ANALYZING THE PROCESS CAPABILITY FOR AN AUTO MANUAL TRANSMISSION BASE PLATE MANUFACTURING

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ABSTRACT

The industry today is working intensively on a goal-oriented way towards introducing regular studies in manufacturing. The current study is part of a large overall spanning project aiming towards an increase in productivity, i.e. more products produced per year with availability. In this paper we have analyze what Process Capability is and how it is implemented on a current process. All the steps are listed out in an easy to understand manner. In current scenario, specifications for products have been tightened due to performance competition in market. Statistical tools like control charts, process capability analysis and cause and effect diagram ensure that processes are fit for company specifications while reduce the process variation and improve product quality characteristic. Process capability indices (PCIs) are used in the manufacturing process to provide numerical measures on whether a process is capable of producing items within the predetermined limits. For the analysis purpose MINITAB 16.0 is used and is found that the process is placed exactly at the centre of the control limits. Analysis also shows that process is not adequate. The cause and effect diagram is prepared to found out the root cause of variation in diameter of work. In this study, a process-capability analysis was also carried out in a medium-sized company that produces machine and spare parts.

KEYWORDS

Process Capability, Process Capability Indices (PCIs)

1. INTODUCTION

Process Capability Study (PCS) is a scientific and a systematic procedure that analyzes and uses control charts to detect and remove the unusual causes of variation until a state of statistical control is reached. PCS is performed for a new or changed production process so as to verify the process capability or performance and achieve additional inputs for controlling the process [1]. Suitable methods need to be applied for monitoring and measurement of processes. These methods determine the ability of the processes to get desired results. When planned results are not achieved, corrective measures need to be taken, to ensure conformity of the product. The current study is part of a large aim that is more products produced per year with the available manufacturing equipments and a minimum of investments [1]. There are several capability indices, including Cp, Cpu, Cpl and Cpk, that have been widely used in manufacturing process to provide common quantitative measures of process potential and performance. Process capability indices are powerful tools of studying the process ability for manufacturing a product that meets

specifications [3].We are using Base plate used in auto manual transmission for our study which is manufactured for a leading automobile company. In this research we take a close look at the procedure involved before a process capability is achieved

Table 1: Data Index and Estimate equation. [4]

Index Symbol	Meaning	Estimated Equation
Cp	Capability index	(USL-LSL)/6s
Cpu	Upper Capability Index	(USL-X Bar)/3s
Cpl	Lower Capability Index	(X Bar-LSL)/3S
Cpk	Centering Capability Index	Min of (Cpu, Cpl)

2. OBJECTIVE

The aim of this project is to observe weather the operation done on the product are well in limits and if not how to overcome those variation. Following are the points on which we will focus during this study:

a) To prevent the product from deviation from a specification.
b) The continuous measure of improvement.
c) The identification of directions for improvement.
d) The auditing of the quality system.

3. METHODOLOGY

Process capability studies are recognized as able aids in improving a process. By PCS it is possible to establish best quality standards for the current process & further improvement will so possible. Certain precautions are necessary before conducting PCS [2]:

a)   Process should be in statistical control.
b)   Independent data should be collected.
c)   To make control Charts.

Process capability analysis steps are following [4]:

a)   To collect samples at regular intervals or after production
b)   To compute an appropriate statistics of product under consideration such as its range, sample mean etc.
c)   To plot the statistics of the particular product on a chart as a function of sample number of time to reflect the quality of the remaining products.
d)   To calculate the control line, upper control limit and lower control limit.
e)   To observe the change and conclude
     A control chart is made up of three lines.
     • Central line (CL) which indicates the standard of process.
     • Upper Control Limit (UCL).
     • Lower Control Limit (LCL).

Control limit for X bar chart [7]

$$USL = \bar{X} + A_2\bar{R}$$

$$Centre\ line = \bar{\bar{X}}$$

$$LSL = \bar{X} - A_2\bar{R}$$

Control limit for R chart [7]

$$USL = D_4\bar{R}$$

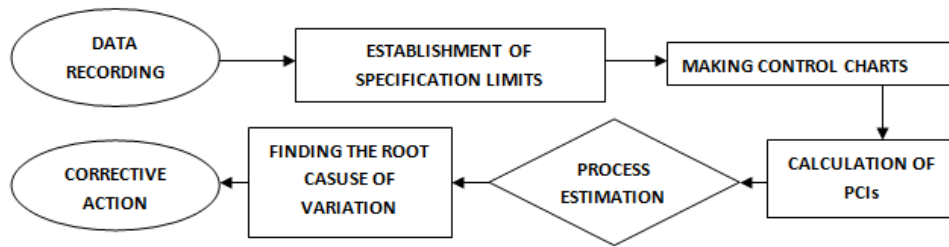$$Centre\ line = \bar{\bar{X}}$$

$$LSL = D_3\bar{R}$$

Fig 1: Steps of work

4. PROCESS CAPABILITY RULES OF THUMB

a) If Cp >1 process is capable (product will fit between the customer's upper and lower specification limit if the process is centered).
b) If Cpk >1 process is capable and centered between the LSL and USL.
c) If Cp = Cpk the process is at the middle point of the given specification limits.
d) If Cp >Cpk the process is off-center.
e) If Cpk = 1 the process is barely capable.
f) If Cpk <1 the process is not capable.
g) Pp is the performance index. Like Cp it measures how well data fits within the USL and LSL. It make use standard deviation in the calculation instead of sigma estimator.
h) Ppk is the performance centering index. Like Cpk it measures how well your data is centered between the USL and LSL. It uses standard deviation for calculation instead of sigma estimator.
i) Cp and Cpk should be close in value to Pp and Ppk.
j) If Cp and Cpk are much greater than Pp or Ppk, the process may not be stable.

5. PROCESS CAPABILITY ANALYSIS

In this paper we have discussed an Auto Mobile product named Auto Manual Transmission Base Plate manufactured in Bhiwadi, India. This company is making a vast range of products that meets international standards. The focus of the study was to determine the process capability of a current process so as to decide upon the suitability of the machine to hold particular tolerance. A single sampling plan was enforced by using the lot-acceptance sampling plan. Samples were taken randomly during an ongoing boring process. The data for the analyzing characteristic was collected for 5 days in the company, determined for 25 samples (Observation Table).The machine used is Fanuc VMC.

The control chart for sample mean and ranges with their control limits are shown in Figure 2, 3, and 4. Control charts show that all points are within the control limits, so the process seems to be under control and stable. The control limits are as follows:

Table 2: Observation Table.

| Groups	Diameter					X
	1	2	3	4	5	
1	9.01	9.01	9.02	9.03	9.01	9.016
2	9.04	9.03	9.04	9.02	9.05	9.038
3	9.05	9.01	9.04	9.06	9.03	9.038
4	9.01	9.02	9.04	9.05	9.03	9.032
5	9.02	9.03	9.01	9.04	9.05	9.03
6	9.01	9.04	9.05	9.01	9.02	9.038
7	9.04	9.02	9.02	9.03	9.01	9.024
8	9.02	9.03	9.01	9.01	9.02	9.018
9	9.04	9.05	9.05	9.01	9.04	9.04
10	9.04	9.02	9.02	9.05	9.01	9.028
11	9.01	9.02	9.01	9.02	9.05	9.024
12	9.04	9.02	9.02	9.04	9.05	9.034
13	9.01	9.04	9.01	9.04	9.02	9.024
14	9.05	9.04	9.04	9.04	9.01	9.038
15	9.03	9.04	9.04	9.05	9.03	9.04
16	9.05	9.01	9.04	9.05	9.03	9.038
17	9.01	9.02	9.04	9.05	9.03	9.032
18	9.02	9.03	9.01	9.04	9.05	9.03
19	9.01	9.04	9.05	9.01	9.02	9.038
20	9.04	9.02	9.02	9.03	9.01	9.024
21	9.02	9.03	9.01	9.01	9.02	9.018
22	9.04	9.05	9.05	9.01	9.04	9.04
23	9.05	9.01	9.04	9.06	9.03	9.038
24	9.01	9.04	9.06	9.01	9.02	9.038
25	9.04	9.06	9.05	9.01	9.04	9.04
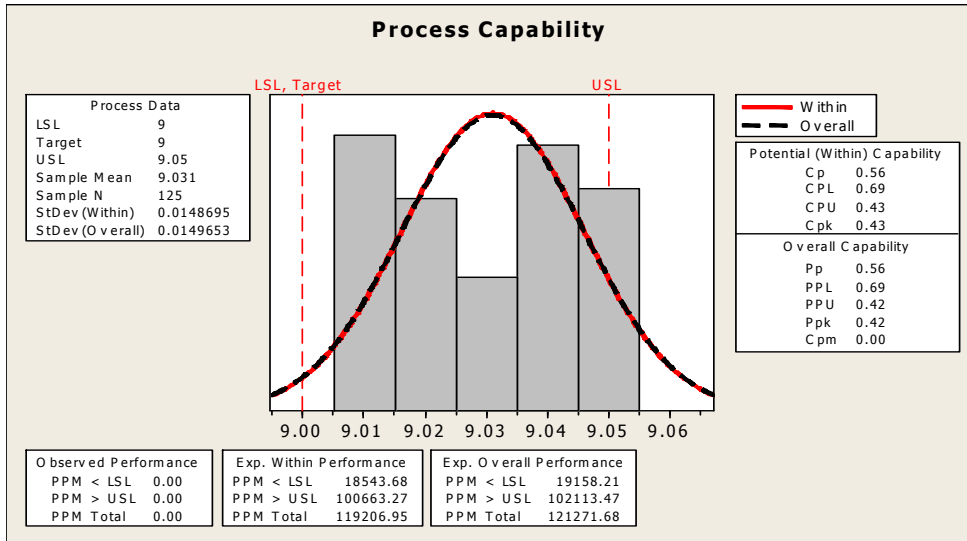
Fig 2: Process capability analysis
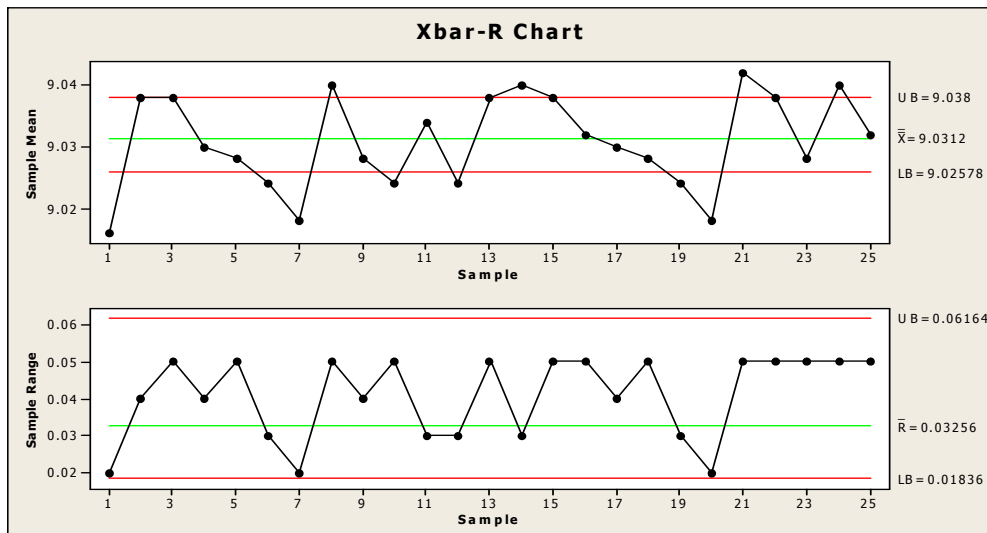
Fig 3: X and R Chart
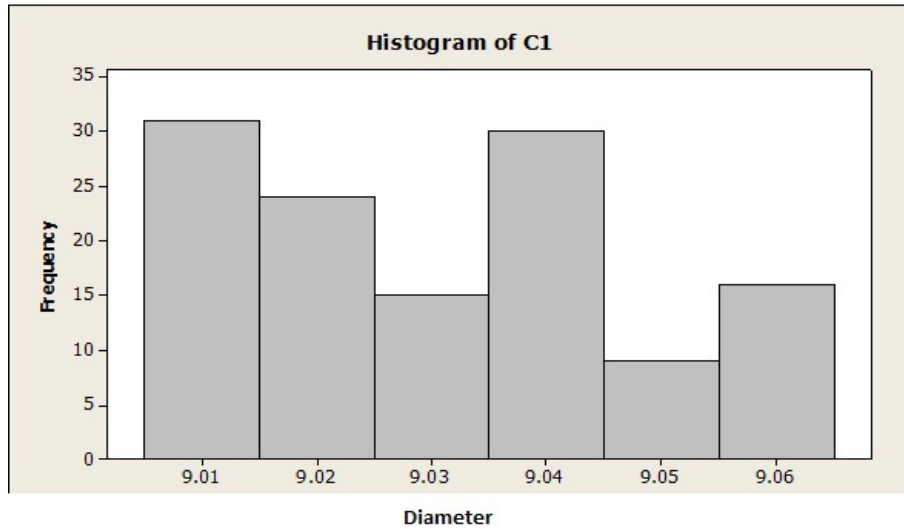
Figure 4: Histogram

6. RESULTS AND DISCUSSION

Table 3: Results

C_p	0.56
C_{pk}	0.43
UCL_X	9.038
LCL_X	9.025
CL_X	9.0312
UCL_R	0.06164
LCL_R	0.01836
CL_R	0.03256

The results shown in table 3 are taken from the Process Capability Graph figure 2 and X-R bar control charts figure 3 shows that the process is almost in center but C_p is less than 1 which means process is not capable. The study shows a very rare case in which process is in center but not capable. The reason being its limited width with no room for error during the process.

7. FINDING THE ROOT CAUSES FOR THE VARIATION

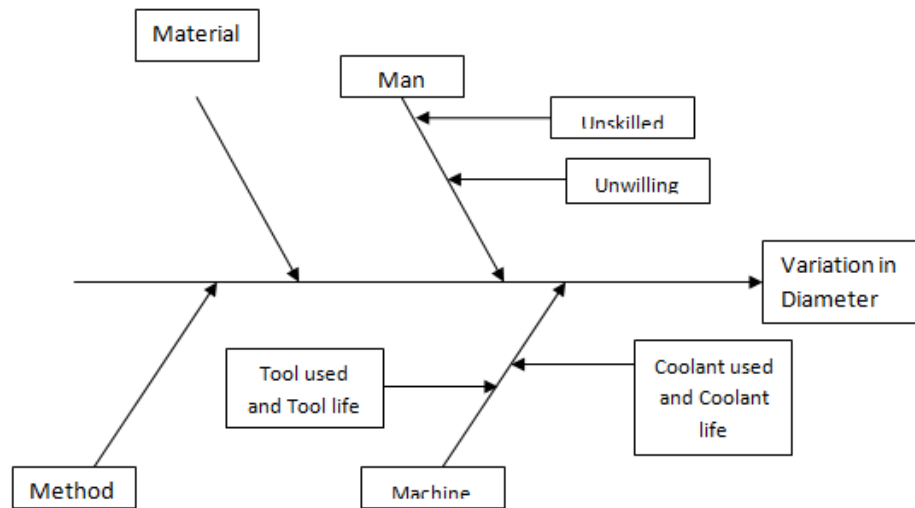To find out the root cause, cause and effect diagram was drawn which is shown in Figure 5.

Fig 5: Root cause diagram

Possible causes of variation in diameter of the process are mostly due to machine causes and man causes. Sometimes Tool used and the coolant type and life cause errors in the machining process. Following are the observations that are made during the study:

1. The quality of the material should be checked before starting the machining process because it might be possible that it was not up to the standards
2. Tool used should be changed after machining of 100-110 pieces.
3. Coolant quality should be regularly checked
4. Coolant filters are to be cleaned at regular intervals especially in the case when coolant is not changed for a long time.

After analyzing these causes it is observed that coolant overused which in turn damaging the tool and producing variations in the diameter. The variations can be minimized by removing these causes.

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