A CASE STUDY ON TOOL & FIXTURE MODIFICATION TO INCREASE THE PRODUCTIVITY AND TO DECREASE THE REJECTION RATE IN A MANUFACTURING INDUSTRY

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ABSTRACT

Indian economy is running with lots of small & medium enterprises who fulfill the need of any individual. To fulfill the needs of consumers, the industries have to supply large number of goods. As the production is increasing, the rejection rate may be high and hence per unit cost increases. In present work the analysis of problems faced in existing manufacturing processes followed in manufacturing Industries has been done to decrease per unit cost. Present work revises an existing manufacturing process and applies some modifications in the tool and fixture. As a result, the numbers of processing steps is reduced to 03 (three) from 5. The rejection rate was 8.15% when the project was undertaken. After modification, rejection rate was reduced by 3% and the production was increased by 19.32%.

I INTRODUCTION

At present, micro, small and medium enterprises are facing difficulties because input cost (like raw material, electricity, fuel and transportation cost) has increased but price of final product is not increasing. Rejection & reworking are non-value added activity of the company. No customer will pay cost for this. So customer wants defect free product with economical price. When the manufacturing operation of different components were studied, it was found that, in manufacturing of aluminum mixing tubes, company was producing an average of 4760 pieces per month. It was also found that there were many flaws in the manufacturing processes by virtue of which the production time was high and approx. 3 minutes and the number of processing steps were five. This has led to an urgent critical motion and time study analysis of the production process of aluminum mixing tubes.

II PROBLEM FORMULATION

The major reasons for low production of the components are as follows:

- Improper holding of component in the lathe fixture is a major cause of rejection.
- Low production due to high ideal time (i.e. job setting time, tool changing time).

III ANALYSIS FOR FIXTURE DESIGN

C.R. Gagg[1] concluded that manufacturing necessitates the transformation of raw materials from their initial form into finished, functional products. This change was achieved by a variety of processes, each of which was designed to perform a specific function in the transformation process. Pankaj Jalote[2] described the when–who–how approach for analyzing defect data to gain a better understanding of the quality control process and identify improvement opportunities. J. Zackrisson [3] focused on the effectiveness of the on-line quality control in the low scale industries. The basis of the study was manufacturing process of trams. The result indicates that the quality control program demands a solid base to be effective from the beginning of its implementation. Michael Yu Wang [4] presented an analysis describing the impact of localization source errors on the potential datum-related geometric errors of machined features. A. Y. C. Nee and A. Senthil Kumar [5] determined that automation of the fixture design process can be accomplished with the use of solid modeler, an object/ rule based expert system and a feature recognizer coupled with external analysis routines. X Dong et al. [6] investigated the use of features in the domain of fixture design. They developed a method to describe a machined part, intermediate work piece geometry and material properties, machined features and their intermediate states. Hiroshi Sakural [7] developed an automatic setup planning and fixture design system. Algorithmic and heuristic methods were developed to synthesize and analyze setup plan and fixture configurations. E.C. DeMeter [8] used total restraint analysis to evaluate the ability of a machining fixture to restrain work piece motion. He explained how to apply restrain analysis to a fixture which relies on frictionless or frictional surface contact Shyr-Long Jeng et al. [9] described the minimum clamping forces that keep the work piece stable during the metal cutting process. Ajay Joneja and Tien-Chien Chang [10] developed a system that attempted to perform setup planning, fixture planning, unit design and verification. Verification is limited to ensuring that stability of the work piece is achieved. Y.F. Wang et al. [11] Developed an intelligent fixturing system (IFS) for machining and presented the concept, architecture, control scheme, models and methodologies for IFS. A. Senthil Kumar et al. [12] Used a GA/neural network approach to conceptually design complete fixture units. S. Kashyap and W.R. DeVries [13] concerned with minimizing deformation of the work piece due to machining loads about fixturing support positions, especially in thin castings. Kulankara Krishnakumar and Shreyes N. Melkote [14] employed a GA approach to determine an optimal fixture plan layout i.e. the optimal locating and clamping points such that the deformation as a result of clamping and machining forces was minimized. A. Senthil Kumar et al. [15] Discussed a methodology to capture fixture design rules using the induction process.

IV CONCLUSION OF ANALYSIS

From the present analysis, it can be concluded that process changes could result in great improvements in quality and productivity. Fixture forms an important factor in traditional and modern manufacturing systems since fixture

design directly affects manufacturing quality and productivity. Traditionally, fixtures were designed by trial and error, which was expensive and time consuming. But now, research in flexible fixture and Computer-Aided-Fixture-Design (CAFD) has significantly reduced manufacturing lead-time and cost. Typically, fixture design involves the identification of clamp, locator, support points and the selection of corresponding fixture elements for their respective functions. Fixture design configuration can be separated into three phases:

- Description of design requirements
- Fixture analysis
- Fixture synthesis

V METHODOLOGY

The methodology adopted for present work was as follows:

- Studying the existing manufacturing process of Aluminum Mixing Tube
- Study of Existing fixture
- Fixture Modification

5.1 Existing Manufacturing Process

OPERATION NO.	DESCRIPTION
1	Setting of work piece on fixture
2	Facing, Outer Diameter
3	Facing Inner Diameter
4	Outer Turning
5	Unclamping
6	Polishing Outer Face

5.2 Study of Existing Fixture

The Company was using a three jaw chuck as a fixture. This fixture was very simple and any lay man can operate this fixture. Also the repair was very less. Only disadvantage of this fixture for aluminum mixing tube was that the

clamping of the component on this fixture was through jaws of the universal chuck and a leveling bolt i.e. fastened into the chuck for leveling. It was a time consumable process as it took more time for clamping and unclamping

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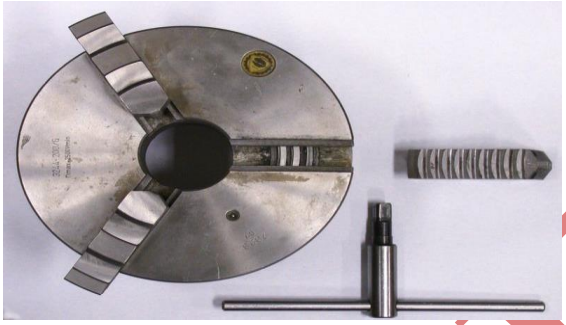


5.3 Fixture Modification

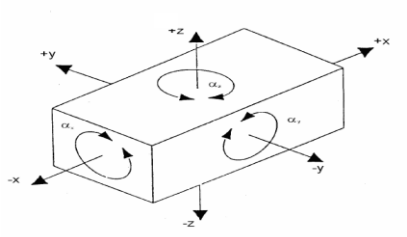
A careful study of cause and effect diagram reveals that the main cause of low production was high setting up time of aluminum mixing tube on lathe machine and high tool changing time during machining operations. If the machining is done on drilling machine instead of lathe by using a modified fixture and tool, then the production time can be minimized. To overcome this problem, it was decided to revise the manufacturing process. If facing and turning operation is done simultaneously and the clamping of the component is to be changed from the previous clamping method where it was held through a universal jaw chuck to a new clamping device then production time can be minimized. Hence a need of modification in tool and fixture is required in existing fixture.

5.3.1 Fixture Design

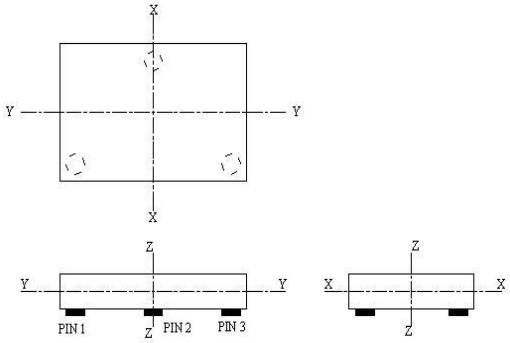
A fixture is a device used for rapidly and accurately position (or "locate" as is the more commonly used term) the work piece, and support and secure it adequately such that all parts that are produced using this fixture will be within the design specifications for that part. The basic principles of fixture design can be categorized under six broad headings [16]:

- Handling and fixing
- Location
- Clamping
- Clearance
- Stability and rigidity
- Ease of construction and design

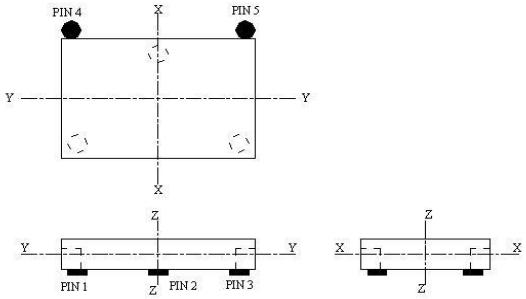
VI PRINCIPLES OF LOCATIONS



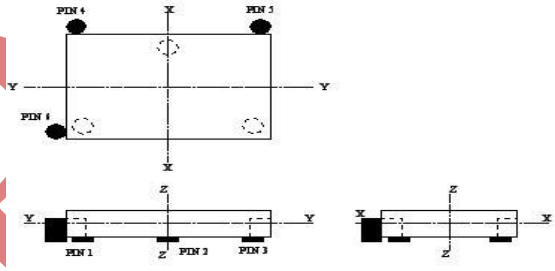
Six Degrees of Freedom



Work piece Constrained by Three Pins



Work piece Constrained by five Pins



3-2-1 Location Principle

VII MODIFIED MANUFACTURING PROCESS

OPERATION NO.	DESCRIPTION
1	Setting of work piece on fixture
2	Facing, Turning
3	Unclamping
4	Polishing Outer Face
5	Inspection of Face

7.1 Modified Fixture

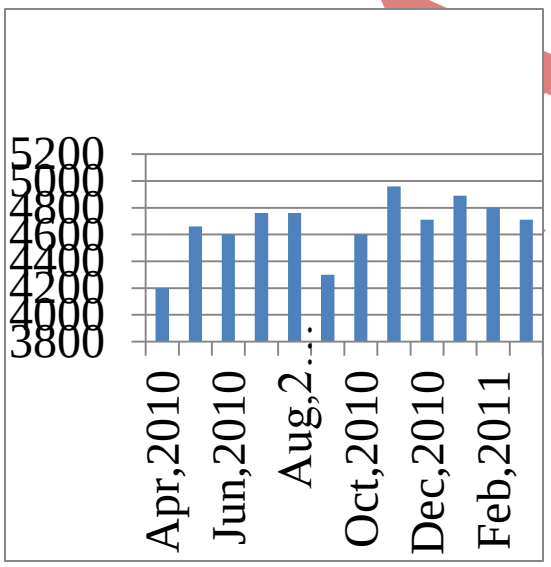
7.2 Modified Tool

VIII BENEFITS OF USING DRILLING MACHINE

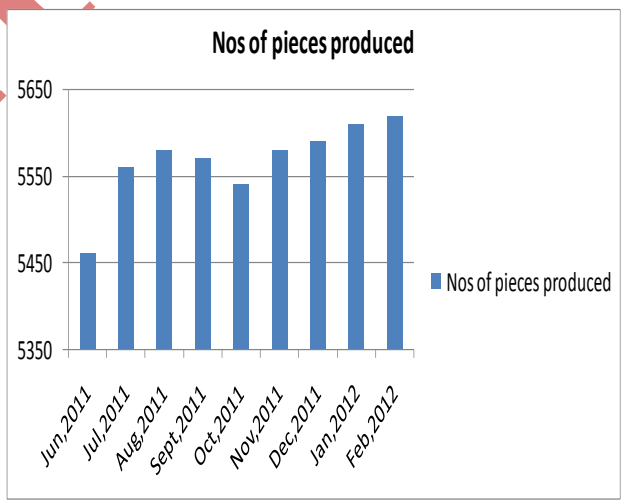
Earlier all the machining work was done on conventional lathe in which the machining cost, tool cost, machine ideal time and the rejection rate was high , but the rejections, clamping and unclamping time, machining time on drilling machine is very less as compared to lathe.

8.1 Production Trial

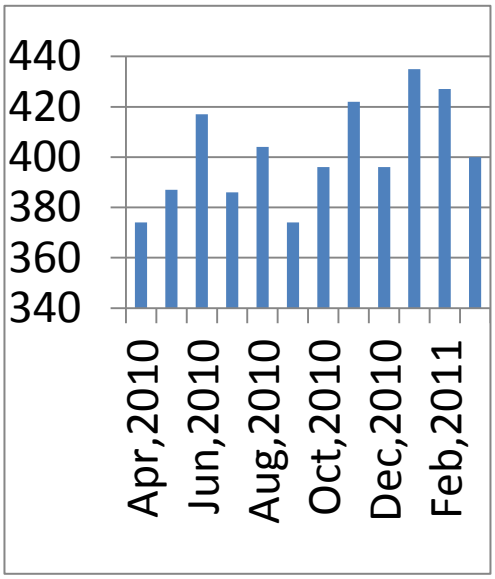
8.1.1 Production before modification



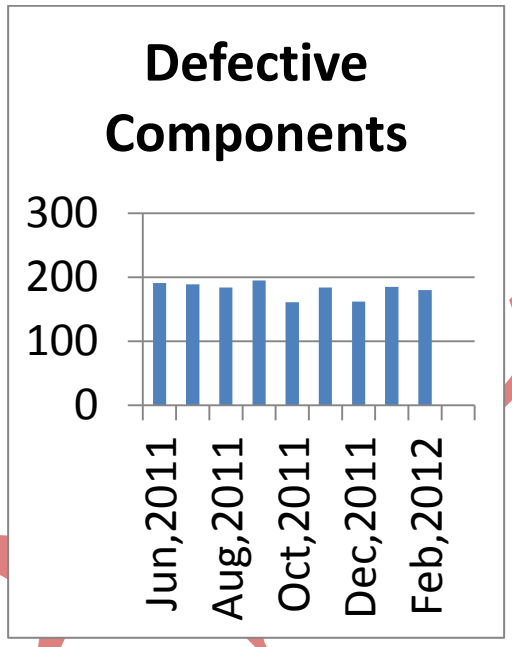
8.1.2 Production after modification



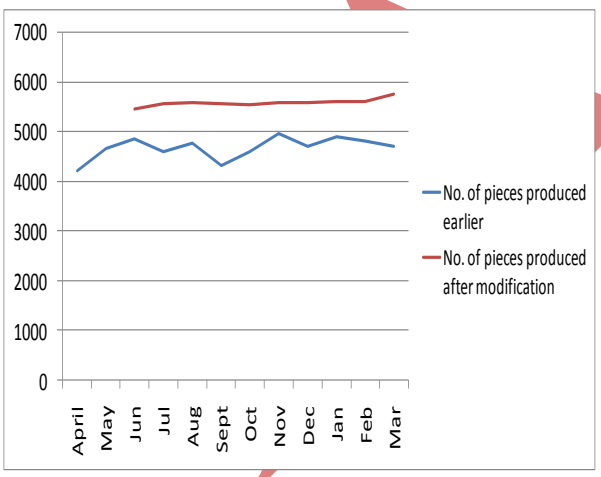
8.2.1 Defective components before modification



8.2.2Defective components after modification



IX COMPARISON OF PRODUCTIVITY



It shows the comparison of existing and modified process. It is clear from that when existing process was used, average defective components were 8.4% and by using modified process, defective components variation reduced to 3.3.1%. This resulted in average 5.1% reduction of defective components.

X CONCLUSIONS

- The defective components were found due to existing fixture clamping method.

- For the rectification of these problems, following suggestions were approved by the management of the company for implementation:
  - Modification of manufacturing process
  - Fixture modification
- In the modified process, machining time on drilling machine is very less as compared to lathe machine, so it compensated for the cost and also productivity was very high.
- Cycle time of all machining operation on conventional lathe machine was 120 sec and on drilling machine this cycle time was reduced to 60 sec. This resulted in 33% reduction of machining time.
- Reduction in labor by using modified process is also reduced.
- The modified clamping method of the component for machining operation helps the company to enhance the productivity.
- Modification in manufacturing process and fixture resulted in decrease in defective components by 5.1%.

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