DESIGN OF MULTIFUNCTIONAL MACHINE

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ABSTRACT

The concept of Design ofMulti-Function Machine mainly carried out for production based industries. Industries are basically meant for Production of useful goods and services at low production cost, machinery cost and low inventory cost.

Today in this world every task have been made quicker and fast due to technology advancement but this advancement also demands huge investments and expenditure, every industry desires to make high productivity rate maintaining the quality and standard of the product at low average cost. We have developed a machine which would be capable of performing different operation simultaneously, and it should be economically efficient.reduction in cost associated with power usage, increase in productivity, reduced floor space.

This is aims to explore the theories and techniques behind procedures of developing a high precision cost-effective multi-function machine. This newly designed machine tool can be widely used in making small parts and engraving small features. Various structures were explored and compared during the design stage. Different commercial products were carefully selected and purchased from the Indian market.

Keyword - *Design,Multifunctional machine,Welding,Milling,Profile Cutting,Grianding,Wood Carving,Turning,Slotting,Cutting ,etc*

1. INTRODUCTION-

Industries are basically meant for Production of useful goods and services at low production cost, machinery cost and low inventory cost. Today in this world every task have been made quicker and fast due to technology advancement but this advancement also demands huge investments and expenditure, every industry desires to make high productivity rate maintaining the quality and standard of the product at low average cost In an industry a considerable portion of investment is being made for machinery installation. So in this project we have a proposed a machine which can perform operations like drilling, sawing, slotting, welding, milling, 2-D cutting, 3-D cutting some lathe operations at different working centers simultaneously which implies that industrialist have not to pay for machine performing above tasks individually for operating operation simultaneously. Economics of manufacturing: According to some economists, manufacturing is a wealth-producing sector of an economy, whereas a service sector tends to be wealth-consuming. Manufacturing provides important material support for national infrastructure and for national defense. With the on-going development of technology and economy, new industrial requirements such as high precision, good quality, high production rates and low production costs are increasingly demanded. Most of such requirements, including dimensional accuracy, conformance to tolerances of finished products and production rate can be met with better machine tools. With the help of CNC technology, machine tools today are not limited to human capabilities and are able to make ultra-precision products down to Nano scales in a much faster manner There are several advantages of using small machines to produce small sized objects. With a smaller machine size, space is saved. The energy required to operate the machine is reduced as well. It now requires less material and components to make the machine, hence bringing down the cost greatly. The weight of moving component also

comes down so that during operation, the vibration and noise, as well as pollution to the environment, are markedly reduced. Drilling operation is one of the most important machine operation in a workshop. It was designed to produce cylindrical hole of required diameter and depth on metal work pieces. Though holes can be made by different machine tools in a shop, drilling machine is designed specifically to perform the operation of drilling and similar operations. Drilling can be done easily at a low cost in a shorter period of time in a drilling machine. Drilling can be called as the operation of producing a cylindrical hole of required diameter and depth by removing metal by the rotating edges of a drill. The cutting tool known as drill is fitted into the spindle of the drilling machine. A mark of indentation is made at the required location with a center punch. The rotating drill is pressed at the location and is fed into the work. The hole can be made up to a required depth. In this machine for drilling operation we have given a special fixture for drilling machine in this operation the X&Y axis will be locked and only z-Axis will have an vertical perpendicular movement of the axis for depth control and height adjustment with precision nut is provided with scale .We can also go an angular drilling operation as the Z- axis has given an rotational moment with indexing plate. Milling is the machining process of using rotary cutters to remove material from a workpieceby advancing (or feeding) tool. It is one of the most commonly used processes in industry and machine shops today for machining parts to precise sizes and shapes.Milling can be done with a wide range of machine tools. Milling is a cutting process that uses a milling cutter to remove material from the surface of a work piece. The milling cutter is a rotary cutting tool, often with multiple cutting points. As opposed to drilling, where the tool is advanced along its rotation axis, the cutter in milling is usually moved perpendicular to its axis so that cutting occurs on the circumference of the cutter. As the milling cutter enters the work piece, the cutting edges (flutes or teeth) of the tool repeatedly cut into and exit from the material, shaving off chips from the work piece with each pass. In this machine we will provide and end mill cutter to the router which will fix in the z axis with special fixture for

2. LITRATURE REVIEW

Before starting our work we have undergone through many research papers which indicates that for a production based industries machine installation is a tricky task as many factor being associated with it such as power consumption (electricity bill per machine), maintenance cost, no of units produced per machine i.e. capacity of machine, time consumption and many more…. Some research papers which have led us to approach to the idea of a machine which may give solution to all these factors are as follows:

Dr.B.Jayachandraiah, O.Vamsi Krishna, P.Abdullah Khan, R.Ananda Reddypublished paper on Fabrication of low cost 3 axis cnc router in June 2014 this paper helped us to know the various compnantpresne in the 3 axis cnc machine .From this paper we selected the lay out of our machine as moving gantry setup .This paper helped us for knowing the component of 3 axis .Ball bearing ,Linear Rods, Linear Ball bearings, Shaft end supports. From this paper we got information about fabrication of 3 axis machine and how to fix the x-axis ,Y-axis and how to fabricate the base of the machine With the help of this paper we assembled a linear rails in such way that we achived the 3 axis moment with linear bearing.Sharad Srivastava , Shivam Srivastava ,C.B.Khatri published paper on Multi-function machine conceptual model in June 2014 from this paper we come to know that there is a machine which can do the number of operation but it has an limited degree of freedoms and limitation on some operations .In this paper they done operations like Grinding,Sawing,Cutting,Drilling centre but we observed that this machine fails at some points like it don't have depth construability in drilling operations, Itcant fix the big work piece when it is grinding and it uses hacksaw for cutting which is very slow in operation so considering this factor we overcome this factors we have provided the depth contrarily ,We can fix any type of component on our machine like flat workspace, round work piece .This paper helped us for comparing the result of the grinding .Mr.Dhruv H. Patel, Prof. V. N. Patni (2014) from this paper we know about Toguchi method which is developed by Dr. Genichi Taguchi, a Japanese quality management consultant. The method explores the concept of quadratic quality loss function and uses a statistical measure of performance called Signal-to- Noise (S/N) ratio. The S/N ratio takes both the mean and the variability into account. The S/N ratio is the ratio of the mean (Signal) to the standard deviation (Noise). The ratio depends on the quality characteristics of the product/process to be optimized. The standard S/N ratios generally used are as follows: - Nominal is Best (NB), Lower the Better (LB) and Higher the Better 68 (HB). The optimal setting is the parameter combination, which has the highest S/N ratio. In this study lower the better is used. From this paper we gain the information about cnc router used for the wood carving operations we studied its operation and from that we added a operation wood carving ,profile cutting ,acrylic cutting ,Engraving to our machine .For wood compostitematerials.aluminium,steel.Plastic and foams for the pattern making .In cnc router it can move the cutter left-right,From-to,or up down all at the same time this paper we fix the vertical Z-axis mechanism we used in our machine From this paper helped us to know the information abou the surface finish

measurement ,factor affecting the surface roughness, how to control the surface finish with the different parameters.ManjhshreeD.Sutar ,Bhagyash B. Deshmukhpublishd paper on A recent technology for higher accuracy and precision motion of machine tool in Oct 2013.From this paper got information about linear motion guide ways. Guide ways are the part which makes tool movement along predetermined path in either horizontal direction or vertical direction.This paper contain various types of Linear motion bearing which are Sliding contact bearing ,Rolling element linear motion bearing, Hydrostatic linear motion Bearing,Magnetic linear motion bearing from this we selected the Rolling element linear motion bearing because it decreases friction utilizing rolling contact through rolling balls.This paper helped us to slect linear guide ways over the another transmission elemt as this paper contain advantages of linear motion bearings

3. DESIGN AND ANALYSIS

Machine structure is the "backbone" of the machine tool. It integrates all machine components into a complete system. The machine structure is crucial to the performance of the machine tools since it is directly affecting the static and dynamic stiffness, as well as the damping response of the machine tool. A carefully designed structure can provide high stiffness, result in higher operation bandwidth and more precise operation. A small-scale machine tool generally requires even higher stiffness than the ordinary large-scale machine tool since it is usually operated at higher speeds. There are several other issues related to the machine structure such as symmetry, connectivity and errors. In this chapter, some most common structures used on machine tools will be compared and analyzed.The desired structure should achieve high stiffness and a workspace. The accuracy of the prototype should achieve at least 50μm and the repeatability should be within 10μm. To achieve higher efficiency, the maximum machine speed should be as fast as possible.

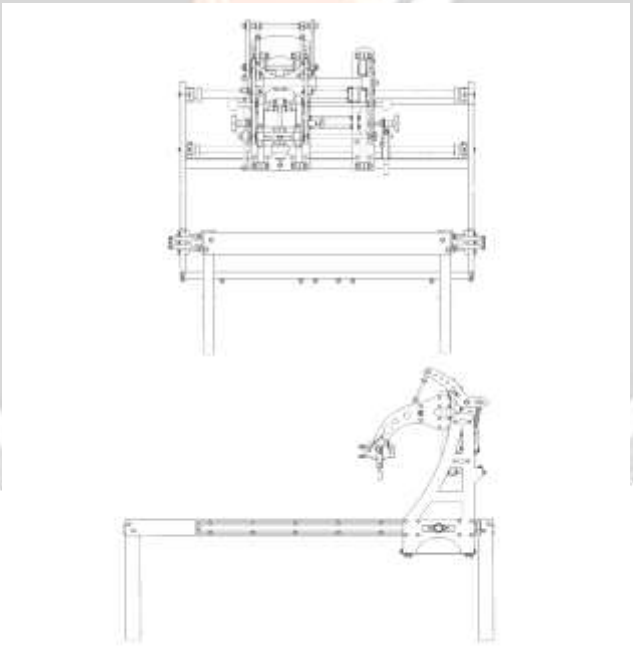

Figure1: Design Of Machine

3.1 DESIGN CONSIDERATION

Calculation of the torque

The torque of the spindle motar is given by

$T=Fc \times r$

Fc=Cutting force

r= radius of the tool

Calculation of the spindle motar power

$P=T\times W$

$P=T\times 2\pi N/60$

Calculation formulas

Service life of linear guide ways

Service life:

When the raceway and the rolling elements of a linear guide way are continuously subjected to repeated stresses, the raceway surfaces shows fatigue, and flaking will eventually occur. This is called fatigue flaking. The life of a linear guide wayis defined as the total distance travelled until the fatigue flaking appears on the surface of the race way or the rolling elements.

Nominal life (L):

The service life varies greatly even when the linear motion guide waysare manufactured in the same way or operated under the same motion conditions. For this reason nominal life is used as the criteria for predicting the service life of a linear motion guide way. The nominal life is the total distance that 90% of group of identical linear motion guide ways operated under identical conditions can travel without flaking. With the basic dynamic rated load is applied to a linear motion guide way, the nominal life is 50 Km.

Calculation of Nominal Life:

The acting load will affect the nominal life of a linear guide way. Based on the selected basic dynamic rated load and the actual load, the nominal life can be calculated by:

$L=x^3 \times 50$ [50km]

$x=c/p$

L=Nominallife

C= Basic Dynamic load rating

P=Actual load

If the environmental factors are taken into consideration, the nominal life is influenced greatly by the motion conditions, the hardness of the raceway, and the temperature of the linear guide way. The relationship between these factors is expressed in eq.

$L=x^3\times 50$ [km]

$x=(Fh\times Ft\times C)/(Fw\times Pc)$

L =Nominal life;

Fh = Hardness factor;

C =Basic dynamic load rating;

Ft = Temperature factor;

Pc =Calculated load;

Fw = Load factor.

3.1.1Factors of Normal Life

Hardness factor

In general, the raceway surface in contact with the rolling elements must have the hardness of HRC 58-62 to an appropriate depth. When the specified hardness is not obtained, the permissible load is reduced and the nominal life

is decreased. In this situation, the basic dynamic load rating and the basic static load rating must be multiplied by the hardness factor for calculation.

Temperature factor

Due to the fact that the temperature will affect the material of linear guides, therefore the permissible load will be reduced and the nominal service life will be decreased when reaching a temperature superior to 100°C. Therefore the basic dynamic and static load rating must be multiplied by the temperature factor. Assume accessories are plastic and cannot resist high temperatures, the working environment is recommended to be lower than 100°C.

Load factor

The loads acting on a linear guide way include the weight of slide, the inertia load at the times of start and stop, and the moment loads caused by overhanging. These load factors are especially difficult to estimate because of mechanical vibrations and impacts. Therefore, the load on a linear guide way should be divided by the empirical factor.

Calculation of Service Life:

Transform the nominal life into the service life time by using speed and frequency.

$Lh=(L\times1000)/(Ve\times60)$

$Lh=((c¦p)^3\times50\times1000)/(Ve\times60)$

Lh= Service life [hr];

Ve=Speed [m/min];

C= Nominal life [Km];

c/p=Load factor.

Applied load

Loading contains 3 elements: force, direction of load, and the object subjected to load.

Force:

Weight: system inertia must be considered when in motion.

Outer force: additional forces can be applied to the system, and have no inertia.

Direction of load:

The load direction can be divided into 3 segments: Fx, Fy, Fz.

Position of load:

Pfx, Pfy and Pfz are defined as the distance from the applied load to the system

Center.

Distance between 2 carriages / rails:

L and L, as shown.

Forces on carriages:

R , R2, R3, R4 - forces in vertical directions.

S1, S2, S3, S4 - forces in horizontal directions.

Calculating applied Load

Carriage vertical load equation

$R\_1=(-fz)/4+((fz\times Pfy-fy\times Pfz))/(2\times L1)-((fx\times Pfz-fz\times Pfx))/(2\times L0)$

$R\_2=(-fz)/4+((fz\times Pfy-fy\times Pfz))/(2\times L1)+((fx\times Pfz-fz\times Pfx))/(2\times L0)$

R_3=(-fz)/4-((fz×Pfy-fy×Pfz))/(2×L1)+((fx×Pfz-fz×Pfx))/(2×L0)

R_4=(-fz)/4-((fz×Pfy-fy×Pfz))/(2×L1)-((fx×Pfz-fz×Pfx))/(2×L0)

Carriage Horizontal Load Equation

S_1=fy/4+((fy×Pfx-fx×Pfy))/(2×L0)

S_2=fy/4-((fy×Pfx-fx×Pfy))/(2×L0)

S_3=fy/4-((fy×Pfx-fx×Pfy))/(2×L0)

S_4=fy/4+((fy×Pfx-fx×Pfy))/(2×L0)

Calculation of equivalent load:

An equivalent load is used to consolidate applied load components into one value which can be used to calculate the minimum required load rating and the expected life of the selected carriage.

Feq.=Rn+Sn

Feq=Equivalent load;

Rn=Vertical component of applied load;

Sn=Horizontal components of applied load.

Friction resistance:

A profile rail linear guide is composed of a carriage, rail, and rolling elements (either balls or rollers). During motion, sliding occurs between these components,resulting in friction resistance.

Friction can be calculated by:

F=μW+f

F=Friction resistance;

W=Load;

μ=Coefficient of friction;

f=Block seals resistance.

4. FABRICATION MODEL

Figure 2:Fabricated X-Y Axis

Figure 3:Gantry Side

5. CONCLUSIONS

With the increasing demand for small scale high precision parts in various industries, the market for small scale machine tools has grown substantially. Using small machine tools to fabricate small scale parts can provide both flexibility and efficiency in manufacturing approaches and reduce capital cost, which is beneficial for small business owners and hobbyists. In this thesis, a small scale three axis multi-function operating machine is designed and analyzed under very limited budget of 40,000. During the structure design stage, various common structure frames are explored and analyzed. The most suitable structure frame, the open frame vertical type structure, is chosen. Critical components such as linear guides, motors. The best value components are selected to accommodate stiffness requirements and budget constraints. The issues of assembling mechanical components parts into mechanical structure are all well considered. The completed machine is tested using three different techniques, i.e. surface testing, perpendicularity testing. The possible error sources are determined. The machine has been used to create several parts already.This will certainly help to achieve the desired characteristics with the same amount of budget.

6. ACKNOWLEDGEMENT

Performance of ‘‘Design Of Multi-Function Machine ’’has been a wonderful subject to research upon, which leads one’s mind to explore new heights in the field of Mechanical Engineering.We dedicate project works to our esteemed project guideProf.Karwande Swapnil.whose interest and guidance helped us to complete the work successfully. This experience will always steer us to do our work perfectly and professionally. We also extend my gratitude to Prof. Pathan Farhan(H.O.D. Mechanical Department)who has provided facilities to explore the subject with more enthusiasm.I would like to express my deepest gratitude to our Project Co-coordinator Prof. Mali Pravin Kiran his excellent and consistent guidance, understanding, patience, and providing me with wonderful atmosphere for doing project work.We expressour immense pleasure and thankfulness to all the teachers and staff of the Department of Mechanical Engineering. For their co-operation and support. Last but not the least, we thank all others, and especially our friends who in one way or another helped us in the successful completion of this Project.
Finally, thanks to our parents and brother for their consistent encouragement and for hours of patience, respect, and love.

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