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Productivity Enhancement by Designing Fixture, SMED Technique for Manufacturing HSTC Cross Slide

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Abstract

Over the past century, manufacturing has made substantial progress. New machine tools, high performance cutting tools, and modern manufacturing processes facilitate today's industries to make parts more rapidly and better than ever before. HSTC cross slide is a component which is used in CNC machine in Manufacturing Company. Presently HSTC cross slide component machined on three different machines. The tools like SMED technique and Time Study were used for analyzing the manufacturing process of HSTC cross slide. The objective is to optimize the Cycle Time, Setup Time, operational cost and optimization of the process to improve productivity and reduce the operational cost. The result obtained after implementing SMED technique and new fixture showed that the Cycle time is reduced from 22.71hrs to 14.7hrs, Setup time is reduced from 7.25hrs to 2.41hrs, and hence Productivity is increased from 52.84% to 81.63%.

Keywords: *Fixture Design, SMED technique, Time study, Process optimization.*

I. INTRODUCTION

The global economy evolution has increased the level of competition for virtually all businesses. In order to maintain the level of competitiveness, it is required to satisfying customer's expectation that firms get better feedback. In the current period, the small and medium scale enterprises are mounting and emerging as manufacturers giving quality products at a more decent cost. The competition in the current business world is marked by intense agitation and severe contention[1].

During machining of HSTC cross slide 40*70. The different setup's on different machines causes loss in time, increase in setup time, cycle time and also the number of process are been increased. So, there is need to develop system which can help in improving productivity and time. Fixtures reduce operation time and increases productivity and high quality of operation is possible. Hence, the project work focused to find out the significance of quick changeovers in machining line. The Set-up activities are a vital part of the production lead-time and affect overall product cost. Tools like SMED technique, Pareto analysis, fish boon diagram and method study have been used to analyze the existing system[2].

A. Fixture

The fixture is necessary in mass production, where large quantity of output will offers ample opportunity for recovery of the necessary investment. It is a special tool used for locating, positioning and firmly holding a work piece in the proper position during a machining operation. A fixture is like a mechanism because it eliminates individual marking, positioning and frequent checking before starting of actual operation[3].

B. SMED Technique

The SMED technique helps to perform equipment setup and changeover the operations under less time. This technique improves setup operations and provides a setup time reduction up to 90% with fewer investments. The setup operations are divided into two parts: Internal setup and external setup. Internal setup operation can be done only when the machine is shut down (attaching or removing the dies). External setup operation can be done when the machine is still running[4].

C. Cycle Time Reduction

The shifting of conventional mass production to batch production has been accelerated in recent years. In satisfying to continuously varying customer requirements the products are being manufactured in small batches, each with custom features and their requirements. This trend is complicated in both commercial and defense markets and has severe impact on the operations of a manufacturing industries[5].

D. Process Optimization

Productivity and Quality are two important but conflicting criteria in the machining operations. In the modern industry, one of the main trends is to

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manufacture a product at low cost and high quality products in short time. Therefore it is essential to optimize productivity and quality simultaneously. Productivity can be interpreted in terms of lesser cycle time and setup time. Dimensional accuracy, surface smoothness, form stability, fulfillment of important requirements in prescribed area of applications is important quality attributes of the product[6].

II. PROBLEM DEFINITION

On study of GER, BMV 65, and Wotan machine, which reveals that the losses occurred during machining of HSTC cross slide (40cm*70cm) in each machine and taking too high setup time. These losses lead to low effectiveness of machine as well as the component and hence reduce the productivity. Hence the activities were recorded in each machine in order to reduce the losses.

The first operation of HSTC cross slide was machined in GER grinding machine and taking 5.65 hours against 3.15 hours, then the next operation i.e. milling operation would be done in BMV 65 machine and taking 6.52 hours against 3.20 hours. Finally the last operation would be done in Wotan machine where it is taking 10.54 hours against 5.80 hours for boring operation.

III. OBJECTIVES AND METHODOLOGY

A. Objective of Work

The project work carried in a Manufacturing Company. The main focus of the project is to understand machining of HSTC cross slide in different machines with various setups.

The work is carried out in fallowing steps

1) Observation of machining process in GER, BMV 65 and Wotan machine.

2) Detailing of different setup and clamping elements.

3) Detailing of various processes carried out while machining in each machine.

4) Observing the time taken for each operation and doing time study using stop watch.

5) Analyzing the machines to design the fixture.

6) Implementation of solution to improve the productivity.

B. Methodology

Designing the fixture is the way to monitor and improve the efficiency of a manufacturing process. This project presents a systematic way to investigate the root causes to increase productivity and reduces Cycle Time, Setup Time, operational cost of HSTC cross slide. The methodology for the project has been representing in Figure 1.

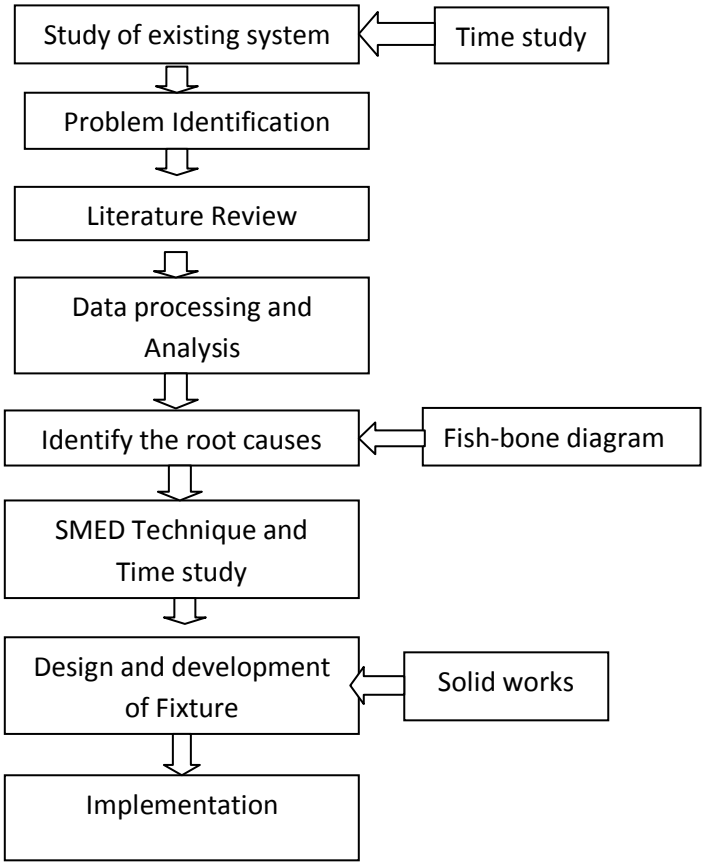

Fig.1 Methodology

The project work starts with the observation of GER, BMV 65 and Wotan machine. Using Time study technique time required to perform each activity was recorded by using stop watch. Time study helps to determine the performance of each machine. Problems were identified while observing the machining operation and setup conducted for machining in each machines. Process of operations helps to know about the sequence of setups and operations carried out in each setup. Time study helps to found time required for performing operations in each setup.

IV. TIME STUDY

A work measurement practice, generally using a stopwatch to record the real elapsed time for the performance of a job, adjusted for any experimental variance from normal effort or pace, unavoidable or machine delays and rest periods to perform a given task. Time Study is the examination of a specific job by an experienced worker in an effort to find the most resourceful method in terms of time and effort. Time Study measures the time essential for a job or task to be finished using the best method.

A. Fish Bone Diagram Analysis

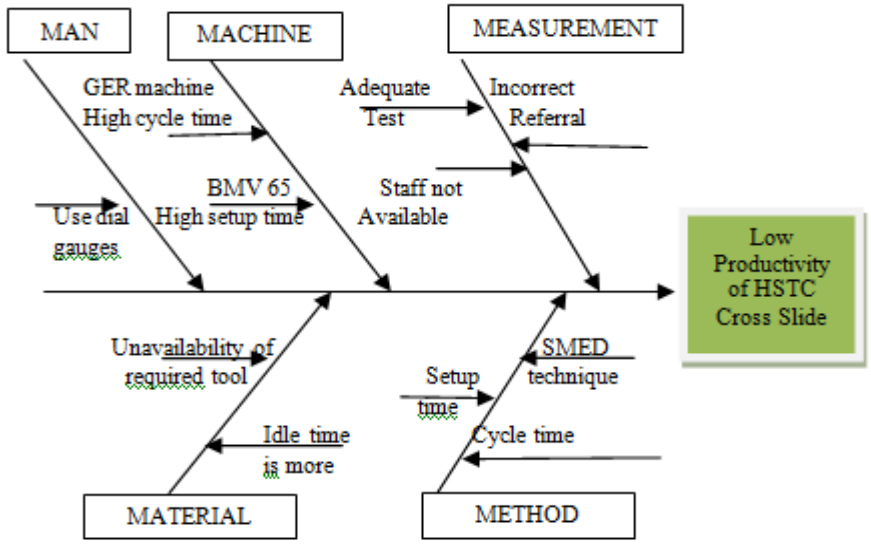

Fig.2 Fish bone diagram for HSTC Cross slide

Root cause analysis is a problem solving method used to identify the root cause nature of the problems. The completed representation of low productivity of HSTC Cross slide has shown on Figure 2. In this, an error which may be responsible for affecting the low productivity is considered, i.e. Man, Machine, Material, Measurement and Method.

V. FIXTURE DESIGN

A fixture is a tool used in machining, inspection, assembly, welding, and other manufacturing operations to position and hold a work piece tightly in position so that the necessary manufacturing processes can be carried out equivalent to design specifications. Fixtures are designed particularly for an operation and so these are named on the base of the operation to be carried out with their assist. Fixtures are used to hold the work piece appropriately to carry out the operations.

A. Advantages of Fixture

1) *Productivity:* Fixtures amplify the productivity by eliminating the individual marking, positioning and frequent inspection. The operation time is also reduced due to raise in speed, feed and depth of cut because of high clamping firmness.

2) *Interchangeability and Quality:* Fixtures facilitate the production of products in large quantities with high degree of accuracy, standardized quality and interchangeability at a competitive cost.

3) *Skill Reduction:* There is no requiring for skilful setting of work on tool. Fixtures makes achievable to employ unskilled or semi skilled machine worker to make savings in labour cost.

4) *Cost Reduction*: Higher production, decrease in scrap, effortless assembly and savings in labour cost results in eventual reduction in unit cost.

B. Fixture design plan

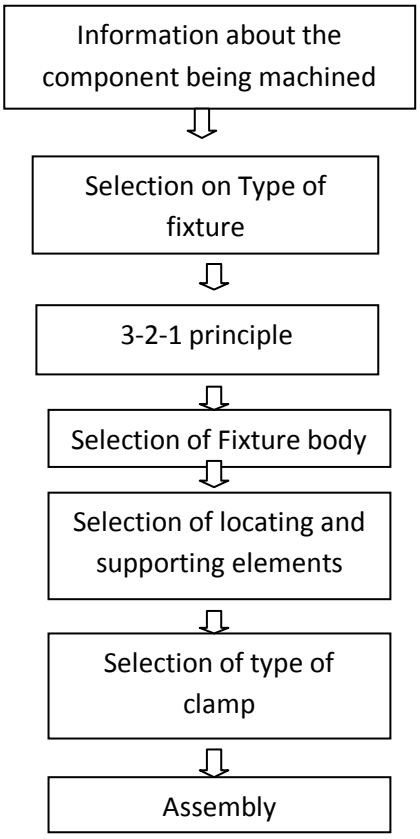

Fig.3 Methodology for fixture design

Fixture planning is to conceptualize a basic fixture arrangement through analyzing all the existing information regarding the material and geometry of the work piece, operations required, processing tools for the operations and the operator.

The component to be is HSTC Cross slide 40*70 in three different machines in a manufacturing Company for the purpose of assembly of CNC machines. There are three machining operations are performed. They are Grinding, Milling and Boring operations in GER, BMV 65 and Wotan machines respectively. Hence manufacturing time is increased and process of operations also.

C. Application of 3-2-1 principle

The principle of fixture is to hold the work piece firmly during machining. If the fixture fails in firmly holding the work piece, at the time of machining the work piece may slide due to force applied by the tool and it may cause the break of both the tool and the work piece. This is where 3-2-1 principle came into picture which helps the designer to justify the appropriate placement of work piece on the fixture.

There are two objectives taken into account while mounting a part in a fixture for machining

- Accurately locating the part at the desired co-ordinates
- Restrict all six degrees of freedom so that the part cannot shift

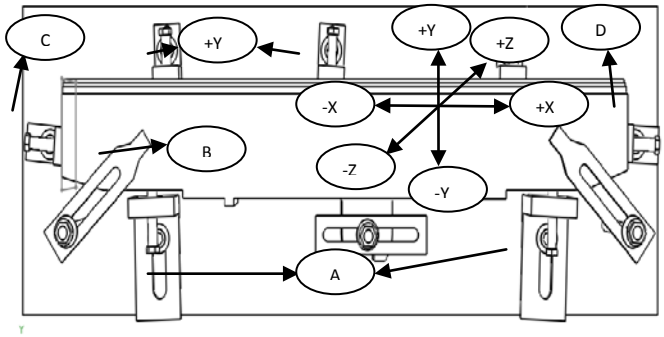

Fig.4 3-2-1 principle applied for the designed fixture

Table.1 Detailed description of 3-2-1 principle applied for the fixture restricting six degrees of freedom

Degrees of Freedom	Constraining Element
+X	Stopper 'D'
-X	Stopper 'C'
+Y	Stoppers 'E'
-Y	Stoppers 'A'
+Z	Clamps 'B'
-Z	Fixture Base

VI. RESULTS AND DISCUSSIONS

The important objectives considered in this project were to condense operational cost involved in machining the component HSTC Cross slide, to improve productivity and also to reduce the cost incurring for machining HSTC Cross slide.

Based on observation of the existing method, high operational cost is incurring due to machine hour rate of the existing method, hence comparison of existing method and proposed method is done based on cycle time, machine hour rate, productivity and Machining cost to justify the replacement of machine from existing method to proposed method. The results obtained are satisfactory.

Table.1 Overall Comparative results between Existing Method and Proposed method

SI No	Type of Comparison	Existing Method	Proposed Method
1	Cycle time in hour	22.71	14.7
2	Setup time in hour	7.25	2.41
3	Machine Hour rate in Rupees/hour	786.61	400
4	Machining cost in rupees	17864	5880
5	Productivity in percentage	52.84	81.63

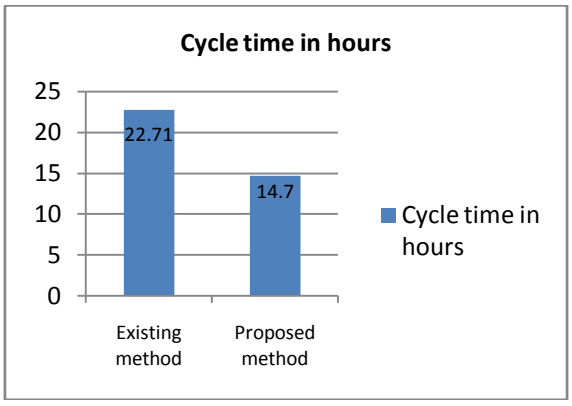

Figure.5 Graph plotted to view the difference of cycle time between Existing method and proposed method

The cycle time taken by proposed method for machining the component is much lesser when compared to that of Existing method i.e. a difference of 8.01 hours in machining a single component. The graph is plotted to show the difference in a improved way which is as shown in Figure.5.

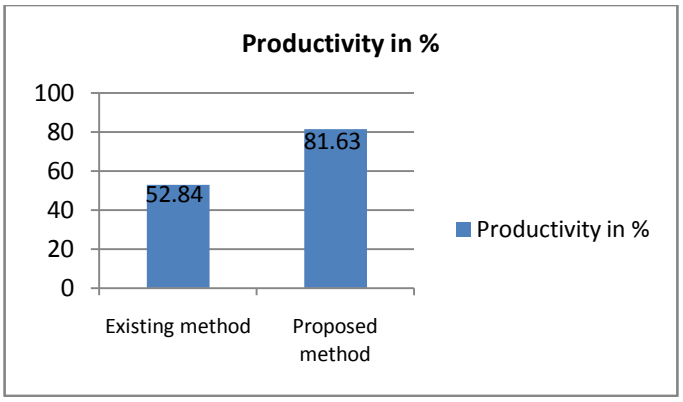

Figure.6 Graph plotted to view the difference of productivity between Existing method and proposed method

With the proposed setup method the company will be able to accomplish the requirement of customers and would make satisfying profit. The objective to be reached and the productivity delivered by the existing method and proposed method is compared and shown the graph in Figure.6.

VII. CONCLUSION

Following are the conclusion drawn from the present work

- The project had practice in many technical aspects and gained realistic knowledge. It gave an experience in adapting suitable procedures, various methods of ability to understand and put things to improved way of working.
- In this project a challenge is made to reduce the operational cost involved in machining the component HSTC Cross slide and design a suitable fixture in order to improve productivity.
- Hence with the substitution of the machine the overall operational cost is reduced to 60% than the previous existing setup.
- The productivity of the component is improved and with the proposed setup company will be able to achieve the suitable demand.
- The proposed fixture setup saves the time and cost occurring during machining of operation

A. Scope of Future Work

- The scope of the present work is to design a fixture and decrease operational cost involved in machining the component HSTC Cross slide which is successfully accomplished with improved results as per ethics of fixture.
- The future scope of this project is to confirm on the quality aspects for the designed fixture and to authorize the performance of the system after implementation of the designed fixture on it.
- Further improvements in clamping system may decrease some more setting time.

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