Design and Fabrication of Machine Performing Multi-Operation

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ABSTRACT

Machinery cost, inventory cost and production cost are important key factors for production of useful goods and services in industries. In an industry a considerable portion of investment is being made for machinery installment. In industries various manufacturing operations are carried out by separate machines. It needs more space and time. We have developed a model of a machine which would be capable of performing different operation simultaneously and it should be economically efficient .In this machine we are actually giving drive to the main shaft. On the main shaft we have use pulley system for power transmission at different locations. Objective of this model are conservation of electricity (power supply), reduction in cost associated with power usage, increase in productivity, reduced floor space. It include operations such as Facing Operation, Turning Operation, Internal Boring, Drilling Operation, Grinding Operation, Cutting Operation, Shaper Machine Operation, and Wood Cutting Operation.

Keywords:Cutting, Drilling, Facing, Grinding Wheel, Solidworks designing, Scotch Yoke, Turning.

1. INTRODUCTION

In this competitive world, speed and time is mostly required in each and every field of manufacturing. Hence rapid working and quick working are the most important factors may be used in industry to manufacture varieties of product at single time and single place. The engineer constantly working in the field of manufacturing to bringing new ideas and design in machines and use various techniques to manufacture various products continuously at higher quality with cheaper rates.

Machinery cost, inventory cost and production cost are important key factors for productionof useful goods and services in industries.To overcome these problem we have proposed a machine which can perform multi-operations like drilling, shaping, grinding, cutting and some lathe operations(turning, facing) at different working stations simultaneously which implies that industrialists have not to pay for machine performing above tasks individually for operating operation simultaneously.

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As compare to single purpose machine, multi-operational machine is a compact, portable, unit capable of doing many operations.

AIM AND OBJECTIVE

The main aim and objective of our project is to design and fabrication of multi-operational machine which can perform various operations at a place without greater movement of workers. Which is used for performing various operations such as Facing Operation, Turning Operation, Internal Boring, Drilling Operation, Grinding Operation, Cutting Operation, Shaper Machine Operation, and Wood Cutting Operation.

2. LITERATURE REVIEW

In manufacturing field power and time consumption, maintenance cost, number of units produced per machine is a tricky task as many factor being associated with it. Before going to start our work we undergo through various research papers and some research papers which may give solution to all these factors are as follows:

Heinrich Arnold (1 November 2001): Rather long re-investment cycles of about 15 years have created the notion that innovation in the machine tool industry happens incrementally. But looking at its recent history, the integration of digital controls technology and computers into machine tools have hit the industry in three waves of technology shocks. Most companies underestimated the impact of this new technology. This article gives an overview of the history of the machine tool industry since numerical controls were invented and introduced and analyzes the disruptive character of this new technology on the market. About 100 interviews were conducted with decision-makers and industry experts who witnessed the development of the industry over the last forty years. The study establishes a connection between radical technological change, industry structure, and competitive environment. It reveals a number of important occurrences and interrelations that have so far gone unnoticed [1].

Dr. ToshimichiMoriwaki recent trends in the machine tool technologies are surveyed from the viewpoints of high speed and high performance machine tools, combined multifunctional machine tools, ultra precision machine tools and advanced and intelligent control technologies [2].

Frankfurt am Main (2011): The crisis is over, but selling machinery remains a tough business. Different machines have different working principles to operate different functions. Multi-purpose machines are the declarations of independence [3].

The trend towards the kind of multi-purpose machining centers that are able to cost efficiently handle a broad portfolio of products with small batch sizes accelerated significantly during the crisis. “With a multi-purpose machine, you’re less dependent on particular products and sectors”, explains Biermann [3].

Sharad Srivastava have fabricated a machine using scotch yoke mechanism, belt drive and gears. In an industry a considerable portion of investment is being made for machinery installation. They have proposed a machine which can perform operations like drilling, sawing, grinding at different working centers simultaneously which implies that industrialists do not have to pay for machine performing above tasks individually for operating operation simultaneously [4].

3. METHODOLOGY

In this project, we will give the power supply from the electric motor as well as pedal drive to the shaft by pulley and belt drive.

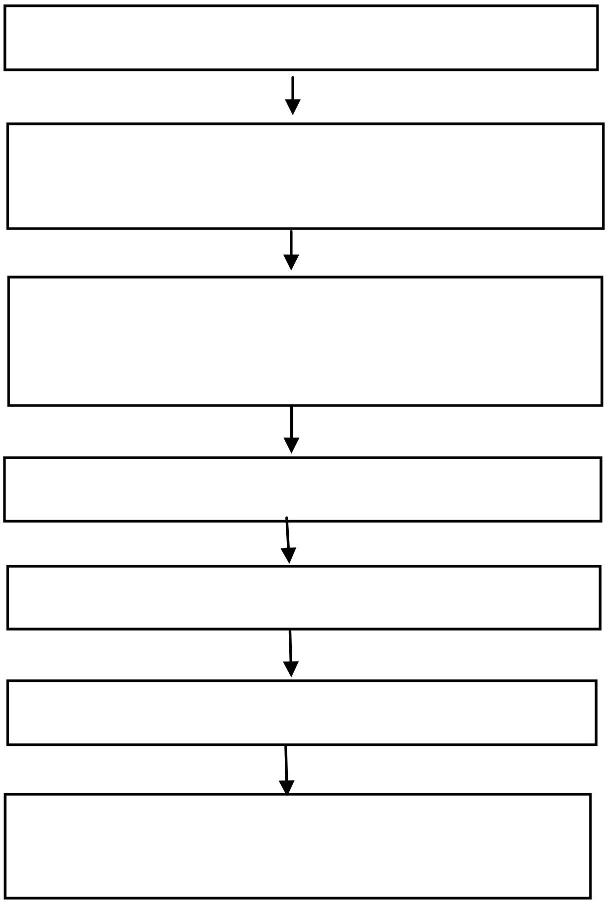

Figure 1: Proposed Methodology

4. WORKING

In the present the power required for the operations i.e. cutting, drilling, grinding and shaping are achieved by using v- belts, bevel gears and scotch yoke mechanism.

The power to the shaft by:

1. AC Motor
2. Pedal Drive

The motor is mounted at the base of the frame. One shaft is located at the base in the center of the table and is supported between the bearings. There are four pulleys mounted on this shaft. Pulley 1 is used to drive the drilling, 12V Dynamo motor and scotch yoke mechanism; there is a bevel gear arrangement to get drilling operation. Pulley 2 is used to drive the shaft on which grinder, cutting and lathe is mounted. Pulley 3 is

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connected with induction motor by belt drive for power transmission. Pulley 4 is connected with pedal drive by belt drive for power transmission. There are three major principles that help our machine to work:

1. Belt drive
2. Bevel gears
3. Scotch yoke mechanism

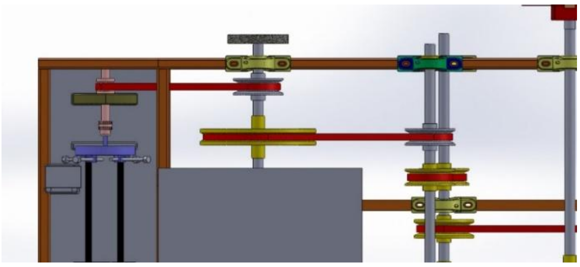

Figure 2: Arrangement of belt-pulley drive

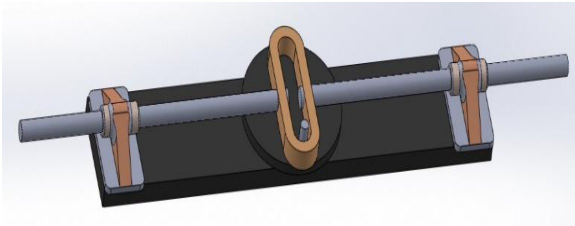

Figure 3: A closer view of scotch yoke mechanism

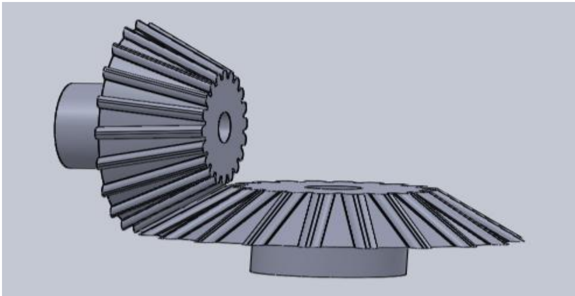

Figure 4: A closer view of bevel gears

5. BLOCK DIAGRAM

The block diagram consists of cutter, frame, scotch yoke mechanism, main shaft, belt-pulley mechanism, bearing and motor etc.

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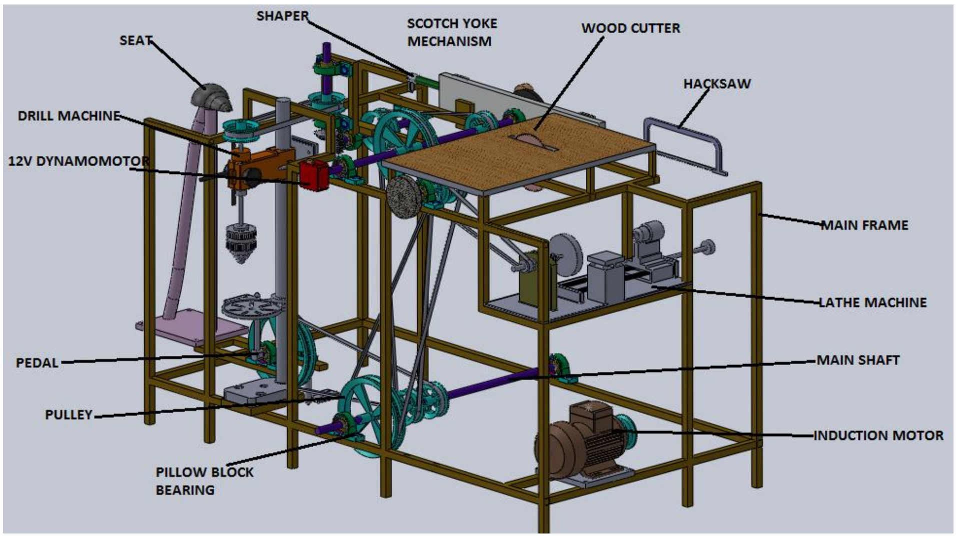

Figure 5(a)

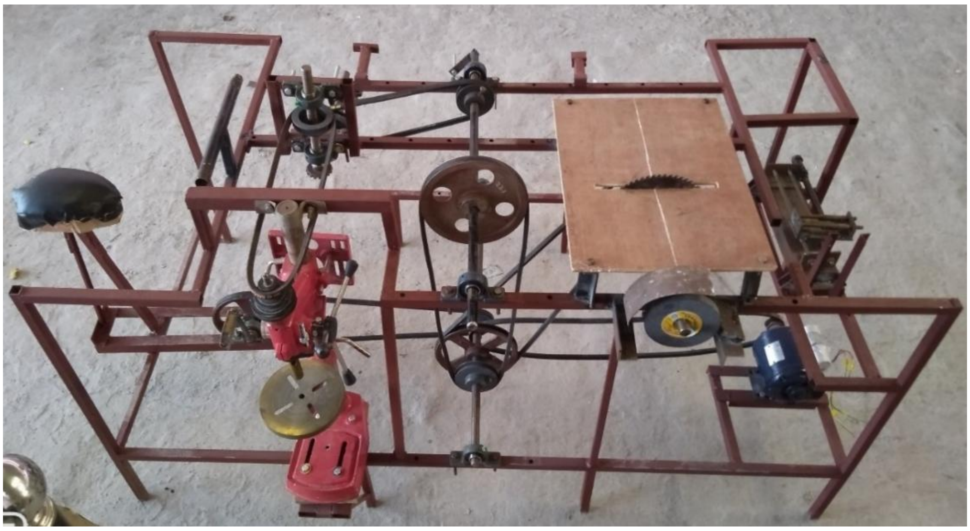

Figure 5(b)

Figure 5: Overview of the model

6. OPERATION PERFORMED

1) Facing Operation
2) Turning Operation
3) Internal Boring
4) Drilling Operation
5) Grinding Operation
6) Cutting Operation
7) Shaper Machine Operation

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8) Wood Cutting Operation

Facing is a lathe operation in which the cutting tool removes metal from the end of the workpiece or a shoulder. In which work is rotated against a single point tool. A workpiece may be held in a 3, 4, or 6 jaw chuck, collets or a faceplate [5].

Turning is a lathe operation in which the cutting tool removes metal from the outside diameter of a workpiece. A single point tool is used for turning. A workpiece may be held in a 3, 4, or 6 jaw chuck, collets or may also be held between centers [5].

Boring is an operation to enlarge and finish holes accurately. This may be done on a lathe or a milling machine. Boring is a machine operation in which the work is in contact with a single point tool [5].

Drilling is an economical way of removing large amounts of metal to create semi-precision round hole or cavity. Drilling allows a person to make holes through boards, metals, and other materials. Used for last removal of stock on preparation for other operations like boring, reaming, or tapping [5].

Grinding is an operation in which the cutting is done by the use of abrasive particles. Grinding processes remove very small chips in very large numbers by cutting the action of many small individual abrasive grains.The abrasive grains are formed into a grinding wheel. Very smooth surfaces can be accomplished by the use of the proper grinding wheel [5].

Shaper is a machine used for the production of flat surfaces in vertical, horizontal, or angular planes [5]. The shaper cuts by passing a single point tool by the workpiece.

7. VIEWS OF MACHINE

Following four figures show different views of multi-operational machine.

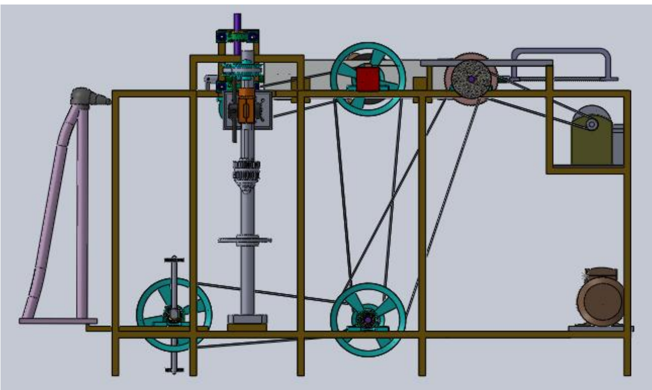


Figure 6(a)

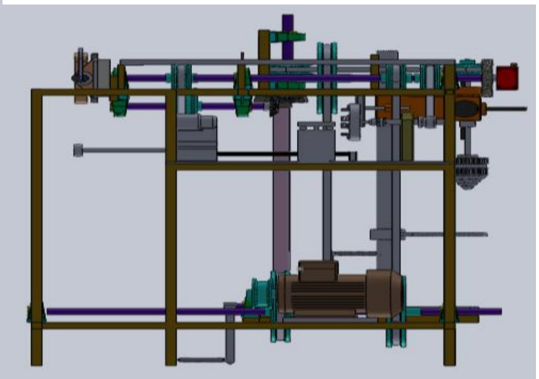
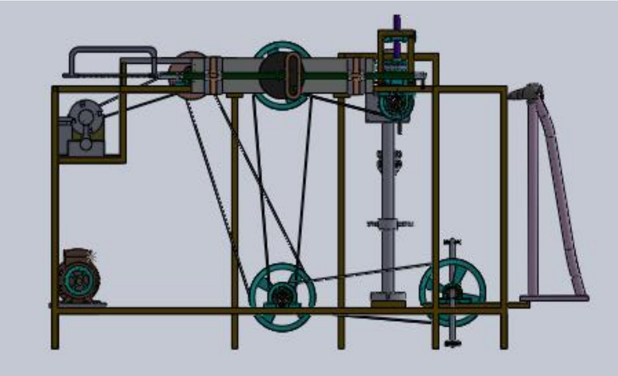


Figure 6(b)



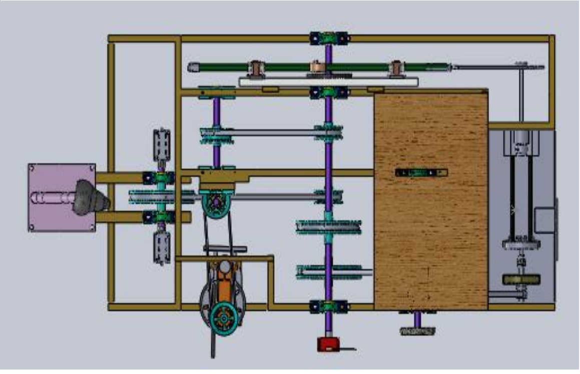


Figure 6(c) **Figure 6(d)**

Figure 6: Different Views of Machine

8. COMPONENTS USED

Frame, Bevel Gear, Scotch Yoke Mechanism, Induction Motor, Pulley, Bearing (Ball &Pillow Block Bearing), Rocker arm, Hacksaw Blade, Tool Post, Drilling Chuck, Drill Tool, Single Cutting Tool, Table, Nut & Bolt & Other Components.

8.1 SPECIFICATION OF THE COMPONENTS

Table 1: Specification of the components

Components	Specification of the components
Frame's model	length =2m width =1m height = 1.1m
Bevel gears	T1 = 40, T2 = 20 (two teeth) material = mild steel
Shaft	diameter = 25 mm length = 2.7 feet material = mild s
Belt	material = V-belt
Pulley	diameter = 8 inch diameter = 5 inch diameter = 4 inch
Frame	iron
Operations	drilling, cutting, shaping, grinding, facing and turning

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9. COMPARISON BETWEEN INDIVIDUAL AND MULTI- PURPOSE MACHINES

Table 2: Comparison of Machines

S.No	Type of Machine	Cost Range of Basic Individual Machines with Multi-Machine
1.	Individual Machine	Drilling Machine: Rs. 8,000-10,000 Power hacksaw cutting machine: Rs.5000-7000 Grinding Machine: Rs. 4500-5500 Wood cutter machine: Rs. 4000-5000 Lathe and shaper machine: approx. Rs. 40000 (on the basis of no. of operations)
2.	Multi Machine	Cost of Multi-operational Machine: Rs. 18,000

10. CALCULATIONS

10.1 CALCULATION OF SPEED OF MAIN SHAFT

Since, motor and main shaft connected through belt pulley mechanism. We calculate the speed of main shaft i.e. the main pulley. From the relation of speed and diameter equation (1.1) can be defined as,

$N_s/N_m=D_a/D_b$(1.1)

where, N_s is the speed of the main shaft, N_m is the speed of the motor which is 1445 rpm, D_a is the diameter of the motor pulley which is 50.8mm, D_b is the diameter of the main shaft pulley which is 101.6mm.

So, the speed of the main shaft is given under equation (1.2).

$N_s=(D_a/D_b)*N_m$(1.2)

$N_s=(50.8/101.6)*1445$

$N_s= 723.21$ rpm

Therefore, main shaft speed is 723.21rpm.

10.2 CALCULATION OF SPEED OF SYM SHAFT

Since, SYM shaft and main shaft connected through belt pulley mechanism. We calculate the speed of SYM shaft. From the relation of speed and diameter equation (2.1) can be defined as,

$N_y/N_s=D_c/D_d$ (2.1)

Where, N_y is the speed of the SYM shaft, N_s is the speed of the main shaft which is 723.21 rpm, D_c is the diameter of the main shaft pulley which is 127mm and D_d is the diameter of the SYM shaft pulley which is 203.2mm.

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So, the speed of the SYM shaft is given under equation (2.2).

$N_y=(D_c/D_d)*N_s$(2.2)

$N_y=(127/203.2)*723.21$

$N_y=452$rpm

Therefore, SYM shaft speed is 452rpm.

10.2.1 CALCULATION OF HACKSAW CUTTING SPEED

Angular velocity=w*r (2.3)

Where, r is the radius of the crank wheel which is 0.1397mts. Angular speed can be,

Angular speed (w)=2πN/60 rad/sec (2.4)

Where, N is the speed of crank wheel in rpm which is 452rpm. Therefore from equations (2.3) and (2.4),

w = 2*π*452/60

w = 47.33rad/sec

V = 47.33*0.1397 = 6.61m/sec

V = 6.61*60 =396.75m/min.

Therefore, the angular velocity of hacksaw is 396.75m/min.

10.2.2 CALCULATION OF SHAPING SPEED

Since, the hacksaw and shaping is assembled on the same shaft i.e. on the other corner of the scotch yoke mechanism (SYM). So, the velocity of shaping will be equal to the velocity of hacksaw cutting. Therefore, the velocity of shaping equals to 396.75m/min.

10.2.3 CALCULATION OF DRILLING SPEED

No. of teeth on gear to be 40 and no. of teeth on pinion to be 20. This is done by the relation given under equation (2.5),

$N_d/N_y=(40/20)$ (2.5)

$N_d=(40/20)*N_y$

$N_d=(40/20)*452$

$N_d=904$rpm

This equation give the value of the drilling speed as stated below.

$N_d = (40/20)*452 = 904$rpm

Since we used 1:2 gears, i.e. the gear has 40 teeth and pinion has 20 teeth, the speed of drilling gets double to that of the speed of the SYM shaft wheel.

10.3 CALCULATION OF SPEED OF GRINDER SHAFT

Since, grinder shaft and main shaft connected through belt pulley mechanism. We calculate the speed of grinder shaft. From the relation of speed and diameter equation (3.1) can be defined as,

$N_g/N_s=D_e/D_f$(3.1)

Where, N_g is the speed of the grindershaft, N_s is the speed of the main shaft which is 723.21 rpm, D_e is the diameter of the main shaft pulley which is 203.2mm and $D_f$is the diameter of the grinder shaft pulley which is 101.6mm.

So, the speed of the grinder shaft is given under equation (3.2).

$N_g=(D_e/D_f)*N_s$(3.2)

$N_g=(203.2/101.6)*723.21$

$N_g=1446.42$rpm

Therefore, grinder shaft speed is 1446.42rpm.

10.3.1 CALCULATION OF GRINDING SPEED

Since, grinder wheel assembled on grinder shaft. So, the speed of grinder wheel will be same as speed of grinder shaft. Therefore, the speed of grinder wheel equals to 1446.42rpm.

10.3.2 CALCULATION OF WOOD CUTTER SPEED

Wood cutter speed=grinder wheel speed=1446.42rpm

10.3.3 CALCULATION OF LATHE CHUCK SPEED

Since, grinder shaft and lathe chuck connected through belt pulley mechanism. We calculate the speed of lathe chuck. From the relation of speed and diameter equation (3.3) can be defined as,

$N_l/N_g=D_g/D_h$(3.3)

Where, N_g is the speed of the grinder shaft which is 1446.42 rpm, N_l is the speed of the lathe chuck, D_g is the diameter of the grinder shaft pulley which is 101.6mm and D_h is the diameter of the chuck pulley which is 50.8mm.

So, the speed of the lathe chuck is given under equation (3.4).

$N_l=(D_g/D_h)*N_g$ (3.4)

$N_l=(101.6/50.8)*1446.42$

$N_l=2892.84$rpm

Therefore, lathe chuck speed is 2892.84rpm.

11. APPLICATIONS

1. Used in small scale industries to reduce machine cost.
2. In such places where frequent change in operation are required.
3. This can be used in garage for small house hold purpose.
4. This process is fully mechanical without using much of the electronics.

12. CONCLUSION

1. It can be better useful for small scale industries.
2. Workers movement minimized by utilizing multiple operations at one setup.
3. Number of operations can be carried out on the single machine.
4. Power consumption, floor area and cost of manufacturing is also reduced.

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