CASE STUDY ON THE DEMONSTRATION OF CAPABILITY TO MANUFACTURING PROCESS

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Abstract: *There are two factors that reduce the opportunity for certification process as capable. The first factor is the volume of production and the second factor is related to the level of precision required by the client runtime, ie the size tolerances. The tolerance is low, the capability value decreases and the process must be improved to meet the minimum capability values. Both aspects of production volumes and related capabilities accuracy (precision and accuracy of the estimate process capability) are combined in a calculation of economic efficiency, it finally generates design quality system.*

Keywords: capability, manufacturing process, quality assurance.

1. INTRODUCTION

The quality assurance system is based, without exception, on the measurement of the range, or on samples (a statistical demonstration), either by checking each piece. Either of the two methods is used, however, quality assurance begins with the certification of the measuring instruments of those odds. The measured values of the pieces are showing evidence of compliance and process this data in turn are provided by the systems and equipment. It is therefore essential that this equipment to provide precise data (tolerances) to be able to have confidence in the values. Although the first logical step is analyzing the capabilities of the measuring equipment for reasons of understanding will first analyze capabilities through the process, assuming perfect metering means, at the end of paragraphs to be presented demonstrating the capability of the methodology of measurement. To demonstrate conformity of the product, parts supplier can use two methods:

A) The simplest of terms, is the measurement of each piece that stands out from the process. In this way, presenting himself and then each piece a measurement report, he provides evidence of compliance. Although the method is simple in theory, it has the big drawback that generates a metrological major resources consumption, given that each piece come before delivery to the laboratory of metrology. Thus, to apply to each of the pieces;

B) 100% control adds a practical step in the process, unproductive thing that generates value but only consumes resources and which is outside the stream of lean production. The series is over, with both the resource consumption increases, he is actually a variable cost per piece.

The second method is the statistics, consists of the measurement of a sample of songs and then, whilst respecting the principles which will be explained later, to demonstrate that the quality of the sample studied is applicable to the entire production batch.

Must, however, clarified that the quality assurance capabilities of the statistical models are actually close to actual measured values, allowing the quality of the whole production. In the case of statistical models, the values of these features will not represent the exact status of never, but an estimated. The difference between the value of the capability and the reality is determined by the precision of the statistical model.

II. CONTENTS

It will take to study a piece of tree turbocharger share consideration will be landing diameter D, with a value of 5.8 (mm) and tolerated ± 0. 02 (mm), Figure 1.

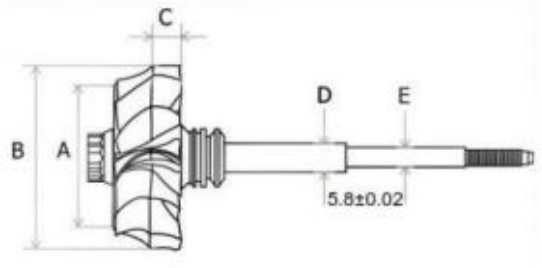

Fig.1. Turbocharger shaft.

Assuming an industrialized process - mass production - and for which it was established as required to be able to a volume of 1,000,000 pieces. Share whose capability will be studied is the diameter of 5.8 ± 0.02. It starts the series in standard conditions (any factor may result as irrelevant to the calculation capability). The decision is to use a sample of 200 consecutive parts. By using a sample of consecutive tracks can accurately calculate the instantaneous capability of the process, one which, as will be explained later, it is essential to calculate the long-term future capability. After measuring parts of the sample is obtained the following distribution of values, Figure 2:

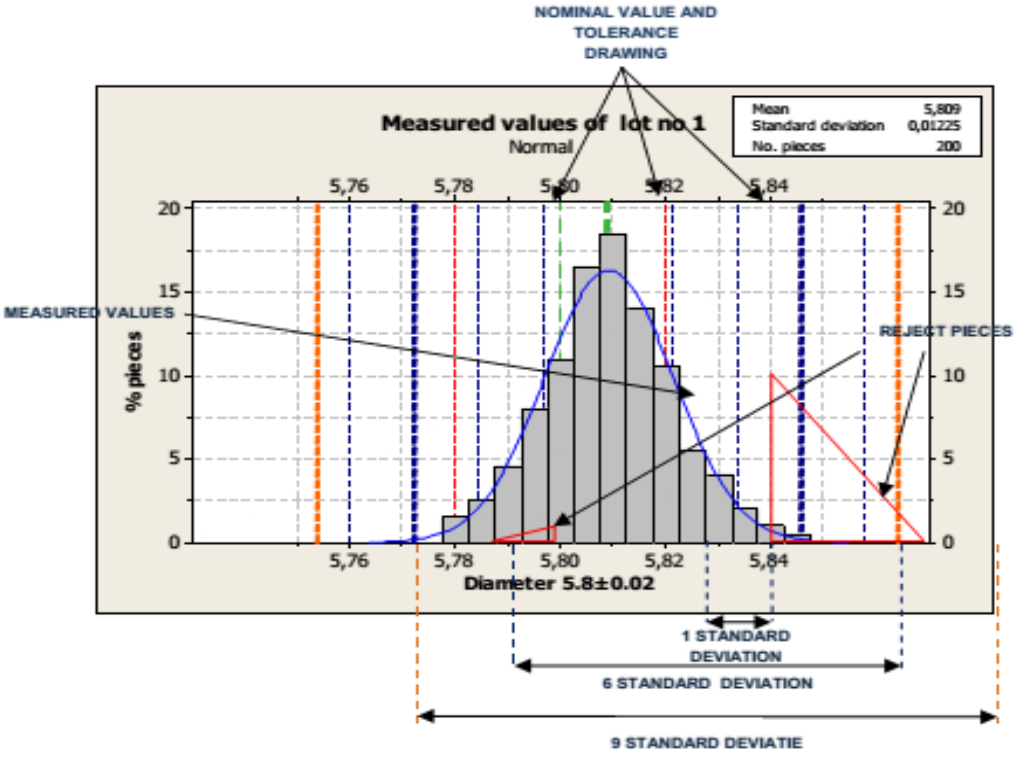

Fig.2. Histogram of measured values.

$\bar{x}_4$

The values describe a normal distribution, symmetrical. Therefore, we use a normal distribution function to achieve the statistical model. It is noted that non-compliant parts were produced on both sides of tolerance. The process is centered approximately 18% of the tracks around 5.8091 higher than the nominal value and the sample standard deviation is 0.0123. Using standard six standard deviations are calculated for the spreading process is 0.074. Comparing tolerance of 0.4, the estimated incapable.

The set of measured values in the histogram described above will be used in calculating capability. The diagram shows the same conclusions stated above, now transposed digits.

From the sample of 200 parts 17% were non-compliant, as follows: 0.5% below the tolerance; 16.5% over tolerance; Normal distribution is indicated with the following parameters: standard deviation 0.0123; average value of 5.8091.

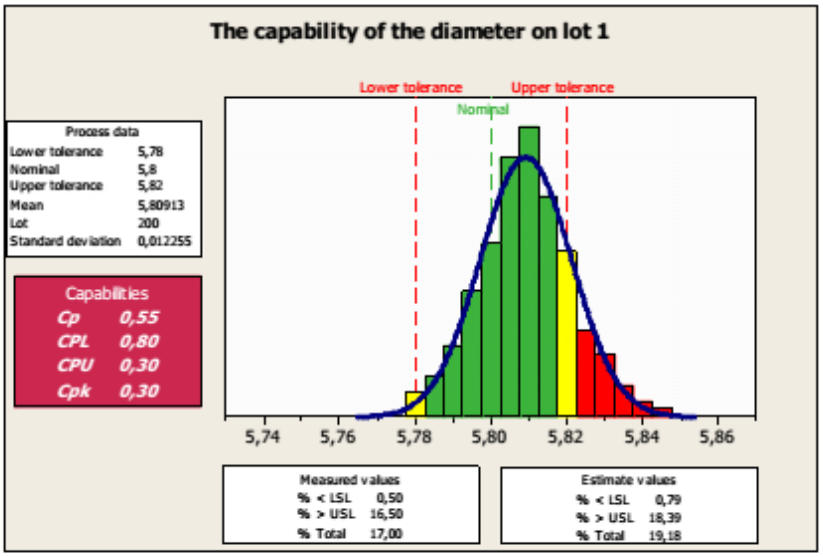

Fig.3. The capability of the diameter on lot 1.

These data are sufficient to create the statistical model. According to this model, the capability analysis estimates, Figure 3: 1000000 a lot of parts will be inconsistent 19.18 %: 0.79 % below the tolerance; 18.39 % over tolerance.

Indicator Cp is the first type of capability to be studied. It is a measure of relative dispersion process. This scattering is calculated in principle (6σ processes) that range between 3 standard deviations to the left and 3 right average value measured. Reporting available on this spreading tolerance obtain Cp indicator. Cpk capability index is indexed and is more complex than the index Cp. Capability index is calculated using Cp value comparing available scattering process tolerance checking it at each end of tolerance. If Cpk appears as a key factor mean measured value. As shown in the example considered, in addition to the Cp rate indications appear Cpl and the CPU. One of them has a value less than the index Cp, specifically at testing the tolerance limit closest to the average. In this case Cpu is set to 0.30 to 0.55 for the PC as explained in the paragraph above, most of the components approach the upper limit of tolerance. As a result, Cpl index has a value greater than Cp for the same reason; most pieces are far from the lower limit.

It can be concluded that the CP will always be between Cpl and Cpu. How Cpk is the minimum of Cpl and Cpu , it can be concluded that Cpk can be at most equal to Cp. This case represents the Cpk = Cp if the process perfectly tuned, because it appears only when the average value measured is exactly the nominal rate.

The main conclusion of this first batch is that the scattering process is too high. Relatively Cpk index can not draw conclusions as not relevant as long as Cp is worth so little. Due to intervene on the machine to reduce vibration and games and have implemented standard operating procedures. Did not intervene in any way the processing tool. After this operation is resumed production and sampled a new batch of 200 pieces.

The results show that the new batch intervention on the machine significantly reduced scattering process, calculating Cp index of 2.17. It may be noted in this regard and only 0.003 standard deviation reduction.

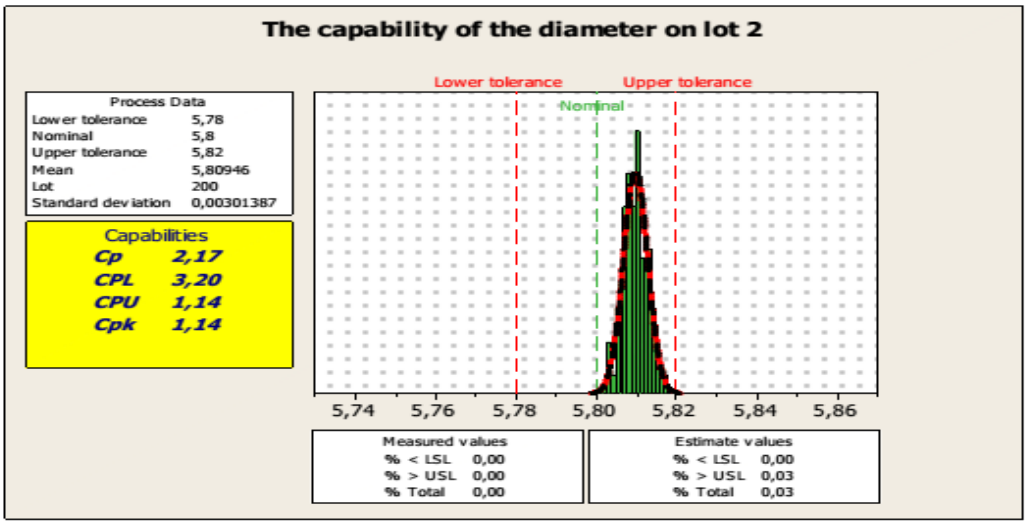

Fig.4. The capability of the diameter on lot 2.

However, not interfering in any way the tool to the measured mean value remains the same, the off-center position remains the same as for group 1, though with greatly reduced scattering. Therefore, the large difference observed between the index and the index Cpk Cp. Statistical model estimates still non-compliant parts (0.03% in some parts 1000000) right upper tolerance. This effect is anticipated and because index CPU (and thus Cpk) less than 1.67. However, the improvement was from 0.30 to 1.14 to improve the prediction is correlated with the percentage of non-conforming parts, from 18.39% to 0.03%.

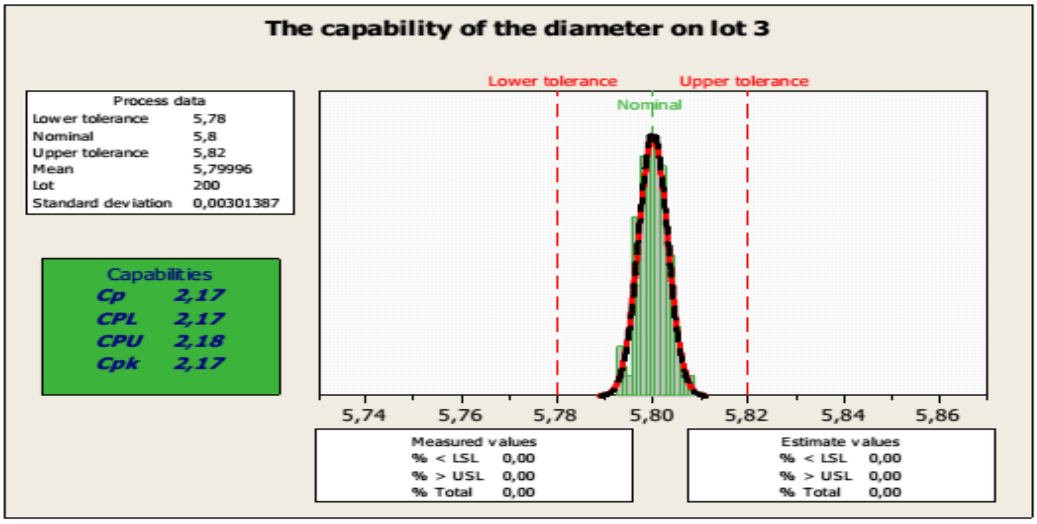

Fig.5. The capability of the diameter on lot 4.

To align policy ***"0 defects",*** it comes back, this time on the machine by restoring them at face value, without influence any machine. Resumes production capa-bilities and recal-culate using a 3rd batch, Figure 5. The results show a perfect process, indicated by Cp and Cpk gender. Also, keeping the same values of Cp is found that the shape remained identical process to group 2. Cpk value of 2.17 is able and safe process. To summarize the methodology of calculation capabilities and interpretation of the results can be used the following scheme of Figure 6.

C_p	C_{pk}	Process stage	Corrective actions
<1,67	Irelevant	Incapable, without the potential for adjustment	Reduction of scattering (standard operating equipment)
=1,67	<1,67	Unable to limit (if $C_{pk} = C_{pk}$)	Reduction of scattering
>1,67	<1,67	Unable, potentially capable	Adjusting the cutting tool
>1,67	>1,67	Capably	Process control

Fig.6. Interpretation of results.

III. Conclusions

Although estimates only as a process capabilities have the major advantage of a limited resource consumption. Measuring a sample resource consumption measurement becomes a fixed cost of the entire process and it does not need an extra step in the production flow. This aspect becomes more advantageous as the series is greater. Basically, series volume can be increased however without consuming additional resources measurement as long as the sample studied remains relevant.

There are two factors that reduce the opportunity for certification process as capable. The first factor is the volume of production and the second factor is related to the level of precision required by the client runtime, i.e. the size tolerances. The tolerance is low, the capability value decreases and the process must be improved to meet the minimum capability values.

Both aspects of production volumes and related capabilities accuracy (precision and accuracy of the estimate process capability) are combined in a calculation of economic efficiency, it finally generates design quality system. For this reason, the control system 100% is common in the aerospace industry, where volumes are relatively small but the precision required is very high, so the tolerances and the standard calculation capabilities. Compared automotive industry widely uses processes capable of being economically efficient installation of such a process, given the high volume production.

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