MEE 510

PRODUCT DESIGN ASSIGNMENT

DEVELOPMENT OF WOOD LATHE MACHINE

BY

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(GROUP PROJECT)

Assignment 1

Early Development of Wood Lathe

A wood lathe is an ancient tool and it is assumed to be the oldest machine tool used by man having its origin from the early tree lathe which was turned by a rope wound around the work and attached to a sparingly branch overhead (Jain R, 2008). The earliest evidence of lathe dates back to ancient Egypt around 1300BC. Primarily, there are two things that are achieved in this lathe machine set-up. The first is the turning of the wood working piece manually by a rope; and the second is the cutting of shapes in the wood by the use of sharp tool. As civilization progresses, there have been constant modifications and improvements over the original two-person lathe machine, most importantly on the production of the rotary motion (Raffan, 2001).

The production of the rotary motion therefore evolved according to the following procedures: the Egyptians manual turning by hand; the romans addition of a turning bow; the introduction of the pedal in the middle ages; the use of steam engines during the industrial revolution; the employment of individual electric motors in the 19^{th} and mid-20^{th} centuries; and the latest of which is the adaptation of numerically controlled mechanisms in controlling the lathe machine.

Also, during the industrial revolution, mechanical power was applied to the lathe via steam engine and shafting, which allows fast and easier work to be made. Apart from the fact that the early inventions were so crude and demanding much of manual effort in operations, it was also limited to operation on the wood. The design of this crude beginning continued over a period before the engine lathe evolved (Sacky, 1999). They all found no application in metal cutting until above 1970 because they lacked adequate power, strong and accurate holding device which could guide the tool and ensure safety of the operator, the work piece and the machine. From different historical records, the design capacity of the lathe was reported to be useful only for turning woods into the desired shapes. The integration of those design to be suitably employed for metallic material led to the development of the sliding carriage by Henry Manldstey (Jain, 2008). He also built a screw cutting lathe in 1880. Metal working lathe evolved into heavier machines with the introduction of thicker and more rigid parts. Ultimately the carriage aid the application of lead screws, slide rests, and gearing which practically enhanced the producing of screw cutting for commercial purpose.

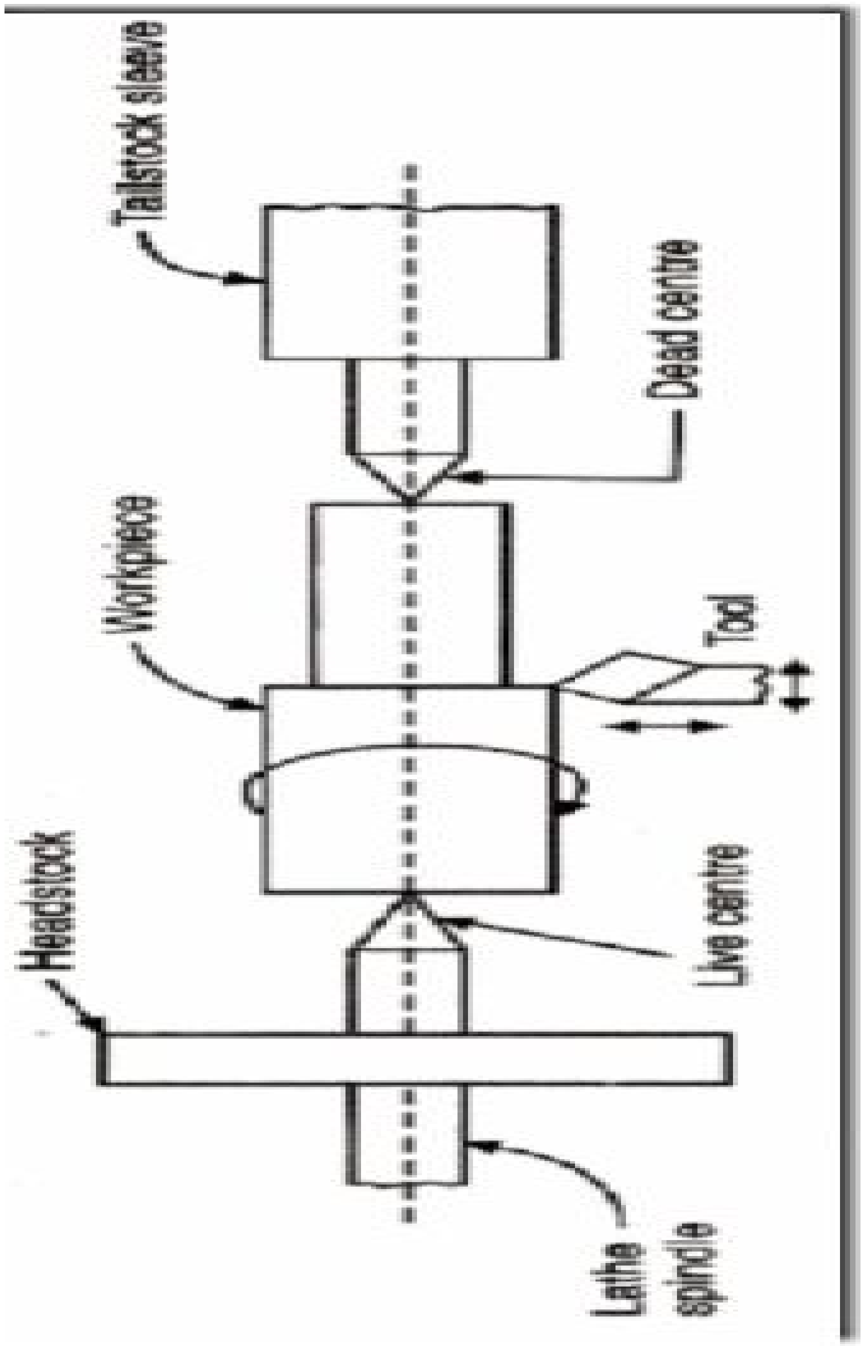
Lathe machine come in variety of models amongst which are bench lathes which can sit on a bench or table, CNC lathes that are controlled by a computer, vertical lathes i.e. lathe with vertical axis. Also, there are some lathes that are equipped with indexing plates, profiled cutters, spiral or helical guide, etc. so as to enable ornamental turning. Thus, the machine from its inception till date have under gone series of improvement, some parts have been simplified, modified or eliminated where found not absolutely necessary, hence different models exist in the market. What remains indisputable in all model is the fact that the same principle of machining is employed. The wood lathe, just like other types of lathe can be used to carry out a wide range of machining operations. It saves time and does not need much skill as in the use of hand tools.

Machine Description and Principle of Operation

The wood lathe is a machine which hold and rotates wood between two rigid supports called centers which revolves to produce circular, cylindrical or any desired shape (Gasper, 1981). Wood lathes all have the same general functional parts, even though the specific location of a certain part may differ from the other. The bed is the foundation of the working parts of the lathe to another. The main feature of its construction is the ways which are formed on its upper surface and run the full length of the bed. Ways provide the means for holding the tailstock and the tool rest, which slides along the ways, in alignments with the permanently attached headstock.

The wood lathe has seven major components. Which are the

I. bed
II. drive mechanism
III. headstock
IV. tool rest
V. Tailstock
VI. control mechanism
VII. mounting means.



Tailstock sleeve
Dead centre
Workpiece
Tool
Headstock
Live centre
Lathe spindle

Component of a Wood Lathe Machine

The Bed

The bed of the wood lathe machine is its basic structure which is a horizontal beam. It is usually a frame in which the basic components can be mounted. The bed is a heavy, rugged casting in which are mounted the working parts of the lathe. The essential part of the bed of the wood lathe is that which provide a reference surface for other components to ride. It carries the headstock and tail stock for supporting the workpiece and provides a base for the movement of carriage assembly which carries the tool

The Drive Mechanism

These ranges from a basic electric motor in line with the turning axis of the wood lathe to an elaborated set of belts and pulleys driven by a motor

2.2.2 Electric Motor

Electric motor is use to convert electric input into mechanical output (torque) which rotates a shaft. This power required by the lathe is generated by an electric motor consist of a stator and a rotor. The rotor is the moving part of the electric motor which turns the shaft to deliver the mechanical power. The rotor usually has conductors laid into it which carry currents that interact with the magnetic field of the stator to generate the forces that turn the shaft. However, some rotors carry permanent magnets, and the stator holds the conductors. While the stator is the stationary part of the motor's electromagnetic circuit and usually consists of either windings or permanent magnets. The stator core is made up of many thin metal sheets, called laminations. Laminations are used to reduce energy losses that would result if a solid core were used. The distance between the rotor and stator is called the air gap. The air gap has important effects, and is generally as small as possible, as a large gap has a strong negative effect on the performance of an electric motor. It is the main source of the low power factor at which motors operate. The air gap increases magnetizing current. For this purpose, air gap should be minimum. Very small gaps may pose mechanical problems in addition to noise and losses.

2.2.3 The Headstock

The headstock is usually clamped on the left side of the bed of the lathe machine, It serves as a housing for the drive pulleys and gears. It consists of the main spindle and the gearing mechanism for obtaining different speeds and also for transmission of power to the threading and feeding mechanism. The headstock is driven by an electric motor which is either connected to a pulley system or a belt, or to a geared system. The spindle is mounted on bearings in the headstock and specially ground to fit different lathe holding devices.

I. **Headstock spindle**

The headstock must be strong. Otherwise the cutting forces involved may deform it, which in turn instigate harmonic vibrations. These vibrations would be passed to the workpiece thereby, reducing the quality of the finished workpiece.

II. **Hollow cylindrical shaft**

The main spindle is hollow in order for long bars to extend through to the work area. It is supported by precision bearings and is fitted with chucks or faceplates to grip workpieces. A taper is often included at the end of the spindle. This allow hollow tubular (Morse standard) tapers to be inserted, reducing the size of the tapered hole and permitting the use of centers.

III. **Driving work-holding devices**

On machines built during the 1950s, the bull gear was used to lower spindle speed. Modern lathes use gear boxes. various speeds are selected through the gearbox.

Figure 2.2.3: A Headstock

Source: (Ehsan Pourali, 2020)

2.4.4. Tool Rest

The tool rest provides an edge onto which to reference the turning tool. The toll rest assembly has a base which ride on the ways. In a manner such as the tailstock, the tool rest clamps to the ways to keep in one place. The tool rest based has a means of holding a vertical shaft and enabling it to be adjusted up and down. The tool rest itself is made up of the vertical shaft and a horizontal bar or some other resting edge. The tool rest is moved often while turning almost any object, so easy adjustment is critical. Most modern lathes have a cam locking device, which allows for easy movement and lock down of the tool rest. Size of the tool rest varies.

(diagram 0f tool rest here)

Figure 2.5: A Tool Rest

2.4.5 Tailstock

The tailstock is located on the opposite end of the headstock (the right side). It can be moved along the ways from touching the headstock to the far end of the lathe. It supports one end of the work when machining between centers, support work pieces held in the tool rest. The tailstock is mounted on the bed and is designed to be camped at any point along the bed. It has a spindle that is operated by a hand wheel and clamped in position by means of a clamp. The tailstocks can be adjusted toward or away from the operator by sliding it along the bed to accommodate different lengths of workpiece between the centers.

Figure 2.2.3: Tailstock

2.4.5.1 Tailstock Quill

The tailstock has an adjustable quill which provides a means to attach centers which fix the right end of some work pieces, keeping them from moving longitudinally, thus holding them between the headstock mounting and the tailstock. The fixing means are called centers. A dead center is just a point which fits into an indentation in the end of the work piece. A live center is a similar device but with a bearing, enabling the center tom turn the work piece. Thus, eliminating the friction developed by the dead center.

Mounting Mechanism

There are two basic mounting means for any lathe – between the centers and face work.

Between Centers.

Mounting between centers means that the work piece is held to the headstock by bringing the tailstock up to fix it between them. This can be for any piece from a spindle to a large piece of wood intended, for example, to be turned for a bowl.

Face Mounting

In this process the work piece is attached to headstock alone. This can be done by use of anything from a spindle faceplate and screws to elaborate chucks

Materials

There are many different types of materials that can be used on a lathe. Anything from metals like aluminum, steel, and titanium to plastics, wax, and Delrin can be used on a lathe. The different materials used must be within the size limitations of the machine (8" diameter, 42" length). The material used also affects aspects of manufacturing, like the speed of rotation, time used to produce the lathe, the cost etc. All of this must be considered while deciding on the best material to use

Design Consideration

One of the most important factors considered before the start of this design is failure. A machine parts fails whenever it does not function the way it was designed to function or does not perform it's required function. It is therefore important that proper selection of material for fabrication of a machine in engineering is the most important aspect to be considered before and during design. Materials selection is the core of engineering design are selected on the bases of putting machinability, cost, and all other physical and mechanical properties of the material into consideration. The following should be considered for materials selection when designing, so as to obtain high efficiency and reliability of the machine.

I. Material Availability
II. Ease of machinability
III. Environmental consideration
IV. Materials should be easily machined
V. Cost effective
VI. Chemical and mechanical properties of the material

Table 3.1: Parts List of the Machine

S/N	Components	Function	Materials	Reasons for Selection
1.	Headstock	It houses the spindle (on a lathe, the spindle holds a chunk which holds and rotates the work piece)	Mild Steel	Durability High Strength
2.	Tool Rest	It supports one end of the work when machining between centers	Angle bar mild steel	Durability High Strength
3.	Tailstock	It provides a support the free end of work during operation.	Cast Iron	High Strength Better wear resistance

				Easy Machinability
4.	Shaft	It transfers torque and motion from the pulley to turn the headstock	Cast Iron	High strength better wear resistance easy Machinability
5.	Flange Bearing	Put the bearing into position	Cast Iron	Firm support better wear resistance
6.	Pulley	It transmits the torque from the electric motor to the Shaft	Cast Iron	Low cost
7.	Stand	It allows the body to rest on firmly and absorbed vibration	Angle bar mild steel	Durability high strength
8.	Bearing	To allow free movement of the live center	Cast Iron	Low cost
9.	V-Belt	To transmit the torque from the electric motor to the pulley	V-belt 25mm IS-2494-1974 Leather	Suitability for the working condition in service
10.	Metal Sheet	It is used to protect the headstock	1mm mild steel	High strength
11.	Electric motor	To generate a torque for the System	2hp	

3.2 Belt Design

The belts is used to transmit power from one shaft to another by means of pulleys which rotate at the same speed or at different speeds (Khurmi & Gupta, 2005). According to (Khurmi & Gupta, 2005) the amount of power transmitted by a belt depends upon the following factors:

I. The velocity of the belt.
II. The tension under which the belt is placed on the pulleys.
III. The arc of contact between the belt and the smaller pulley.
IV. The conditions under which the belt is used.

A belt can also be defined as a loop of flexible material used to link two or more rotating shafts mechanically. Belts are frequently necessary to reduce the higher rotational speeds of the electric motor to lower values required by mechanical equipment (Spotts, 1995). A *V*-belt is selected for this design.

According to (Khurmi & Gupta, 2005) the *V*-belts are made of fabric and cords molded in rubber and covered with fabric and rubber. These belts are formed to a trapezoidal shape and are made endless. These are particularly suitable for short drives. The included angle for the *V*-belt is usually from 30° to 40°.

V-belt is selected for use because of the following

i. Efficient means of transmitting power from one pulley to another
ii. For low cost
iii. Easy installation and removal
iv. Do not require axial alignment
v. Operation of the belt is quiet
vi. *V*-belt has the ability to cushion shock when the lathe is started
vii. The drive of the smooth, since the belt are made endlessly and there is no joint trouble.

DESIGN CONSIDERATION

With reference to some standard values recorded by (Khurmi & Gupta, 2005), the following assumptions were made.

1. Allowable tensile stress in belt, a = 2.8MPa = 2.8N/mm^2
2. Coefficient of friction between belt and pulley (u)=0.25
3. Maximum permissible stress in the shaft, T_{max} = 42N/mm^2
4. Required speed of belt, V=6.7m/s = 400m/min

Length of Belt Required

The length of the belt is given by;

Where:

L = the length of belt

D = diameter of motor pulley

d = diameter of the spindle pulley

Y = distance between the two pulleys

=1474.2mm

Hence standard grade A V-belt designated A 62, 1636 is selected.

Power Transmitted Per Belt

According to (Banga, et al, 2004), the power transmitted per belt is given as the product of the belt velocity and the effective pull applied at the rim of the pulley. It is expressed mathematically as:

Where:

P = power transmitted

T_1 = tension in the belt tight side

T_2 = tension in the belt slack side

V = velocity of belt

For a wood working lathe the belt drive operates at a speed range of 1 to 10m/s (Khurmi and Gupta, 2008), with a spindle speed ranging from 1200 to 36000rpm.

But weight per meter length of belt

W =1.06N/M

Mass per length, m =

= 0.11kg/m

Centrifugal tension:

Where:

= the centrifugal tension

M = mass per length

V = required speed of belt

therefore;

= 0.11 X 8^2

= 7.04N

Maximum tension in the belt:

With reference to some standards values recorded by (Khurmi and Gupta, 2005) the following assumptions were made;

1. Allowable tensile stress in belt, a = 2.81MPa= 2.8*N/mm*^{2}

= 2.8 x 83.25

= 233.1N

Hence, in the belt tight side:

=233.1-7.04

= 226.06N

According to (Erik et al, 200), the lap angle (θ) is given as

Where:

D = diameter of driven pulley

D = diameter of driving pulley

Y = distance between centers of pulleys

= are of control (lap angle)

= 176.04°

E	30-350	500	38	23

From table 3.2 above and a motor rating from 2.0kw, the suitable choice is class A. for the pitch length: the standard for class A according to IS standard are in table 3.3.

Type of belt	Standard pitch length of V-belt (mm)
A	645, 969, 747, 848, 925, 1001, 1026, 1051, 1102, 1128, 1204, 1255, 1331 1344, 1458, 1509, 1560, 1636, 1661, 1687, 1763, 1814, 1941, 2017, 2068 2093, 2195, 2322, 2474, 2703, 2880, 3084, 3287, 3693.

Shaft

A shaft is a rotating machine element which is used to transmit power from one part of a machine to another. The power is delivered to the shaft by some tangential force and the resultant torque (or twisting moment) set up within the shaft permits the power to be transferred to various machines linked up to the shaft. In order to transfer the power from one shaft to another, the various members such as pulleys, gears etc., are mounted on it. The various members are mounted on the shaft by means of keys or splines. (Khurmi & Gupta, 2005)

According to (Redford, 1987) there two main types of shaft;

I. transmission shaft: Transmission shaft are used to transmit power between the source and the machine using power Such shaft carrying machine parts such as gears and pulley and therefore are subjected to bending the twisting.

II. machine shaft: this shaft is a main part of the machine; a typical example is the crank shaft.

The design of this wood lathe machine is such that the shaft receives power from the electric motor by a *V*-belt with the aid of a pulley.

Shaft Speed and Motor Speed

I. Shaft speed (N_1): According Khurmi & Gupta, 2005 the shaft speed is calculated by the formula:

=

= 1060 rpm.

II. Motor speed (N_2): According Khurmi & Gupta, 2005 the speed of the motor is gotten from the formula:

=

= 1591 rpm.

The Power Required

The power required by the wood lathe to perform the turning operation is a function of the weight of the different component that is to be driven by the electric motor. A wood is fixed to the lathe shaft on which two pulley are attached. In order to avoid failure of the lathe. A power that will able to overcome the weight of the wood shaft and pulley is required. For the purpose of this work, a squired induction motor is selected. The power rating of an electric motor is the product of its torque and rotational speed. According to (Woodbury, 1986), the required power of the motor for a machine tool using belt drive is given as:

$Power_{(req)}$ = Power transmitted by belt x machine service factor (3.11)

$P_{(req)} = P \times K$

= 1.4 x 1.3

= 1.82kw

= 1820w

= 2.0 Horse power

Torque =

=

=P

=

=

=

= 10.92NM

The implies that the motor have a capacity of 2hp and can rotate at 1591rpm given a torque of 10.92NM

Where service factor for a machine tool is 2.0

Least Permissible Shaft Diameter

The minimum diameter of shaft that can withstand torsion and bending effect is given as in equation.

$d = ((\sqrt{M^2 + T^2}))^{1/3}$ (3.13)

But

Torque transmitted by the shaft:

$T = (T_1 - T_2) R$ (3.14)

= (226.06 – 16.6) 65

= 13614.9 Nmm

Vertical weight on the pulley:

$w = T_1 + T_2$ (3.15)

=226.06 +16.6

= 242.66N (3.16)

Bending moment:

M=Wx X

= 242.66 x 150

= 36399Nmm (3.17)

Substituting T equation 3.13 and M 3.15 in equation

$\sqrt{}$

$d = (\quad (M^2 + T^2)^{1/3}$

$d = (\quad \sqrt{(36399^2 + 13614{,}9^2)}\ ^{1/3}$

$= 4469.89mm$

Key Design

This is a demountable machinery part, which when assembled into keysets, provides a positive means for transmitting torque between a shaft and a hub or bushing. In order to lock a hub or bushing and shaft together, and prevent the shaft from rotating in the bore, a key is commonly inserted into a keyway that is machined in both the bore and shaft. The key is responsible for preventing rotation between the shaft and the bore, and carries a portion of the torque load. Improperly fitted keys and keyways – either too tight or too loose- can result in mechanical failures. Different types of keys are available, the choice of which is dependent on power requirement, stability of connected, tightness of fit, and cost. For a light transmission, a screw thread may be employed. But for this work a flat key was adopted.

Therefore, to ensure appropriate fit, the width and height dimensions of standard key and keyways must be held to recommended tolerances. Industry standard for key sizes in various bores exist for both English and Metric systems. A common standard available from the Mechanical Power Transmission Association is MPTA –B1-2003.

Metric Standard Parallel Keyway and Key Sizes					
Keyway (mm)		**Key (mm)**			
From	**To**	**Width (W)**	**Depth (h)**	**Width (W)**	**Depth (T)**
6	**8**	**2**	**1.0**	**2**	**2**
9	**12**	**3**	**1.4**	**3**	**3**
11	**17**	**4**	**1.8**	**4**	**4**
13	**22**	**5**	**2.3**	**5**	**5**
18	**30**	**6**	**2.8**	**6**	**6**
23	**38**	**8**	**3.3**	**8**	**7**

31	**44**	**10**	**3.3**	**10**	**8**
39	**50**	**12**	**3.3**	**12**	**8**
45	**58**	**14**	**3.8**	**14**	**9**
51	**65**	**16**	**4.3**	**16**	**10**
59	**75**	**18**	**4.4**	**18**	**11**
66	**86**	**20**	**4.9**	**20**	**12**
76	**96**	**22**	**5.4**	**22**	**14**
86	**110**	**25**	**5.4**	**25**	**14**
96	**130**	**28**	**6.4**	**28**	**16**
111	**150**	**32**	**7.4**	**32**	**18**
131	**170**	**36**	**8.4**	**36**	**20**
151	**200**	**40**	**9.4**	**40**	**22**
171	**230**	**45**	**10.4**	**45**	**25**
201	**260**	**50**	**11.4**	**50**	**28**
231	**290**	**56**	**12.4**	**56**	**32**
261	**330**	**63**	**12.4**	**63**	**32**
291	**280**	**70**	**14.4**	**70**	**36**
331	**440**	**80**	**15.4**	**80**	**40**
281	**500**	**90**	**17.4**	**90**	**45**

s

Table 3.4: Standard Metric Keyway and Key Dimensions (Khuni and Guptta, 2005)

Fabrication of Wood Lathe Machine

Fabrication can be defined as the building of metal structures by assembling, bending and cutting processes. The fabrication of wood lathe machine was done in the central workshop of the Department of Mechanical and mechatronics Engineering, college of engineering, Afe Babalola University Ado-Ekiti, Ekiti State. Nigeria.

Fabrication Operations

The operation involved in the fabrication of wood lathe machine include;

I. Cutting
II. Grinding
III. Welding
IV. Drilling

V. Rolling

VI. Lathe machine

VII. Guillotine machine

Cutting

This is done by using various kind of cutting tools such as the milling machine, lathe machine are saw, power are saw and clamping the materials on a vice. The work is held on the table and moved against the power are saw to perform the quick and automatic sawing operation. And also used to remove unwanted materials to produce a desired shape, size.

Grinding

The operation is performed to give a surface finish to the work piece and reduce stress build up resulting from surface imperfection from various machining operation.

Welding

Along with cutting, welding is one commonly used metal fabrication processes among craft men. It is a process for joining two separate similar or dissimilar metals part. It joins different metals/alloys, with or without the application of pressure and with or without the use of filler metal. A weld can be achieved through the application of heat along the points where the pieces of metal are to be joined. In the fabrication of a wood lathe machine an electric arc welding machine was used.

Electric Arc Welding

The work piece is prepared for welding. In this the filler metal is supplied by metal welding of electrode which ranges from gauge 10 or gauge 12 based on the thickness of the metal to be welded. The tongue hold the electrode, the material to be welded is earthed such that as the griped electrode strikes the papered work piece the electrode melts and from a molten substance between.

Rolling Machine

This is a technique of metal working whereby metal sheets are folded, repeatedly forged and annealed and unfolded. This operation is done by roller b, it forms predetermined bends by clamping the work piece between a matching die.

Equipment and Tools Used.

The following tools and equipment were used in the workshop to carryout the machining process:

Lathe Machine

This is used to remove metal from a job to give it the required shape and size of the shaft. The job is securely and rigidly held in the chuck or in between centers on the lathe machine and then turn it against a single point cutting tool which will remove metal from the job in the form of chips. (Rajender, 2005).

Milling Machine.

This is used to removes metal and develop a key way as the work is fed against a rotating multipoint cutter. The milling cutter rotates at high speed and it removes metal at a very fast rate with the help of multiple cutting edges. It was also used for machining external and internal threads.

Arc Saw

Single face cutting tools used to cut already marked cut metal sheet, angle iron and shafts into required sizes needed.

Other tools and equipment used:

1. Grinding machine: This is a machine for used material removal with geometrically non-defined, bonded cutting edges, where the relative movement between tool and workpiece is rotational or linear.
2. Vernier caliper: A Vernier Caliper is a visual aid to take an accurate measurement reading between two graduation markings on a linear scale by using mechanical interpolation, thereby reducing measurement uncertainty by using Vernier acuity to reduce human estimation error

3. Tape rule: A tape measure or measuring tape is a flexible ruler used to measure size or distance
4. Chisel: chisel is a tool with a characteristically shaped cutting edge of blade on its end, used for cutting a hard material such as wood, stone, or metal by hand, struck with a mallet, or mechanical power.
5. Sand paper
6. File: A file is a tool used to remove fine amounts of material from a workpiece.
7. Drilling machine: A drilling machine, called a drill press, is used to cut holes into or through metal, wood, or other materials

Figure 3.1: Components of head stock before assembly

Figure 3.2: Components of head stock after assembly

Figure 3.3: Components of tail stock before assembly

Figure 3.5: Tensioning system

Figure 3.6: Tool rest

Figure 3.7: Hss tool, carbide turning tool and drill bit

Bill of Engineering Measurement and Evaluation (BEME)

This is a tool used before starting a work to give an estimate cost of the work and to show how reliable the project would be. It contains the materials, quantity and price of the material. BEME does not show the total cost of the project, only gives an estimate.

Table 3.8: Bill of Engineering Measurement and Evaluation

1	Materials	Parts	Quantity	Rate	Processing	Amount
2	Angle Iron 3"x3" 6mm thick	Frame	2	9000		18000
3	Angle Iron 2"x2" 6mm thick	Frame	1	6500		6500
4	Mild steel plate 6mmX500mm x500mm	Frame	1	30000		30000
5	Mild steel diameter 30 x400mm	Spindle Shaft	1	3000	15000	18000
6	Mild steel diameter 25x300mm	Tail stock Shaft	1	2000	6500	8500
7	Mild steel diameter 25x350mm	Electric motor base hinge	1	2500	3000	5500
8	Mild steel hollow diameter 60x250x5mm	Tail stock barrel	1	5500	7500	13000
9	Hand wheel diameter 120mm	Tail stock handle	1	1500	1000	2500
10	Pillow bearing diameter 25mm	Bearing	2	4000		8000
11	Mild steel diameter120x200mm	big step pulley	1	15000	9500	24500
12	Mild steel diameter 70x150mm	small step pulley	1	3000	5500	8500
13	Sheet metal 1mmx600x200mm	Frame	1	18000		18000
14	Mild steel bar 60x200mm	Revolving centre	1	3500	2500	6000
15	Mild steel bar 50x100mm	Dead centre	1	2000	2000	4000

16	Mild steel bar 25x400mm	lock, hand for tail stock	1	3000	1500	4500
17	Mild steel bar 50x400mm	Lock base for tail stock	1	4000	2500	6000
18	Mild steel plate10x100x300mm	Crest base slider	1	12000	2500	14500
19	Electric motor 2hp	Power	1	50000		50000
20	V belt	Transmission	1	1500		1500
21	M10 bolts and nut, flat washer and spring	Fastner	1 dozen each	1300		1300
22	M8 bolts and nut, flat washer and spring	Fastner	1 dozen each	1000		1000
23	M12 bolts and nut, flat washer and spring	Fastner	1 dozen each	1500		1500
24	M24x50 bolts and nut, flat washer and spring	Fastner	1 dozen each	3000		3000
25	electrode		1pack	5000		5000
26	cutting disc		4 pieces	500		2000
27	grinding disc		3pieces	1000		3000
28	hack saw blade		3pieces	1000		3000
29	paint red oxide	Paint	1litre	1500		1500
30	paint blue	Paint	1litre	1500		1500
31	tinner	Paint	1litre	1500		1500
32	paint brush		2 pieces	500		1000
33	Transport					30000
	TOTAL					302800

RESULT AND DISCUSSION

This chapter includes the analysis of data and observed results generated from the Autodesk inventor software, the performance evaluation and discussion of results of the wood lathe machine.

Result

Load Carrying Capacity and Stability of the Machine Bed

In the design specification;

Length of bed, L = 1500mm

Width of bed, b = 210mm

Inclination of table's leg, 0=85°

Modulus of elasticity of steel, E – 210 GN/m^2

Strain developed, E= 0.25mm

Factor of safety for steady load FOS =2

The ultimate stress developed in the machine table is estimated using the relations

Stress = strain x modulus of elasticity (4.1)

And stress = (4.2)

Substituting required values into the equation, we have ultimate stress

a_{out} = 2.5 x 10^{-1} x 201

= 5.25 x 10^{-2} GN/m^2

Total estimate the safe working stress we have

Working stress a_w = (4.3)

= =

=

= 2.6 x 10^{-2}GN/m^2

Again, since the table is inclined at a given angle with the floor then, the working stress can be expressed as:

Working stress aw = (4.4)

α_w =

$P_r = \alpha_w$ x A = $\alpha_{w \times L \times b}$

= 2.6 x 10^{-2} x 1.50 x 0.21

= 81.9MN

Hence the machine can carry an estimated load of 81.9MN. But at each application of load, the horizontal component of the Load (P_h) is:

Ph = Pr cos 85^O (4.5)

= 81.9 x cos 85^o

= 7.14MN

The percentage of horizontal force:

= x 100

= 8.72%

Specification of the Machine

The specification of the machine is as follows:

1. Maximum diameter of work that can rotate between the centers, D = 50mm
2. Height of the centers above the top of the bed, H=230mm
3. Maximum length of work that can be accommodated between the centers, L=900mm
4. Width of ht e bed, W =210mm
5. Height of the headstock = 410mm
6. Height of the machine table, H = 900mm
7. Height of the machine, H = 1200 mm

8. Diameter of driving pulley, D = 80mm
9. Diameter of driven pulley, d = 120mm
10. Distance between centers of the two pulley, Y = 540mm

Table 4.1: Computations

Quantity	Formula	Value	Unit
Length of belt L	= 2y	1474.2	mm
Power transmitted by belt, p	$(T_1 - T_2)$ v	14	Kw
Centrifugal tension, T_c	Mv^2	7.04	N
Maximum tension in the belt, T	a x A	233.1	N
Tension in the belt slack side, T_2		16.6	N
Speed of shaft, N_1		1060	rpm
Speed of motor, N_2		1591	rpm
Power rating of electric motor, P(req)	P x K	2.0	hp
Torque transmitted by the shaft, T	$(T_1 - T_2)$ R	13614.9	Nmm
Vertical weight on the pulley, w	$T_1 - T_2$	242.66	N
Bending moment, M	w x X	36399	Nmm
Permissible shaft diameter, d	$((\sqrt{M^2 + T^2})^{1/3}$	4469.89	mm
Working stress, αw	αw	2.6×10^{-2}	GN/m^2
Resultant load on bed, *Pr*	αw x L x b	81.9	MN

Discussion of Results

The model of the machine was tasted and simulation was carried out in dynamic simulation environment of the Autodesk Inventor Software. The shafts are made of steel with the required properties. Other components were appropriately computed and calculated and they all indicate design compliance.

Wood lathe machine was fabricated based on engineering approach with the aid of software computer aided design and values, the performance and efficiency of the machine is a benchmarked against the commercially available wood lathe machines. The wood lathe machine was tested to determine the extent to which the design specification and the overall performance goals of the machine were achieved. This was done at the College of Engineering central workshop. The test of the result confirmed the performance of the machine. The electric motor rotated the headstock spindle with the aid of the V- belt ad pulley with the speed range of 1591 rpm and the headstock spindle rotated the wood mounted between the headstock and the tailstock centers of 480mm to create the desired shape.