

# **Abstract**

## **Introduction:**

Wire drawing is a cold working process, in the process the workpiece is pulled through a single or series of drawing die. There are numerous types for wire drawing including electrical wiring, cables, tension-loaded structural components and springs. Wire drawing is quite simple in concept. Basically, it is pulling a wire through a die with the use of lubricants to decrease the friction between the die and the wire. The objective of the wire drawing process is to reduce the cross-section with better surface finishing in a simple yet efficient way. also, we aim to make an adjustable die to suit the necessary specifications. The knowledge and skills required in order to succeed with the project are understanding the properties of materials, sufficient knowledge in cold working processes, including the mechanism of wire drawing process, grain refinement, structure of materials, and the stresses applied on the specimen. We are seeking to implement the wire drawing mechanism in the mechanical labs at PMU.

## **Problem Definition:**

The requirements of the project are rollers to get rid of the outer layer of the wire, lubricants to coat the wires to reduce the friction and increase the lifetime of the dies, multiple dies to reach the specifications required, a motor to pull the wire out of the die. Some of constraints of the project are that the wire drawing takes up a lot of space and time depending the application for example to make telephone wires it is required to draw it 20-30 times. The main constraint of the project is that the conventional dies have fixed diameters we aim to make it adjustable.

### **Current Status of Art:**

The current technologies used are fixed diameter dies in this case we need to make multiple dies. However, we aim to make at an adjustable die to suit the specifications needed for different applications. There are numerous advantages of wire drawing such as the rod can be manufactured to the required specific size diameter, improves the finish surface and removes scale from the rod, improves the tensile strength in the finished material, and provides more consistent round shape of the workpiece. However, there are some disadvantages such as limitation on cross-sectional area reduction, special sleeves required to assist the workpiece driving into the die, process is costly for low production rate.

### **Engineering Approach, Constraint and Standard:**

The wire drawing mechanism is mainly used to reduce the cross-sectional area with the help of multiple dies that the wire used is pulled through by a motor, the wires are coated with lubricants to decrease the friction. However, by using an adjustable die we can solve the problem of having fixed dies which requires us either to add multiple dies or have the wire manufactured in a specific way.

### **Tasks and Deliverables:**

First of all, we are planning to visit a company specialized in wire drawing to get a wider understanding on the subject. Also, to start with the prototype we need to get the fixed dies and implement our own adjustable dies. Moreover, we need to test different kinds of lubrication in order to apply it on our prototype, and a motor to pull the wire.

**Project Management:**

Some of the facilities we will use are the mechanical labs at PMU. Regarding the safety concerns the wire drawing process is not dangerous at all but, the technician should not touch the machine while it is functioning.

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## CHAPTER 1: INTRODUCTION

Strengthening refers to the process of adjusting the mechanical properties of a particular material to be used for its designed purpose. There are some ways in which this can be achieved. For example:

- Work Hardening
- Grain boundary strengthening
- Solid solution strengthening and alloying
- Precipitation hardening
- Transformation hardening

In this chapter grain boundary strengthening, work hardening, age hardening, and solid solution hardening will be discussed.

### **Grain boundary strengthening:**

The grain size has a great effect on metals that exist in polycrystalline form. Therefore, strengthening using this method relies on the fact that there are low chances for dislocation to pass from grain to grain. This is due to the existing relationship of the different crystallographic orientation nature of grains which increases grain boundaries [1].

During deformation, slip motion occurs. There two reasons for the grain boundaries functioning as dislocation barriers:

-Dislocation causes different orientation of the grains resulting in change in direction of movement

-Stop slip planes from grain to grain.

It is safe to conclude that, the effort needed to achieve dislocation that can plastically deform a particular material is dependent on the grain size. Materials with large grain size retain force used during dislocations. Thus, very little effort is required to push this force from grain to grain. For materials with smaller grains, a lot more effort is required during dislocation.

Reducing grain size contributes to the rigidity of a material [1].

The goal for using strengthening techniques is to make a material tougher and resilient to dislocation motion.

### **Work hardening:**

Work hardening which is also referred to as strain hardening. It occurs by strengthening a metal using plastic deformation. Alloys that can withstand pressures of high heat are usually work hardened. These include low-carbon Steel, pure Copper, and Aluminum.

### **Age hardening:**

Age hardening refers to a strengthening process that involves the application of heat treatment to harden metals as well as alloys. This process is also referred to as **precipitation hardening**. It involves the use of solid impurities/precipitates hence the name. The aging process of a metal can be done in two ways; heating or storing in low temperature. This facilitates precipitation. Nickel, Magnesium, Titanium and their alloys are the common malleable used. This method is also suitable for other types of steel [1].

The amount of heat applied depends on the material to be used and the desired results. During the process, the tensile and yield strength grows. The precipitates formed prevent dislocation from taking place. Heat applied also weakens the metal crystal lattice which in turn hardens the material.

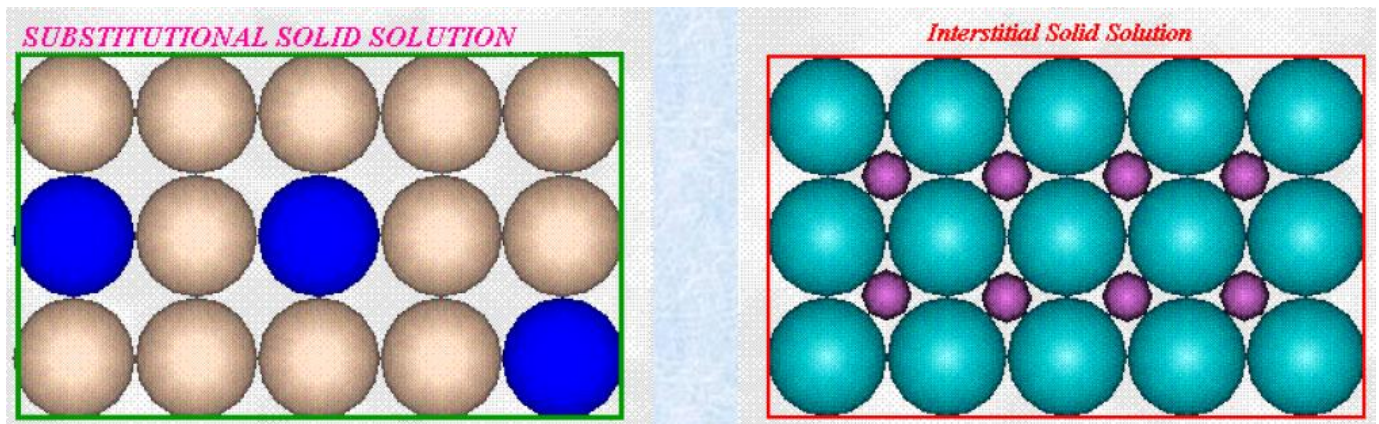
The metal needs to be under high temperatures for a long time. This results in the name ‘age hardening.’

### **Solid solution hardening:**

This refers to the process of adding one metal to another – a process is a form of alloying. The purpose of the procedure is to strengthen the pure metal. Solute atoms of one element are added to another element which is in a crystalline lattice form to form a solution. There is however a level to which no more solute can be dissolved. This is the solubility limit [2].

Two types of solutions could be formed. These are:

1. Substitutional solid solution
2. Interstitial solid solution



A substitutional solid solution is as a result of large solute atoms that take the existing positions previously occupied by solvent atoms in their lattice form.

Interstitial solid solution occurs when the solute atoms are small enough and fit between solvent atoms at interstitial sites.

A commonly used solvent is Copper.

**Objective:**

This project seeks to:

- Give detailed information on the wire drawing process.
- Understand the metallurgy process as it relates to wire drawing.
- Point out on design modification.

## CHAPTER 2: LITERATURE REVIEW

### 2.1 Introduction:

Materials with defects appear stronger. The study of defects is categorized in dimensions. These are:

- Point defects. Interstitials and vacancies.
- Linear defects: Dislocations (edge, screw mixed)
- Grain boundaries, surfaces
- Extended defects: pores, cracks

The principle used behind strengthening using grain reduction is that there are low chances that a dislocation can pass through from grain to grain when they are not in order. This sort of disorder results in a discontinuity in the slip planes. Dislocations can pass through small angle grain boundaries [1]. Similarly, when force is applied at the end of a high- angle grain boundary, new dislocations are formed in adjacent grain boundaries.

Finer grains constitute too large areas of grain boundaries. The level of toughness of a material increases greatly when grains have reduced. There is a co-relationship between the yield strength and the grain size.

Also, solidification and plastic deformation control the grain size.

This chapter gives a detailed description of the imperfections of the crystal structure.

These are:

- Point defects
- Line defects
- Planar defects

- Linear defects
- Dislocations (edge and screw dislocations)
- Grain boundary
- Strengthening grain
- Strain hardening/work hardening

Also, the relationship of metal properties with regards to:

- i. Cold working
- ii. Drawing process
- iii. Heat treatment

## **2.2 Imperfection of crystal structure**

### **2.2.1 Point Defects:**

Point defects refer to atoms that are absent in a lattice point. Types of point defects are:

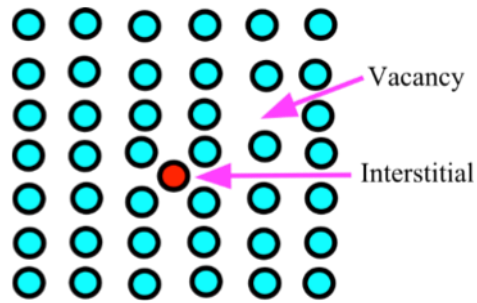
Self-interstitial atoms –These are defects that contain,

**Vacancies** – Also known as Schottky effect, this situation arises when atoms are absent from a lattice position [3].

**Self- Interstitial impurity atoms** – This is a form of defect that contains atoms that are similar to those already in the lattice.

**Substitutional atom** – This occurs when introduced atoms take space of other existing atoms in the initial metal.

**Frenkel defect** – This is as a result of a self-existing atom occupying a vacant site that it does not belong to [3].



**\*Fig 2.1 Types of point defect of crystals. [3]**

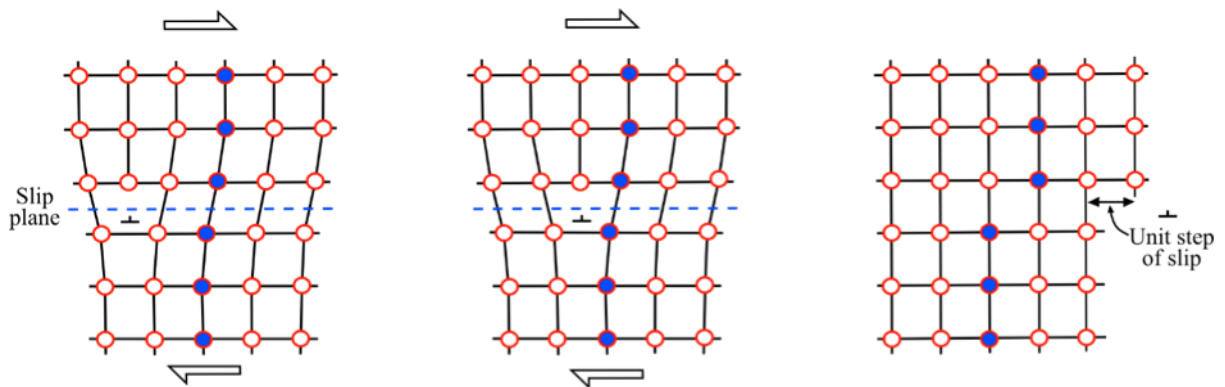
### 2.2.2 Line defects

Line defects are simply categorized into edges and screws.

#### 2.2.2.1 Edge dislocations:

This type of dislocation occurs as a result of an extra plane of atoms which are existent replacing a half plane of atoms in the middle of a lattice.

Edge dislocations make metals possess the characteristics of malleability and ductility [3].



**\*Fig 2.2 Edge Dislocation [3]**

#### **2.2.2.2 Screw dislocations:**

Screw dislocation, a category of line dislocation, takes place when a section of the planes atoms in the lattice solution shifts to take a different route. In this case, atomic planes spiral hence motion is perpendicular to the area that force is applied. The Burgers vector determines the quantity characterization between distorted crystals and otherwise perfect crystals.

Work hardening increases dislocation density. Dislocation density refers to the total length of dislocations in a unit crystal. However, cracks and fractures could form if the dislocation density is enhanced [3].

#### **2.2.3 Planar defects:**

Plan defects are deformities in otherwise complete crystal structures. An important planar defect is the grain boundary. Grain boundaries divide regions that have different types of grains.

Boundaries existing between two grains could be as a result of the grains rotating in the different axis in a crystal lattice. Grain boundaries exist when there are different types of rotation axes.

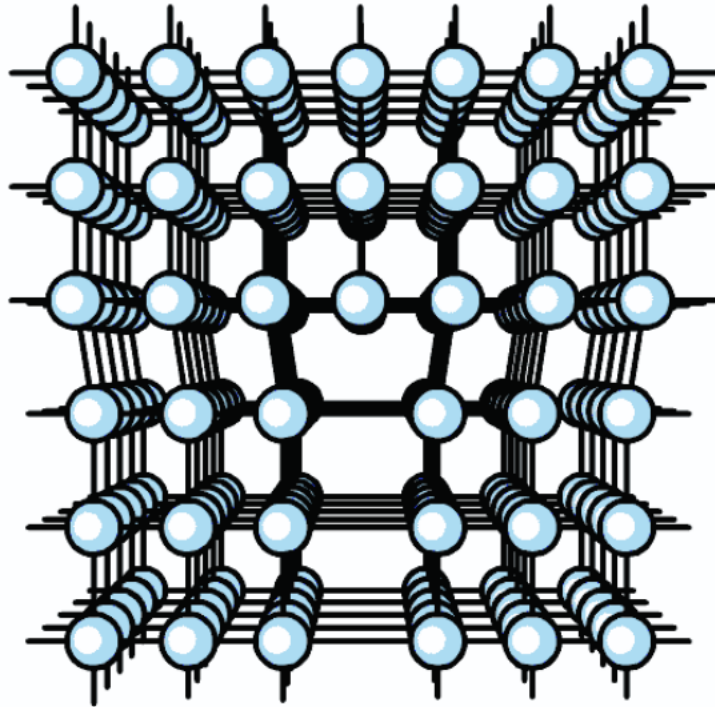
#### **2.2.4 Linear defect- dislocations:**

Dislocations are another form of defects in crystals. These occur when atoms are displaced in a crystal structure. When stress is applied, dislocations are formed and move. There are two main types of dislocations. These are screw and edge dislocations. The edge and screw dislocation represent the final stages of dislocation. Other forms of dislocations are a combination of the two.

#### **2.2.5 Edge dislocation:**

The edge defect refers to an extra half plane of atoms. It is categorized as a line defect due to the location of the defective points. They are produced in the lattice in a parallel manner. The line runs

along the top of the other half plane. Deformation of atomic bonds occurs in the area surrounding the dislocation line.

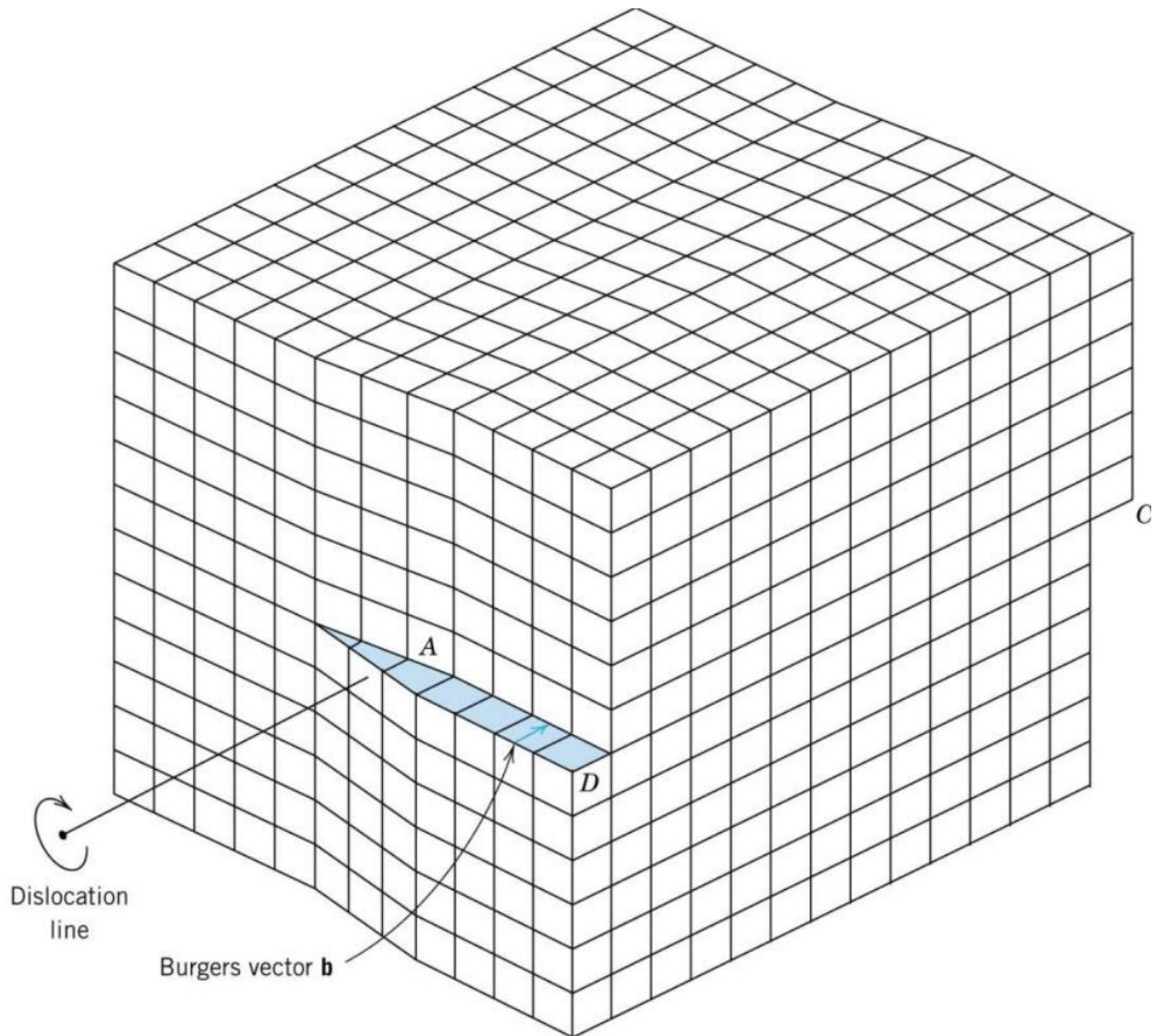


**\*Fig. 2.3 Edge dislocation [3]**

The direction of movement of a dislocation explains why deformation occurs when little stress is applied in a portioned area than when in a whole perfect crystal. An analogy that could best explain this is the caterpillar analogy. A caterpillar requires a large force to move its whole body. However, the caterpillar moves its rear end creating a hump movement. This later results in moving the body forward in small sequences.

### 2.2.6 Screw dislocation:

An analogy that could best explain the screw dislocation is a block of metal having stress applied on one end till the metal begins to tear apart.



**\*Fig 2.4 Screw dislocation[3]**

The image of figure 2.4 illustrates the plane of atoms that are just above where the materials rip. Atoms that have been indicated by blue have retained their position. However, those in red have occupied new positions forming metallic bonds. Green represents atoms in motion. Green

represents motion. At any given moment, bonds are broken in small portions. Similarly to edge dislocation, less stress is applied which breaks bonds in the middle plane all at the same time. If the stress applied to the shear increases, atoms would fall on the right side. The motion will take place in the red atoms; the blue atoms will then be dislocated. In this way, screw dislocation taking place upwards, perpendicular to the direction of the force. Edge dislocation, however, moves parallel to the direction of stress. Dislocations occur along dense planes of atoms in a material. The reason is that force that is required to move dislocations need stop to be increased if there are spaces between the planes. An example of planes that have dislocations going through is FCC and BCC metals. Their planes are dense. These materials, in turn, are very ductile. Strengthening of metals makes it almost impossible for dislocations to move. For this to be possible, obstacles such as interstitial atoms and grain boundaries are used to prevent dislocations. Point of notice: during plastic deformation of a material, a large number of dislocations are produced. Colluding of these deformations restricts movement. This results to strain or work hardening.

### **2.3 Planar defects:**

When a long-range stacking sequence is disrupted the following two crystal effects take place;

- Stacking fault
- Twin region

The change observed in a stacking sequence due to a few atomic spaces results into a stacking fault. However, change in many atomic spaces results in a twin region. Stacking forms occur when one or two layers are interrupted in atomic planes of a stacking sequence. They easily happen in closed packed structures.

#### **2.4 Grain boundary strengthening grain:**

Grains are separated by grain boundaries that are of different crystallographic orientations. The structures consist of grain boundary dislocations that are stationary but produce an extensive slip.

Reducing the grain size acts as a restriction to slip.

- Small grain size increase barriers to slip
- The strength of barriers increases with misorientations.

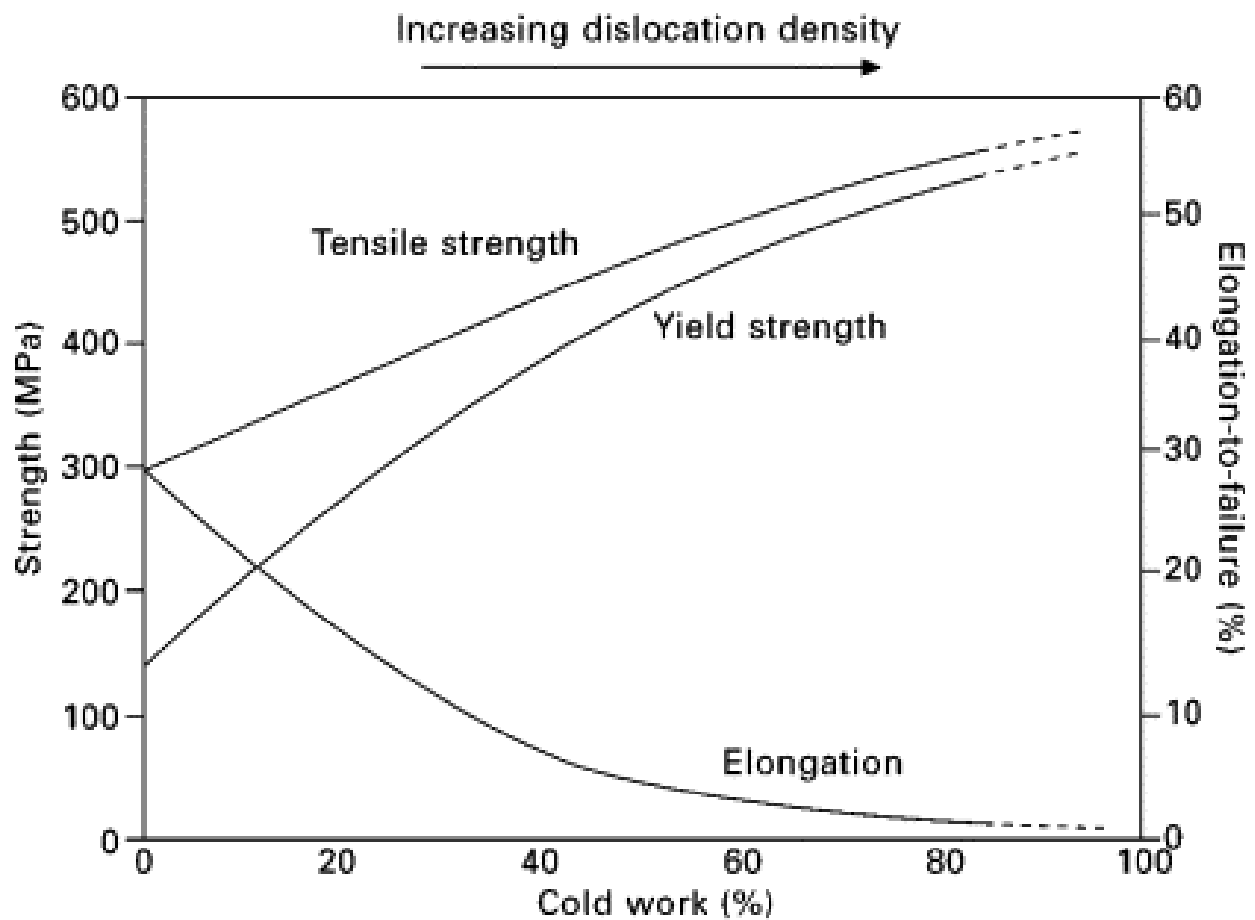
#### **2.5 Strain Hardening:**

This is a technique that is applied when heat treatment is not applicable. It is used to harden alloys.

When cold work is increased, ductility is reduced. The amount of strain hardening to be used is greater in cubic metals than in HCP. A pure metal that has been cold worked is not as tough as a cold-worked solid solution alloy.

### 2.5.1 Cold working:

Cold working is the process in which metals are plastically deformed below the recrystallization temperature.



\*Reduction by cold work %

\*Fig 2.5 Variation of tensile properties in response to cold-work. [5]

There are some benefits that would lead a manufacturer into selecting cold working over hot working [1].

- No heat requirement
- Good service fishing.

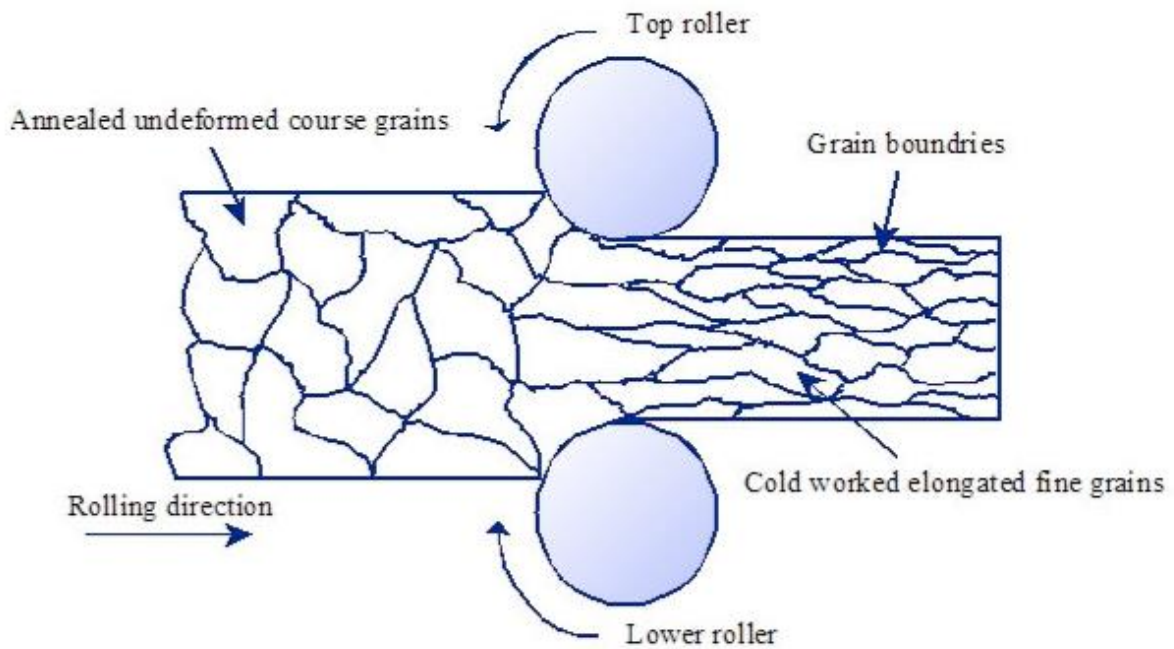
- Less risk of contamination
- Superiority in dimension control
- Greater strength properties.

The disadvantages are [1]:

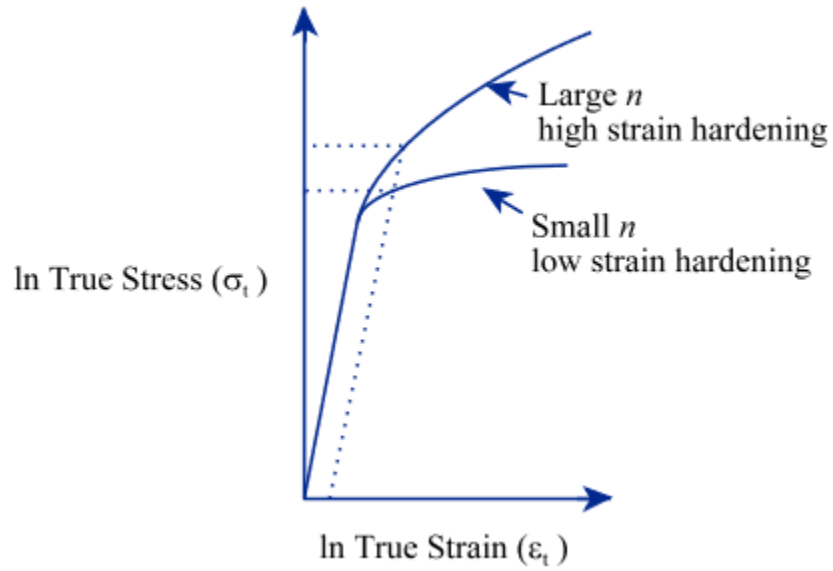
- High level of stress is required for deformation to occur
- The materials have less ductility
- The surfaces of metal have to be clean with no contamination.
- The process requires very heavy equipment to be used.
- High cost

### **2.5.2 Annealing of cold worked metal:**

Annealing is done at high temperatures, which also soften the metal in the process, to prevent staining during the cold working process. Annealing is used in metal to restore its ductility characteristic.



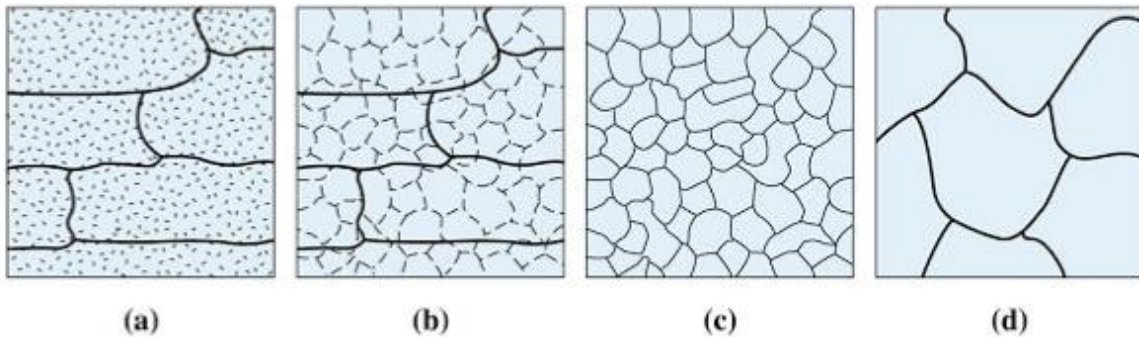
**\*Fig 2.6 Rolling operation showing deformation of grains. [6]**



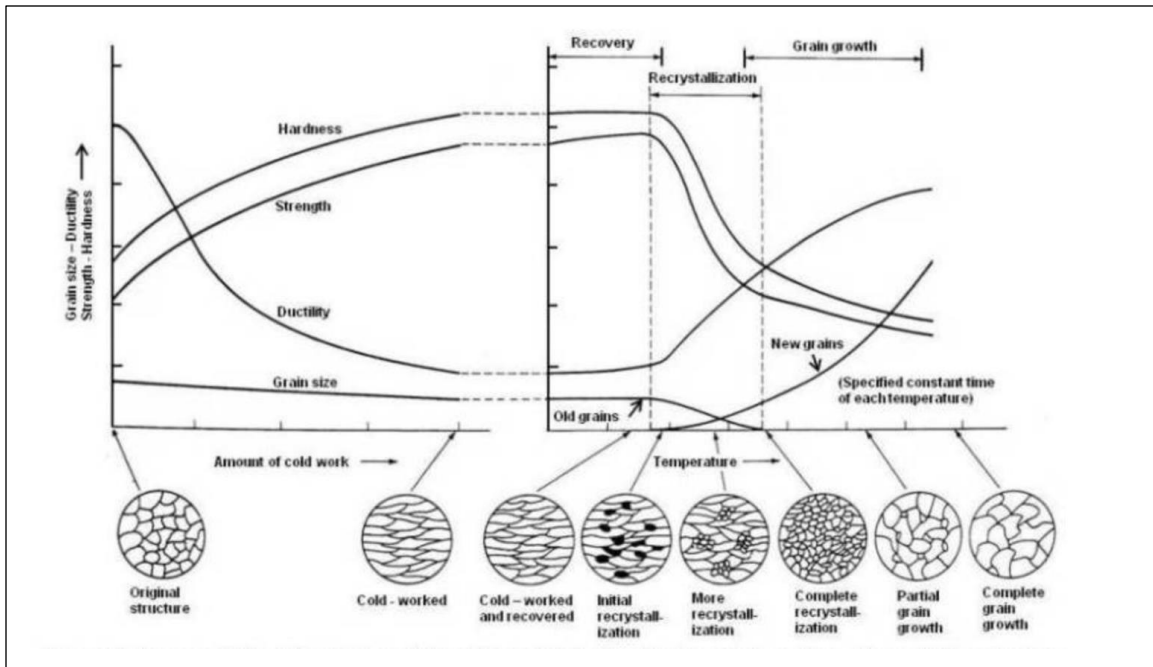
**\*Fig 2.6 True stress vs. true strain diagram [6]**

The process is divided into the following stages:

- Recovery
- Recrystallization
- Grain growth



**\*Fig 2.8 The effect of annealing on the microstructure (a) cold work, (b) after recovery, (c) after recrystallization, (d) after grain growth. [6]**



**\*Fig 2.9 The change in properties during recovery, recrystallization and grain growth**

## Chapter 3

### **Introduction:**

Wire drawing is a metalworking process which uses tensile force to stretch the materials by pulling it through a single or series of drawing dies. It is two types: sheet metal drawing, wire, bar, and tube drawing. the specific definition for sheet metal drawing is that it involves plastic deformation over a curved roller. For wire, bar, and tube drawing the starting stock is drawn through a die to reduce its diameter. Also, by doing that process the length and strength increase. These processes are usually done at room temperature, thus classified as a cold working process. The wire drawing process is quite simple in concept. the wire is prepared by shrinking the beginning of it by hammering, filling rolling or swaging, so it will fit through the die. As the wire is pulled through the die, its volume remains the same, so as the diameter decreases the length increases, usually the wire requires more than one draw through a series of smaller dies to reach the desired size. The process of wire drawing changes material properties due to cold working, the area reduction is generally 15-25% and in large wires is 20-45%. However, it may be performed at elevated temperatures to hot work large wires, rods or hollow sections in order to reduce the force required to deform it. In this chapter we will discuss the design of the wire drawing mechanism, the adjustable die, and material selection.

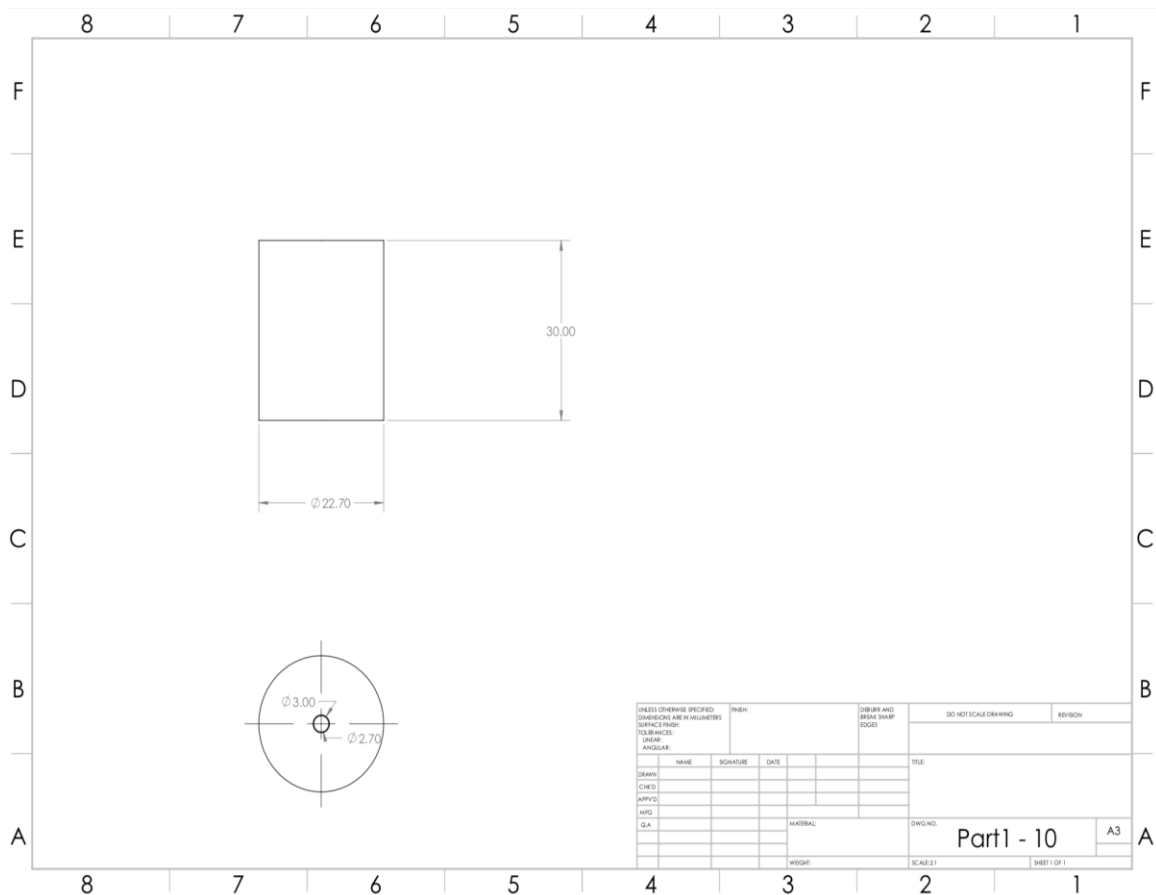
### **Material Selection:**

The wire drawing process can be done on any kind of metals. The yield strength of the die must be larger than the yield strength of the wire to avoid deformation or failure in the die. The wire that will be selected for the design is the galvanized steel with code: ASTM-A653 According to the American Society for Testing and Materials standards the tensile strength is varying between

465-501 MPa and the yield strength is varying between 445-473 MPa. Therefore, the die must have a yield and tensile strength more than the Galvanized Steel ASTM-A653.

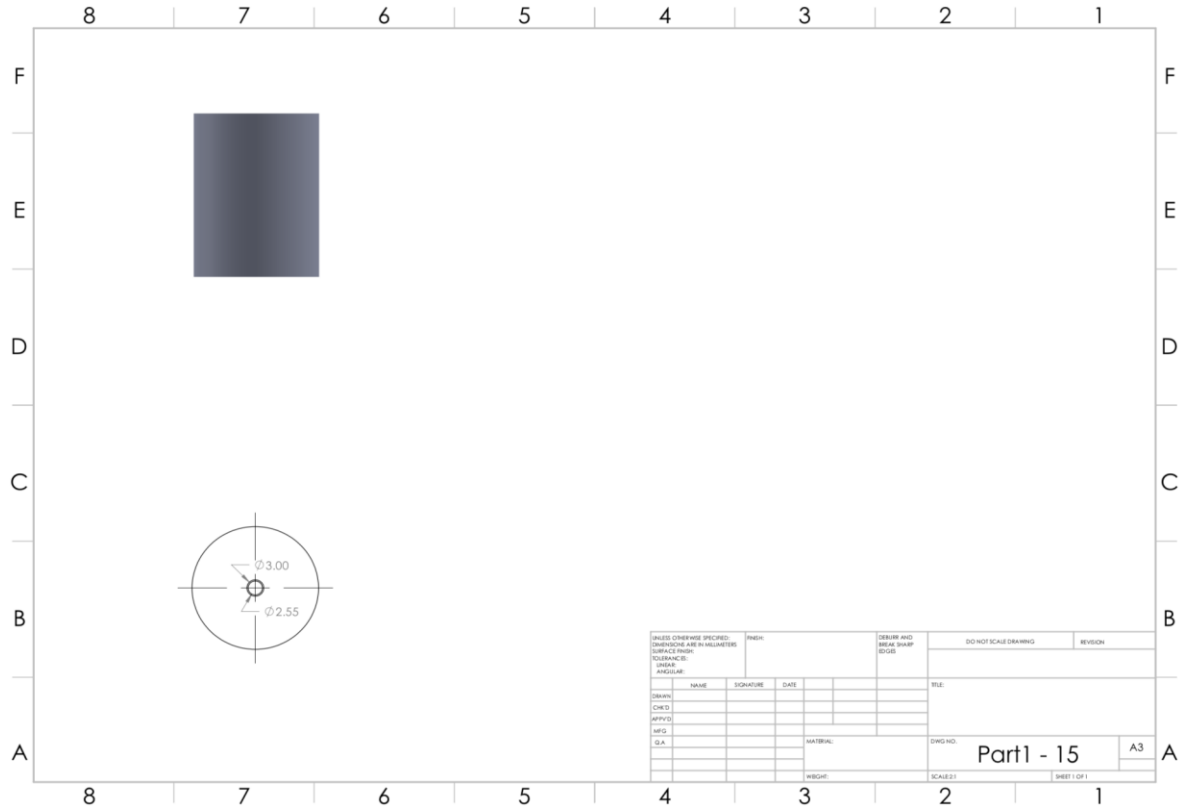
**Calculation:**

A 3 mm galvanized steel wire is used. The die designed to has four different sizes. The first hole diameter reduction is 10%. starting from 3mm to 2.70 mm as shown in figure 1.



**\*Fig 3.1 Solidworks 2D Drawing [1]**

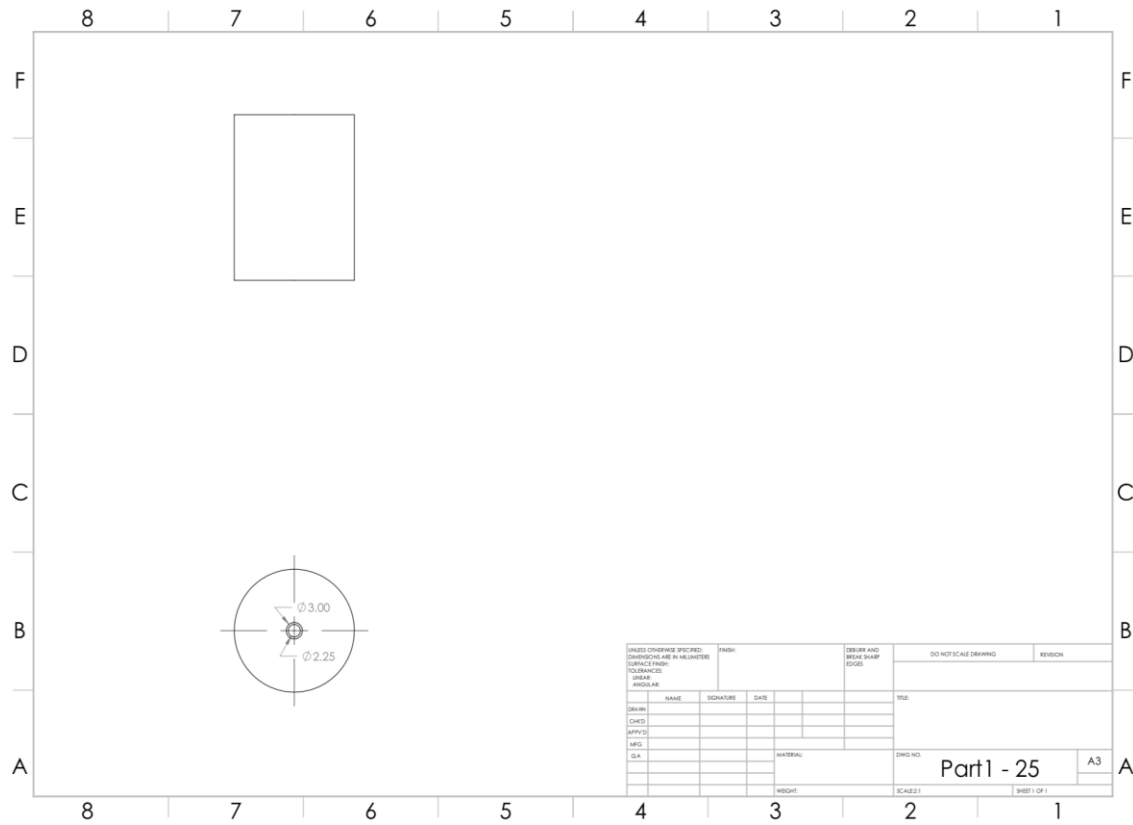
The second hole the diameter reduction is 15%. Starting from 3 mm to 2.55 mm as shown in Figure 2.



**\*Fig 3.2 Solidworks 2D Drawing [2]**



The fourth hole the reduction was 25%. starting from 3mm to 2.25mm as shown in figure 4.

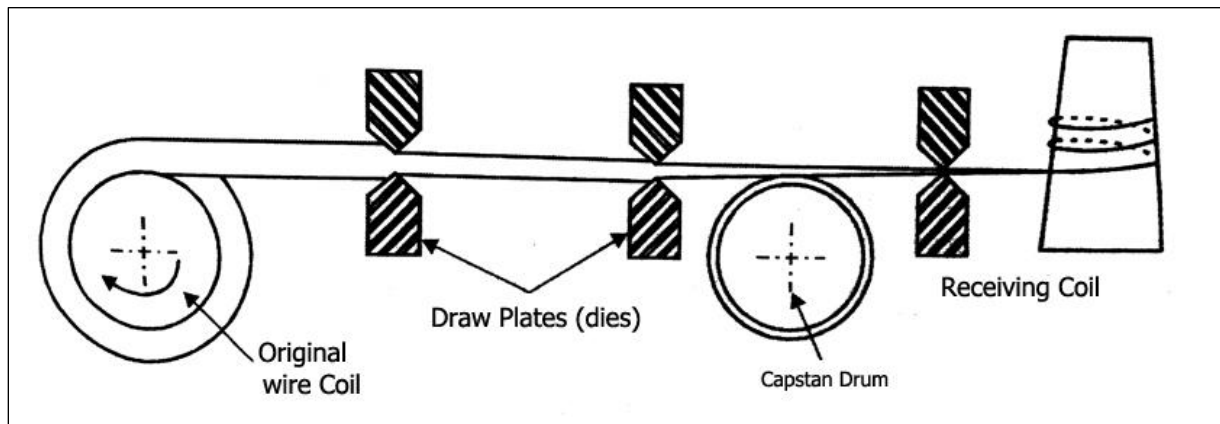


**\*Fig 3.4 Solidworks 2D Drawing [4]**

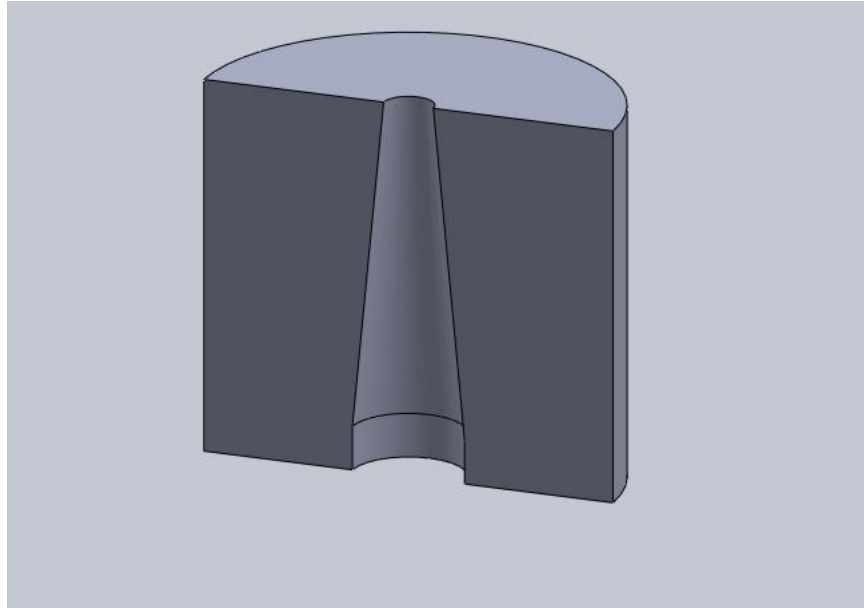


### System Setup and Design:

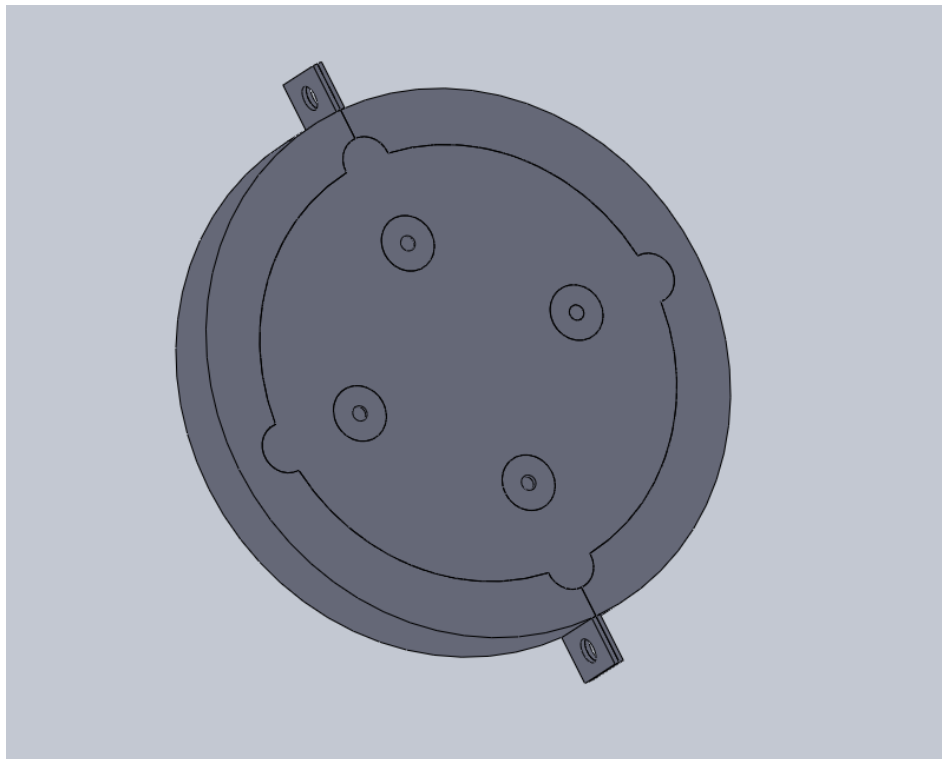
There are four main parts that are necessary for the design which are; rollers, lubricants, a drawing die, and a motor. Starting from the first stage, the wire goes around rollers, it is used to put the wire in a zig-zag pattern to get rid of scale. The second stage is lubrication which has two types wet lubrication and dry lubrication, wet lubrication reduces the friction more than the dry lubrication, however the dry lubrication is easier to clean which can be done by air only. The third stage is the drawing of the wire through the die, where the wire goes through multiple holes in order to reduce its diameter according to the specifications above. The fourth and last stage is the motor which is used to pull the wire through the stages that are mentioned.



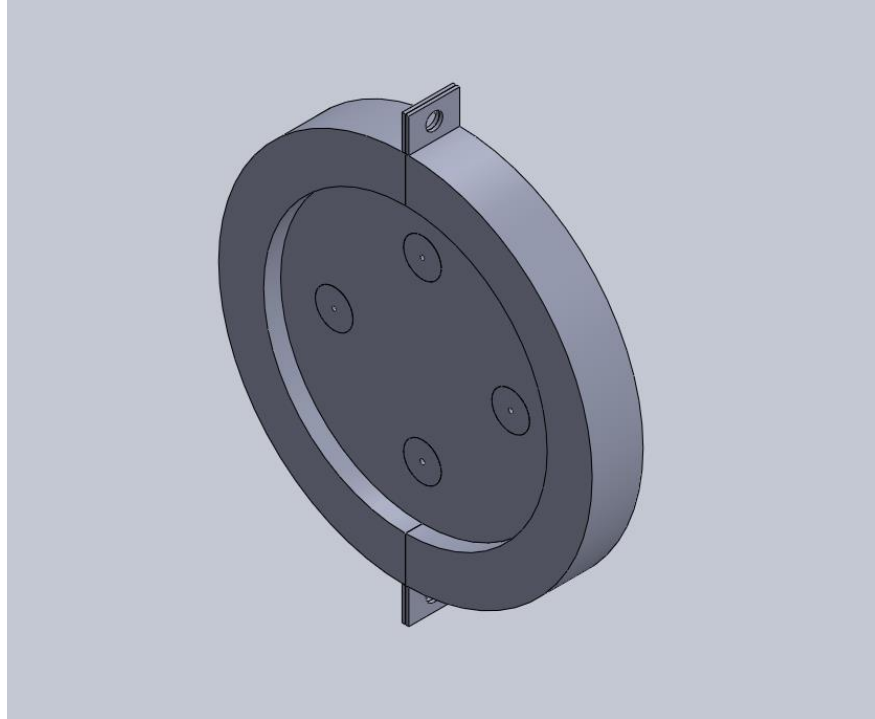
**\*Fig 3.6 System Setup and Design**



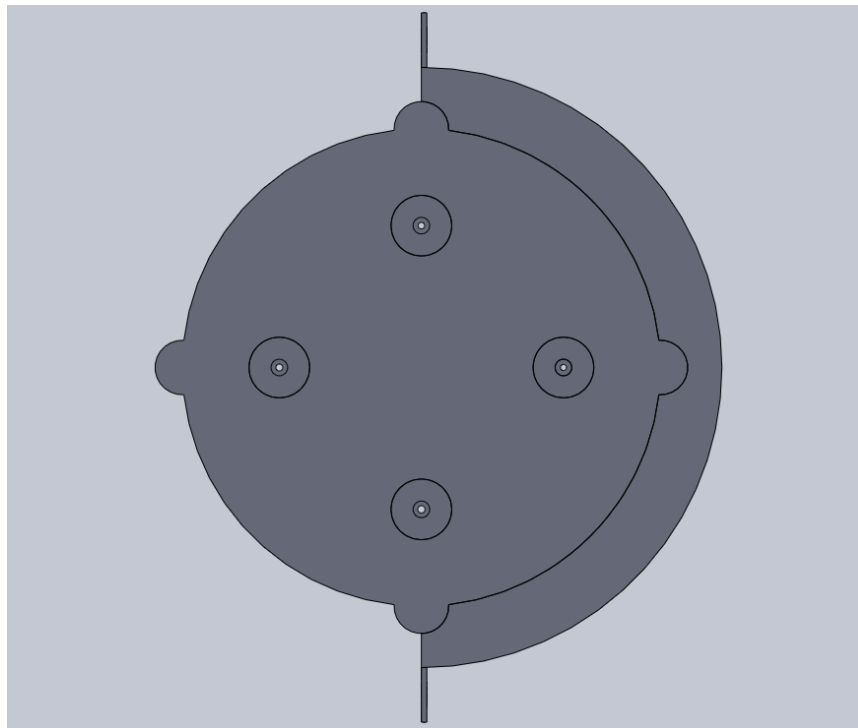
**\*Fig 3.7 Solidworks 3D Design [1]**



**\*Fig 3.8 Solidworks 3D Design [2]**



**\*Fig 3.9 Solidworks 3D Design [3]**



**\*Fig 3.10 Solidworks 3D Design [4]**

## Chapter 4

### 4.1 Experimental Steup:



**\*Figure 4.1: System Setup**

In this project, the rollers are the first stage to draw the wire. This stage it must be there to get rid of scale which is the thin layer that created naturally on the surface of the wire, that will make the wire softer than before which will help in reducing the power required to draw it. The second stage is lubricant, after removing the scale the wire goes through lubrication to reduce friction inside the die. There are two types of lubrications; wet and dry lubricant. Each one has its own specification. The third stage which is the most important stage is the adjustable die. Here the wire pulled the blue motor that shown in figure 4.1. The die has a reduction angle of  $11^\circ$  which will squeeze the wire to deform it to our specifications.

### 4.2 Results, Analysis and Discussion:

The aim of this project is to reduce the diameter of the wire. So, the wire goes through four different holes, each hole has a reduction percentage. The first hole has 10% which mean the diameter will be reduced from 3 mm to 2.7 mm. the second hole has 15% so, the diameter will be 2.55 mm. the

third hole has 20%, that will reduce the diameter to 2.4 mm. the fourth and smallest hole has 25%, which will end the wire with 2.25 mm diameter.



**\*Figure 4.2: System Setup from the top.**



**\*Figure 4.3: The Die with Four Holes.**



**\*Figure 4.4: The Motor with the Roller**

# Chapter 5: Project Management

## 5.1 Project Plan

Task 1: Startup	Start Date	Days to complete
Identifying Project (Amer, Khalid)	20/01/2018	11
Determine objectives (Amer, Khalid)		
subdividing small tasks to collect information (Amer)		
search and write small report about useful instruments (Amer, Khalid)		
<b>Task 2: Data and Design</b>		
Collect a data on the mechanism of Wire Drawing Process (Omar)	29/02/2018	14
Writing chapter 1 and chapter 2 (Rayan, Omar)	03/02/2018	
Design Adjustable Die (Amer)	13/02/2018	10
Design the Wire Drawing Mechanism (Rayan)	23/02/2018	10
Prepare for midterm	25/02/2018	5
<b>Task 3: Calculations</b>		
Taking the Calculations of :	04/03/2018	10
Diameter Reductions (Khalid)		
Motor Speed (Khalid)		
Stress on the Mechanism (Khalid)		
Required Torque and voltage (Khalid)		
<b>Task 4: Solid Works</b>		
Solidworks model (omar, Amer)	14/03/2018	3
Adjustable (Omar, Amer)		8
Selecting Materials (Amer)		5
Motion Analysis (Omar, Amer)		7
Optimizations (Omar, Amer)		2
<b>Task 5: Testing</b>		
Test the system (Rayan)	25/03/2018	10
Measure Reduction (Rayan)		
Strength Testing (Amer, Khalid)		
<b>Task 6: Finalize the Project</b>		
Writing (Rayan)	27/03/2018	5
Corrections (Khalid, Amer)		
Presentation (All)	29/03/2018	11
Prepare for Final (All)	01/04/2018	
Finalize final report (All)	08/04/2018	7

## 5.2 Contribution of Team Members

Task Description	Team member	progress
Solid Works-Stresses on the die-Optimization	Omar	100%
Manufacturing the Die	Amer	100%
Chapter 3	Khalid	100%
Buying the Rollers	Rayan	100%
Buying the Motor	Khalid	100%
Selecting materials	Amer	100%
Measurement of the thickness of the wire	Khalid	100%
Chapter 4	All	0%
Chapter 6	Rayan	100%
Select lubrication	Amer	0%
Buying the Galvanized steel wire	Omar	100%
Midterm presentation	All	100%
Testing the prototype	Amer	0%
Manufacturing the base	Omar	100%

### 5.3 Project Execution Monitoring

#### List various activities:

- 7<sup>h</sup> of Jan: meeting with Dr. Fraj to decide on the topic of our project.
- 14<sup>th</sup> of Jan: Meeting with Dr. Panos to get a better understanding on delivering the 1<sup>st</sup> milestone 1.
- 4<sup>th</sup> of Feb: Meeting with Dr. Fraj in order to discuss the abstract and the objectives of our project.
- 13<sup>th</sup> of Feb: Meeting with Dr. Fraj to discuss the system design and where to get the parts needed.
- 14<sup>th</sup> of Feb: meeting with Dr. Fraj to advise us about the types of materials that we need can select for our project.
- 14<sup>th</sup> of Feb: meeting with Dr. Asad to discuss the mechanism of the die to get a better understanding
- 24<sup>th</sup> of Feb: Meeting with Dr. Fraj To discuss our midterm presentation.
- 6<sup>th</sup> of Jan: 1<sup>st</sup> group meeting to form the team.
- 7<sup>th</sup> of Jan: Group meeting to decide on the topic of the project.
- 12<sup>th</sup> of Jan: Group meeting to work on milestone 1
- 31<sup>st</sup> of Jan: Group meeting to split the tasks for milestone 2
- 10<sup>th</sup> of Feb: Group meeting to discuss the system design.
- 18<sup>th</sup> of Feb: Group meeting to work on the midterm presentation
- 17<sup>th</sup> of Feb: Measuring the galvanized steel wire's thickness at the PMU mechanical lab

### 5.4 Challenges and Decision Making

- First problem we faced is on deciding the title of the project, at the beginning of the semester we were five members then we decided on splitting up to two groups so we turned out to be four.

- The design we had in mind was a single die with one adjustable hole. However, we have found out that it is difficult to make so we have decided on a single die with multiple fixed holes.
- We bought a motor with 2 Hp and 3000 Rpm but after doing the calculations we have found that it is too much for our design, so we decided to replace it with a 1.5 Hp and 1770 Rpm motor.
- We ordered rollers online from china when it arrived the sizes of the rollers were too small for our design so we had to order again which means that we have faced small delay.
- We contacted a company to manufacture the die and the engineer that was in charge told us that they can do it. However, he stopped answering our calls and after a week he told us that they could not manufacture it. We have decided to contact another company to do it.

## **5.5 Project Bill of Materials and Budget**

The total project budget is 5000 SR. So, the materials that we need to build up the project should not be more than 5000 SR.

- Motor costs 1100 SR
- Designing and Manufacturing the die: 3000 SR
- Aluminum Rollers: 75 SR
- Galvanized steel wire: 45 SR

## **Chapter 6: Project Analysis**

### **6.1 Life-long Learning**

Working as a group was critical to the success of this project. The primary task was broken down into activities that were assigned to the group members based on their strengths. Besides, the members also supported each other while undertaking the tasks. Group work is associated with several benefits. To begin with, it provides learning opportunities leading to the development of life-long skills. Certain steps and standards are adhered to when undertaking the tasks assigned to the group members. These tasks are also engaging enabling the members to not only attain skills but also retain the concepts. Below are some of the skills acquired from the project:

#### **6.1.1 Software Skills**

The primary software used in the project is SolidWork CAD for drawing and design the mechanical parts (All of the group members were familiar with this application since we have used it on the undergraduate level. However, we had to acquire and use advanced skills to complete this project.

#### **6.1.2 Time Management Skills**

The group work was critical in developing the time management skills. The group members were assigned several tasks intended at attaining the project's objective. However, the time was limited as we had to attend to other courses and personal lives. We used a Gantt Chart to overcome the challenge of limited time. A Gantt Chart subdivides the project into tasks with definite start and end dates. The Gantt Chart helped the team members to plan, coordinate and track the specific tasks within the project.

### **6.1.3 Project Management Skills**

Despite struggling with limited time and resources, we successfully almost completed the project. The time available to undertake the project was limited as each group member had other obligations. To overcome this challenge, we strictly adhered to our schedule. We also had to create additional time by using collaborative tools, such as Dropbox to communicate our progress and access files remotely. Remote access of files creates flexibility as it allows members to retrieve and work on files from anywhere and at any time.

## **6.2 Impact of Engineering Solutions**

### **6.2.1 Society**

People employed by wire manufacturers earn an income that helps in improving their quality of lives and reducing dependency levels.

### **6.2.2 Economy**

Wires are used in the construction of residential, industrial and commercial properties. The high demand for wires creates employment opportunities.

### **6.2.3 Environment**

Our manufacturing process involves recycling raw materials and reducing energy consumption hence conserves the environment.

## **6.3 Contemporary Issues Addressed**

GCCs construction sector is set for 100% growth by the end of April 2019 and it has been experiencing positive growth in the last decade (Moon & Kim, 2012). The growth of the sector will increase the demand for wires creating more opportunities for wire manufacturers.

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