IMPLEMENTATION OF STATISTICAL PROCESS CONTROL TOOL IN AN AUTOMOBILE MANUFACTURING UNIT

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Abstract - *In this paper, an attempt has been made to implement the some statistical process control (SPC) techniques in the industry that is offering its customers the widest and latest range of sealing solutions for various applications in the automotive industry. The power of SPC lies in the ability to examine a process and the sources of variation in that process, using tools that give weightage to objective analysis over subjective opinions and that allow the strength of each source to be determined numerically. Only two main techniques i.e. cause and effect diagram and control charts are implemented in this industry out of seven SPC techniques. The present work deals with the study of defects in clamp coining tool of an automotive industry. It is found that after implementing the SPC tools to remove the root causes, the percentage rejection is reduced from 9.1% to 5% and reduction in cost is achieved.*

Keywords*—Cause and effect diagram, control charts, process capability index, and percentage rejection.*

1. INTRODUCTION

Statistical process control (SPC) is the application of statistical methods to the monitoring and control of a process to ensure that it operates at its full potential to produce conforming product. Under SPC, a process behaves predictably to produce as much conforming product as possible with the least possible waste. While SPC has been applied most frequently to controlling manufacturing lines, it applies equally well to any process with a measurable output. Key tools in SPC are control charts and cause & effect diagrams, focused on continuous improvement. Variations in the process that may affect the quality of the end product or service can be detected and corrected, thus reducing waste as well as the likelihood that problems will be passed on to the customer. With its emphasis on early detection and prevention of problems, SPC has a distinct advantage over other quality methods. In mass-manufacturing, the quality of the finished article was traditionally achieved through post manufacturing inspection of the product; accepting or rejecting each article (or samples from a production lot) based on how well it met its design specifications. In contrast, Statistical Process Control uses statistical tools to observe the performance of the production process in order to predict significant deviations that may later result in rejected product. Two kinds of variation occur in all manufacturing processes: both these types of process variation cause subsequent variation in the final product. The first is known as natural or common cause of variation and consists of the variation inherent in the process as it is designed. Common cause of variation may include variations in temperature, properties of raw materials, strength of an electrical current etc. The second kind of variation is known as special cause of variation, or assignable cause of variation, and happens less frequently than the first. With sufficient investigation, a specific cause, such as abnormal raw material or incorrect set-up parameters can be found for special cause variations.

By observing at the right time what happened in the process that led to a change, the quality engineer or any member of the team responsible for the production line can troubleshoot the root cause of the variation that has crept in to the process and correct the problem. SPC indicates when an action should be taken in a process, but it also indicates when NO action should be taken. An example is a person who would like to maintain a constant body weight and takes weight measurements weekly. A person who does not understand SPC concepts might start dieting every time his or her weight increased, or eat more every time his or her weight decreased. This type of action could be harmful and possibly generate even more variation in body weight. SPC would account for normal weight variation and better indicate when the person is in fact gaining or losing weight.

The preparatory phases of SPC involve several steps, using a number of different tools. Seven quality tools are available to help organizations to better understand and improve their processes. The essential tools for the discovery process are: Check Sheet, Cause-and-Effect Sheet, Flow Charting, Pareto Chart, Scatter Diagram, Histogram or probability plot and Control Charts. Check sheets are simply charts for gathering data. When check sheets are designed clearly and cleanly, they assist in gathering accurate and pertinent data, and allow the data to be easily read and used. Cause-and-Effect or Fishbone diagram are also called Ishikawa diagrams because Kaoru Ishikawa developed them to search the root causes of problem. The fishbone chart organizes and displays the relationships between different causes for the effect that is being examined. This chart helps organize the brainstorming process.

The major categories of causes are put on major branches connecting to the backbone and various sub-causes are attached to the branches. Flowcharting breaks the process down into its many sub processes. Analysing each of these separately minimizes the number of factors that contribute to the variation in the process. The Pareto chart can be used to display categories of problems graphically so they can be properly prioritized. The Pareto chart is named for a 19th century Italian economist who postulated that a small minority (20%) of the people owned a great proportion (80%) of the wealth in the land. The Scatter plot is another problem analysis tool. Scatter plots are also called correlation charts. A Scatter plot is used to uncover possible cause-and-effect relationships. It is constructed by plotting two variables against one another on a pair of axes. A Scatter plot cannot prove that one variable causes another, but it does show how a pair of variables is related and the strength of that relationship.

Improving quality with basic statistical process control tools to significantly improve the monthly defect quality from 13.49% to 7.4% (Tengetal.2001). Rs12, 677.57 saved per year (Jajuetal.2009) for an operation of control valve cylinder head. About 75% to 80% US companies are practicing quality control tools for managing quality. Regarding, survey has been conducted to see the extent to which they used quality management practice (Khanna, 2000). Rao (1994) shows the companies which are using quality control tools to achieve higher customer satisfaction but more stress on work culture. Grewal and Gupta (2005) conducted a case study in automobile Industry and found the improvements in process capability and reduction in rejections. In this research, the rejection of the casting components has been reduced by the applications.

1.1 Benefits of implementing of quality control tools:

i) Helpful in controlling reject rate/rework.

ii) Benefits towards reducing production cost.

iii) Reduction in customer complaints.

iv) Improvement in process.

V) Helpful to find the root cause of the problem.

1.2 Quality Control tools

The Quality control tools are simple statistical tools used for problem solving. Following are the quality control tools used to solve the problems.

Check sheet: The function of a check sheet is to present information in an efficient, Graphical format. This may be accomplished with a simple listing of items. However, the Utility of the check sheet may be significantly enhanced in some instances by incorporating a depiction of the system under analysis into the form.

Pareto Charts: Pareto charts are extremely useful because they can be used to identify those factors that have the greatest cumulative effect on the system and thus screen out The Less significant factors in an analysis. Ideally, this allows the user to focus attention on A few important factors in a process.

Flow Chart: Flowcharts are pictorial representations of a process. By breaking the process down into its constituent steps, flowcharts can be useful in identifying where errors are Likely to be found in the system. In quality improvement work, flowcharts are particularly useful for displaying how a process currently functions or could ideally function

Cause and effect Diagram: This diagram, also called an Ishikawa diagram (or fish bone Diagram) is used to associate multiple possible causes with a single effect. Causes in a Cause & effect diagram are frequently arranged into four major's categories. While these Categories can be anything: Manpower, methods, materials and Machinery.

Histogram: A Histogram is a specialized type of bar chart. Individual data points are grouped together in classes, so that you can get an idea of how frequently data in each class occur in the data set. Histograms provide a simple, graphical view of accumulated data.

Scatter diagram: Scatter diagrams are graphical tools that attempt to depict the influence that one variable has on another. A common diagram of this type usually displays points representing the observed value of one variable corresponding to the value of another Variable.

Control chart: The control chart is the fundamental tool of statistical process control as it indicates the range of variability that is built into a system. Thus, it helps determine Whether or not a process is operating consistently or if a special cause has occurred to Change the process mean or variance.

1.3 Company profile:

Manufacturing unit is located at Chandigarh Road Phase-8 Ludhiana. The unit is spread over 18000 sq. feet. Industry has developed more than 400 parts in Fine Blanking for different customer in Automotive and other sectors. Every Month industry is producing almost 1.4 Million Parts for its various customers and still has 35 to 40% capacity to produce more. Industry is developing the parts almost at the pace of 30 to 40 components in Fine Blanking every Year and also capable of Fine blanking Stainless Steel and High Tensile material. The plant is equipped with press shop ranges from 20 ton to 600 ton. Tool room facility is also available in the unit. All the tools are manufactured in the unit. The unit also comprises tool design facility which consists of Auto Cad for 2D model, Solid Works for 3D model, Unigraphics. Welding facility is also available under one roof which consists of MIG Welding, TIG Welding and going for up gradation for robotics welding. The unit has also facilitated with VMC, HMC, CNC, EDM, Grindings, Milling Machines and other machines. Heat treatment facility is also available in the unit.

The unit is involved in the manufacturing of sheet metal parts, cold forged parts, automotive parts with the different range of products and in different varieties and is the leading manufacturer of automobile parts. List of OEM includes HONDA, HERO, SWARAJ MAJDA, TVS, and MARUTI SUZUKI. With the annual turnover of 35 crore for the year 2013-2014 industry was involve in the manufacturing of number of components with different price range. The following components are taken into consideration for the study based on their price range. Out of these components listed in table 1.2 manufactured in the unit, ROD K24 is nominated for the study due to following reason:-

1. Due to its high cost.
2. Component is in mass production.
3. Due to its huge share in annual turnover.

Table 1.2 Lists of Components Produced by Industry

S no.	Component	Price(Rs.)
1.	Clamp Coining tool	15.30
2.	Rod Rr Grip Kzna	14.35
3.	Arm Component K14	14.90
4.	Pipe Air Feed Kpr	11
5.	Cush Kspa	11.90

It has been observed that there are many quality related problems in manufacturing Industries Ludhiana. The rejection/rework is on higher side i.e. 10% from January 2015 to March 2015. No. of manufacturing and design related problems are analyzed in the production department. Selection of process of Clamp Coining Tool is to be studied due to high rejection rate and with the extent to the safety of the workers.

Clamp coining tool is selected for the following reason:-

1. Rejection rate is higher.
2. Safety required for the workers.
3. Accidental rate is higher.
4. Production (cycle) time is high.

Figure 1 Clamp Coining Tool Die

In Figure 1 Mandrel was not attached with the die. So while manufacturing it is always required to hold the mandrel when the manufacturing is done. With the least reduction in manufacturing cost of the component there is a big profit for the manufacturing industry. It is also required to reduce the rejection of the component. To achieve this following SPC tools are required to implement in industryThe Pareto chart, Fishbone diagram and Flow diagram has been used for data analysis in this study. Pareto chart allows the user to focus attention on a few important factors in a process.

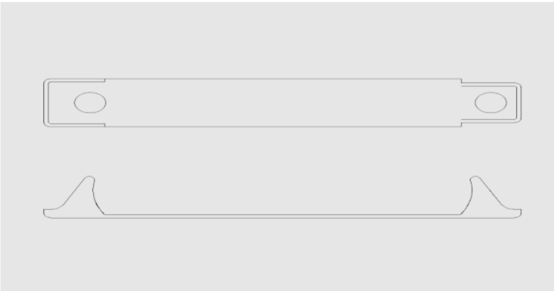
Fishbone diagram used to associate possible causes with a single effect. Flow charts has used in identifying where errors are Likely to be found in the system.

1.4 PROCESS BACKGROUND

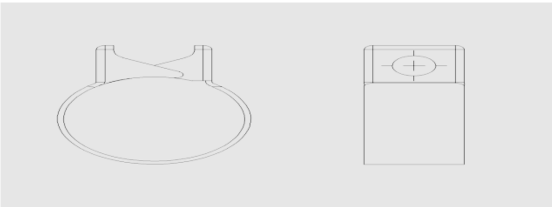
1. In the first operation blanking is done on a bending machine on press of 25 ton.

2. According to the drawing the second process is bending operation which is done on the press tool of 30 ton

3. According to the drawing the next process of piercing is on the work piece with the press of 30 ton.

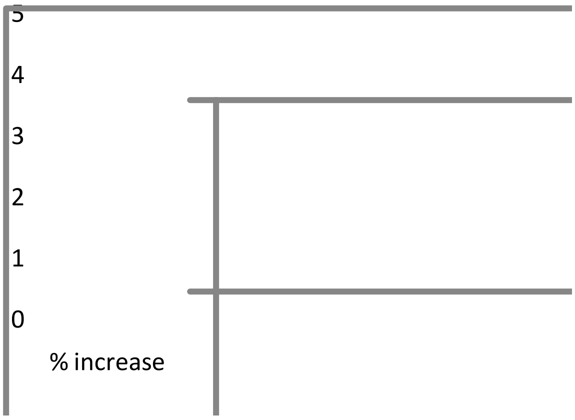


4. Final process of round bending is done on the work piece.



1.5 DATA COLLECTION

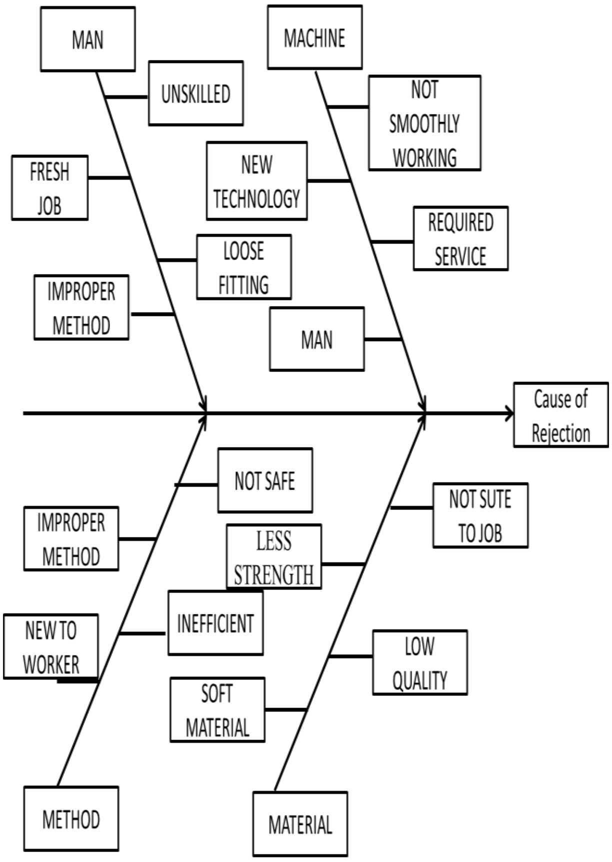
- The rejection data has been collected from the production shop from January(1) 2015 to May(5) 2015 from the daily inspection reports.
- The rejection trend for the manufacturing of clam coining tool is 10-15% increase in monthly wise



As it is clear from the figure that rejection of the manufactured component is increasing rapidly.

So it is required for the manufacturing unit to reduce the rejection. A cause and effect tool is required to check the cause of the problem. The cause of the problem is analyzed by the following four M's. I.e. Man, Machine, Material and Method. A complete analyze is too made with these four M's and cause of all these is to be collected from the different departments in the manufacturing industry. Ahead with this counter measure for each cause is to be done and implement to find the solution to reduce the rejection of Clamp Coining Tool.

Figure 3. Cause and effect diagram for clamp coining tool.



Counter measure for different M's has to be analyze and studied for the changing purpose.

	COUNTER MEASURE FOR MAN
1	Sufficient training provided to operators regarding the causes & cures of Clamp Coining Tool.
2	As the job is new to the production department, many alternatives are required to the manufacturing.
3	Checking of the fitting of the tool die is done to reduce the rejection.
4	Improper method is also the cause of the rejection and safety of the process.
	COUNTER MEASURE FOR MACHINE
1	Sufficient training provided to operators regarding the causes & cures of Clamp Coining Tool.

2	As the job is new to the production department, many alternatives are required to the manufacturing.
3	Checking of the fitting of the tool die is done to reduce the rejection.
4	Improper method is also the cause of the rejection and safety of the process.

	COUNTER MEASURE FOR METHOD
1.	As the job is new to the worker, so rejection is possible. Demand for the new concept and alternatives is required
2.	Worker also find the method to be improper because of risk of accident and improper clamping of tool.
3.	Worker also find the method to be improper because of risk of accident and improper clamping of tool.
4.	As the worker has to hold the clamp, which increase the risk of accident. So there is demand of new design process in which the worker does not have to make any physical contact with tool and die.

	COUNTER MEASURE FOR MATERIAL
1	Material is according to the specimen required by the demand. So no changes required for the change of material
2	Internal property of the material is done properly by the quality department.
3	Material is selected best for the job and no changes required for this.
4	Hardness, tensile strength of the material is to be check before use.

Implementation Phase

- With the analysis of various accepted alternatives collected with the brainstorming tool.
- New design is to be made in which the mandrel is attached with the press tool
- With the attached mandrel with the tool no attachment of the worker with the press tool is required.
- The risk of accident is avoided if the inclusion of worker is avoided with the machine.
- Rejection rate also get reduced to a large extent
- New work piece is made with proper dimension and accurate as required
- According to drawing work piece is required
- Even the production time get reduced with new concept
- Production gets enhanced.

DESIGN COMPARISON

OLD DESIGN	NEW DESIGN
	

PRODUCTION TIME COMPARISON

Old Design Production Time	New Design Production Time
1. Bending- 05 sec 2. Blanking- 03 sec 3. Peircing- 06 sec 4. Round bending- 08 sec Total Production Time=22 sec	1. Bending- 05 sec 2. Blanking- 03 sec 3. Peircing- 06 sec 4. Round bending- 04 sec Total Production Time=18 sec

PRODUCTION COST COMPARISON

Old Total Production Cost	New Total Production Cost
1. Blanking (25 ton)	1. Blanking (25 ton)
2. Bending (30 ton)	2. Bending (30 ton)
3. Piercing (30 ton)	3. Piercing (30 ton)
4. Round Bending (45 ton)	4. Round Bending (35 ton)
Total Cost-15.30	Total Cost-14.10

Result and Conclusion

1. With the safety point of view, no accident is there while manufacturing the clamp coining tool as there is no requirement of holding the mandrel.
2. Least rejection trend is there in clamp coining tool.
3. Less production time to be taken by the manufacturing of clamp coining tool.
4. Less production cost as there reduction of Rs.1.20 in round bending process.

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