Design and Development of Duplex Grinding Machine-A Case Study

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***Abstract*:- This paper discuss the case study and comparison of productivity of component using old duplex grinding machine and special purpose duplex grinding machine(SPM) for grinding operation. In this case study, the SPM is used for grinding the four faces of universal joint/universal joint cross (UJ cross). In this paper the following studies are carried out 1. Time saved by component handling (loading and unloading), using hydraulic clamping, 2. Increase in productivity both qualitative and quantitative, 3. Less human intervention, indirectly reduction in operator fatigue, 4. Less rejection due to automatic controls, and 5. Increase the profit of company.**

I. INTRODUCTION

A special purpose machine is the customer designed machine for a specific job to do a special operation or combination of two or more jobs mostly in mass production. Generally special purpose machines are developed to increase production rate and to improve productivity.

Special purpose machine is part of multi-tasking machine. This is new approach to increase the productivity of organization. If we compare between ordinary machine and special purpose machine in terms of time, costs, number of steps involved, etc, the multi-tasking machine is preferred choice. The technology of SPM is decided upon the principles of minimization of cost, improved productivity and improved safety, better safety etc., which posses with high initial investment, higher maintenance cost etc. This is new approach to increase the productivity of organization. The multi-tasking machine is preferred choice.SPM is higher degree mechanism in which human participation is replaced by mechanical, electrical, fluid power technologies capable of doing physical effort and even mental work as in case of CNC machines. In some simultaneous SPM also demands accurate sensing, recall, memory storage, physical effort or movements requires special sensors for controlling the technologies processes.

The objective of this case study was to increase the production rate and improve productivity in Spicer industry through developing a special purpose duplex grinding machine.

II. COMPONENT DESCRIPTION

DANA Spicer produces a component universal joint also known as universal joint cross which is used in the assembly of driveshaft and axle. Material of the component is SAE 8620, hardness 58~63 RC.

The need of developing the Special purpose duplex grinding machine can be summarized as follows:

- To improve existing method of machining.
- To meet the ever growing demand of customer.
- To eliminate the operator fatigue.
- Full proofing process to eliminate chances of rejection.
- Reduce manufacturing lead time.
- Maintain consistency in production quality and quantity.

Fig 1: Universal joint cross

III. SETUP DETAILS

The duplex grinding machine is designed for grinding operation of universal joint cross, in which grinding operations are to be carried out on four faces of the component in which 0.2 mm cut on each side of the face is to be performed .In this duplex grinding machine first it is required to design three main units according to their specific operation. The units are given below

3.1 Unit A: - Mechanical Unit

The mechanical unit used in the duplex grinding machine consists of the following parts:

1. Fabricated base L shaped made up of Mild Steel.
2. Housing and spindle bearing.
3. Electrical motor and poly V-belt pulley.

4. Slide and slide base.
5. Ball screw and servo motor system.
6. Fixture to mount the component.

First the two jobs are placed by operator firmly on the V-type fixture. The jobs is placed correctly by using pins, and hydraulic cylinders is used to clamp the jobs from top. Then the cycle is start and the mechanical unit feeds the jobs by using slide ways. The slide ways is operated by using hydraulic power pack. The job passes through the grinding wheel unit, and the facing operation is accomplished. The design of hydraulic power pack, slide way and selection of motor is done according to specific requirements. The grinding of all four faces is completed in 112 seconds.

Fig 2: Mechanical Unit

3.2 Unit B: Grinding Unit

In unit B the actual grinding operation is accomplished .Two grinding wheels are mounted face to face in front of each another separated by a known distance so that the job can pass through it. Each set of grinding wheel is driven by a separate electric motor using poly V .For feed operation the ball screw and servo motor arrangement is used. When the cycle starts the ball screw mechanism operates and moves the slide ways and feeds the grinding wheel till the required position and remains steady and the fixture mechanism holding the jobs travels along required path. For this operation motor of 10 hp of 1440 rpm is selected. The motor is mounted on column

Fig 3: Grinding Unit

3.3 Unit C: Electrical Unit

The electrical unit comprises of

1. Servo motor semen's made 808D (advanced) system.
2. Limit switch for limiting and positioning.
3. Proxy Sensor for proper ensured clamping and de-clamping of jobs.

Fig 4: Electrical Unit

IV. WORKING

Two jobs are firmly placed and securely mounted on the V-type block on the slide ways. The two hydraulic cylinders mounted on the top slowly descend and clamps the job on the fixture and restricts the movement of the job. Coolant mechanism of 160 lpm starts which is operated by 2 pumps. The three slide ways one of the job and other two of the grinding unit move simultaneously (rapid forward).The main slide feeds the job at 700 mm in between the grinding wheel mechanism. The motor spindle stops at defined position of grinding. Limit switch is made ON after completion of grinding operation. After completion of grinding operation the job returns to the home position. At the same time wheel spindle also returns to home position. The coolant supply is made OFF and the job is decamped, unloaded and process repeats.

The special feature of the machine is that it has a automatic dressing unit which is used to dress the grinding machine at regular interval and a compensation unit to compensate the amount of wear of grinding wheel.

In the early days the grinding operation are performed by using old duplex grinding machine. In grinding of four faces, each face is required to be grinded separately. Hence the time required for four faces is 95 seconds. Each time the job is required to be clamped and de clamped separately. It is also difficult to mount the job as it is done manually. Hence it is difficult to maintain accuracy, which demands the skilled worker. The comparison between the duplex grinding machine and old DGM machine is given below in tabular form

Parameters	Old DGM	DGM
Machine Cost	Rs.3000000	Rs 45,00,000
Cycle time/job	95 sec	112 sec for two jobs
Jobs/day	265	450

Table 1: Comparison of Old and new Duplex grinding machines

Hence by using the old duplex machine requires more cyclic time, due to this the production rate is very low.

But by using duplex grinding machine the total cyclic time is reduced up to only just 112 seconds for two jobs. Hence greater the production rate, can produce 450 components in just one day.

Fig 5: Duplex Grinding Machine

V. CASE STUDY

1. Time saved by component loading and unloading. In duplex grinding machine the time taken by operator was around 15 seconds for loading and unloading. For clamping of job hydraulic cylinder is used. In previous grinding machine two operations are done at a single time, again the job is required to be de-clamped and again clamped and grinded .Hence it requires more time. It requires 95 sec for single component whereas on duplex machine two components can be grinded in only 112 seconds.
2. Productivity improvement both qualitative and quantitative. The productivity increases by decreasing the lead time of component, increasing productive rate.

Time Calculation Chart

Tool Material	Unit	Plastic bonded wheel
Tool Dia	MM	400
Cutting speed	M/Sec	33
Spindle Speed	R.P.M	1660
Feed/Min	MM	700-1000
Machining time	Sec	97
Idle Time	Sec	15
Load & Unload Time	Sec	15
Cyclic Time	Sec	112

Table 2: Time Calculation Chart

3. Less human interaction. Reduction in the work load is attained through the automatic process which directly helps in less operator fatigue.
4. Less rejection due to automatic controls
5. Increase the profit of company, increases production rate, reduced production cost, reduced labor cost which minimizes the production cost.

Fig 6: Old duplex Grinding Machine

Fig.7: New Duplex Grinding Machin**e**

VI. CONCLUSION

As a result from the case study we have undertaken, we can conclude that the duplex grinding machine made a

considerable and beneficial difference in the production and productivity of the company. The use of the machine is giving some benefits to the company like improved machining method, decrease the pressure of demand, reduced operator fatigue, reduced rejection, reduced manufacturing lead time, production quality and quantity, etc .Initially the machine methodology was concerned with the old duplex grinding machine which is replaced by the new Duplex grinding machine with proper fixturing device, hydraulic clamping, continuous coolant supplying unit, dressing unit, compensating unit due to which there is positive change in the machining methodology, and also this change is concerned with the production quality and quantity.

Finally it is conclude that the machine designed is working properly and fulfilling the requirements of batch production of the component.

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