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# DESIGN AND DEVELOPMENT OF A 3D PRINTER.

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***ABSTRACT***

*A 3D printer is also known as desktop fabrication or Additive Manufacturing (AM). It is a devise that processes a prototype which synthesizes structure into a 3d model. The 3d model is stored in as a Selective Laser Sintering (STL) format. The process is known as 3D Printing. It can use a vast range of materials like acrylonitrilebutadienestyrene (ABS), polylactic acid (PLA) and composites too. 3D printing is a fast developing and cost-effective form of high-speed prototyping. A 3D printer puts or prints the CAD design layer by layer as it forms a real object. The 3D printing process is gotten from inkjet desktop printers in which numerous deposit jets and the printing material, layer by layer are obtained from the computer aided design (CAD) 3D statistics.*

*The significant reasons for businesses and institutes to expend in 3D printing solutions are to obtain fast prototyping, to envisage architectural scale models, to improve healthcare as there have been experiments with 3d printed prosthetics and printing with human tissue, to effectively use engineering processes, to replace machine components and digitized-component files are included in a parts-management system among others.*

*Many market sectors are recording huge growth rates arising from the increasing use of 3D printers amongst existing consumers, and the acquisition of 3D printing by new employers in industries where mass customization is required as standard and design complexity no longer adds cost. Aerospace, oil and gas have the top two rates of growth of end-user industries.*

*3D printing will significantly help mass production processes in the future. This type of printing is likely to influence industries, like automotive, medical, education, equipment, consumer products industries and different trading.*

***Keywords****: 3D Printing, Rapid Prototyping, ABS, PLA*

CHAPTER 1

## 1.0 INTRODUCTION

The 3D printing is also known as desktop fabrication and has an affective prototyping process where a concrete object can be designed from a 3D model. A 3D printer machine employs a CAD model for this effective prototyping process. The 3D design is saved in an STL style and then later conveyed to the 3D printer. The machine (3D Printer) is able to use a large assortment of materials which include the PLA and ABS. However, the composites can also be used.

The advantages of the 3D printing are that it is not only way of fast development but also a kind of cost serving. It prints the CAD design layer by layer in making a concrete object. The process of the 3D printing is acquired from the inkjet desktop in which several deposit jets as well as the printing material made in layers taken from the CAD 3D data. The 3D printing has the ability to convey information in ways as well as that of early photocopying technologies and therefore, it identifies the appropriate software and applications, it identifies the sources of information and its technologies.

With the use of the 3D printing methods, the extraction and innovations of new technologies, institutions and companies are able to have design replications at the shortest period of time at a minimal cost. 3D printing has influenced many service and manufacturing industries such as automotive, architecture, education, consumer industries as well as medical businesses.

## 1.2 BACKGROUND INFORMATION

The 3D printing technologies were designed in the 1980’s and were called Rapid Prototyping (RP) technologies. The very first patent application for RP technology was filed by a Dr. Kodama in 1985. Hull became the co-founder of the 3D corporations which is one of the largest and most major companies in the field of 3D printing and rapid Prototyping.

The primary business Rapid prototyping framework, the SLA-1, was presented in 1987. The patent in regards to the FDM innovation was at initially issued to Stratasys in 1992. After a wasting with the stereo lithography process, EOS' R&D center was chiefly on the laser sintering (LS) process, which got reinforced step by step. Today, the EOS frameworks are all around perceived the world over for their gainful and subjective yield for mechanical prototyping and enthusiastic applications in the 3D printing part. The organization's metal laser sintering (MLS) procedure came about because of an undertaking with a bureau of Electrolux Finland, which was later obtained by the organization EOS in the year 1993.

## 1.3 PROBLEM STATEMENT

For any business entity to thrive, there must be high production to satisfy demand. High sales result into high profits and expansion of the business entity. Zambia has, however, very few industries to produce goods that that can satisfy demand therefore a great need to find a way for these local industries to keep afloat by coming up with a mechanism that can ably help them maximize quality production and compete on the global market.

## 1.4 SITUATION ANALYSIS

Zambia is basically an import country. This has made the country lose the much-needed reserves that could has been used to expand our economy. In all sectors of our economy, there are products which are foreign branded. The revenue used to import all these goods help to expand foreign industries and create employment for their citizens at the expense of many jobless Zambians. The few industries that exist cannot satisfy local demand and cannot as such even compete internationally like China for instance does. China is a household name because it has satisfied its local demand and even foreign markets like Zambia. Toys and hardware stuff of all sorts are flooded on our market. This scenario proves that there is great expansion of industries and job creation in China. That is why it is one of the biggest economies in the world. Zambia is one country that has helped China to grow its economy to the level it is by over importing from it.

## 1.5 JUSTIFICATION OF THE STUDY

A country that is self-sustaining has invested greatly in the manufacture and production of goods and services. Zambia has not invested enough in technology that can boost its local industries. By designing and a 3D printer, existing industries can thrive, expand and their products can compete favorably on the international market. The use of 3D printing makes the production of products easy and efficiently. Zambia needs to quickly grow it economy and create employment in the expanded and newly created industries much to the use of 3D printing.

## 1.6 OBJECTIVE

The main objective is to design and make a 3D printer using local materials that will help Zambia efficiently produce products, grow the economy and create employment.

### 1.6.1 SPECIFIC OBJECTIVES

The following are the specific objectives;

- To look at the different methods of 3D printing and changes over time
- To investigate various mechanisms of 3D printing
- To study the application of the 3D printers
- To design and make a 3D printer

## 1.7 STATEMENT OF THE SCOPE

The idea in this project is to design and make a 3D printer which would produce locally made and parts of any design in Zambia. The 2D printing method dominated the world for a long time which was much easy to read and understand but it had its limitations as it could not affect the real-life model a 3D model is able to do. The machine will be made from locally obtained materials such as metal sheet (0.8mm or 1 mm), soft wood (preferably pine wood) of 10mm, mild steel square tubes measuring 20mm by 20mm, aluminum round tubes of diameter 12mm. To make a frame of the 3D printer, several machines will be used such grinding machine, sheet metal shear, drilling machine, grinders and some hand tools. The project will to be electronically operated and hence will require electrical and electronic components for controls.

## 1.8 PROJECT SCOPE

The scope of the project is limited to the below parameter and material:

i. Material

- Mild steel square rod - 20 x 20mm with 5mm thickness,
- Aluminum round tube (Ø12)
- Metal Sheet 0.8 - 1mm thicknes10mm thickness pine wood
- Electronic components

(ii) Sketching and Drawing

Freehand sketching was done. Then Google Sketch Up, AutoCAD, SolidWorks and Sketch Book were used as computer software were used whose advantage is that they fastest and easiest way of drawing. The use of CAD software assisted in working on the 2D and other details added as it was changed into a 3D model.

(iii) Fabrication

Used angle grinder for cutting and cleaning, drilling machine/\ as well as hand drill for making holes in the wood and

(iv) Plan of activities

CHAPTER 2

2.0 LITERATURE REVIEW

2.1. INTRODUCTION

The origin of the 3D printing is directly related to, sculpting, photographing and landscaping designs some era back in America. However, a remarkable evolution in the technology was seen in the mid-1980. The 3D printing was then called the Rapid Prototyping. A renowned man by the name of Chuck Hull, of 3D Systems Corporation, made the first usable 3D printer. Later, the Selective Laser Sintering (SLS) technology was amalgamated by Dr. Deckard at the University of Texas during the commencement of project being done by Defense Advanced Research Projects Agency. The evolution continued in the 1990s when the technology was further improvised with the advancement of a technique that uses UV light to solidify photopolymer, a highly viscous liquid material. In the 20th century, 3D printers were mostly owned by scientists and electronics groupies for research and display because they were very expensive and were used to print a few numbers of products.

2.2. PRINTING TECHNOLOGIES

It is evident that there are different processes and technologies that were developed over the past 36 years since 3D printing was invented. One thing they all have in common is that they are all additive, differing mainly in the way layers are put on top of each other in order to create the object. The following are some different types of technologies.

2.2.1. FUSED DEPOSITION MODELLING

This process used Acrylonitrile butadiene styrene (ABS), the thermoplastics which comprise wax and nylon. The Fused deposition Modeling (FDM) procedure was first to heat up the thermoplastic mixture until it was at an interlaced state. Then, the 3D printer used advanced demonstrating information from a CAD record to form a 3D item layer by layer. The phenomenon is that the printer joins a much weaker bolster composite. The bolster material goes about as framework to the test item. This act is important whilst the manufacturing process when parts have overhangs that could not bolster it. The thermoplastic for the most part has a filamentous structure which benefits warmth exchange and serves to move with a print head that navigates in the x and y bearings. After every layer is printed, a cylinder navigates the stage beneath (z-hub) the

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separation of thickness of printed layer. The benefits of the FDM innovation are many. The expense of the machine and materials are literally low

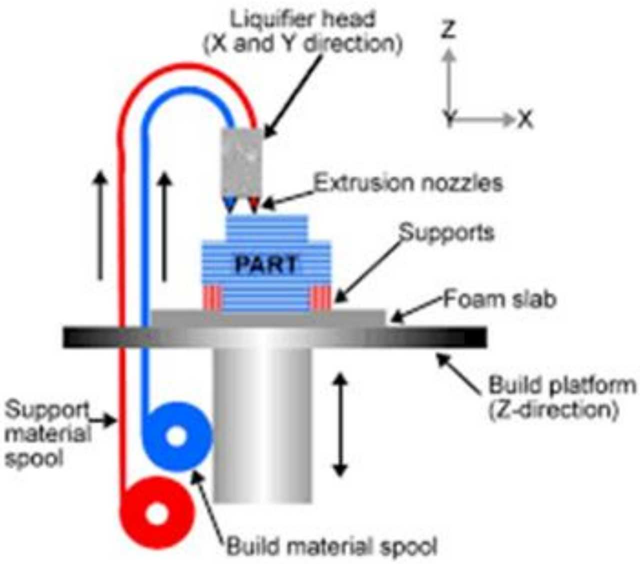



Figure 1: Basic Method of FDM

2.2.2 GRANULAR MATERIAL BINDING - USING BINDING AGENT

The granular material binding methodology used fluid binding material for the binding procedure of the powder together, instead of a laser. Unlike using paper as a part of the instance of a 2D printer, a 3D printer moves the print heads over a bed of powder where it prints information sent from the product. The fluid binding materials used is much the same as super glue. Composite material or mortar is used as powder. In here, 3D printing is also termed fundamental inkjet printing procedures.

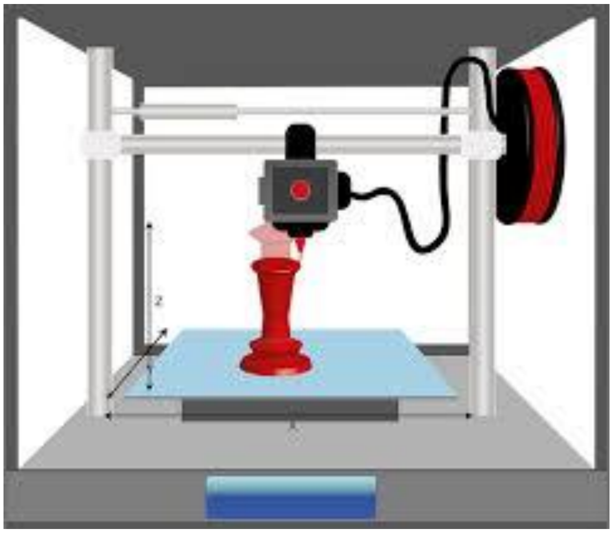
Figure 2: Granular material binding using agent

Source: https://www.google.co.zm/

2.2.3. GRANULAR MATERIAL BINDING - USING HEAT ENERGY

The joining of granular materials involves specifically fusing powder, layer by layer. It is a process that involves fusing different layers of granules in a repeat process in order to build a desired project. Mostly, the sintering process that helps create solid media is often done using a laser beam and support system. However, the elemental composition of the powder and binding process relies on the machine.

Figure 3: Granular material binding



Source: https://www.google.co.zm/url

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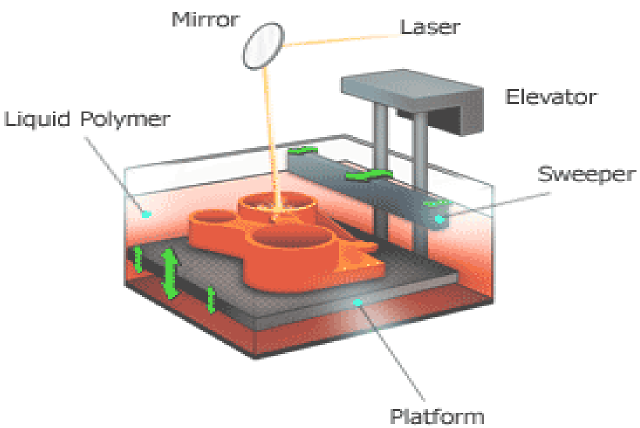
### 2.2.4 STEREO LITHOGRAPHY

This is an additive manufacturing process that works by focusing an ultraviolet (UV) laser on to a vat of photopolymer resin. The photopolymers are sensitive to the light and so the resin is photo chemically solidified. Hence making a single layer of the desired 3D object.

Figure 4: Illustration of SLA Platform

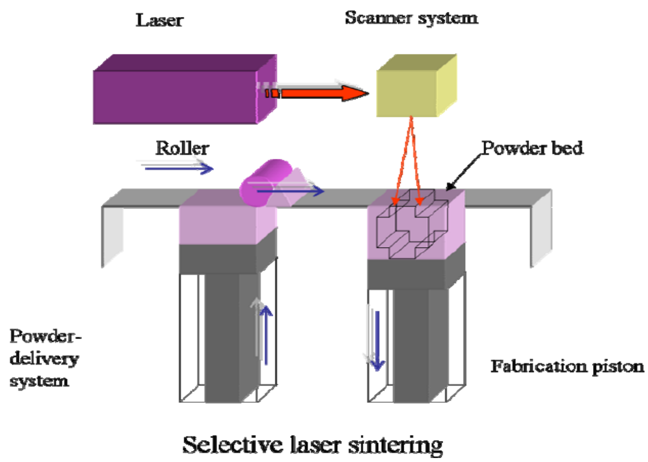



*Source:* [*http://www.c3plasticdesign.co.uk/images*](http://www.c3plasticdesign.co.uk/images)

### 2.2.5. SELECTIVE LASER SINTERING (SLS)

The Selective Laser Sintering a binding process that utilizes a high-powered laser to sinter the powder. Once the first layer is made, the whole granular plate, in which the powder and the print are found, is cut down. This procedure is supplemented by the vertical development of a cylinder. Moreover, cylinders are additionally utilized as a part of a few printers to send the coupling powder up so that the moving instrument would continue working adequately and the sintering can proceed. A mirror is integrated to control the laser bar into the foreordained cut of the CAD model. When the greater part of the layers is appropriately sintered, the item is removed from the build chamber.

Figure 5: Selective Laser Sintering Citation Process

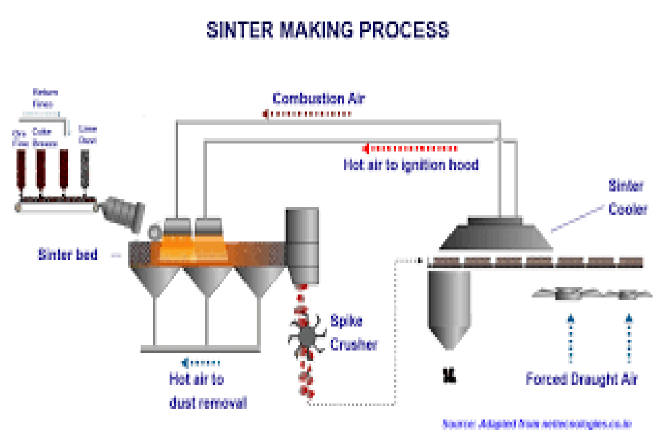



*Source:* [*https://www.google.co.zm/url?sa=i&source*](https://www.google.co.zm/url?sa=i&source)

### 2.2.6. SELECTIVE HEAT SINTERING

Selective Heat Sintering utilized a thermal print head to apply heat to layers of powdered thermoplastic. When a layer is finished, the powder bed moves down and an automated roller adds a new layer of material which is sintered to form the next cross- section of the model. This new strategy uses concentrated heat to fuse the binding powder.

Figure 6: A model created by Blue Print Citation

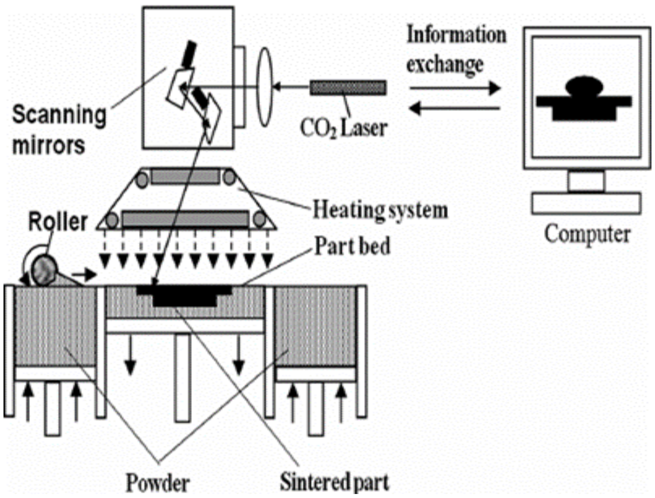



[*https://www.google.co.zm/*](https://www.google.co.zm/)

2.2.7. SELECTIVE LASER MELTING (SLM)

SLM is almost as same as SLS. A more powerful laser is generally used. It requires more energy for the metal to be melted.

Figure 7: Selective Laser Sintering Method

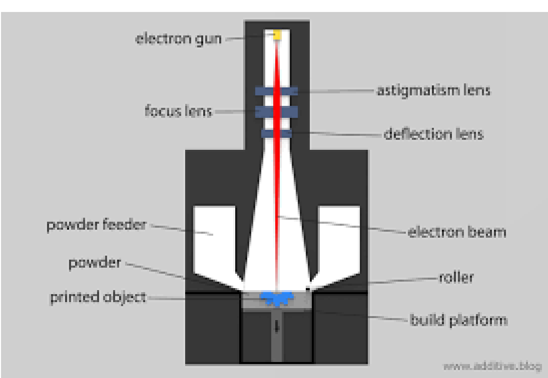



https://www.google.co.zm/url?sa=i&source=images&cd

2.2.8. ELECTRON BEAM MELTING (LBM)

Electron Beam Melting is some cases similar to SLM; an electron beam was used to melt the powder. Unlike models produced by SLM, EBM models are fully accurate, void-less, and extremely powerful.

Figure 8: Illustration of EMB process citation




Source: https://www.google.co.zm

2.2.9. DIGITAL LIGHT PROCESSING (DLP)

Digital Light Processing (DLP) is a kind of stereo lithographic procedure that uses a projector to solidify a layer of photopolymer at once. A mirror is used to position and size the replication precisely onto layer of photopolymer.

Figure 9: Illustration of DLP projection

https://www.kisspng.com/

2.2.10. MATERIAL JETTING

Material Jetting is much the same as the FDM process but works absolutely in an alternate manner than the basic plastic extrusion system. Layers are made by emanating fluid photopolymer into a specific example. These sorts of printers utilize a bolster material alongside the model material. When every layer is shaped a UV, laser is employed for the solidification of the photopolymer. The platform is then moved down, and the model is printed layer by layer.

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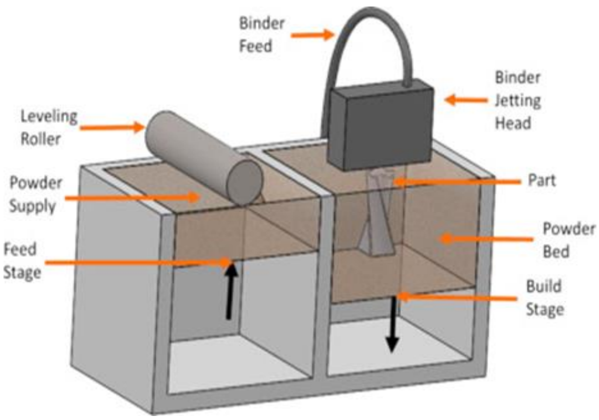
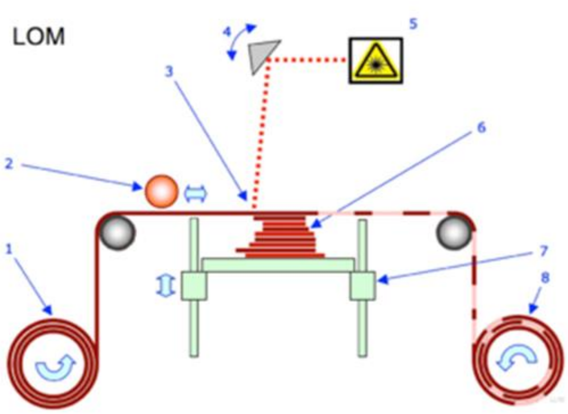
Figure 10: Illustration of Material Jetting Process




https://www.netl.doe.gov/File%

2.2.11. LAMINATED OBJECT MANUFACTURING (LOM)

In this process paper is unwound from the first feed roll onto the stack and bounded to the previous layer using a heated second roller. The roller melts a plastic coating on the bottom side of the paper to create the bond. Covered article assembling can give great results. Other than the laser (carbon dioxide) that is involved for following the patterns in the material. It is a less prevalent rapid prototyping process.




https://en.wikipedia.org/wiki/File:Laminated

Figure 11: A Laminated Manufacturing Process

Laminated object manufacturing: 1 Foil supply. 2 Heated rollers. 3 Laser beams. 4. Scanning prism. 5 Laser unit. 6 Layers. 7 Moving platform. 8 Waste.

2.2.12. PHOTO POLYMERIZATION

It is an additive manufacturing process. This methodology utilizes UV light for the hardening of the photography polymer. There are diverse sorts of photopolymers which are accessible today. Photograph polymerization is really same as FDM and Granular Material binding process. The fundamental contrasts are the material sand that are used for the printing systems.

CHAPTER 3

DESIGN METHODOLOGY

3.1INTRODUCTION

In this chapter, there will be method of the data gathering, design concept and interpretation, material selection and material specification.

All the parts were designed with correct dimensions. The majority of the tool-kit and components as well as the electronics parts for the design were sourced locally and from abroad. Part of the assembly structure was machined and fabricated at the David Kaunda Technical School workshop. Then all the parts are assembled in the solid works workbench to create the 3D printer assembly.

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3.2DATA COLLECTION

Primary data was collected through interviews of people if they knew anything related to 3D printing. The target was mostly small-scale entrepreneurs dealing in making metal windows and door frame and popcorn machines. This was to investigate if these entrepreneurs ever thought of growing their business to the level where 3D printing could be used.

Secondary data involved the use of Witten literature on 3D printing and also googling on the net. Secondary data was gotten from already published books and online sources. This information is important as it broadens the understanding of the project. It allows for comparisons of projects previously done.

3.2.1 DESIGN CONCEPT

The concept of the project was derived from nature and the ant was picked.

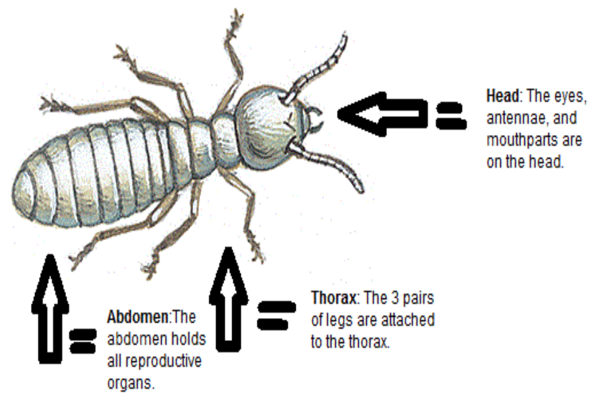
3.2.2DESIGN INTERPRETATION

The similarity between the ant and the 3D printer arises from the common aspect of building up something that grows into a real object.

The selection of an ant was because of the technique that it employs to build its colony or hill. It takes its materials and builds up layer by layer until its colony grows and stands.

- Its mouth rather than the mandible act like a Hot- end extruder print nozzle as it works on the hot bed
- Its thorax and the abdomen are a representative of the frame of the 3D printer giving support to the whole machine.

Figure 12: Body parts of an ant




*Source:www.enchantedlearning.com*

Figure 13: Ants building a colony

Source: www.enchantedlearning.com

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3.2.3 SKETCH DRAWING

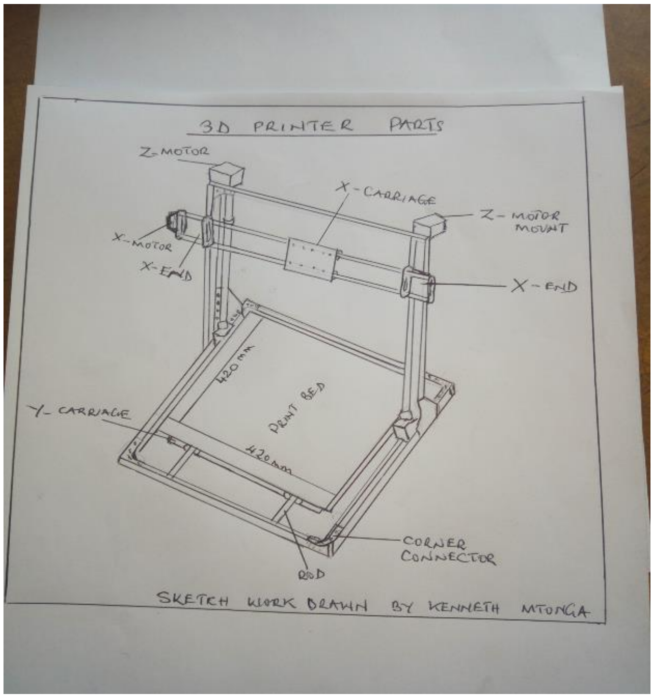


Figure 14:3D Sketch drawing (source: Author)

3.3 SELECTION OF MATERIALS

The selection of materials was determined by the ability to source them locally in Zambia. The factors looked at were;

- Availability
- Affordability
- Quality of material with respect to its properties.

3.3.1. MATERIAL SPECIFICATION

The materials sourced locally were

- Wood (pine)
- Metal sheets
- Aluminum Bars

3.4 WORKING PRINCIPLES

This section covers specific design details of the project with the specific materials sourced to come up with the locally made 3D printer machine. It involves the hardware, working drawings as well as the orthographic view of the final design of the project.

3.4.1 Hardware

This part of hardware show in part in some raw materials and tools used in manufacturing of the 3D printer. Figure 20 is the frame the holds all the parts of the 3D printer which has some movable and immovable parts.

Figure 15: wood cut into shapes (source: Author)

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Figure 16: Metal into shapes (source: Author)

Figure 17: Square tub (source: Author)

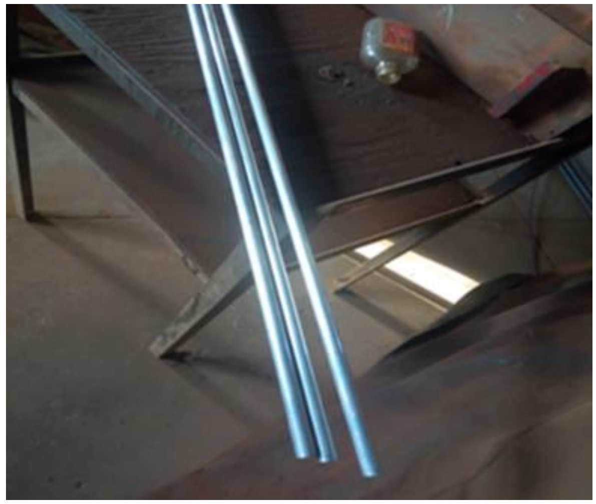

Figure 18: Round rod (source: Author)

Figure 19: Various working tools (source: Author)

Figure 20: Grinder and hacksaw (source: Author)

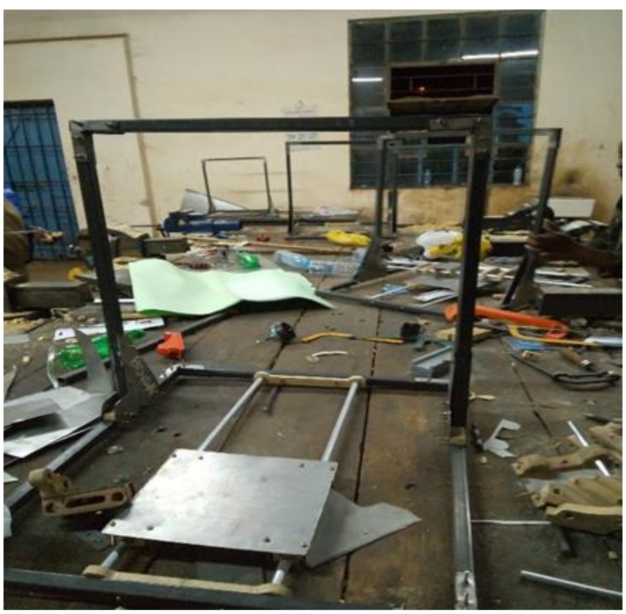

Figure 21: 3D Printer frame (source: Author)

Figure 22: X- Axis, Y- Axis and Z-Axis (source: Author)

Figure 22 above shows a complete structure of the frame of the 3D printer, housing the houses the electronic parts and allows movements of the Y-axis, X-axis and Z-axis. The Z-axis moves the X-axis up and down the frame.

X-Axis

The line controller for the X-axis is made of two 5/8" precision-ground which are hard steel shafts supported at each end by holes in box-beam extrusion. The two shafts facilitate the carriage to move in a straight-line. The carriage which transports the print heads moves along these shafts on linear bearings. The design prevents over limitations because the bearings can move the other way during assembly, allowing their separation to be matched to the separation between the guide shafts.

Y-Axis

The Y-axis is carried on four linear ball bearings riding on a pair of 5/8" precision-ground hardened steel shafts. It carries the X-axis as its load and the carriage. The box-beam extrusion attaches

One pair of bearings at the motor-carrying end of the X-axis and the other pair of bearings is attached to the idler end of the X-axis with a pair of flexures. The flexures permit the position of the bearings to shift slightly to account for misalignment of the guide shafts or thermal expansion of the X-axis. Therefore, a pair of end plates supports each shaft of the Y-axis. To ensure the support holes are parallel, the two end plates for each shaft are made and together.

The Y-axis has two drive belts, one for each guide rod and each belt has its own tensioner and is fixed to one end of the X-axis. A double shafted 24Y-404D stepper motor is used to start both belts at the same time to ensure that the X-axis is carried easily. The shaft of the motor's covers out both sides of the case as each end connects to its corresponding belt drive 30pulley through a helical beam coupling which permits for the misalignment between the motor and the drive shafts. The end plates of the Y-axis and the motor are fixed to the structural frame of the 3D printer.

Z-Axis

Contrary to the X-axis and Y-axis, the Z-axis makes few movements and that each time a layer is finished when it drops away one layer in height. Therefore, stiffness and strength are of serious significance as it must support the weight of the build platform in the direction of movement.

As such a lead screw drive offers exactly the essential combination of features needed for this work. The mechanical advantage of the screw drive means a sizeable motor will be able to move the weight of the build platform. Screw drives are nonblack drivable and so the drive motor will not have to apply a great holding torque to maintain the platform's position. Lastly, the backlash in the lead screw system is removed because the weight of the build platform preloads the drive nut against the lead screw. Three independent screw drives are used to control the Z-axis due to the size and weight of the build platform in the printer. The usage of extra screw drives provides more support for the platform, as well as the ability to tilt the platform for leveling and setting. Just like on the X-and Y-axes, the linear guide on each Z-axis screw driver is also made from a pair of 5/8-inch precision-ground hardened steel shafts. The end plates of each screw drive were drilled and reamed in a single machining operation to make sure that the guide shafts would be parallel. Clamps on the end plates grip the shafts in position.

As the screw drives move more slowly and less frequently than the X- and Y-axes, their carriages ride on bronze guide bushings instead of linear ball bearings. These bushings provide a low-cost and robust alternative to linear ball bearings. The guide bushings are mounted in oversize holes and were glued into place on the carriage during final assembly of each screw drive, ensuring alignment with the guide shafts.

The motor at the top of a leadscrew turns the carriage up and down. The screw drive device is preloaded by the weight of the platform. Each linear screw drive features a 23Y-002D stepper motor from Anaheim Automation at its upper end. The motor drives a "-10 acme lead screw using a helical beam coupling, which compensates for misalignment between the motor shaft and lead screw. A Teflon PTFE lead screw nut is attached to the carriage, making the carriage to go across linearly when the stepper motor rotates. The screw is preloaded by the weight of the build platform, removing backlash from the system. A pair of needle roller bearings at the upper end plate supports the weight on the lead screw. Belleville washers apply preload strength to the bearings, and the whole bearing and end plate assembly is secured between two Acme nuts held in place by Loctite. Loading forces on the screw place it in tension rather than compression, avoiding the potential for buckling as the lead screw suspends by its top end.

The helical coupling compensates for misalignment between the lead screw and the stepper motor, while the needle thrust bearings upkeep the weight of the platform.

**Modular System**

The printer features multiple print heads, allowing the use of a variety of materials and print technologies to create objects. The printer's modular system serves to attach the print heads to the printer carriage. In order to simplify development of individual print head systems, each print head module can be easily removed from or reattached to the printer allowing for easy testing of individual print heads or combinations of print heads.

The optical rail is bolted to an aluminum box beam, which stiffens the rail and serves as a transition between the rail and the carriage. Although the dovetail rail does not provide exact kinematic constraint, it does provide a relatively stiff attachment point for the print head modules. In addition, both the rails and the carriers are commercial off-the-shelf components, which allows for a relatively simple design and short development time.

Furthermore, print head modules can be positioned at any location along the length of the optical rail, allowing for print heads of differing widths to be mounted to the carriage without wasting space.

Frame and Enclosure

The structural frame of the printer supports the motion axes of the printer, houses the electronics, and isolates the interior of the printer from the surrounding environment.

As the printer is intended for research, it is important that the frame and enclosure be simple to assemble and modify, and also allow for easy inspection of the printer's mechanical elements.

The structural frame of the printer is made from "80/20" T-slotted aluminum beams, which provides the requisite structural strength. Due to the T-slots, printer subsystems can be mounted at any point along the length of a structural framing element. Attached to the frame of the printer are UV-blocking acrylic sheets. These sheets isolate the interior of the printer from the environment, containing any volatiles or gases that are emitted during the printing process. This isolation allows the use of materials with toxic or unpleasant fumes without harming people nearby. As the panels also block ultraviolet rays,40 UV-sensitive materials and photopolymers can be used as printing materials. In addition, the panels also protect individuals nearby from the UV light source used to cure photopolymers within the printer.

To improve access to the printer's internals, the upper portion of the printer’s enclosure is mounted on a separate section of aluminum framing and can swing upwards to allow access to the printer's internals. Friction hinges connect the lid to the rest of the printer and hold the lid in the open position. Like the rest of the frame, the lid is covered with UV-blocking transparent acrylic panels, allowing for easy inspection of the printer's internals while the lid is closed.

A safety switch disengages when the lid is opened, keeping the printer from moving or moving while the lid is open for inspection. One potential concern when printing with potentially toxic materials, such as photopolymers, is that volatile gases may leak out through the printer, endangering people nearby. Two electric fans attached to the rear panel of the printer expel any gases or particulates produced during the printing process through a pair of exhaust ducts.

The exhaust gases can then be vented to a chemical fume hood or captured in filters. As the exhaust fans are sufficiently powerful to lower the pressure within the print volume outside air is pulled into the printer through any leaks, rather than exhaust gases within the printer leaking out. This system simplifies the design of the enclosure, as not every seam on the printer must be sealed perfectly.

Finally, the rear panel of the printer also features an electronics door pass through the printer's enclosure via this door, allowing power and control signals to be transmitted to subsystems within the printer. The door features seals that conform to wires passing through, reducing leakage of air through the door.

3.4.2 THE SOFTWARE THE SOFTWARE

The software developed should be user friendly, should be able to display electrical and mechanical variables and should be able to send commands and receive answers. The commands must be sent in a manual or automatic way. Therefore, the computer program would have to be able to communicate with peripherals connected to the computer. Although interfacing with peripherals connected through a serial port is massively documented in various programming languages, i.e. and, the LabVIEW IDE was chosen, because it presented more features aligned to those desired.

The program should implement a bidirectional interface, controlled by the computer. The communication should happen in a way that the computer always has the knowledge of the present task being executed by the machine. Therefore, a protocol would have to be developed, allowing the data exchange between the machine and the computer. The program should feature two operation modes: the manual and the automatic.

In the manual mode, the user should be able to send commands of discrete steps, which would send to the controller a number of discrete steps on each axis, and fast forward, which would send to the controller a command to move the spindle to the extreme positive or negative of the related axis.

In the automatic mode, the user would have to load a file containing CNC code, such as G and M codes. The program then loads the selected files, decodes commands and sends them to the machine.

SVG

Scalable Vector Graphics (SVG) is a World Wide Web Consortium (W3C) standard for portraying two-dimensional vector picture records. Vector pictures comprise of shapes, line vectors and style data rather than the varieties of pixels accessible in raster pictures like JPEG or PNG. SVG records are ASCII content reports in XML arrange, and can be controlled with a drawing project, (for example, the open source editorial manager Inkscape) or with a content manager as plain content. The open standard and XML arrange permits the documents to be scanned in as content and afterward parsed into a usable information structure by our image conversion software.

G-code

G-code is an industry standard for a machine control guideline set, specified in a few international standards including RS274D and ISO 6983. G-code documents are ASCII content records, comprising of an arrangement of charge codes. Each order code is, as a rule, a solitary in sequential order character took after by numeric parameters. G Code Example The program, given below, will draw a 1" diameter circle about the origin.

Model:

- Arduino Software:

This application permits installing the printer firmware on the ATMEGA 2560 microprocessor. To update the firmware each time this installation is necessary.

- Skein Software:

The application to slice STL files into the G-Code is called as Skein Software. Each time the part that needs to be printed needs this type of software.

- Host Software:

Before the print job this application is responsible for the communication with the electronics. It makes the printing output to be ready before the actual printing job.

DESIGN SPECIFICATIONS

| NO | DESCRIPTION | L (mm) | W (mm) | TH (mm) | OFF | MATERIAL |
|---|---|---|---|---|---|---|
| 1 | Steel Square pipes | 560 | 20 | 20 | 2 | Mild Steel |
| 2 | Steel Square pipes | 585 | 20 | 20 | 3 | Mild Steel |
| 3 | Steel Square pipes | 620 | 20 | 20 | 2 | Mild Steel |
| 4 | Cylinder linear rails | X- axis – 624 DIA 12 | | | 2 | Aluminium |
| 5 | Cylinder linear rails | Y-axis – 620 DIA 12 | | | 2 | Aluminium |
| 6 | Cylinder linear rails | Z- axis - 588 DIA 12 | | | 2 | Aluminium |
| 7 | Corner connector | 70 | 70 (20) | 0.8 | 12 | Mild Steel |
| 8 | Bearing holders | 29 Internal DIA 21 | 29 | | 14 | Wood |
| 9 | X Bearing holders | 124 Internal DIA 21 | 21 | 30 | 4 | Wood |

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| | | | | | | |
|---|---|---|---|---|---|---|
| 10 | X Holder linear rail shaft | 100 Internal DIA 12 | 24 | | 4 | |
| 11 | Bed bottom | 230 | 210 | 1 | 1 | |
| 12 | X Plate extruder | 124 | 75 | 0.8 | 1 | |
| 13 | X Plate no Engine | 100 | 59 | 0.8 | 1 | |
| 14 | X Plate with engine | 101.5 Internal DIA 22.5 | 100(99 X 42.51) | 0.8 | 1 | |
| 15 | Y- Shafts | 210 Internal DIA 12 | 27(140 // centers. | 10 | 2 | |
| 16 | Z Bearing holder + nut | 75 Internal DIA 21 DIA 10 | 41.5 | 10 | 2 | |
| 17 | Z Holder bottom linear rail shaft | 36 | 20 | 10 | 2 | |
| 18 | Z Holder top linear rail shaft | 55 | 20 | 10 | 2 | |
| 19 | Platform | 545 | 500//300 | | | |
| 20 | Motor mount (Nema 17) | | | | 3 | |
| 21 | Extruder holder | | | | 1 | |
| 22 | Fan holder | | | | 3 | |
| 23 | Bearing Top holder | | | | | |
| 24 | Filament pipe holder | | | | | |
| 25 | Z - Motor mount plate | 200(20) | 116 | 0.8 | 2 | |

DESIGN PARTS

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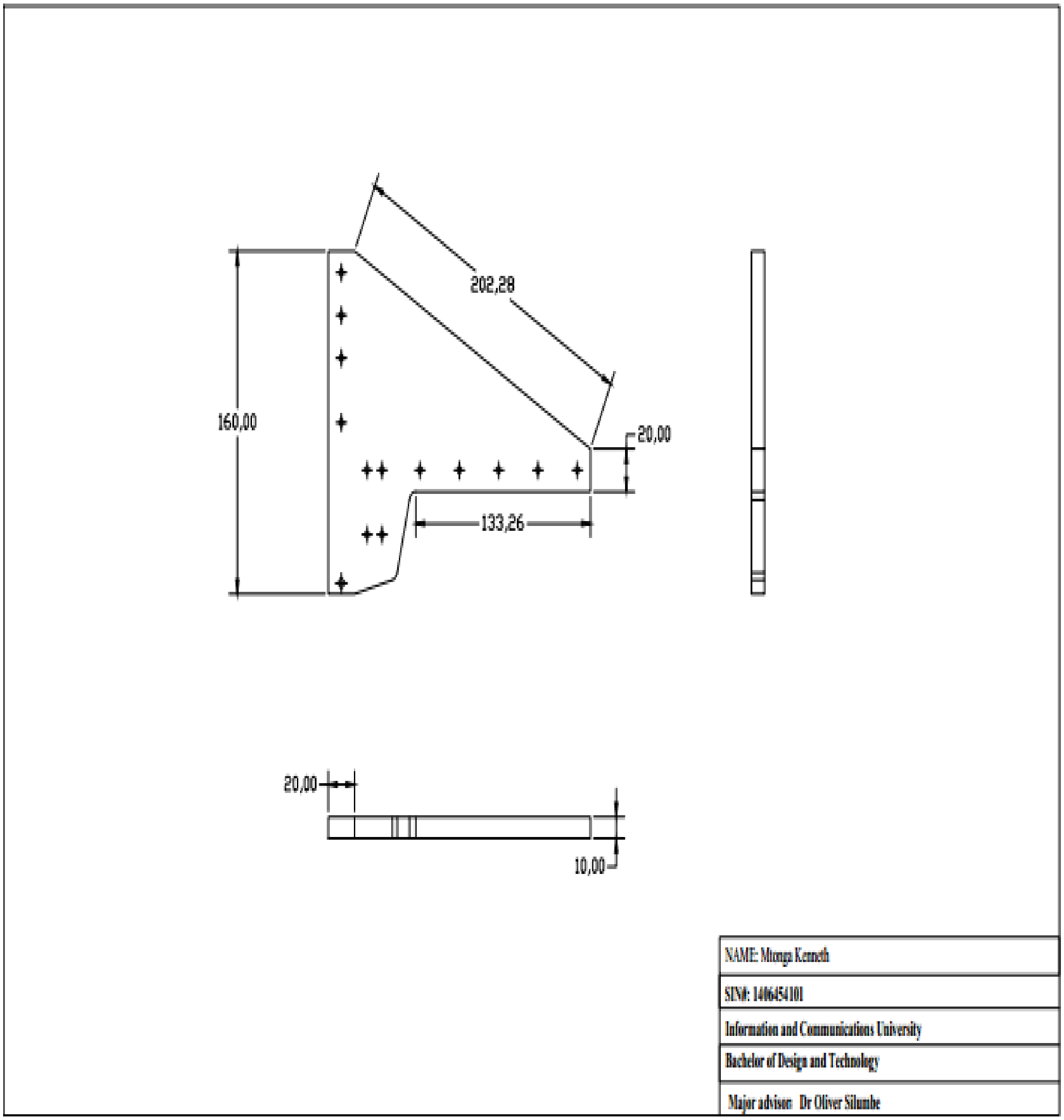


Figure 23: Z Mount Plate (Source: Author)

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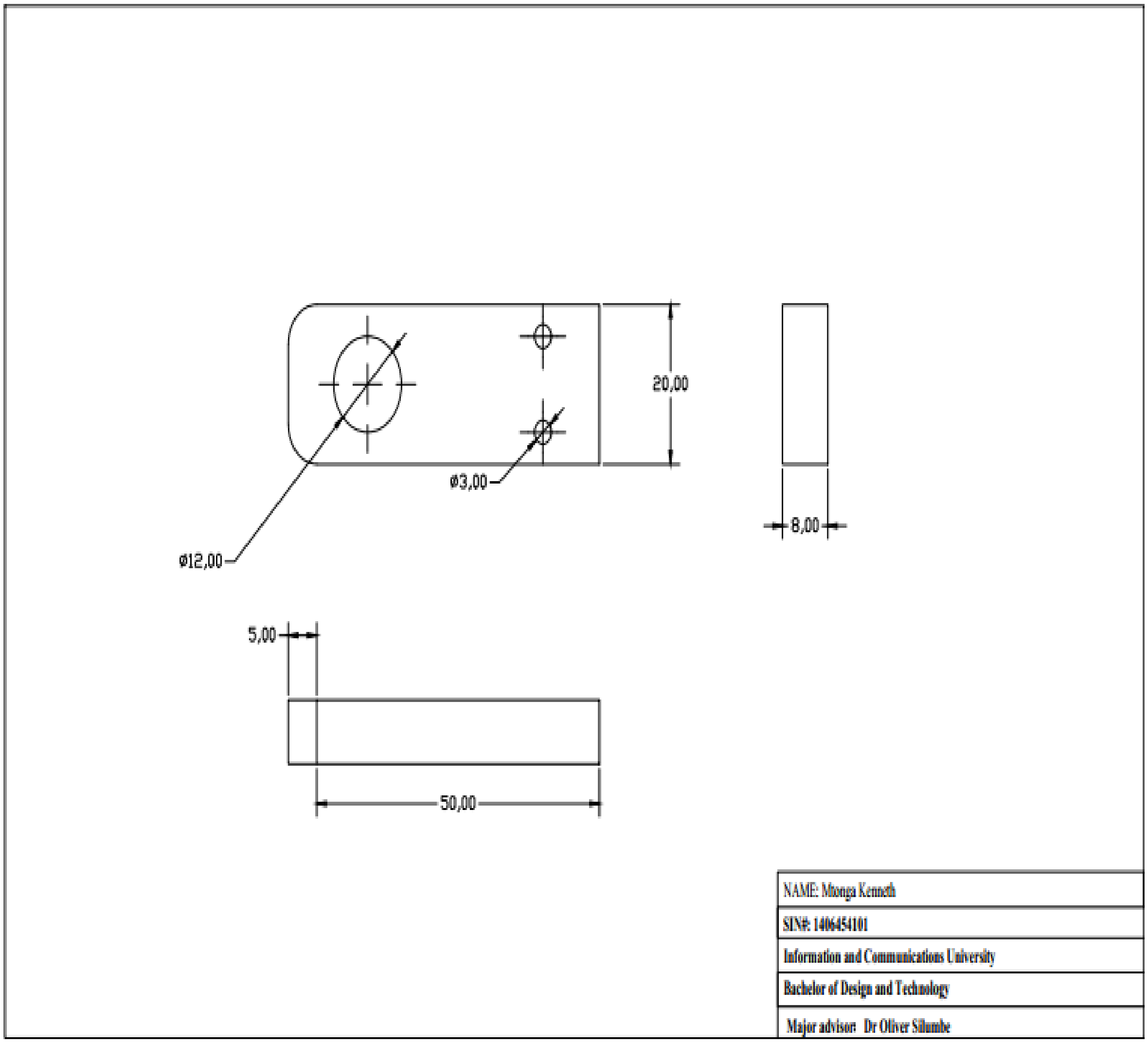


Figure 24: Z Holder top linear rail shaft (Source: Author)

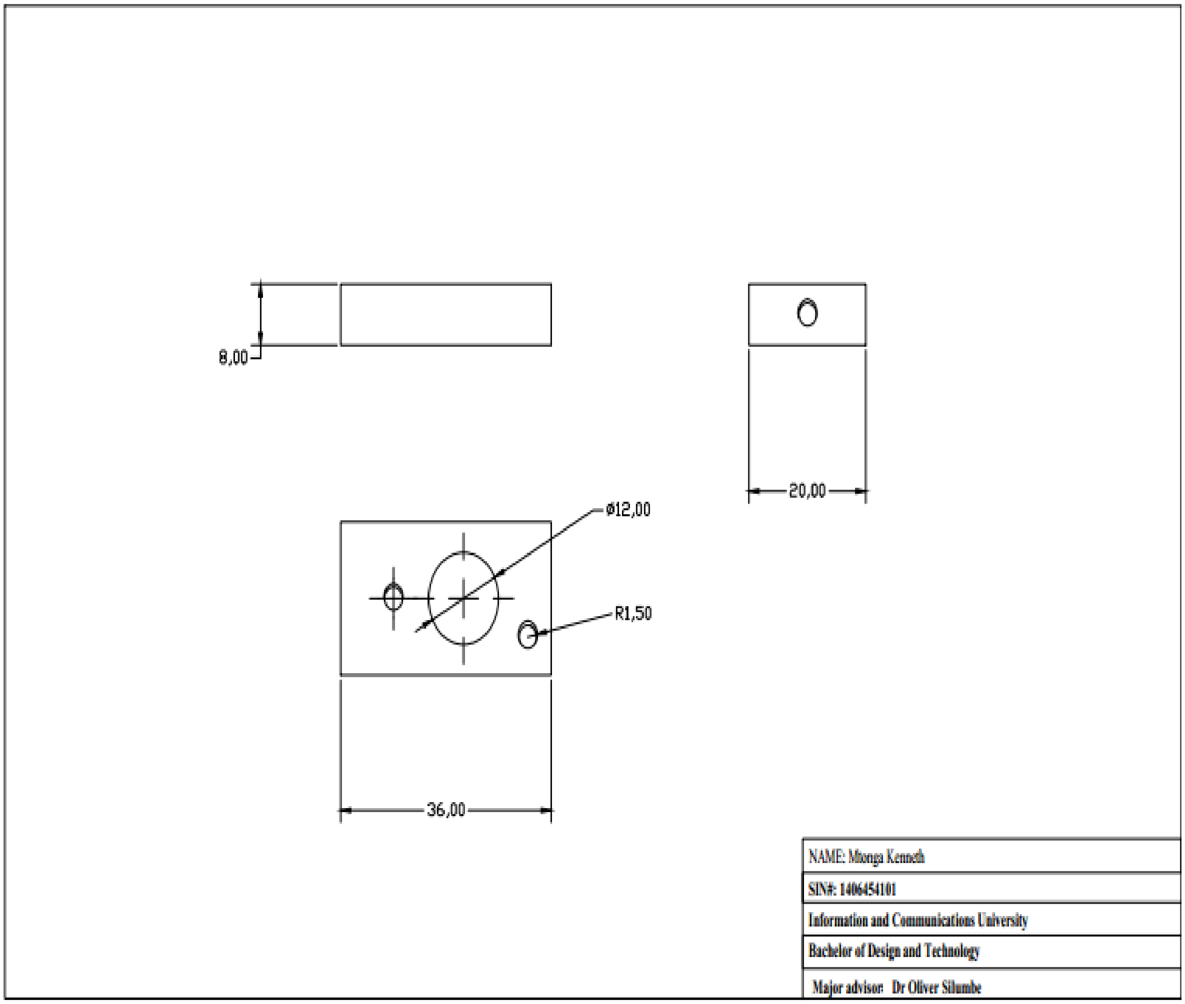


Figure 25: Holder bottom linear shaft (Source: Author)

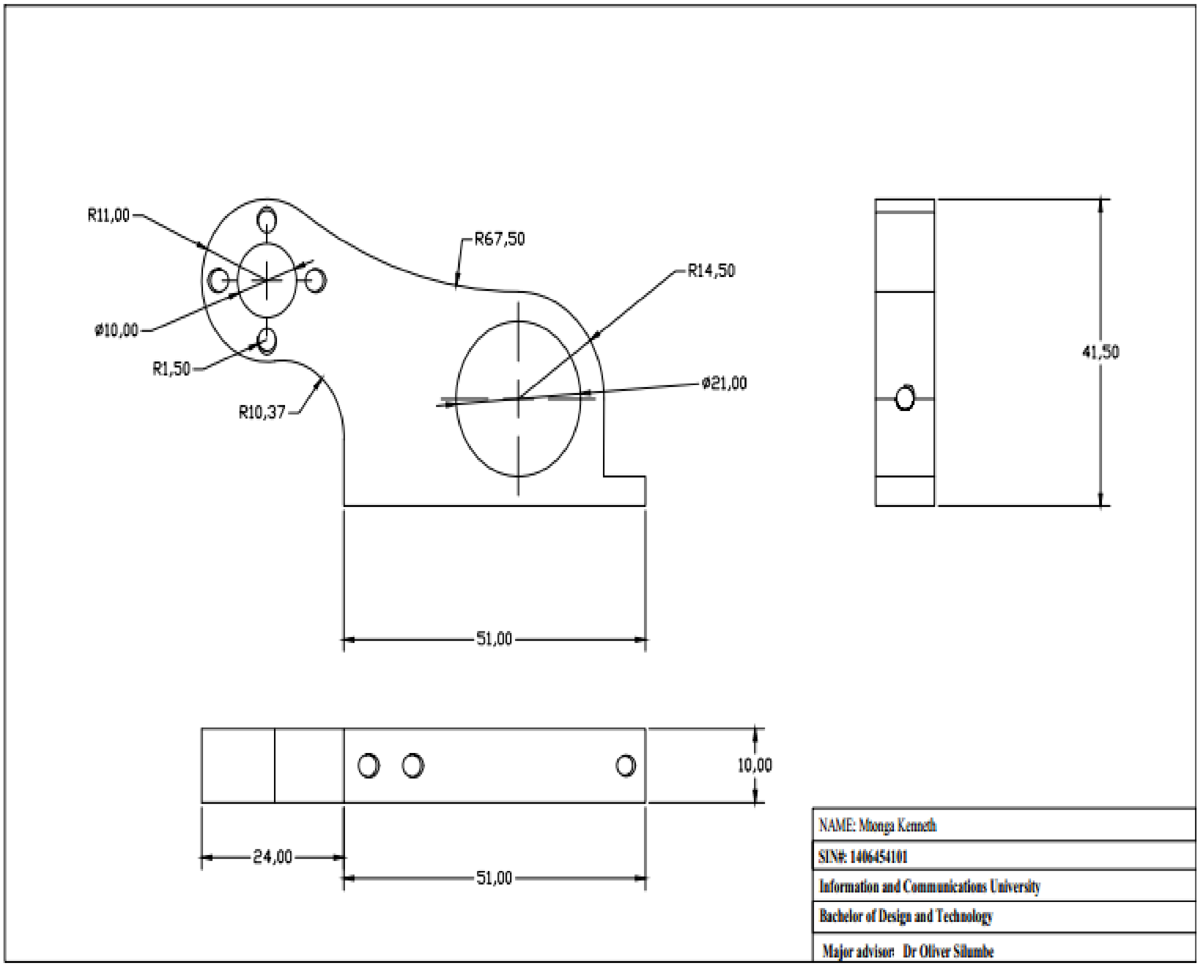


Figure 26: Z Holder nut (Source: Author)

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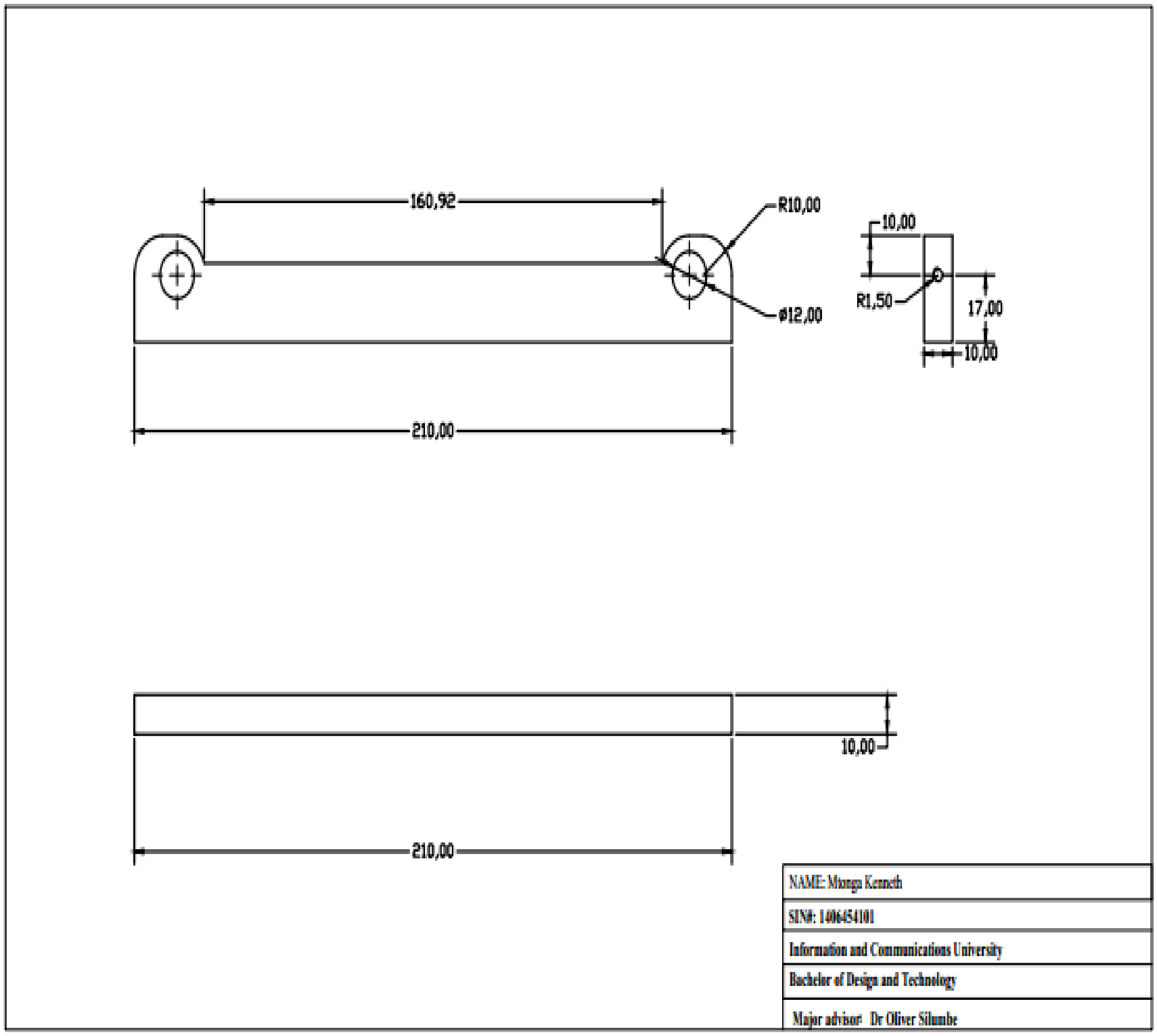


Figure 27: Y Shaft (Source: Author)

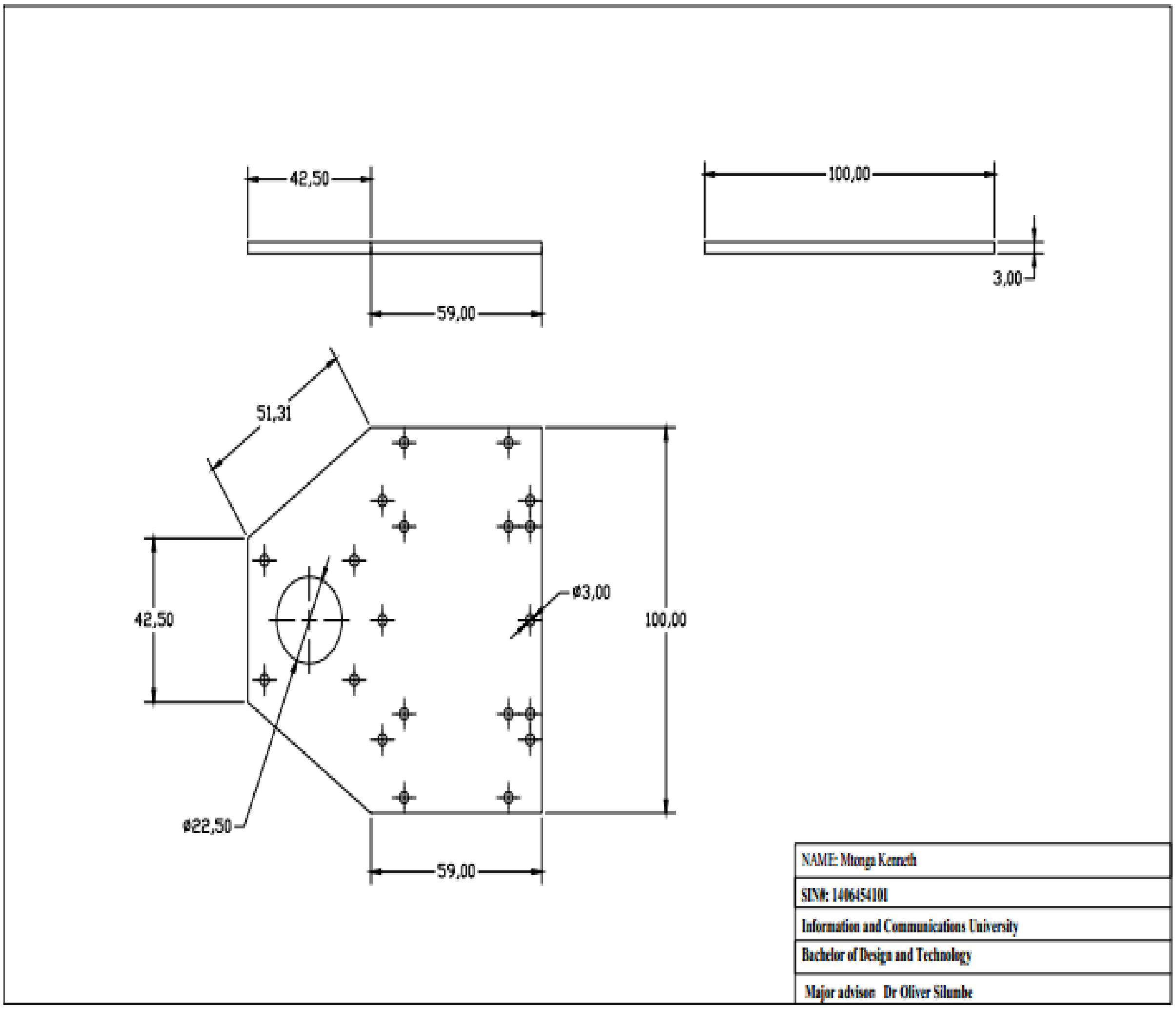


Figure 28: X Plate (Source: Author)

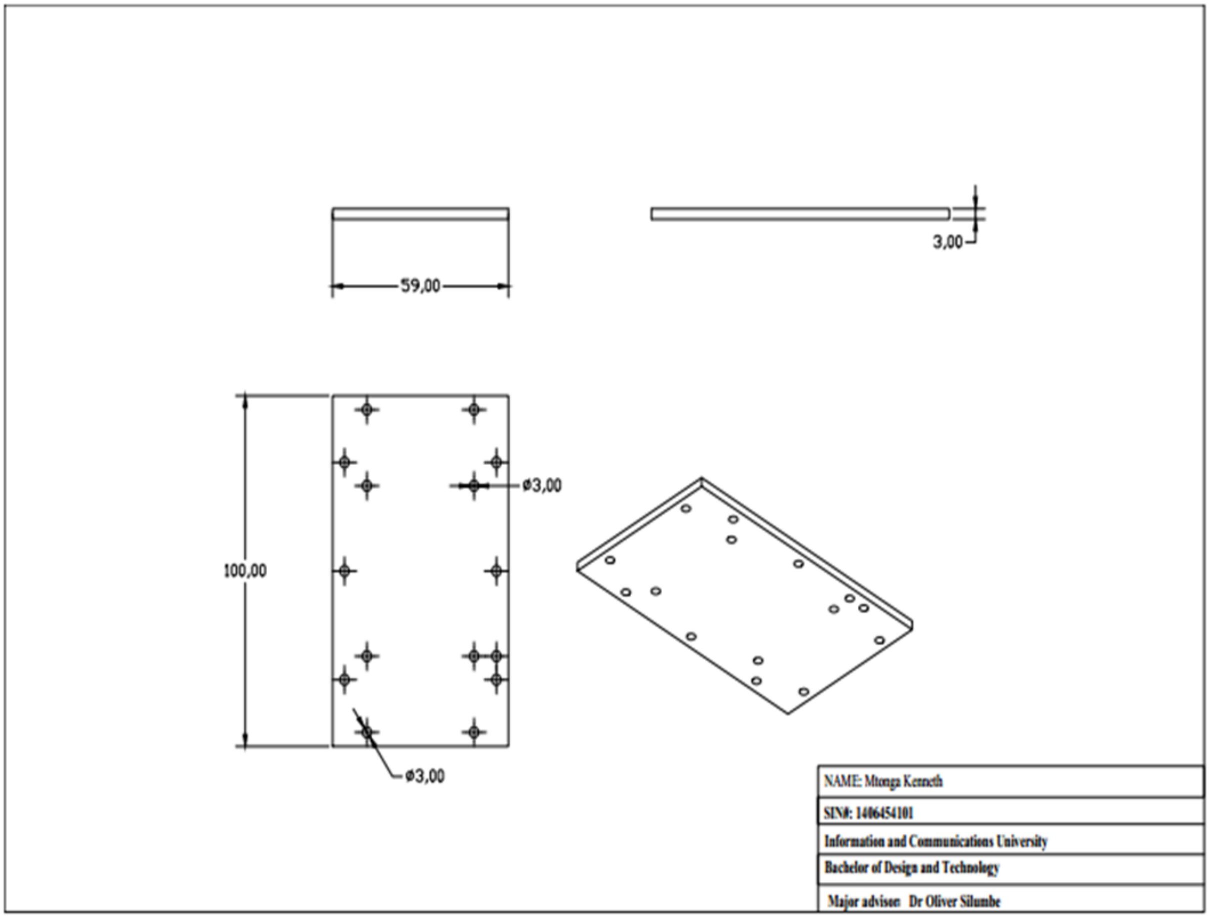


Figure 29: X Plate with no engine (Source: Author)

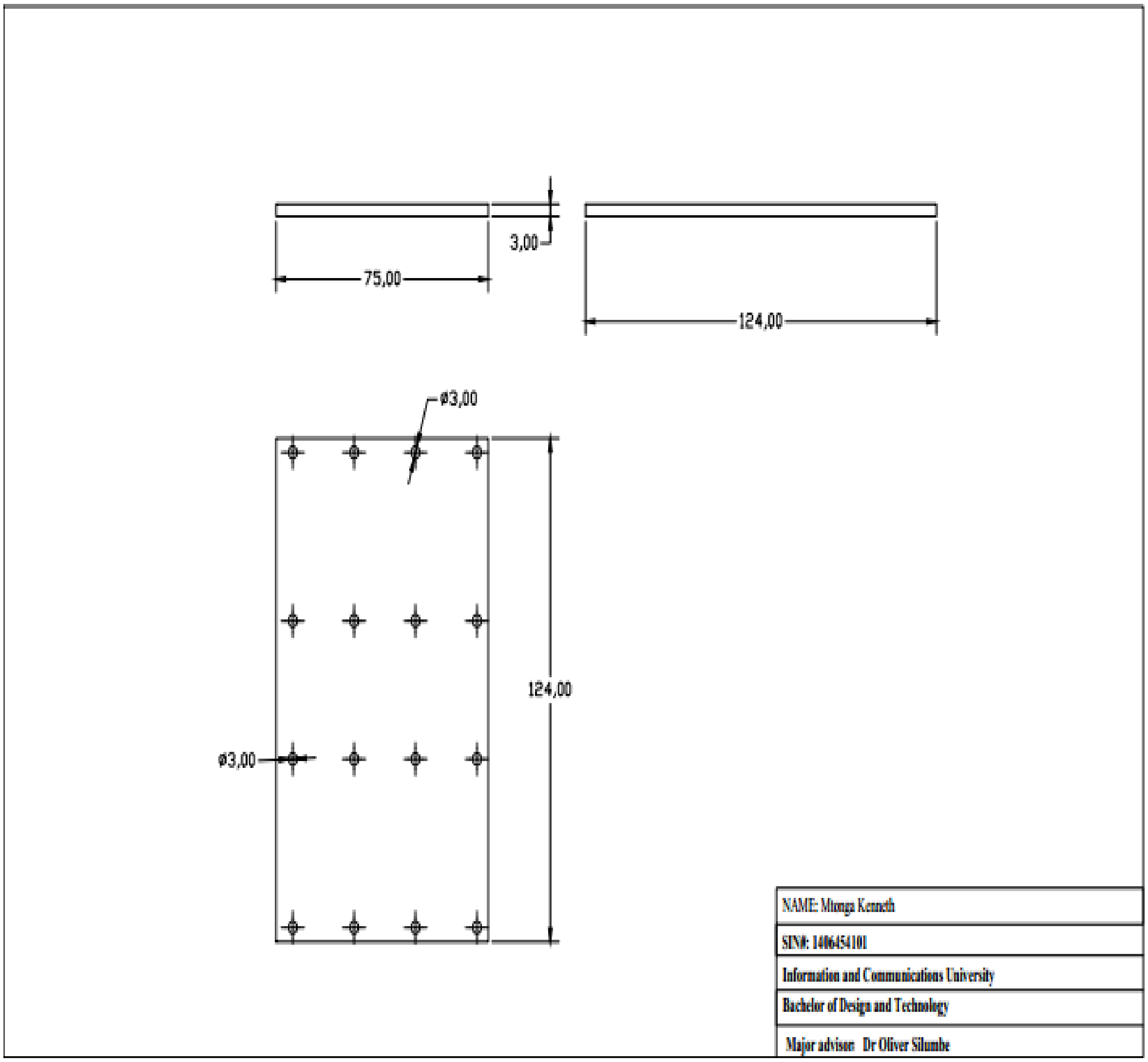


Figure 30: X Plate extruder (Source: Author)

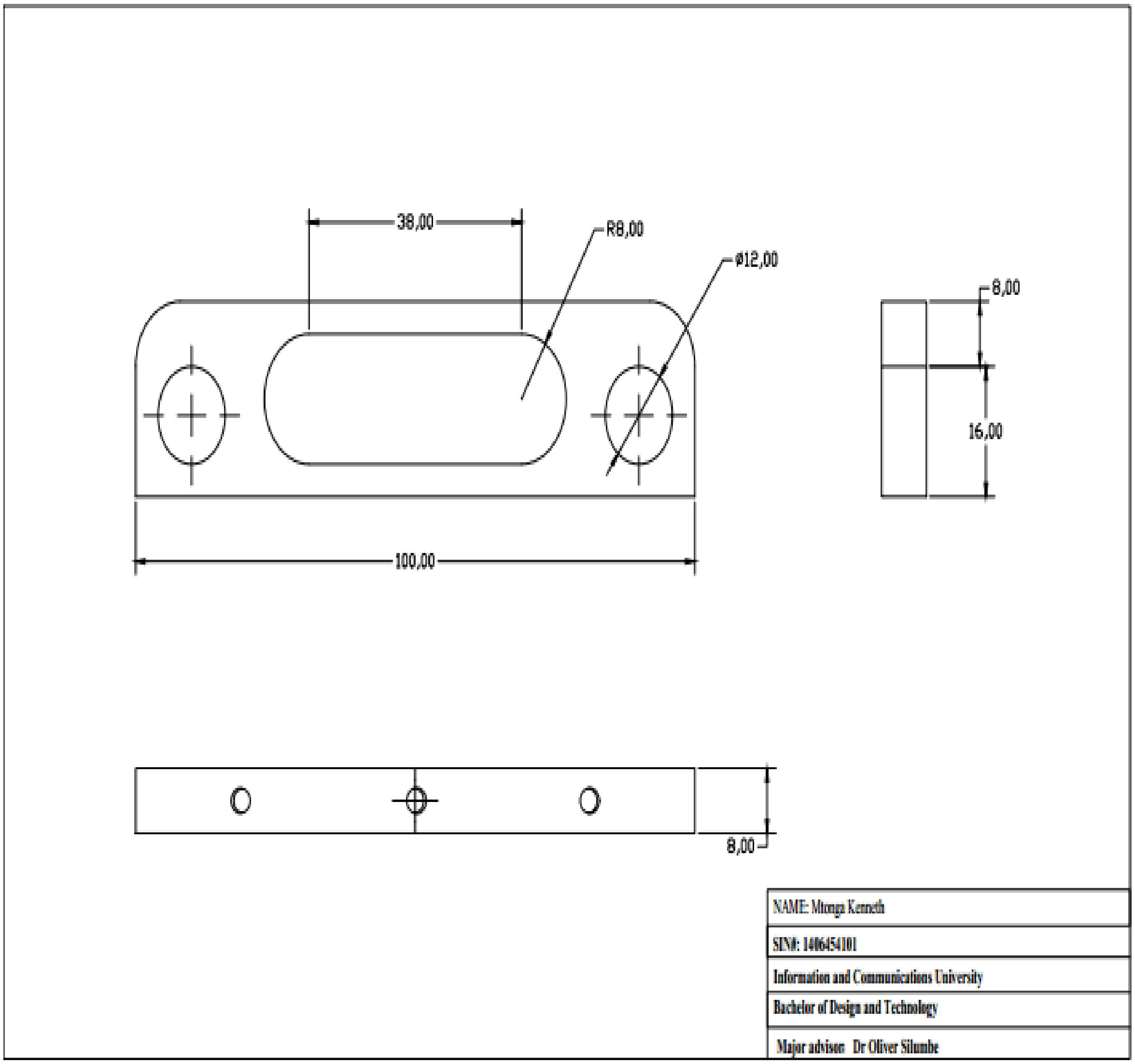


Figure 31: X Holder linear rail shaft (Source: Author)

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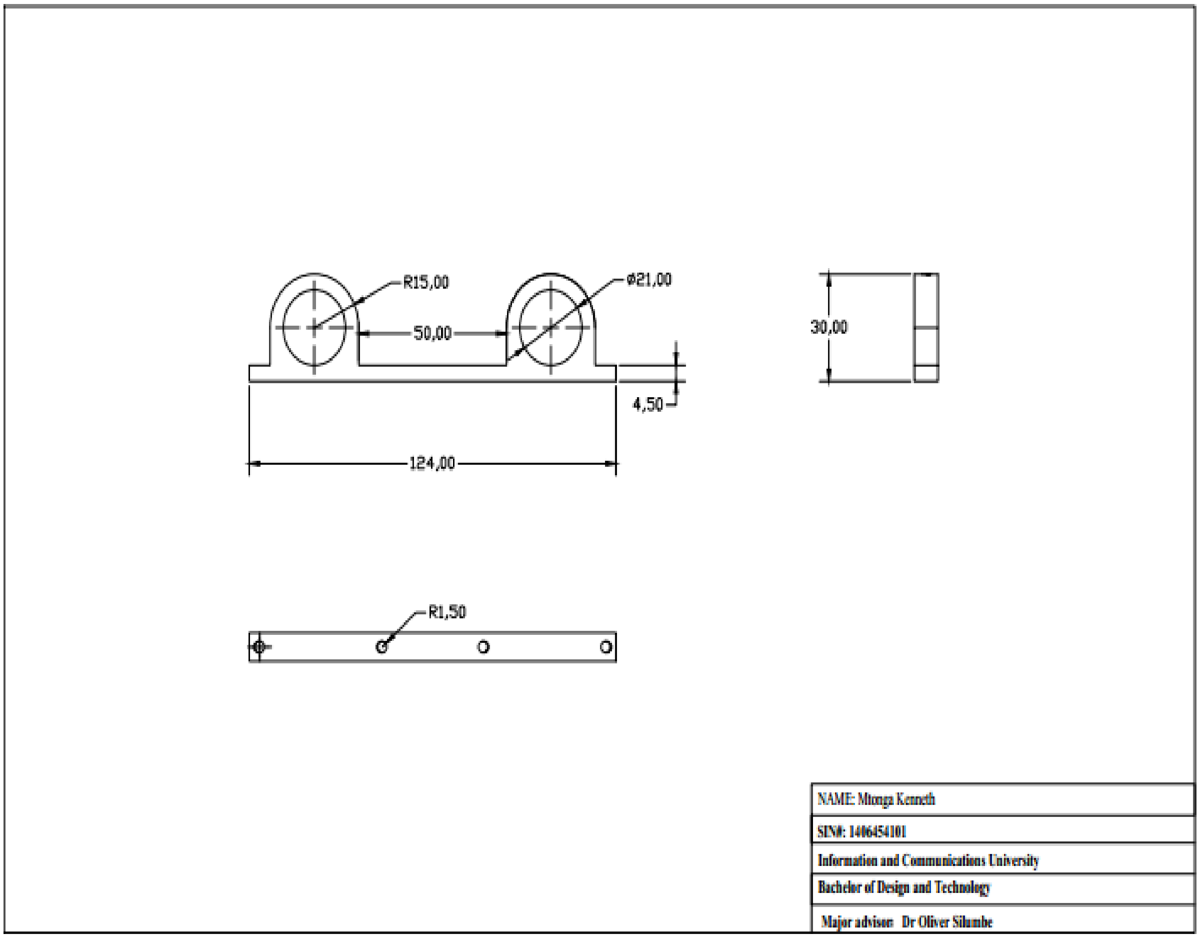


Figure 32: X Bearing Holder (Source: Author)

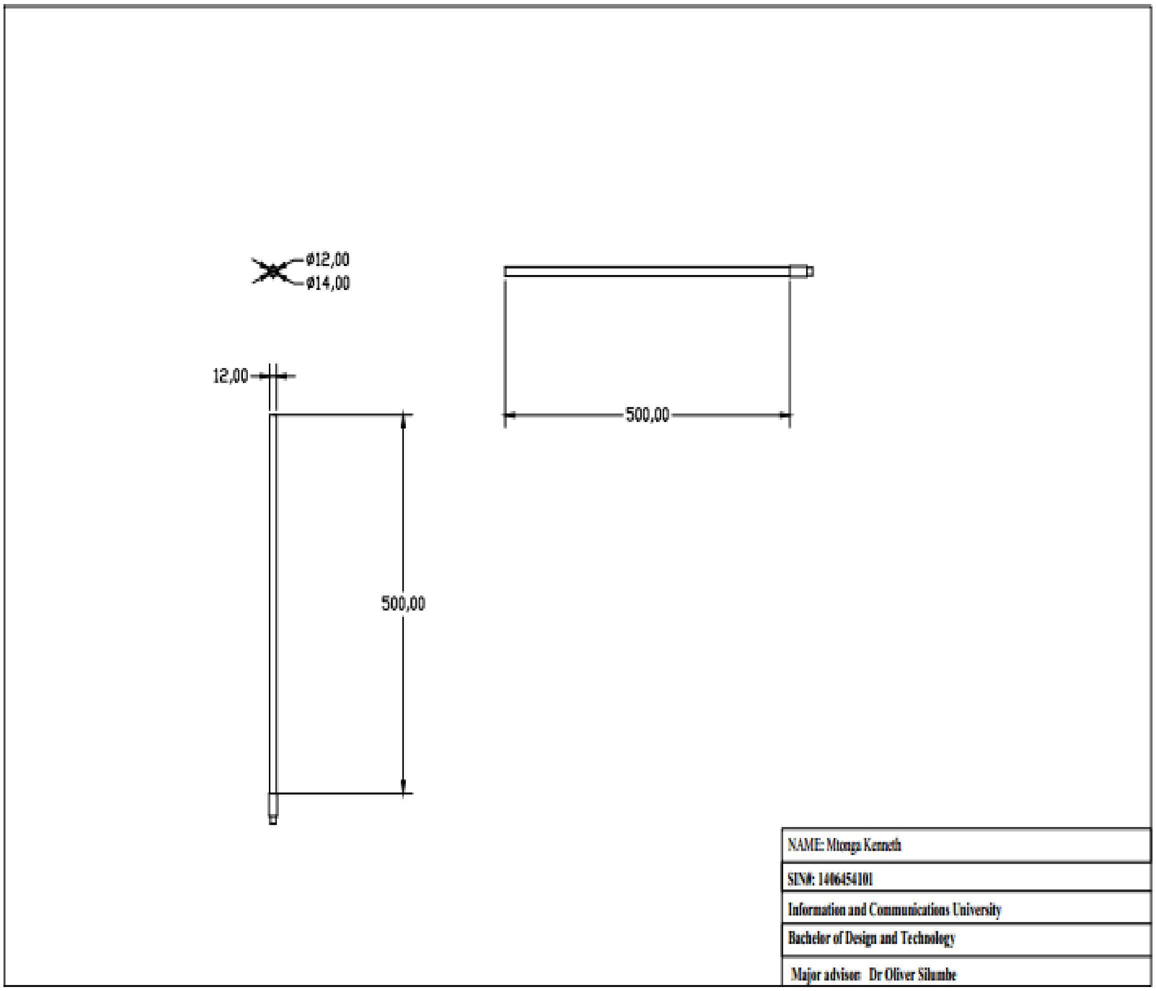


Figure 33: Shaft (Source: Author)

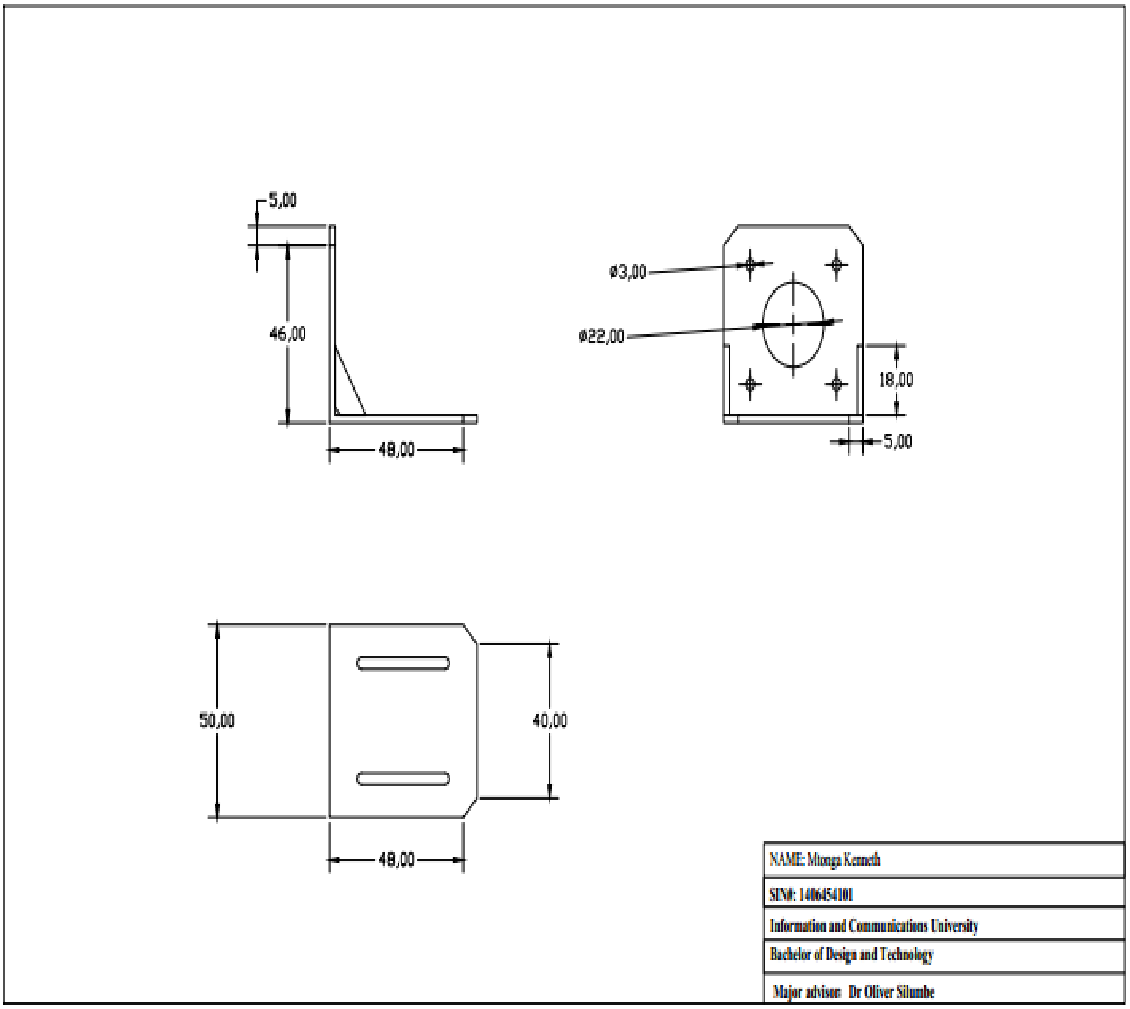


Figure 34: Plate form (Source: Author)

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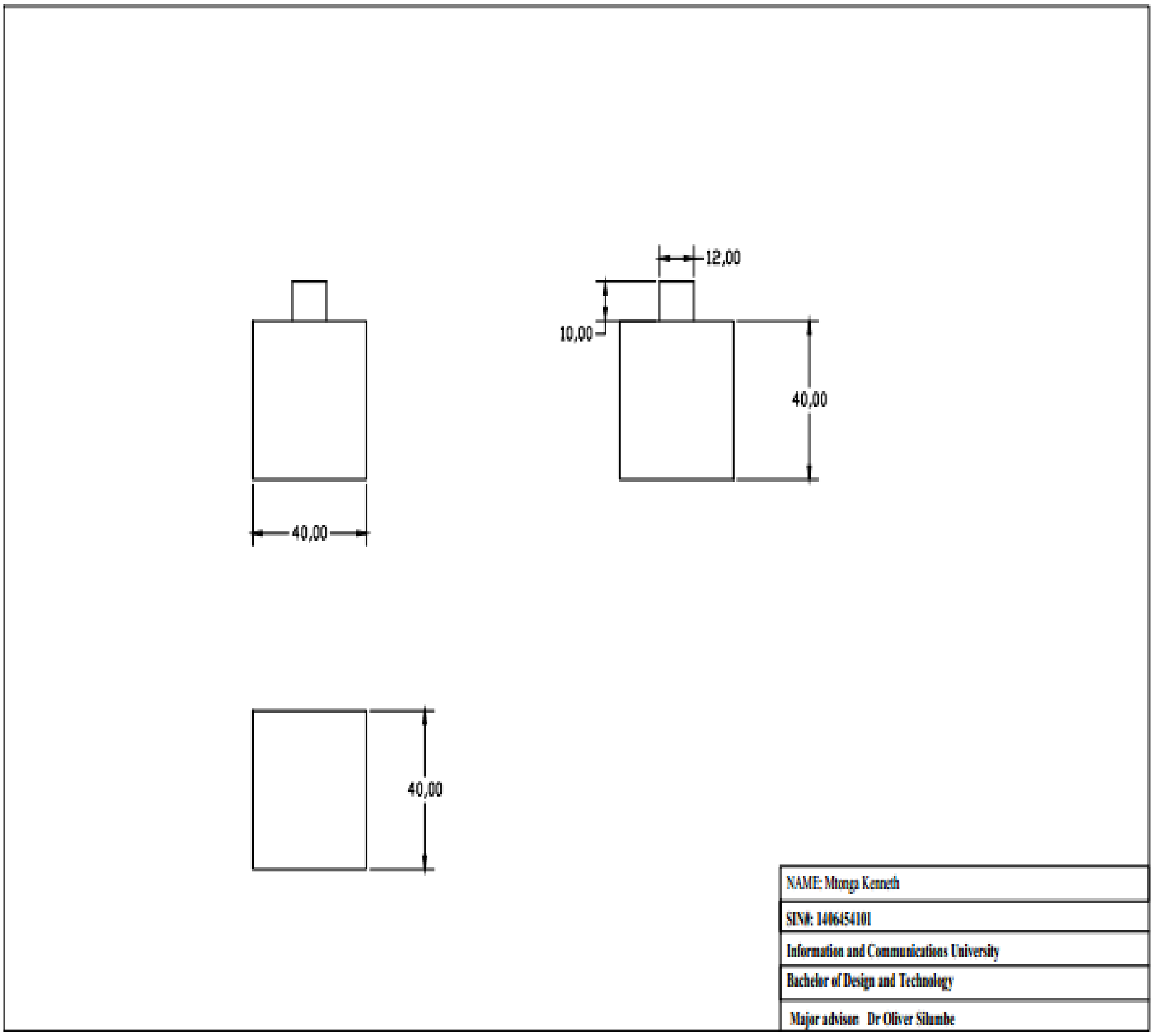


Figure 35: Motor (Source: Author)

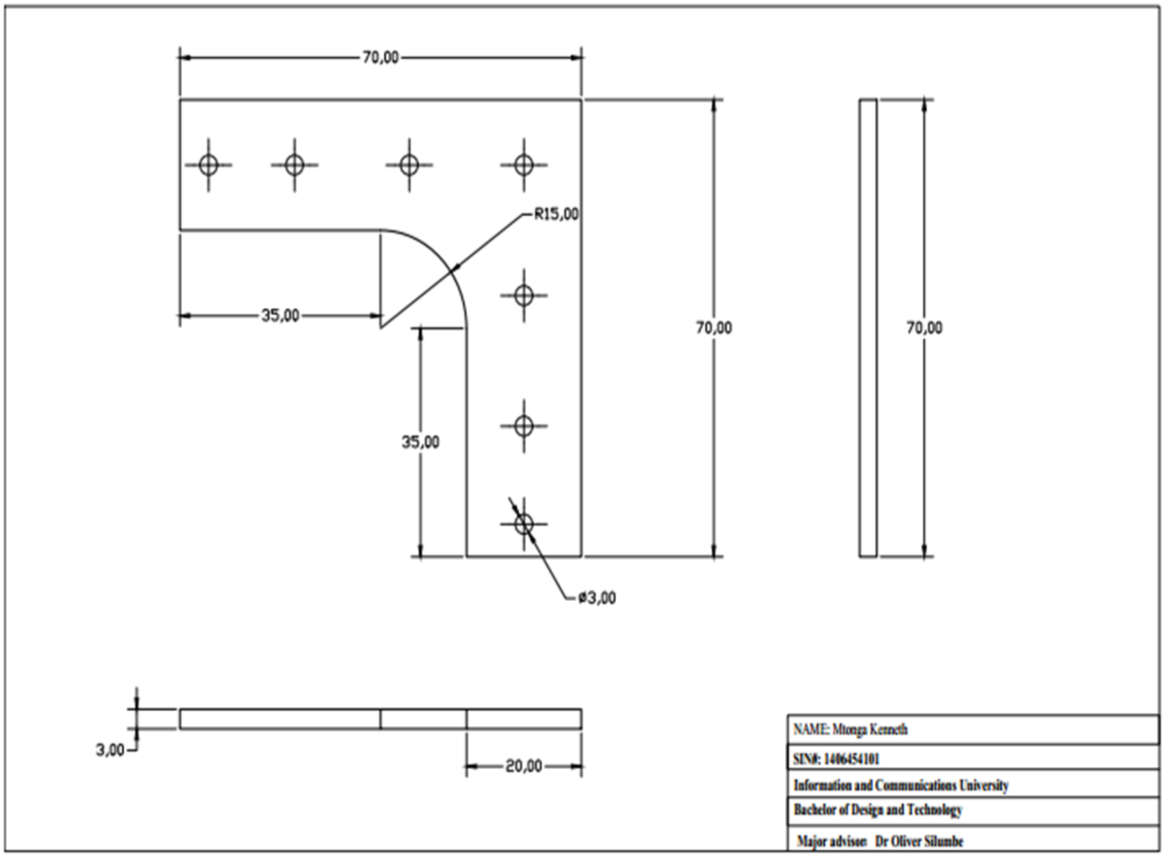


Figure 36: Corner Connector (Source: Author)

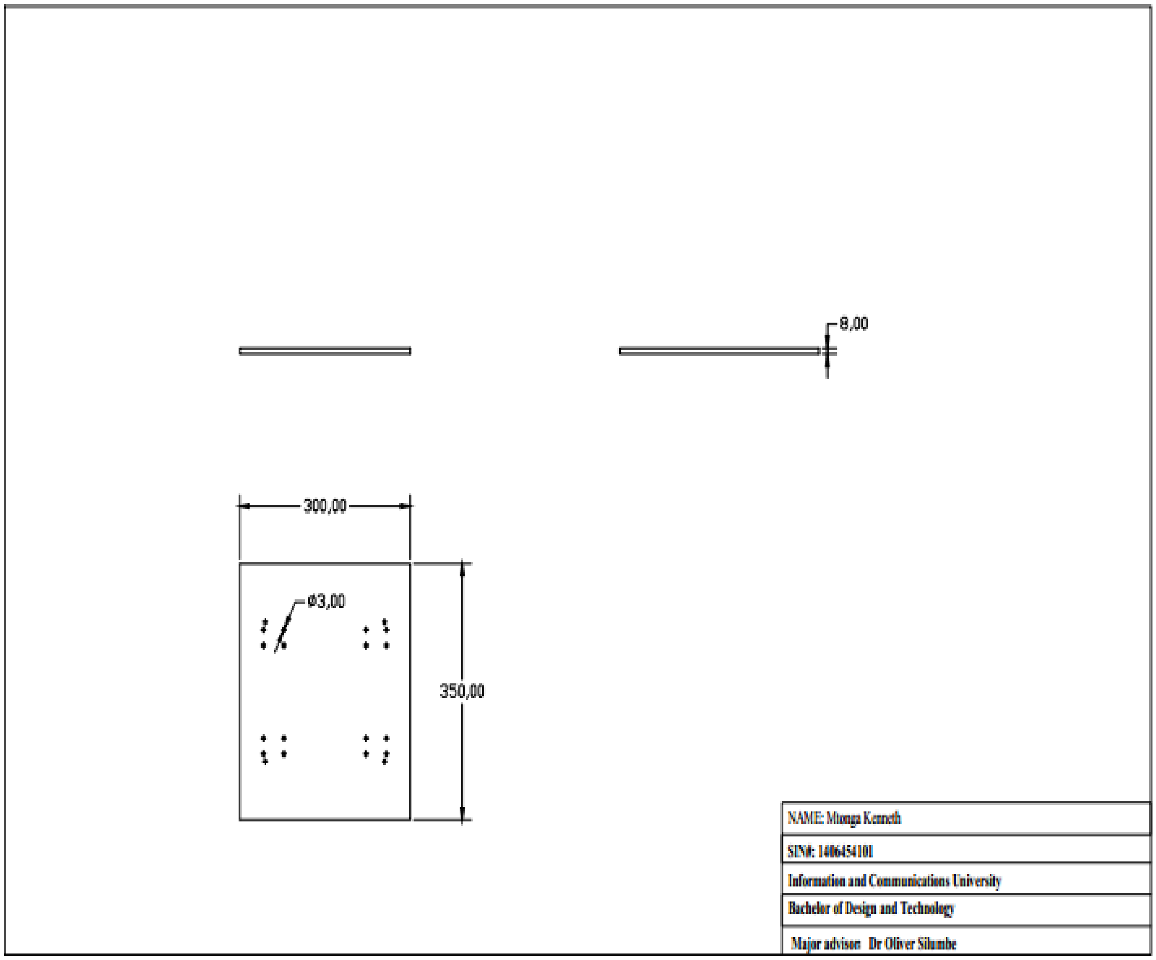


Figure 37: Bed Bottom (Source: Author)

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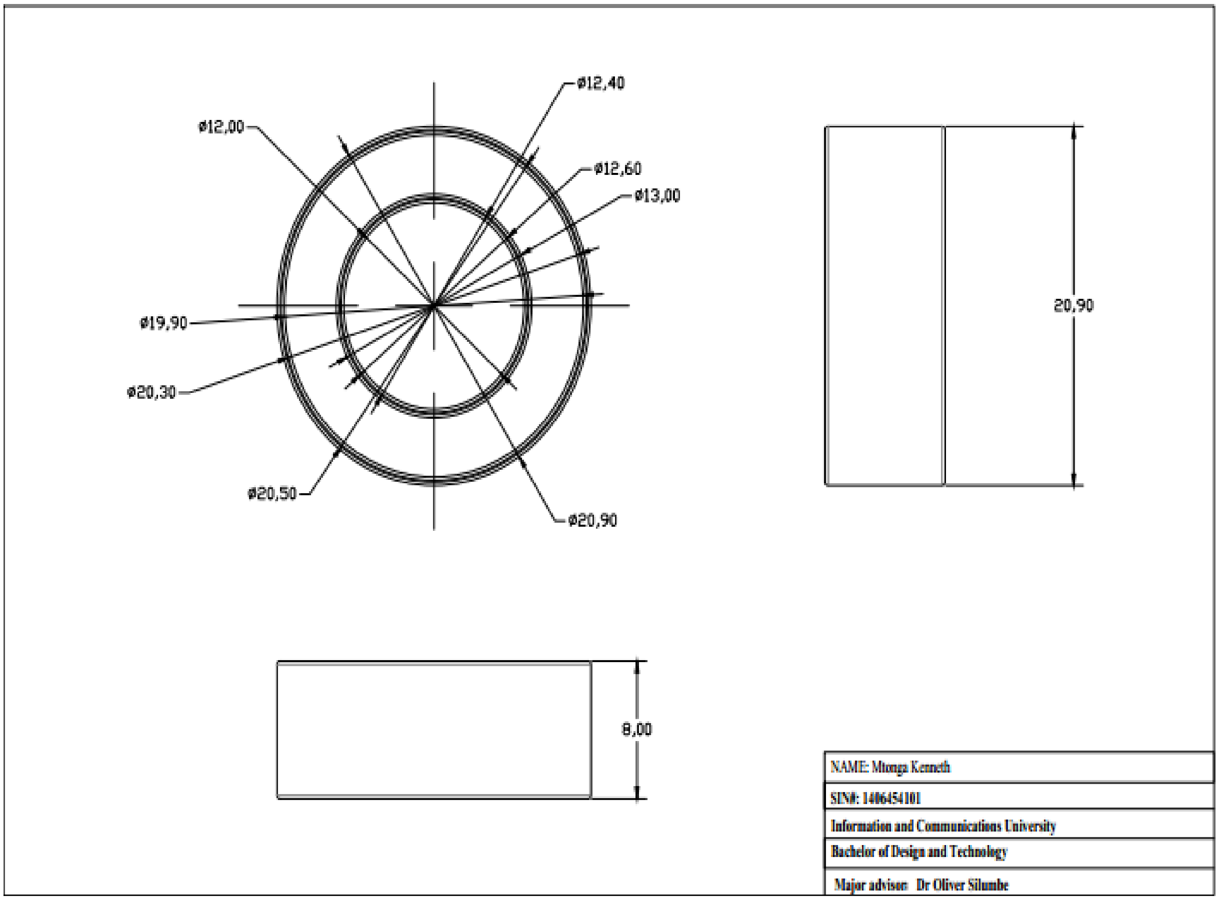


Figure 38: Bearing (Source: Author)

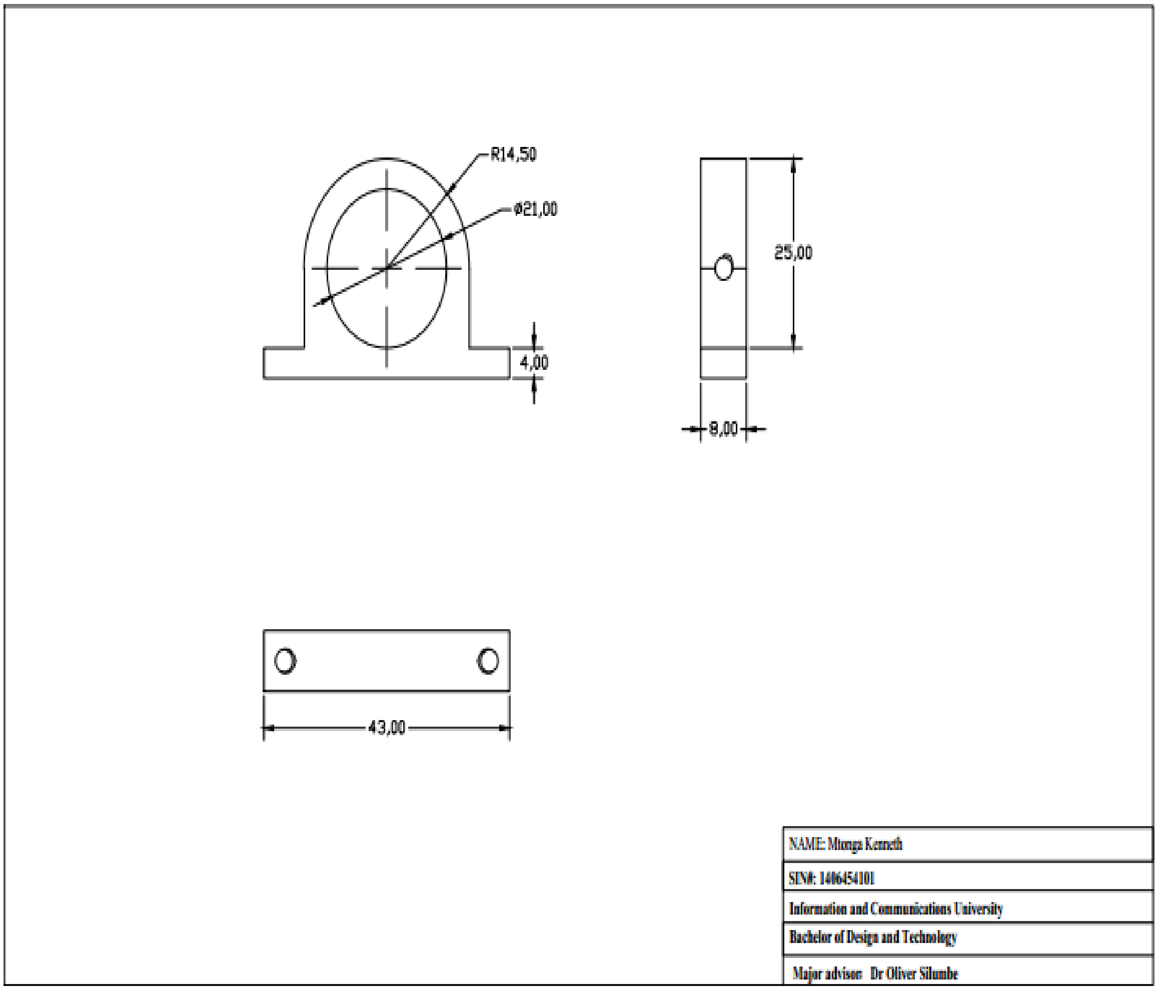


Figure 39: Bearing Holder (Source: Author)

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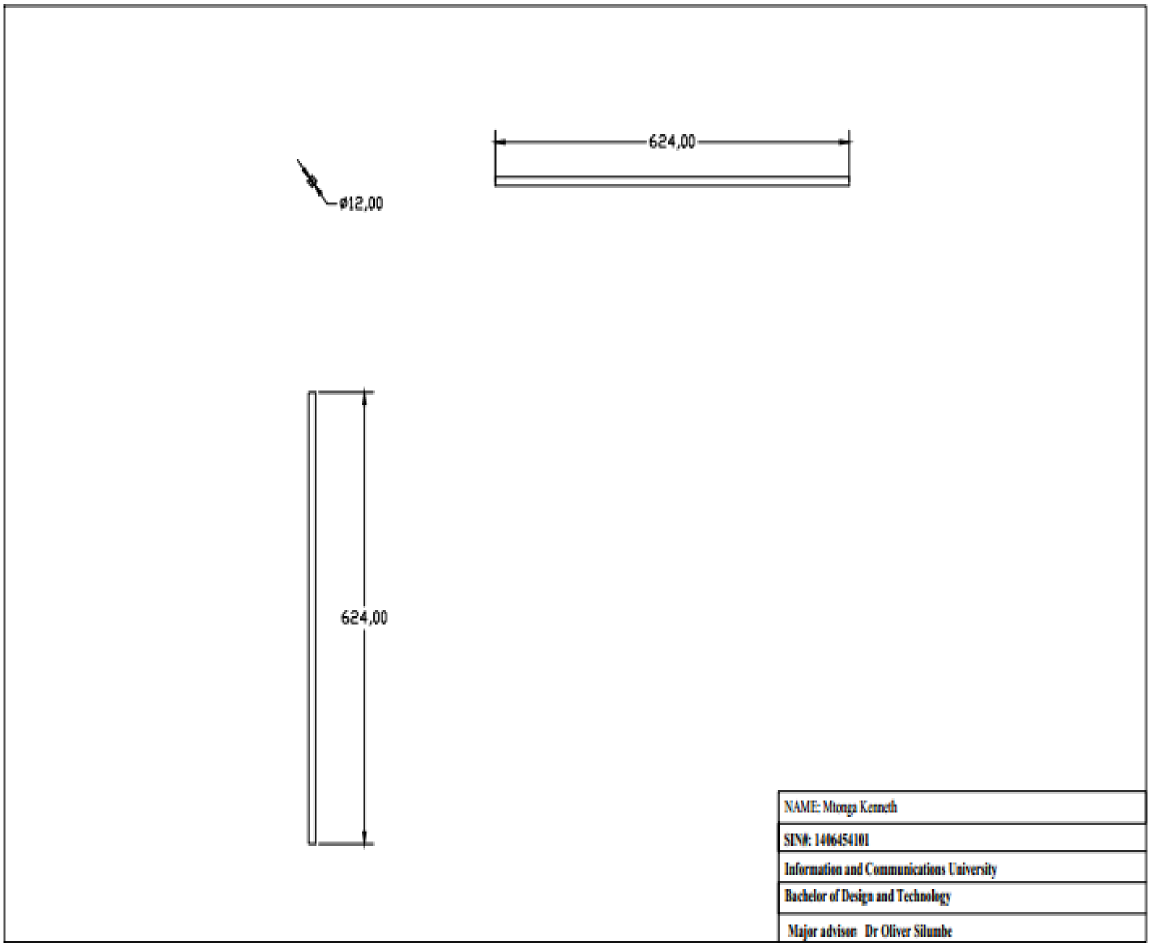


Figure 40: 624 mm Part (Source: Author)

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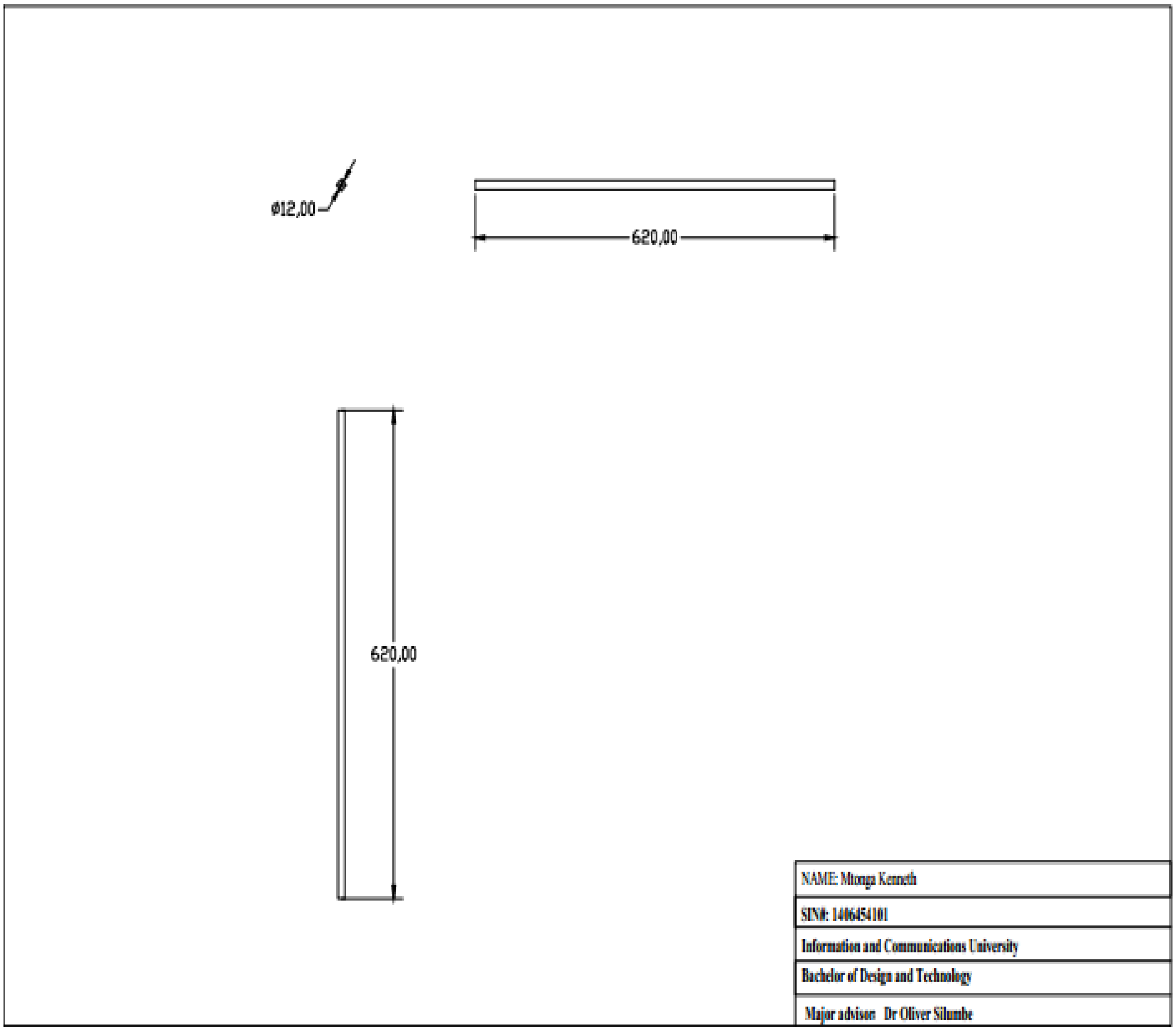


Figure 41: 620 mm Part (Source: Author)

ISSN: 3471-7102, ISBN: 978-9982-70-318-5

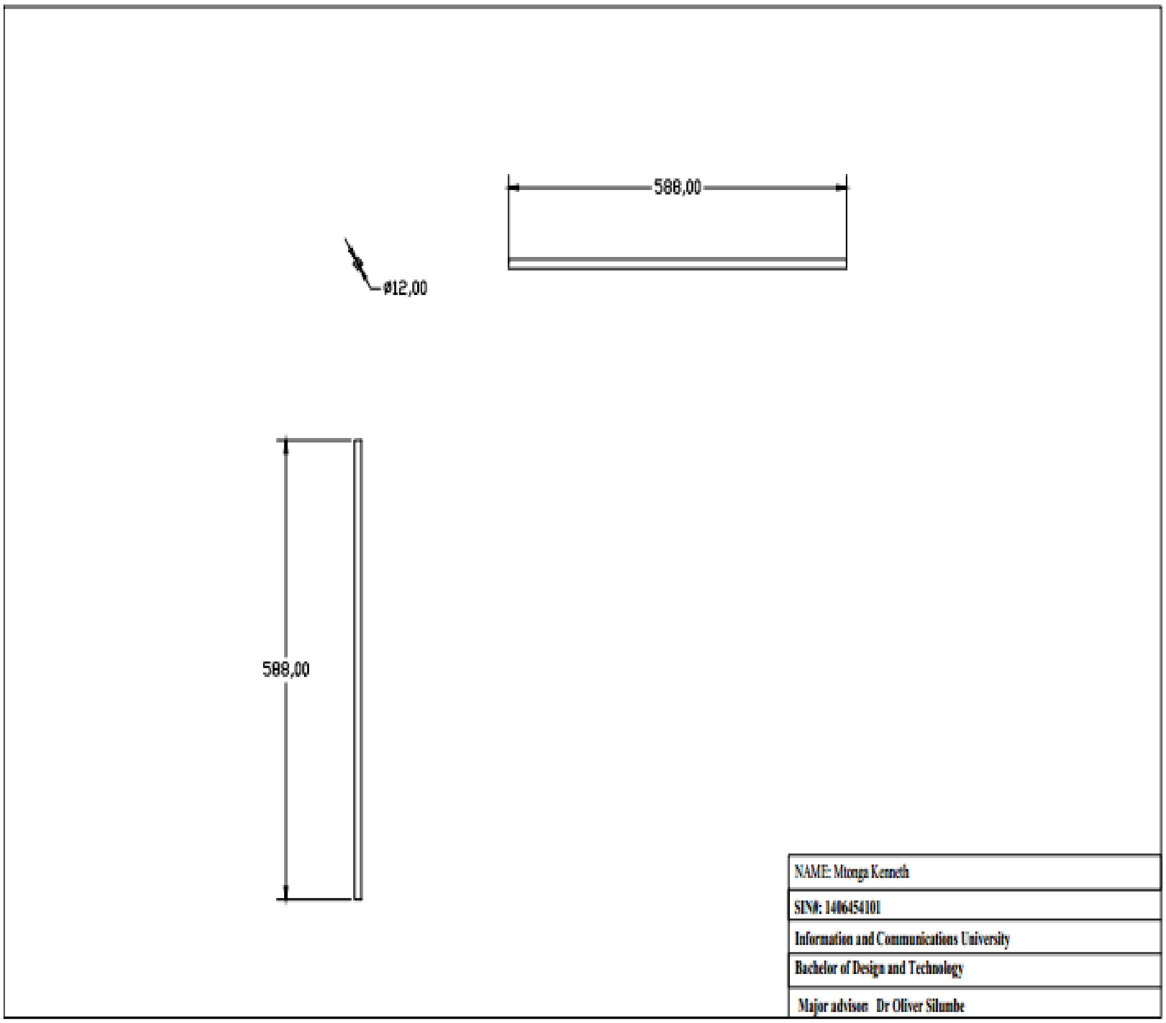


Figure 42 : 588 mm Part (Source: Author)

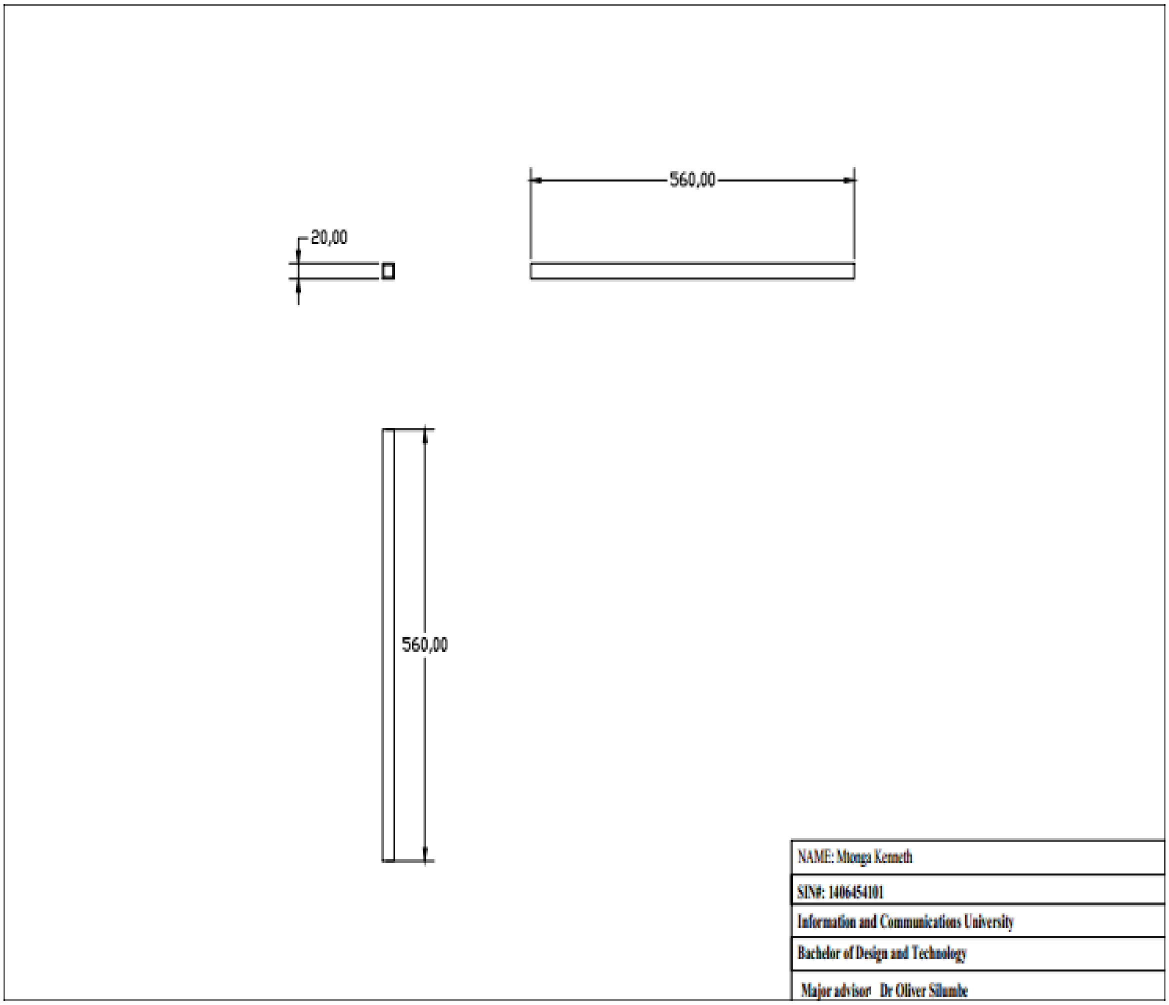


Figure 43: 560 mm Part (Source: Author)

CHAPTER 4

## 4.0 RESULTS AND DISCUSSION

### 4.1 RESULTS

The initial testing of the constructed printer consisted of two parts and these are verification of the motion system, and printing test objects. Experiments with the printer's motion system were used to develop and test an appropriate input-shaping scheme for the X-axis and Y-axis, as described in the Controls System section. The motion system of the machine provides its workability necessary for making intended designs. The electrical components initiated the motions of the movable parts. The easy way of designing and the accuracy using the 3D printer was able to help do work designs quickly and economical with time and resources. The prudence in the usage of time by the machine entailed that a lot of work can be done swiftly thereby meeting the target if so given.

Current experiments focus on using the characterizing the printer's printing capabilities; testing is ongoing.

### 4.2 FUTURE PERSPECTIVE IN ZAMBIA

The use of the 3D printer in Zambia in most industries and institutions like education is likely to be. In the near future, 3DP can to be applied in diverse sectors of our daily lives. It could be used to print advanced objects and materials in learning institutions. Locally made skeletons for Biology lessons, weather instruments for Geography lessons and a lot more other teaching and learning aids can easily manufactured with the country enhancing production and boosting the economy.

CHAPTER 5

## 5.0 CONCLUSION AND RECOMMENDATION

### 5.1 CONCLUSION:

Not all technical information about 3D printing could be shared in this introduction of the subject. Documenting the technology, very much a work-in-progress, must also recognize that not all authors agree on the likelihood of 3D printing gaining wider dissemination into the homes of individuals. Also, as a still emerging technology, 3D printing is not without its problems, such as slow printing speeds. Nevertheless, as prices are decreasing, the number of 3D printers sold worldwide has been growing steadily.

### 5.2 RECOMMENDATION:

The following recommendations can be considered for the improvement in the field of 3D printing.

1. There should be a deliberate policy to promote local production of things in Zambia. Materials that were used for making the project like pine wood, metal sheets and aluminum rods could be affordable for the purpose of enhancing the making of 3D printers locally.
2. Subsidize local producers who wish to be involved in the manufacture of 3D printers.
3. Design and Technology in Secondary Schools be a compulsory subject order to promote creativity and innovation. This policy direction would invariably make the use of the printer 3D a necessity as an important tool for learning and working.

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