

# Development Of Quality Control Systems For A Machine Tool Industry (Tractor Division) In Northern India :A Case Study

Aadhar Gupta

*Department of Production Engineering  
PEC University Of Technology, Chandigarh, India*

Dr.Suman Kant

*Department of Production Engineering  
PEC University Of Technology, Chandigarh, India*

**Abstract:** - This paper consists of developing quality control solutions for a machine tool industry in a north India. The case was taken to improve the processes by providing solution by the help of appropriate control chart. The first product taken was crankcase and X bar and R chart were applied for this product with variable measured as bore size of crank case. The second product was bonnet of tractor. The attribute control chart for defect (u chart) was applied to find the assignable causes of defects if any. Overall it was found that some assignable causes of variations were present during boring of crankcase. The painting operation of bonnet was found reasonably good (under control).

**Keywords – Control Chart, X bar and R chart, u chart**

## I. INTRODUCTION

The paper focuses on the development of quality control systems for a machine tool industry (tractor division). The paper addresses quality related issues in painting operation, machining operation (Boring of the crankcase) of tractor. A study was made using tools of Statistical Quality Control (SQC) and results were obtained, which have been presented in the paper. Tools used are Control Charts for variables (X bar and R chart), Control Charts for attributes (u chart).

Control Charts were developed by Dr. Shewart and is based upon the fact that variability does exist in all the repetitive processes. There exists two kind of variations [9]

- a) Variation due to chance causes
- b) Variation due to special causes

Variation due to chance causes are inevitable in any process or product. They are difficult to trace and difficult to control under best conditions of production. Variation due to special causes may be due to the following factors [9]

- a) Difference among machines
- b) Difference among workers
- c) Difference among materials.
- d) Difference in each of these factors over time.

Control Charts for attributes measure quality characteristics that can be classified as either conforming or non conforming to the specifications.

## II UNDERSTANDING THE TOOLS OF SQC

### A. X Bar And R Chart

X bar and R charts are used in combination for the control process.  $\bar{X}$  shows the centering of the process i.e. shows the variation in average of samples. It is the most commonly used variables chart.

R chart shows the uniformity or consistency of the process i.e. it shows the variations in the ranges of samples. It is a chart for measure of spread.

$\bar{\bar{x}} = \bar{x}$  i.e. the averages of the  $\bar{x}$  values will be the same as  $\bar{x}$ , the average of the universe.

$\sigma_{\bar{x}} = \sigma / \sqrt{n}$  where  $\sigma_{\bar{x}}$  is the standard deviation of the expected frequency distribution of the average and  $\sigma$  is the standard deviation of the universe and  $n$  = sample size.

Control Limits

$$\bar{\bar{x}} = \sum \bar{x} / n$$

$$\bar{R} = \sum R / n$$

$$\text{Upper Control Limit For } \bar{x} \text{ chart} = \bar{\bar{x}} + 3\sigma_{\bar{x}}$$

$$\text{Lower Control Limit For } \bar{x} \text{ chart} = \bar{\bar{x}} - 3\sigma_{\bar{x}}$$

$$\text{Upper Control Limit For } \bar{R} \text{ chart} = D_4 \bar{R}$$

$$\text{Lower Control Limit For } \bar{R} \text{ chart} = D_3 \bar{R}$$

Where  $D_4$  and  $D_3$  are factors.

### B. *u* chart

It is the control chart for defectives. Each characteristic that does not meet the specification is a defect.

When the subgroup size varies from sample to sample, it is necessary to use *u* charts.

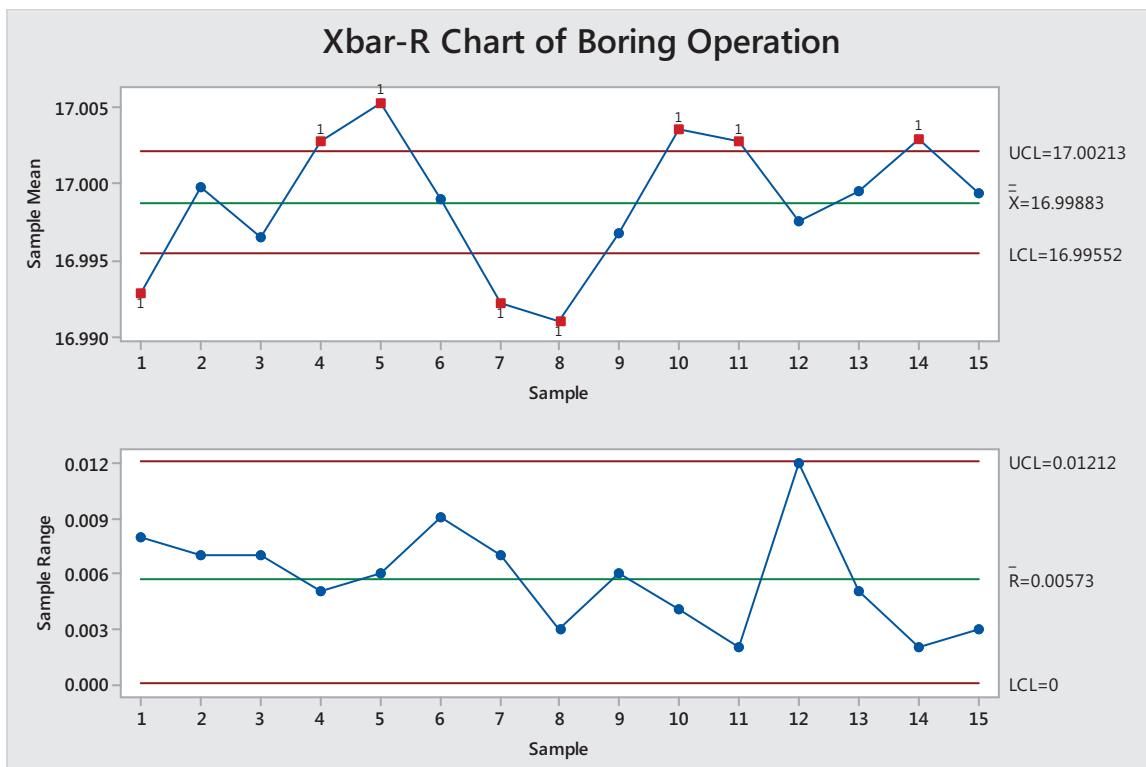
$$\bar{u} = c / n \text{ (Number of defects in a sample / Number of units in a sample)}$$

$$UCL = \bar{u} + 3 \sqrt{\bar{u} / n}$$

$$LCL = \bar{u} - 3 \sqrt{\bar{u} / n}$$

The larger the number of units in a sample, narrower the limits.

### III. DATA ANALYSIS AND RESULT



It can be seen from the  $\bar{X}$  - R chart plotted for the machining operation (boring of crankcase of tractor ) that the process is out of control as two out of three consecutive points fall outside the 3 $\sigma$  control limits on the same side of the centre line. This shows that there are some special causes of variation [9].

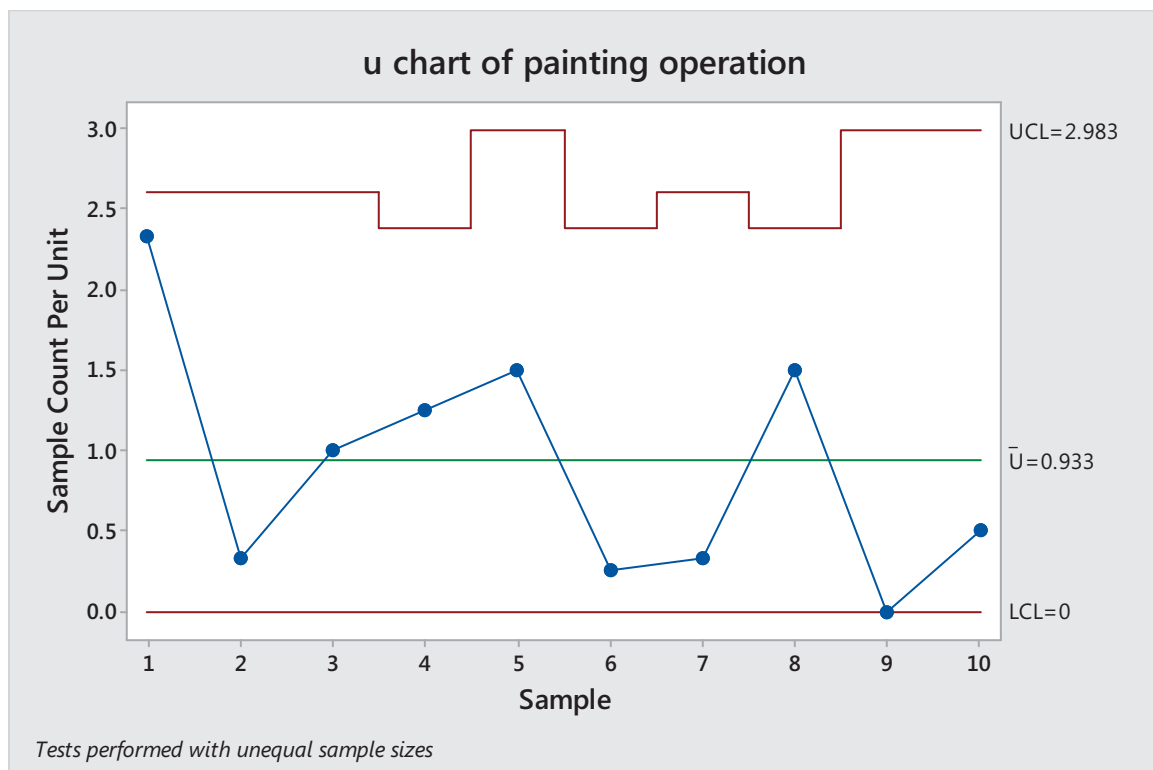
Upon investigation, it was found that the special causes of variation are as follows:-

- a) Tool not fitted properly.
- b) Operator-To-Operator variation.
- c) Blow holes in the casting
- d) Tapering of the tool during machining..

The process was in control; however this mentioned assignable causes of variation

The other problem being faced pertaining to painting to bonnet of Tractors. Due to variation of demand, daily production of bonnet is varied. Hence forth variable sample size was considered to construct u chart. The details data are shown in table below.

Sample Number	Sample Size	Defects	$U_i$	UCL	LCL
1	3	7	2.3	2.606	0
2	3	1	0.3	2.606	0
3	3	3	1	2.606	0
4	4	5	1.25	2.381	0
5	2	3	1.5	2.982	0
6	4	1	0.25	2.381	0
7	3	1	0.33	2.606	0
8	4	6	1.5	2.381	0
9	2	0	0	2.982	0
10	2	1	0.5	2.982	0



U chart was drawn for this data with variable control limits. The control limits are varied according to sample size. After plotting it was found that no point fall outside the control limits. Hence the painting process was found to be reasonably good and under control.

#### IV.CONCLUSION

The paper illustrates the use of tools of SQC ,in particular, control charts ,to study a process and to find out the special causes of variation ,if any .The trial version of Minitab 17 was applied to develop control charts (X bar and R charts ) for boring operation and it was found that the process was out of control and some special(assignable) causes of variation were present.

U chart was plotted for painting operation of bonnet and it was found that the process was in control and no assignable causes of variation were found to be present. The special causes of variation with regard to the boring operation were analysed by studying the operation in detail and were told to the management for further action.

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