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SPC Tools in Automobile Component to Analyze Inspection Process

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ABSTRACT: Statistical Process Control (SPC) charts are graphs that is used in industries to process data and to help understand, control and improve processes. It is based on statistical theory that is easy for practitioners to use and interpret. Control charts are valuable for analyzing and improving the process outcomes. In this work, SPC tool X-bar chart is used to analyze the present process and process capability is calculated to improve the performance of the process to eliminate the error and to improve the process automatically using data acquisition system. Using LVDT setup the data's are measured, hence there is no need for the production process to be stopped during inspection. With this setup, the inspection process is automated and the offline statistical process control is converted into online statistical process control method.

***KEYWORDS**:* SPC, X-bar Chart, Process Capability, Automation

I. INTRODUCTION

Three types of quality can be considered: quality of design, conformance and performance**.** The difference between goods and services with the same basic purpose is given by the Quality of design. Quality of conformance is the ability of a process to meet the specifications set forth by the design. How well the product or service actually performs in the market place is given by Quality of performance. Statistical Process Control is a method of monitoring a process during its operation in order to control the quality of the products while they are being produced—rather than relying on inspection to find problems after all the process is over.

SPC is both a data analysis method and a process management philosophy, with important implications on the use of data for improvement rather than for blame, the frequency of data collection and the type and format of data that should be collected. The need for SPC is the manufacturing organizations are looking to help them with the following areas of improvement in product quality, reduction of scrap and rework, increase in manufacturing yield, meeting the customer requirements and managing the change of plan ahead [2].

A goal of SPC is to make ones processes as stable as possible. The objective is to assure that services are consistent as per the requirements given by the customer. By reducing variations within a process stability is guaranteed [3]. There are two types of variation; common cause variation and special cause variation. In order to remove common cause variation fundamental changes are needed and special cause variation is caused by sources that are not inherent in the process. Pareto principle can be applied only after the causes of variation in a process have been found.

II. METHODOLOGY

2.1. Control Charts

A control chart is a graphical display of a measured quality characteristic. A fundamental principal of SPC is that the emphasis to control the process. The basic purpose of all quality control charts is to eliminate the causes and reduce variation. The first way variation is reduced by eliminating or correcting the cause of quality problems that is the measurements outside the limits. The second way variation is to reduce variation within the control limits so the limits get closer and closer to the chart central value. In constructing the control charts, the measurement is plotted on the vertical axis and the sample (subgroup, subsample or sample number) is recorded on the horizontal axis.

There are at least 27 types of control charts which is divided into two categories: charts for variables and charts for attributes. All variable control charts must track only one quality characteristic of one product on the same chart. Attribute charts can only provide non-conformance information on characteristics outside of specifications. The specification limit is the only constrain for a variable chart.

2.1. Process Capability and Capability Index

The Process Capability is a property of a process to describe the specification, where the process capability index is expressed (e.g., C_{pk} or C_{pm}) or as a process performance index (e.g., P_{pk} or P_{pm}). The output of this measurement is usually illustrated by a histogram and calculations that predict how many parts will be produced Out of Specification (OOS). Process capability is also defined as the capability of a process to meet its purpose as managed by an organization's management and process definition structures ISO 15504. Two parts of process capability are: Measure the variability of the output of a process, and Compare that variability with a proposed specification or product tolerance.

III. EXISTING INSPECTION PROCESS

In existing process, the data's are calculated manually and based on the measured value, X-bar chart is drawn to study the variation in the process and process capability and process capability index values are determined for analysis. Fig. 1 shows the flowchart of the existing inspection process of wheel rim.

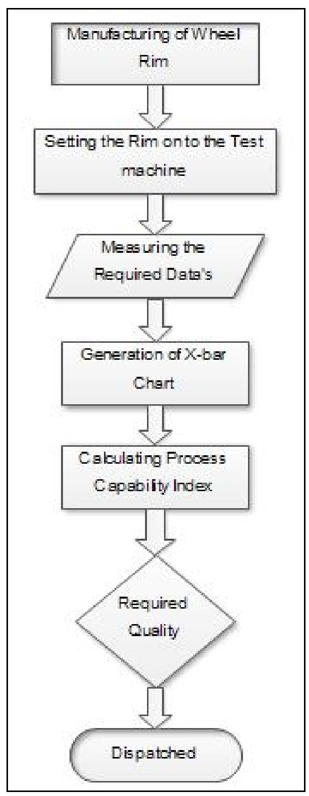

Figure 1 Flowchart showing the existing process

Initially the wheel rim is mounted manually in a rotating shaft. The rim is rotated by a person and the other person takes the readings using the dial gauge. The top wobble is calculated by keeping the dial gauge in the top of the outer cone and the bottom wobble in the bottom of the outer cone. Similarly the top and bottom lift is calculated by placing the dial gauge in the top and the bottom of the inner cone of the rim respectively. Once all the readings are taken they are tabulated. Based on the values determined, X-bar chart is drawn. While taking the readings for a set of rims the production has to be stopped which results in heavy loss. During this inspection process, the whole production process needs to be stopped as the wheel needs to be taken from the production spot to the analysis spot.

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IV. PROPOSED METHOD FOR PROCESS IMPROVEMENT

A LVDT with four probes is connected to the automatic test run machine in which the wheel rim is attached. This set up is connected to a personal computer through which the data's are collected online. These readings were send to the quality department by using the LAN link up. The rims for which the inspection should be carried out is moved through a conveyor belt system and loaded into the machine having LVDT with four probes, since it is easy to automate the system. The data's from Top Lift, Bottom Lift, Top Wobbling and Bottom Wobbling are taken from the test rim and directed send to the attached computer. This computer installed with the DATALYSER software checks; either the readings match the given tolerance or not. This compared result is send to the quality department automatically by using the LAN link up. When the rim enters into the test run machine, the probes in the LVDT automatically senses the lift and wobble and take the readings. These readings were send to the computer which is kept near the machine. The computer is already installed with the DATALYSER software. Fig. 2 shows the wheel rim loaded into the automatic test run machine for inspection purpose.

Figure 2 Automatic Test Run Machine

V. RESULTS

The bottom wobble of the rim is measured by using the LVDT setup for 100 samples. There are 10 subgroups of 10 samples each. The measured values are given in Table 1.

Table 1 Data's for Bottom Wobble

No	1	2	3	4	5	6	7	8	9	10
X1	80	110	100	70	60	100	80	60	120	40
X2	70	130	120	80	80	70	110	60	110	60
X3	90	100	120	60	80	40	90	40	70	60
X4	110	110	70	50	100	80	50	120	80	110
X5	100	120	70	80	80	80	40	120	100	70
X6	80	70	60	60	60	60	100	80	70	50
X7	60	80	100	40	110	100	80	60	60	120
X8	80	60	100	60	50	60	80	80	60	70
X9	80	70	80	40	50	60	50	70	70	50
X10	100	100	80	100	90	100	50	90	50	40

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Table 2 shows the measured values of bottom lift using the LVDT and the X-bar chart is drawn for the measured values.

Table 2 Data's for Bottom Lift

No	1	2	3	4	5	6	7	8	9	10
X1	100	120	80	50	140	90	40	60	110	70
X2	70	90	40	60	60	90	90	120	90	120
X3	80	120	40	70	80	70	70	80	100	90
X4	90	130	90	110	80	80	60	90	80	60
X5	80	130	90	70	70	40	60	90	140	40
X6	90	80	80	60	70	50	90	110	110	70
X7	140	70	90	50	60	40	90	80	100	120
X8	60	50	60	100	100	110	50	100	100	100
X9	110	80	80	40	40	90	80	90	80	60
X10	100	90	100	40	50	90	80	80	40	70

The measured values for Top wobble are provided in Table 3 for 100 samples chosen for analysis.

Table 3 Data's for Top Wobble

No	1	2	3	4	5	6	7	8	9	10
X1	100	140	100	80	80	100	80	50	90	90
X2	120	100	120	100	80	90	80	60	120	100
X3	120	100	140	120	80	100	70	110	80	110
X4	100	130	120	80	90	50	100	70	70	120
X5	90	140	120	80	100	80	80	80	90	100
X6	120	100	120	80	80	90	110	50	130	110
X7	140	80	120	40	90	50	60	80	110	80
X8	70	100	100	120	90	70	100	80	60	80
X9	110	100	90	70	70	60	90	70	40	80
X10	110	100	130	80	80	70	70	90	80	110

For top lift, the measured values are given in Table 4, based on which the upper control limit and lower control limit are calculated and X-bar chart is drawn for analysis purpose.

Table 4 Data's for Top Lift

No	1	2	3	4	5	6	7	8	9	10
X1	90	130	80	50	90	100	50	60	90	50
X2	110	140	90	90	60	90	100	40	100	70
X3	120	10	90	110	100	50	110	70	80	40
X4	70	10	30	100	80	40	90	120	100	70
X5	90	100	30	60	100	120	50	100	120	80
X6	120	70	110	70	100	40	80	60	60	120
X7	140	70	100	100	100	80	90	80	40	110
X8	80	60	110	70	70	80	60	90	70	80
X9	100	70	80	70	100	50	40	80	60	60
X10	110	60	100	100	40	70	40	50	60	40

The X-bar chart for bottom wobble generated using Minitab-16 is shown in Fig. 3. It is inferred that the process mean and variation are stable and no subgroups are out of control. The precision of the control limits is good because of 100 data points included in the calculation of X-bar chart. From the X-bar chart drawn for bottom lift, it is observed that the sample 7 of subgroup 1, sample 1 of subgroup 5 and sample 5 of subgroup 9 lies very close to the upper control limit but

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no subgroups are out of control which shows that the variation are stable within the limits. It is visualized from the X-bar chart of top wobble that some samples of subgroups 1 and 2 is very closer to the upper control limit and sample 7 of subgroup 4 and sample 9 of subgroup 9 are very nearer to the lower control limit, but none of the samples are out of control. The control limits on the X-bar chart for top lift is too wide for the data. This condition is likely caused by stratified data, which occurs when we have a systematic source of variation within each subgroup. The data collection strategy should be examined for possible sources. Sample 7 of subgroup 1 and sample 2 of subgroup 2 is very close to the upper control limit. Samples 3 and 4 of subgroup 2 lies on the lower control limit itself.

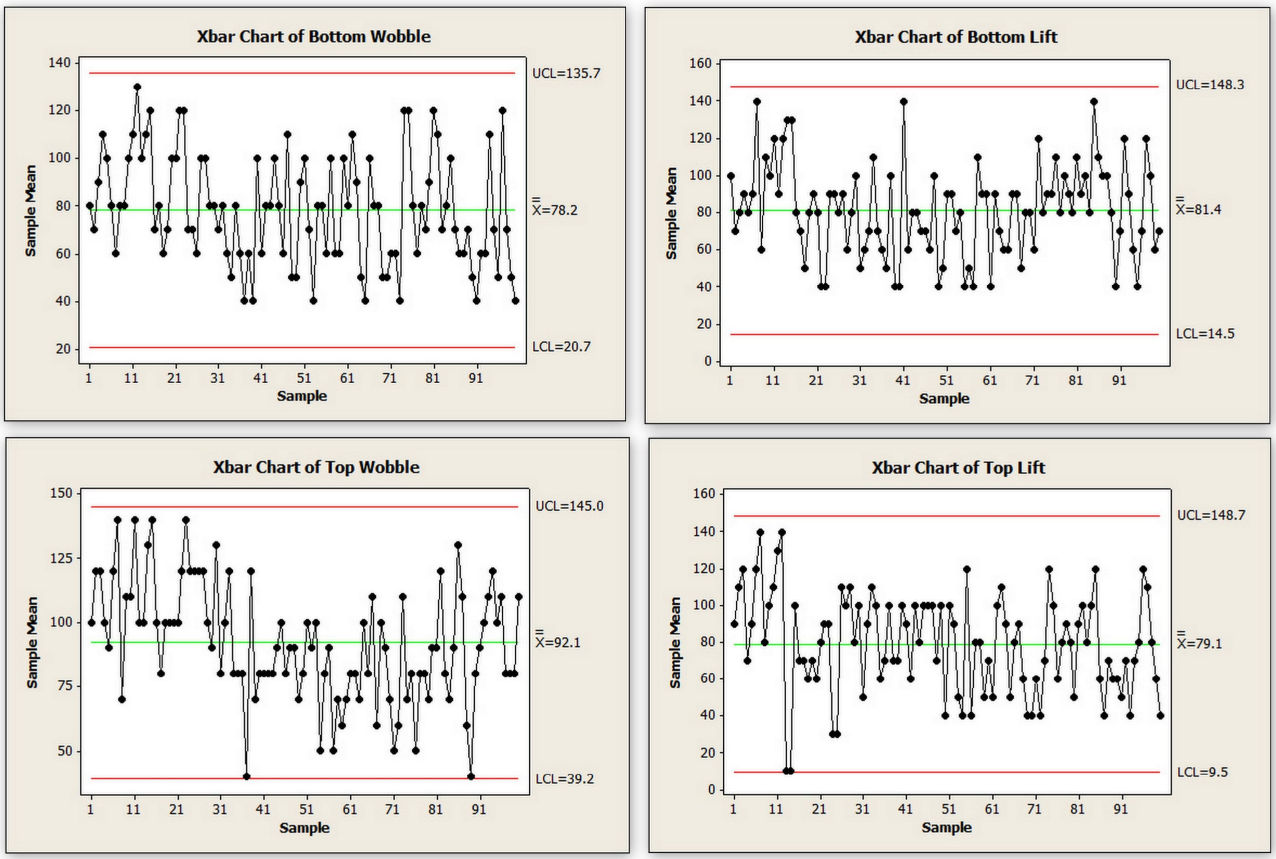

Figure 3 X-bar Chart for Bottom Wobble, Bottom Lift, Top Wobble and Top Lift

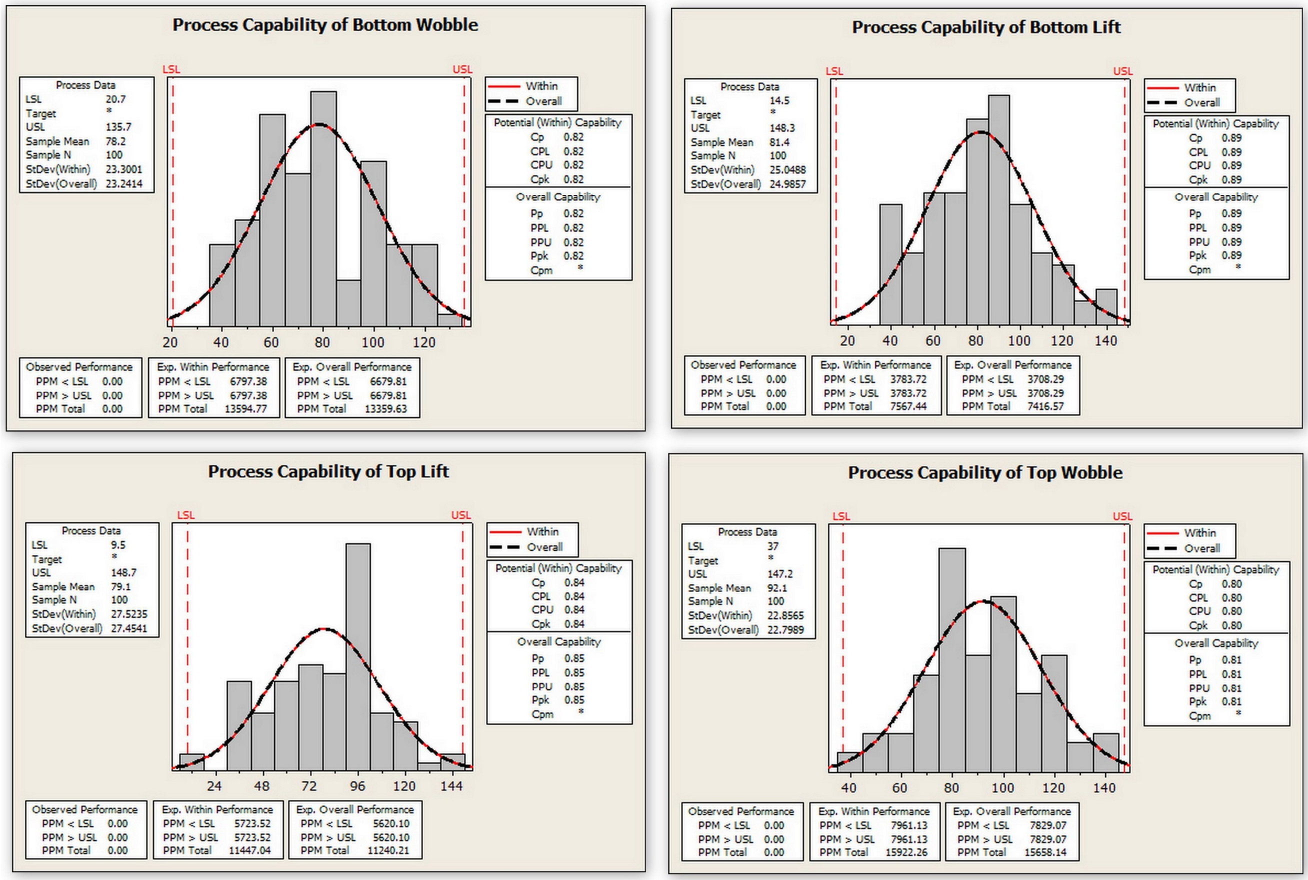

Figure 7 Process Capability for Bottom Wobble, Bottom Lift, Top Wobble and Top Lift

Figure 7 shows the process capability histogram for bottom wobble, bottom lift, top wobble and top lift. The process capability index for bottom wobble is 0.82, bottom lift is 0.89, top wobble is 0.80 and top lift is 0.84. For bottom wobble and bottom lift, the histogram is skewed towards left. For top lift, the histogram is even expect for the data's range on 90 to 100. A left skewed histogram is obtained for top wobble. From this it is observed that the process is in control and the inspection process can easily be automated using this setup.

VI. CONCLUSION

In this work, the inspection of wheel rim of an automobile is automated using an automatic run test machine and the calculations, conversion of offline statistical process control to online be done by datalyzer successfully. Thus the time taken for inspection is reduced and the production is not stopped during the inspection. Therefore the production rate increases and the time consumption is reduced. And by datalyzer the statistical process control is made online and hence the process stability is done instantly as the datalyzer provide LAN link-up.

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