Implementation of Statistical Quality Control (S.Q.C.) in Aircraft Prototype Manufacturing Facility in National Aerospace Laboratory

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Abstract— In the manufacturing environment, quality improves reliability, increases productivity and customer satisfaction. Quality in manufacturing requires the practice of quality control. This internship report investigates the level of quality control in National Aerospace Laboratories, in Aircraft Prototype Manufacturing Facility. The study involves data collection of Base plate of Main landing gear on daily bases. The data was collected two times (morning and afternoon shifts) per day. This was done for 12 days. Some of the data was collected from department. The physical observations from the company were analyzed using statistical parameters. Here the Objective is to Find whether process is capable of meeting specification by constructing charts and finding Cp and Cpk values for different dimensions (key quality characteristics). Results depicted that Cp and Cpk values are less than 1.33. Finally Cause and Effect diagram is laid for understanding Causes and increasing the Cp and Cpk value to 1.33.

Key words: Process Capability, Process capability index, Process chart

I. Introduction

Quality control has been an important part of manufacturing since the beginning.

statistical process control has been widely used in different manufacturing facilities around the world to reduce scrap and improve quality.

Thus, statistical process control can be defined as a quality control tool that uses statistical analysis to monitor and improve a given process.

II. Materials and Methods/Definitions and Preliminaries:

A. Process Control Chart:

The visual depiction of the state of a process is highly beneficial in not only understanding its state and deviations but also for real time control and responsiveness. The chart contains a center line that is the average of the data set of the measured characteristic on the part. The actual measurements are plotted on the chart along with upper and lower control limits. The generally used control limits are called 3 sigma limits that are plotted at 3 standard deviations above and below the center line.

B. Process Capability:

Process capability is a measure of how well the process can meet target specifications. It is descriptive of the relationship between the natural spread of the process and the allowable spread per target specifications. The target specifications are set based on the requirements of the design and allowable tolerance limits above and below the nominal value.

Cp is a measure of the spread of the process and ignores any mean shifts existing in the process. It considers the natural spread of the process and the required specification.

Cpk measures how centered the data is between specification limits.

The relationship between Cp and Cpk is indicative of both the ability of the process to meet target specification and how centered the process is in between USL and LSL.

If Cp>1, the process will lie between customer upper and lower limits if it is centered. (shown in figure below).

If Cpk>1, then not only is the process within specification limits, but it is also centered between those limits. Cpk value is the percentage of out of the specification parts of that are expected to be made from a process. (shown in figure below).

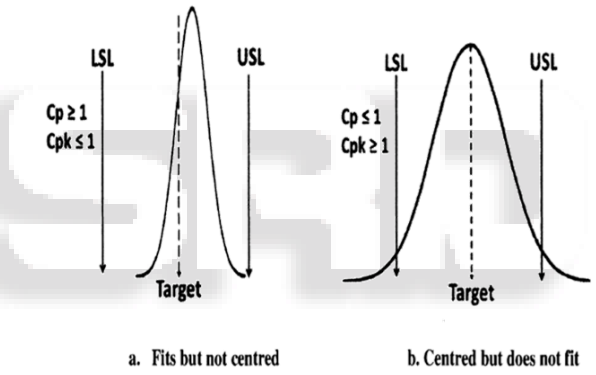

Fig. 1:

The numerical value Of Cpk can be defined as follows:

$$C_{pk} = \min\left(\frac{(USL - X_{bar})}{3\sigma_x}, \frac{(X_{bar} - LSL)}{3\sigma_x}\right)$$

The numerical value of Cp can be defined as follows:

$$C_p = \frac{USL - LSL}{6\sigma_x}$$

Where, USL =Upper Specification Limit
LSL =Lower Specification Limit
Target = Nominal Specification
Xbar = Sample Mean
σ x = Sample Standard Deviation

C. Objective:

To find whether the dimensions (Key Quality Characteristics) of base plate landing gear are process capable operation.

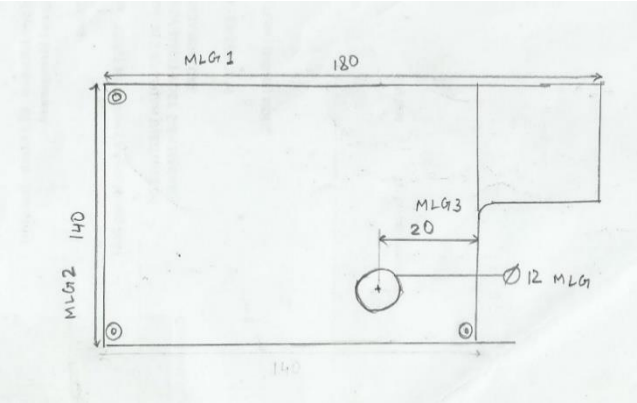

Fig. 2:

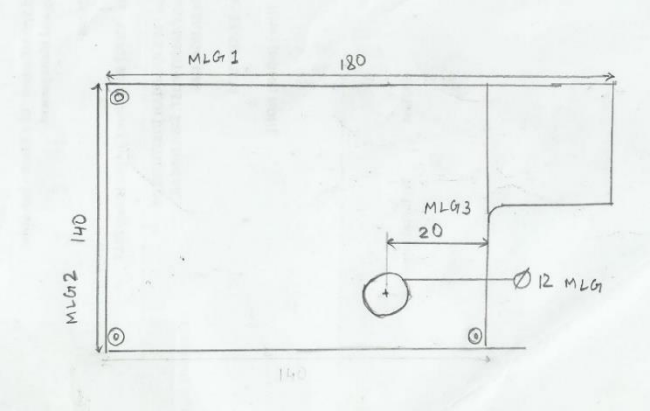

Fig. 3:

D. Measurement Phase:

In this phase the dimensions marked above in the figure of main landing gear is collected. About 30 samples is collected and Process chart is plotted.

E. Tolerances Provided(medium):

Sl.no	Measurement range(mm)	Tolerance
1.	0.5-15	+or- 0.2
2.	15-200	+or- 0.5

F. Data Collected:

MLG1	MLG2	MLG3	MLGhole1
180.712	20.207	140.32	11.95
180.615	20.332	140.65	11.96
180.785	20.117	140.965	11.92
180.034	20.1	140.231	11.99
180.063	20.336	140.32	11.89
180.107	20.065	140.44	11.95
180.785	20.056	140.84	11.93
180.207	20.548	140.153	11.95
180.695	20.365	140.142	11.97
180.801	20.325	140.632	11.91
180.332	20.178	140.362	11.98
180.235	20.452	140.321	11.92
180.719	20.145	140.021	11.93
180.665	20.154	140.365	11.95
180.963	20.058	140.452	11.86
180.755	20.118	140.21	11.93
180.352	20.034	140.779	11.95
180.036	20.662	140.365	11.91
180.65	20.654	140.801	11.93
180.215	20.803	140.452	11.94
180.963	20.098	140.325	11.94
180.658	20.145	140.412	11.92
180.237	20.341	140.123	11.87
180.741	20.002	140.326	11.9
180.801	20.576	140.399	11.95
180.094	20.149	140.451	11.91
180.71	20.398	140.213	11.93
180.321	20.509	140.325	11.95
180.697	20.062	140.442	11.91
180.12	20.679	140.375	11.94

G. Process charts:

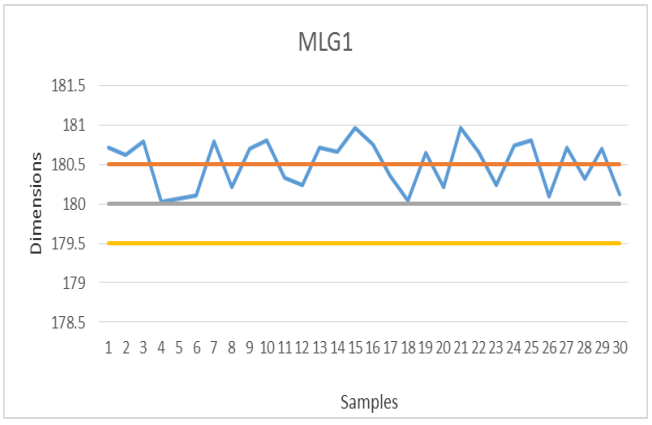

Fig. 4:

Note that most of the points lie outside the specification limits showing low process capability.

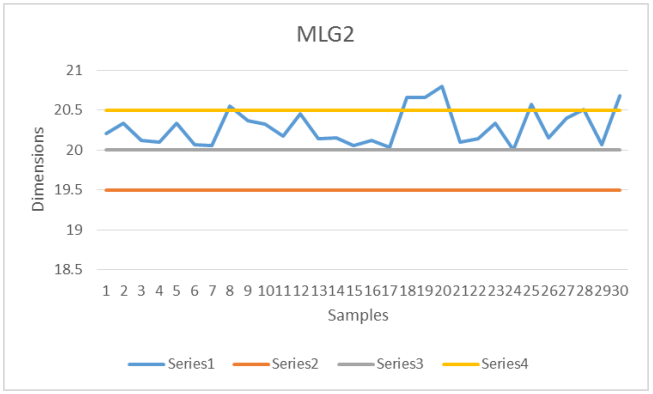

Fig. 5:

Note some of the points are out of specification limits showing medium process capability.

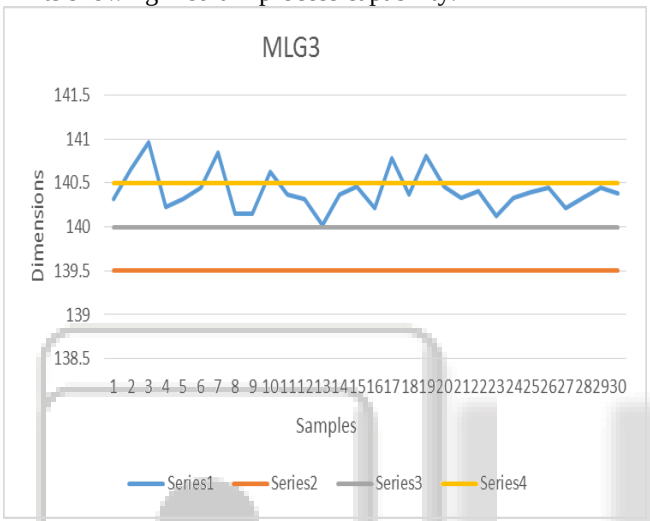

Fig. 6:

Note some of the points are out of specification limits showing medium process capability.

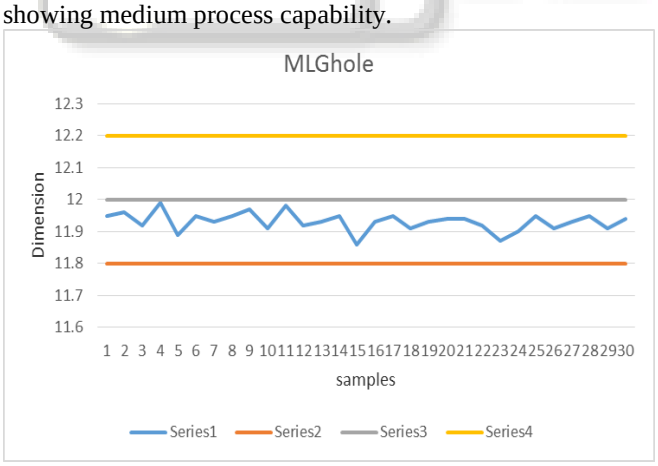

Fig. 7:

Note all points lie well within specification limits showing high process capability.

III. RESULTS

FORMULA	MLG 1	MLG 2	MLG 3	MLG5(HOLE1)
USL	180.5	20.5	140.5	12.2
LSL	179.5	19.5	139.5	11.8
σ	0.2984	0.2254	0.2184	0.0286
Cp=(usl-lsl)/6σ	0.5585	0.2957	0.7631	2.331
Cpku	0.0254	0.3135	0.141	3.131
Cpkl	1.19	1.170	1.38	1.530
Cpk	0.0254	0.3135	0.141	1.530

IV. DISCUSSION

The first set of the statistical process capability study is composed of the raw data of the main landing gear. Continuous set of readings of the different dimensions of the base plate of main landing gear were captured with the help of a Vernier calipers on a surface plate. Hence, it is seen here in the table of statistical process control (SPC) studies that the process is not capable, and the Cp and Cpk values of the characteristic under study are 0.5585,0.2254,0.2184 which are far less than that for process to be capable, i.e., 1.33. But the Cp and Cpk value of the hole is 2.331 which is capable. Hence, the dimensions of MLG1, MLG2, MLG3 are not out of control.

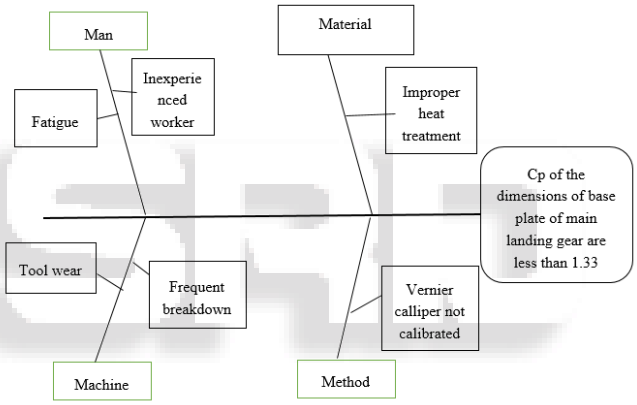

Fig. 8:

V. CONCLUSIONS

It is seen that most of the Cpk values are very low showing that process is incapable of meeting target specifications. Meeting these tolerances require better machining, better inspection techniques and better operators. If these things are incorporated there's less chance of rejecting parts and in turn saving costs.

SPC studies were found to be useful for finding whether the process is capable or not. The cause-and-effect diagram formed an important scientific tool for enlisting the causes behind the poor performance of the process.

- Consistently small value of Cpk suggests that the process capability is low and tolerances are very tight. Consistent low value of the Cp also suggests that process is off center.
  - Thorough engineering analysis to set specification limits.
- The points are out of specification limits; source of variation can be in the dimensions of incoming parts themselves and the variations introduced in the process.
  - This would require corrective actions to solve the problem.

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