REJECTION REDUCTION IN MANUFACTURING OF AUTOMOBILE CLUTCH PEDAL USING SIX SIGMA

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ABSTRACT

Six sigma is the management approach that reduce the defects in process and improve the quality of manufacturing parts by using the systematic data collection and statistical data analysis. Six Sigma method work on 3.4 per million opportunities for error and whose ultimate goal is to reduce the deviation between mean and target value. In present investigation six sigma method is used to reduce the inspection of forming height in clutch pedal of automobile. Hence, in order to achieve the six sigma level investigation is carried out by DMAIC cycle through the different statistical tools such as Statistical Process Control (SPC), Cause and Effect Diagram (CED), Gauge Repeatability and Reproducibility (GRR), Design of Experiment (DOE) tools and brainstorming . After implementing six sigma method, it was found that profit of firm was increase by eliminating the 100% inspection of forming height of clutch pedal. After implementing six sigma, sigma level was achieved 5.80 from 1.94.

Key words: C_p, C_{pk}, σ Level, Clutch Pedal, SPC, PPM, DOE.

I. INTRODUCTION

Six sigma is a management system that helps any organisation to improve their profitability by achieving the goals of reduction if defects, elimination of wastes and improvement in customer satisfaction six sigma have been labelled as a metric, a methodology and now a management system. Six sigma practitioners measure and assess process performance using DPMO and sigma. They apply the rigorous DMAIC (Define, Measure, Analyze, Improve, and Control) methodology to analyse processes in order to root out sources of unacceptable variation, and develop alternatives to eliminate or reduce errors and variation. Using this DMAIC methodology has netted many organisations significant improvements in product or service quality and profitability over a last several years.

In present work, sigma methodology was applied to reduce the inspection of clutch pedal through DMAIC cycle, which is defined as follows,

1. **Define**: - Confirm the business opportunities, define the boundaries and goals of the project.
2. **Measure**:-Gather data to establish the "current status", what is actually going on at the workplace and quantify the problem,
3. **Analyze**: - analyze and determine the root cause(s) of the defects.
4. **Improve**: - Develop solutions targeted at confirmed causes.
5. **Control**: - Implement procedures to make sure improvements can be sustained.

1.1 Six Sigma Methodology

Define, measure, analyze, improve, control (DMAIC) comprise the major phases of process improvement project. Each phase consist of a set of tools and deliverables. DMAIC is just one of a variety of proposed methodologies.

Fig 1: Six Sigma Methodology

II. DEFINE

Define is the phase when a problem or an improvement initiative is identified and scoped. In this phase, the problem statement is developed to describe the pain for the problem that needs solving or the improvement that is required. During this phase the problem is also defined in term of the measurable criteria or metrics and is factors that are criteria or customer's quality requirements are identified. Define phase provides full information about the problem such as the rejection % and type of response.

We selected the project on the basis of:-

a. Critical to quality
b. Critical to satisfaction

Critical to quality: - It is specially used when concern is related to scrap reduction or rework reduction or variation reduction. It may also be related to resolving customers complaints.

Critical to satisfaction: - Here are no complaints from customer or user. Project is selected only to enhance the performance of products or service level.

Our project is critical to quality as well as critical to satisfaction.

- Steps for clutch pedal manufacturing process

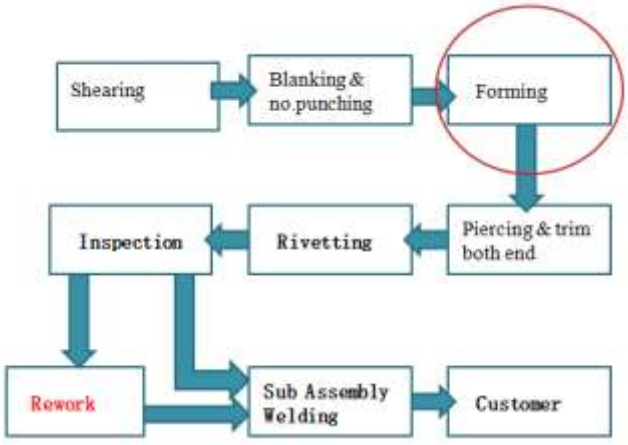


Fig 2: Process Flow

III. MEASURE

To define the baseline measurements on current process for future comparison. Map and measure the process in question and collect required process data that is needed to quantity the problem. The main objective is to ensure that the data that is being used for the project is validated using specific tools. The focus is to get accurate and sufficient measurement of the process.

The process in which the problem is occurring or improvement is required would mapped out in detail ad would include time, people and material elements to ensure that the current state is clearly understood.

Gather data to establish the "current/ baseline status", what is actually going on the workplace with the process as it works today.

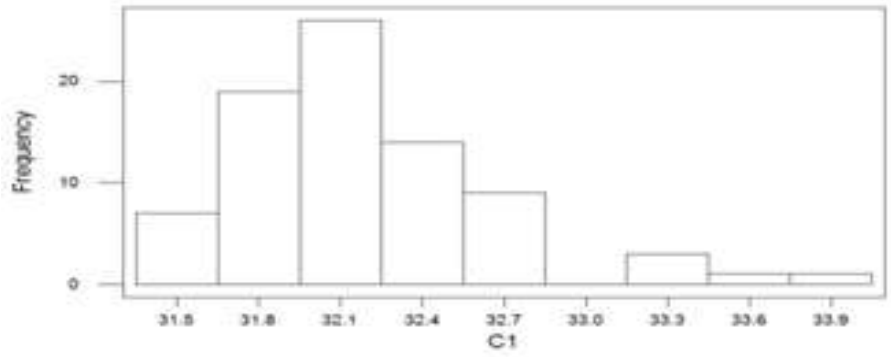
Study of Gauge repeatability and reproducibility: - Gauge R & R is an estimate of combined variation of repeatability and Reproducibility.

Repeatability: - Repeatability is the variation in measurement obtained with one measurement instrument when used several times by one Appraiser while measuring identical characteristics on the same part.

Reproducibility: - Reproducibility is the variation in the average measurement by different appraiser using same instrument when measuring an identical characteristics on the same part.

Conclusion from GRR: - GRR<10% measurement then system is Accepted.

Statistical Process Control (SPC):- SPC is the application of statistical method for monitoring and controlling of processes, so that it operates at its full potential to produce conforming product. Process cycle time reduction coupled with improvements in yield have made SPC a valuable tool from both cost reduction and customer satisfaction standpoint. It is a technique of checking variation in components. Following are the readings take before applying improvements process.



Graph 1: Histogram (Before)

Conclusion from SPC: - The process was shift to USL. Hence, take action to reduce variation.

Out come from measure phase: - As there is more variation in parts, root cause should be found to reduce variation & it should be eliminated.

IV. ANALYSIS

The purpose of analyze phase is to sort through all the potential X's through a funnel so that are causing defects. It's like inputting all the X' through a funnel so that resulting output is vital few X's that are causing the defects.

In this phase, a thorough data analyses is carried out to narrow down, from the many reasons of a problem occurring to the critical few. Additionally, activities such cause and effect study, analysis of statistical data will be performed in this stage and the results are used to assist with the identification of the critical few root causes. First of all the suspected causes which directly or indirectly affecting the forming height dimension needs to be found. For this purpose we used Cause and Effect Diagram.

CAUSE AND EFFECT DIAGRAM:-

-To analyze cause and effect relationships.

-A Graphic tool that helps to identify, sort and display possible causes of a problem or Quality characteristics.

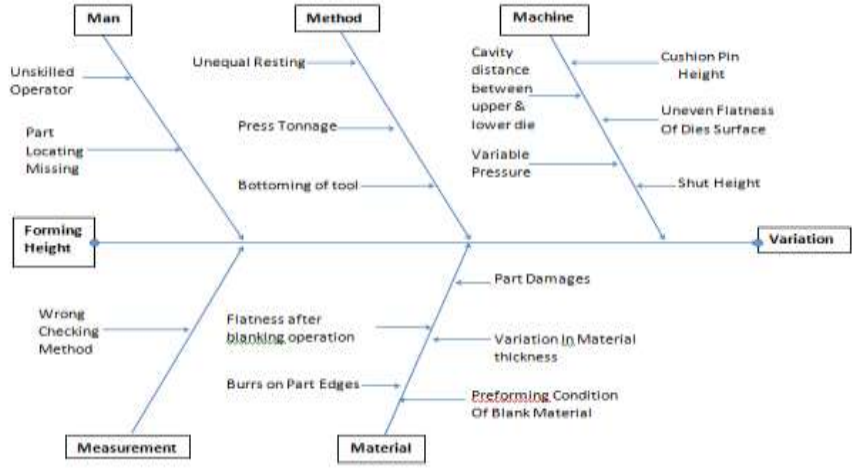


Fig 3: Cause and effect Diagram

V. DOE TOOLS

- Paired Comparison
- Multi-vary Analysis.

5.1 Paired Comparison

Application: - Can be used only when source of variation are measurable on good and product. Good and Bad products are selected based on the response defined in the problem.

- Response can be either attribute or variable.
- Source of variation either be attribute or variable.
- Is source of variation are attributing, and then they need to be converted to a scale of at least 1-5.
- Generally this is applicable to input material related source of variation.

We use this tool for verifying suspected source "flatness after blanking "which is output result of blanking process and which is input to the forming process. Here, if any change in flatness after blanking operation and if this change in flatness resulting in forming height, it can be verified. The flatness after blanking should be considered as ZERO.

VI. CONCLUSION FROM PAIRED COMPARISON

Here, the Max and Min value Belonged to same category (i.e. both the values were BOB) when transition Takes place, hence the total mo of Counts=0

Hence the parameter analyzed is NOT creating the problem.

6.1 Multi vary analysis

In our case response type is variable, so MULTI VARY ANALYSIS which is used to find out what sources of variation is the highest in the process. It is apply on after the process creating the problem is established using the other tools. It content following type of variation.

1. Part to part
2. Time to time
3. Stream to stream

6.2 Conclusion from Multi vary Analysis

In present work from multi vary analysis found that part to [art variation was more. Hence, source of variation was either in machine or process design. So in next process we used Brainstorming to find out the actual cause in either machine or process design. It helps in determining root causes, indicating possible causes of variation and hence increases process knowledge. After identifying all the possible causes of out given problem and using-why-why technique: it as noticed that main causes were:

1. Uneven flatness of die surface.
2. Cavity distance between upper and lower die.
3. Cushion pin height
4. Shut height.
5. Cushion pressure/press tonnage
6. Bottoming of tool.

But the main cause was uneven flatness of die surface which have their major contribution to problem due to which forming height gets shifted. So it was decided that to avoid that problem a complete study of various dies surfaces should be carried out and whatever the variation is their it should be reduce to zero that would reduce the main problem uneven flatness of the die surface.

As per TPM check sheet Machine is OK so that problem in FLATNESS.

At the time of part locating there have play between job and the die surface so that at the time of part locating due to this flatness variation the formed part dimension i.e. forming height shift to upper side or oversize.

Hence, in order to eliminate source of variation related to prove design, process parameter, we need direct experimentation on the process itself.

These suspected source of variation are with their action plan is as shown below.

Table 1: List of Confirmed Causes

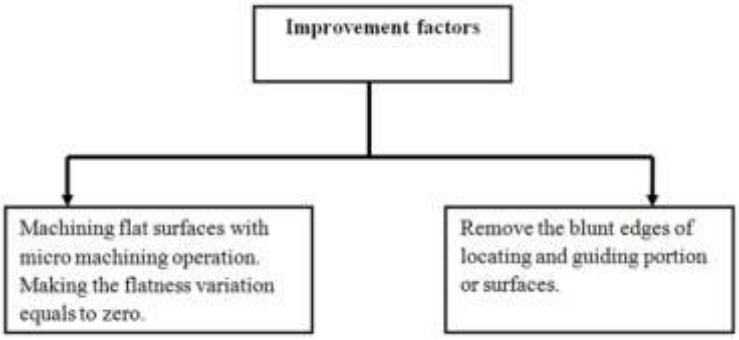
Sr. No.	Input Variable(Causes)	Action	Benefit
1	Forming Variation	Trial taken on press machine.	We got clear picture of forming variation.
2	Shut Height, Cushion Pressure	Check & Verify Shut Height & Cushion Pressure as per Machine specifications.	We reduced the part to part Variation.
3	Cushion Pin Height	Cushion Pin Height to be Checked & verified.	Due to this we avoid pressure variation between lower & upper

			die
4	Die Flatness	Check & Verify as per design parameters.	Observed changes in forming Height.
5	Bottoming of tool	Bottoming block is provided.	To reduce excess pressure on Parts.

VII. IMPROVE

In this phase the team members generate ideas for improving the process, analyze and evaluate ideas, select and test the nest potential solutions, plan and implement the solutions, and then validate the results with data and statistical analysis.

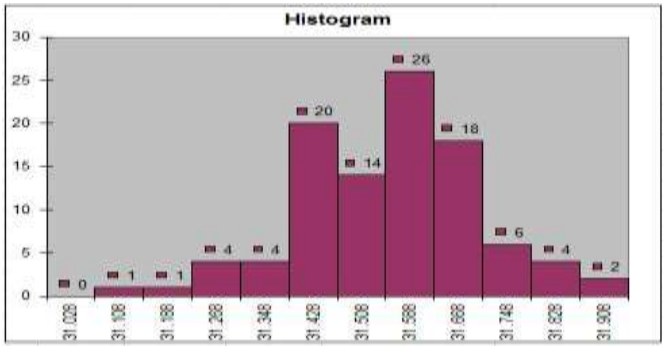
From the above reading we have indentified problem is that maximum variation due to uneven flatness of die surface of forming tool. Hence improvement factor to avoid variation in surface.



Due to machining of the surfaces the flatness variation comes to zero, hence the component is clamped or locate flat to the surface. Due to this the affect of uneven flatness is reduced and forming pressure applied is uniformly distributed over the complete surface of the component and hence final result of forming dimension is comes as specified in the component drawing.

Also, the blunt edges of the guiding portion or block is also removed with polishing operation in small quantity hence effect of improper locating can be eliminated.

7.1 SPC After Improvement Action



Graph 2: Histogram (After)

7.2 Conclusion from SPC

Above histogram shows that the process is neither shifted to USL nor LSL, i.e. not beyond the target point and we conclude that there is no variation within the process.

VIII. CONTROL

Control is the process in the DMAIC where the corrected results are checked for a long duration of time so as to validate our above processes and maintains the zero level defect of the product. The objectives of the control phase is to establish the required action plan that reflect the findings from improve phase and to drive control to sustain the improved performance.

IX. CONCLUSION

The six sigma improvement methodology viz. DMAIC project shows that the performance of the company was increased to a better level as regards to enhancement in customers (both internal and external) satisfaction, adherence of delivery schedules, development of specific methods to redesign and reorganize a process with a view to reduce or eliminate errors, defects, development of more efficient, capable, reliable and consistent manufacturing process and more better overall process performance, creation of continuous improvement and do it right the first time mindset. Six Sigma provides business leaders and executives with the strategy, methods, tools and technique to change their organizations. Six Sigma as a powerful business strategy has been well recognized as an imperative for achieving and sustaining operational (process) effectiveness, producing significant savings to the bottom line and thereby achieving organizational excellence. If implemented properly with total commitment & focus, Six Sigma can put industries at the forefront of the global competition. Hence by improving, sigma value got decreased from 84% to 18% thereby increasing sigma level from 1.94 TO 5.80 that resulted in minimum variation and hence rejection.

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