DEVELOPMENT OF STAINLESS STEEL TROLLEY

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BORANG PENGESAHAN STATUS TESIS ◆

JUDUL: DEVELOPMENT OF STAINLESS STEEL TROLLEY

SESI PENGAJIAN: 2008/2009

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DEVELOPMENT OF STAINLESS STEEL TROLLEY

NUR ADILAH BINTI AHMAD

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

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

NOVEMBER 2008

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

Signature

Name of Supervisor: RUSLI BIN GHANI
Position: INSTRUCTOR ENGINEER
Date:

Signature
Name of Panel:
Position:
Date:

STUDENT'S 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 diploma and is not concurrently submitted for award of other diploma.

Signature

Name: NUR ADILAH BINTI AHMAD

ID Number: MB06009

Date: 16 OCTOBER 2008

ACKNOWLEDGEMENTS

I would like to express my gratitude and appreciation to all those who gave me the possibility to complete this report. Special thanks is due to my supervisor Mr. Rusli bin Ghani whose help, stimulating suggestions and encouragement helped me in all time of fabrication process and in writing this report.

I would also like to acknowledge with much appreciation the crucial role of the staff in Mechanical Laboratory, who gave me a permission to use the mechanical equipment and also the machine and to design the drawing and giving a permission to use all the necessary tools in the laboratory.

Many thanks go to the all lecturer and supervisors who have given their full effort in guiding the team in achieving the goal as well as their encouragement to maintain our progress in track. My profound thanks go to all classmates, especially to my friends for spending their time in helping and giving support whenever I need it in fabricating my project.

ABSTRACT

This report presents about trolley that always been used especially in lab. This trolley is a device which is important in order to ease transportation and to decrease the load when we want to lift or transport heavy items from one place to another. The idea of the fabricating of this trolley is based on student's creativity. The selection of suitable materials in the fabricating of this trolley is a loaded material which has minimum weight, long life-span and can detain heavy load. Materials are proposed for the fabrication of the trolley is a stainless steel material. In this report, we'll also be having more to the fabrication of this trolley.

ABSTRAK

Laporan ini membentangkan tentang troli yang sering kali digunakan terutamanya di dalam makmal. Troli merupakan suatu perkakas yang penting untuk memudahkan pergerakan dan meringankan beban ketika hendak mengangkat atau mengubah barang yang berat dari satu tempat ke satu tempat. Idea pembentukan troli ini berdasarkan kreativiti pelajar sendiri. Pemilihan bahan yang sesuai untuk digunakan bagi pembentukkan troli ini merupakan bahan yang mempunyai berat yang ringan, jangka hayat yang tahan lama dan boleh menahan beban yang berat. Bahan yang dicadangkan untuk pembentukkan troli ini merupakan material jenis stainless steel. Dalam laporan ini juga akan lebih memfokuskan kepada pembentukkan troli.

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e	Strain
σ	Stress (N/m^2)
E	Young's Modulus = σ /e (N/m^2)
y	Distance of surface from neutral surface (m).
R	Radius of neutral axis (m)
I	Moment of Inertia (m^4 - more normally cm^4)
Z	Section modulus = I/y_{max}(m^3 - more normally cm^3)
M	Moment (Nm)
W	Total load on beam (kg) or (N as force units)
F	Concentrated force on beam (N)
S	Shear Force on Section (N)
L	Length of beam (m)
x	Distance along beam (m)

LIST OF ABBREVIATIONS

AL	Aluminium
AISI	The American Iron and Steel Institute
ASTM	American Society for Testing and Materials
CAD	Computer Aided Design
MIG	Metal Inert Gas Welding
PPE	Personal Protective Equipment
UHMWPE	Ultra high molecular weight polyethylene
SMAW	Shielded metal arc welding
UMP	Universiti Malaysia Pahang

CHAPTER 1

INTRODUCTION

1.1 PROJECT SYNOPSIS

1.1.1 General Project Synopsis

The project involves designing and fabricating a Trolley. As the Diploma final year project allocates the duration of 1 semester, this large man-hour project therefore requires significant efforts of the students to participate. Basically the entire trolley could be divided into three stages, which are concept review and development, designing and fabrication.

The trolley is equipped by using stainless steel 304 2B material which include, rectangular plate steel, round hollow steel, and wheels in manufacturing process by perform MIG welding to joint the parts and etc. The advantages of the proposed trolley to be developed can be seen to be moved such that, man are offered to make their task easier since the trolley will facilitate them to transfer heavy items for instance, computer and etc.

The process of development is initiated from designing the shape of the trolley by considering the function as well. In order to produce user friendly product that is suitable to the consumer, consideration to the ergonomic factor is taken into account. It involves the measurement process before the materials are cut into pieces before joined together.

1.1.2 Specific Project Synopsis

My project title is Development of Stainless Steel Trolley. The project involves small analysis of the Trolley frame body and fabrication of the trolley itself with concerns regarding strength, durability, ergonomic factor, and convenience. Test need to be done to verify the strength of the trolley right before the fabrication process to avoid material and fund wasting. The projects prerequisites are Static, Dynamic and Strength of Material. Overall, the project will meet acquire skills of design, analysis, and fabrication.

1.2 PROBLEM STATEMENT

The concept of the trolley is to facilitate man for loading items. This trolley will primarily help staff especially members of Faculty of Mechanical Engineering to load and unload heavy items that's need trolley for convenience. Members are facing problem while the need to bring things from one place to another due to unavailability of trolley. Thus, with the development of this trolley, it is hope that it can contribute to give them ideas how to overcome problem in loading items by choose the better way in facilitate their routine at University Malaysia Pahang especially for Faculty of Mechanical Engineering staff.

1.3 PROJECT SCOPE OF WORK

1.3.1 **Literature Review:** Valuable data are searched and gathered. Considering the shape of the trolley in terms of its complexity and method to produce.

1.3.2 **Sketching & Designing**: Sketching and designing using Solidwork software in creating the design of the trolley.

1.3.3 **Fabrication**: Fabricate and produce the trolley by using all necessary manufacturing process such as welding, cutting, grinding and etc.

1.3.4 **Testing & Evaluation**: Simulate the mechanism of the trolley produce is in line with the expected function to be.

1.4 PROJECT OBJECTIVES

1.4.1 General Objectives

Diploma final year project objective is to practice the knowledge and skill of the student that have been gathered before in solving problem using academic research, to born an engineer that have enough knowledge and skill. This project also important to train and increase the student capability to get know, research, data gathering, analysis making and then solve a problem by research or scientific research.

The project also will educate the student in communication like in a presentation and educate them to defend their research in the presentation. The project also will generate students that have capability to make a good research report in thesis form or technical writing. This project also can produce and train student to capable of doing work with minimal supervisory and more independent in searching, detailing and expanding the experiences and knowledge.

1.4.2 Specific Project Objectives

The project objectives are to design trolley that is suite to its application especially for loading items and to minimize the manufacturing cost by minimize the complexity of the trolley and simulate the material used with cheaper material but having high strength and endurance.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Literature Review	■	■	■	■	■										
Design & Measurement consideration			■	■	■	■	■								
Acquisition & Material preparation						■	■	■							
Methodology study					■	■	■								
Fabrication								■	■	■	■	■	■		
Evaluation & Improvement										■	■	■	■		
Report writing	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Presentation							■							■	

Table 1: Project Schedule

1.5 PROJECT FLOW CHART

For the diagram as shown as below, the project starts with literature review and research about the title. This consist a review of the concept of trolley, trolley system, trolley features and type of trolley used in various fields such as food industries, hospital and etc. These tasks have been done through research on the internet, books and others sources.

After gathering all the relevant information, the project undergoes design process. In this step, from the knowledge gather from the review is use to make a sketch design that suitable for the project. After several design sketched, design consideration have been made and one design have been chosen. The selected design sketched is then transfer to solid modelling and engineering drawing using Solidworks program. The materials and the measurement needed for the trolley listed down and calculated to give an ergonomic shape of the trolley.

Next, after the needed material is listed, acquisition step take places. There are only a few materials that need to buy such as wheels. Some of the needed material is well-prepared by the university.

After all the parts needed had been gathered, the project proceeds to next step that is fabrication process. The finished drawing and sketching is used as a reference by following the measurement and the type of materials needed. The fabrication process that involved is cutting, welding, and others. If all the parts had been processed, the parts are joined together to produce full-scaled trolley. Here come the testing and evaluation process. The trolley will be test to see if it fulfills the requirement such as ergonomic aspect, safety, strength and manoeuvrability. During the testing, if problem occur such as malfunction or unstable platform, the trolley will step back to the previous process, where the error is fixed. The trolley is expected to have an error that may cause the part to be re-designed and re-fabricate again.

After all the parts had been joined together, here comes the last phase of process that is data discussion. In data discussion, the draft report and all the related articles are gathered and hand over to the supervisor for error checking. The finish product will be compared with the report to make sure that there is no mistake on both project and report.

After the product and the report had been approved by the supervisor, the report is rearrange and print out to submit at the supervisor, the project coordinator and faculty of Mechanical Engineering. In this stage, the final presentation was also being prepared and waited to be present.

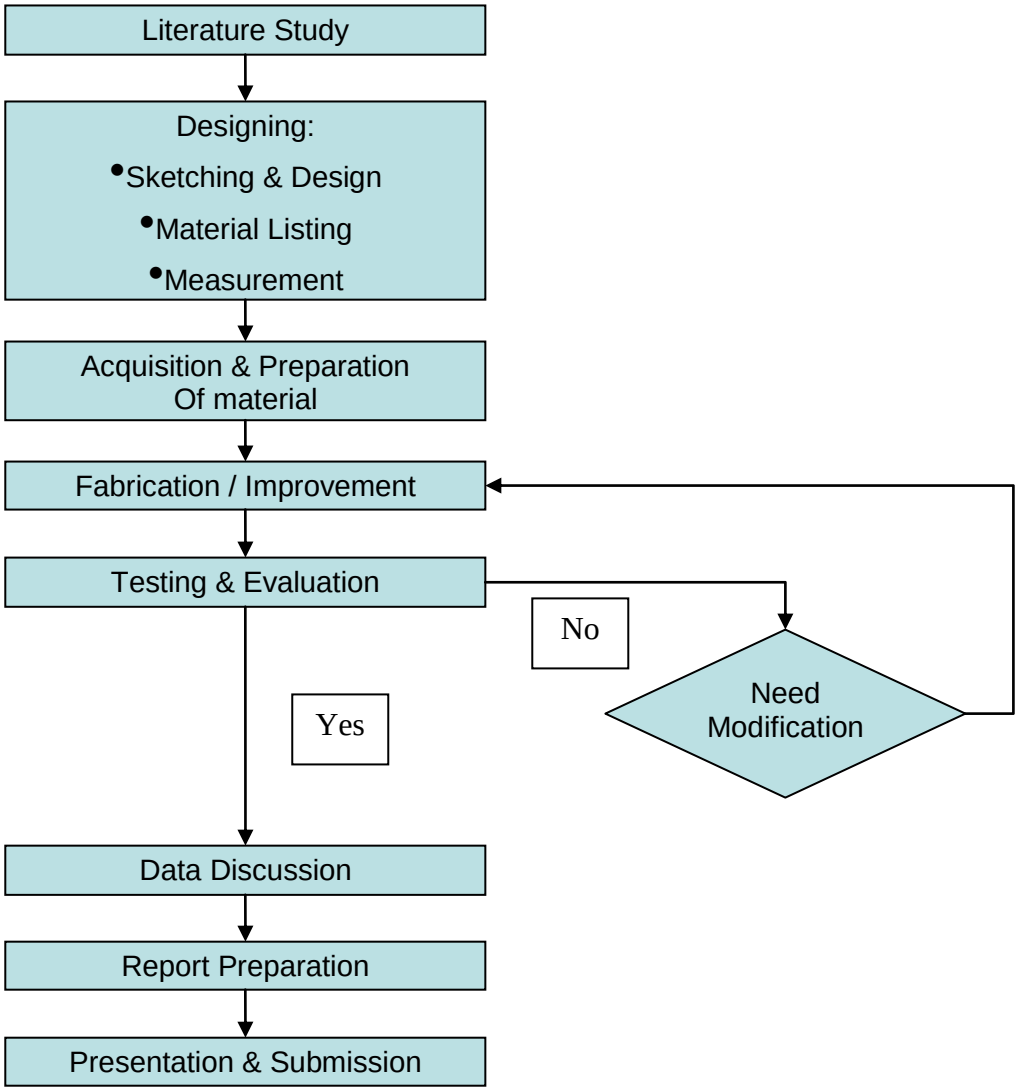

Figure 1.1: Project Flow Chart

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The trolley is a mechanism that allowed man to transfer their heavy items such as computers, files and etc to other places. It's help man to do their work without having a problem due to the heavy loading. Its also helps to reduce pain in waist, back, hand and feet. No mater how light the loading is, people usually will suffocate a large pain in their body if lifting the items in many times. So, this is when the people rely upon a trolley that can do items transferring many times with just a little effort. From the statement above conclude that the trolley playing a major role as an items transferring mechanism for people without having a problem of doing that. A trolley also functioned as a helper to people to hold items orderly while transferring between rough lands.

2.2 PAPER REVIEW

2.2.1 Trolley types and functions

(i) **Food Trolley:** a small table on wheel or castor that typically used to convey foods and drinks.

(ii) **Supermarket trolley:** a large metal basket or frame on wheels used for transporting heavy and unwieldy items.

(iii) **Luggage trolley:** a frame on wheel used to transporting heavy luggage at airport or railway station.

(iv) **Hospital trolley:** a tray on wheels for transporting icebox for organ, surgery items and others.

(v) **Full-storage trolley:** a cabinet on wheel for keeping workshop tools and transporting them easily.

(vi) **Lightweight portable trolley:** a platform on wheels for transporting wide and heavy items in workshop, office, warehouse and etc.

2.3 TECHNICAL REVIEW

2.3.1 Pictures

Figure 2.1: Hospital Trolley

Figure 2.2: Full-storage Trolley

Figure 2.3: Luggage Trolley

Figure 2.4: Lightweight Portable

2.4 BASIC PARTS

2.4.1 **Wheel**: Usually made from rubber that joined together with the bolt and nut with steel frame to ensure strength.

2.4.2 **Body**: For outdoor use such as warehouse or workshop that requires full strength of body, wire frame or sheet metal body is used. Some trolley doesn't have any body on it on purpose.

2.4.3 **Handle Bar**: Usually all the trolley must have handle to provide less effort while using the trolley due to heavy it's loading.

2.5 JOINING METHOD

Joining involves in assembly stage. Commonly used method to join metal part is Metal Inert Gas (MIG) welding.

Figure 2.5: Metal Inert Gas (MIG) Welding

2.5.1 Metal Inert Gas (MIG) Welding

MIG (Metal Inert Gas) or as it even is called GMAW (Gas Metal Arc Welding) uses an aluminum alloy wire as a combined electrode and filler material. The filler metal is added continuously and welding without filler-material is therefore not possible. Since all welding parameters are controlled by the welding machine, the process is also called semi-automatic welding.

The MIG-process uses a direct current power source, with the electrode positive (DC, EP). By using a positive electrode, the oxide layer is efficiently removed from the aluminum surface, which is essential for avoiding lack of fusion and oxide inclusions. The metal is transferred from the filler wire to the weld bead by magnetic forces as small droplets, spray transfer. This gives a deep penetration capability of the process and makes it possible to weld in all positions. It is important for the quality of the weld that the spray transfer is obtained.

There are two different MIG-welding processes, conventional MIG and pulsed MIG:

a) Conventional MIG uses a constant voltage DC power source. Since the spray transfer is limited to a certain range of arc current, the conventional MIG process has a lower limit of arc current (or heat input). This also limits the application of conventional MIG to weld material thicknesses above 4 mm. Below 6 mm it is recommended that backing is used to control the weld bead.

b) Pulsed MIG uses a DC power source with superimposed periodic pulses of high current. During the low current level the arc is maintained without metal transfer. During the high current pulses the metal is transferred in the spray mode. In this way pulsed MIG is possible to operate with lower average current and heat input compared to conventional MIG. This makes it possible to weld thinner sections and weld much easily in difficult welding positions.

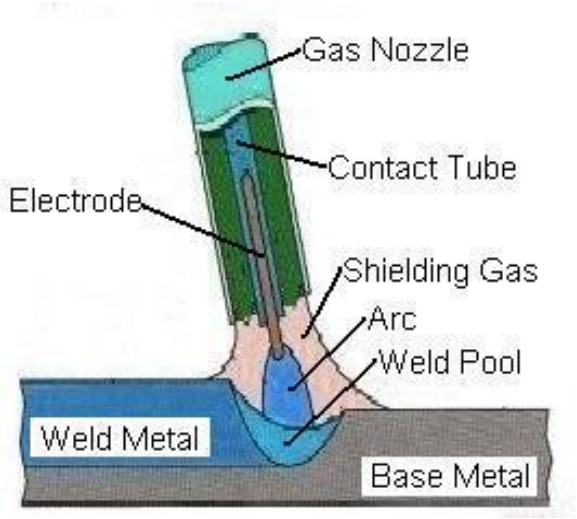

Figure 2.6: Schematic of Metal Inert Gas (MIG) Welding

GMAW is frequently referred to as MIG welding. MIG welding is a commonly used high deposition rate welding process. Wire is continuously fed from a spool. MIG welding is therefore referred to as a semiautomatic welding process. [1]

There are some advantages and disadvantages in using MIG welding:

The advantages of MIG welding

- All position capability
- Higher deposition rates than SMAW
- Less operator skill required
- Long welds can be made without starts and stops
- Minimal post weld cleaning is required

The disadvantages of MIG welding

- Costs money of consumable, such as tips and nozzles
- Is not worth a dang on paint, rust, or dirty surfaces
- No good for thick steel because it does not get the proper penetration

2.6 SHEARING PROCESS

Shearing is a metalworking process which cuts stock without the formation of chips or the use of burning or melting. Strictly speaking, if the cutting blades are straight the process is called shearing; if the cutting blades are curved then they are shearing-type operations. The most commonly sheared materials are in the form of sheet metal or plates; however rods can also be sheared. Shearing-type operations include: blanking, piercing, roll slitting, and trimming. [3]

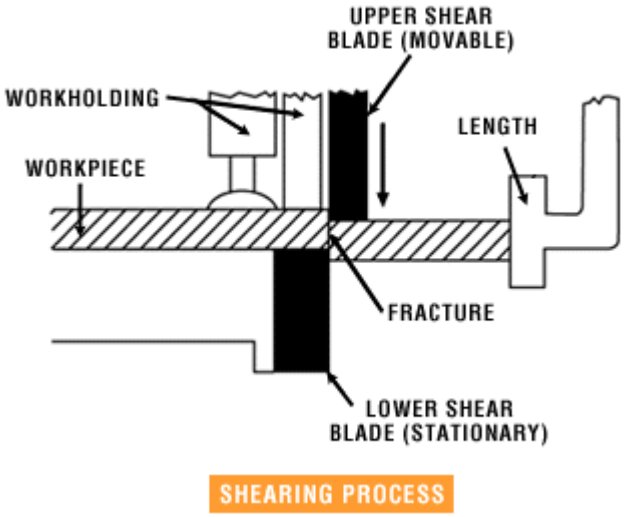

Figure 2.7: Shearing Process

Materials that are commonly sheared include Aluminum, Brass, Bronze, Mild steel and Stainless steel. The shearing process uses three types of tool systems. They are used for shearing:

- Sheet metal and plate using a squaring or bow tie shear
- Angle materials using and angle shear, and
- Bar stock using a bar shear.

Figure 2.8: Shearing Machine

2.7 BENDING PROCESS

Bending is a process by which metal can be deformed by plastically deforming the material and changing its shape. The material is stressed beyond the yield strength but below the ultimate tensile strength. The surface area of the material does not change much. Bending usually refers to deformation about one axis.

Bending is a flexible process by which many different shapes can be produced. Standard die sets are used to produce a wide variety of shapes. The 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. Press Brakes normally have a capacity of 20 to 200 tons to accommodate stock from 1m to 4.5m (3 feet to 15 feet). Larger and smaller presses are used for specialized applications. Programmable back gages, and multiple die sets available currently can make for a very economical process. [4]

Figure 2.9: Bending Machine

2.8 DRILLING

Drilling is easily the most common machining process. One estimate is that 75% of all metal-cutting material removed comes from drilling operations. Drilling involves the creation of holes that are right circular cylinders. This is accomplished most typically by using a twist drill, something most readers will have seen before. The chips must exit through the flutes to the outside of the tool. As can be seen in the figure, the cutting front is embedded within the work piece, making cooling difficult. The cutting area can be flooded, coolant spray mist can be applied, or coolant can be delivered through the drill bit shaft. [5]

2.8.1 Drill Press

A typical manual drill press is shown in the figure below. Compared to other powered metal cutting tools, a drill press is fairly simple, but it has evolved into a versatile necessity for every machine shop.

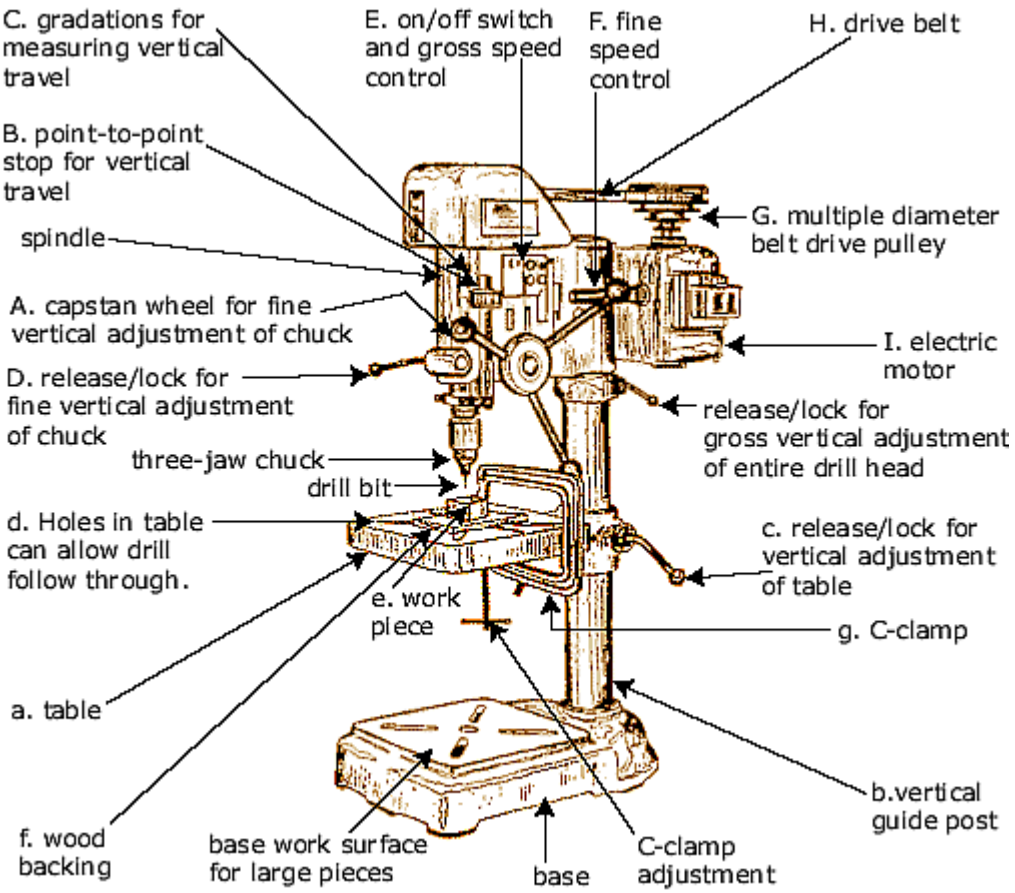

Figure 2.10: Drill Press Machine

2.9 GRINDING PROCESS

Grinding is a finishing process used to improve surface finish, abrade hard materials, and tighten the tolerance on flat and cylindrical surfaces by removing a small amount of material. Information in this section is organized according to the subcategory links in the menu bar to the left.

In grinding, an abrasive material rubs against the metal part and removes tiny pieces of material. The abrasive material is typically on the surface of a wheel or belt and abrades material in a way similar to sanding. On a microscopic scale, the chip formation in grinding is the same as that found in other machining processes.

The abrasive action of grinding generates excessive heat so that flooding of the cutting area with fluid is necessary. [6]

Figure 2.11: Grinder

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Project methodology is a body of practices, procedures and rules used by those who work in a discipline or engage in an inquiry and a set of working methods. In this chapter, I will explain about the process that involved during the fabrication process. I also will explain about the design and analysis that had been chosen to be as the final idea to be producing or fabricate. All the fabrication process in this project is going to be explained in details.

3.2 DESIGN

The Design of the Trolley must be compliance to several aspects. The design consideration must be done carefully so the design can be fabricated and the parts are all functioning. The aspects that must be considered in designing the trolley are:

3.2.1 **Strength**: Must have certain strength to ensure that it can load heavy items.

3.2.2 **Ergonomic Factors**: Trolley must be user friendly as easy and convenience.

3.2.3 **Suit to environment**: The trolley must be suitable to be use in factory area.

3.3 DRAWING

The drawings are divided into two categories, which are:

3.3.1 **Sketching**: All the ideas for the trolley fabrication are sketched on the paper first to ensure that idea selection an be made after this, and

3.3.2 **CAD Drawing**: The final idea is drawn into the CAD drawing format with details features.

3.4 DESIGN SPECIFICATION

The design of the Trolley must be considered that it can endure several specifications, which are two platform trolley, maximum load for the platform: 8kg –10kg, overall materials are 1 in X 31.5 in hollow steel (4 hollow steel), 870mm X 570mm X 1.2mm Stainless Steel plate (2 plate), and also wheels (4 wheels) and lastly convenience.

3.5 SKETCHING DRAWING SELECTION

From the existing ideas, only three sketching that had been chosen to be considered as the final ideas, which are:

3.5.1 Sketching 1

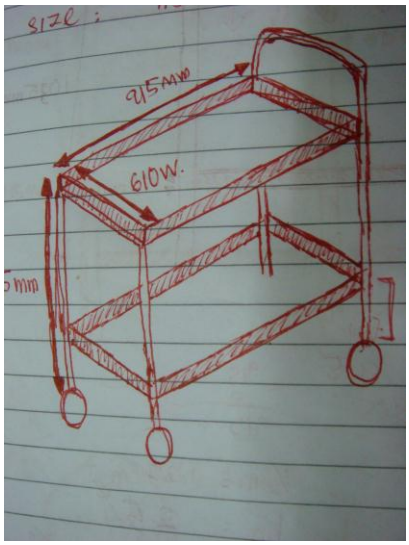

Figure 3.1: Sketching 1

3.5.2 Sketching 2

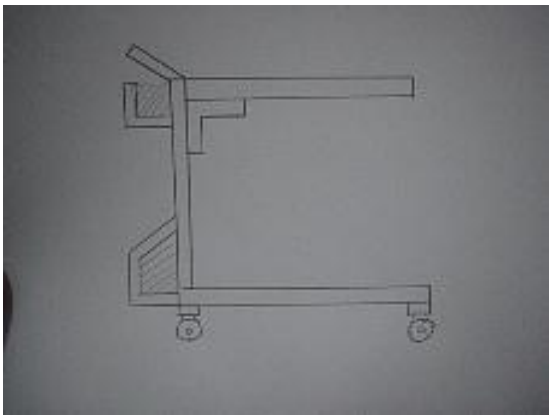

Figure 3.2: Sketching 2

3.5.3 Sketching 3

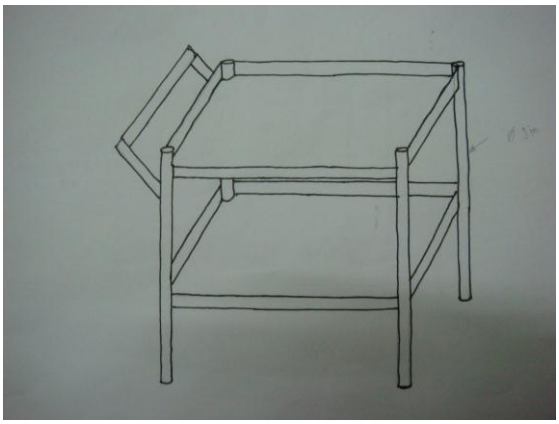

Figure 3.3: Sketching 3

3.6 SKETCHING SELECTION

3.6.1 Suggested Drawing

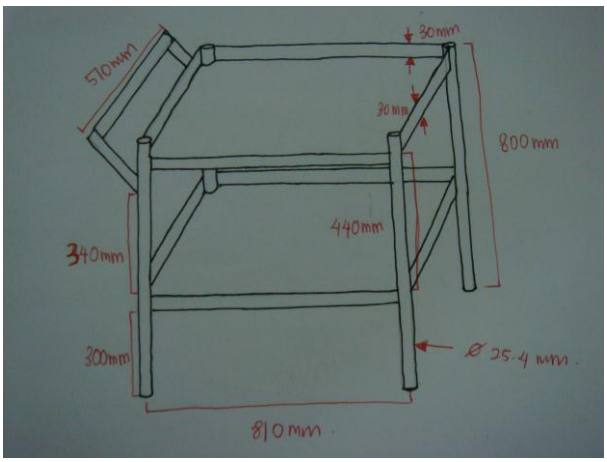

Figure 3.4: Sketching 4

I'm choosing this sketching as my project concept is because it is simple but yet convenience. Thus, the support bar was located on the right spot of the pressure point.

3.7 COMPUTER AIDED DESIGN DRAWING

After a design has been selected, the next step in the designing process is dimensioning. The dimensioning is base on relevant dimensions and also referring to the existence trolley so that the design is fit into others part.

After dimensioning, the engineering drawing of the design is drawn using Solidworks application, at this stage solid modelling method is used. Part by part solid modelling created according to the dimension done before, after all part created, the 3D model is assembled with each other base on the design.

3.8 OVERALL VIEW OF THE DESIGN

3.8.1 Design Descriptions

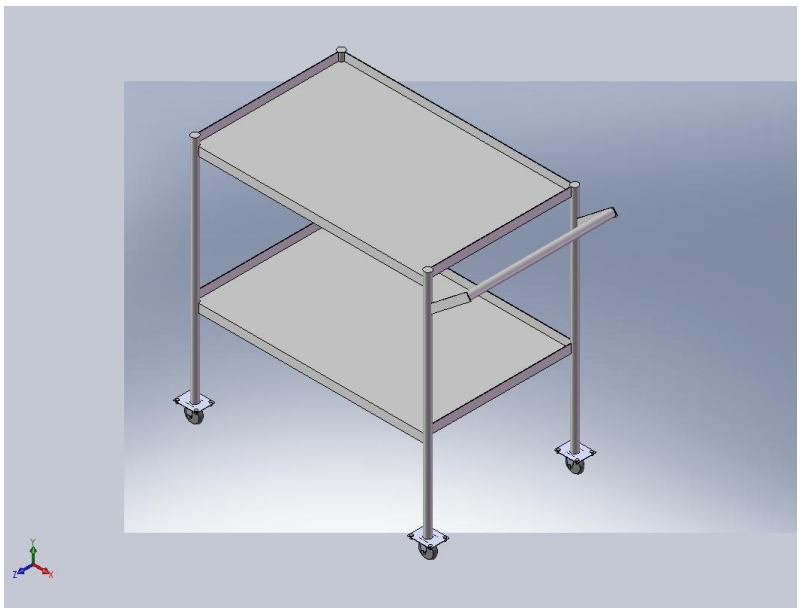

Figure 3.5: CAD Drawing

This design show that the final idea of the Stainless Steel Trolley. Additional base for tire also were added to make sure that the trolley can be easily to move.

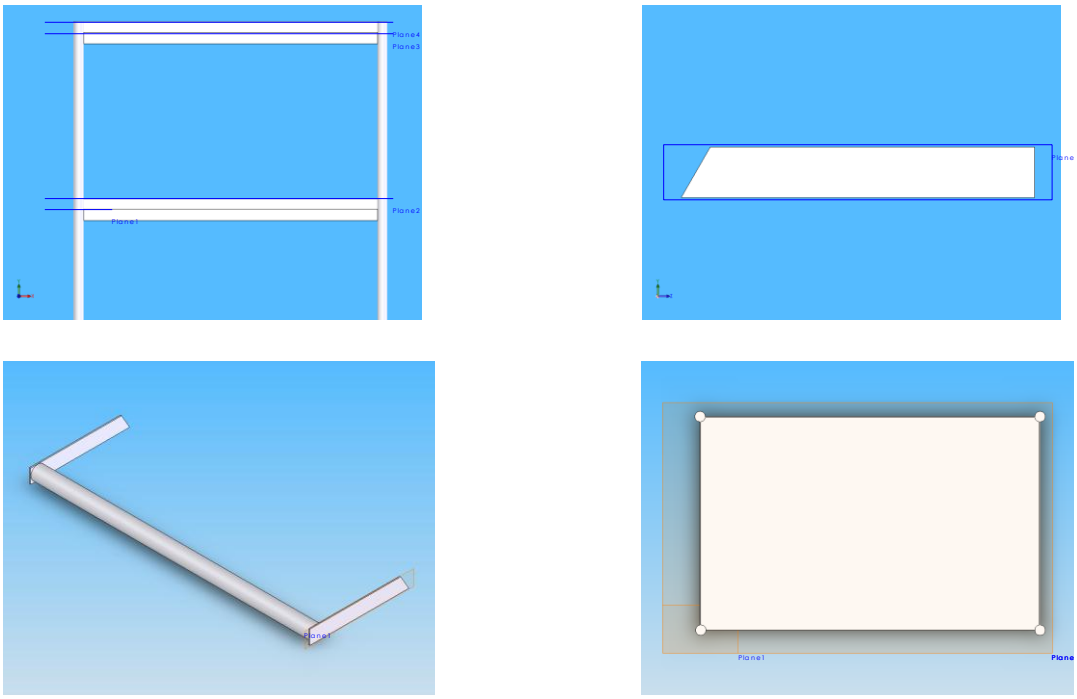

Figure 3.6: Explode CAD Drawing

3.9 CALCULATION

3.9.1 Engineering strain on a sheet during bending

$$\varepsilon = \frac{1}{(2R/T) + 1}$$

$$= \frac{1}{(2(3)/1.2\text{mm}) + 1}$$

$$= 0.1667\text{mm}$$

3.9.2 Bend Allowance

$$B = \frac{A\Pi}{180}(R + Kt)$$

$$B = \frac{95\Pi}{180}(0.089 + 0.047/3)$$

$$= 0.174in$$

3.9.3 Bend Radius

$$R = \frac{180B}{A\Pi} - Kt$$

$$R = \frac{180(0.174)}{95\Pi} - (0.047/3)$$

$$= 0.089in$$

3.9.4 Bend Force

$$P = \frac{KLSt^2}{V(1000)}$$

$$P = \frac{(1.3)(16.32)(0.047)^2(45)}{6}$$

$$= 0.35 \text{ ton}$$

3.9.5 Cutting Force

For contours steel TN $= \frac{SLT}{2000}$

$= \frac{(241.3)(20.08)(0.047)}{2000}$

$= 0.114$ ton

For hollow TN $= \frac{\pi DST}{2000}$

$= \frac{\pi (241.3)(0.047)(1)}{2000}$

$= 0.0178$ ton

3.10 FABRICATION PROCESS

After designing phase, comes fabrication process. These processes is about using the material Selection and make the product base on the design and by followed the design dimension. Many methods can be used to fabricate a product, like welding, fastening, cutting, drilling and many more method. Fabrication process is difference from manufacturing process in term of production quantity. Fabrication process is a process to make only one product rather then manufacturing process that focus to large scale production. In the project fabrication process needed to make the base plate, framework of display board and display board. Fabrication process was used at the whole system production. This was include part by part fabrication until assembly to others component.

3.10.1 Process Involve

In order to make the design come to reality, fabrication process needs to be done first. The fabrication process starts from dimensioning the raw material until it is finish as a desired product. The processes that involved are:

- **Measuring**: Materials are measured to desired dimensions or location.
- **Marking**: All measured materials need to be marked to give precise dimension.
- **Cutting**: Marked materials are then cut into pieces.
- **Joining**: Materials joined by the method of welding and using bolt nuts.
- **Drilling**: Marked holes are then drilled to make holes for bolts.
- **Finishing**: Any rough surface cause by welding spark were grind to give smooth and safe surface.

3.10.2 Material of The Project

Material of the project is totally using stainless steel according to the title given which is Development of Stainless Steel Trolley 304. Grade 304 is the standard "18/8" stainless; it is the most versatile and most widely used stainless steel, available in a wider range of products, forms and finishes than any other. It has excellent forming and welding characteristics. The balanced austenitic structure of Grade 304 enables it to be severely deep drawn without intermediate annealing, which has made this grade dominant in the manufacture of drawn stainless parts such as sinks, hollow-ware and saucepans.

For these applications it is common to use special "304DDQ" (Deep Drawing Quality) variants. Grade 304 is readily brake or roll formed into a variety of components for applications in the industrial, architectural, and transportation fields. Grade 304 also has outstanding welding characteristics. Post-weld annealing is not required when welding thin sections. Grade 304L, the low carbon version of

304, does not require post-weld annealing and so is extensively used in heavy gauge components (over about 6mm). Grade 304H with its higher carbon content finds application at elevated temperatures. The austenitic structure also gives these grades excellent toughness, even down to cryogenic temperatures.

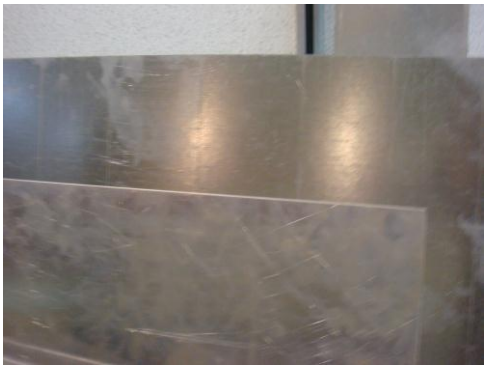

Figure 3.7: Sheet Plate

Figure 3.8: Hollow Steel

Figure 3.9: Wheel

3.10.3 Step By Step Process

The fabrication process was started with measuring the material into the required dimension. 4 X 1 inch X 3.15 inch hollow steel was the first material that measured. A total of two plates of 870mm X 570mm X 1.2mm Stainless Steel plate was the next that will be measured. All the measuring and marking process is done by using steel ruler, measuring tape, and steel marker.

Then, after several quantities of material had been marked, the next step is to cut the material into its desired length. This process is done using the shearing machine, floor cutter disc and vertical saw. This process also includes bending method. The upper and lower tray needs to be bending to avoid from falling objects while objects is on the trolley. Before proceeding with this process, safety measurement had been carried out by wearing Personal Protective Equipment (PPE) such as goggle, gloves and ear plug. These safety measurements are so important in order to prevent the projectile spatter from the process. During this process, I'm using the L-shape in order to make sure the dimension of the material length is correct and precise.

All the material that had been cut is grinded to give smooth surface on the edge to make sure that joining process can be done precisely. Then all the material was arranged into joining position. Next is the joining process.

The joining process was carried out by using the Gas Metal Arc Welding or formerly known as MIG (Metal Inert Gas). First, the welding machine is set up to make sure that the output of the process will satisfy. Face shield, apron, goggle and others PPE equipment are not to be forget. Then, all the materials were weld together. During this process, a minor movement of the materials will give bad effect to the joint and to the framework. It is because the hollow tube will expand and twist a little due to the temperature changes.

After finished welding, the entire welded places were then grinded to make sure that the entire joint surface was smooth from any spatters or sharp edge. During

the process, the careless of wearing an ear plug will cause high risky damage to ears. Hand gloves and goggles are also need to give attention.

Then, several locations were drilled to make holes for bolts and nuts for the support bar. Hand drill was used during the process because all the hollow tube had been weld together. It is also one of the ways to make sure that all the joint are joint together perfectly before drilling any holes because any mistake of drilling will cause the material to damage.

After all the process had been done, come the last part that is tightening the bolt and nut of the wheels.

3.10.4 Fabrication Process

Figure 3.10: Cutting sheet plate using shearing machine

Figure 3.11: Bending process

Figure 3.12: Cutting sheet plate for more shape using vertical saw

Figure 3.13: Drilling process

Figure 3.14: Welding process using MIG welding

Figure 3.15: Finishing step using grinder

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

The final fabrication of the trolley is done from only limited times due to several problems occur to the project. In this chapter will discuss mainly about the problems encountered during the whole project was been carried out.

4.2 PROJECT PROBLEMS

4.2.1 **Literature Review**: The concept and ideas review for this project are not very wide because it is not widely modified by the manufacturer. Students should come with their ideas on the project.

4.2.2 **Designing & Sketching**: Because of the idea were from the student directly, so there are no references that can be referred. All the drawing and dimension need to generate by student itself.

4.2.3 **Fabrication Process**: Students need to be given more time to finish fabricating their product because of slackness of skill and training, the joining finishing was not so god but yet can still reliable.

4.2.4 **Material Preparation**: Some of the needed material needs to buy at the city. University should prepare the material or either provides the place where the material can be obtained from.

4.2.5 **Budget Preparation**: It is not so effective to use student's money to get the materials. University should provide budget at first stage so that student's expenses are not interfere.

4.3 PROBLEM DURING FABRICATION PROCESS

4.3.1 Material (Stainless Steel)

Problem during this stage is very critical that make the project schedule is delayed. The problem comes when the material buying handle by supervisor is undergoing strict procedure and the budget for the project is in unknown situation. Because of this problem the fabrication process cannot be run according to schedule. This is because, no material needed is ready to fabricate.

4.3.2 Welding Process

During welding process some problem has occurs. Using the MIG welding we need to set a suitable voltage. If the voltages to high, the material like stainless steel will be melting. It occurs to my project.

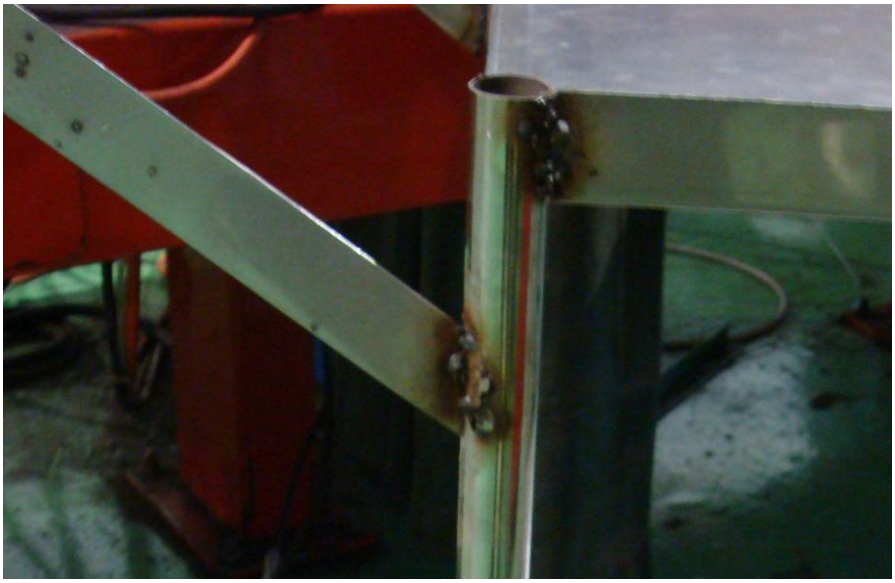

Figure 4.1: The result of the high voltage

4.3.3 Bending Process

During bending process the problem is about the spring back. It occurs not only in flat sheets and plates, but also in solid or hollow bars and tubes.

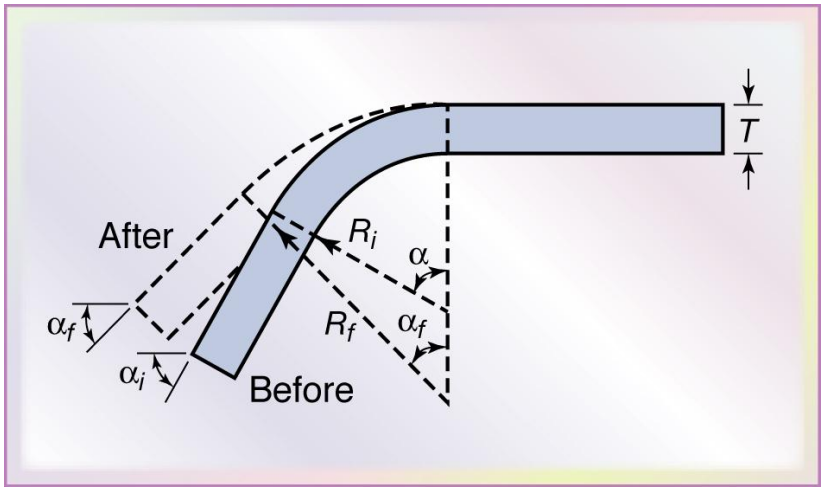

Figure 4.2: Spring back in bending

The part tends to recover elastically after bending, and its bend radius becomes larger. Under certain conditions, it is possible for the final bend angle to be smaller than the original angle (negative spring back). So for my sheet plate, the angle that I had used is 95° to get the 90° bending shape. [7]

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

For the final chapter it represent about conclusion and recommendation for the project. In this chapter will discuss mainly about the conclusion of the project, concluding all the process that involved. Besides that this chapter also contains recommendation about the project. So for this recommendation it can make improvement about the project in the future.

5.2 CONCLUSION

As a conclusion I think my project had been practice me before start the practical. It is because I had learned a lot of skills and method of using several of machines. I also had using internet to search a lot of things that connect with my project. Based on this literature review, I had found many types of trolley and with different design. Beside that, I also can gain my knowledge about the material type, structure and others else. Within a short time to finish the project, there are a lot of problems quickly because there is no enough time if I delay to settle it.

This project also generates my capabilities as a responsibility person. This is because I had to take care and take a look for my project. Beside that, I also had made a private meeting with my supervisor for a discussion about my progress of work and the progress of report. So by the time I also can make some improvement and learn how to share others opinion and idea to make my product better.

Finally for the last, I can conclude that final year project is very important because it can make our self more discipline and be punctually on time in whatever work I do. I also have achieved my objective and a scope of project about design and fabricate a trolley using my idea.

5.3 RECOMMENDATION

5.3.1 Facilities

Based on the progress of the project that I had done, so many things in facilities aspects can be improved especially in welding process. It is because the MIG welding machine doesn't have enough quantity for the student user. So the faculty especially must provide more welding machine for the student user because amount of student is increase by a year.

5.3.2 Student Budget

Some of the materials also need the student to buy such the things that doesn't have in mechanical laboratory. For the budget, the faculty should provide the budget to student at first. Precise planning of the work progress will make sure that the project can be done in a shorter time. Having a good time management can guaranty that any of student task to complete in a good ways and also give more time to focus on others subject.

5.4 FUTURE WORK

The final year project is a most important subject that must be learns in the final semester. It is because this project can make the student practice their skill of machining process since semester one. Its include using welding machine, shearing machine, bending machine, drilling machine, CAD software, Solidwork software and others else. So for my trolley project, I think a lot of things can be improved in the future. The improvement could be in the characteristics and functioning of the

existed trolley. Besides that, the financial is very important to develop this trolley sophisticated and could be produce to the market in the future.

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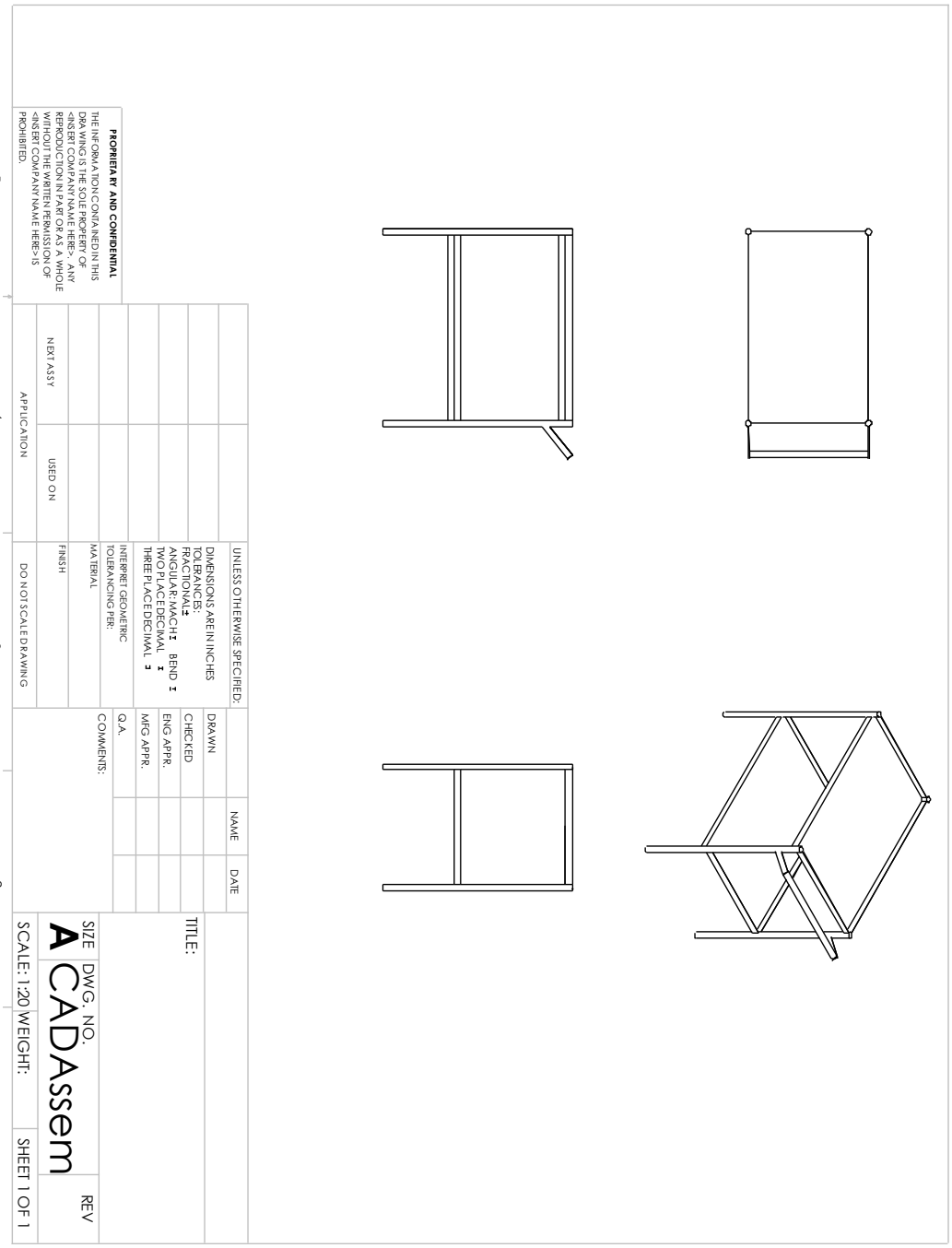
APPENDICES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TYPICAL YIELD STRENGTH

Material	Yield strength (MPa)	Ultimate strength (MPa)	Density (g/cm^3)
Structural steel ASTM A36 steel	250	400	7.8
Steel, API 5L X65 (Fikret Mert Veral)	448	531	7.8
Steel, high strength alloy ASTM A514	690	760	7.8
Steel, prestressing strands	1650	1860	7.8
Steel Wire			7.8
Steel (AISI 1060 0.6% carbon) Piano wire	2200-2482 MPa		7.8
Stainless steel AISI 302 - Cold-rolled	520	860	
Cast iron 4.5% C, ASTM A-48	276 (??)	200	
Titanium alloy (6% Al, 4% V)	830	900	4.51
Aluminium alloy 2014-T6	400	455	2.7
Copper 99.9% Cu	70	220	8.92
Cupronickel 10% Ni, 1.6% Fe, 1% Mn, balance Cu	130	350	8.94
Brass	approx. 200+	550	5.3
Tungsten		1510	19.25
Glass		50 (in compression)	2.53
E-Glass	N/A	3450	2.57
S-Glass	N/A	4710	2.48

Basalt fiber	N/A	4840	2.7
Marble	N/A	15	
Concrete	N/A	3	
Carbon Fiber	N/A	5650	1.75
Spider silk	1150 (??)	1200	
Silkworm silk	500		
Aramid (Kevlar or Twaron)	3620		1.44
UHMWPE	23	46	0.97
UHMWPE fibers (Dyneema or Spectra)		2300-3500	0.97
Vectran		2850-3340	
Pine Wood (parallel to grain)		40	
Bone (limb)	104-121	130	
Nylon, type 6/6	45	75	
Rubber	-	15	
Boron	N/A	3100	2.46
Silicon, monocrystalline (m-Si)	N/A	7000	2.33
Silicon carbide (SiC)	N/A	3440	
Sapphire (Al_2O_3)	N/A	1900	3.9-4.1
Carbon nanotube (see note above)	N/A	62000	1.34