AN INTEGRATED TYPE OF MIG TORCH CLEANER

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BORANG PENGESAHAN STATUS TESIS♦

JUDUL: **AN INTEGRATED TYPE OF MIG TORCH CLEANER**

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DEDICATION

To my beloved parents, Mr. Abdul Halim Bin Abdullah and Mrs. Che Rohana Binti Che Ab Rahman, family and friends, without whom and his/her lifetime efforts, my pursuit of higher education would not have been possible and I would not have had the chance to study for a manufacturing course. Also to my supervisor, Dr. Ahmad Razlan Bin Yusoff, because of the guidance without whose wise suggestions, helpful guidance and direct assistance, it could have neither got off the ground nor ever been completed.

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ABSTRACT

This thesis deals with the designing and development of MIG weld torch cleaner that efficient and effective clean in order to protect the torch from corroded during the cleaning process. The objectives of this thesis are to develop a torch cleaner that can clear and retards buildup of spatter in welding torch. The purpose for this study is to maintain quality in your MIG welding cell by removing spatter build-up in the nozzle. The scope of this project is that the validation of the torch cleaner through analysis software is considered precise. The design will justify the ergonomics principle and the finite element analysis was performed. The finite element model of design was analyzed using Static Stress with Linear Material Models. Three designs of torch cleaner were constructed. For the reamer blade, the analysis of strength of material is used in for the construction. For the each component of MIG torch cleaner, the analysis of different forces had been applied. The forces that being applied shown that the ability of the torch cleaner to support the force. The result shows that the design A has lower Stress von Misses than design B and design C. From the result, it is observed that the design is success and achieved to produce the special tool without using any power sources. An analysis of this product is achieved with comparing the three designs. The design A has meets all the criteria and specification that needed in this project. Lastly, the result of the testing and fabrication is overall succeeding in order to protect the torch from corroded during the cleaning process at the same time meets with the entire objective in this project.

ABSTRAK

Karya ini berkaitan dengan rekabentuk dan pembangunan pembersih obor kimpal MIG yang cekap dan berkesan yang bersih untuk melindungi obor tersebut dari berkarat semasa proses pembersihan. Objektif tesis ini adalah untuk membangunkan pembersih obor yang boleh membersihkan dan melambatkan pembentukan percikan api di obor kimpalan.Tujuan kajian ini adalah untuk mengekalkan kualiti dalam sel kimpalan MIG dengan mengeluarkan hamburan yang membina di dalam muncung. Skop projek ini adalah bahawa pengesahan pembersih obor melalui perisian analisis dianggap sebagai jitu. Reka bentuk akan menjustifikasikan prinsip ergonomik dan analisis unsur yang terhingga telah dilakukan. Model elemen terhingga reka bentuk telah dianalisis dengan menggunakan Tekanan Statik dengan Model Bahan Linear. Tiga reka bentuk pembersih obor telah dibina. Bagi bilah alat untuk membesarkan lubang, analisis kekuatan bahan yang digunakan dalam pembinaan. Bagi setiap komponen pembersih obor MIG, analisis daya yang berbeza telah digunakan. Daya yang dipohon menunjukkan bahawa kebolehan pembersih obor untuk menyokong daya. Hasilnya menunjukkan bahawa reka bentuk A mempunyai Tekanan von mises yang lebih rendah daripada reka bentuk B dan reka bentuk C. Daripada keputusan kajian ini, didapati bahawa reka bentuk berjaya dan tercapai untuk menghasilkan alat khas tanpa menggunakan mana-mana sumber kuasa. Satu analisis produk ini dicapai dengan membandingkan tiga reka bentuk. Reka bentuk A mempunyai memenuhi semua kriteria dan spesifikasi yang diperlukan dalam projek ini. Akhir sekali, hasil ujian dan fabrikasi keseluruhan berjaya untuk melindungi obor tersebut dari berkarat semasa proses pembersihan pada masa yang sama menepati dengan objektif keseluruhan dalam projek ini.

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CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

This project is about to designing and development of MIG Weld Torch Cleaner. In the market place now there have many differences between this MIG Weld Torch Cleaner with current design and it also called torch cleaning station. In gas welding, it is not uncommon for small and minute pieces of metal, commonly called “spatter”, to collect within and about the outlet end of a welding torch through which oxygen and acetylene gas pass to the weld pool. In a conventional welding apparatus, the operator takes a hammer or the like and bang it against the welding torch nozzle of metal, in an effort to dislodge the material seriously affect the efficiency of the welding operations.

One attempt to overcome the above problem has been the application of a coating of liquid containing silicon to the inner surface of the welding nozzle. In other patent, a ball is arranged to strike the welding nozzle in response to a cam-operated mechanism activated by the movement of a welding wire continually fed to the nozzle. Yet another method of cleaning the welding nozzle is to ream its interior. This latter method has the disadvantage of scoring the inside of the nozzle, which scoring permits a more aggressive adhering of the spatter to the scored interior. Also, reaming frequently catches and destroys the welding wire in the torch during the cleaning cycle, causing unacceptable intervention in automatic welding operations.

These attempts do not lend themselves to contemporary welding apparatus which is carried and directed by computer-controlled robotic equipment. The primary object of this invention to provide an efficient and effective welding nozzle cleaning apparatus adapted for use with robotic controlled welding apparatus.

The MIG torch cleaner also known as torch cleaner station used to remove spatter from welding nozzle by reamer. There are many types that have been released in the market. Their purpose and function kindly the same and most of them used reamer blade concept as their way to remove spatter from the nozzle. Now days a current design and concept much advanced and there are also has troublesome method anyway. This invention relates to produce special tool to clean the weld torch nozzle. The design where has been choose should more flexible and effective in cleaning the torch nozzle from spatter. In the mean time, with anti spatter spray built-in it should be protect the torch from corroded during the cleaning process.

1.2 PROBLEM STATEMENT

This project is to avoid the spatter problems during welding operation. Currently, there are very few studies have been done for such a function. A MIG torch cleaner will be designed by adapting the ergonomics criteria. In doing this, some of the problems associated with the design are tackled. Other problems are not tackled in the duration of this project. Usually the issues that always been claims are:

- The product must be economic and efficient in manner.
- Must be effective mechanism.
- Periodic cleaning extends the life of MIG welding torches significantly while maintaining the best possible performance.
- The best ways to keep MIG welding torches spatter-free
- The looking of the torch cleaner and friendly user

1.3 PROJECT OBJECTIVES

This project is to practice student to figure out the problem in detail using application using research and absolutely improving student skill and knowledge. This project also could train student as well before facing a real situation about producing a special tool that effectively clean the torch at the same time protect the torch from corroded during the cleaning process. So, objective of this project are:

i. To analysis the torch cleaner for accept in work to maintain quality in MIG welding cell.
ii. To develop a torch cleaner that can clears and retards buildup of spatter in welding torch.
iii. To fabricate and test the torch cleaner design using CAD modeling.

1.4 PROJECT SCOPE

The project is about to design the mechanical part of the tool ands to fabricate the mechanism part of the system from the title that has been given. Besides that it is also need to apply all the knowledge and skill that require to makes it done. So it give us advantages to learn new process to produce this product and absolutely we could find lot of advantages neither realized or not. In order to achieve the main objective there are some guide that must be follow to successfully done the project:

i. Literature

   The literature is including doing the research about the MIG torch cleaner. The sources are the journal from sciencedirect, search from internet and also people around.

ii. Design concept

   The fabrication process will refer to the design concept that has been produce with their dimensions and criteria.

iii. Detail drawing

Detail drawing was developed from the final concept. The project feature will be more easy to understand and also used for the next steps of the project.

iv. Fabricate

Fabrication is one of the most important parts in this project. The fabrication will only achieve when the analysis, material, and detail drawing had been finished. The fabrication process also includes the welding process, fastening, machinery and many more. While doing this part, all the knowledge and skills will be applied.

v. Report

The report will submit to the lecturer after all the information and all the work have done. The report consist all the work that have been done through the semester. The presentation slide also must been done while making the report. So that at the end of the project the presentation will take placed.

1.5 PROJECT SCHEDULE

This Final Year Project will be arranged through this semester from week 1 until week 14. The planning process is to make sure the project run smooth and finished before the due date. Besides that, these also use to manage the objective and solve the task without having problems of time. Candidate can teach their self to arrange between Final Year Project and other subject. In the industries, time management is important. If these kinds of skill do not been look over, it may give a big trouble to us in the future. Furthermore, the planning through this semester is shown by the table 1.1 in appendix A.

1.6 PROJECT FLOW CHART

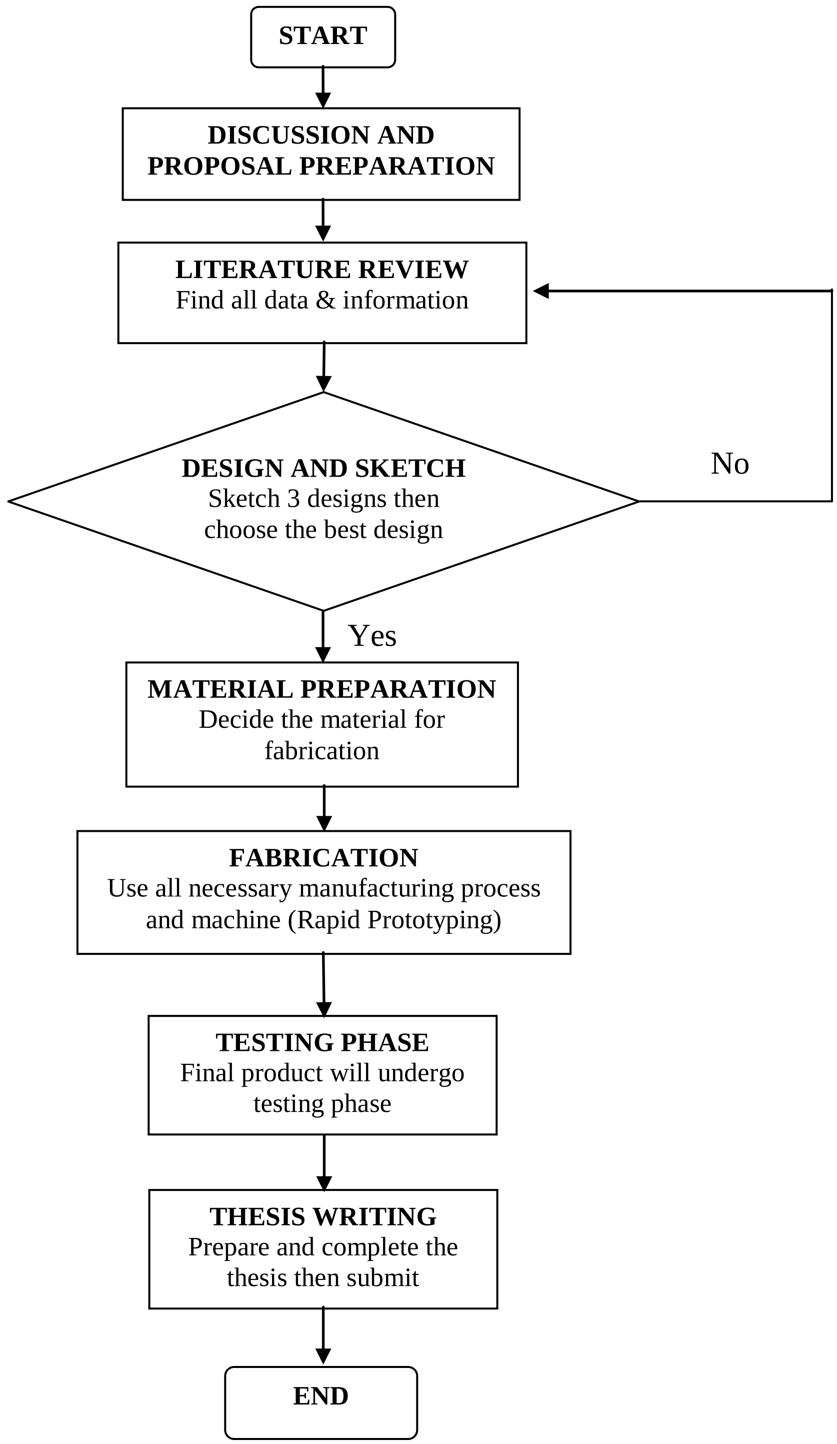


Figure 1.1: Project Flow Chart

From the flow diagram on figure 1.1, this final year project started by discussion about the project title with supervisor after got it from project coordinator. This discussion shall cover about project overview and throw out an opinion that related with title of the project. Supervisor instructs to propose a certain design and concept before proceed to the next step. Then draft proposal is needed to prepare.

After that the literature review of the project is the most important in this section is to define the project scope, project objective and project planning. It is easily get a clear overview about the project expected. The information related to the project through a many sources such as from internet, journal and others are obtained. All information related to the project, will proceed to the next step which is design process. In this step, use all the knowledge and brilliant idea then come out with the draft sketching. The sketch should be come out at least 3 designs. The best design will be chosen then transfer to the engineering drawing by using CATIA software in order to improve product capability and effectiveness.

Then the processes continue with material preparation which is to determine the suitable material for the product. The material choosing should be considered on material type, suit to the product usage environment. This stage also covering on purchasing material, measuring material and fabrication method based on product requirement. This is important because the material is one of the factor whether our product in way to failure or otherwise.

After it done the product drawing and material was prepared and the next step is the fabrication process. This process will be conduct in laboratory. The dimension and scale of the product has been determined from the drawing. All the manufacturing process machines will be used which is suitable to the product requirement such as Rapid Prototyping (RP). Lastly, after it done all the process on flow chart above without any problem, all the data and information will be gathered in order to prepare for thesis writing purpose. The thesis should cover all manners from week 2 to the end. These stages also include a final presentation for the project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter contains a review of information about the issues related to this project. The definition of design process, ratchet mechanism, torch cleaner, mathematical modeling and other selected terms will also included in this chapter. All of the information is gathered from books, journals, articles and websites. This literature review not only attempts to collect and categorize previous researches, but also attempted to analyze and evaluate previous works leading to this project's framework. (Jones, J.C, 1996)

2.2 Engineering Design Process

The basic five-step process usually used in a problem-solving works for design problems as well since design problems are usually defined more vaguely and have a multitude of correct answers, the process may require backtracking and iteration. Solving a design problem is a contingent process and the solution is subject to unforeseen complications and changes as it develops. The five steps used for solving design problems are:

i. Define the problem
ii. Gather pertinent information
iii. Generate multiple solutions
iv. Analyze and select a solution
v. Test and implement the solution

The first step in the design process is the problem definition. This definition usually contains a listing of the product or customer requirements and specially information about product functions and features among other things. In the next step, relevant information for the design of the product and its functional specifications is obtained. A survey regarding the availability of similar products in the market should be performed at this stage. Once the details of the design are clearly identified, the design team with inputs from test, manufacturing, and marketing teams generates multiple alternatives to achieve the goals and the requirements of the design. Considering cost, safety, and other criteria for selection, the more promising alternatives are selected for further analysis. Detail design and analysis step enables a complete study of the solutions and result in identification of the final design that best fits the product requirements. Following this step, a prototype of the design is constructed and functional tests are performed to verify and possibly modify the design. When solving a design problem, you may find at any point in the process that you need to go back to a previous step. The solution will chose may prove unworkable for any number of reasons and may require redefining the problem, collecting more information, or generating different solutions. This continuous iterative process is represented in the following Figure. The idea generation activities are usually organized based on Figure 2.1. (Jones, J.C, 1996)

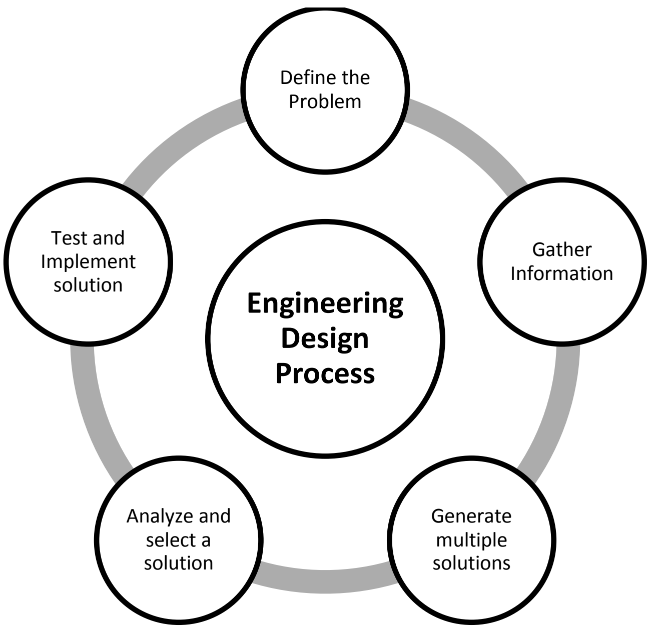


Figure2.1: Engineering Design Process

2.2.1 Define the problem

It is needed to begin the solution to a design problem with a clear, unambiguous definition of the problem. Unlike an analysis problem, a design problem often begins as a vague, abstract idea in the mind of the designer. Creating a clear definition of a design problem is more difficult than, defining an analysis problem. The definition of a design problem may evolve through a series of steps or processes as it develop a more complete understanding of the problem. (Jones, J.C, 1996)

2.2.2 Gather Information

Before it can go further in the design process, it needs to collect all the information available that relates to the problem. Novice designers will quickly skip over this step and proceed to the generation of alternative solutions. However, that effort spent searching for information about the problem will pay big dividends later in the design process. Gathering pertinent information can reveal facts about the problem that result in a redefinition of the problem. It may discover mistakes and false starts made by other designers. Information gathering for most design problems begins with asking the following questions. If the problem addresses a need that is new, then there are no existing solutions to the problems, so obviously some of the questions would not be asked. For example, are the problem real and its statement accurate or not. (Jones, J.C, 1996)

2.2.3 Generate Multiples solution

The next step in the design process begins with creativity in generating new ideas that may solve the problem. Creativity is much more than just a systematic application of rules and theory to solve a technical problem. It starts with existing solutions to the problem and then tear them apart-find out what's wrong with those solutions and focus on how to improve their weaknesses. Consciously combine new ideas, tools, and methods to produce a totally unique solution to the problem. This process is called synthesis. Psychological research has found no correlation between intelligence and creativity. People are creative because they make a conscious effort to think and act creatively. Everybody has the potential to be creative. Creativity begins with a decision to take risks. It can improve your creative ability by choosing to develop these characteristics in yourself. Solutions to engineering design problems do not magically appear. Ideas are generated when people are free to take risks and make mistakes. Brainstorming at this stage is often a team effort in which people from different disciplines are involved in generating multiple solutions to the problem. (Jones, J.C, 1996)

2.2.4 Analyze and Select a Solution

Once it conceived alternative solutions to the design problem, it needs to analyze those solutions and then decide which solution is best suited for implementation. Analysis is the evaluation of the proposed designs. It applies the technical knowledge to the proposed solutions and uses the results to decide which solution to carry out. It will cover design analysis in more depth when it gets into upper-level engineering courses. At this step in the design process, it must consider the results of your design analysis. This is a highly subjective step and should be made by a group of experienced people. This section introduces a systematic methodology it can use to evaluate alternative designs and assist in making a decision. Before deciding which design solution to implement, you need to analyze each alternative solution against the selection criteria defined in step l. It should perform several types of analysis on each design. Every design problem is unique and requires different types of analysis. The following is a list of analysis that may need to be considered; bear in mind that the importance of each varies depending on the nature of the problem and the solution. (Jones, J.C, 1996)

- Functional analysis
- Industrial design/Ergonomics
- Mechanical/Strength analysis
- Electrical/Electromagnetic
- Manufacturability/Testability
- Product safety and liability
- Economic and market analysis
- Regulatory and Compliance

2.2.5 Test and Implement the Solution

The final phase of the design process is implementation, which refers to the testing, construction, and manufacturing of the solution to the design problem. It must consider several methods of implementation, such as prototyping and concurrent engineering, as well as distinct activities that occur during implementation, such as documenting the design solution and applying for patents. (Jones, J.C, 1996)

2.3 The Ratchet Mechanism

A ratchet mechanism for tools includes a ring member having first bevel teeth and second bevel teeth respectively defined in an outer periphery of the ring member. The first bevel teeth and the second bevel teeth are separated by an annular groove defined in the outer periphery of the ring member. Two pawl members are connected by a spring and each pawl member has third bevel teeth and fourth bevel teeth so as to respectively engage with the first bevel teeth and the second bevel teeth. (Cannon, J.R. 2005)

2.3.1 Design Principle

A ratchet is a device that makes adjusting easier or clutching more efficient. In hand tools, a ratchet facilitates tightening or loosening. As a machinery component, a ratchet can be used in a variety of operations, often re-placing less effective knobs and hand wheels, and is especially useful for controls that are hard to reach. In clutching applications under 1,000 rpm, ratchets develop little overrunning or frictional torque and consume minimal power. Ratchets make a good choice for both automated and manual operations. The key elements in all ratchet designs are the toothed wheel and pawl. Together, they control intermittent motion in one direction of rotation. Ratchets have one or more pawls that are usually spring-loaded to ensure positive contact with the wheel teeth. A ratchet’s rotation direction can be reversed with a cam-type shifter positioned between the pawls. When using dual shifters and pawls, both pawls can be engaged simultaneously to lock the wheel in place, or both can be disengaged to allow free-running in either direction. All of the above components are enclosed in Lowell ratchet arms, ratchet clutches, and socket wrenches. On all our ratchet arms and socket wrenches, Lowell's unique Bolt-Thru feature allows bolts to pass entirely through the socket or ratchet so that nuts can be secured on any threaded length. Although Lowell offers many stock ratchet designs, we can easily custom-configure a ratchet to meet special needs. Our design team will be happy to show you how well Lowell ratchet technology can work in this application. (Cannon, J.R. 2005)

2.3.2 Theory of Operation

A ratchet consists of a round gear (see Figure 2.2) or linear rack with teeth, and a pivoting, spring-loaded finger called a pawl that engages the teeth. The teeth are uniform but asymmetrical, with each tooth having a moderate slope on one edge and a much steeper slope on the other edge. When the teeth are moving in the unrestricted (i.e., forward) direction, the pawl easily slides up and over the gently sloped edges of the teeth, with a spring forcing it into the depression between the teeth as it passes the tip of each tooth. When the teeth move in the opposite (backward) direction, however, the pawl will catch against the steeply sloped edge of the first tooth it encounters, thereby locking it against the tooth and preventing any further motion in that direction. (Cannon, J.R. 2005)

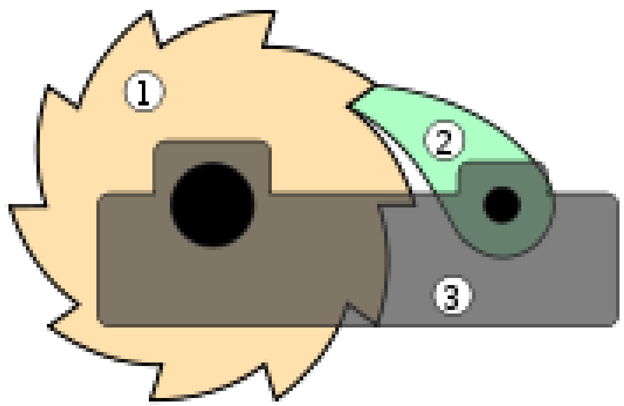


Figure 2.2: A ratchet featuring gear (1) and pawl (2) mounted on base (3) (Cannon, J.R. 2005)

2.3.3 Backlash

Because the ratchet can only stop backward motion at discrete points (i.e., at tooth boundaries), a ratchet does allow a limited amount of backward motion. This backward motion—which is limited to a maximum distance equal to the spacing between the teeth—is called backlash. In cases where backlash must be minimized, a smooth, toothless ratchet with a high friction surface such as rubber is sometimes used. The pawl bears against the surface at an angle so that any backward motion will cause the pawl to jam against the surface and thus prevent any further backward motion. Since the backward travel distance is primarily a function of the compressibility of the high friction surface, this mechanism can result in significantly reduced backlash. (Cannon, J.R. 2005)

2.3.4 Mathematical Model of the Ratchet

The design requirements of a pastry slicer are as follows. First, the pastry thickness scope is 10~20 (mm). Second, the pastry high scope is 5~80(mm).Third, The pastry width is 300(mm).The pastry width is 300(mm). The feeding mechanism was designed by using SolidWorks according to these requests. Ratchet mechanism and belt drive mechanism were used as the machine feeding mechanism of pastry slicer in order to alter the pastry thickness. According to the design requirements, the pastry thickness is 10~20(mm), according to (1):

$$\mathbf{L = R \times \phi \times \pi / 180o} \qquad \textbf{(1)}$$

Where L is the arc length, in m; R is the ratchet radius,in m;ϕ is the circumferential angle, in degree. According to the design requirements, the maximum pastry thickness is 20mm, let L = 20(mm) ,ϕ = 20o in Eq.(1), the ratchet radius(R) is equal to 180 /π (mm) o . According to Eq.(1), if R=180 /π (mm) o and ϕ = 5o , obviously, L is equal to 5(mm), therefore, the arc length that each turn of a ratchet tooth corresponding to is 5(mm), as a result, if pastry thickness is 10(mm), ratchet will turn 2 teeth, if pastry thickness is 15(mm), ratchet will turn 3 teeth, and if pastry thickness is 20(mm), ratchet will turn 4 teeth. The ratchet contour which is shown in Figure 2.3 is obtained according to the above calculated data.

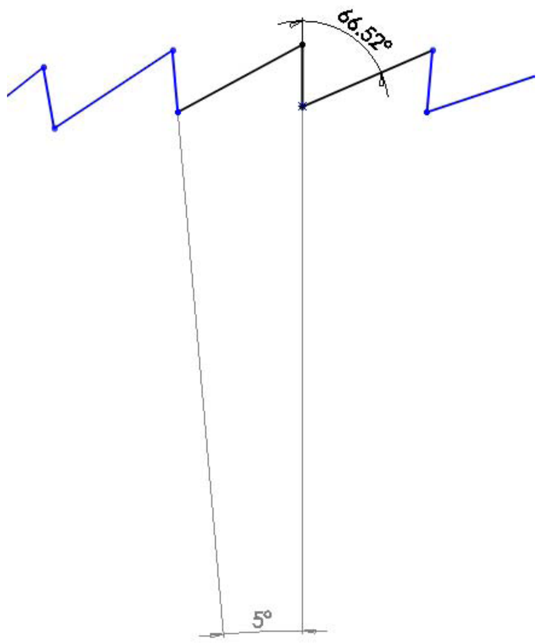


Figure 2.3: Ratchet contour sketches

(Cannon, J.R. 2005)

2.4 Welding Nozzles Cleaning Apparatus

Torch cleaning apparatus offers the complete solution for reliable automatic servicing of the Robotic torch neck combined in a single station. Automatic Robotic Nozzle Cleaning Stations are designed to maintain quality and productivity in your Robotic MIG welding cell by removing spatter build-up in the gas nozzle. Long life reamers along with powerful pneumatic motor provide fast and efficient cleaning. Adjustable feed rate provides optimal cleaning results. Adjustable V-Block allows for all nozzle sizes. Built up welding spatter is quickly and easily removed from welding nozzles and contact tips of Robotic Mig welding guns. Compact systems replaces older, more expensive, less efficient systems and are programmer friendly. Only 1 move of the welding torch and a 24v signal are required for full torch servicing. The figure 2.4 below has shown the complete torch cleaning station.

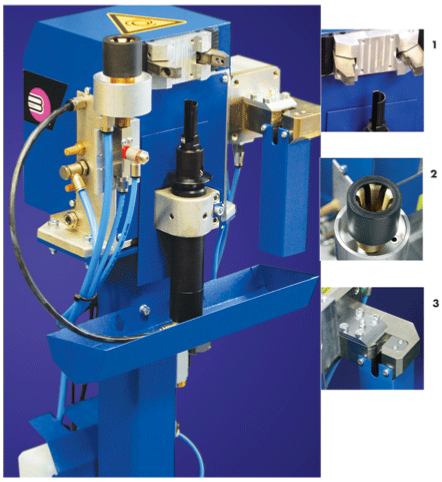


Figure 2.4: Torch Cleaning Station
(Seo DW, 2004)

2.4.1 Mechanical configuration is important

The unit provides accurate, three point, secure clamping of the welding torch so that the pneumatically operated reamer can access the welding nozzle for optimum cleaning performance with no vibration or reaction forces transmitted to the robot. The torch is locked into the exact position every time for precise cleaning and less wear on the parts cleaned. The V-block can be matched to the specific external diameter of the gas nozzle and is available in sizes from 15 to 30 mm diameters. The reamer is offered in assorted sizes to fit the specific gas nozzle inside diameter and a bushing helps set the torch height for reaching the proper insertion depth.

2.4.2 Spatter is a torch problem

It is impossible to avoid spatter during welding operations. Hot particles from the arc easily adhere into the gas nozzle. The problem is familiar to all welders – a gradual build up of spatter in the nozzle leading to blocked wire feed and absence of shielding gas or short circuiting make the torch useless. Even relatively small amounts of spatter in the gas nozzle affects the operation, giving poor starting and low quality weld as a result. But what is a nuisance to welders becomes a potentially serious problem to welding robots. The Torch Service Centre is an integrated system for mechanically removing spatter from welding torches. The robot control system operates and supervises the cleaning operation to make sure that it will not start until the torch is clamped in the correct position. This ensures that no vibration or shocks reach the robot and the torch is locked in the same position every time for more precise cleaning and less wear on the parts cleaned. The entire cleaning operation is automatic in one sequence, including mechanically cleaning, pneumatic cleaning and finally oil injection into the gas nozzle.

2.4.3 Nozzle Reamer Blade

Reamer Blade Selection - Select the Nozzle Reamer Blade for your application according to the dimensions of the Contact Tip and Nozzle used. To assure proper fit and operation the Outer Diamater of the Reamer Blade (d) in figure 2.5 should be 1mm Smaller than the Inner Diamater of the Gas Shield Nozzle (D). The Inner Diamater of the Reamer Blade (d1) should be 1mm Larger than the Outer Diamater of the Contact Tip (D1).

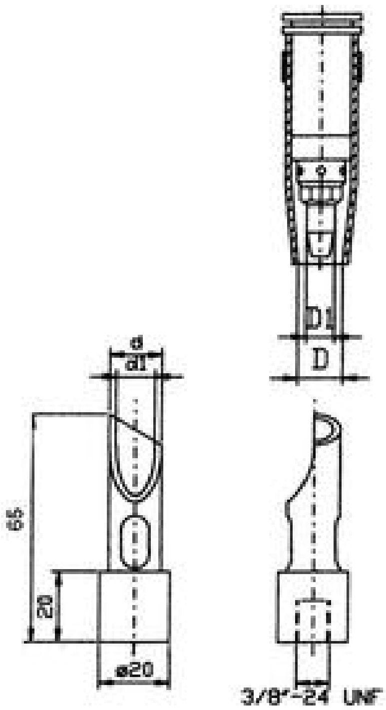


Figure 2.5: Standard One reamer blade

(Seo DW, 2004)

2.5 MIG welding (gas metal arc welding)

In gas shielded arc welding both the arc and the molten weld pool are shielded from the atmosphere by a stream of gas. The arc may be produced between a continuously fed wire and the work. This is known as metal inert gas (MIG) welding. The arc may also be produced between non-consumable tungsten electrode and the work piece. This process is known as tungsten inert gas (TIG) welding. In TIG welding extra metal must be supplied separately to fill the joint. For TIG welding the shielding gas is usually argon or helium, but for MIG welding the inert gases can have additions of either oxygen or carbon-di-oxide depending on the metal being welded. Carbon steels can be welded with carbon-di-oxide alone as shielding gas and the process is then called "CO2 welding". (Jenkins Neil T, 2005)

2.5.1 The principles of gas metal arc welding

Gas metal arc welding is a gas shielded process that can be effectively used in all positions. The shielding gas can be both inert gas like argon and active gases like argon-oxygen mixture and argon-carbon-di-oxide which are chemically reactive. It can be used on nearly all metals including carbon steel, stainless steel, alloy steel and aluminium. Arc travel speed is typically 30-38 cm/minute and weld metal deposition rate varies from 1.25 kg/hr when welding out of position to 5.5 kg/hr in flat position. MIG welding is a well established semi-automatic process. Continuous welding with coiled wire helps high metal depositions rate and high welding speed. MIG gives less distortion and there is no slag removal and its associated difficulties like interference with accurate jigging. Because of the good heat input control, MIG can be used for non-ferrous welding with good results. However, since the torch has to be very near to the job, there is a constraint where accessability is limited. Spatter is high and so deposition efficiency is less. Absence of slag in solid wire welding processes allows a higher cooling rate of the weld zone and hence joints made with the process on hardenable steels are susceptible to weld metal cracking. The filler wire is generally connected to the positive polarity of DC source forming one of the electrodes. The work piece is connected to the negative polarity. The power source could be constant voltage DC power source, with electrode positive and it yields a stable arc and smooth metal transfer with least spatter for the entire current range. AC power source gives the problem of erratic arc. So is DC power source also with electrode negative. Power sources are rated at 60 per cent duty cycle for semi-automatic and at 100 per cent duty cycle for automatic continuous operation with maximum amperage of 600 amps and 1000 to 2000 amps respectively. AC constant voltage power source, pulsed current constant voltage power source or pulsed current power source with voltage feedback controlled wire system are also in practice. Among these, constant voltage power source is generally used. With a constant voltage power source, the welding current increases when the electrode feeding rate is increased and decreases as the electrode speed is decreased, other factors remaining constant. When the current value is increased the melting rate of the electrode will also increase. The figure 2.6 below has shown basic MIG welding process. (Jenkins Neil T, 2005)

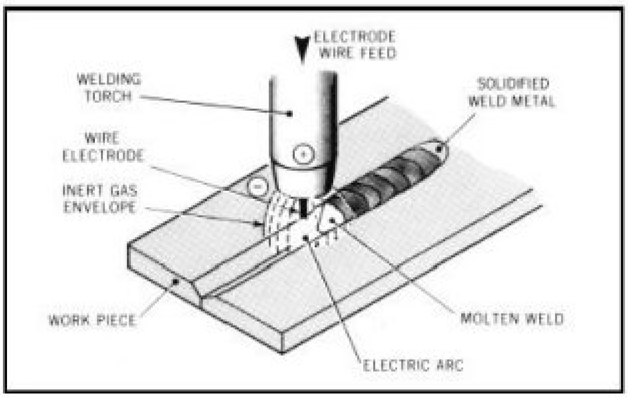


Figure 2.6: MIG Welding Process
(Kang SK, 2005)

2.5.2 Process Variations-Metal Transfer

The basic mig process includes three distinctive process techniques: short circuiting metal transfer, globular transfer, and spray arc. These techniques describe the manner in which metal is transferred from the wire to the weld pool. In short circuiting metal transfer, also known as ”Short Arc”, ”Dip Transfer”, and ”Microwire”, metal transfer occurs when an electrical short circuit is established. This occurs as the molten metal at the end of the wire touches the molten weld pool. In spray arc welding, small molten drops of metal are detached from the tip of the wire and projected by electromagnetic forces towards the weld pool. Globular transfer occurs when the drops of metal are quite large and move toward the weld pool under the influence of gravity. Factors that determine the manner of metal transfer are the welding current, wire size, arc length (voltage), power supply characteristics, and shielding gas. Figure 2.7 has shown the types of metal transfer. (Jenkins Neil T, 2005)

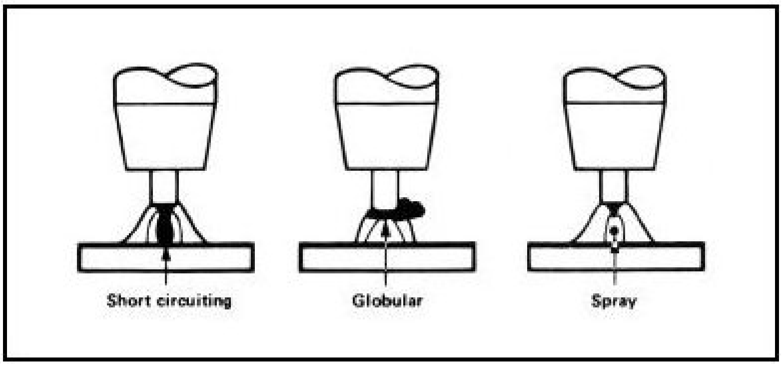


Figure 2.7: Types of Metal Transfer
(Kang SK, 2005)

2.5.3 Welding gun and wire feed unit

The typical GMAW welding gun has a number of key parts—a control switch, a contact tip, a power cable, a gas nozzle, an electrode conduit and liner, and a gas hose. The control switch, or trigger, when pressed by the operator, initiates the wire feed, electric power, and the shielding gas flow, causing an electric arc to be struck. The contact tip, normally made of copper and sometimes chemically treated to reduce spatter, is connected to the welding power source through the power cable and transmits the electrical energy to the electrode while directing it to the weld area. It must be firmly secured and properly sized, since it must allow the passage of the electrode while maintaining an electrical contact. Before arriving at the contact tip, the wire is protected and guided by the electrode conduit and liner, which help prevent buckling and maintain an uninterrupted wire feed. The gas nozzle is used to evenly direct the shielding gas into the welding zone—if the flow is inconsistent, it may not provide adequate protection of the weld area. Larger nozzles provide greater shielding gas flow, which is useful for high current welding operations, in which the size of the molten weld pool is increased. The gas is supplied to the nozzle through a gas hose, which is connected to the tanks of shielding gas. Sometimes, a water hose is also built into the welding gun, cooling the gun in high heat operations. The wire feed unit supplies the electrode to the work, driving it through the conduit and on to the contact tip. Most models provide the wire at a constant feed rate, but more advanced machines can vary the feed rate in response to the arc length and voltage. Some wire feeders can reach feed rates as high as 30.5 m/min (1200 in/min), but feed rates for semiautomatic GMAW typically range from 2 to 10 m/min (75–400 in/min). (Jenkins Neil T, 2005)

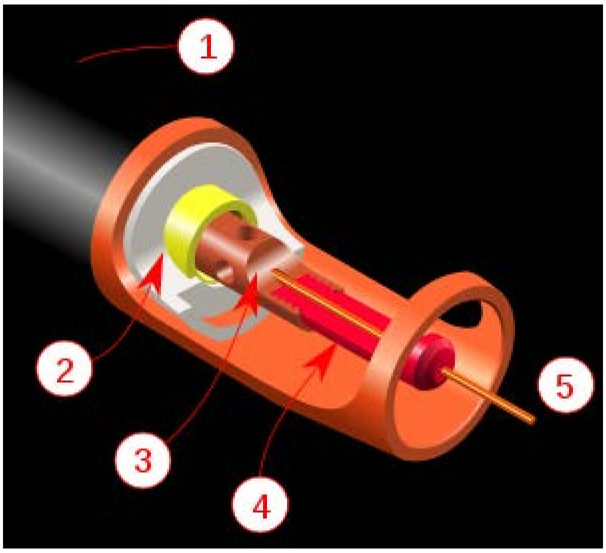


Figure 2.8: Welding Torches

(Kang SK, 2005)

2.5.4 Welding Nozzle

A welding nozzle plays a very specific roll in the welding process.The main function of the welding nozzle is to control and direct the flow of the welding gases. It is important to keep the nozzle clear from welding spatter. Because any restriction to the gas flow will hinder the welding torches performance. A build up of spatter on the inside of the welding nozzle will create turbulence in the gas flow. This turbulence will make the gas flow coming out of the nozzle uncontrolable. Resulting in insufficent shielding gas around the welding arc. Which means a less that perfect weld. Nozzles and shrouds are a welding consumable that become useless over time. Often the ones that have the white ceramic insulation material inside them such as the Beranrd mig guns (WIA welding machines) will end up leaking air, and falling off. They need this air tight seal around the contac tip holder so that as the welding gas is flowing it does not suck in outside air like a venturi effect on a carburettor. (Jenkins Neil T, 2005)

Figure 2.9: Welding Nozzle
(Kang SK, 2005)

2.6 Finite Element Analysis

Finite Element Analysis (FEA) is a computer simulation technique used in engineering analysis. It uses a numerical technique called the finite element method (FEM). In this, the object or system is represented by a geometrically similar model consisting of multiple, linked, simplified representations of discrete regions — finite elements. Equations of equilibrium, in conjunction with applicable physical considerations such as compatibility and constitutive relations, are applied to each element, and a system of simultaneous equations is constructed. The system of equations is solved for unknown values using the techniques of linear algebra or nonlinear numerical schemes, as appropriate. (Cooper, K.G,2001)

FEA has become a solution to the task of predicting failure due to unknown stresses by showing problem areas in a material and allowing designers to see all of the theoretical stresses within. This method of product design and testing is far superior to the manufacturing costs which would accrue if each sample was actually built and tested. The example of the von mises analysis has shown in figure 2.10.

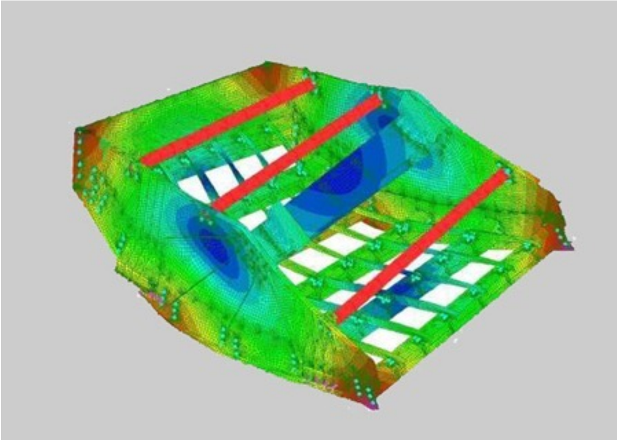


Figure 2.10: Von Mises Stress
(Cooper, K.G,2001)

There are generally two types of analysis: 2-D modeling, and 3-D modeling. While 2-D modeling conserves simplicity and allows the analysis to be run on a relatively normal computer, it tends to yield less accurate results. 3-D modeling produces more accurate results while it can only be run satisfactorily on a faster computer effectively. Within each of these modeling schemes, the programmer can insert numerous algorithms (functions) which may make the system behave linearly or non-linearly. Linear systems are far less complex and generally do not take into account plastic deformation. Non-linear systems do account for plastic deformation, and many also are capable of testing a material all the way to fracture. While being an approximate method, the accuracy of the FEA method can be improved by refining the mesh in the model using more elements and nodes, though this will retard the process of converging. (Cooper, K.G,2001)

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will cover the details explanation of methodology that is being used to make this project complete and working well. Many methodology or findings from this field mainly generated into journal for others to take advantages and improve as upcoming studies.

The method is use to achieve the objective of the project and accomplish a perfect result. In order to design and develop this project, the methodology based on Engineering Design Process. Generally five major step, which is define the problem, gather information, generate multiple solution, analyze and select a solution and finally is tested and implemented the solution.

All the methods used for finding and analyzing data regarding the project related. The project methodology will be based on the flow chart of the project. The flow steps by steps are show in figure 3.1.

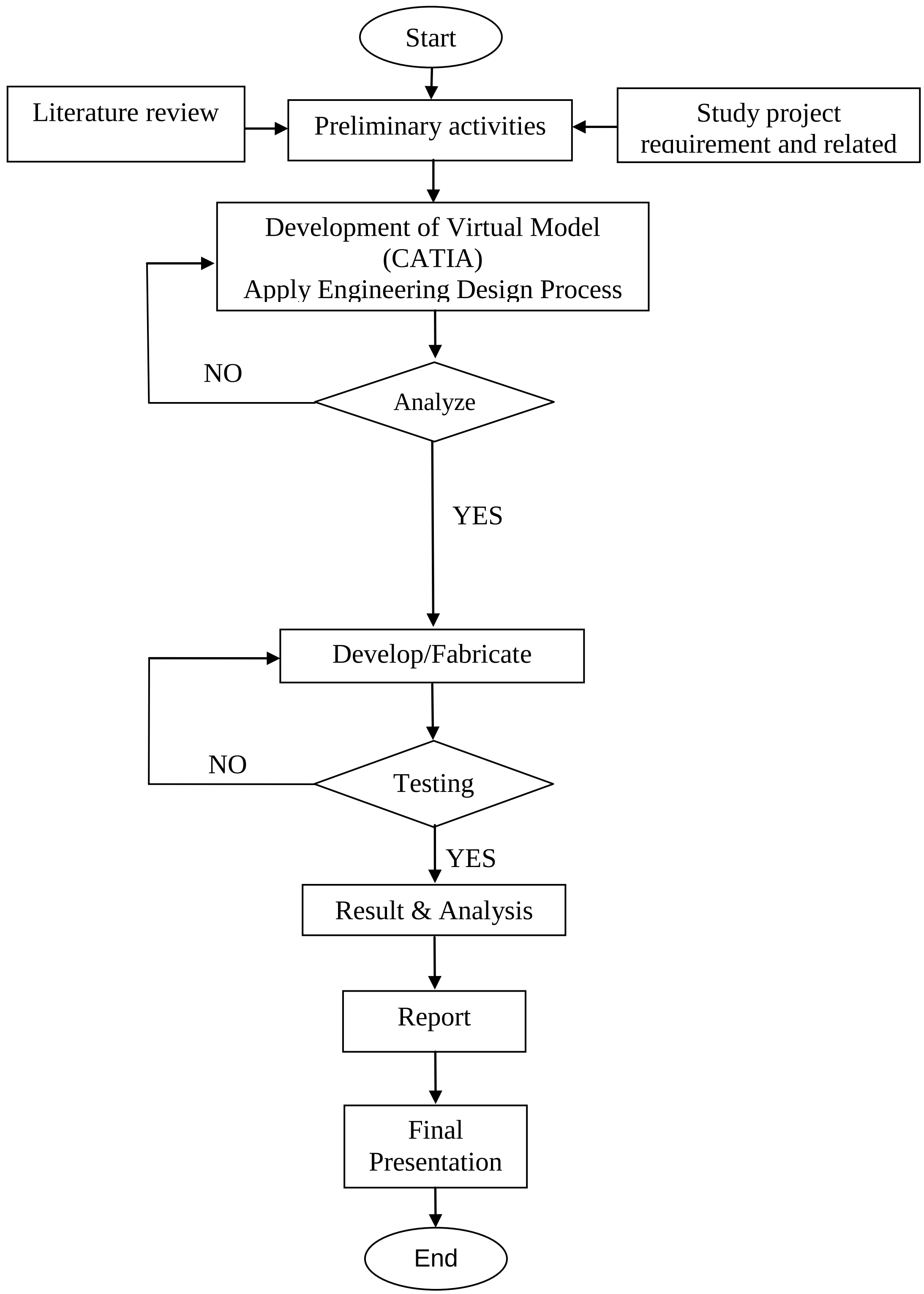


Figure3.1: Project flow

3.2 Preliminary Activities

Based on the project's title, the requirement of the project is to develop and design MIG weld torch cleaner to clean the nozzle from droplet form and at the same time it protect the nozzle from corroded during the cleaning process. The information and theoretical about the current torch cleaner, design process and mechanism is searched through internet and library. Besides that, to justify and initiate the study, student should conduct an extensive literature review of writing on standards development, theoretical frameworks and models appropriate to the project. In other word, with all information that related should produce an effective special tool which mean free energy source and flexible to used.

3.3 Development of Virtual Model approach Engineering Design Process

The basic five-step process usually used in a problem-solving works for design problems as well since design problems are usually defined more vaguely and have a multitude of correct answers, the process may require backtracking and iteration. Solving a design problem is a contingent process and the solution is subject to unforeseen complications and changes as it develops. The five steps used for solving design problems are define the problem, gather pertinent information, generate multiple solutions, analyze and select a solution and implement the solution. The first step in the design process is the problem definition. This definition usually contains a listing of the product or customer requirements and specially information about product functions and features among other things. In the next step, relevant information for the design of the product and its functional specifications is obtained. Once the details of the design are clearly identified, the design team with inputs from test, manufacturing, and marketing teams generates multiple alternatives to achieve the goals and the requirements of the design. Considering safety, and other criteria for selection, the more promising alternatives are selected for further analysis. Detail design and analysis step enables a complete study of the solutions and result in identification of the final design that best fits the product requirements. Following this step, a prototype of the design is constructed and functional tests are performed to verify and possibly modify the design. When solving a design problem, we may find at any point in the process that we need to go back to a previous step. The solution we chose may prove unworkable for any number of reasons and may require redefining the problem, collecting more information, or generating different solutions. The idea generation activities are usually organized based on Figure 2.1 in previous chapter 2.

3.3.1 State the problem in nozzle

In the first stage, we need to begin the solution to a design problem with a clear, unambiguous definition of the problem. Unlike an analysis problem, a design problem often begins as a vague, abstract idea in the mind of the designer. Creating a clear definition of a design problem is more difficult than, defining an analysis problem. The definition of a design problem may evolve through a series of steps or processes as we develop a more complete understanding of the problem. From the preliminary activities we come out several problems that find from the literature review.

The first step in the problem-solving process, therefore, is to formulate the problem in clear and unambiguous terms. Defining the problem is not the same as recognizing a need. The problem definition statement results from first identifying are a need. Once a need has been established, we define that need in terms of an engineering design problem statement. To reach a clear definition, we collect data, run experiments, and perform computations that allow that need to be expressed as part of an engineering problem-solving process. So there are two problems that I define in this project. First is a gradual build up of spatter in the nozzle leading to blocked wire feed and absence of shielding gas or short circuiting make the torch useless in figure 3.2.

Figure3.2: Droplet Form
(Rinaldi, E. 1979)

The second problem is shown in figure 3.3 where the nozzles have been corroded. Normally the inner of the nozzle have been corroded by the spatter built-up in the nozzle torch.

Figure3.3: Corrosion
(Rinaldi, E. 1979)

3.3.2 Collect Pertinent Information

Before we can go further in the design process, we need to collect all the information available that relates to the problem. Novice designers will quickly skip over this step and proceed to the generation of alternative solutions. However, that effort spent searching for information about the problem will pay big dividends later in the design process. Gathering pertinent information can reveal facts about the problem that result in a redefinition of the problem. We may discover mistakes and false starts made by other designers. There are several important information that it needs for this project.

Torch cleaning apparatus offers the complete solution for reliable automatic servicing of the Robotic torch neck combined in a single station. Automatic Robotic Nozzle Cleaning Stations are designed to maintain quality and productivity in your Robotic MIG welding cell by removing spatter build-up in the gas nozzle. Long life reamers along with powerful pneumatic motor provide fast and efficient cleaning. Adjustable feed rate provides optimal cleaning results. Adjustable V-Block allows for all nozzle sizes. Built up welding spatter is quickly and easily removed from welding nozzles and contact tips of Robotic Mig welding guns. Designed for use with all existing or new Robot Mig welding systems and all Robotic Mig welding guns. Compact systems replaces older, more expensive, less efficient systems and are programmer friendly. Only 1 move of the welding torch and a 24v signal are required for full torch servicing. No costly PC boards or Clamping devices to replace. Replace your worn out - tired - costly systems. The figure 3.4 below has shown the complete torch cleaning station.

Figure3.4: Torch Cleaning Apparatus

(Zucchi, F. 2001)

It is impossible to avoid spatter during welding operations. Hot particles from the arc easily adhere into the gas nozzle. The problem is familiar to all welders – a gradual build up of spatter in the nozzle leading to blocked wire feed and absence of shielding gas or short circuiting make the torch useless. Even relatively small amounts of spatter in the gas nozzle affects the operation, giving poor starting and low quality weld as a result. But what is a nuisance to welders becomes a potentially serious problem to welding robots. The Torch Service Centre is an integrated system for mechanically removing spatter from welding torches. The robot control system operates and supervises the cleaning operation to make sure that it will not start until the torch is clamped in the correct position. This ensures that no vibration or shocks reach the robot and the torch is locked in the same position every time for more precise cleaning and less wear on the parts cleaned. The entire cleaning operation is automatic in one sequence, including mechanically cleaning, pneumatic cleaning and finally oil injection into the gas nozzle.

A welding nozzle plays a very specific roll in the welding process. The main function of the welding nozzle is to control and direct the flow of the welding gases. It is important to keep the nozzle clear from welding spatter. Because any restriction to the gas flow will hinder the welding torches performance. A build up of spatter on the inside of the welding nozzle will create turbulence in the gas flow. This turbulence will make the gas flow coming out of the nozzle uncontrollable. Resulting in insufficient shielding gas around the welding arc which is means a less than perfect weld. Nozzles and shrouds are a welding consumable that become useless over time. Often the ones that have the white ceramic insulation material inside them such as the MIG guns (WIA welding machines) will end up leaking air, and falling off. They need this air tight seal around the contact tip holder so that as the welding gas is flowing it does not suck in outside air like a venturi effect on a carburetor.

Nozzle Reamer Blades for Nozzle Cleaning Stations is important in produce special tool for cleaning the mig nozzle. The selection of the Nozzle Reamer Blade for this application is according to the dimensions of the Contact Tip and Nozzle used. To assure proper fit and operation the Outer Diamater of the Reamer Blade (d) in figure 3.5 should be 1mm Smaller than the Inner Diamater of the Gas Shield Nozzle (D). The Inner Diamater of the Reamer Blade (d1) should be 1mm Larger than the Outer Diamater of the Contact Tip (D1). The design sketching of these tools has shown in appendix B.

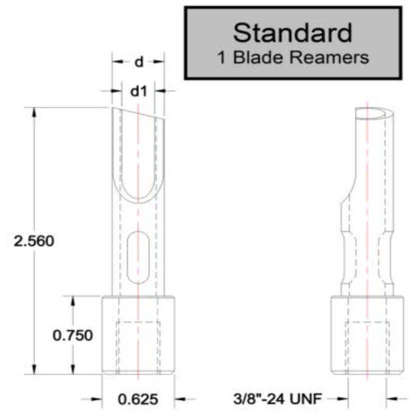


Figure3.5: Reamer Blade

(Zucchi, F. 2001)

3.3.3 State the Multiple Solutions

The next step in the design process begins with creativity in generating new ideas that may solve the problem. Creativity is much more than just a systematic application of rules and theory to solve a technical problem. We start with existing solutions to the problem and then tear them apart-find out what's wrong with those solutions and focus on how to improve their weaknesses. Consciously combine new ideas, tools, and methods to produce a totally unique solution to the problem. This process is called synthesis. There are several solution that we found to design this product.

The pawl ratchet is simple, versatile, inexpensive and reasonably accurate. It is used in all sizes, shapes and power capacities. The action of a ratchet can be either harsh or smooth depending on the configuration of teeth & pawls, accuracy of design and manufacture and the method used to drive the pawls. When a solenoid or spring is used as in the mechanism below the drive pawl strikes the ratchet wheel with an impact and the wheel will jump ahead if the load is sufficiently light. This is one of the principal drawbacks of the plain ratchet. A brake or detent, or careful attention to load will ensure accurate indexing. The unit shown below includes a second set of teeth which engage a projection on the pawl arm to prevent over travel. Most ratchets incorporate a device to prevent the drive pawl from pulling the ratchet wheel backwards when the pawl backs up to take another bite. In the figure 3.6 a holding pawl is used for this purpose. In some cases the load is sufficient to hold the wheel.

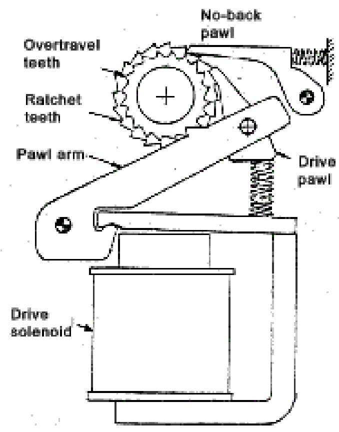


Figure3.6: Pawl Ratchet

(Howell, L.L., 2005)

The ratchet shown in figure 3.7 below uses flat springs as drive and holding pawls. With proper heat-treatment this type of drive will give long life under light loading. Indexing rates can be as high as several a second and the wheel can be indexed with accuracies of about one-tenth of a degree. Spring-blade ratchets are typically used to wind springs and drive printed-circuit commentators or timing cams.

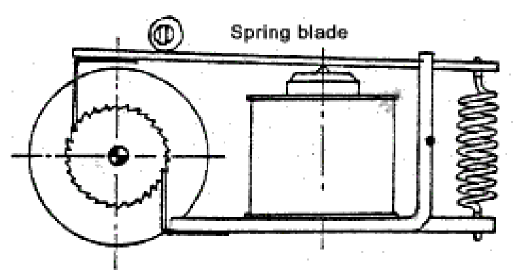


Figure3.7: Spring Blade Ratchet

(Howell, L.L., 2005)

In this type of ratchet as shown in figure 3.8 below the cam can be design so that the drive pawl has very little kinetic energy when it strikes the wheel: this reduces impact & over travel. The unit shown below illustrates another variation of cam input. The ratchet wheel is indexed in a clockwise direction for either clockwise or counterclockwise rotation of the input shaft. Although the ratchets shown are normally used in small counters, the same configuration can be used to drive loads of kW size. Permissible indexing rates depend on the design strength of the various parts.

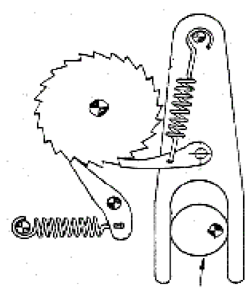


Figure3.8: Cam Driven Ratchet

(Howell, L.L., 2005)

In addition to the more common types of ratchets is pawl and toothed-wheel mechanisms other types of indexing drives can be classed as ratchets. The main feature is that an oscillating member works a one way clutch to index a wheel. One typical system is shown in figure 3.9 below. A reciprocating linkage drives the output shaft by means of a one-way spring clutch. Many other types of clutches can be used in a similar arrangement.

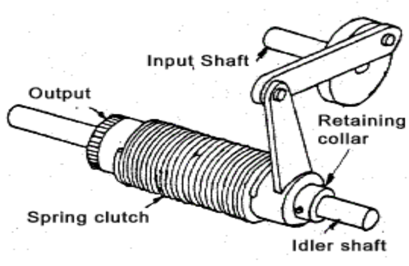


Figure3.9: Friction Ratchet

(Howell, L.L., 2005)

The figure3.10 below shows a fully magnetic ratchet. When the solenoid is energized the soft-arm pole piece fastens to a soft iron tooth on the wheel and indexes the wheel. When the solenoid is turned off, a compression spring raises the pole to meet the next tooth, whilst a permanent magnet holds the wheel. This method is useful for driving a wheel inside a hermetically sealed housing.

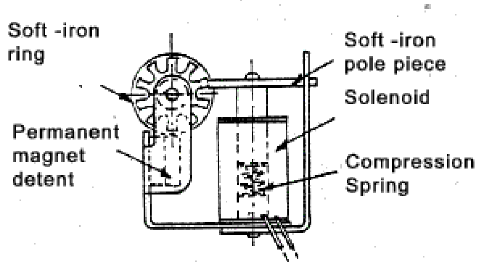


Figure3.10: Magnetic Ratchet
(Howell, L.L., 2005)

3.3.4 Analyzing the Idea and Design Solution

Before deciding which design solution to implement, it needs to analyze each alternative solution against the selection criteria defined. We should perform several types of analysis on each design. Every design problem is unique and requires different types of analysis. The following is a list of analysis that may need to be considered; bear in mind that the importance of each varies depending on the nature of the problem and the solution.

This part determines whether the given design solution will function the way it should. Functional analysis is fundamental to the evaluation and success of all designs. A design solution that does not function properly is a failure even if it meets all other criteria. A wheel provided with suitably shaped teeth, receiving an intermittent circular motion from an oscillating or reciprocating member, is called a ratchet wheel. In this project, the idea selection of mechanism selection has been conduct to evaluate which mechanism is the best choice. The table 3.1 was illustrated about the idea of the ratchet mechanism in appendix C.

A simple pawl ratchet has been chosen as the mechanism of the torch cleaner. The figures 3.11 show a simple form of ratchet mechanism that will use in torch cleaner.

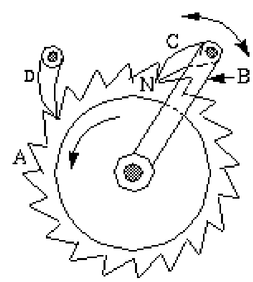


Figure3.11: Ratchet
(Howell, L.L., 2005)

A is the ratchet wheel, and B is an oscillating lever carrying the driving pawl, C. A supplementary pawl at D prevents backward motion of the wheel. When arm B moves counterclockwise, pawl C will force the wheel through a fractional part of a revolution dependent upon the motion of B. When the arm moves back (clockwise), pawl C will slide over the points of the teeth while the wheel remains at rest because of fixed pawl D, and will be ready to push the wheel on its forward (counterclockwise) motion as before.

Ergonomics is the human factor in engineering. It is the study of how people interact with machines. Most products have to work with people in some manner. People occupy a space in or around the design, and they may provide a source of power or control or act as a sensor for the design. For example, people sense if an automobile air-conditioning system is maintaining a comfortable temperature inside the car. These factors form the basis for human factors, or ergonomics, of a design. A design solution can be considered successful if the design fits the people using it. The handle of a power tool must fit the hand of everybody using it. The tool must not be too heavy or cumbersome to be manipulated by all sizes of people using the tool.

After analyzing our alternative solutions, decided is needed to choose which design is the best for MIG torch cleaner that will produce. It will refine and develop the best solution in more detail during the later stages of the design process. At this stage, to evaluate each solution objectively against the stated design criteria or requirements, a quantitative basis is needed for judging and evaluating each design alternative. One widely used method to formalize the decision-making process is the decision matrix. The decision matrix is a mathematical tool that can use to derive a number that specifies and justifies the best decision. To perform this method, a design idea is sketched. There are 3 design concepts which are illustrated in the following Figure in appendix D, E and F.

After analyzing each solution against the six criteria, we evaluate each design alternative. After assigning a rating factor to each design alternative for each of the specified criteria, we multiply the rating factor by the value factor. The product of the value and rating factors is then summed down the column for each design alternative. The total sum at the bottom of each column determines the best design alternative. The results of this decision matrix are show in the following example in table 3.2 of design selection in appendix G.

3.3.5 Design and Implement the Solution

The final phase of the design process is implementation, which refers to the solution in the analysis of the design solution. To perform this stage 3D CAD modeling is used which is CATIA software. Using CATIA software, the complete all three designs is drawn according to the best design idea that we choose. The complete drawing of the three design product has shown in appendix D, E and F. Normally, after 3D CAD drawing has constructed, the material preparation must be provide in order to go the next stage which is fabricating. The material needed in this project has shown in table 3.3.

Table 3.3: Bill of Material

No	Item	Types of material	Qty	Description
1	Rectangular plate	A36 Steel	1	140mm x 25m
2	Rectangular plate	A36 Steel	1	100mm x 12mm
3	Cylinder block	A36 Steel	1	Diameter 20mm x 150
4	Gear	A36 Steel	1	standard
5	Bolt	A36 Steel	6	20mm x 3mm
6	Nut	A36 Steel	6	6mm x 2mm
7	Hose	Polymer	1	Diameter 3mm x 200mm

3.4 Mechanical Analysis

After the best design has been chosen, it need an engineering analysis of a design often include the analysis of its mechanical features. The engineer conducts mechanical analysis to answer questions which is will the device or structure support the maximum loads that it will be subjected to nozzle. It must determine the effect of shocks and repetitive or dynamic loading over the life of the product. There are three major calculations which are important to calculate the design. By using CATIA finite element analysis, every each part of the design can be measured for the strength. All the analysis will illustrated in result and discussion in chapter 4.

3.4.1 Von Mises stress

From the finite element analysis, it comes out the von mises stress. It uses a first-order solid tetrahedral element which, by design, can only model constant stress within its volume. Knowing that, there are two big problems. First, only one element is placed across the thickness of the plate in bending. This model is not capable of representing bending stress which changes from compressive to tensile across the plate thickness. Consequently, bending stresses are badly represented by constant stress. The second problem is that the elements are highly distorted. Each type of element works well only if it is within specified shape limits. If element distortion is beyond these limits, then numerical procedures used to calculate displacements and stresses return false results.

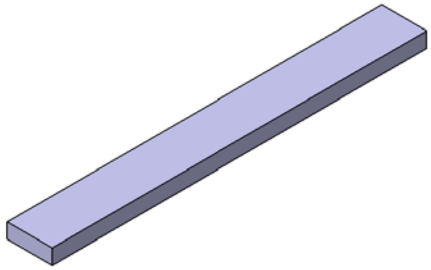
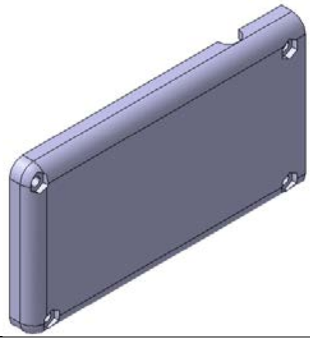
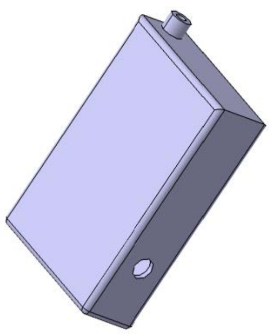
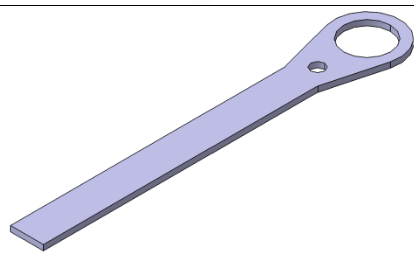
3.4.2 Torque Wrench

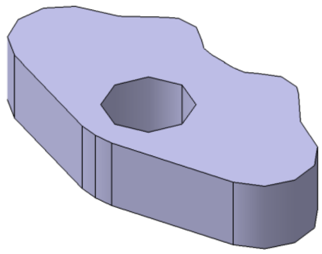
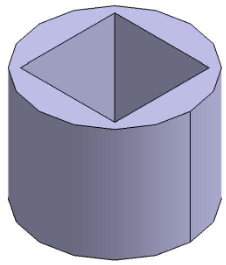
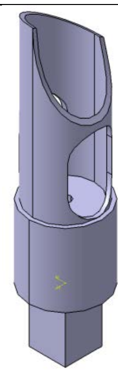
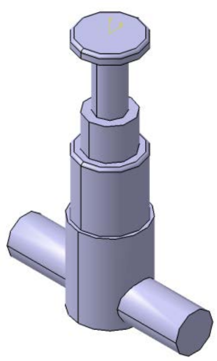
A torque wrench is a tool used to precisely apply a specific torque to a fastener such as a nut or bolt. It is usually in the form of a socket wrench with special internal mechanisms. A torque wrench is used where the tightness of screws and bolts is crucial. It allows the operator to measure the torque applied to the fastener so it can be matched to the specifications for a particular application. This permits proper tension and loading of all parts. So, the torque wrench can be calculated manually. Using this formula, the optimum torque was obtained to cleaning the nozzles which is 30N. The calculation of the torque wrench has shown in appendix H.

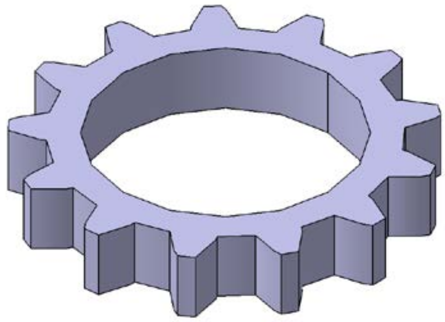
3.5 Manufacturing process

A creative and systematically design is important to produce a product which is convenient and easy to be used by the user. In this stage, it is necessary using four manufacturing process to develop a successful project for each part of the product. There are five processes that needed in torch cleaner fabricating which is rapid prototyping, milling, lathe, drilling and joining. The elaborations about this are shown in table 3.4 with part by part. Each part must be drawn in 2D drawing. The detail drawing of each part has been shown in appendix I, J, K, L, M, N, O, P and Q.

Table 3.4: Manufacturing process

Name	Sketch	Material	Process
Support bar		A36 Steel	Milling -This part is use to support between handle. To conduct this process, the dimension of the part has been marked and measure. Then end mill method is used to get the shape.
Casing		ABS polymer	Rapid prototyping -This part is a body that attach to the handle. The design has been conducted before it transfers into rapid prototyping machine. The material use in this process is ABS polymer.
Container		ABS polymer	Rapid prototyping -This part is a container that uses to fill up anti rust liquid. RP machine have been use to make this product. It also use same material in this process which is ABS.
Handle		A36 Steel	Milling -This part is the main part to develop the product. This part is use to twist the reamer. To conduct this process, the dimension of the part has been marked and measure. Then numerical control has been performed to get the shape.

pawl		ABS polymer	Rapid prototyping -This part is pawl switcher that uses to lock the gear and change the rotation. With the design sketching, RP machine have been use to make this product. The material uses is ABS.
shaft		A36 Steel	Milling and lathe -This part is a shaft that attach to gear and reamer. This part is use to twist the reamer. To conduct this process, the dimension of the part has been marked and measure. To get this shape this part must go to lathe process and after that milling process.
Reamer blade		A36 Steel	Lathe and drilling -This part is a reamer blade that attach to the shaft. This part is use to remove the spatter inside the nozzle. To create this part, the dimension of the part has been marked and measure. The first process need to go is lathe and follow by drilling process.
pump		ABS polymer	Rapid prototyping -This part is pump mechanism that play as a spray. This part is attached with container and reamer by hose. With the design sketching, RP machine have been perform to make this product.

Gear		A36 Steel	EDM wire-cut -This part is a gear that integrates with pawl. It will rotate clockwise and counterclockwise based on the pawl switch. The process of this part needs a design that will produce a G code to run the machine.

3.6 Testing

A test method is a definitive procedure that produces a test result. A test can be considered as technical operation that consists of determination of one or more characteristics of a given product, process or service according to a specified procedure. Often a test is part of an experiment. The test result can be qualitative (yes/no), categorical, or quantitative (a measured value). It can be a personal observation or the output of a precision measuring instrument. In this project the testing for the product are using the real equipment on under real problem. So the result is measure by the human visual and it is manually checked the equipment that has been tested. The result will discuss in chapter 4. The figure 3.12 is shown the exploded view for assembly stage that will result 3D drawing with actual product.

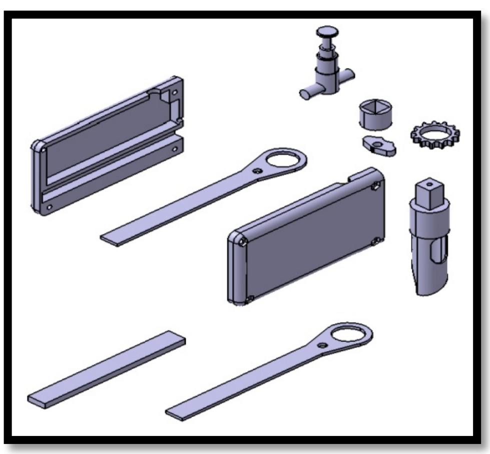


Figure 3.12: Exploded view

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

This chapter presents the results of the evaluation matrix and finite element analysis that were conducted based on the methods described in Chapter 3. The results obtained throughout the Pugh matrix were analyzed and interpreted. The analysis was conducted based on the exploratory aims of the study. Summarizes of results are generally presented in table. Typical table for each designs that relating in this project will be provided in this chapter.

4.2 Pugh Matrix Method

In the matrix below there are ten criteria C1, C2, C3 and till C10 playing role in final decision with respective weights. On other side there are three alternatives, named Design A, B and C. All design was conducted using CATIA 3D software and have shown in figure. There are two evaluation have been done in this chapter. For the seconds evaluation we have identified criteria C1 till C10 playing a role in the final decision, with a respective weight of 1, 2, and 3. Moreover, we've found 3 prospective providers A, B, and C, whose offer may constitute a good solution. Rates should be on ratio scale, e.g. 0-5, 0-10, or 0-100. After rating all alternatives scores are computed as follows: Score = Rating x Weight. At the end the end total score is computed as: Total Score = SUM (Scores).

4.2.1 Design Concept A

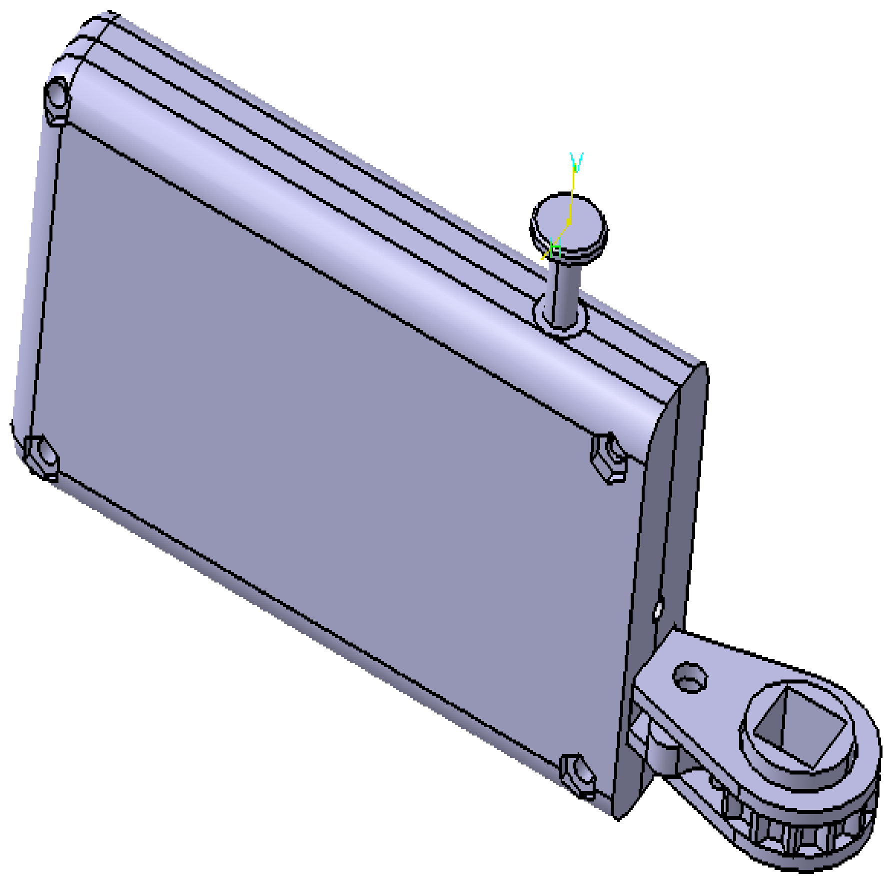


Figure 4.1: Concept A

This is design concept A. It possess ratchet mechanism where the reamer is plug in the shaft of the gear that twist clockwise and counter clockwise. This product use steel for the handle, shaft and gear. For the casing it uses ABS material that produce from rapid prototyping. The inside of the casing have sprayer mechanism that uses to protect the nozzle from corroded. The process for assemble the part is use joining fastener. The details drawing of this design has shown in appendix R.

4.2.2 Design Concept B

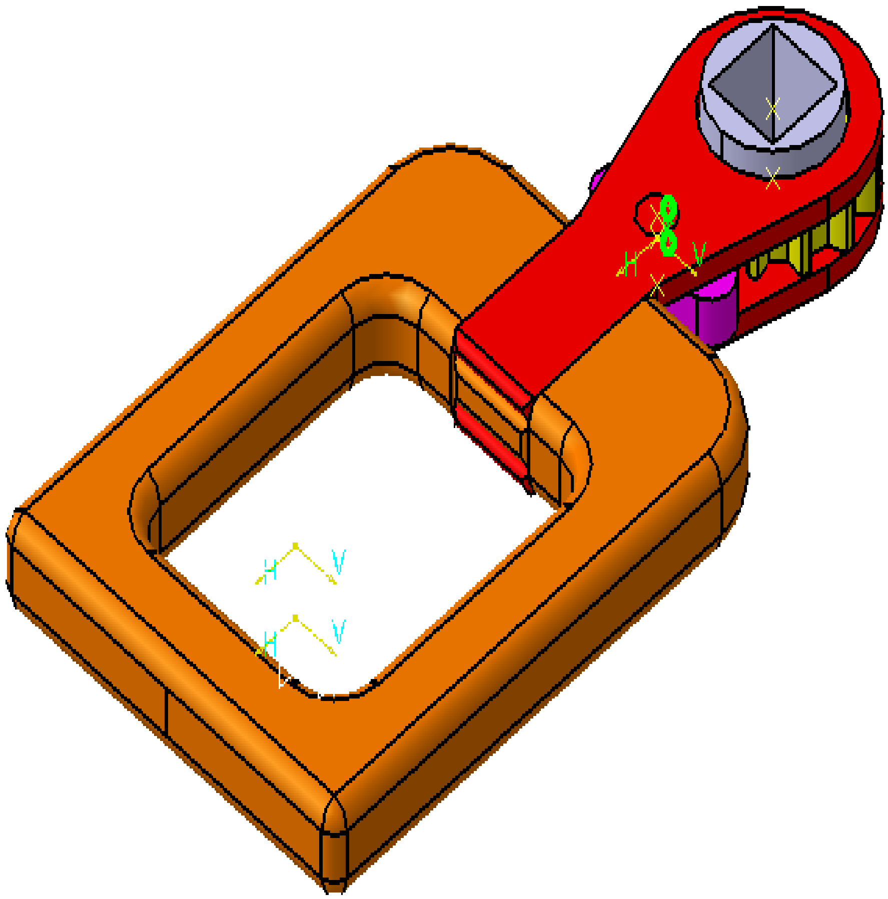


Figure 4.2: Concept B

This is concept B. this design possess the same mechanism same with the first design concept A. The material uses to create all the part in this design also same which uses steel as the shaft, gear and handle head. For the handle that uses to twist the reamer is made from the rapid prototyping too. It is light and not suitable for this design because it no safer. The details drawing of this design concept B has shown in appendix S.

4.2.3 Design Concept C

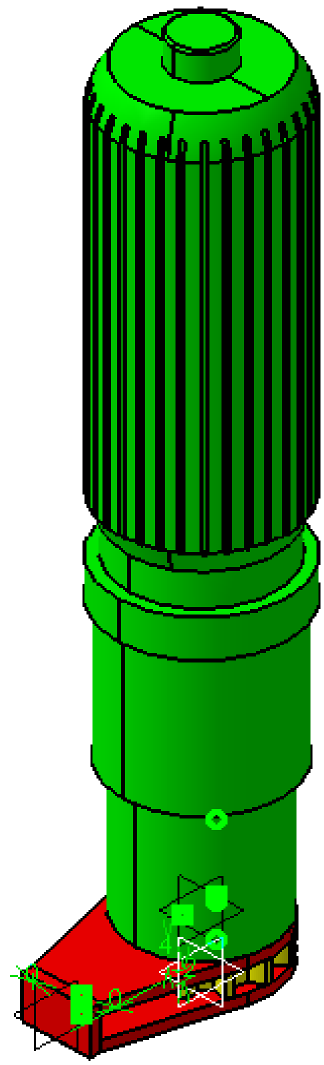


Figure 4.3: Concept C

This is concept C which is the last concept in the design selection. This concept also uses same mechanism from the previous concepts which is ratchet mechanism. This concept was creating by the screwdriver concept. The handle is fully made from rapid prototyping and the head made from the steel. The also can twist clockwise and counter clockwise. The detail drawing has shown in appendix T.

4.2.4 Final Design selection

To evaluate each design for the purposes of selecting them for use to cleaning the nozzle, three design selection matrices were constructed. In this evaluation we did not give any weight on the attributes in this method. Figure 4.1 shows the design selection matrix for the MIG torch cleaner. For the torch cleaner, a number of criteria were chosen including size, cost, usability, upgradability and etc. The results of this selection matrix determined that the design ‘A’ was the best choice for the development of MIG torch cleaner.

Table 4.1: Design selection matrix for torch cleaner (first evaluation)

				design		
			datum	A	B	C
criteria	1	Size/portability		B	B	B
	2	Cost		B	B	B
	3	Usability		S	W	W
	4	Upgradability		B	S	S
	5	Serviceabiltity		B	B	B
	6	Consumable usage		W	W	W
	7	Safety		B	S	S
	8	Weight		B	B	B
	9	Design time		S	S	S
	10	Removal performance		W	W	W
Pugh selection matrix			Sum of better	6	4	4
Title: MIG Torch Cleaner			Sum of same	2	3	3
Project: Final Year Project			Sum of worse	2	3	3
Name: Mohd Saffririzal			Net score	4	1	1
Better / same / Worse						

After the result come out from the first evaluation, the second evaluation is tried weighted scoring method to confirm and make sure whether the result is same or not. Against, figure 4.2 shows the design selection matrix for the MIG torch cleaner. A same number of criteria were chosen including size, cost, usability, upgradability and etc. The results of this selection matrix determined that the same design was the best choice for the development of MIG torch cleaner.

Table 4.2: Design selection matrix for torch cleaner (second evaluation)

					Design					
			Weight	Datum	A		B		C	
criteria	1	Size/portability	30%	3	1	1.35	1	0.45	3	0.9
	2	Cost	20%	3	1	0.75	2	0.25	1	0.25
	3	Usability	5%	3	5	0.15	1	0.25	1	0.2
	4	Upgradability	10%	3	2	0.6	2	0.4	3	0.8
	5	Serviceabiltity	4%	3	3	0.12	3	0	3	0.08
	6	Consumable usage	1%	3	1	0.8	2	0.03	2	0.03
	7	Safety	5%	3	4	0.4	1	0.08	1	0.4
	8	Weight	10%	3	2	0.14	4	0.1	2	0.05
	9	Design time	5%	3	5	0.5	5	1	1	0.17
	10	Removal performance	10%	3	2	0.7	2	0.15	1	0.9
				Total score		4.2		2.78		2.68
				Rank		1		2		3

4.3 Finite Element Analysis of Design A

A common use of FEA is for the determination of stresses and displacements in mechanical objects and systems. It is used in new product design, and also in existing product refinement. It also, able to verify whether a proposed design will be able to perform to the specifications prior to manufacturing or construction. Modifying an existing product or structure is utilized to qualify the product or structure for a new service condition. In case of structural failure, FEA may be used to help determine the design modifications to meet the new condition. Every each part of the design A has been conducted in finite element analysis. From the previous chapter 3, the calculation for standard MIG torch cleaner torque wrench is 30N. In this analysis, the higher load have been apply in this analysis which is 50N there are two type materials has defined for different part which A36 steel and standard ABS. For the A36 steel the allowable tensile strength is 550Mpa and for ABS type the allowable tensile strength is 40Mpa. For details information of this material it can refer in table 4.3 and table 4.4 in appendix U and V.

4.3.1 Analysis of the handle

The piece used in the figure 4.4 is designed using A36 Steel with a yield strength of 550 Mpa. The part measures 12mmX100mmX2mm and the radii are 12mm. The bar is fixed at one end and a load of 50 N is applied to the other end. The detail drawing of these parts has shown in appendix B.

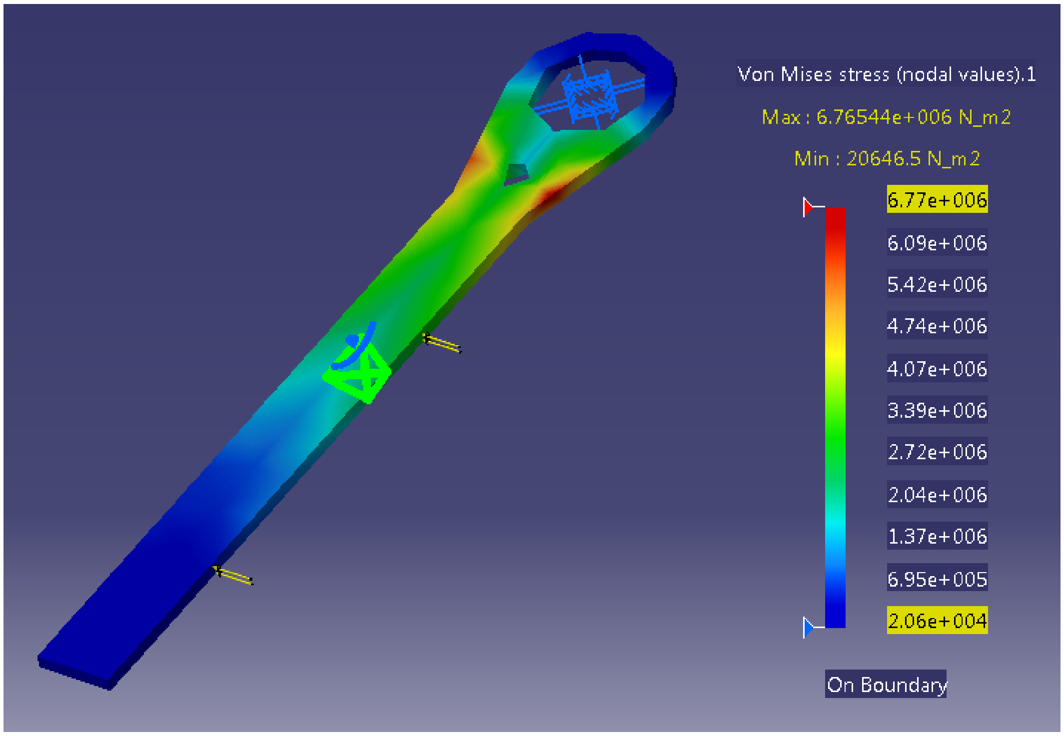


Figure 4.4: Handle analysis

The above plot shows the von-Mises stress plot of the results. The contour scale is at its default setting which will take the maximum and the minimum stresses and evenly divide the stress contours based on the number of colors that you want to use. In this case, nine colors are used. Blue usually represent the lowest stress and Red the highest. Knowing that the handle is made from A36 steel with a nominal yield strength of 550 Mpa. The areas in this analysis have not exceeded the yield strength of the material. With the above contour scale it would be hard to do. But, if the value at the red transition point is changed to 550 Mpa, anything showing red would then be known to be above the yield point of the material.

4.3.2 Analysis of the shaft

The second piece used in the figure 4.5 below is designed using A36 Steel with a yield strength of 550 Mpa. The part measures the length 12mm and the radii are 16mm. The bar is fixed at one end and a load of 50 N is applied to the other end.

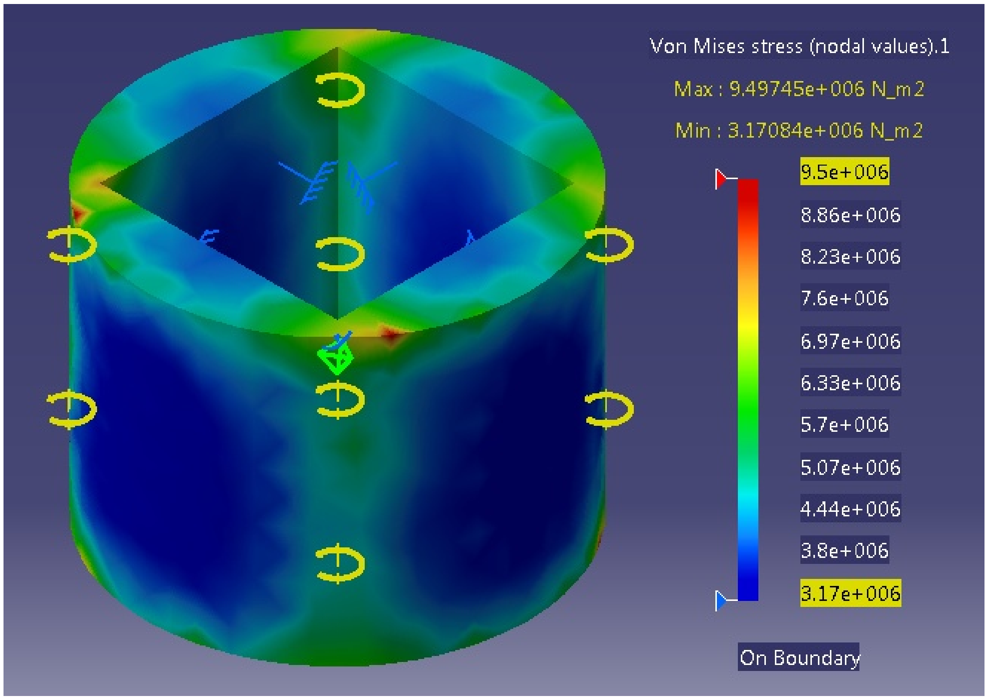


Figure 4.5: Shaft analysis

The shaft also is made from A36 steel with a nominal yield strength of 550 Mpa. This part is more critical than the previous part above where the moment is acting on outer surface. The areas in this analysis have not exceeded the yield strength of the material. With the above contour scale it would be hard to do. But, if the value at the red transition point is changed to 550 Mpa, anything showing red would then be known to be above the yield point of the material.

4.3.3 Analysis of the gear

The third piece used in the figure 4.6 below is designed using A36 Steel with a yield strength of 550 Mpa. The part measure the outer diameter is 14mm and the inner diameter is 12mm and the peeks are 1mm. The bar is fixed at one end and a load of 50 N is applied to the other end.

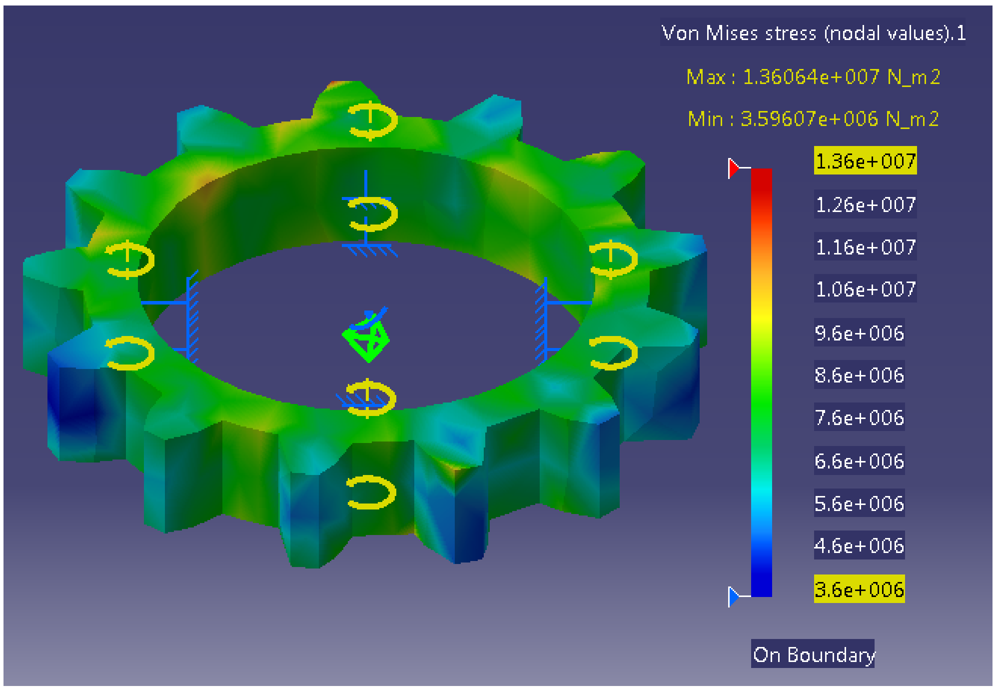


Figure 4.6: Gear analysis

This gear also is made from A36 steel with a nominal yield strength of 550 Mpa. These part is the most critical part in product because this part is functional to hold the twist of the shaft. The areas in this analysis have not exceeded the yield strength of the material. With the above contour scale it would be hard to do. But, if the value at the red transition point is changed to 550 Mpa, anything showing red would then be known to be above the yield point of the material.

4.3.4 Analysis of the support bar

The fourth piece used in the figure 4.7 below is designed also using A36 Steel with a yield strength of 550 Mpa. The part measures 12mmX100mmX2mm. The bar is fixed at one end and a load of 50 N is applied to the other end.

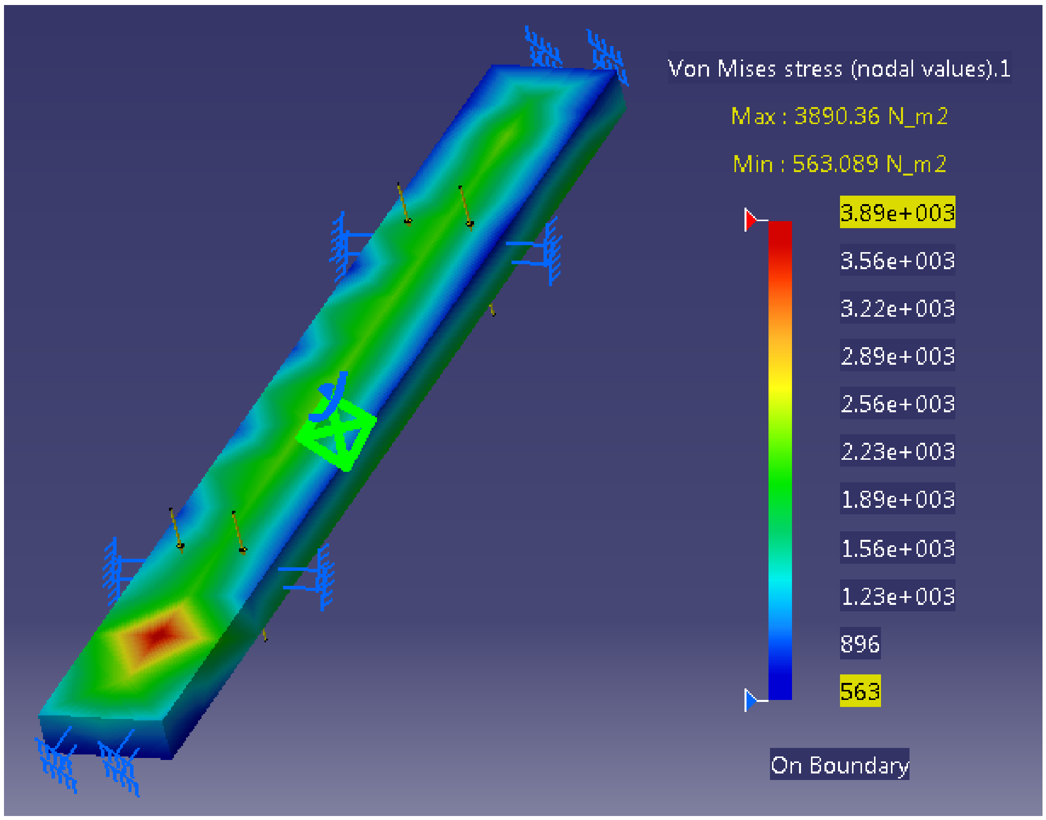


Figure 4.7: Support Bar analysis

Knowing that the steel bar is made from A36 steel with a nominal yield strength of 550 Mpa. This part is not a critical part because is uses for support the two handle that clamp between the steel bar. The areas in this analysis also have not exceeded the yield strength of the material. With the above contour scale it would be hard to do. But, if the value at the red transition point is changed to 550 Mpa, anything showing red would then be known to be above the yield point of the material.

4.3.5 Analysis of the pawl

The fifth piece used in the figure 4.8 below is designed using ABS polymer with a yield strength of 40 Mpa. The part measures 20mmX12mmX4mm and the radii are 2mm. The bar is fixed at one end and a load of 50 N is applied to the other end. The detail drawing of these parts has shown in appendix B.

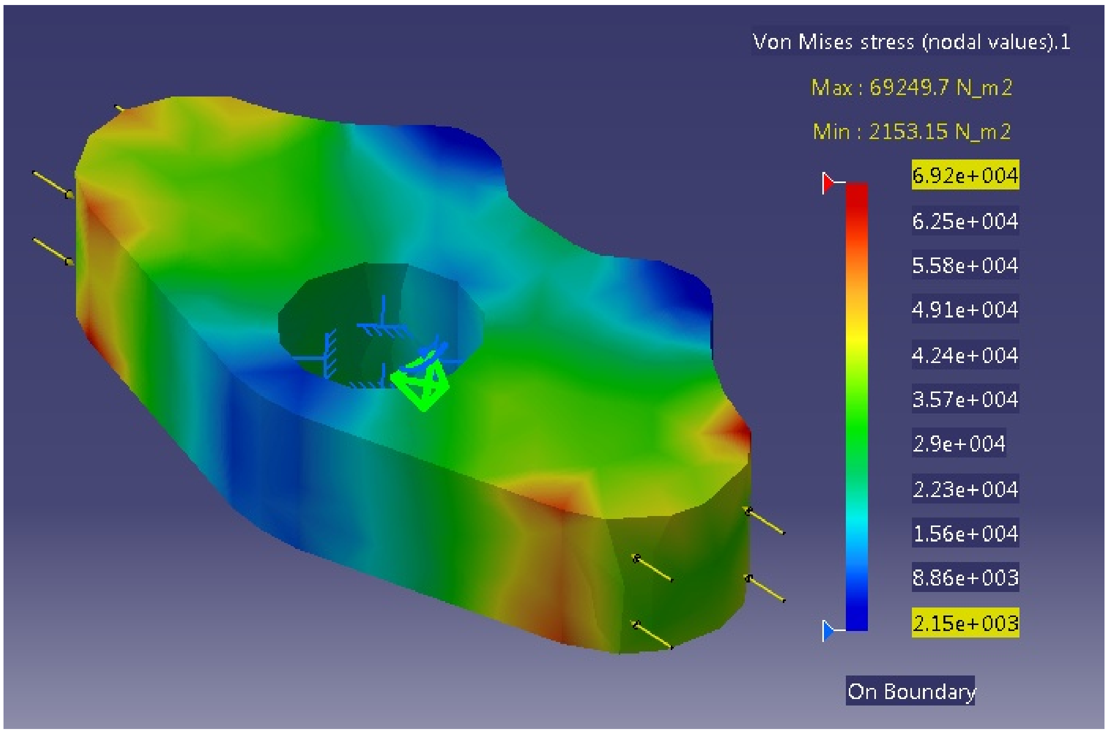


Figure 4.8: Pawl analysis

This pawl is made from ABS polymer with a nominal yield strength of 40 Mpa. This part is uses to change the rotation of handle counter clockwise or clockwise. The areas in this analysis have not exceeded the yield strength of the material. With the above contour scale it would be hard to do. But, if the value at the red transition point is changed to 40 Mpa, anything showing red would then be known to be above the yield point of the material.

4.3.6 Analysis of the casing

The sixth piece used in the figure 4.9 below also is designed using ABS polymer with a yield strength of 40 Mpa. The part measures 102mmX55mmX9mm and the radii of the hole are 1.5mm. The bar is fixed at one end and a load of 50 N is applied to the other end. The detail drawing of these parts has shown in appendix B.

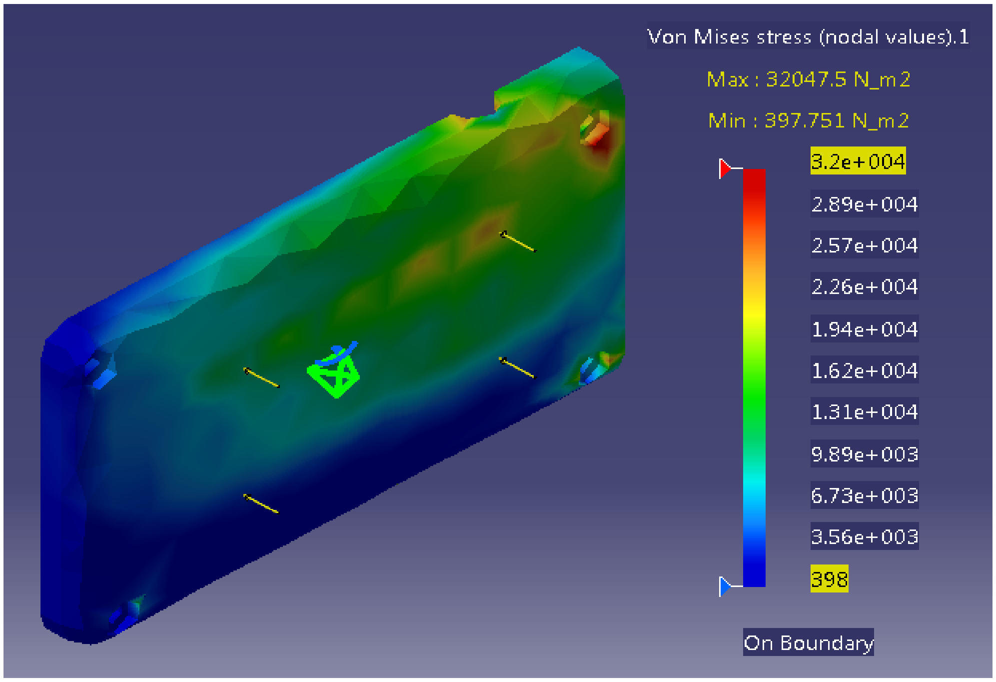


Figure 4.9: Casing analysis

This casing also is made from ABS polymer with a nominal yield strength of 40 Mpa. This part is not critical than the other polymer part above because it uses as the body of the handle. The areas in this analysis have not exceeded the yield strength of the material. With the above contour scale it would be hard to do. But, if the value at the red transition point is changed to 40 Mpa, anything showing red would then be known to be above the yield point of the material.

4.3.7 Analysis of the reamer blade

The last piece used in the figure 4.10 below is designed using A36 Steel with a yield strength of 550 Mpa. The part below measures the length of the tool is 65mm. The outer diameter is 12mm and the inner diameter is 10mm. The bar is fixed at one end and a load of 50 N is applied to the other end.

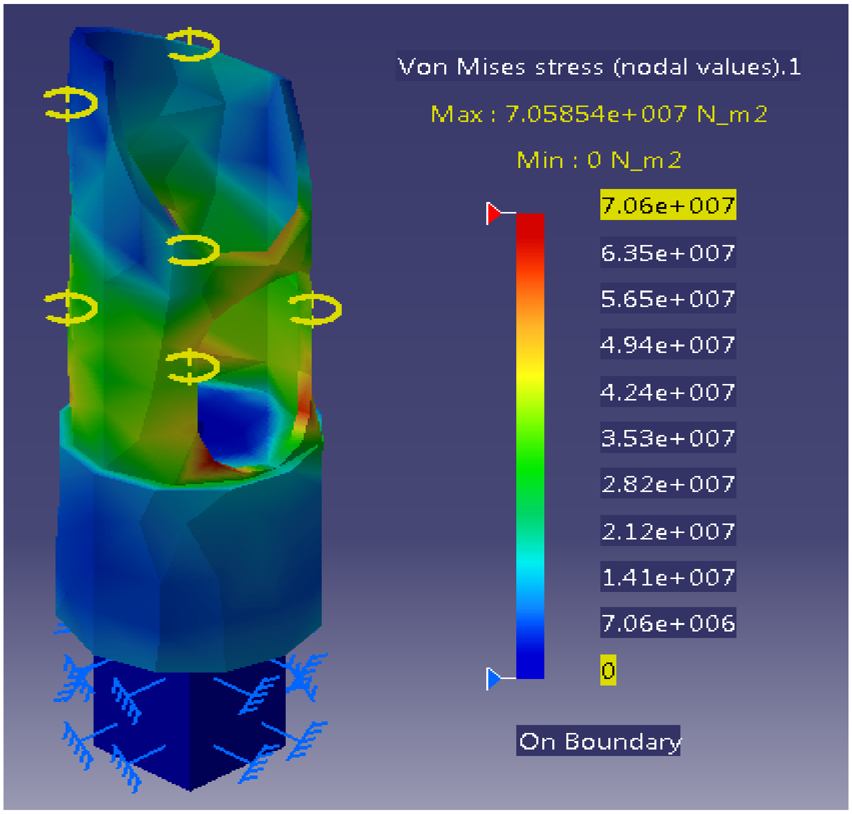


Figure 4.10: Reamer Blades analysis

This blade also is made from A36 steel with a nominal yield strength of 550 Mpa. The parts also are the most critical part in product because this part is functional to twist and remove the spatter in nozzle. The areas in this analysis have not exceeded the yield strength of the material. With the above contour scale it would be hard to do. But, if the value at the red transition point is changed to 550 Mpa, anything showing red would then be known to be above the yield point of the material.

4.3.8 Summary of the analysis

As the above figures show, placing the current material uses, it will reduce the stress in the part. In other word a stronger material will hold better in softer material. This information has been provided as a comparison of different scenarios and not as a definitive load prediction for part failure. The entire circumference of the inner pieces exhibits stress of around 50MPa. This is interesting since we would expect the stress to be higher where the load was applied, this is not the case. This may be due to the FEA model where each part is rigid to the handle where a contact model may yield different or similar results. If the material properties, loads and constraints are not accurate, so we can't expect the results to be either.

4.4 Product Testing Result

A test method is a definitive procedure that produces a test result. A test can be considered as technical operation that consists of determination of one or more characteristics of a given product, process or service according to a specified procedure. Often a test is part of an experiment. The test result can be qualitative (yes/no), categorical, or quantitative (a measured value). So the result is measure by the human visual and it is manually checking the equipment that has been tested.

Table 4.5: Checking Form

		visual		functional	
No.	**Checking**	**Yes**	**No**	**Yes**	**No**
1	Spatter remove	✓			
2	Reamer blades			✓	
3	Nozzle condition	✓			
4	Anti-spatter spray			✓	
5	Ratchet mechanism			✓	

The table 4.5 show that there five types of characteristics which is spatter clean up, reamer blade, nozzle condition, anti spatter spray and ratchet mechanism. The entire characteristic has measured with two methods by human visual and the functional of the tool. So the testing that performed is success and achieved the objective of the thesis.

4.5 Product Manufactured Result

These results come out after all the fabricating and analysis have done. It will compare the actual product with the 3D CAD drawing. In figure, it also will show either the testing of the actual product has achieved the objective of the project or not. Through the figure below, the condition of the nozzle before and after reamer can be study for future work.

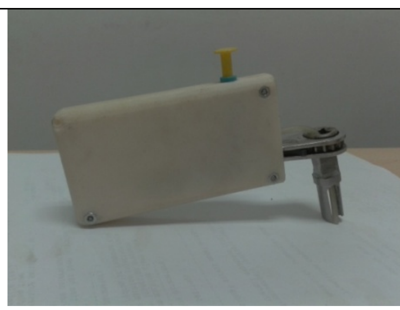
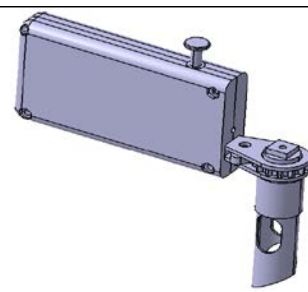
Actual	3D Drawing
	

Figure 4.11: Product Comparison

Before	After
	

Figure 4.11: Nozzle comparison

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Introduction

For the final chapter it represent about conclusion and recommendation for the project. The important thing for this chapter is about the problems encountered during the whole project was been carried out. The problem are included the process planning that had been done. These project problems also make the student to think more creative to solve the problem. In this chapter also will discuss 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

After going through the whole project design and development process, we can conclude on several points in this project. This project was successful and had achieved the objectives of the project. Each of the steps overall had followed well-regulated which is firstly starting with getting the title of the final year project and had found an information about the MIG torch cleaner in the market according to the acceptable for the project title. It also had included the material chosen for the project is suitable for the project and than for the fabrication process. In the other hand, the requirement in making the right decision is needed to decide the correct material and setup machine to fabricate the product. So, students should come with the ideas on the project and must quickly find out the way to overcome limited resources while getting the relevant for the literature reviews such as books and internets resources.

Designing and sketching overall can be conclude as successful in this project caused by the design of this tool is making appropriate with the real dimension for the MIG torch cleaner and reasonable when compared the dimension in the drawing with the real product. Besides that, the most important thing is selecting the better product the selection can made for multiple choices of various selected design which is can used the Pugh selection method because this method is suitable to select the better product according some selected criteria. The student had to sketch as many as can design to choose the good model. Because of the idea were from he student directly, so there are no references that can be referred and needed the creativity from the student to create new invention according with own idea about the project. All the drawing and dimension need to generate by student itself and interpret this design into the fabrication stage during the process of making the MIG torch cleaner. So, here this project successful producing the same result between the drawing and the real products caused by the dimensional had achieved precisely.

After designing phase, comes fabrication process. The process that involved are measuring, marking, cutting, joining, drilling, and finishing. Mostly the cutting process and fastening method is involved to joint the main part of the product. Besides that, this project should be done some modification if something happened could make the skeleton change.

For overall conclusion, torch cleaner is mechanisms that allow user to protect the nozzle by cleaning the torch and at the same time protect the torch from corroded during the cleaning process. The design and development of this product also follow the needed and specification of objective in this thesis. The development of the existing torch cleaner is the first ideas in generate the new invention of the MIG torch cleaner had create where the product is friendly user and free from any power sources. In the other hand, this new design of torch cleaner had some features that difference between with the other existing cleaner.

5.3 Recommendation

Based on the progress of the project that had been done, so many things in financial aspects can be improves especially student budget. Some of the materials also need the student to buy such the things that does not have in the manufacturing laboratory. So students need the budget to buy the things by itself. 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 ensure that any of students task become more complete in a quite good ways and also give more time to focus on others subject.

5.4 Future Work

Overall perception of the project carried out was good due to gantt chart in this project that finish on time. For future experimental works on this topic, in order to improve the study, the following recommendations being suggest.

(i) Use variety of mechanism for cleaning process or using simulation software to produce the torch cleaner such as CATIA and Solidwork.

(ii) Conduct a study on the best design that can integrate with electrical component or power sources.

(iii) Test the nozzle condition or quality using surface measurement machine after the cleaning process.

REFERENCES

Ertas, A., Jones, J. C., The Engineering Design Process, John Wiley and Sons, New York, 1996.

Lumsdaine, E., Lumsdaine, M., Shelnutt, J. W., Creative Problem Solving and Engineering Design, McGraw-Hill, Inc., New York, 1999.

Sanders, M. S., McCormick, E. J., Human Factors in Engineering and Design, McGraw-Hill, Inc., New York, 1993.

Kennedy, J.A., Howell, L.L., and Greenwood, W., "Compliant High-precision E-Quintet Ratcheting (CHEQR) Mechanism for Safety and Arming Devices," Precision Engineering, in press.

Cannon, J.R. and Howell, L.L., "A Compliant Contact-aided Revolute Joint," Mechanism and Machine Theory, Vol. 40, No. 11, pp. 1273-1293, 2005.

Mechanism Design, Analysis and Synthesisby Erdman and sander, fourth edition, Prentice-Hall, 2001,

Machines and Mechanismsby Uicker, Pennock and Shigley, third edition, Oxford, 2002.

Machines and Mechanismsby Myszka, Prentice-Hall, 1999

Corrosion, Metals Handbook, ninth ed., ASM International, Metals Park, Ohio, USA, vol. 13, 1987, pp. 583.

Properties and selection: nonferrous alloys and pure metals, Metals Handbook, ninth ed., ASM International, Metals Park, Ohio, USA, vol. 2, 1979, pp. 3.

Rinaldi, E., 1979. Saldatura e taglio dei materiali. Ulrico Hoelpi ed. Milano, 421–452.

Welding, Brazing and Soldering, Metals Handbook, ninth ed., ASM International, Metals Park, Ohio, USA, vol. 6, 1983, pp. 21.

Zucchi, F., Trabanelli, G., Grassi, V., 2001. Mater. Corros. 52, 853.

Kang SK, Na SJ. A mechanism of spatter production from the viewpoint of the integral of specific current action. Weld J 2005;84:188s–96s.

Seo DW, Jeon YB, Lim JK. Effect of electric weld current on spatter reduction in spot welding process. Key Eng Mater 2004;261/263:1623–8.

Kang MJ. Spatter rate estimation in the short circuit transfer region of GMAW. Weld J 2003;82:238s–47s.

Tanaka K, Nansai K, Ida S, Nishiwari N, Hori S. Study of scattering behaviour and temperature of spatter generated during CO2 gas shielded arc welding. Weld Int 2003;17:196–202.

Jenkins Neil T, Eagar Thomas W. Fume formation from spatter oxidation during arc welding. Sci Technol Weld Join 2005;10:537–43.

K. Ohgushi, T. Tojo, A. Furuta, Development of the 1 kN m Torque Standard Machine, in: Proceedings of the IMEKO-XVI World Congress III, 2000, pp. 217–223.

K. Ohgushi, T. Ota, K. Katase, T. Tojo, Sensitivity measurement in the 1 kn m torque standard machine – an aerostatic bearing for the fulcrum unit, in: Proceedings of APMF 2000, 2000, pp. 99–104.

K. Ohgushi, T. Ota, K. Ueda, E. Furuta, Design and Development of 20 kN m Deadweight Torque Standard Machine, VDI-Berichte (2002) 327–332.

K. Ohgushi, T. Ota, K. Ueda, UNCERTAINTY EVALUATION OF The 20 kN m dead weight torque standard machine, in: Proceedings of the 19th Int. Conf. on Force, Mass & Torque IMEKO TC3, 2005, CD-ROM.

F. A. Davis, Development of the UK National Standard Static Torque Calibration Facility, in: Proceedings of the IMEKO-XV World Congress, 1999, pp. 25–31.

Cooper KG (2001) Rapid prototyping technology: selection and application. Dekker, New York

Hilton PD, Jacobs PF (2000) Rapid tooling: technologies and industrial Applications. Dekker, New York 334

Jacobs PF (1992) Rapid prototyping & manufacturing: fundamentals of stereolithography, Society of Manufacturing Engineers, Dearborn, MI

Lightman AJ, Vanassche B, D'Urso P, Yamada S (1994) Applications of rapid prototyping to surgical planning: a survey of global activities. Proceedings of the Fifth International Conference on Rapid Prototyping-1994, Dayton, OH, 12–15 June 1994, pp 43–49

S. Kalpajian, S.R. Schmid, Material removal processes: abrasive, chemical, electrical and high-energy beam, in: Manufacturing Processes for Engineering Materials, Prentice Hall, New Jersey, 2003, p. 541.

Anonymous, History and development, in: The Techniques and Practice of Spark Erosion Machining, Sparcatron Limited, Gloucester, UK, 1965, p. 6.

E.C. Jameson, Description and development of electrical discharge machining (EDM), in: Electrical Discharge Machining, Society of Manufacturing Engineers, Dearbern, Michigan, 2001,p. 12.

Tooling, Methods and Applications, Society of Manufacturing Engineers, Dearbern, Michigan, 1983, pp. 5–19.

APPENDICES

APPENDIX A

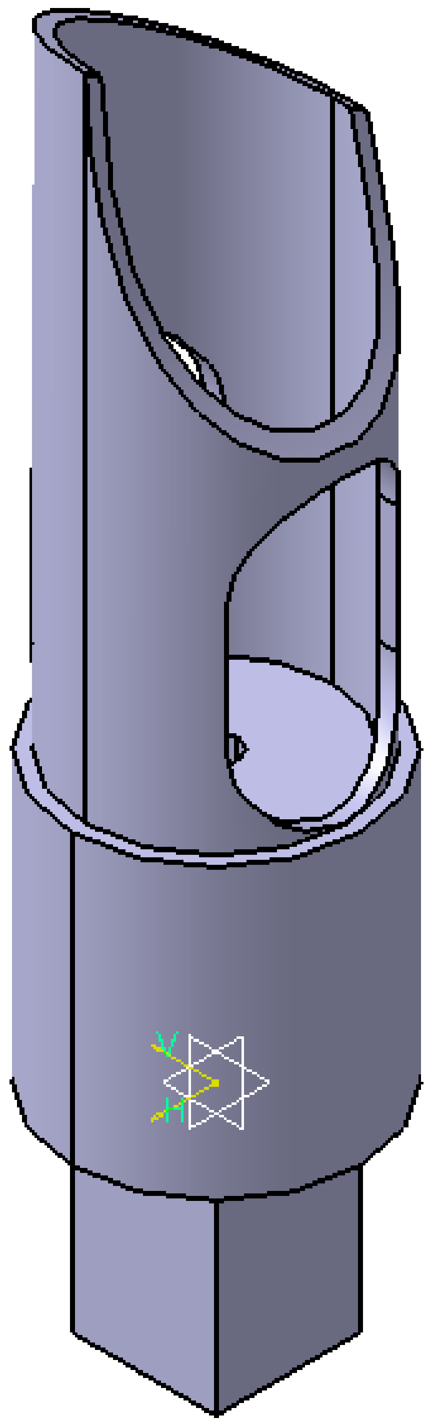
Table 1.1: Gantt chart of the project schedule

SEMESTER 1		WEEK													
TASK		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Briefing About Final Year Project	Plan														
	Actual														
Releasing Of Final Year Project Title	Plan														
	Actual														
Receiving Title Of The Project & Discussion	Plan														
	Actual														
Build And Manage Gantt Chart	Plan														
	Actual														
Preparation Of Project Methodology	Plan														
	Actual														
Make An Analysis For MIG torch cleaner	Plan														
	Actual														
Mid Presentation	Plan														
	Actual														
Present The Progress Of Report And Design	Plan														
	Actual														

SEMESTER 2		WEEK													
TASK		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Start Project Fabricating	Plan														
	Actual														
Finish Up The Final Report And Project	Plan														
	Actual														
Preparing Final Slide Presentation	Plan														
	Actual														
Presentation of Final year Project	Plan														
	Actual														
Submit Final Year Report to Supervisor	Plan														
	Actual														

APPENDIX B

Design sketching of Reamer blade



APPENDIX C

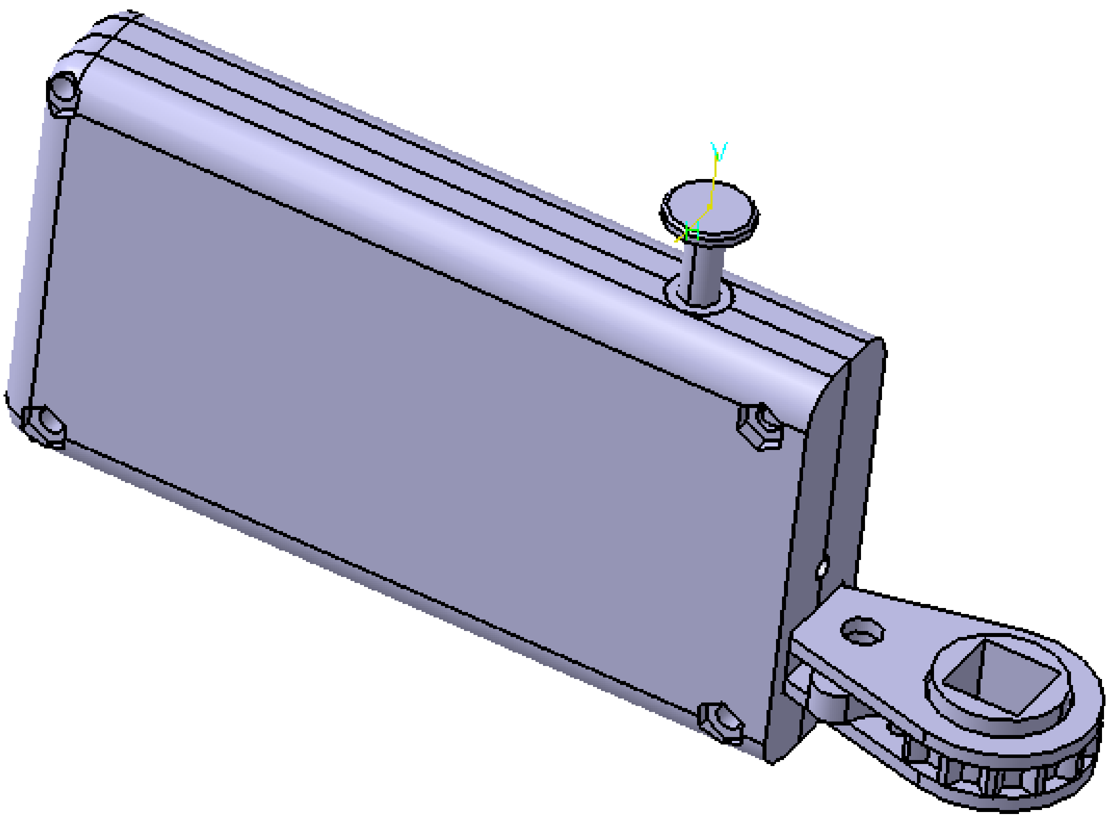
Table 3.1: Idea Selection of ratchet mechanism

criteria	**Ratchet Mechanism**				
	Pawl	**Spring back**	**Cam driven**	**friction**	**magnetic**
Design time	S	S	-	+	-
Part availability	+	+	-	S	S
Manufacturing cost	S	S	-	+	+
implementation	+	-	S	+	S
usability	+	S	+	S	+
Physical operating characteristics	+	S	S	_	S
Sum of +'s	4	1	1	3	2
Sum of –'s	0	1	3	1	1
Sum of S	2	4	2	2	3
Net score	4	0	2	2	1

Selected alternatives	**+** Better alternatives
	-Worse alternatives
	S Same alternatives

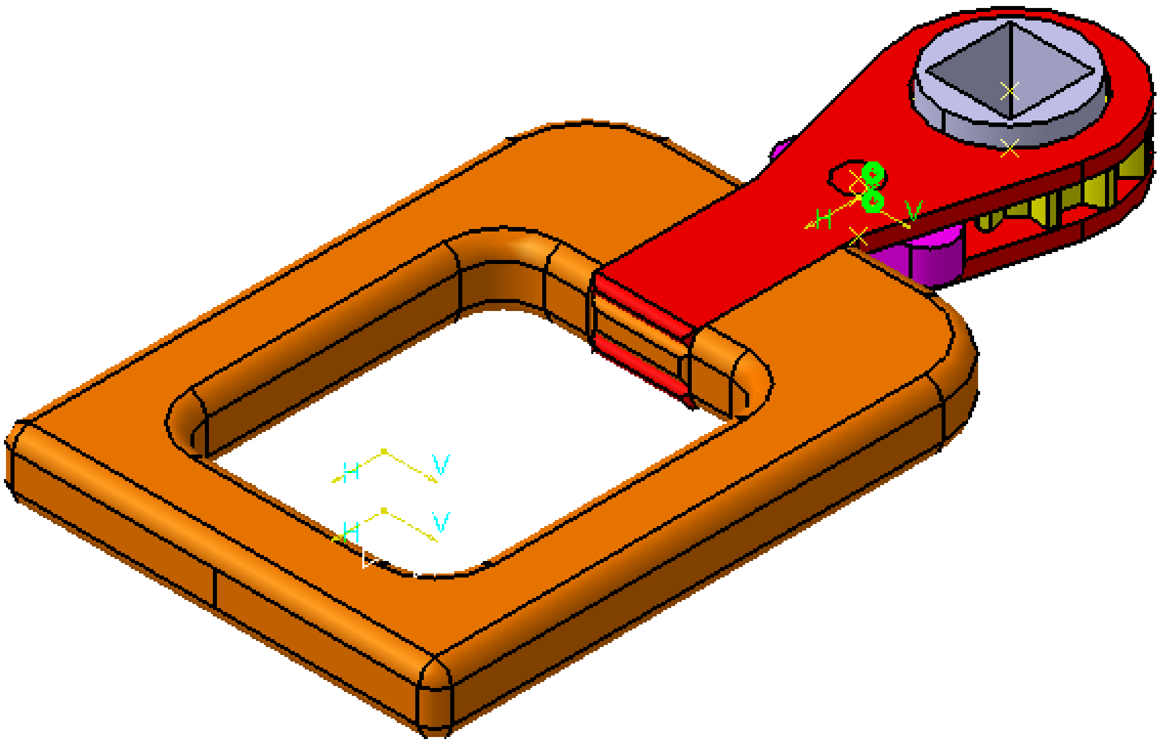
APPENDIX D

Design concept A



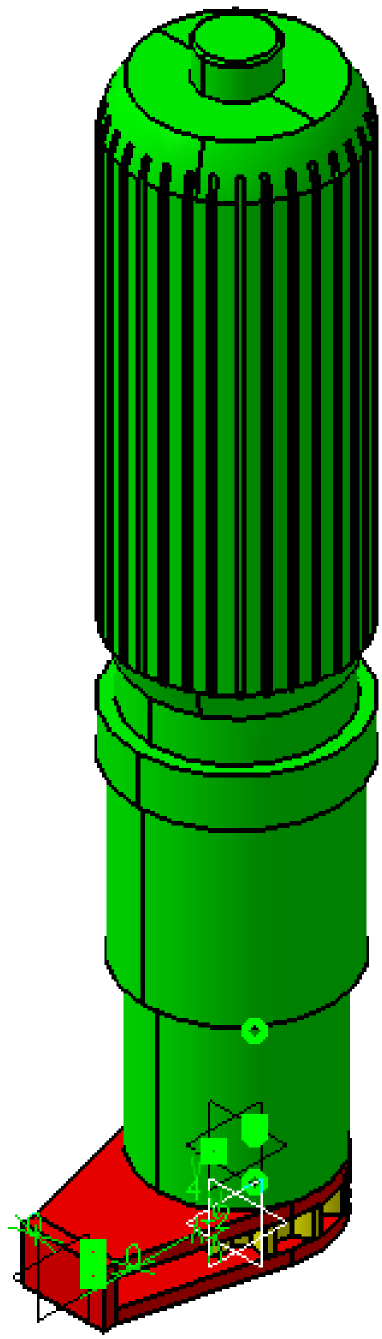
APPENDIX E

Design concept B



APPENDIX F

Design concept C



APPENDIX G

Table 3.2: Example of Pugh matrix design selection

				design		
			datum	A	B	C
criteria	1	Size/portability		B	B	B
	2	Cost		B	B	B
	3	Usability		S	W	W
	4	Upgradability		B	S	S
	5	Serviceabiltity		B	B	B
	6	Consumable usage		W	W	W
	7	Safety		B	S	S
	8	Weight		B	B	B
	9	Design time		S	S	S
	10	Removal performance		W	W	W
Pugh selection matrix			Sum of better	6	4	4
			Sum of same	2	3	3
			Sum of worse	2	3	3
			Net score	4	1	1

Title: MIG Torch Cleaner

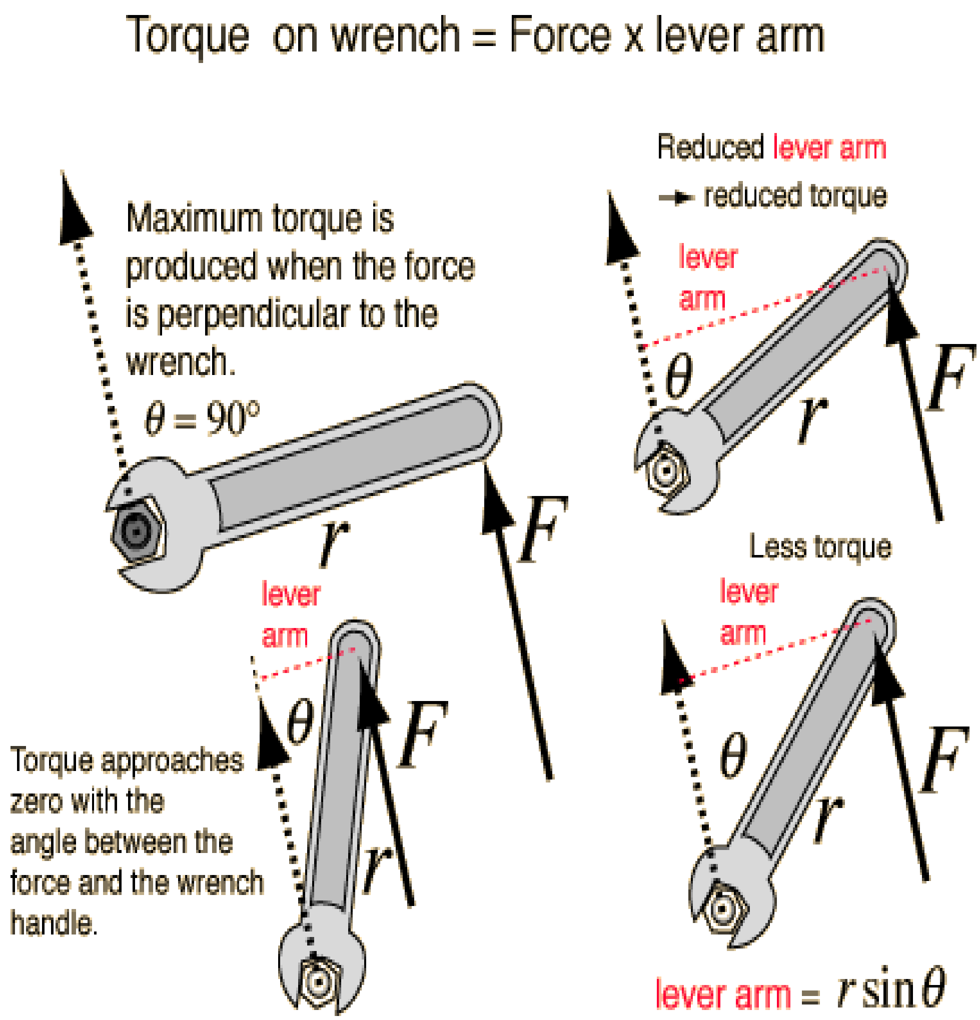
Project: Final Year Project

Name: Mohd Saffririzal

Better   same   Worse

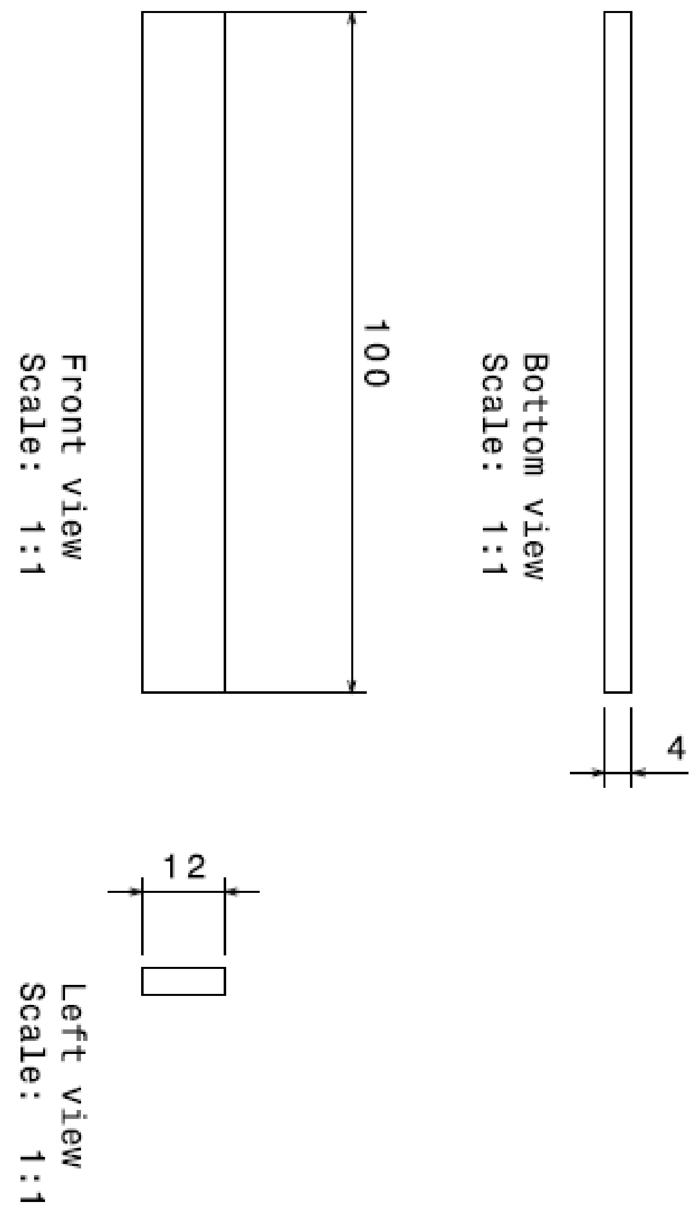
APPENDIX H

Torque Wrench



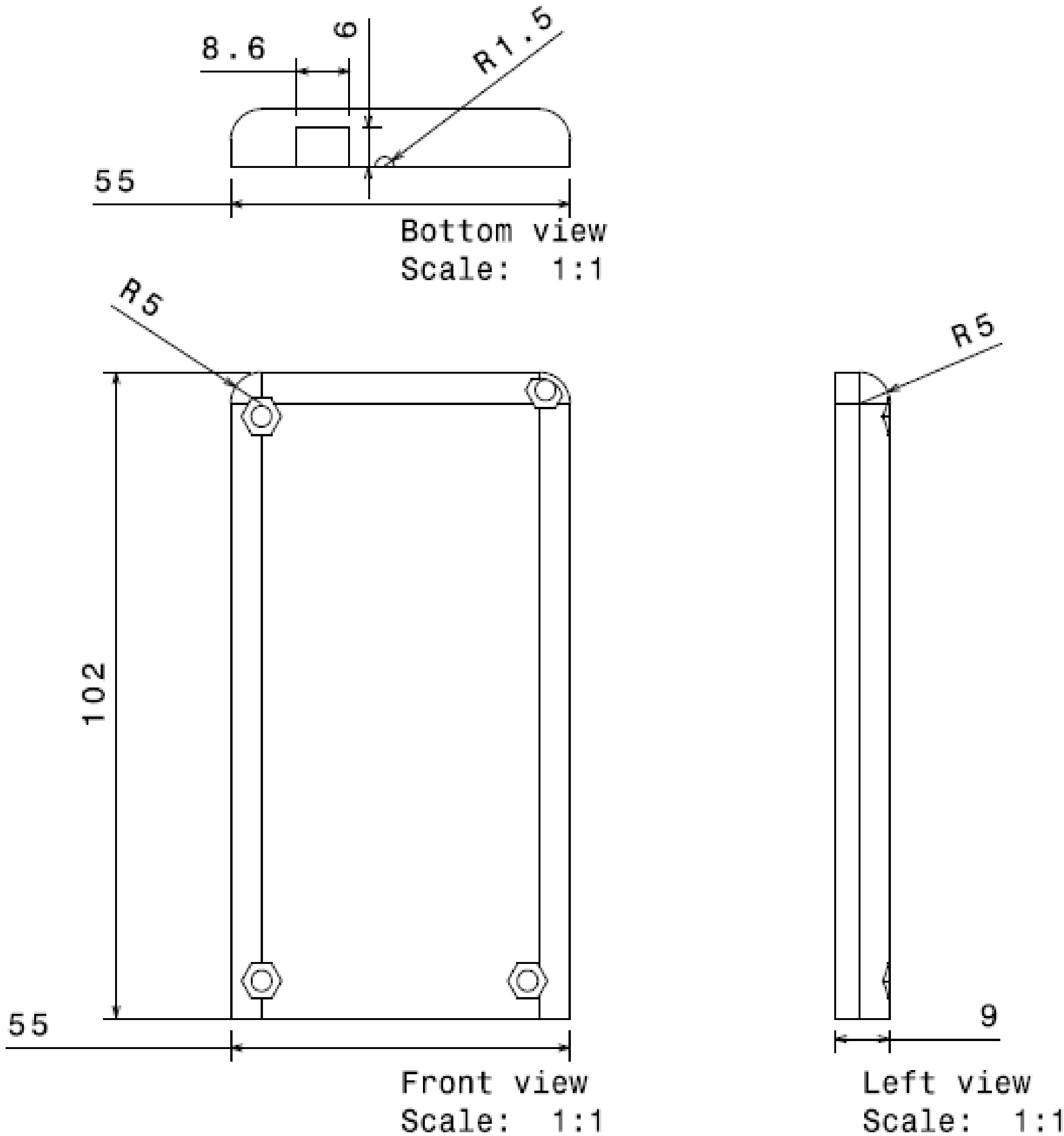
APPENDIX I

Detail drawing of Support bar



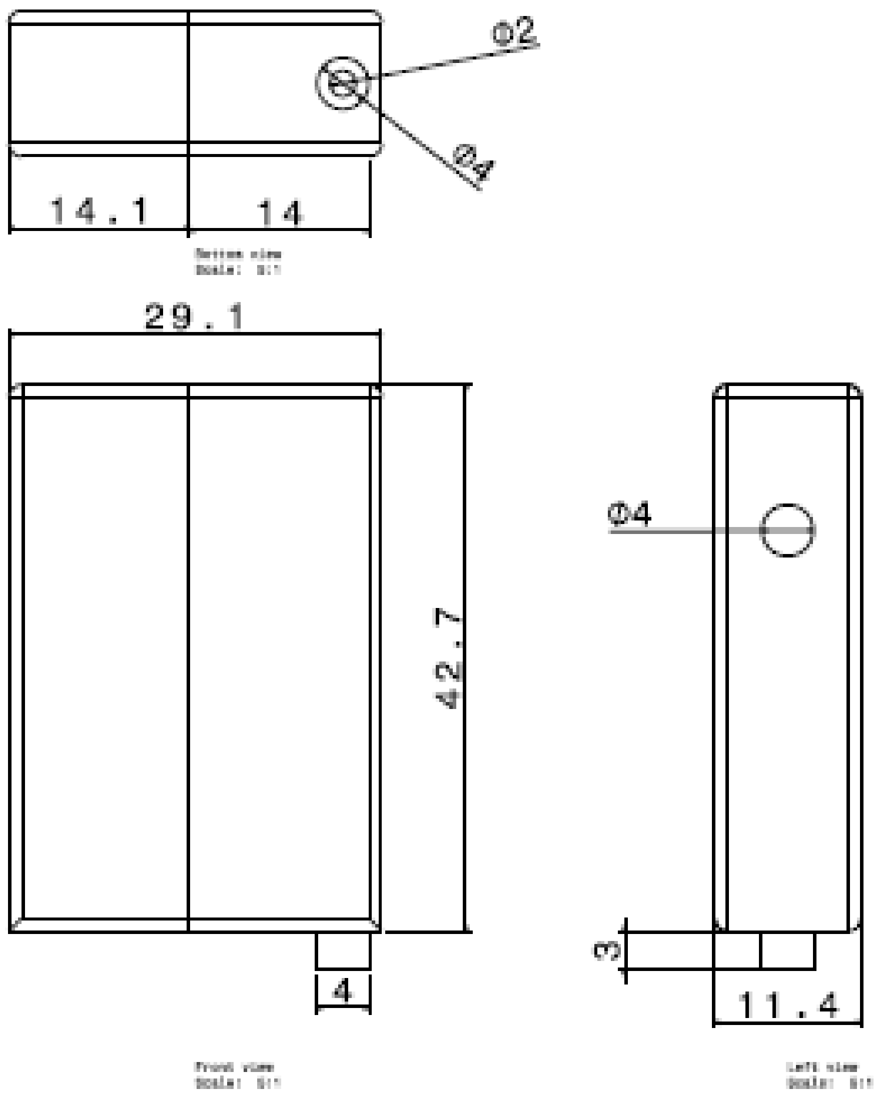
APPENDIX J

Detail drawing of Casing



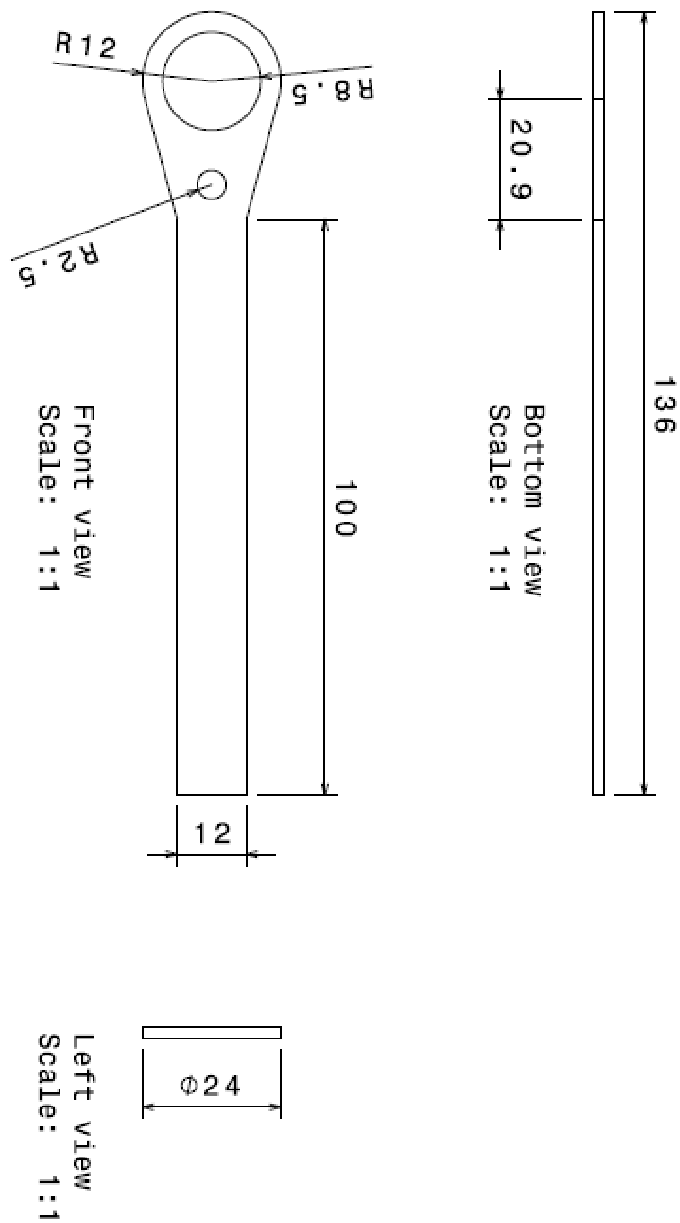
APPENDIX K

Detail drawing of Container



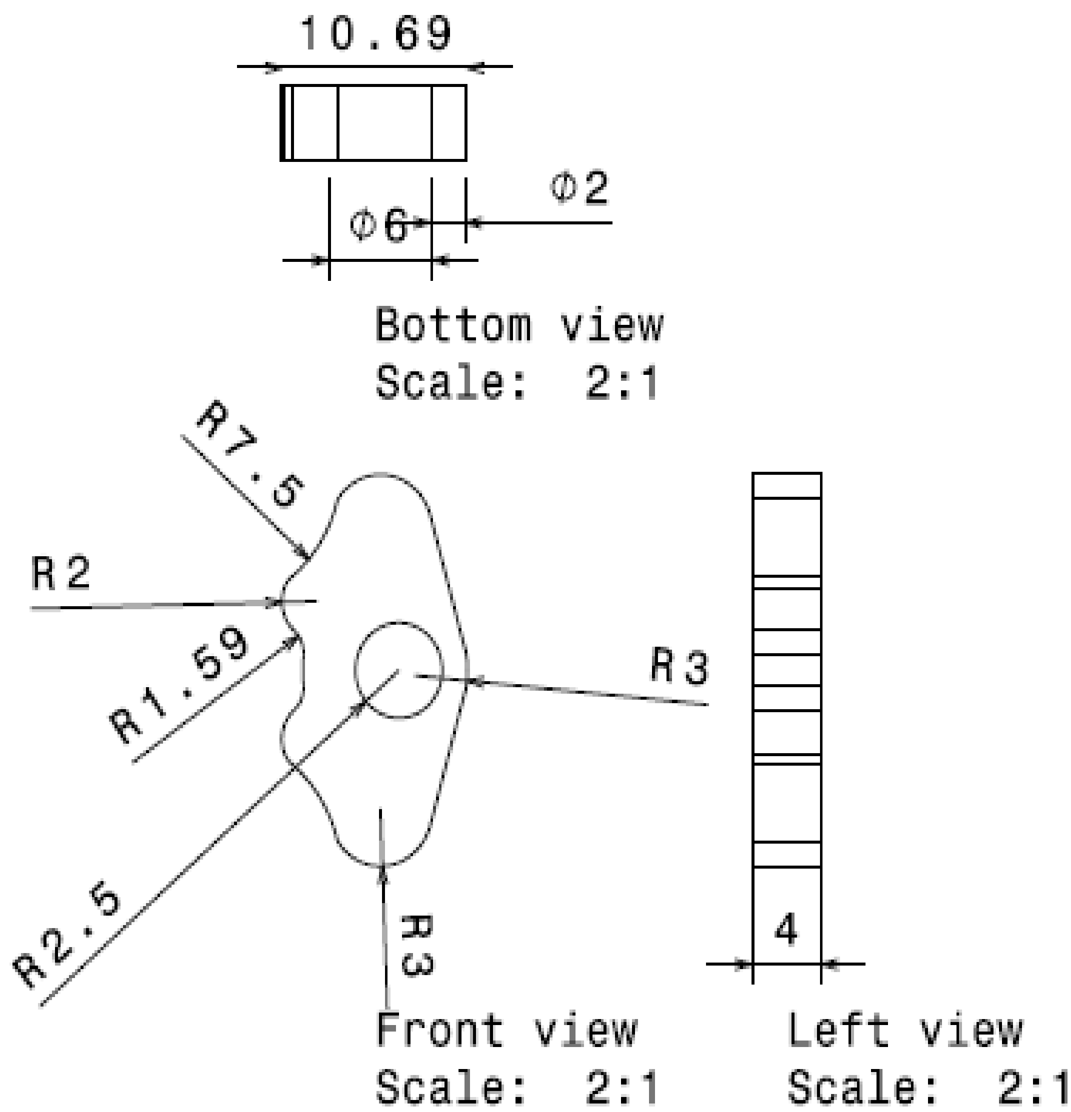
APPENDIX L

Detail drawing of Handle



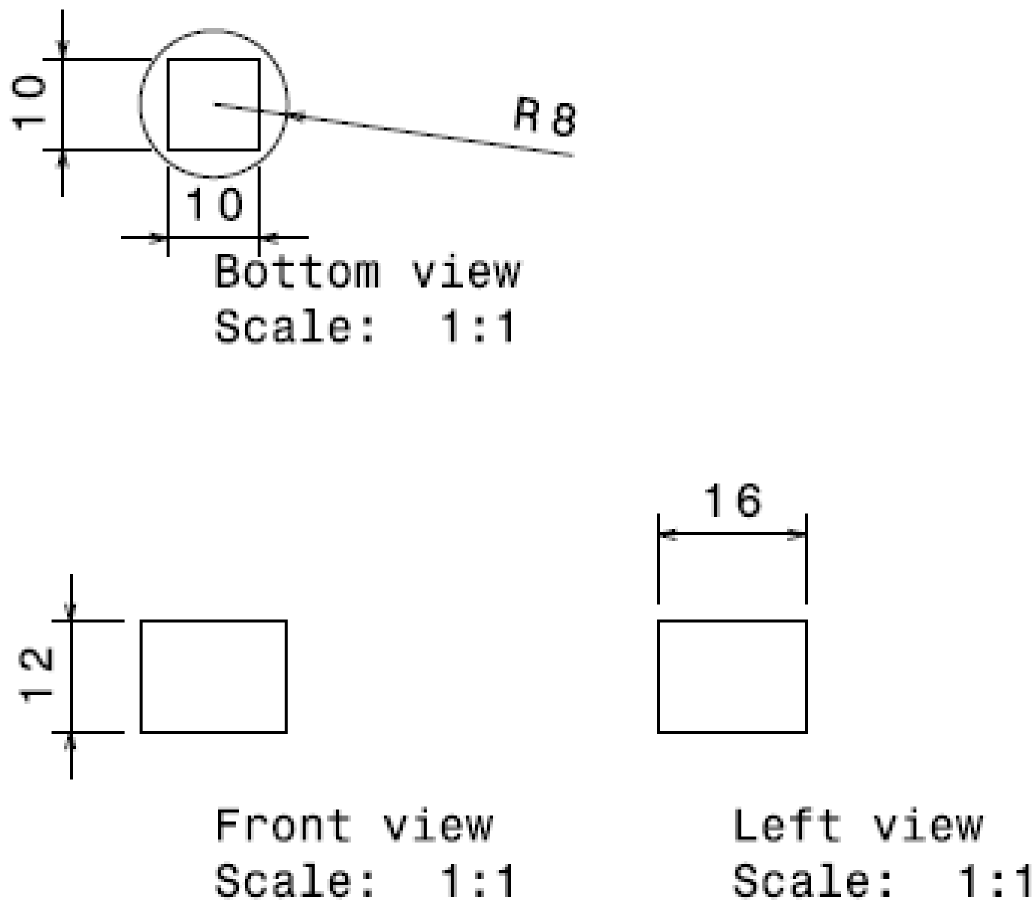
APPENDIX M

Detail drawing of Pawl



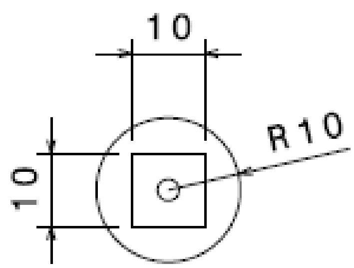
APPENDIX N

Detail drawing of Shaft

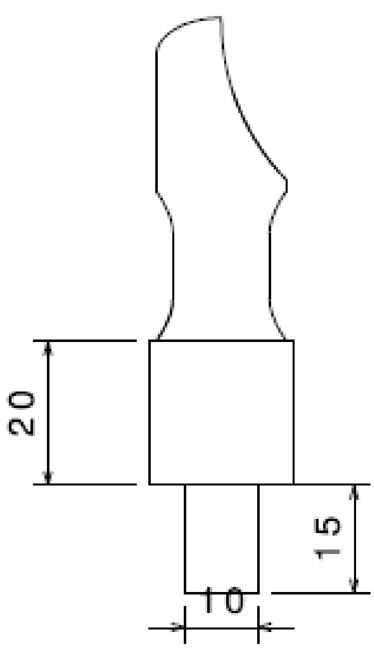


APPENDIX O

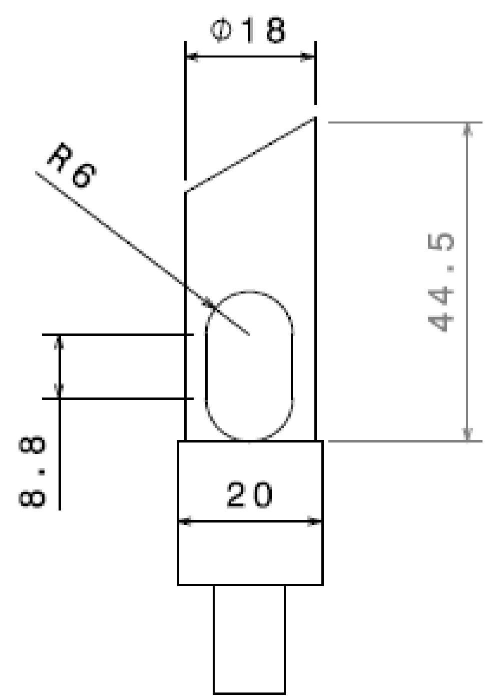
Detail drawing of Reamer blade



Bottom view
Scale: 1:1



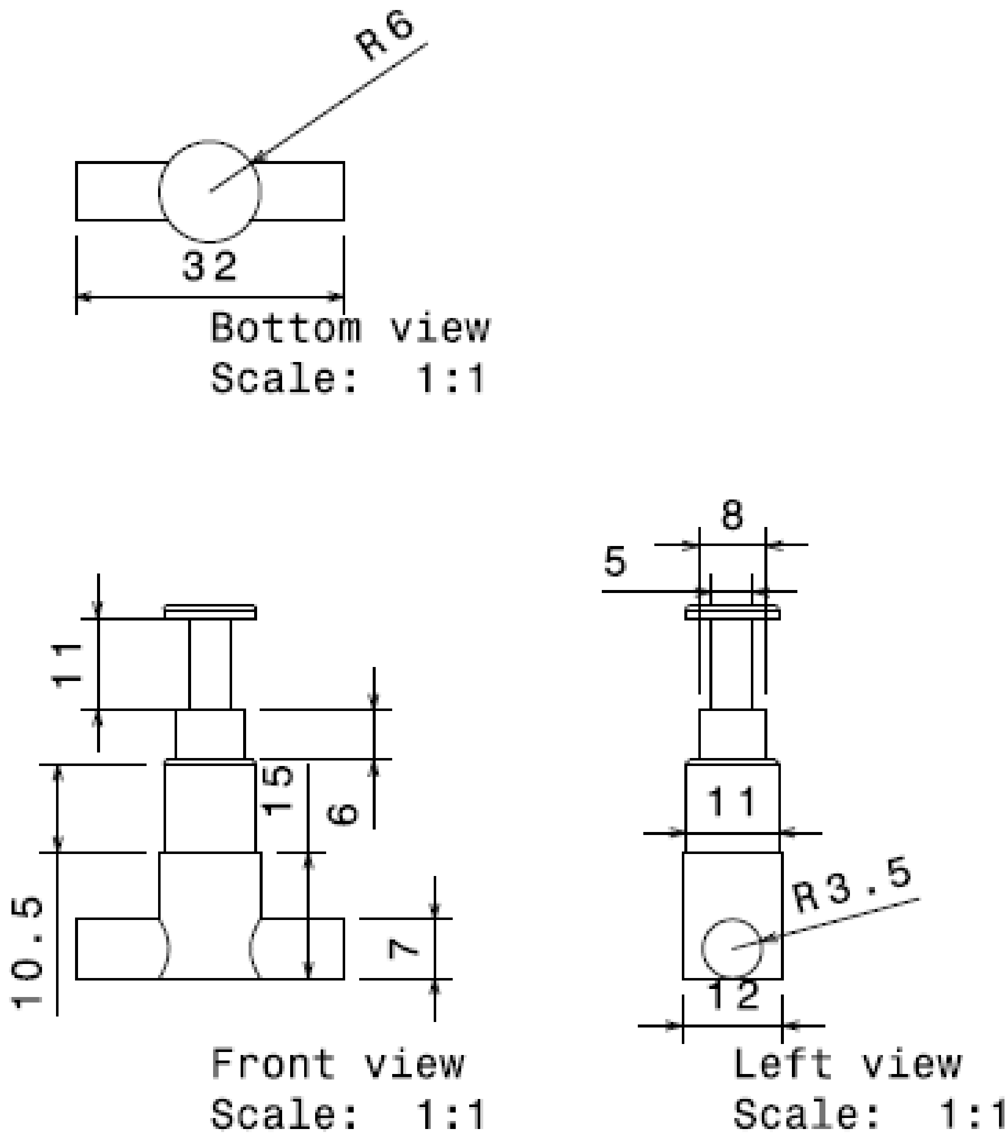
Front view
Scale: 1:1



Left view
Scale: 1:1

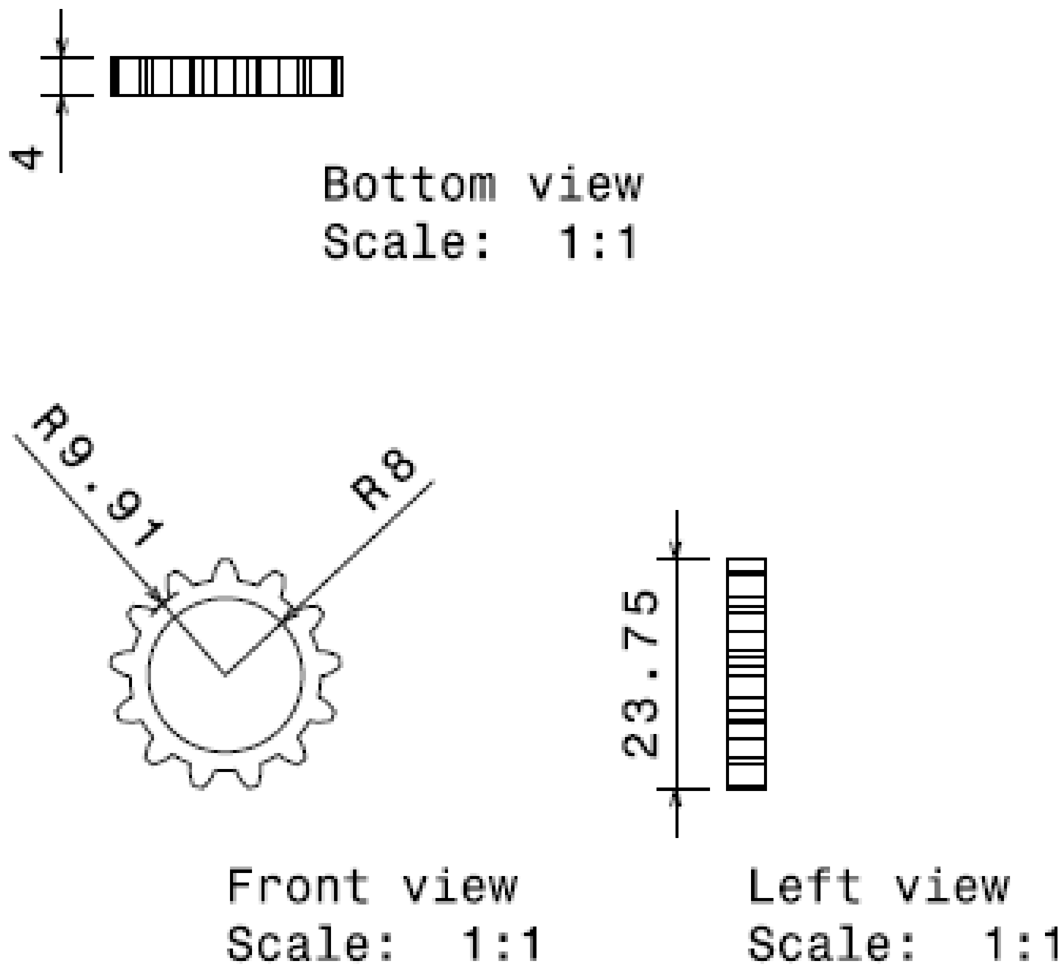
APPENDIX P

Detail drawing of Pump



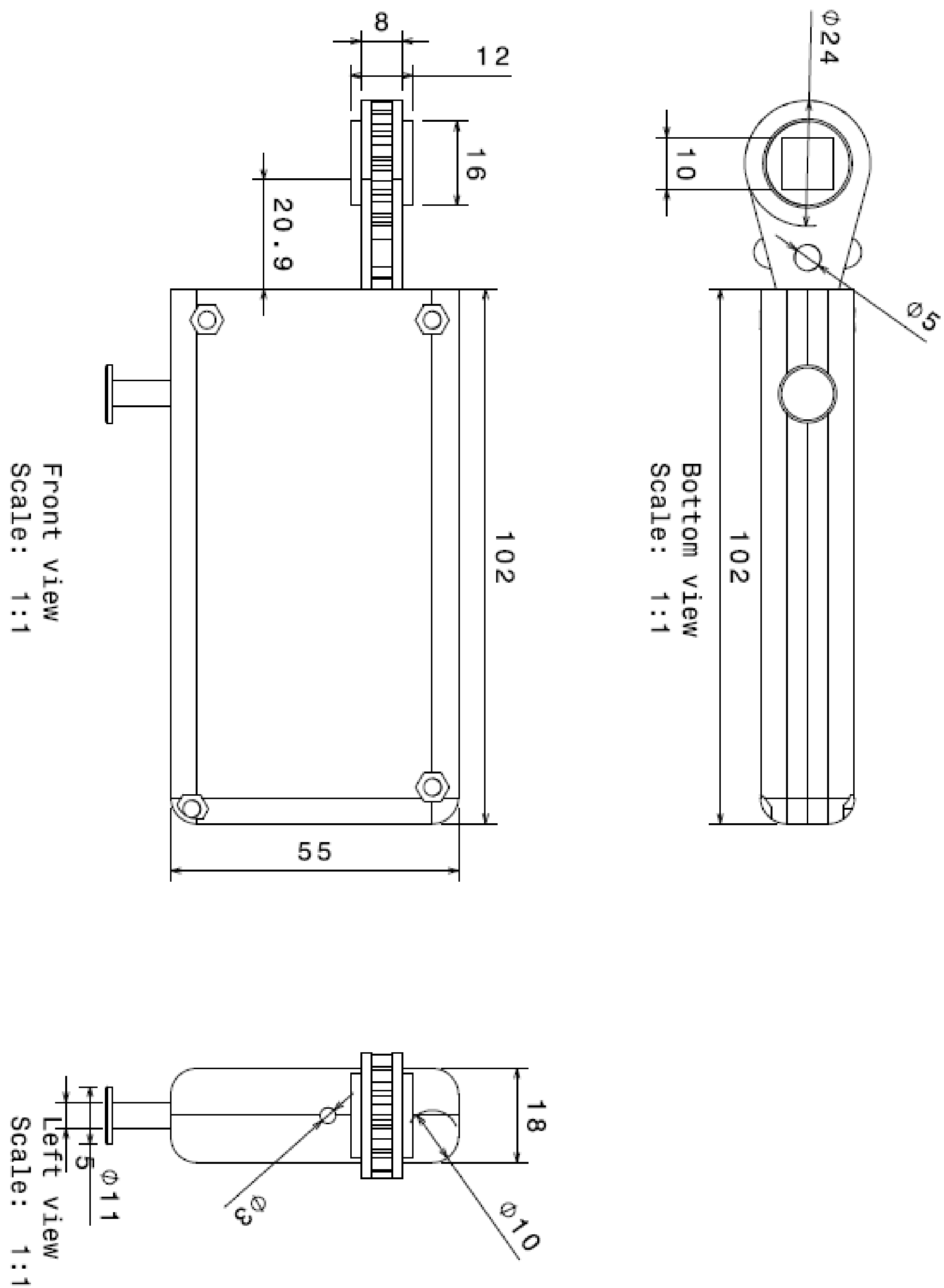
APPENDIX Q

Detail drawing of Gear



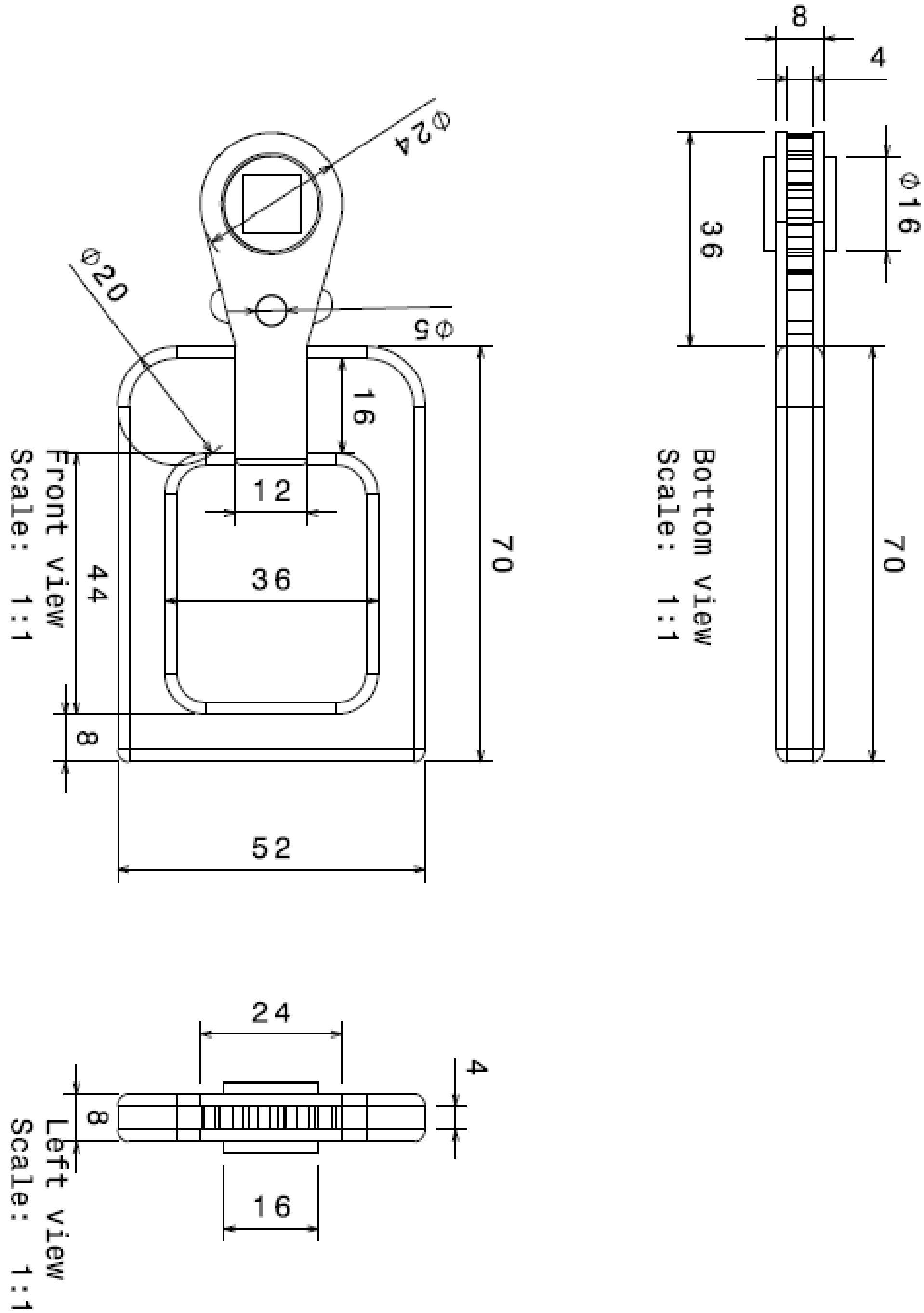
APPENDIX R

Detail drawing of Design concept A



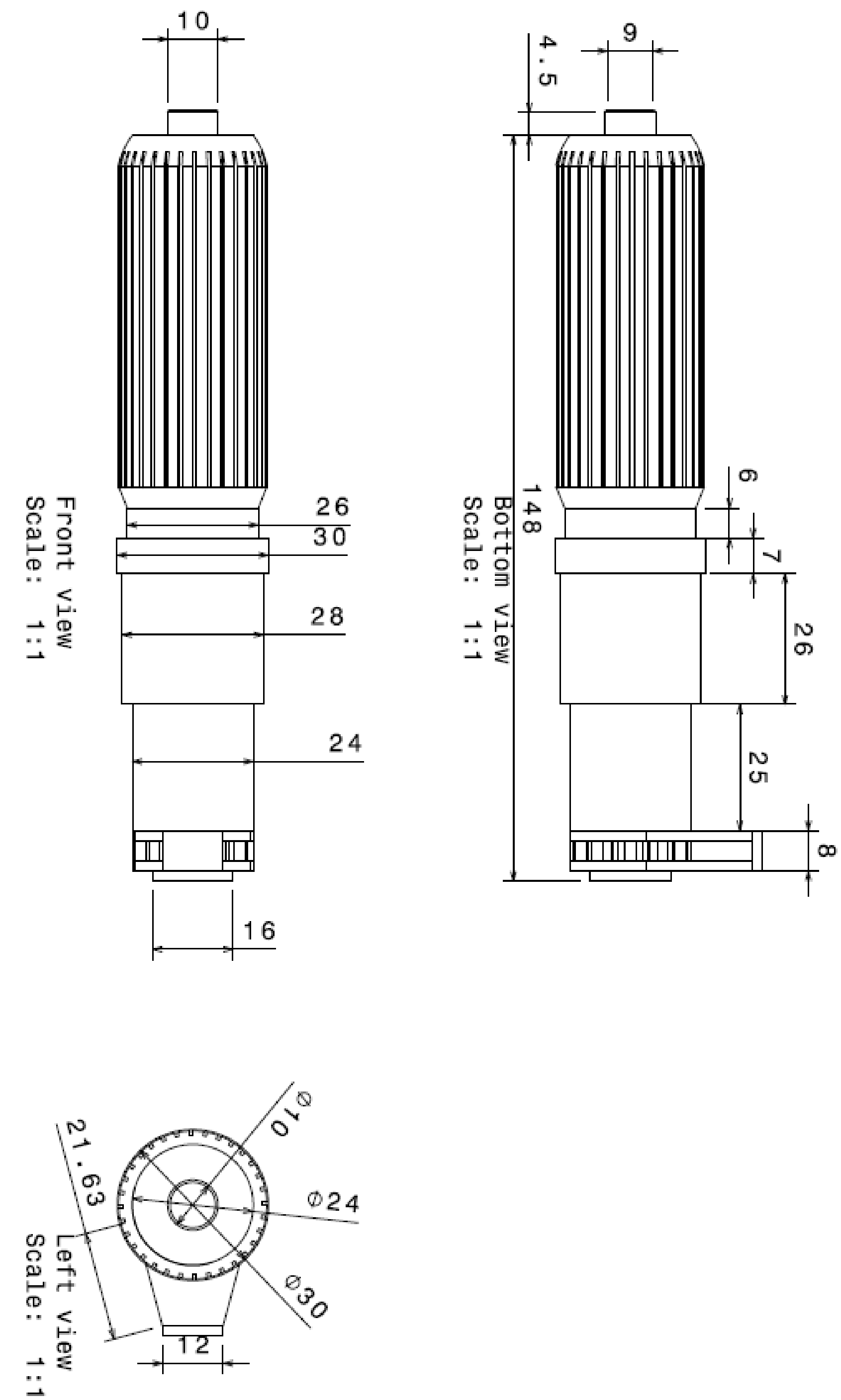
APPENDIX S

Detail drawing of Design concept B



APPENDIX T

Detail drawing of Design concept C



APPENDIX U

Table 4.3: Properties of Standard Steel A36

Standard Steel A36	
Mechanical Properties	**Metric**
Tensile Strength, Ultimate	620 MPa Temperature -78.0 °C
Tensile Strength, Yield	550 MPa Strain 0.200 %
Elongation at Break	12.0 % Temperature -195 °C
Modulus of Elasticity	199 GPa Temperature -78.0 °C
Fatigue Strength	400 MPa Temperature -78.0 °C
Shear Modulus	76.5 GPa Temperature -78.0 °C

APPENDIX V

Table 4.4: Properties of Polymer type

Polymer Type	Ultimate Tensile Strength (MPa)	Elongation (%)	Tensile Modulus (GPa)
ABS	40	30	2.3
ABS + 30% Glass Fiber	60	2	9
Acetal Copolymer	60	45	2.7
Acetal Copolymer + 30% Glass Fiber	110	3	9.5
Acrylic	70	5	3.2
Nylon 6	70	90	1.8
Polyamide-Imide	110	6	4.5
Polycarbonate	70	100	2.6
Polyethylene, HDPE	15	500	0.8
Polyethylene Terephthalate (PET)	55	125	2.7
Polyimide	85	7	2.5
Polyimide + Glass Fiber	150	2	12
Polypropylene	40	100	1.9
Polystyrene	40	7	3