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NAME: MURGOR COLLINS KIRWA

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REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE IN BACHELOR OF SCIENCE IN MECHANICAL AND INDUSTRIAL ENGINEERING.

SUBMITTED TO THE DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING

DECLARATION

I declare that this field attachment report is a product of activities I carried out in Kenya Industrial Research and Development Institute during my attachment from 15th May 2023 to 31th July 2023 and has not been submitted by any other student to any other university for Award of academic certificate.

Name _____

Signature _____

DEDICATION

This Report is dedicated to the following persons who without them the training could not be successfully completed. Materially, intellectually, physically and financially contributed to make the training a success:

- MIE Department
- My Parents
- KIRDI Engineering Department

ABSTRACT

Industrial attachment is one of the main course in Mechanical and Industrial Engineering program. The purpose of this course is to get some touch in the empirical world for utmost 12 weeks.I was assigned new section in the factory at the start of every week. I was stationed in the machine shop, CNC shop and design Unit over the course of twelve weeks.

During my attachment, I also increased knowledge about team work skills, time management skills, working under pressure, meeting with deadline and multitask management.
Industrial attachment played great role in my studies where I practiced the class theoretical knowledge.

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Chapter 1

1.0 Introduction

In this chapter, I will report on the organization structure governing KIRDI, the history, mission and vision of KIRDI. It is a general overview of the company and what it is involved in.

1.1 History of the organization

Kenya Industrial Research and Development Institute (KIRDI) is a national research institution established in 1979 under the Science and Technology Ac Cap. 250 of the Laws of Kenya (now repealed and replaced by the Science, Technology & Innovation Act, 2013) and mandated to undertake multidisciplinary research and development in industrial and allied technologies including; Mechanical Engineering, Energy and Power Resources, Leather Technologies, Textile Technology, Industrial Chemistry Environment, Chemical Engineering, Electrical Engineering, Food Technology, Ceramics and Clay Technologies, Information Communication & Technology (ICT) and Mining.

The history of KIRDI dates back to 1942, when the then colonial government set a Central Laboratory at Kabete, Nairobi. The laboratory aim was to initiate and develop industries to relieve the industrial goods shortages occasioned by the Second World War. The laboratory was administered by the Kenya Industrial Management Board (KIMBO), As the laboratory expanded, it was renamed the East African Industrial Research Organization (EAIRO) and later, its management was taken over by the East African Community (EAC), EAIRO, the predecessor of present day KIRDI has Centres in; Kenya, Uganda, Tanzania, It however, ceased its operations in 1977, following the collapse of the then East African Community and In 1979 an act of Parliament establishing the National Council of Science and Technology (NCST) was amended to establish KIRDI and 5 other research Institutes. This act has been repealed and replaced with the STI Act 2013.

1.2 Objectives of the KIRDI

The Kenya Vision 2030 aims to transform Kenya into a newly industrializing, middle-income country providing a high quality of life to all its citizens by 2030 in a clean and secure environment.

The objective of the Economic Pillar of Vision 2030 is to create a robust, diversified and competitive manufacturing sector in three ways:

- boosting local production,
- expanding to the regional market and
- taking advantage of global market niches.

To achieve this the Vision 2030 identified the following strategies;

- boosting science, technology and innovation by increasing investment in R&D
- strengthening SMEs to become the key industries of tomorrow by improving their productivity and innovation.

To support the implementation of the above strategies in order to realize the said manufacturing sector objectives, MTP I and MTP II identified “transformation of KIRDI into a world class research organization” as one of the flagship projects for the manufacturing sector. The transformation of KIRDI into a world class research organization entails upgrading the research, technology and innovation infrastructure as well as building capacity of human capital (Scientists and Engineers). The importance of the research, technology and innovation has also been recognized in the MTP III with the expansion of the flagship project of “transformation of KIRDI into a world class research organization” to a flagship programme known as “Research, Technology and Innovation programme”.

To support the realization of the MTP III the government came up with the “Big Four Agenda” whose main goals are:

- Support value addition and raise the manufacturing sector share to GDP to 15% by 2022;
- Focus on initiatives that guarantee food security and nutrition to all Kenyans by 2022;
- Provide Universal Health Coverage thereby guaranteeing quality and affordable healthcare to all Kenyans; and
- Provide Housing to all Kenyans by targeting construction of at least five hundred thousand affordable houses by 2022.

1.3 Management and Departments

KIRDI is currently divided into five major departments with each having its management and director in charge of all the operations taken therein. The departments are as follows:

1.3.1 Research, Technology and Innovation (RTI)

- Food Technology Division (FTD)

- Energy Division (ED)
- Environment Management Division (EMD)
- Project Studies Division (PSD)
- Leather Technology Division (LTD)
- Textiles Technology Division (TTD)
- Chemical Engineering Division (CED)
- Mechanical Engineering Division (MED)
- Electrical and Electronic Engineering Division (EEED)
- Ceramics &Building Materials Division (CBMD)
- Information Communication Division (ICTD)

1.3.2 Finance, Human Resource and Administration (FHR&A)

- Finance Division
- Human Resource & Administration Division

1.3.3 Corporate Services (CS)

- Public Relations & Communication Division
- Marketing Division
- Planning Monitoring & Evaluation Division
- Quality Assurance Division
- Library Services Division
- ICT Support Division

1.3.4 Corporation Secretarial and Legal Services (CS&LS)

- Corporation Secretariat
- Legal Services

1.3.5 Technology Transfer and Extension Services (TT&ES)

- Engineering Development & Service Centre (EDSC)
- Laboratory Service Centre (LSC)
- Leather Development Centre (LDC)

- Food Processing Pilot Plants
- Common Manufacturing Facilities
- Consultancy & Training
- Incubation Services
- Intellectual Property Support Services

1.4 Company Layout

Organization Structure

*Figure SEQ Figure * ARABIC 1: Organization Structure*

Chapter 2

Machinery identified and Functions

2.1 Introduction

In this chapter I will focus on majorly the activities that take place in the EDSC where I got an opportunity to be part of from the 6th June 2022 for a twelve weeks industrial attachment. Here we generally deal with the works related to engineering work. It has a workshop that implements the engineering design.
A design is researched by the engineer or someone with an engineering project then the design is presented to KIRDI for testing and implementing the theoretical design.
The main departments are as listed below:

2.2 Machine Shop

This is a manual based workshop which has mechanical machines that help in doing Engineering work as listed below:

2.2.1 HORIZONTAL MILLING MACHINE

Horizontal milling machines feature a similar design in which a spindle containing a rotating cutting tool presses against a workpiece to remove material from the workpiece. With that said, horizontal milling machines differ from their vertical counterparts in several ways.
The Horizontal Milling Machine is a very robust and sturdy machine. A variety of cutters are available to removed/shape material that is normally held in a strong machine vice. This horizontal miller is used when a vertical miller is less suitable. For instance, if a lot of material has to be removed by the cutters or there is less of a need for accuracy - a horizontal milling machine is chosen.

*Figure SEQ Figure * ARABIC 2: REALISTIC IMAGE OF THE HORIZONTAL MILLING MACHINE*

The cutter can be changed very easily. The arbor bracket is removed by loosening nuts and bolts that hold the arbor firmly in position. The arbor can be slid off the over arm. The spacers are then removed as well as the original cutter. The new cutter is placed in position, spacers slid back onto the arbor and the arbor bracket tightened back in position.

2.2.2 LABLOND CENTRE LATHE

A lathe is a machine tool that rotates a workpiece about as axis of the rotation ti perform operations such as cutting, sanding, sanding, knurling , drilling deformation, facing and turning with tools that are applied to the workpiece to create an object with symmetry about that axis. The main **function** of Lathe machine is to remove excess material in the form of chips by rotating the work piece against a stationary cutting tool.

- ❒ This is **accomplished** by holding the work securely and rigidly on the machine and then turning it against cutting tool which will remove metal from the work.
- ❒ To cut the material properly the **tool should be harder** than the material of the work piece, should be rigidly held on the machine and should be fed or progress in a **definite way relative** to the work.

*Figure SEQ Figure * ARABIC 3: Main Parts of Lathe Machine*

1. Bed
2. Head Stock
3. Main Spindle
4. Tail Stock
5. Lead Screw
6. Live Center
7. Dead Center
8. Carriage
   i. Saddle
   ii. Apron
   iii. Tool Post
   iv. Cross slide
   v. Compound Rest
   vi. Compound Slide
9. Feed Mechanism

i. Belt Feed Mechanism

ii. Gear Feed Mechanism

1. Bed

- The **Bed** forms the base of a machine.
- It is mounted on the **legs** of the lathe machine, which are bolted to the floor.
- It is made up of cast iron and its **top surface** is machined accurately and precisely.

2. Head Stock

- **Head stock** is an important part of a lathe machine, which is mounted permanently on the inner **guide – ways** at the left hand side of the bed.
- It consists of a main spindle, a chuck fitted at spindle nose, back gear drive and all **gear drive.**

3. Main Spindle

- ❒ A main spindle is a **hollow** cylindrical shaft.
- ❒ It's face has a standard **moarse** taper.
- ❒ It is used for holding the **live Centre or collet**.
- ❒ The spindle rotates on **two large** bearings housed on the head stock casting.
- ❒ The front end of the spindle is threaded, those are used for holding the chuck, face plate, driving plate and catch plate.
- ❒ It is know as a **spindle nose**.

4. Tail Stock

- A tail stock is located on the **inner** guide – ways at the right side of the bed opposite to the head stock.
- The body of the **tail stock** is bored and house the tail stock spindle.
- The spindle moves front and back inside the hole.
- It has a taper hole to receive the **dead Centre** or **shunk** of tools such as **drill or reamer**.
- It's body made up of **cast iron.**

5. Lead Screw

- It is used to **transmit power to** carriage through gear and clutch arrangement in the **carriage apron.**

6. Live Center

- A Live Center is mounting on bearings and rotates with the work.

- Live centers are using to hold or support a work-piece.

7. Dead Center

- A **dead center** may be use to support the work piece at either the fixed or rotating end of the machine.
- Dead centers are typically fully harden to **prevent damage** to the important mating surfaces of the taper and to preserve the **60° angle** of the nose.

8. Carriage

- A **carriage** is located between the head stock and tail stock on the lathe bed **guide – ways.**
- It can be moved along the bed **either towards or away** from the head stock.
- It has several parts to support, move and control the cutting tool.

*Figure SEQ Figure * ARABIC 4: Carriage*

i. Saddle

- It is **H** – shaped casting.
- The saddle connects the pair of bed **guide – ways** as a bridge.

It fits over the bed and slides along the bed between **head stock** and **tail stock.**

- The **saddle** can be moved by providing hand feed or automatic feed.

ii. Apron

- The front portion of a carriage call as **apron**. It consists of all **control keys.**

The handle operates the carriage. It has a housing, which has a **set** of gears and split nut.

- **Automatic** feed and threading control are on the apron.

iii. Tool Post

- It is located on the top of the **compound slide**. It is used to hold the tools rigidly.
- **Tools** are selected according to the type of operation and mounted on the tool post and adjusted to a convenient working position.
- There are different types of tool post, which are as follows.

a. Single Way / Screw Tool Post

b. Four Way Tool Post

c. Quick Change Tool Post

d. British Type Tool Post

iv. Cross slide

- It is situated on the saddle and slides on the **dovetail guide – ways** at right angles to the bed guide – ways.

It carries compound rest, compound slide and tool post.

- Cross slide hand wheel is rotated to move it at right angle to the lathe machine axis.
- The cross slide hand wheel is graduate on its rim to enable to give known amount of feed as accurate as **0.05 mm**.

v. Compound Rest

- It is a part which connects to cross **slide and compound slide**.
- It is mounted on the cross slide by **tongue and groove joint.**

The compound rest can be swiveled to the required angle while turning tapers.

- A top slide known as **compound slide** is attached to the compound rest by **dovetail joint**.

vi. Compound Slide

- Compound slide is a **T -shaped** rounded slot, which is fixed with cross slide upper surface by two bolts, which is related to a **micrometer sleeve** and screw handle with the outer edge of screw.
- Taper turning can be possible by setting the compound slide at **half of a required angle.**

- This slide is only used for less long job taper turning.
- The **automatic feed** is not possible in compound slide.

9. Feed Mechanism

- There are several **mechanisms** to make the carriage and cross slide move automatically to change the direction of their movement.
- Some important **feed mechanisms** are as follows:

i. Belt Feed Mechanism

Belt feed mechanism is widely use in oldest lathe machines.

- In this, a **cone** stepped pulley is used for providing the different types of speed.
- To change the speed, a lever is used for sliding the belt at one pulley to another.
- Belt feed mechanism has a **disadvantage** of the belt slipping in pulley changing process.

ii. Gear Feed Mechanism

In the **gear feed mechanism**, the power is transmitted from spindle to feed rod or lead screw by power gear train.

- **Gear 1** is situated at the back side of the spindle and the tumbler bracket consists of the gears **2**, **3, 4** and **5**.
- A lever operate the bracket. This **bracket** is pivoted about the axis of the stud gear.
- This position of the bracket can be arrange in three different stages namely:

a. Neutral Position

b. Forward Position

c. Reverse Position

Working Principle of lathe machine

Principle

- A **lathe** is a machine tool which use to removes unwanted materials from a work piece in the form of chips with the help of a tool that travels across the work piece and can be fed deep in work.

*Figure SEQ Figure * ARABIC 5: material removal*

When the **tool** is moved parallel to the work-piece then the cylindrical surface is formed.

Working

- ❒ It holds the work between two supports so call as centers.
- ❒ **Face plate or Chuck** are using for holding the work.
- ❒ Face plate or Chuck are mounted **on the machine spindle**.
- ❒ The **cutting tool** is holding with the help of Tool post.
- ❒ The movement of the job is rotating about the **spindle axis**.
- ❒ Against the revolving work, the tool is feed.
- ❒ The **tool** moves either parallel or inclination to the work axis.

*Figure SEQ Figure * ARABIC 6: Lathe Operations*

2.2.3 SHAPER MACHINE

A shaper Machine is a reciprocating type of machine that is used for producing horizontal, vertical flat surfaces. The workpiece is fixed on the table and the Ram holds the single point cutting tool. During forwarding stroke, (the single point tools attached to the ram and workpiece is fixed on a table).

Shaper Machine consists of following parts:

- ❒ Base
- ❒ Column
- ❒ Table
- ❒ Cross rail
- ❒ Ram
- ❒ Clapper Box
- ❒ Elevating Screw

*Figure SEQ Figure * ARABIC 7: shaper machine*

A shaper machine holds the Single point cutting tool in ram and workpiece is fixed over the table. The ram holding the tool reciprocates over the workpiece and metal is cut during the forward stroke called a cutting stroke and. No metal is cut during its return stroke is called an Idle stroke

2.2.4 DRILLING MACHINE

Drilling Machine is the simplest, moderate, and most accurate machine tool used in almost all the production shops and tool rooms. Drilling is basically a single-purpose machine tool as its main purpose is to make holes in the workpiece.

A machine consists of a spindle that provides rotary motion to the drilling tool, which finally makes the hole in the job (workpiece)
Basically, Boring is a process in which the holes are enlarged that are already being drilled or cored. To perform boring action by a machine a special holder for the boring tool is required. Drilling Machine has based upon the principle that the rotating edge of the tool exerts a large force on the workpiece and holes are being created in the workpiece. The material is removed from the workpiece by the shearing and extrusion process.

*Figure SEQ Figure * ARABIC 8: Drilling Machine*

Drilling Machine consists of the following Main Parts:

- ❒ Bed
- ❒ Pillar
- ❒ Swivel table
- ❒ Motor
- ❒ Steeped pulley
- ❒ Spindle
- ❒ Chuck
- ❒ Drill Bit and
- ❒ Hand-wheel.

Bed:

The bed is the main part of the machine on which the whole machine is being mounted. The bed is made up of cast iron, so it has high compressive strength and good wear resistance.

Pillar:

The pillar is a type of vertical column that rests on the bed. A pillar is present at the center of the bed. The pillar helps the motor and the spindle head.

Swivel Table:

The table is the place where the workpiece is being mounted. The table is attached to the column and it can be rotated around the column and can have an upward and downward moment. A table can be adjusted at any angle as per the requirement.

Motor:

The motor is present at the top of the column. The inside motor shaft is there which is connected to a stepped pulley so that we can increase or decrease the speed of the rotation of the motor.

Stepped pulley:

Two steeped pulleys are present on either side of the column at the top. Out of these two, one pulley will be in an upward direction while the other pulley is inverted.

Always both the pulleys will be there in the opposite direction. The basic function of the stepped pulley is to control the speed of the rotation of the motor.

Spindle:

Spindle arrangement is present at top of the column opposite to the arrangement of the motor.

The top of the spindle is attached to one of the stepped pulleys. The bottom of the spindle is connected to the chuck.

Chuck:

Chuck is present at the bottom of the spindle. The basic function of the chuck is to hold the cutting tool firmly.

Drill bit:

A drill bit is an actual cutting tool that is used to create a hole in the workpiece.

Hand Wheel:

The basic function of the handwheel is to adjust the spindle position as per the requirement.

Drilling Machine Specification:

The following specification of Drilling Machine are:

- ❒ The portable Drill Machine is specified by the maximum diameter of the drill which can be held.
- ❒ Sensitive and the upright drill machine are specified by the diameter of the largest workpiece that can be held.
- ❒ The radial drill machine is specified by the length of the arm and column diameter.
- ❒ Multiple spindle drill machine is specified by the drilling Area, the size and the number of holes the machine can drill.

Cutting Speed, Feed, and Machining Time of Drilling Machine:

The cutting speed can be defined as the speed of the periphery of the cutting tool in meters per minute.

- ❒ The cutting speed depends upon the material to be drilled. Generally, the cutting speed varies from 10 to 90 meters/minute.

❒ The cutting speed for the highspeed drill should be double than that of the carbon steel drill.

Mathematically it can be expressed as:

$$\text{cutting speed} = \frac{\pi * \text{Diameter of the drill in mm} * \text{rpm}}{1000}$$

The precautions which should be followed while using the drilling machine are as follows:

i) The machine tool should be strong enough to drill a hole in the workpiece, otherwise, the parts may be deformed due to the cutting force generated. Drill feeding arrangement must be directionally stable.

ii) To avoid any kind of error it must make sure that the Axis of the spindle, adapter, and tool must coincide.

iii) Accurately ground drills should be used so that the uniform chips are produced by both cutting edges, otherwise, unbalanced forces may deflect the tool during machining.

iv) The workpiece must be held rigidly otherwise it can lead to:

❒ Error in Shape.

❒ Burrs and

❒ Error in hole location.

2.2.5 JIG BORING MACHINE

It is a machine that basically enlarges the already existing holes on a workpiece.

It can also be used as a marking machine in that it marks the workpiece.

The jig boring machine is the most accurate in all type of boring machine. Jig boring machine first developed in the year 1910 in Switzerland. The real jig borer was first built in the year 1917 by Pratt and Whitney.

*Figure SEQ Figure * ARABIC 9: Jig boring machine*

Jig boring machine is now used for the production of jigs, fixtures, tools and other precision parts which require a high degree of accuracy.
They have the highest accuracy through rigidity, low thermal expansion and measuring distance for accurately locating and spacing holes.

Jig boring machine is a metal cutting machine for finishing holes, planes and slots with a highly precise location of centres or surfaces without the use of special attachments for tool alignment.

In jig boring machine machining accuracy is very high within a range of 0.0025 mm.

The spindle and other parts of the machine are extremely rigid to resist deflection and the vibration is minimum.
The spindle runs in preloaded antifriction bearings.
The jig boring machine requires temperature-controlled rooms for operation where temperature can be maintained constant.

Types of jig boring machine :

There are two types of jig boring machine :

1. Vertical milling machine type
2. Planer type

Methods of locating holes in the jig boring machine :

Accurate positioning is essential for producing accurate jigs, fixture, dies etc.
The most important operation in a jig boring machine is the accurate way of positioning a hole that can be done by one of the following methods :

1. Lead screw method
2. Mechanical and electrical gauging method
3. Optical measuring method

Jig boring machine operations :

- The jig boring machine primarily designed to produce precision dies, jigs and gauges.
- They also used as measuring machine to check up a job already manufactured in other machines.
- Also used in enlarging holes.
- Single point tools enables maximum accuracy in locating holes and give a better surface finish.
- Jig boring machine operated by highly skilled workers.

2.3 CNC Shop

2.3.1 SHEET METAL GYC LAISER CUTTING MACHINE

Laser cutting is a technology that uses a laser to vaporize materials, resulting in a cut edge. Laser cutting works by directing the output of a high-power laser most commonly through optics. The laser optics and CNC (computer numerical control) are used to direct the material or the laser beam generated. A commercial laser for cutting materials uses a motion control system to follow a CNC or G-code of the pattern to be cut onto the material.
The focused laser beam is directed at the material, which then either melts, burns, vaporizes away, or is blown away by a jet of gas, leaving an edge with a high-quality surface finish.

*Figure SEQ Figure * ARABIC 10: SHEET METAL GYC LAISER CUTTING MACHINE*

After design
The equipment is taught the language used in designing the design
Then the machine will start reading the design and interpret in DX file language.
Generation of the laser beam involves stimulating a lasing material by electrical discharges or lamps within a closed container. As the lasing material is stimulated, the beam is reflected internally by means of a partial mirror, until it achieves sufficient energy to escape as a stream of monochromatic coherent light. Mirrors or fiber optics are typically used to direct the coherent light to a lens, which focuses the light at the work zone. The narrowest part of the focused beam is generally less than 0.0125 inches (0.32 mm) in diameter. Depending upon material thickness, kerf widths as small as 0.004 inches (0.10 mm) are possible. In order to be able to start cutting from somewhere other than the edge, a pierce is done before every cut. Piercing usually involves a high-power pulsed laser beam which slowly makes a hole in the material, taking around 5–15 seconds for 0.5-inch-thick (13 mm) stainless steel, for example. The parallel rays of coherent light from the laser source often fall in the range between 0.06–0.08 inches (1.5–2.0 mm) in diameter. This beam is normally focused and intensified by a lens or a mirror to a very small spot of about 0.001 inches (0.025 mm) to create a very intense laser beam. In order to achieve the smoothest possible finish during contour cutting, the direction of beam polarization must be rotated as it goes around the periphery of a contoured workpiece. For sheet metal cutting, the focal length is usually 1.5–3 inches (38–76 mm). Advantages of laser cutting over mechanical cutting include easier workholding and reduced contamination of workpiece (since there is no cutting edge which can become contaminated by the material or contaminate the material). Precision may be better, since the laser beam does not wear during the process. There is also a reduced chance of warping the material that is being cut, as laser systems have a small heat-affected zone. Some materials are also very difficult or impossible to cut by more traditional means. Laser cutting for metals has the advantages over plasma cutting of being more precise and using less energy when cutting sheet metal; however, most industrial lasers cannot cut through the greater metal thickness that plasma can. Newer laser machines operating at higher power (6000 watts, as contrasted with early laser cutting machines' 1500-watt ratings) are approaching plasma machines in their ability to cut through thick materials, but the capital cost of such machines is much higher than that of plasma cutting machines capable of cutting thick materials like steel plate.

Types

There are **three** main types of lasers used in laser cutting.

- The CO_2 laser is suited for cutting, boring, and engraving
- The neodymium (Nd)
- neodymium yttrium-aluminum-garnet (Nd:YAG) lasers are identical in style and differ only in application.

Nd is used for boring and where high energy but low repetition are required. The Nd:YAG laser is used where very high power is needed and for boring and engraving. Both CO_2 and Nd/Nd:YAG lasers can be used for welding.

2.3.2 HYDRAULIC ROLLING MACHINE

It is an automated machine that helps in rolling material of width 10mm.
There is an overhead crane above the machine that is used to transport the rolled workpiece.

*Figure SEQ Figure * ARABIC 11: CNC rolling machine*

2.3.3 CNC PRESS BREAK

CNC Press Brake forms predetermined bends by clamping the work piece between a matching punch and die. We apply automated technologies to fabrication to ensure that we produce consistent quality in all our finished product.

A CNC press brake or some may know as CNC metal benders are tremendous machines that are used for bending sheet metal or its components in numerous designs and profiles. There is no hesitation in admitting that the advancement in the technological sectors has enhanced the progression of industries globally.

*Figure SEQ Figure * ARABIC 12: CNC Press brake machine*

Heavy industries are now flooded with various machines and tools to foster productivity at an unimaginable rate. The demand increase worldwide requires industries to take big steps in accommodating advanced machines.

By the name, it's easier to understand that it is a Computer Numerically Controlled (CNC) machine and due to this system, the machine acts as an efficient tool in bending metal sheets no matter what the size is of the sheets.
A press brake is a piece of manufacturing equipment that is used to bend sheet metal. A press brake is typically narrow and long so that large pieces of sheet metal can be bent by it. A press brake bends sheet metal by lowering a punch onto sheet metal that has been positioned on top of a die.

2.3.4 CNC Pipe bending machine

Our **CNC Pipe Bender** CH series is the backbone of our **tube and profile bending machines.** Their rigidity, stability and untouchable precision in exceptional conditions such as humidity or harsh temperatures is what makes them stand out from the crowd.

Ranging from 6mm up to 420mm OD these **pipe bending machines** are adapt for use in a wide range of **pipe manufacturing** sectors and industries.

*Figure SEQ Figure * ARABIC 13: cnc pipe bending machine*

The range includes the **fully CNC pipe bender** version, for wich all three axis are automatic in a single stack machine. There's also the option to add welding

detection, punching/cutting mechanisms and integrated loading and unloading systems if necessary.

The **CH series tube bending machine** come equipped with the AMOB NC touchscreen easy-to-operate controls, or in the CNC version, the latest user-friendly AMOB **3D bending software**.

So, this stores tooling configuration, allows spring-back compensation and boasts anti-collision technology, amongst other features.

These multi-faceted models are easy to operate and suitable for almost all types of applications and industries.

CH Series | CNC Pipe Bender

- **Quick tool changing:** In order to reduce setup times, all CH-HD machines feature quick tool changing.
- **Rear and front tube loading system:** Integrated loading/unloading systems can also be added.
- **Motorised tool adjustment:** CH-HD models can be equipped with motorised tool adjustment.

2.4 Fabrication Shop

2.4.1 SPOT WELDING MACHINE

This is a programmed welding machine that is used to weld. Temperature is fed to the machine to instruct it the temperature at which it is to weld with.
Spot welding (also known as resistance spot welding) is a **resistance welding process**. This welding process is used primarily for welding two or more metal sheets together by applying pressure and heat from an electric current to the weld area.

Spot Welding machines use a method called resistance spot welding to join overlapping metals between two electrodes using electrical resistance. Squeezing the workpieces between the electrodes applies pressure, and the passage of welding current through the resistive metals generates heat. This allows the materials to bind together and form a welding joint. Spot welding has its name as the current is applied precisely over a small area on the metal's surface. The resistance spot welding equipment can be in the form of stationary or bench-type welding machines, portable spot or robotic welding guns, and multi-head spot welding machines designed for different applications. Here at Dahching we have a wide range of spot welding machines and resistance welding equipment to choose from.

*Figure SEQ Figure * ARABIC 14: spot welding machine*

Resistance spot welding is a type of welding that generates heat at the interface of two metal sheets by using electrical resistance. The heat generated by the resistance to the flow of electricity melts the metal and forms a weld where the two sheets come into contact. This procedure is typically carried out with the aid of a specialized welding machine that applies pressure to the sheets in order to keep them in place and control the flow of electricity via the resistance welding process. The current is applied under a controlled force through the electrodes. The diameter of the electrode in contact with the workpiece determines the current density The resistance between the contact area layers is directly affected by the force applied. In practice, the force is adjusted so that heat is generated immediately in the contact area.

2.4.2 FULL AUTOMATIC CUTTING MACHINE

It is a **high-speed cutting and high-ply cutting**. This automation improves cutting room productivity. For mass production, automation is essential to handle huge order volumes in less space. Precision cutting is possible with the automated cutting machine.

2.4.3 Mig welding

Metal Inert Gas (MIG) welding is an arc welding process that uses a continuous solid wire electrode heated and fed into the weld pool from a welding gun. The two base materials are

melted together forming a join. The gun feeds a shielding gas alongside the electrode helping protect the weld pool from airborne contaminants.

*Figure SEQ Figure * ARABIC 15: Mig welding*

MIG/MAG welding is a versatile technique suitable for both thin sheet and thick section components. An arc is struck between the end of a wire electrode and the workpiece, melting both of them to form a weld pool. The wire serves as both heat source (via the arc at the wire tip) and filler metal for the welding joint. The wire is fed through a copper contact tube (contact tip) which conducts welding current into the wire. The weld pool is protected from the surrounding atmosphere by a shielding gas fed through a nozzle surrounding the wire. Shielding gas selection depends on the material being welded and the application. The wire is fed from a reel by a motor drive, and the welder moves the welding torch along the joint line. Wires may be solid (simple drawn wires), or cored (composites formed from a metal sheath with a powdered flux or metal filling). Consumables are generally competitively priced compared with those for other processes. The process offers high productivity, as the wire is continuously fed.

Manual MIG/MAG welding is often referred as a semi-automatic process, as the wire feed rate and arc length are controlled by the power source, but the travel speed and wire position are under manual control. The process can also be mechanised when all the process parameters are not directly controlled by a welder, but might still require manual adjustment during welding. When no manual intervention is needed during welding, the process can be referred to as automatic.

2.4.4 Tig welding

Tungsten Inert Gas (TIG) welding, also known as Gas Tungsten Arc Welding (GTAW) is an arc welding process that produces the weld with a non-consumable tungsten electrode.

*Figure SEQ Figure * ARABIC 16: TIG welding*

In the TIG welding process the arc is formed between a pointed tungsten electrode and the workpiece in an inert atmosphere of argon or helium. The small intense arc provided by the pointed electrode is ideal for high quality and precision welding. Because the electrode is not consumed during welding, the TIG welder does not have to balance the heat input from the arc as the metal is deposited from the melting electrode. When filler metal is required, it must be added separately to the weldpool.

*Figure SEQ Figure * ARABIC 17: TIG Weld example*

Power source

TIG welding must be operated with a drooping, constant current power source - either DC or AC. A constant current power source is essential to avoid excessively high currents being drawn when the electrode is short-circuited on to the workpiece surface. This could happen either deliberately during arc starting or inadvertently during welding. If, as in MIG welding, a flat characteristic power source is used, any contact with the workpiece surface would damage the electrode tip or fuse the electrode to the workpiece surface. In DC, because arc heat is distributed approximately one-third at the cathode (negative) and two-thirds at the anode (positive), the electrode is always negative polarity to prevent overheating and melting. However, the alternative power source connection of DC electrode positive polarity has the advantage in that when the cathode is on the workpiece, the surface is cleaned of oxide contamination. For this reason, AC is used when welding materials with a tenacious surface oxide film, such as aluminium.

Arc starting

The welding arc can be started by scratching the surface, forming a short-circuit. It is only when the short-circuit is broken that the main welding current will flow. However, there is a risk that the electrode may stick to the surface and cause a tungsten inclusion in the weld. This risk can be minimised using the 'lift arc' technique where the short-circuit is formed at a very low current level. The most common way of starting the TIG arc is to use HF (High Frequency). HF consists of high voltage sparks of several thousand volts which last for a few microseconds. The HF sparks will cause the electrode - workpiece gap to break down or ionise. Once an electron/ion cloud is formed, current can flow from the power source.

Note: As HF generates abnormally high electromagnetic emission (EM), welders should be aware that its use can cause interference especially in electronic equipment. As EM emission can be airborne, like radio waves, or transmittedalong power cables, care must be taken to avoid interference with control systems and instruments in the vicinity of welding.

HF is also important in stabilising the AC arc; in AC, electrode polarity is reversed at a frequency of about 50 times per second, causing the arc to be extinguished at each polarity change. To ensure that the arc is reignited at each reversal of polarity, HF sparks are generated across the electrode/workpiece gap to coincide with the beginning of each half-cycle.

Electrodes

Electrodes for DC welding are normally pure tungsten with 1 to 4% thoria to improve arc ignition. Alternative additives are lanthanum oxide and cerium oxide which are claimed to give superior performance (arc starting and lower electrode consumption). It is important to select

the correct electrode diameter and tip angle for the level of welding current. As a rule, the lower the current the smaller the electrode diameter and tip angle. In AC welding, as the electrode will be operating at a much higher temperature, tungsten with a zirconia addition is used to reduce electrode erosion. It should be noted that because of the large amount of heat generated at the electrode, it is difficult to maintain a pointed tip and the end of the electrode assumes a spherical or 'ball' profile.

2.4.5 Stick welding

Stick welding also known as manual arc welding, manual electrode welding, manual metal arc welding or shielded metal arc welding (SMAW) is usually the first welding process that welders are taught during training. It is easy to learn, but already offers insights into the way that welding systems work and into the ratio of metals to electrical voltage.

Welding with the rod electrode offers numerous advantages in comparison with MIG/MAG and TIG processes. In principle, almost all materials can be welded using electrode welding. The process is mainly used in steel and pipeline construction, but is also used in metal trade and industry. Manual metal arc welding allows for any type of weld seam and position, irrespective of whether this involves restricted or overhead positions, vertical up seams or vertical end welding. Furthermore, the welder is not dependent on shielding gases and can easily work outside, even in unfavorable weather conditions such as wind or rain.

*Figure SEQ Figure * ARABIC 18: stick welding machine*

In stick welding, contact between the rod electrode and workpiece ignites the arc. This creates a short circuit for a fraction of a second between the two poles, meaning that current can then flow. The arc burns between the workpiece and the electrode. This creates the required fusion heat. Via the consumable core wire and the coating, which is also consumable, the electrode also supplies the protective slag and the gas shroud.

Manual arc welding requires a low voltage and a high amperage. The welding system converts the available mains voltage into a significantly lower welding voltage. At the same time, it provides the required amperage, which also allows the power source to be adjusted and regulated.

*Figure SEQ Figure * ARABIC 19: stick welding image*

In manual metal arc welding, the amperage is the most important parameter for the quality of the connections. It must therefore remain as constant as possible, even if the arc length changes. In order to ensure this, power sources for electrode welding always have drooping characteristics.

2.4 HEAT TREATMENT SHOP

This was a stalled department that was not in full operation within my time of industrial attachment. However, there are two major machines that were therein namely: oven and heat treatment tank.

2.5 GRINDING SHOP

2.5.1 EXTERNAL CYLINDRICAL GRINDING MACHINE

The cylindrical grinder is a type of grinding machine used to shape the outside of an object. The cylindrical grinder can work on a variety of shapes; however, the object must have a central axis of rotation. This includes but is not limited to such shapes as a cylinder, an ellipse, a cam, or a crankshaft.

External cylindrical grinding is one of the most common grinding processes and is mainly used for grinding rotationally symmetrical workpieces. It differs in the type of workpiece clamping and feed directions:

- Peripheral-cross grinding between centers (plunge grinding)
- Peripheral-longitudinal grinding between centers (oscillation grinding)
- Centerless-peripheral-cross grinding (centerless plunge grinding)
- Centerless-peripheral-longitudinal grinding (centerless through feed grinding)

The most common type of clamping in external cylindrical grinding is between centers. This means that the workpieces must be centered at the front and are driven by a workpiece driver.

*Figure SEQ Figure * ARABIC 20: External Cylindrical Grinding Machines*

For external cylindrical grinding, long, heavy or thin workpieces must be additionally supported by steady rests so that the necessary form and geometry requirements can be met. In the series production of tools like: drills, cutters, step drills, peel grinding is increasingly used. Here the cutting is done by a higher infeed divided into a few cuts and a reduced feed motion (oscillation motion).

In centerless grinding the workpiece is fixed by 3 points. This fixation is determined by the components grinding wheel, control wheel and support ruler. The workpiece is simultaneously guided and machined on the periphery. In centerless plunge grinding, the grinding wheel moves radially towards the workpiece. The following workpieces are produced with this grinding process: Jet needle for injection systems, bearing seats of camshafts, valve tappets for the automotive industry, to name but a few. In centerless through feed grinding, which is a typical serial grinding process, pistons for the automotive industry, shafts, rods and also elements for the rolling bearing industry are produced.

2.6 DESIGN AND PRECISION MEASUREMENT

This is the department that is crucial in KIRDI as it designs all the engineering drawing that are used in Engineering. It was headed by Mr. Ngetich. It majorly comprises of high technology computers which help in designing using solidworks software. This is the recommended software for Mechanical engineers in KIRDI and it is easy to learn and use in technical drawing.

2.7 LAB TESTS CARRIED IN EDSC

MACHINES FOR TESTING AND TESTS

2.7.1 TORQUE TESTER

A torque tester is used as a quality control device to test or calibrate torque-controlled tools. This includes electronic torque wrenches, click torque wrenches, dial torque wrenches, electric screwdrivers, air screwdrivers, pulse tools, cordless screwdrivers, nut-runners, and torque screwdrivers.

2.7.2 CRITICAL REVOLUTION EXPERIMENT

For a rotating mass on a shaft at a given number of revolution and mass added, and fails that is critical revolution

2.7.3 IMPACT TESTING

Common materials tested are

- Mild steel
- Aluminum
- Stainless steel

How the test is carried out;

- Specimen is designed
- Gives the impact at which material fails

Impact in terms of energy (Joules)

2.7.4 FATIGUE TESTING

When a specimen fails due to repeated loading.

Tests the fatigue point of a material

2.7.5 TENSILE TESTING

Load the material

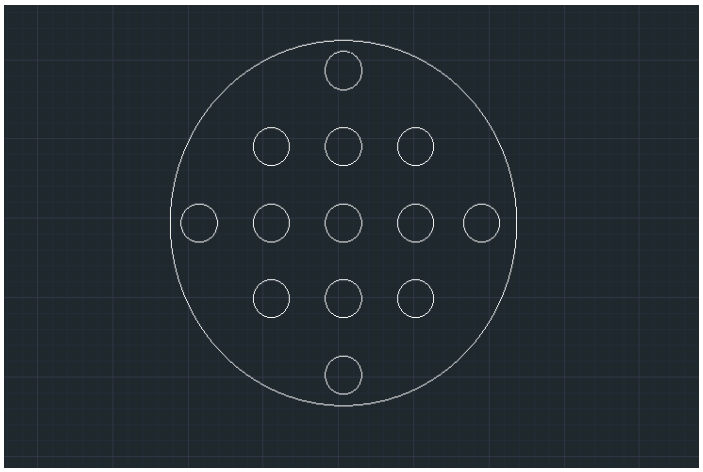
Test for tensile strength

2.8 ASSIGNMENT GIVEN BY MR. ARUSEI DURING ASSESSMENT

2.8.1 TASK: Generate g-codes for two parts of the gasifier jiko.

Circular part of fuel canister.

It is 144 mm diameter with 13*10 mm diameter holes.



G and M Codes

N0010 (Filename: circularjiko.tap)

N0020 (Post processor: centroid THC with scriber .scpost)

N0030 (Date: 22/08/2022)

N0040 G21 (Units: Metric)

N0050 F1

N0060 G53 G90 G40

N0070 (Part: circularjiko)

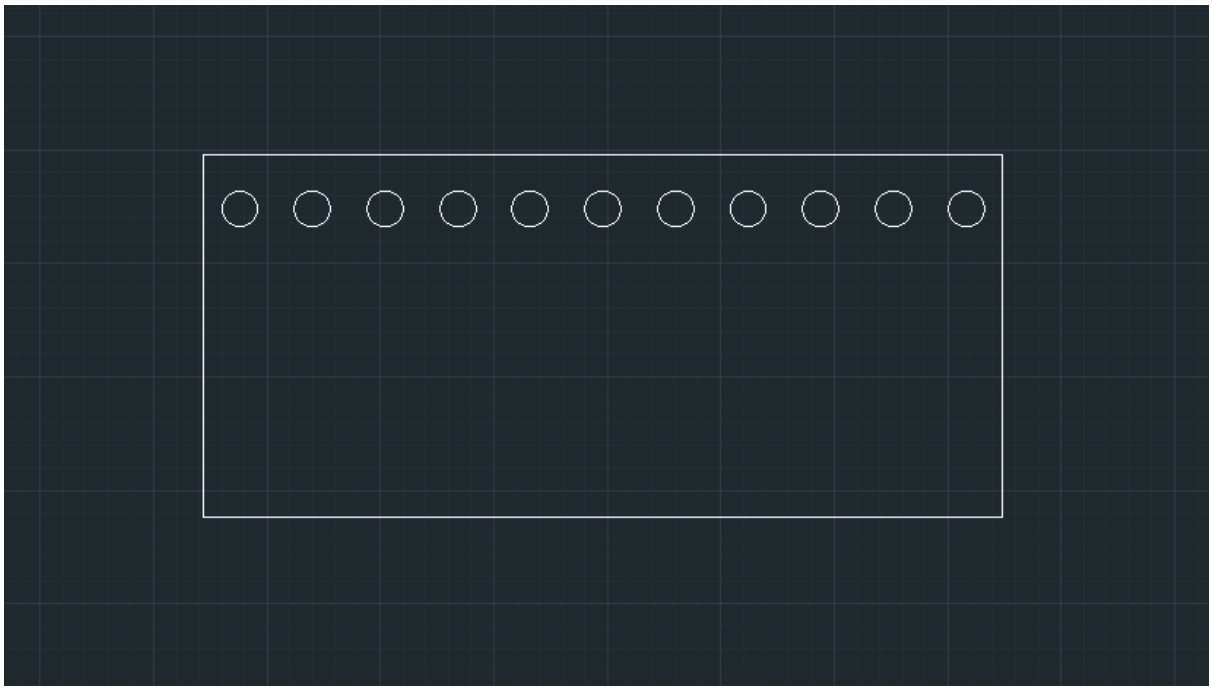
N0080 G00 X0.0000 Y0.0000

N0090 M05

N0100 M30

Cylindrical section of the fuel canister

It is 440mm*170 mm with perforations of 11*10mm in radius.



G and M codes

0010 (Filename: CYLINDERJIKO.tap)

N0020 (Post processor: centroid THC with scriber .scpost)

N0030 (Date: 22/08/2022)

N0040 G21 (Units: Metric)

N0050 F1

N0060 G53 G90 G40

N0070 (Part: CYLINDERJIKO)

N0080 G00 X0.0000 Y0.0000

N0090 M05

N0100 M30

2.5 Design Unit

KIRDI has a robust engineering development and services centre. The centre provides specialized engineering and technical support to local industries and SMEs in the metal and metal products sub-sector. The support provided includes; designing, developing and reconditioning tools, dies, jigs and fixtures, developing and manufacturing of industrial plants and machine prototypes, testing and quality assurance services, training courses in specialized engineering skills, technical consultancy and extension services to industry.

Chapter 3
Manufacturing/production/processes/product

3.1 INDUSTRIAL MATERIALS RESEARCH CENTRE (IM-RC)

IM-RC undertakes demand driven research, innovation and technology development and disseminates the outputs to the relevant industries and other stakeholders. To achieve this, the center has the following research units Leather, Textile, Ceramics, Minerals and Building. We purpose to undertake research, development and transfer innovative technologies in industrial materials for industrial development and socio-economic growth.

3.1.1 Leather and Leather Products Research Unit

- Leather and leather goods production from conventional and non-conventional animal sources (cows, goats, sheep. ostrich, crocodile, snakes, fish, rabbits);
- Research on sustainable and green approaches in leather processing, (hides and skin);
- Consultancy and capacity building on establishment of leather processing plants and leather workshops; and tannery waste management/effluent analysis
- Fabrication of leather equipment – tanning drums and beam tables
- Leather testing
- Product standardization and quality assurance

3.1.2 Textile Research Unit

- Valorisation of natural fibres from commercial plants (cotton, sisal, coconut, banana) for product development (textiles, sanitary pads, natural hair piece, handcrafts)
- Generally-Recognized-as-Safe (GRAS) microorganisms in textile waste-water bioremediation, desizing, scoring (washing)
- Consultancy and capacity building services - sanitary pad making, embroidery and tufting technology (mat and carpet -making technology)
- Product standardization and quality assurance - dyeing, washing, rubbing fastness and wear

3.1.3 Ceramics, Minerals and Building Materials Unit

- Alternative building materials / green construction technology - recycling of waste materials from other industries (e.g. bagasse and rice husks) into building components (ceiling boards, wood panel boards).
- Consultancy in utilization of natural resources (e.g Kisii soapstone, Makueni clay, Mukurweini clay) in ceramics, pottery and construction industries**.**
- Consultancy in building plant and machinery designs for pottery, brickmaking.
- Product standardization and quality assurance services - compression test and tensile test for concrete and soils, wood panels; ball milling services – for rocks and soils; Ceramics, minerals and building materials testing.
- Other consultancies offered; Plant structural design and development, Kiln and incinerator design, Soil and minerals analysis, Structural and concrete technologies

3.1.4 Ceramics and Building Materials Center

We have a pilot production center that offers industrial support services: incubation and common manufacturing services; consultancy and extension services. The center has compression testing machines, ball mills, tensile testing machines, high and low temperature ovens.

3.1.5 Leather Development Center

This is a pilot production tannery and leather goods development unit in Nairobi and Kisumu that offers entrepreneurs the following services: capacity building, incubation and common manufacturing services; consultancy and extension services. The center has assorted equipment/machinery; Tanning and Pilot scale drums, Leather splitting and shaving machine, Embossing/Plating machine, Buffing machine, Leather spraying booth, Leather staking machine, Common leather processing facility for SMEs, Assorted leather testing equipment.

3.1.6 Textile Development Center

This is a textile pilot production center offering capacity building, incubation and common manufacturing services; consultancy and extension services. Equipment in the facility include a sanitary pad making machine, computerized embroidery machine, banana fibre extractor, mat making machines, rotary screen-printing machine, Textile

testing machines; wash fastness, infra-red dyeing, crock meter, wear fastness, water permeability.

3.2 CHEMICAL ENGINEERING AND ALLIED PROCESSES RESEARCH CENTRE (CEAP-RC)

CEAP-RC undertakes industrial research in process development; plant design, optimization and scale, industry processing aids, bioactives compounds and polymers, cosmetics, nutraceuticals, agrichemicals (bio pesticides, bio-fertilisers, feeds/emerging feed sources), biofuels, pharmaceuticals (extract actives) and phytochemistry. Our task is to develop processes and value added-products from basic chemicals, specialty chemicals and consumer chemicals, that are responsive to sustainable manufacturing and support transfer technologies to industry. The future research areas are projected to include nanotechnology, biomass conversion to polymers for use as speciality chemicals, computational fluid dynamics modelling, catalysis, cosmetic science, feed science, chemical toxicology and e-waste material recovery.

3.2.1 Research and Development Activities

- Application of natural products of plants such as myrrh, opopanax, frankincense and eucalyptus trees in pharmaceuticals, cosmeceuticals and agrichemicals, cleaning solutions for households, textiles and industries.
- Process development (lab-pilot-commercialization), plant designs, optimization and scaling-up industry processing aids from natural products.
- Natural products extractives (phytochemistry) for application in pharmaceuticals, nutraceutical, cosmeceutical (gum resins), agrichemicals (bio-pesticides, bio-fertilisers, feeds).
- Process development, plant designs, optimization and scaling-up of industry processing aids for leather, cosmetics, cleaning products, feed, textile processing among others.
- Polymers and complex fluids design and synthesis for use in coatings, rheology modification, membrane separation and adsorbents with application in cosmetics, energy and water treatment.
- Catalysis and reactions targeting biomass conversion to fuels and chemicals, plasma chemistry, environmental catalysis and fuel cells.
- Computational, experimental and modelling approaches for fluid dynamics.

3.2.2 Capacity Building Programmes

- Cosmetic science (skin creams, serums, cleansers, scrubs, oils and gels, hair care {sprays, conditioners, shampoo, treatment, conditioner, gels, curl products, oils, styling products, relaxers}, nail care, lip care, perfumery)
- Soap technology (beauty bars laundry bars, castile soap, shampoo bars among others
- Detergent technology (personal hygiene {body/bath wash and gels, handwash,}, carpet and upholstery, household {general cleaning products, tiles & bathroom, floor, window}, textiles (softening and bleach agents) and industrial cleaning products (dairy, packaging and metal cleaning).
- Extractive technologies for cross cutting sectors, oil extraction via mechanical or solvent oil from extraction from seed/fruit/nuts for non-food applications}, essential oil extraction from gum resins and vegetative feedstock, crude nutra-pharmaceutical extracts from selected plant metabolites, and resinoid extractions
- Develop and transfer technologies on powdered detergents, petroleum jelly, lotions, creams, disinfectant, bleaches and antiseptic technologies
- Animal feeds formulation training

3.2.3 Research laboratories

Our research laboratories have specialized equipment for separation techniques (column chromatography, TLC), UV Visualizer and distillation. The laboratories also support formulation, product and process development, prototyping, testing, product validation), product evaluation (shelf life, stability), proof of concept and training.

3.2.4 Incubation and Common Manufacturing Facilities

Our facilities promote Good Manufacturing Practices (GMP) compliance in production, market testing, product certification, and capacity development (skills, technological and financial). The facilities are also technology demonstration hubs for on-boarding investors and branding in one vertical pipeline and have the following assorted equipment; stainless-steel jacketed reaction vessels, soap plodder, oil press, distillation vessel, bench and industrial weighing scales, disc mill, ribbon mixer, pilot mixer and stainless steel settling vessels.

3.3 ENERGY RESOURCES AND ENERGY EFFICIENCY RESEARCH CENTER (EREE-RC)

EREERC undertakes market driven research and development, testing and product development/improvement and transfer of Renewable Energy technologies. Our aim is to take lead in the quest for sustainable energy solutions through dedicated Research and Development (R&D) and transferring findings support accelerated uptake of renewable energy and energy efficiency in the country.

3.3.1 Research and Development Activities

- Accredited laboratories for research, testing and capacity building on cookstoves, biogas and energy efficiency (electrical appliances, motors and lighting);
- Development of renewable / green energy resources and technologies (solar, wind, hydropower, bioenergy) in the energy matrix
- Waste to-energy technologies (WtE technologies) – industrial (bagasse), municipal and agricultural waste
- Clean cooking fuels and technologies – solid biomass fuels (wood, briquettes, agro-waste), liquid biomass (bioethanol, biodiesel), gaseous fuels (biogas, hydrogen)
- Consultancy services on energy management and audits, feasibility studies (mini-hydro plants)
- Capacity building – biogas, cook stoves, energy management

3.3.2 Biomass Research Laboratory and Testing Center

The stove testing laboratory is equipped with Laboratory Emissions Monitoring (LEMS) equipment. We conduct performance assessment of clean cook stoves and advice on technical areas of improvement and work closely with Kenya Bureau of Standards in the development and review of cook stoves standards.

This laboratory provides services to industries for water boiling tests; determination of emissions and efficiencies; safety test; controlled cooking test.

3.3.3 Energy Efficiency Laboratory

The Energy Efficiency Laboratory has an Inertial Dynamometer System (IDS) for assessment of performance of industrial motors; Spectroradiometer/Integrating Sphere system for study and analysis of general service electric lamps; and modern portable

equipment for on-site measurements and assessment in accordance to the energy management standards.

3.3.4 Biogas Laboratory

The laboratory undertakes analytical work on biogas feedstock, gas and digestate. Analysis Services offered by the laboratory include; biomethane potential analysis; digestate analysis and biogas composition. The laboratory is used as a pilot for biogas production optimization and for hands - on training on biogas technology.

3.2 ENGINEERING AND ICT RESEARCH CENTER (EICT-RC)

EICT-RC provides engineering solutions by undertaking quality industrial research in, mechanical, electrical, electronics, mechatronics and ICT. Our goal is to carry out Engineering and ICT research and transfer innovative technologies for national industrialization and social economic development. The center offers engineering and consultancy services through engineering designs, production of machines, tools, industrial spare parts and transfer of research outputs/technologies.

3.2.1 Research and Development Activities

- Equipment design and fabrication (e.g. arc welding machines, honey processors, ball mills, soap plodders, rice threshers, palm oil digester, mini-hydro electrical power generators among others) through; -

1. Reverse engineering
2. Design for manufacture (CAD/CAM technology)
3. Subtractive manufacturing

- Consultancy services – design, sourcing, installation and commissioning of equipment
- Software development and Artificial Intelligence (AI)

3.2.2 Engineering Development and Services Center (EDSC)

The center is a common production facility specializing in the production of machines, tools and industrial spare parts. We also undertake engineering designs, material selection, machining, fabrication and maintenance activities.

The center also offers specialized engineering and technical support in the manufacture of metal products sector such as; designing and developing products such as gears, shafts, bushings, pins, dies, molds, wheels, selected non-metallic components as well as

packaging products and reconditioning tools, dies, jigs and fixtures, developing industrial processing equipment and machine prototypes; installation, testing and commissioning of machines.
Recently acquired Computer-Aided-Design and Computer-Aided-Manufacture (CAD/CAM) - i.e. design for manufacturing (DfM)– for mass production and modern machinery i.e powder coating machine, bandsaw, spot welding machine, tuber cutter / pipe cutter, plasma (laser) cutting, sheet rolling, pipe bending, mig welding and press brake machines.

3.3 FOOD TECHNOLOGY RESEARCH CENTER (FT-RC)

FT-RC is engaged in various disciplines in food science and technology making significant contributions towards a more sustainable and healthy food eco-system.

We provide innovative solutions to challenges that entrepreneurs face in the food value chain. Application of our research innovations take into consideration; move towards a circular food economy; valorization of by-products in the food chain; transition to a more plant-based diet; development of healthy food products with reduced sugar, salt and fats; clean label products; technological innovation in food production processes with optimized cost/benefit; reduction in food losses, reduced food packaging and food industry digitalization. We aim to deliver innovation in research and sustainable solutions across the agro-food supply chain.

3.3.1 Research and Development Activities

- Valorisation of plant, animal, and blue economy resources to enhance food security, decrease postharvest losses, create employment and increase incomes e.g. cereals, pseudocereals (sorghum, millets, amaranth), root and tuber crops (cassava, sweet potatoes), nuts and oil crops (groundnuts, cashew nuts, coconuts, macadamia), fruits, vegetables, meat, milk and honey, seaweeds
- Promoting Food Safety and Health by taking into account diverse aspects of food sciences and nutrition. The center addresses challenges in the food industry (and related sectors) through innovation, product development, product technology, packaging, shelf life, reducing food wastage, quality assurance, food safety policy and sustainable entrepreneurship

3.3.2 KEY FACILITIES

- Honey pilot plant
- Fruits and vegetables pilot plant
- Nuts and oils pilot plant
- Bakery pilot plant
- Cereals, roots, and tuber and food laboratories
- Product development and training facilities

3.4 INDUSTRIAL MICROBIOLOGY AND BIOTECHNOLOGY RESEARCH CENTER (IMB-RC)

IMB-RC undertakes research and development in competitive biologically based technologies aimed at finding solutions in food, health, agriculture, energy and environment. Our goal is to create a national hub for innovations in Microbiology and Biotechnology Research to meet the national development needs.

3.4.1 RESEARCH AND DEVELOPMENT

- Food safety issues associated with pathogens and contaminants. IMB-RC provides industries with laboratory analysis services for the detection of microbial contaminants in food, feed, and water.
- Application of biotechnology innovations, such as fermentation technologies, to produce value-added products for industries such as agriculture, food, feed, chemical, bioenergy, pharmaceutical, leather and textile.
- GenBank for preservation of various mushroom strains and production of mushroom spawn for entrepreneurs. IMB-RC also supports entrepreneurs with analysis and training in value addition technologies for edible and medicinal mushrooms.
- Provides a platform for local scientists, institutions and the industry to foster innovations as well as advance high-quality research in microbiology and biotechnology to achieve maximum economic impact.

3.4.2 KEY FACILITIES

Biosafety Level 1 Laboratory – BSL 1 - Generally Recognized as Safe (GRAS) microorganisms in food production; waste management and bioremediation;

Biosafety Level 2 Laboratory - BSL 2 - Product standardization and quality assurance services for industries.

Chapter 4

Companies health, safety and environmental issues

4.1 ENVIRONMENTAL SUSTAINABILITY AND CLIMATE CHANGE RESEARCH CENTER (ESCC-RC)

ESCC-RC undertakes environmental sustainability research and development and consultancy work for industries, community organizations, research institutions, and government agencies. We purpose to undertake collaborative and multidisciplinary research and transfer knowledge and technology for sustainable production.

4.1.1 Research and Development Activities

- Clean / low cost lighting and cooking energy technologies - gasifier technology; focuses on development of clean cooking stoves, safety & performance testing of stoves and emissions testing and monitoring.
- Green and Circular Economy initiatives– cleaner production; 3R initiative (Reduce, Reuse, Recycle);
- Green Manufacturing to enhance industrial competitiveness; focuses on materials, water and energy flows assessments in industries to establish utilization efficiencies along the various stages of production or processing lines and help implement efficient and clean solutions.

4.1.2 Other areas of focus

- Waste minimization and management in industries (social impact assessment, solid waste management and waste water management)
- Climate change mitigation and adaptation.
- Carbon footprint determination and monitoring.
- Development of policies integrating biophysical, social and economic systems, with industrial processes.
- Environmental impact assessments and audits for industrial and other projects.

4.2 Quality assurance and control

This programme utilizes national, regional and international standards to assure the quality characteristics of industrial goods and services in order to enhance competitiveness and productivity of local industries. KIRDI offers industries analytical and testing services in water

and waste water, food, animal feed, chemicals (soaps, detergents, and petroleum products), leather, textiles, minerals and related materials. In addition, KIRDI offers technical advice on appropriate packaging and labelling to enhance market penetration. In 2021/2022, KIRDI offered analytical services over 500 industries.

4.3 Industrial problem identified

4.3.1 GENERAL PROBLEMS FACED

- Politics of the country. Being a company of the government, the major politics in the country affect the management and even the production.
- High capital-intensive research. Some projects are so expensive to set up research on and to acquire the machines and tools to conduct them
- Low Efficiency output of some projects. Some good projects are so good to the community but the efficiency in implementing them beast logic in that they may yield less income and the value addition to the market will be negligible compared to the cost of implementing the research or the idea.
- Coping with the technology. Technology is advancing every time and the rate at which new products are coming, they end up nullifying the use of the old products and machines. So KIRDI being a research center is required to cope with the emerging trends in the market.

4.4 TECHNICAL PROBLEMS

4.4.1 WASTE SCRAP METAL MANAGEMENT

Most of the work done in EDSC uses mild steel, stainless steel or aluminum. In the five major departments where most of the work was done, there lied a pile of sheet metals of waste scraps that occupied a large space of the department. This at times might hinder operations to continue smoothly because the space is limited.

HOW IT IS MANAGED CURRENTLY

Most of the waste scrap is currently managed by squeezing it in one room and piled up in an organized way so as to create space in the other departments. This however has contributed to having dormant departments since the space is limited in the areas where the waste scrap has been piled up.

PROPOSED SOLUTIONS

i. *Quotation of exact material to be used*

When ordering materials to be used in doing any work, there should be a proper research and calculation of the material that can be used. This will predetermine the amount of lets say sheet metal that will be enough for the that specific work. This will reduce the pile of waste material accumulated and is no longer in use.

ii. *Teaching staff on proper utilization of materials*

Educating the staff on the importance of proper and precise utilization of materials should be considered. There should be a policy that no extra material should be used unless the already used one is depleted. If it is a one by one mild steel metal tube, it should be used in manufacturing until it is depleted before taking another one by one mild steel metal tube.

iii. *Selling waste to scrap metal companies*

The management should consider incorporating with the private sector that is specialized in the recycling of scrap metals and sell to them the inevitable scrap waste that was accumulated. This will not only reduce the amount of waste accumulated but it will also generate more income to the company.

iv. *Recycling*

There are other waste scrap metals that can be considered useful in other works of the company. This should be taken note of and be used to manufacture other products that can be made from the scrap metals.

v. *Sorting of metals that can be used later*

Sorting out of the remaining metals into different sizes when the work is done is paramount. This will not only help to ease the process of finding the required material but it will also encourage recycling and saving the extra cash that could have been used to purchase the other materials.

vi. *Setting up of a forging and foundry*

Forging is a manufacturing process involving the shaping of a metal through hammering, pressing, or rolling. These compressive forces are delivered with a hammer or die. Forging is often categorized according to the temperature at which it is performed—cold, warm, or hot forging.
This forging shop will help in the management of the waste scrap metal in that if well equipped, it can restructure the used scrap metal to one uniform usable metal that can be of use again.

4.4.2 MOVEMENT OF HEAVY MACHINES FROM ONE DEPARTMENT TO ANOTHER

EDSC was responsible in maintenance and repair of any machine that may break down within the company. Other departments like food processing department are a bit far from the EDSC block. So when a machine is to be maintained and is in the food processing department, the machine is to be carried to the EDSC for maintenance. If the machine is a bit heavy, greater manpower is required and it carried to the EDSC for maintenance. This carrying of machines and getting extra manpower from other departments may inconvenience the people called from their routine work. This in turn will reduce the productivity of the company objectives. Therefore, the company has some machines that help in the movement of machines from one department to another but they have their limitations which I think could be curbed by my newly thought of design.

HOW IT IS MANAGED CURRENTLY

KIRDI has the following machines that ease in the movement of machines from one department to another. They however, have limitations as described below:

- Steel roller skids

A roller skid is a small, low-profile transportation tool equipped with rollers or wheels. It slips under heavy objects and reduces drag or friction, allowing the material to be rolled instead of dragged.

This is efficient in that it can be handled by one person but it if the machine is heavy, it requires more than one person to carry the machine and place on the roller skid.

- Lifters

A lifter is a trolley like transportation equipment that ease movement of carton packed goods from one place to another.
This is also efficient since it can be handled by just one person when the goods to be carried are already packed in a carton. However, it becomes inefficient when the goods or machine are bulky and cannot be packed in the carton.

- Cranes

According to oxford dictionary, a crane is a large, tall machine used for moving heavy objects by suspending them from a projecting arm or beam. This is efficient in that it can lift very heavy machinery. But its limitation to just one place makes it not ideal for moving machines from one department to another. It is also power intensive and expensive to acquire.

- Trolleys

According to Wikipedia, a trolley is an L-shaped box-moving handcart with handles at one end, wheels at the base, with a small ledge to set objects on, flat against the floor when the hand-truck is upright. The objects to be moved are tilted forward, the ledge is inserted underneath them, and the objects allowed to tilt back and rest on the ledge.
The truck and objects are then tilted backward until the weight is balanced over the wheels, making otherwise bulky and heavy objects easier to move. It is a first-class lever.
This is cheap and helps in moving machines from one place to another. However, it requires many people to carry the machine and place it on the truck. It also cannot carry bulky machines.

PROPOSED SOLUTIONS

With the above-named equipment, I thought of an equipment that can do the following:

- An equipment that can be handled by one person
- An equipment that is portable
- One that can lift the machine to be carried and place it on its base before transporting it
- An equipment that can be easily maintained
- An equipment that is easy to handle
- A cheap equipment

PROPOSED DESIGN AND DRAWINGS

*Figure SEQ Figure * ARABIC 21: PROPOSED DRAWING*

*Figure SEQ Figure * ARABIC 22: PROPOSED 3D DESIGN*

PRINCIPLE OF OPERATION

This modified pallet track works on two major principles:

- Hydraulic lift principle
- Hoists or pulley principle

Hydraulic lift principle

This is used to raise or lower the lifter to load and offload it. Hydraulic lifts work on a basic principle: to go up, a pump pushes the fluid in the hydraulic system into the cylinder, pushing the piston the base of the modified pallet up. To go down, the valve opens and the fluid is allowed to flow back into the reservoir, and is pushed back using the gravitational force of the lifter.

Pulley or Hoist principle to lift

Inside the chain hoist housing are two gears. One is smaller than the other. Most chain hoists use a 20cm and 25cm gear. The two gears are attached, so when one moves, the other moves. The chain is looped over the smaller gear, and then hangs down in a loop (the loop you pull on). The chain then continues on over the larger gear and down to a point or another loop, depending on the type of hoist you are using. The operator pulls on the section of chain which is looped over the smaller gear.

How the mobile pallet track works

The mobile pallet track works by combining the two named above principle to transport goods from one place to another within a short distance like in warehouse or an industry. Heavy machines can be carried by the mobile pallet track with just one person. The mobile pallet has a hoist system that has a chain and a hook that will help you to get hold of the machinery to be carried and load it to the pallet track.

It can also be used to carry packaged cartons with the base of the mobile pallet that uses the hydraulic lift principle.

This is just a modification of a normal lifter that is attached with a crane like system that will minimize the labor required to lift and load it. This modified lifter will help KIRDI in transporting heavy machinery from one place to another with ease.

Chapter 5

Conclusion recommendation and summary

5.1 Conclusion

The Big Four Agenda is the country's major transformation blueprint being implemented within five years from 2017-2022. Government seeks to enhance manufacturing contribution to GDP from 9.2 % to 20 % by 2022 through investment in core areas such as; leather, agro-processing, textile and construction materials. Enablers for this sector include investment in Industrial Parks/Zones, SME's Development interventions and improved market access and export standards

Research, Technology and Innovation plays a central role in driving the manufacturing sector through technological developments and transfer. Innovations in manufacturing technology and product developments enhance the value chain thereby upgrading products and enhancing global competitiveness of the sector. In addition, technology transfer will make production faster, simpler and more efficient for our manufacturing industries thus raising the manufacturing sector share to GDP. As part of the support towards realization of "Big Four Agenda" (MTP III), KIRDI is identified as a key player in the establishment of state-of-the-art industrial research laboratories. This is expected to develop value addition and manufacturing technologies that will be transferred to MSMEs in areas including: leather processing, agro-processing, energy and natural products.

Attainment of Food security and nutrition is dependent on increased agricultural productivity and post-harvest management which are largely technology driven. It is also expected that incentives will lower the cost of agricultural and post-harvest machinery. KIRDI will engage in research and prototype development, reverse engineering and commercialization of innovations that will lower the cost of agricultural and post-harvesting machinery. In addition completion of food processing laboratories at KIRDI Kisumu will support development of value addition technologies which will be transferred to MSMEs.

As part of contribution towards affordable universal health coverage and housing, completion of the ongoing research laboratories has an enabling role in the "Big Four Agenda". Local production of the diagnostic machinery and medicines will lower their cost, thus contributing to their availability and affordability under which KIRDI will play a supportive role. Commissioning

of advanced materials Science laboratories will engage in research and development of ceramics and building materials and innovative technologies that can lower the cost of building material

5.2 Recommendation

I would like to suggest for Human Resource to provide a meeting with student weekly or monthly to ensure the welfare of the students are not ignored. It is important for ensuring the health, welfare and fitness of students in the company. In fact, a lot of new information can be obtained by the students. Besides that, I expect the company will provide a suitable place or room for trainees so that they can have a place to do reports and communicate with other trainees for more knowledge. Moreover, I hope supervisors could improve motivation session to trainees so can be more competitive and motivated. This can improve trainees' skills, general knowledge and expertise on certain matter.

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