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APPLICATION OF "8D METHODOLOGY" FOR THE ROOT CAUSE ANALYSIS AND REDUCTION IN REJECTIONS OF PUSH ROD POCKETS IN TRACTOR BRAKES MANUFACTURING COMPANY: A CASE STUDY

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Abstract

Day by day advancement of technology especially in mechanical manufacturing sector allows technocrats to use CNC machines extensively especially in automotive and aerospace industries. High speed machines used for cutting, boring, drilling, machining etc. needs the work piece to be cooled simultaneously as in the process of machining, high amount of heat is generated which is detrimental to the part or component manufactured for high precision and accuracy. The role of coolant is not only to cool the work piece and tool but also to remove chips and burrs formed effectively so that the waste materials should not come in the way of tool and work piece and damage the finished product. The position of coolant nozzle plays a vital role in producing a finished product with higher accuracies as the manufacturing process is continuous and simultaneously several operations are performed in the same work piece by changing the tools and their orientation. Cases of several rejections of parts and components by quality division in an industry revealed positioning of coolant as also one of the potential reason for producing components with dimensions over or under leading to additional machining process which consumes considerable time which is absolutely undesirable. In this paper, management tool 8D methodology is used to identify the problem of rejections of push rods manufactured for tractor brakes and further correct it technologically by re-positioning of the coolant nozzle.

Keywords: 8D; Coolant; Burr; Push Rod; Pocket Depth, Chips

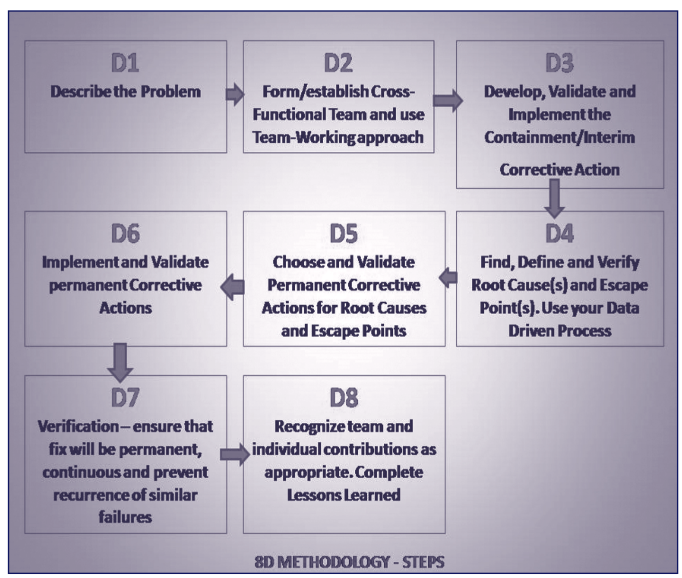
1. INTRODUCTION

In factories and industries where high volume of manufacturing parts and components are undertaken, CNC machines are used mostly. The components manufactured needs more precision and hence utilization of CNC machines becomes mandatory to achieve the target of production. In most of the cases, work pieces translates or rotates at high speed and tool holders as per the command takes the tool in the vicinity for carrying out cutting or machining operations. The machining process generates high amount of heat due to friction between the tools and work piece and hence continuous flow of coolant is also needed not only to cool the surfaces but also to prevent additional surface defects due to presence of burr materials and chips. Incorrect position of coolant flow may not clean the surface completely and hence damages such as scratches may take place to the finished products. The push rods manufactured in an industry were returned from quality division because of over and under dimensions and was not suitable for use in brakes due to incorrect seating in its depth.

2. METHODOLOGY

A management tool "8D Methodology" is used to identify the root cause and its analysis further for arriving solutions to the problem. The problem found is the returns or rejections of push rods used in tractor brakes and further arriving to the conclusion that the additional marks created on the surface of the push rods makes the components unsuitable in perfect seating in its depth resulting in sending back for corrections. Most of the components were subjected to rework which consumes considerable production time and also affects largely on production plan.

Fig. 1: Steps in 8D Methodology.



2.1 Step 1 – D1 - Describe the Problem

The push rod manufactured for tractor brakes were rejected due to non-meeting of the criteria of specific dimension by the quality division engineers. Nearly 37% rejections were noticed and it was affecting even manufacturing of other components which need to be loaded on the machine only after getting a final finished product of push rods.

Fig. 2: CNC Machine used in production.

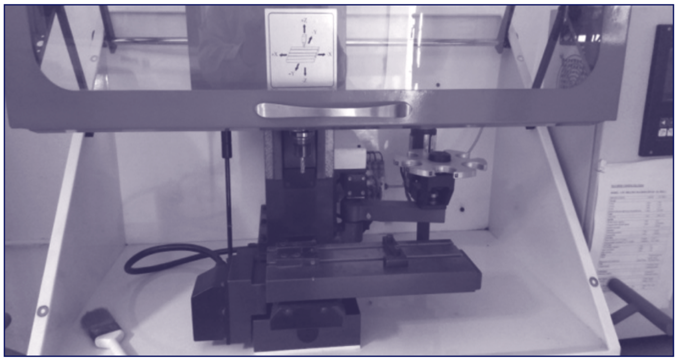
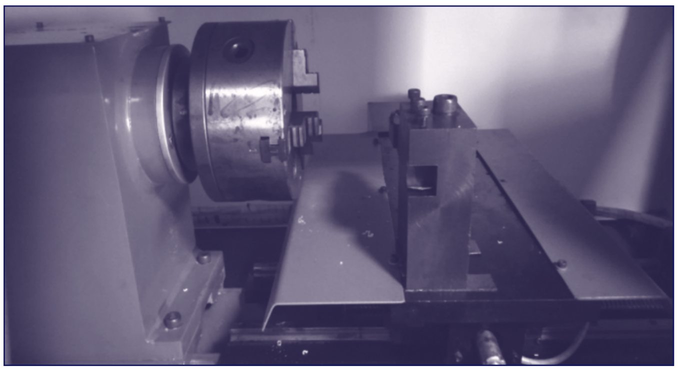


Fig. 3: CNC Lathe Machine used in production



2.2 Step 2 – D2 - Form/Establish Cross-Functional Team and use Team-Working approach

The authors discussed the issue with operators and technicians of CNC machines having expertise in production and and also with Supervisors for identification and suggestion of suitable solutions of the problem. Experts from quality division were also included as a part of the team and in the study for analysis of root cause and elimination.

2.3 Step 3 – D3 - Develop, Validate and Implement the Containment/Interim Corrective Action

The team started its investigation with quality checks in every work stations. In the manufacturing stage itself, the operator is asked to show the way the push rod is manufactured in CNC machine following various machining operations. After each operation, the push rod is checked for its dimensional accuracy and after staisfaction of the team, the part was moved further to next work station.

2.4 Step 4 – D4 – Find, Define and verify root cause(s) and escape point (s).

The push rod manufactured for tractor brakes were examined carefully by team of engineers and tool marks on push rod pocket face were detected after dimensioning and finishing work on it in CNC machine. It was undesirable and unintentional. On close observation during the work operations on CNC machines, it is observed that the chips produced by cutting tools were adhering to the surface even after continuous pressurised coolant flow to the work piece. This adhering of wutting chips were found at one position and it is found that the coolant flow direction is slightly not in alignment with the formation of chips. The coolant flow direction was aligned at 45^0 to the vertical axis and it was not completely solving the purpose of removal of all chips and burrs to avoid interferring in further manufactutring operations.

3. RESULTS AND DISCUSSIONS

3.1 Step 5 – D5 – Choose and Validate Permanent Corrective Actions for Root Causes and Escape Point.

In most of the CNC machines, the nozzle angle can be adjusted upto 70 degree and the nozzle holder can rotate complete 360 degree. Here the nozzle angular position is adjusted from 45 degree to 45.9 degree with an increment to 0.1 degree and towards lesser side 44.1 degree to 45 degree to achieve an optimum positioning angle as per the desired output of tool mark free work piece and less percentage of rejections. At 45 degree position, almost 37% rejections were found. The data obtained are shown in the table 1. Rejections were calculated by taking a sample of 100 work pieces batch size and observation of intensity of tool mark on the finished product.

Table 1: Analysis – Data Collection

Sl. No.	Position of the Coolant flow Nozzle in Degrees upper side	Position of the Coolant flow Nozzle in Degrees Lower side
1.	45	45
2.	46	44
3.	47	43
4.	48	42
5.	49	41
6.	50	40
7.	51	39
8.	52	38
9.	53	37
10.	54	36
Avg.	**$\sum X_i / 10 = 49.5^0$**	**$\sum X_i / 10 = 40.5^0$**

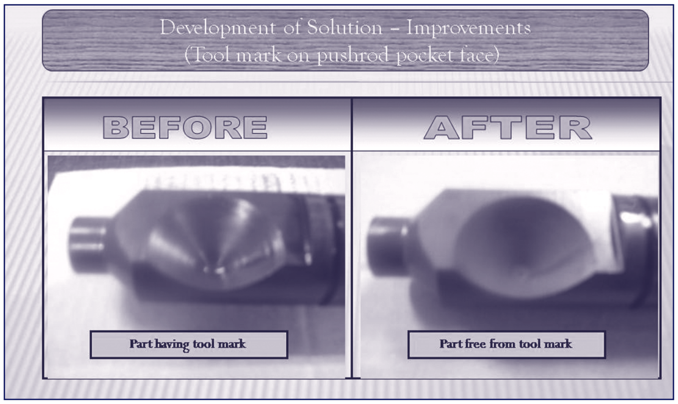
Calculated an average angle by taking 10 increments towards upper side and 10 increments towards lower side from 45^0 with an increment or decrement of 1^0. The average obtained from the data calculated is found to be 49.5^0 and 40.5^0 in upper side and lower side angles respectively. Mean of all the 20 observations taken together was $\mu = 45^0$.

Standard Deviation σ = Sq. Rt. of $\sum (Xi - \mu)^2 / n = 1.2$

Therefore, it was decided to take two angles 45^0± ١,٢ i.e. ٤٣,٨^0 and 46.2^0 for further performance check.

The coolant nozzle was realigned from 45^0 to 43.8^0 and the part push rod pocket was found with tool marks on the finished surface as shown in Fig.4. Again the coolant nozzle was realigned from 45^0 to 46.2^0 and the part push rod pocket was found free from tool marks on the finished surface as shown in Fig.4.

Fig. 4: Tool Marks on Pushrod pocket face – Before and After the rectification Step.



3.2 Step 6 – D6 – Implement and validate permanent corrective actions.

The angle of 46.2^0 is found to be the suitable angle on which coolant nozzle gives its optimum performance by not allowing any burrs or cutting chips to get stuck on the surface. The dimensions of the finished part (Pushrod pocket face) were also in conformity with specified quality control requirements and the same is decided to continue further in manufacturing of all other manufacturing operations.

3.3 Step 7 – D7 – Verification, ensure that fix will be permanent, continuous and prevent recurrence of similar failures

Implementation of the solution as mentioned in 3.2 –Step 6 – D6 is continued for a batch of manufacturing of the part –pushrod pocket face. The finished products were highly satisfactory and the rejections came down to 10% from 37% on final inspection of dimensions.

3.4 Step 8 – D8 – Recognize team and individual contributions. Complete lessons learned.

The work of team members were highly appreciated as their supervised and dedicated technical work saved considerable machine time which was wasted in reworking on parts due to high rejections and repeating the manufacturing operations on machines. The same time is utilised to increase production.

4. CONCLUSIONS

The push rod pocket rejections was 37% which was appreciably high. On analysis it was found that some burrs and cutting chips were clinging to the surface and were not cleaned by the coolant flow. The same part in further manufacturing operations were having tool marks on the surface leading to incorrect dimensions in the finished product. The coolant nozzle was repositioned from 45^0 to 46.2^0 and the result is found satisfactory. The dimensions of the finished part (Pushrod pocket face) were also in conformity with specified quality control requirements and the same is decided to continue further in manufacturing of all other manufacturing operations.

5. FUTURE SCOPE AND LIMITATIONS

In future, further research work can be done to find other suitable positions of coolant nozzle for further reduction of the rejection percentage.

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