow of the project after conducting literature study. A flow chart is shown in this chapter. Other than that, 3 concept designs have been generated based on the criteria identified through market study. It is then followed by the selection of the final concept through concept scoring. The considered criteria are portability, multifunctional, space occupied, storage capacity, table surface area and stability. The concept design with the highest number of score in concept scoring will be selected as the final drawing. The drawing on the selected concept was drawn out using Solidwork. All the parts such as the cabinets, whiteboard and its support mechanism, stationary and foldable table top and castors are drew out with actual dimension. It is then followed by the selection of materials use for fabrication of prototype which are zinc sheet metal, plywood, mild steel hollow bar, and steel-rubber castors. Finally, the method of fabrication process has been identified to fabricate the prototype of this project. Fabrication processes including shearing process, bending process, drilling process, joining process and finishing process.

3.2 CONCEPT GENERATION

3.2.1 Concept A

Concept A is designed to have 2 shelves and 2 drawers. In order to increase the capacity of working space, 2 foldable table top is designed on each side of the table. It has a dimension of 1400mm in height, 900mm in width and 1100 in length. Figure 3.1 shows the sketching for concept A.

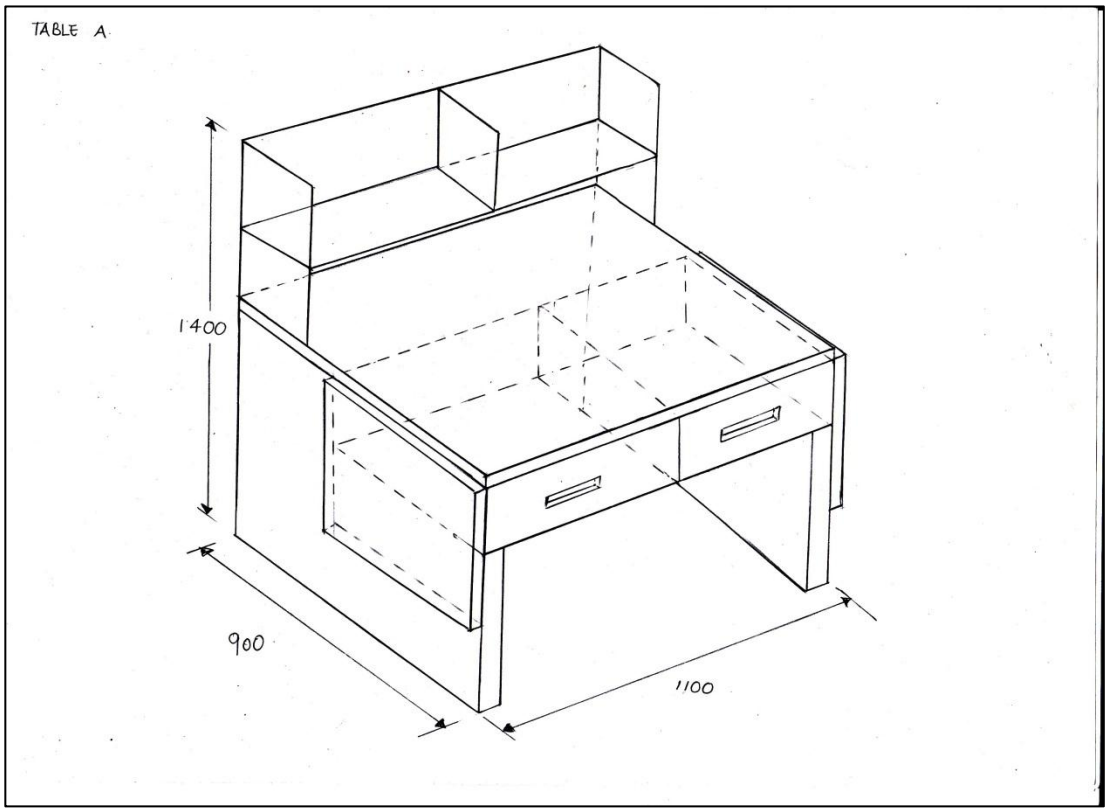


Figure 3.1: Design of Concept A

3.2.2 Concept B

Concept B has a length of 1800mm, 720mm in height and maximum width of 800mm. There are 2 shelves provided with one of it close by a door while another one doesn't. Besides that, a small cabinet can be pulled out from the bottom of the

table top and increase the surface area of the table top. Figure 3.2 shows the sketching for concept B.

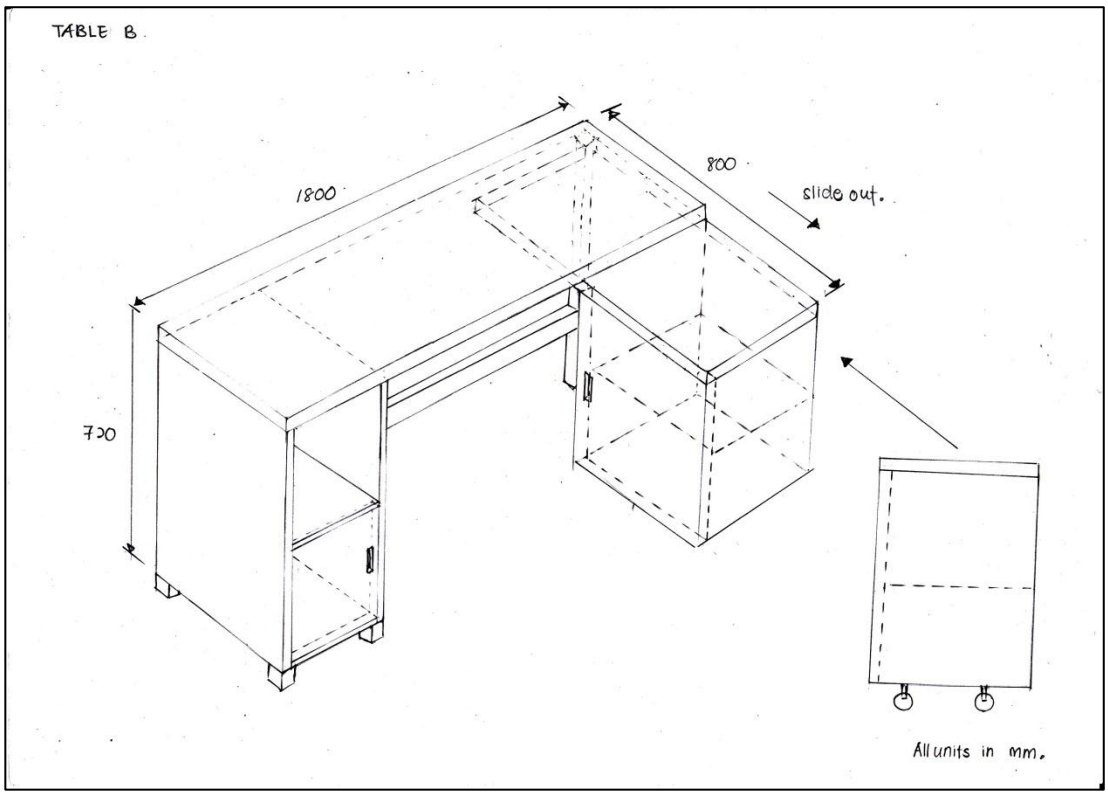


Figure 3.2: Design of Concept B

3.2.3 Concept C

Concept C has 2 foldable table top, 3 cabinets, and a whiteboard. Moreover, 6 castors are available for easier movement of the working table. This working table has a length of 1100mm, 600mm in width and 750mm in height. Figure 3.3 shows the sketching for concept C.

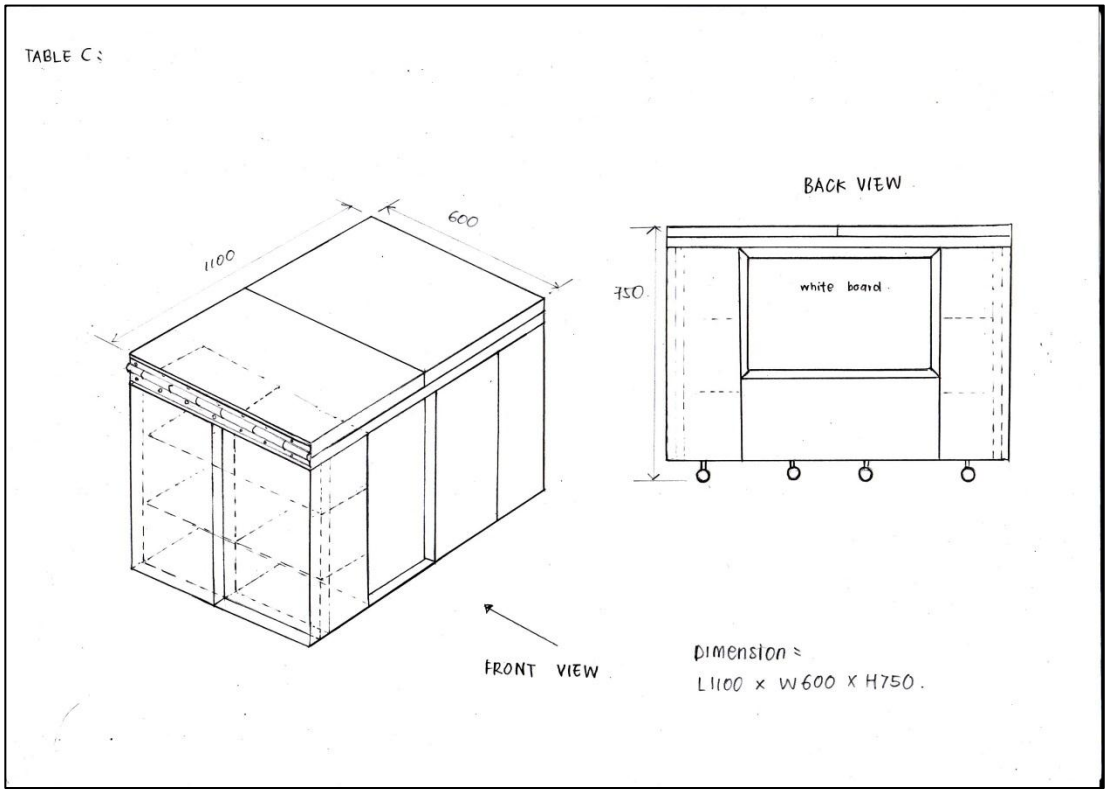


Figure 3.3: Design of Concept C

3.3 CONCEPT SCORING

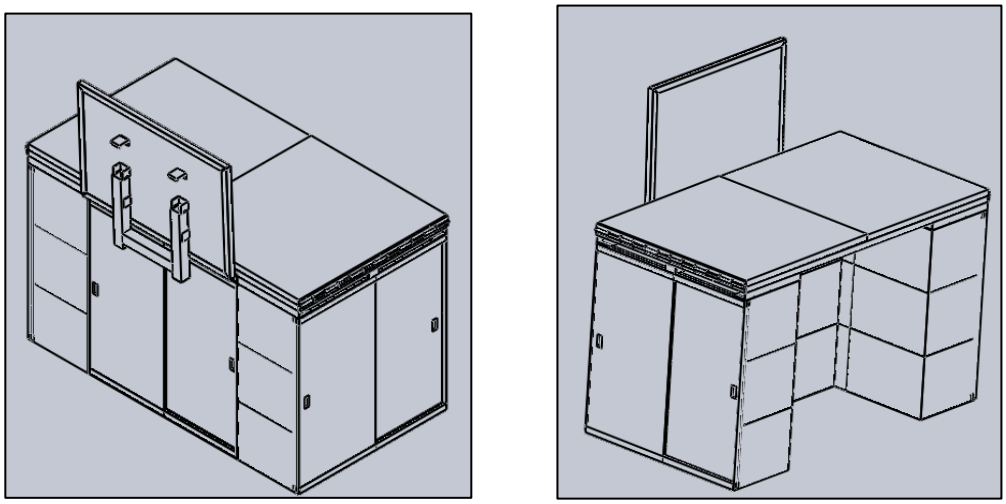
There are 6 criteria considered in selection of the most suitable design for the working table. "+" indicates it is better than, "0" indicates it is same as, and "-" indicates it is worse than. All of these signs refer to the datum. The datum is the 3rd product namely office table in the literature study (Refer to Figure 2.3). Concept with the highest net score will be the final concept of working table. Table 3.1 shows the data tabulation of concept scoring.

Table 3.1: Concept Scoring

Selection criteria	Concepts			
	A	B	C	D (Datum)
1. Portability	0	0	+	0
2. Multifunctional	0	0	+	0
3. Space occupied	0	-	0	0
4. Storage capacity	0	0	+	0
5. Table surface area	+	+	+	0
6. Stability	+	+	0	0
∑ + ∑ 0 ∑ -	2 4 0	2 3 1	4 2 0	0 7 0
Net score Rank	2 2	1 3	4 1	0 4

3.4 CONCEPT FINALIZATION

After carry out concept scoring, Concept C (Refer to Figure 3.3) has the highest net score. Thus, it is identified to be the best concept to proceed for the next stage. Figure 3.4 (a) & (b) shows the overview of the working table in Solidwork.



(a) **(b)**

Figure 3.4 (a) : Isometric view 1, **(b):** Isometric view 2

3.4.1 Cabinets

Cabinets are the first parts in the drawing process since it is not only act as the storage compartment but it also function as the supporting base of the surface table. Figure 3.5 shows the combination of 3 cabinets to form the storage compartment. The dimension for the whole cabinets is 600mm in width, 1100mm in length and 620mm in height. The enlarge view for the cabinets can refer to appendix C.

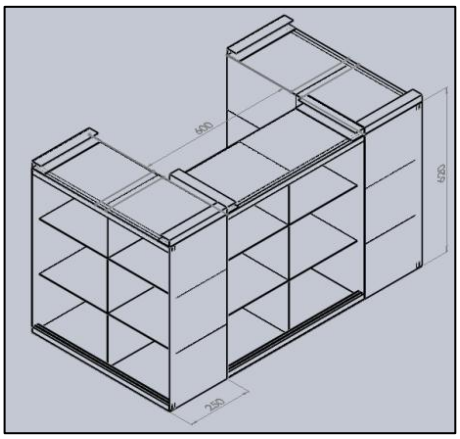


Figure 3.5: Cabinets

3.4.2 Table Top, Foldable Table Top and Support Mechanism

After that, the foldable table top is attached to the stationary table top by using hinge. Figure 3.6 shows the Solidwork drawing of stationary table top. The support mechanism is added on accordingly. Figure 3.7 shows the foldable table top with hinge while Figure 3.8 shows the support mechanism of table top. The surface area of the stationary table top is 1100mm x 550mm, with thickness of 9mm.

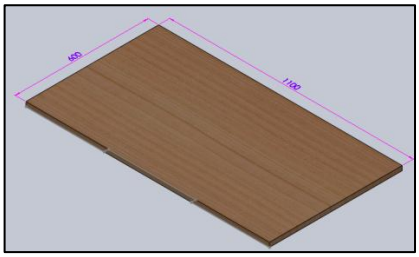


Figure 3.6: Stationary Table Top

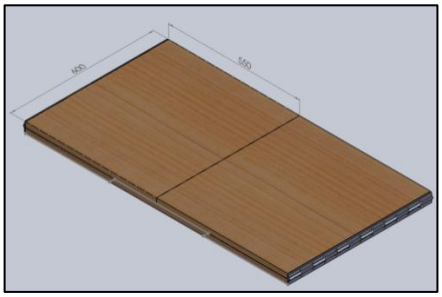


Figure 3.7: Foldable Table Top with Hinge

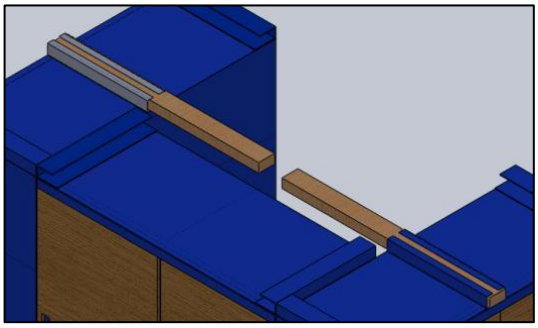


Figure 3.8: Support Mechanism

3.4.3 Base

Next, the base of the working table which is the 6 castors are attach. The diameter for each of the castors is 10cm. Figure 3.9 shows the Solidwork drawing of castors from the base of the working table.

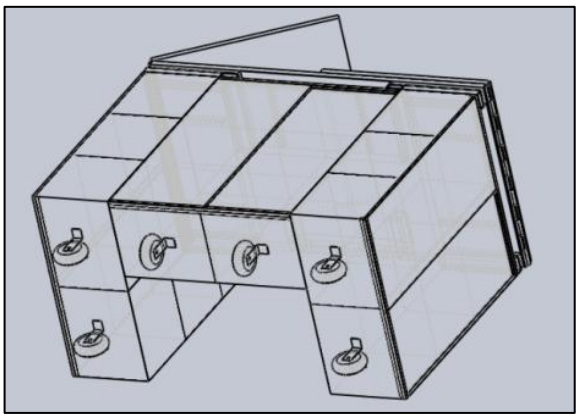
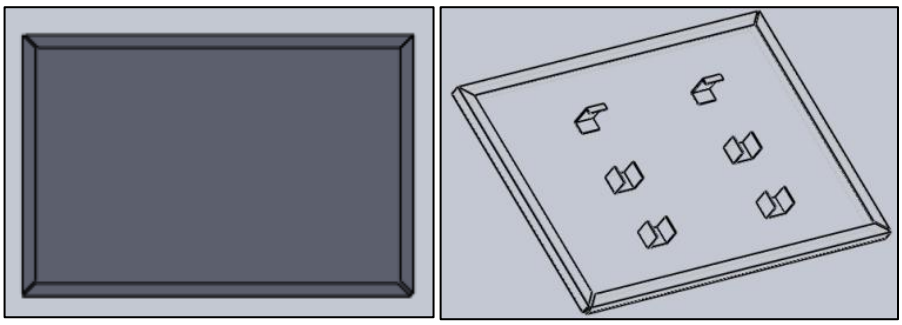


Figure 3.9: Castors

3.4.4 Whiteboard and Support Mechanism

Finally, with the attachment of whiteboard and support mechanism, the whole drawing is done. Figure 3.10 until Figure 3.13 shows the view of whiteboard and its support mechanism.



(a) **(b)**

Figure 3.10(a): Front View of White Board **(b):** Back View of White Board

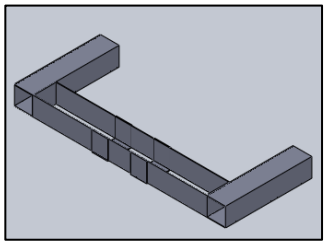


Figure 3.11: Whiteboard Support

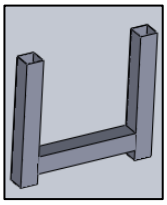
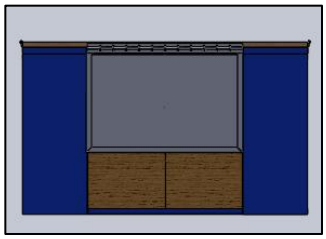
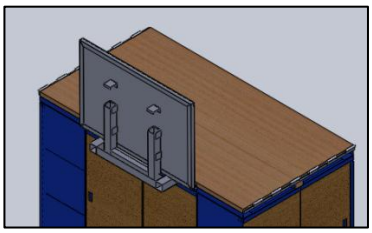


Figure 3.12: Whiteboard Holder



(a)



(b)

Figure 3.13(a) Whiteboard at Released **(b)** Whiteboard at Stand

3.5 List of Material

Table 3.2 shows the identified materials that need to be purchased for fabrication of working table's prototype.

Table 3.2: Material List

No	Part	Material	Dimension	Quantity
1.	Table top	Plywood	550mm x125mm x9mm	2
2.	Whiteboard	-	300mm x 200 mm	1
3.	Base (Castors)	Rubber with Metal	5 cm in diameter	6

3.6 FABRICATION PLANNING

In this stage, fabrication process planning is prepared for fabrication of working table's prototype after selection of material.

3.6.1 Shearing Process

Firstly, identify the total parts needed for the working table's prototype. After that, carry out shearing process by using shearing machine to obtain the required sheet metal parts. Other than that, the dimension of wood should be recognized and mark out the dimension on the wood using pencil. After that, carry out cutting process on wood by using vertical band saw machine. Figure 3.14 shows the image during shearing process of wood.

Figure 3.14: Shearing Process of Wood

3.6.2 Bending Process

After the required sheet metal parts are form, the bending process will be carried out. No marking step is needed for this process because the bending machine is able to bend the material based on the inserted length and angle.

3.6.3 Drilling Process

Before drilling, the hole to be punched should mark with center punch to act as the guide for drill bit during drilling. The diameter for the drill bit to be used is 3.5mm.

3.6.4 Joining process

There are 3 main types of joining methods are planned to be used for joining process. They are riveting, welding and gluing. Riveting is used to join up the cabinets that made from zinc sheet metal. Welding process is used to join the middle support parts on the cabinets and also for attaching of castors at the bottom of the cabinets.. Gluing is used to join the parts between woods and metals and the sliding path on the cabinets. The equipment and tools that used for these 3 methods are rivet gun, metal inert gas welding (MIG), and hot glue gun. Other than that, for attachment of sliding roller and hinges to the wood, it will be done by directly using the screwdriver to shift the screws into the wood. Figure 3.15 shows the image of the hot glue gun.

Figure 3.15: Hot Glue Gun

3.6.5 Finishing process

Grinding process will be carried out to eliminate the sharp edges and burred edges. Besides that, the surface of welded parts would be grinded to obtain a better surface appearance. Other than that, painting process will be carried out after all the

parts are joined up together. Figure 3.16 shows the image of grinding process by using hand grinder.

Figure 3.16: Grinding Process

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CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 INTRODUCTION

In this chapter, the fabricated prototype with 1: 2 ratio will be shown. Other than that, the calculation of purchase cost list is provided. Besides that, analysis are conducted on foldable table top support mechanism and shelve to obtain the maximum stress, maximum displacement and safety factor of the parts. Moreover, discussion will be provided to discuss about the problem faced during the whole progress of design and fabrication. The accuracy for the conventional machines are limited, thus tolerance is critical in obtaining the exact dimension of the prototype. Other than that, the welding process is obstructed due to break down of machine. However, this problem is solved by changing the welding type from Metal Inert Gas welding (MIG) to shielded metal arc welding (SMAW).

4.2 FINAL PRODUCT

4.2.1 Overview of Prototype

The fabricated prototype with 1:2 ratio is shown in Figure 4.1.

Figure 4.1: Overview of Prototype in Open State

4.2.2 Overview of Cabinets

There are 3 cabinets available and all of these cabinets are come in same size and attach together to form an entity. The cabinets are shown in Figure 4.2.

Figure 4.2: Cabinets

4.2.3 Overview of Table Top Support Mechanism

The foldable top is support by a wood with thickness of 3.5cm. The wood can be pulled out to support the foldable table top when users wish to open the foldable table top. Figure 4.3 shows the location of the supporting mechanism.

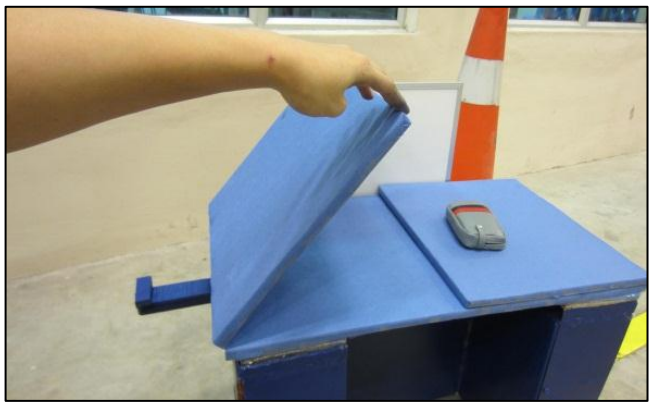


Figure 4.3: Support mechanism

4.2.4 Whiteboard

This whiteboard is hinged at the side of the table top. It is at fixed position by pulling out the support mechanism beneath it. This whiteboard is not only functions to drop down important notes and write down data, it can even act as a medium for magnet. So, users can put magnet on the whiteboard to stick papers note. The back view of whiteboard is shown in Figure 4.4.

Figure 4.4: Back View of Whiteboard

4.2.5 Castors

There are 6 castors attach at the bottom of the working table. The installment of castors enables the working table to be portable and easier to move from a location

to another. The castors can be locked when the working table needs to fix at a location. Figure 4.5 shows the image of castors at the base of the working table.

Figure 4.5: Castors

4.2.6 Overview of Closed Working Table

The Working Table can be closed after use. The foldable table top is folded up and rest on top of the stationary table top. The whiteboard is release, and locates at the back of the working table. The overview for closed working table is shown in Figure 4.6.

Figure 4.6: Closed Working Table

4.3 Cost Calculation

Table 4.1 shows the calculation of purchased materials. The raw materials obtained from laboratory are excluded.

Table 4.1: Calculation of Materials' Cost

Items	Dimension (mm)	Quantity	Price (RM)
Table Top and Sliding Doors (Wood)	550 x 275 305 x 155	2 6	12.00 10.00
Sliding mechanism	-	12	24.00
Whiteboard	300 x 200	1	12.50
Castors	Diameter 50	6	45.00
Colour spray shellac	- -	3 1	19.50 9.00
Piano Hinges Hot Glue Gum Screw, Bolts, Nuts	300 x 10 - -	3 5 -	2.00 5.00 3.00
		Total:	135.00

4.4 ANALYSIS

There are 3 types of analysis that has been conducted which are consisting of stress analysis, displacement analysis and safety factor analysis. These analyses are carried out on 2 parts which are the foldable table top support mechanism and shelve. The purpose of this analysis is to determine the maximum stress, and displacement for each of the parts.

4.4.1 Stress Analysis

Stress analysis shows the distribution of stress when a certain value of force is applied.

In Figure 4.7, the load applied is 300N. The purple arrows show the direction of force exerted while the green arrows indicate the fixture location. Besides that, the maximum stress located at the center of the support mechanism while minimum stress located at the end of the fixture.

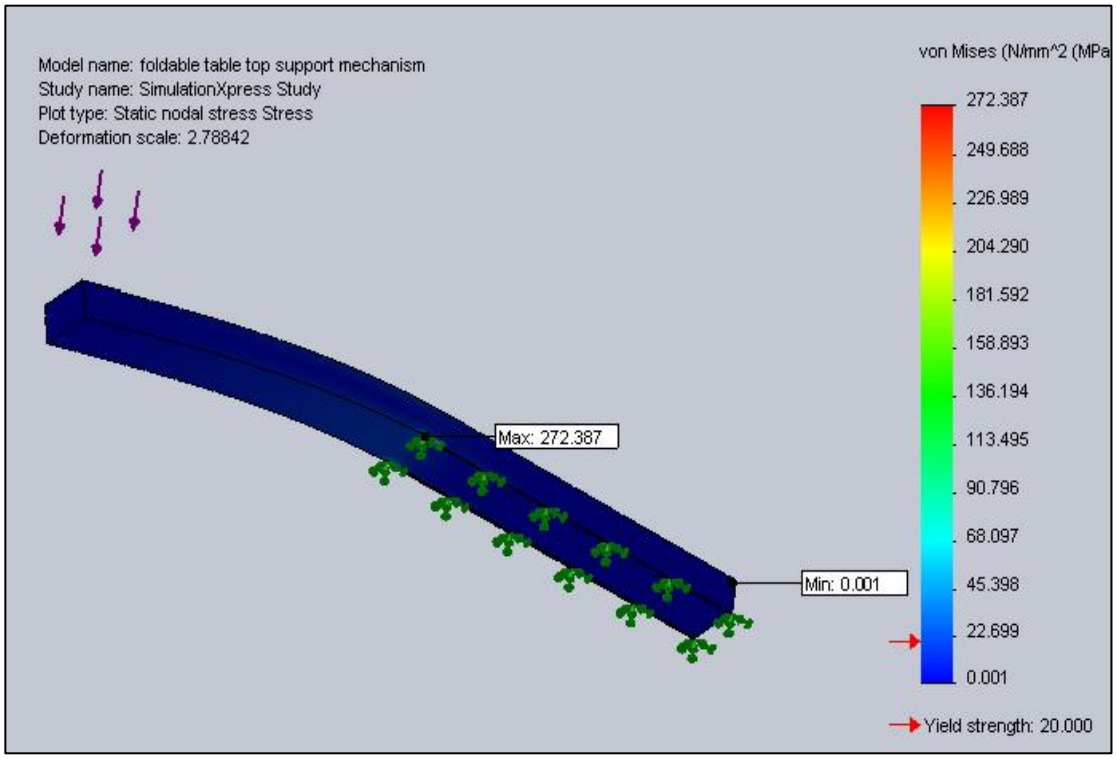


Figure 4.7: Stress Analysis on Foldable Table Top Support Mechanism

Table 4.2: Stress Analysis on Foldable Table Top Support Mechanism

Name	Type	Minimum Stress (N/mm^2)	Maximum Stress (N/mm^2)
Foldable Table Top Support Mechanism	Stress Analysis	0.001	272.387

In Figure 4.8, the load applied is 550N and it is distributed uniformly on the whole surface area. The maximum stress located at each side of the metal which is near to the fixture location while the minimum stress is located at the middle of the metal.

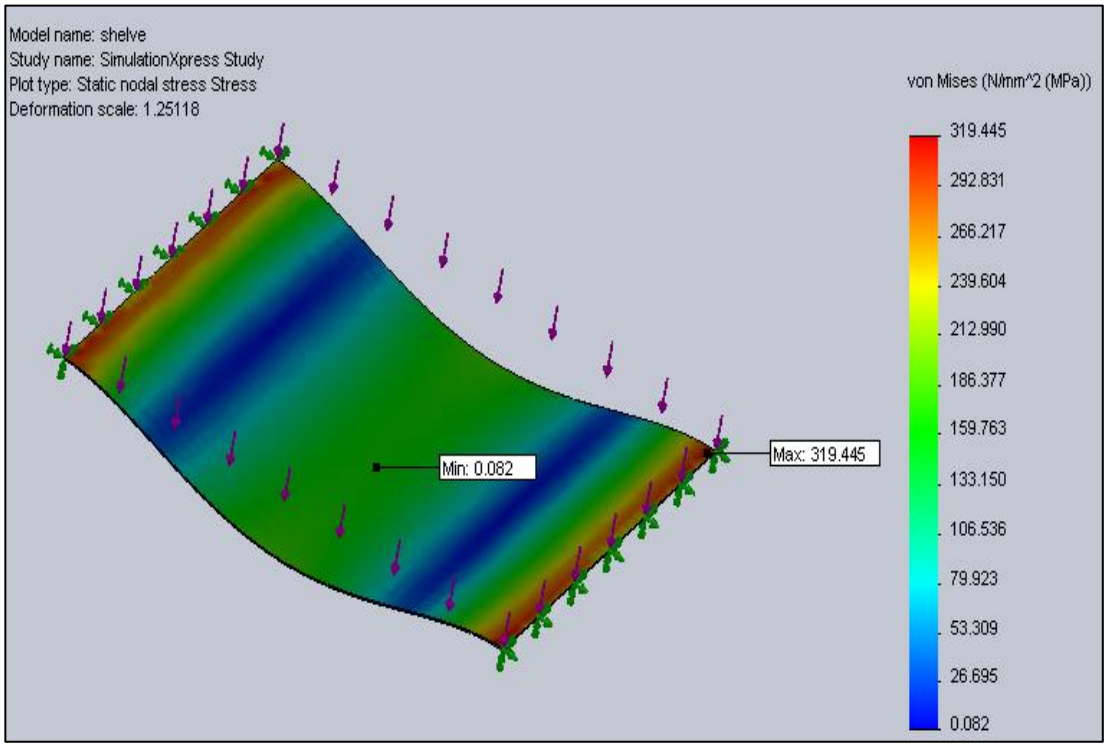


Figure 4.8: Stress Analysis on Shelve

Table 4.3: Stress Analysis on Shelve

Name	Type	Minimum stress (N/mm ²)	Maximum stress (N/mm ²)
Shelve	Stress analysis	0.082	319.445

4.4.2 Displacement Analysis

Displacement analysis shows the maximum displacement of the parts to bend during deformation. Based on Figure 4.9, largest displacement occurs at the area where the force applied.

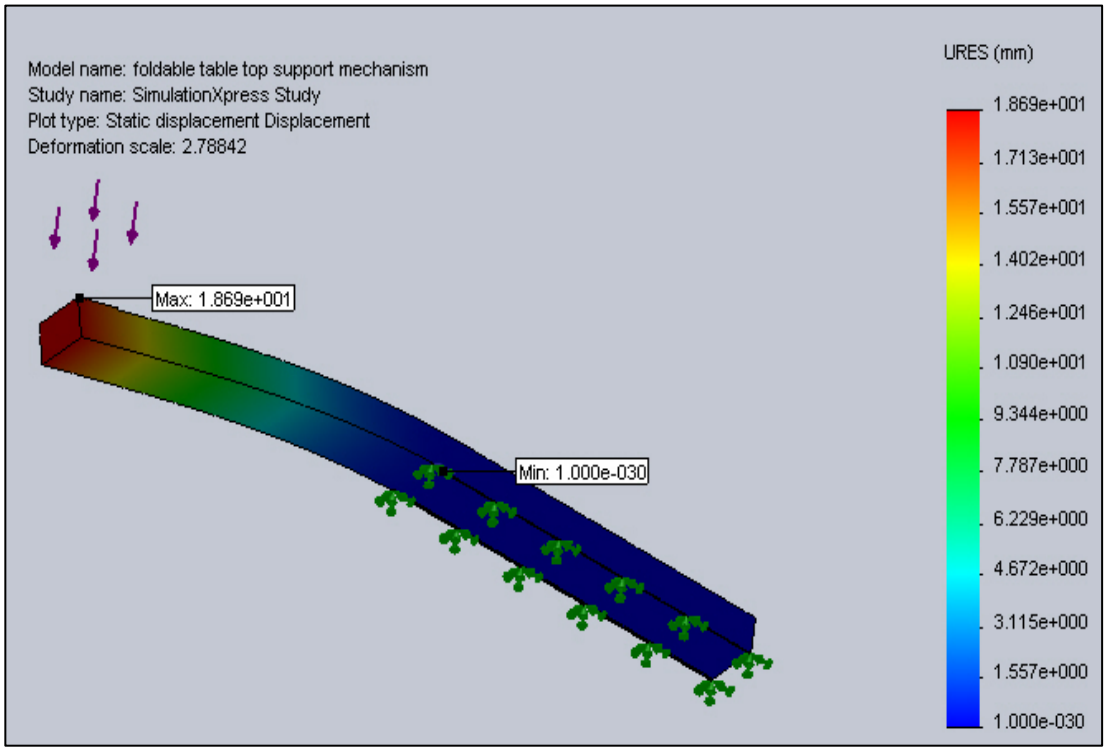


Figure 4.9: Displacement Analysis on Foldable Table Top Support Mechanism

Table 4.4: Displacement Analysis on Foldable Table Top Support Mechanism

Name	Type	Minimum displacement (mm)	Maximum Displacement (mm)
Foldable Table top Support mechanism	Displacement analysis	0	18.69

In Figure 4.10, the displacement increases from the each side towards the middle of the part. Thus, largest displacement changes occur at the middle when force distributed uniformly.

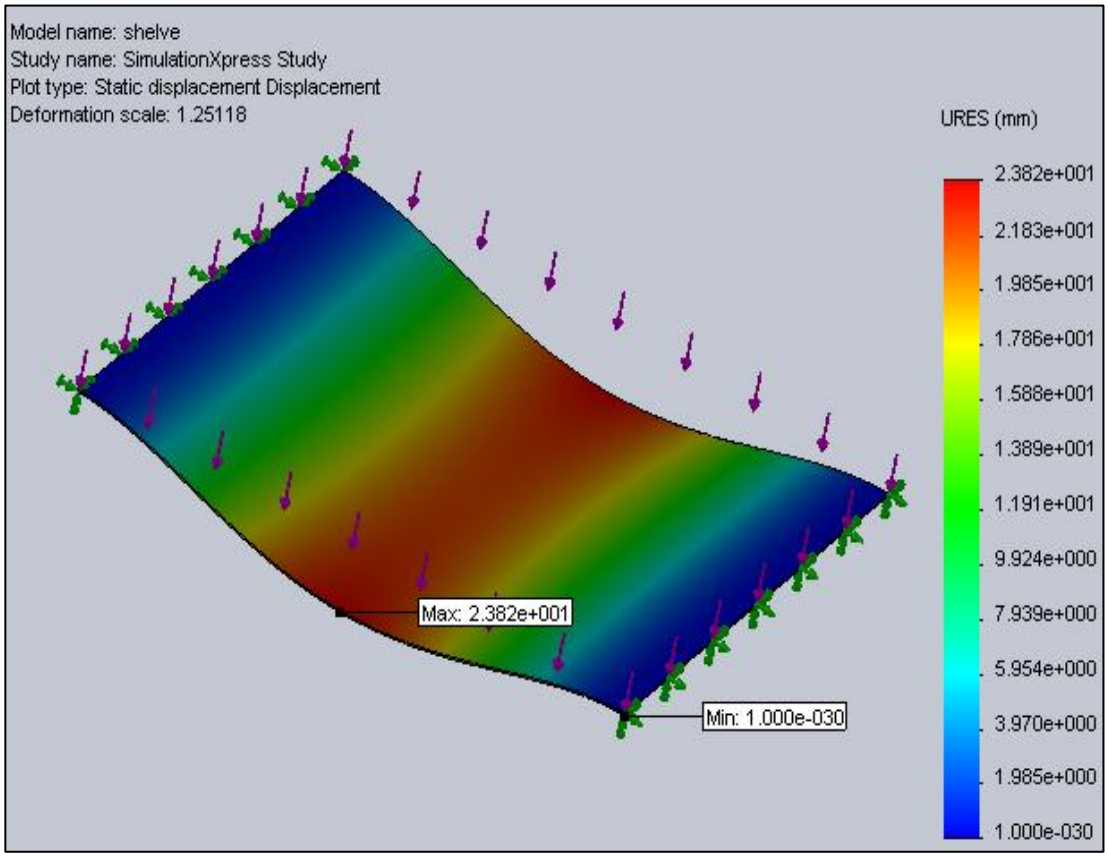


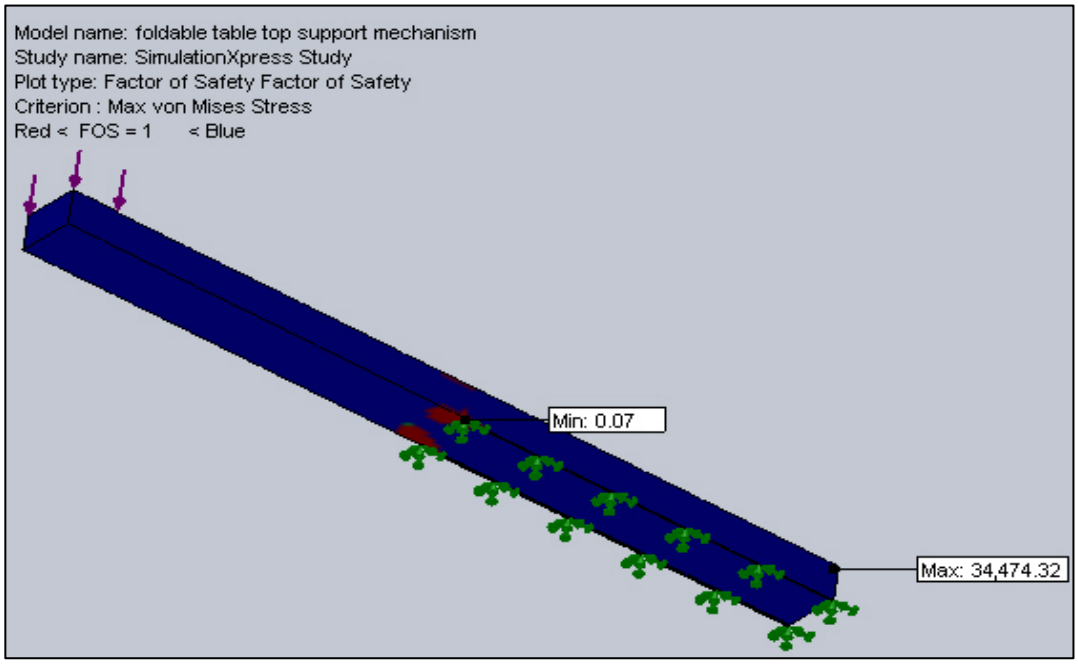
Figure 4.10: Displacement Analysis on Shelve

Table 4.5: Displacement Analysis on Shelve

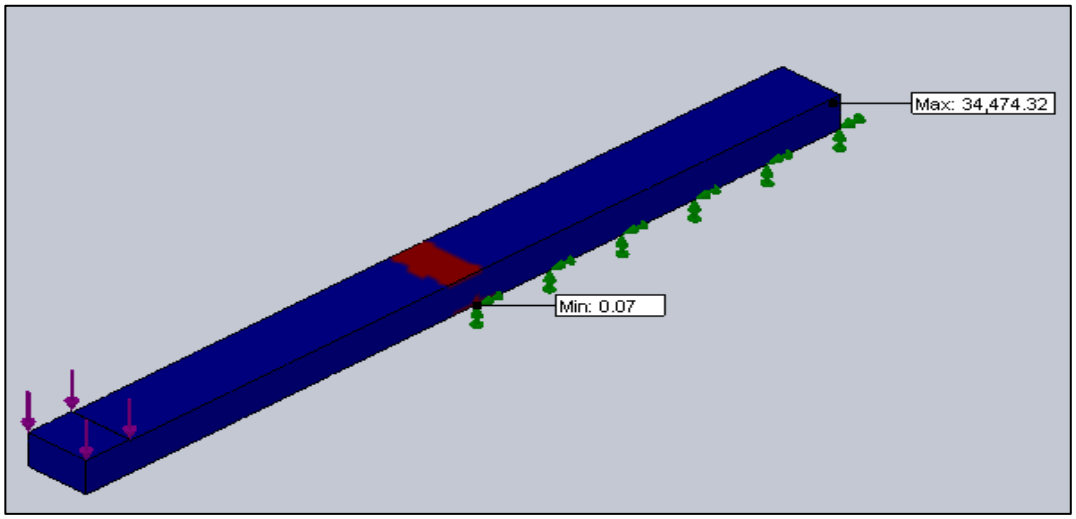
Name	Type	Minimum displacement (mm)	Maximum Displacement (mm)
Shelve	Displacement analysis	0	23.82

4.4.3 Safety Factor Analysis

In Figure 4.11 and Figure 4.12, red colour zone has the safety factor of lower than 1 while the blue colour zone indicates that area has safety factor of more than 1. Thus, crack would be likely to start occur at the red colour zone.



(a)



(b)

Figure 4.11: Safety Factor Analysis on Foldable Table Top Support Mechanism **(a)** Bottom View **(b)** Top View

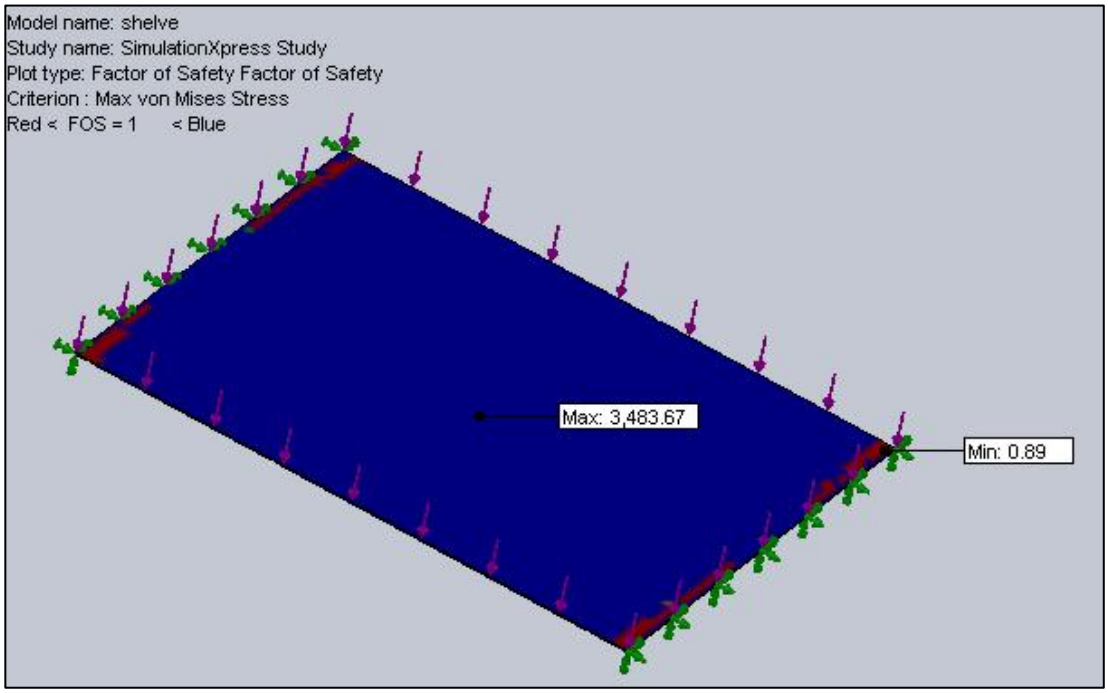


Figure 4.12: Safety Factor Analysis on Shelve

4.5 DISCUSSION ON PROJECT PROBLEMS

4.5.1 Design Process

During concept design, the concept generation is challenging, this is because there are many available working table which comes in variety of design and functions. Thus, the first and second generated concepts were not having distinctive improvement. However, the third concept design was rather better than the previous 2 concepts with the attachment of white board after spending a long duration of time in generating the 3rd concept.

4.5.2 Fabrication Process

During the fabrication process, the tolerance produced is very large, and it is not easy to achieve an accurate cutting and bending measurement because all of the machines used are conventional. It requires skill and experience. Accordingly, all of

the materials have to cut into required tolerance in order to ensure the flexibility of dimension of the materials during joining process.

For joining process, initially, Metal Inert Gas (MIG) is planned for joining the cabinets. However, it was break down and another way need to be figure out for joining of cabinets. Consequently, Metal Arc Welding was used for the joining of cabinets; however, due to the unsuitability of sheet metal in using this method, the cabinets appeared to have few holes at the joining edges. Although the appearance of the cabinets is not as good as using MIG, but the attachment are firm.

4.5.3 Analysis Process

From the analysis obtained, the table top support mechanism is able to withstand a maximum load of 330N only, which is 33kg.This value indicates that the extendable table top is practically cannot be used. There are a few factors in causing this problem to happen. Firstly, it is due to the location of fixture. The stress distribution could be reduce by reducing the distance between the load and fixture, and also change the direction of the fixture. A better load support could be achieved by changing the direction of the fixture so that it is perpendicular to the direction of the force exerted. Besides that, the selection of material also affected the capability of the supporting mechanism. By changing the types of materials used from wood to metal, the yield strength of the supporting mechanism will increase, thus the capability to endure higher load will also increase.

CHAPTER 5

CONCLUSION

Working tables come in variety of functions and shapes. It can be function for a specific task or function to be multipurpose task. All of these working tables are designed to meet the requirements of the task.

After undergo concept generation and finalize design, the working table is designed to be able to provide working spaces for more than 1 user, able to carry out variety of task, portable and able to keep to smaller size when it is not in used. The fabricated prototype is able to achieve the identified project objective which is to design and fabricate a functional working table. The working table is functional in terms of extendable table top, attachment of whiteboard on the working table, and the installment of castors which add on with the portability criteria.

Other than that, a few improvements are suggested in order to further increase the functionality of the working table. The recommendations are as follow.

i. Installment of electrical gadgets such as lamp and electrical extensions on the working table. By doing this installment, users will have extra lights to aid their task and easier to reach plug in or unplug their electrical equipment.
ii. Improve the supporting mechanism of the extendable table top so that it can withstand stronger force.
iii. Improve the flexibility of the storage compartment. For instance, the shelves in the storage compartment are adjustable so that users would be able to adjust the space of the storage compartment based on the size of their tools or equipment.

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APPENDIX A

Gantt Chart

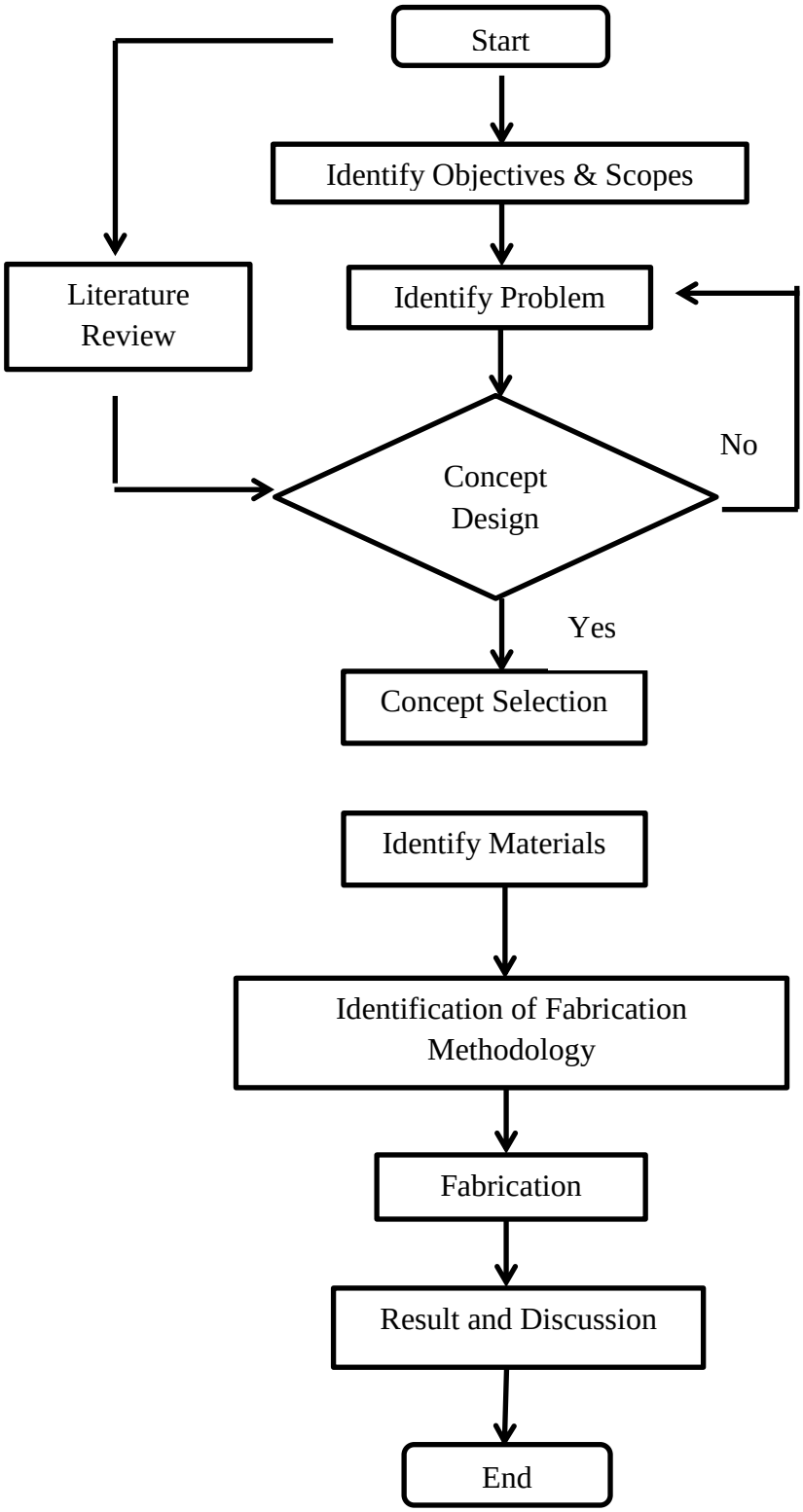
	WEEK														
PROJECT ACTIVITES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Identify problem statement, objective and scope															
Identify available working table in market															
Sketching of working table															
concept generation and finalize concept															
Finalize drawing (SOLIDWORK)															
Identify fabrication methodology															
Fabrication process															
Result and Discussion															
Presentation															

Planning

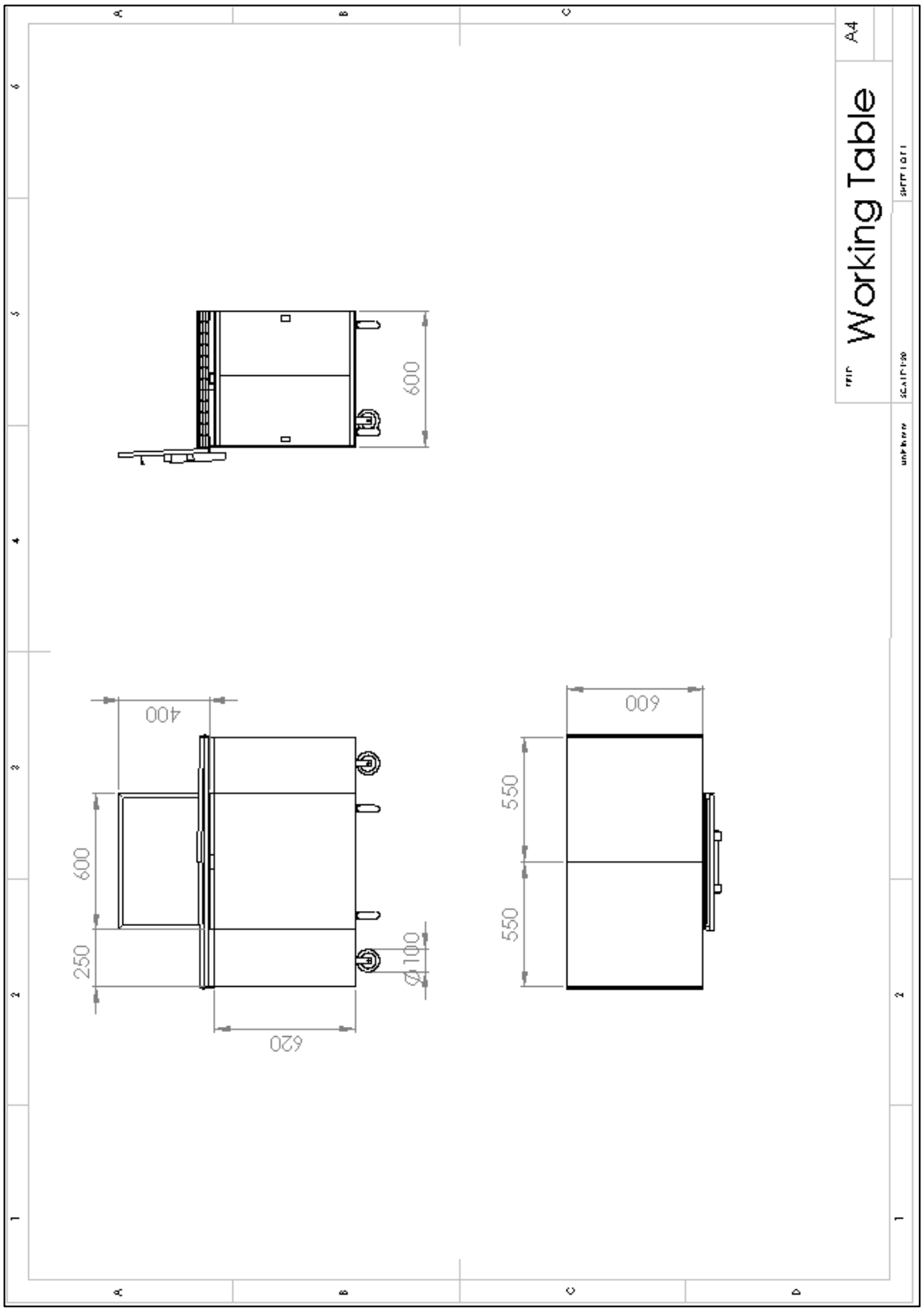
Actual

APPENDIX B

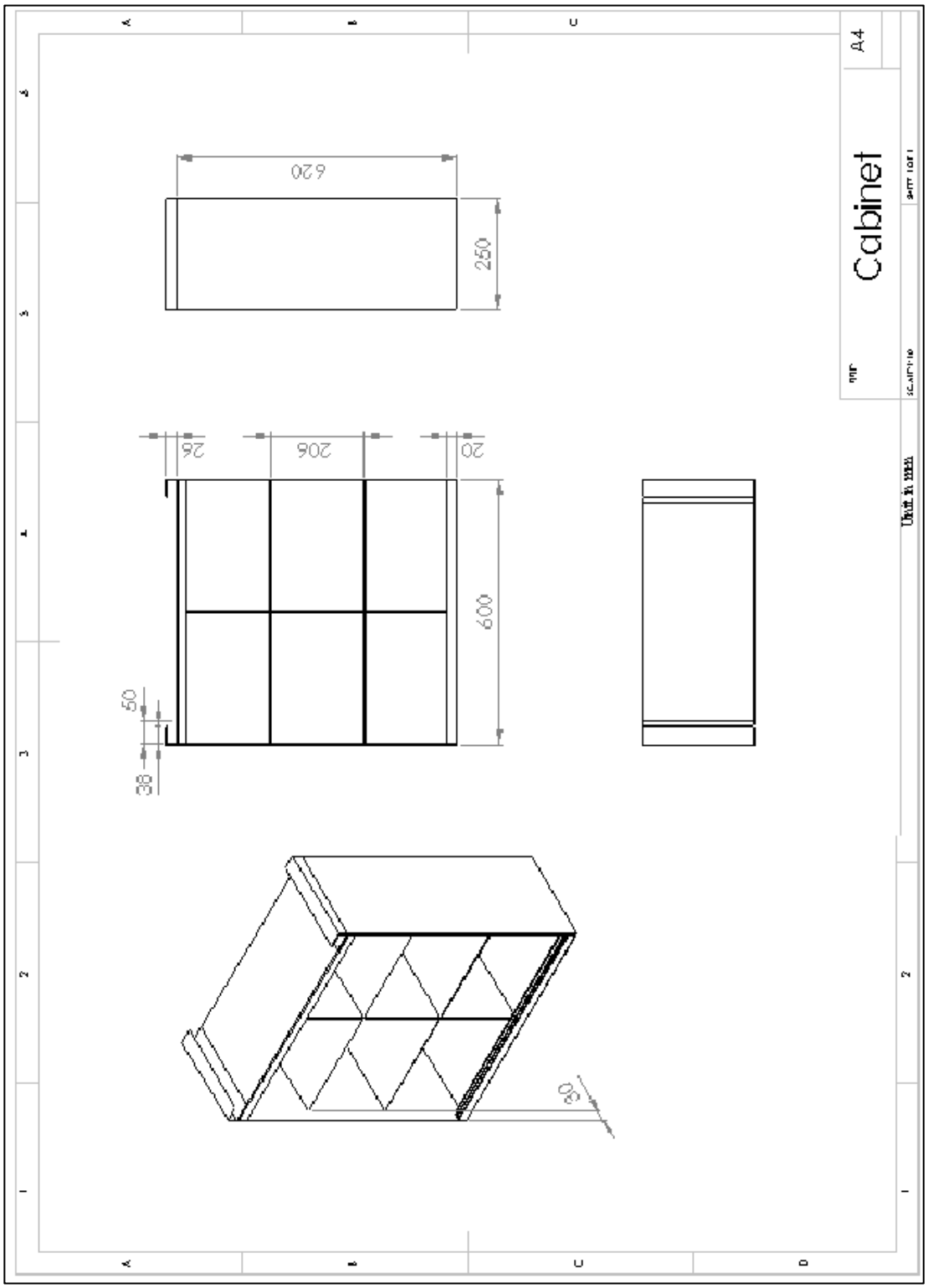
Flow Chart



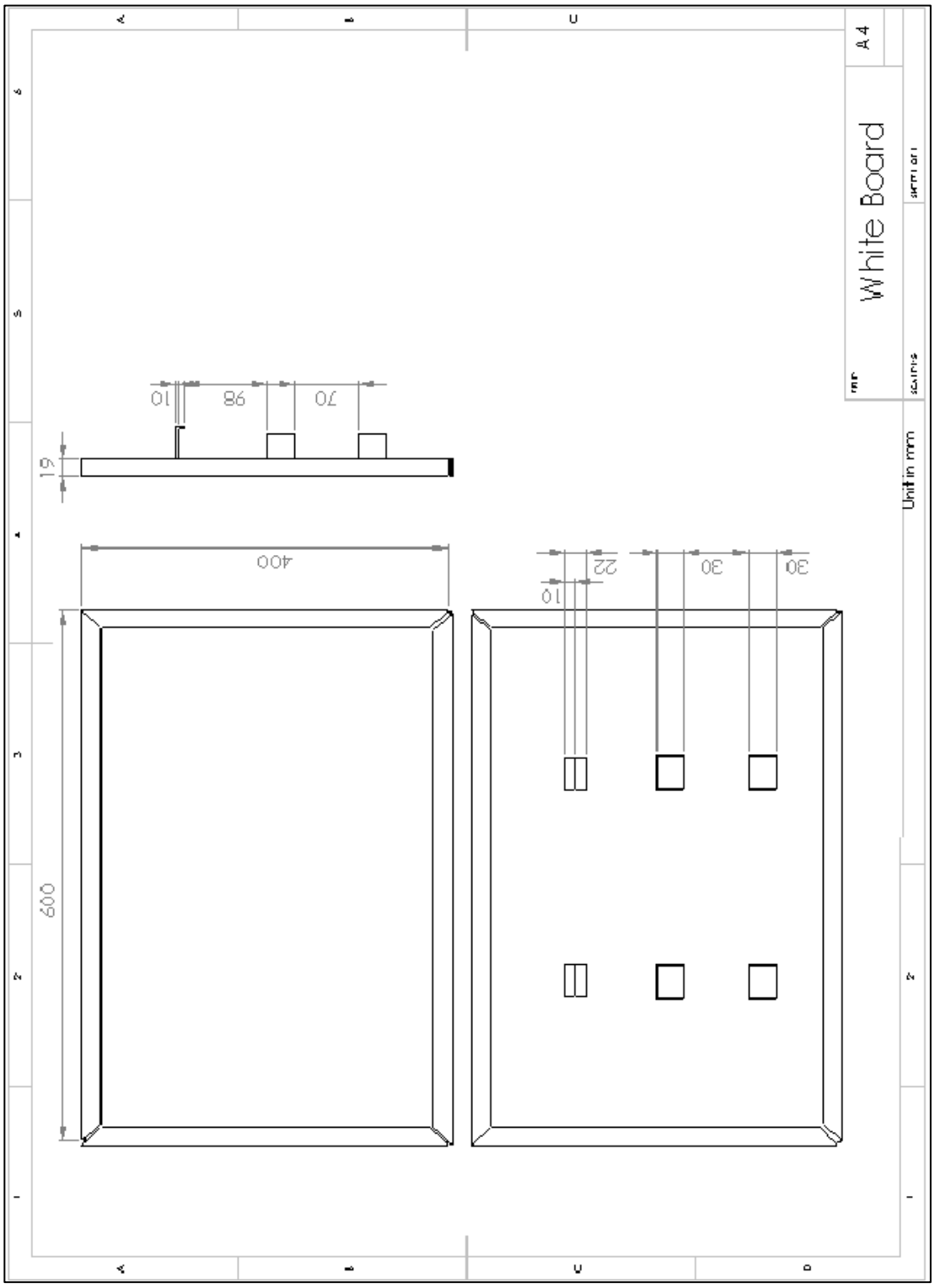
APPENDIX C



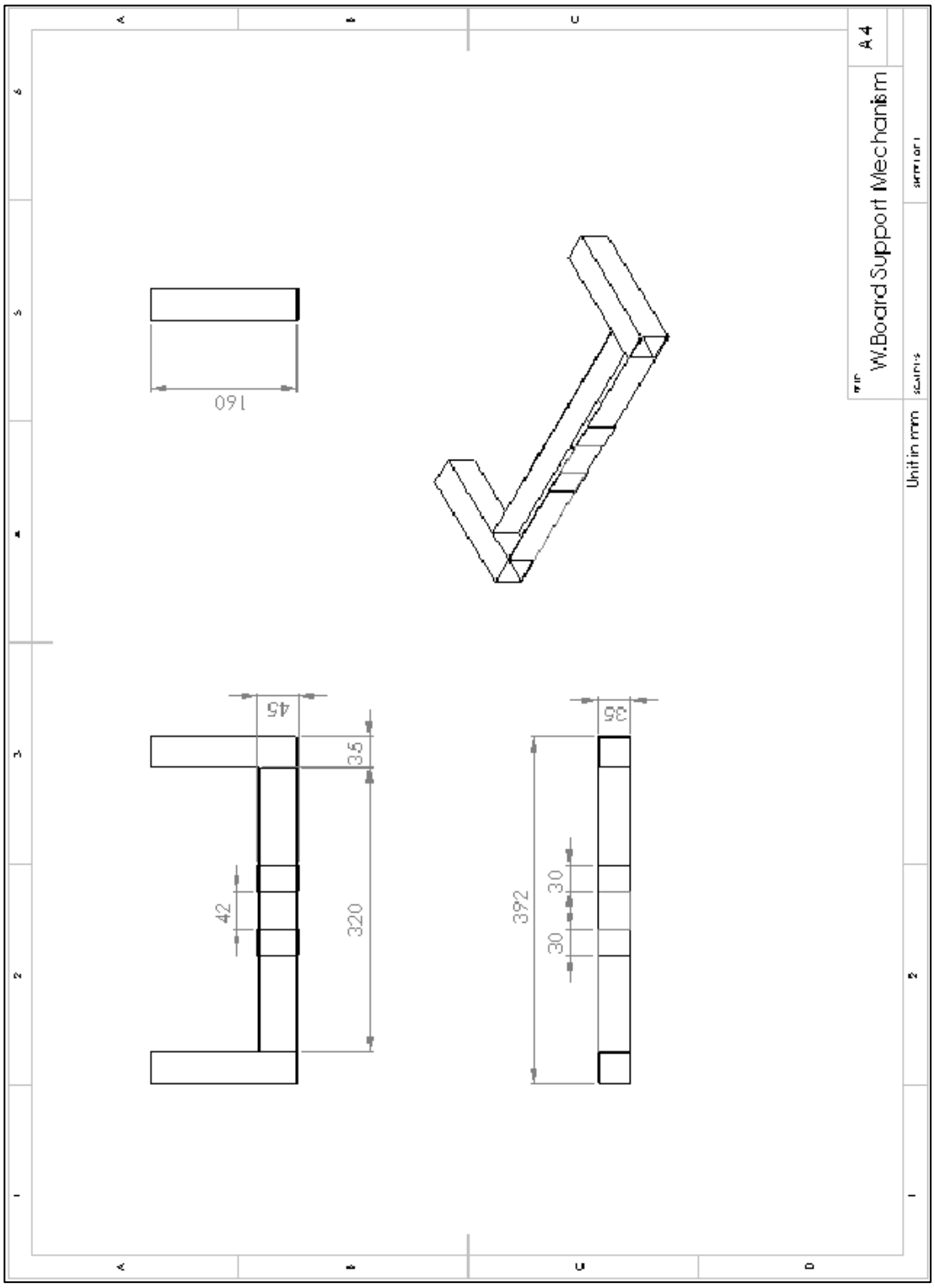
APPENDIX D



APPENDIX E



APPENDIX F


A4
W.Board Support Mechanism
Unit in mm
160
45
35
42
320
35
392
30
30

APPENDIX G