STUDY CONCERNING THE QUALITY TOOL USE FOR THE BOLTS QUALITY IMPROVEMENT

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Abstract. *In this paper there are presented some quality management tools that can be applied for the analysis and evaluation of quality problems in the case of mechanical processing by cutting a batch of bolts. The possibility of applying the following tools was studied: Histogram, Stratification Analysis, Cause-effect Diagram, Pareto Diagram, Tree Diagram and Control Sheets. The paper presents the construction schemes for the diagrams and graphical representations specific to each method*.

Key words: quality management, methods, tools, bolts

1. Introduction

The changes produced in the industrial field in the 20th century had consequences on the increase of the quality of the manufactured products, through the qualitative control of each manufactured product. With the development of quality control and assurance concepts, various technical methods and tools have been progressively developed with the aim of improving quality. Currently, a large number of quality techniques and tools are used, some based on numerical data, others based on non-numerical data. In the field of quality, organizations frequently use quality management tools to make the best decisions about quality improvement. The quality management tools used in the analysis and evaluation are very diverse and can be used both in the field of production and in the field of services. The specialized literature offers many works that present studies of the application of quality management tools and techniques in different fields of activity. Thus, some papers present case studies and applications in the field of industrial engineering [1, 2, 3, 4, 5, 6, 7], others in the field of chemical industry [8] or automotive engineering [9, 10, 11, 12, 13], as well as from many other technical fields. Also, the application of quality management tools in services in different fields was studied. It can be exemplified with works in the field of health [14, 15], education [16, 17], administrative [18], economic and others.

The category of techniques and tools for numerical data includes: Histogram, Control Diagram, Pareto Diagram, Demerite Method, ANOVA Method, Taguchi Method, 6 σ Method, etc. We also have many techniques, methods and tools for non-numerical data, such as: Stratification, Brainstorming, Benchmarking, Cause-effect diagram, Tree diagram, Affinity diagram, etc. Choosing the most appropriate techniques and tools for quality improvement and using them as efficiently as possible is the responsibility of the organization's management team.

This paper presents the application of quality management tools for analyzing and evaluating the quality of the manufacture of a batch of n bolts. The presented techniques show that different information necessary to improve the quality of bolt parts can be obtained. The proposed case study shows that it is possible to determine: possible causes that cause defects, the relationships between the proposed objectives and the measures to be taken to improve manufacturing accuracy, the evolution of dimensional characteristics, identification and isolation of causes of

quality problems, relative frequency of various problems/defects, stability of the manufacturing process.

2. Quality management tools applicable for the bolt-type piece manufacturing quality improvement

2.1. Histogram

Histograms are graphical representations that visually show the evolution of different quality characteristics of a product or batch of products.

For a batch of n bolts, a histogram can be drawn showing the distribution of the outer diameter values. All n pieces are measured. Interval classes are established to include the dispersion range of the effective values of the outer diameter. We calculate the absolute frequency for each class. The histogram will highlight the pieces that do not fall within the prescribed tolerance (figure 1). This information will be the basis for the analysis of the measures that will be established in order to improve the execution quality in the turning process of the bolts.

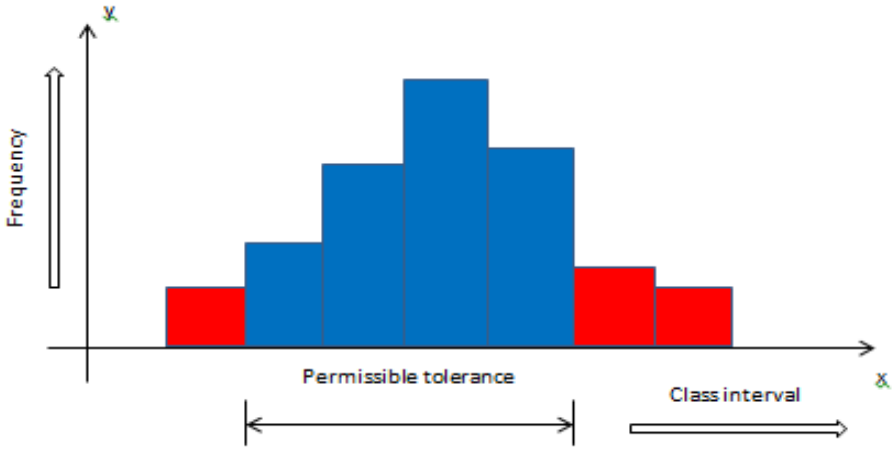

Fig. 1. The construction scheme of a Histogram

2.2. Analysis by stratification

The stratification analysis is a method of grouping data by common data characteristics (type of material, processing method, operator, type of machine, device and tool, work environment, etc.) that helps identify the problem that generates nonconformities. Stratification and comparison of data is an effective method to isolate the cause of a problem. Stratification can be applied to correlation diagrams, histograms, etc.

For example, for a batch of n bolts processed by turning, the stratification of histograms related to the outer diameter of the bolts can be applied. It was considered that the batch of n bolts was processed on the same machine, on two shifts, with a number of 2 operators (one on each shift). The stratification is done by separating the data as follows:

- bolts processed on lathe A, in shift 1 by operator M1,
- bolts processed on lathe A, in shift 2 by operator M2.

In the presented situation, 2 stratified histograms are obtained per operator. Layered histograms help to find the cause that generates the defects (bolts with inappropriate diameter). If diagrams like the ones in figure 2 are obtained, it results that the operator M2 is the cause of the defects. And in this case there will be analyzed the experience and seriousness of the operator, his age, the procedure and measuring instruments used by the operator to verify

the diameter as well as other aspects related to the involvement of the operator in the turning operation.

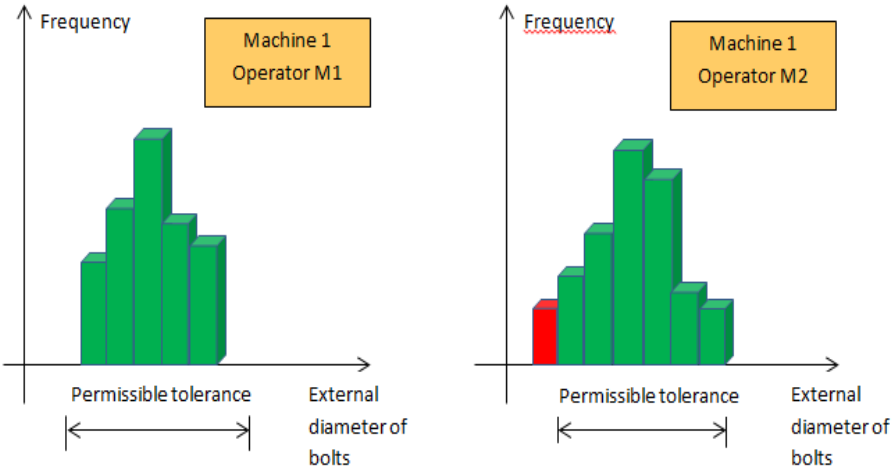

Fig. 2. The construction scheme of a stratification analysis

2.3. Cause-effect diagram (Ishikawa diagram)

The cause-effect diagram is a method of analysis generally used to determine the causes that generate a problem (an effect). The application of the diagram has been extended to very diverse categories of problems.

For the case considered, a batch of n bolts mechanically processed by cutting, the Ishikawa diagram can illustrate the relationships between different quality characteristics of the parts and the causes that influence them. For example, consider the following effect: the accuracy of the geometric shape (deviations from circularity and cylindricality).

A diagram can be made with 6 possible main causes or large branches: Material, Machine, tools and devices, Parameters of the cutting regime, Worker, Environment, Measurement. On these main branches there are represented the corresponding middle branches, then higher order branches. After the graphic realization of the diagram, it is possible to proceed to the analysis of the possible causes and to identify the real causes that determine the quality problem. Then the necessary measures are taken to improve the quality of the bolts. It is very important to follow the correct application of the proposed measures as well as their effect on the quality characteristics studied with the help of the Ishikawa diagram. Figure 3 shows the construction scheme of the Ishikava diagram for the considered problem.

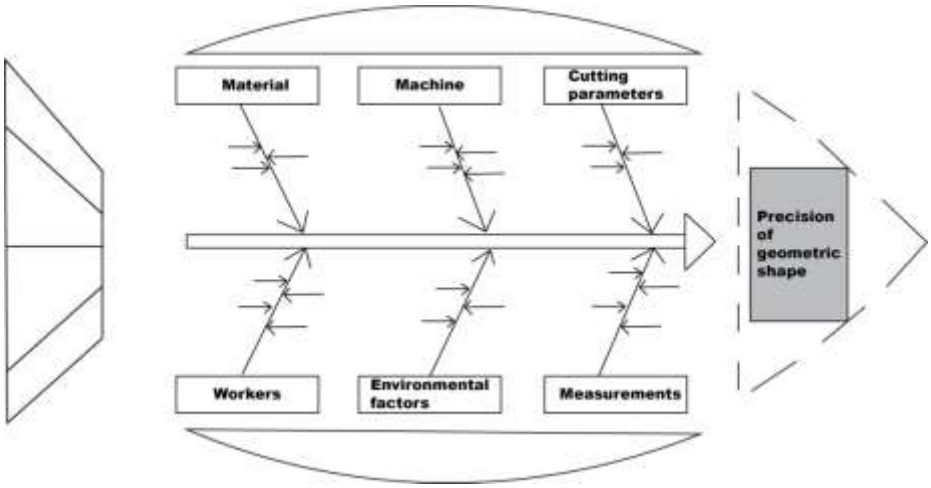

Fig. 3. The construction scheme of a Ishikawa diagram

2.4. Pareto diagram

The principle on which this diagram is based starts from the idea that in nature, in life, in manufacturing processes, negative effects or losses are not proportional to the causes that produced them. Pareto's theory states that 20% of causes are responsible for 80% of defects and is also called "80/20 theory".

The Pareto diagram is a bar graph that highlights the relative frequency of different problems/ features/ defects/ errors/ complaints.

Pareto diagram for the precision of bolts machined: The following types of defects can be studied: D1-roughness too high, D2-effective diameter less than dmin, D3-effective diameter greater than dmax, D4-deviation from circularity outside the prescribed tolerance, D5-deviation from cylindricity outside tolerance prescribed. The Pareto diagram is a graph that will present information in descending order, from the fault with the highest frequency to the fault with the lowest frequency (Figure 4).

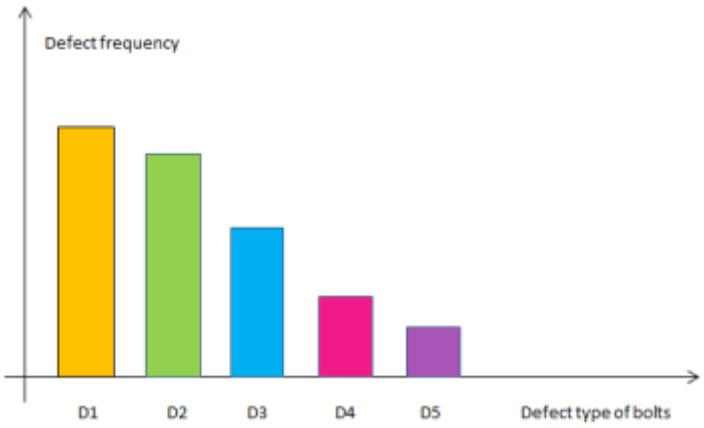

Fig. 4. The construction scheme of a Pareto diagram

2.5. Tree diagram

The tree diagram is used to show the relationships between the objectives pursued and the actions or measures to be taken to achieve the proposed objectives. The tree diagram is a graphical representation of groups of 2, 3 elements that are considered specific objectives for achieving a general objective. For each specific objective, possible actions/measures are represented. Figure 5 shows the model of a shaft diagram for improving the quality of the batch of n bolts machined by cutting. The main objective (target) was defined: Improving the execution accuracy of the bolts processed by cutting. The proposed tree diagram highlights 3 specific objectives: improving the dimensional accuracy, improving the precision of the geometric shape, improving the roughness. The diagram provides the answer to the question *How can the execution accuracy of the bolts be improved?*

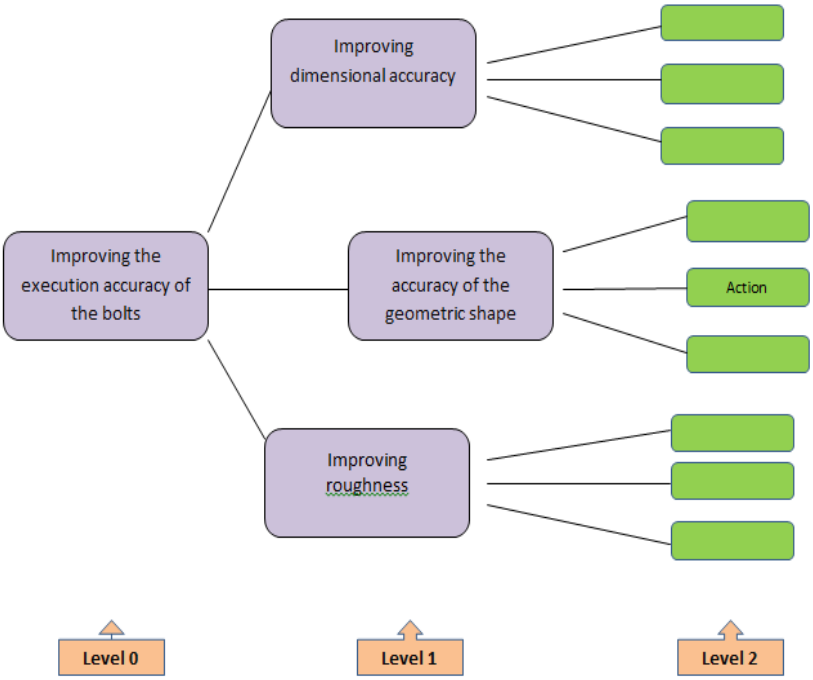

Fig. 5. The construction scheme of a Tree diagram

2.6. Check sheets (control chart, control diagram)

Walter Shewhart has developed a simple but very effective tool for studying the stability of processes. The evolution in time of a process and its stability can be followed with the help of the control sheet. The control sheet is a visual analysis tool that can highlight the quality of the process: the process ensures that the specifications are met, the process does not completely meet the specifications or the process is inadequate. The process is under control if the process and output variables are kept within normal limits.

For the studied case, the manufacture of a batch of n bolts, a control sheet can be drawn up in order to evaluate the stability of the manufacturing process according to the nature of the variability of the quality parameter.

The following steps are followed:
-establishing the quality parameter verified by measurement and gathering the data in chronological order (outer diameter measured for a number of bolts),
-calculating the middle line CL (CL-Center Line) and drawing it on the graph,
-calculation of control limits on statistical bases (UCL- Upper Control Limit and LCL-Lower Control Limit) and their tracing on graph,
- graphical representation of the points defined by the value of the investigated characteristic (outer diameter) for the measured bolts,
- the graph is analyzed based on the distribution of points, respectively the dispersion of the measured dimension values,
- the evaluation of the process is made according to the value of the process capacity index Cp ($Cp = T/6\sigma$).

Figure 6 shows the construction scheme of a control sheet for the example presented.

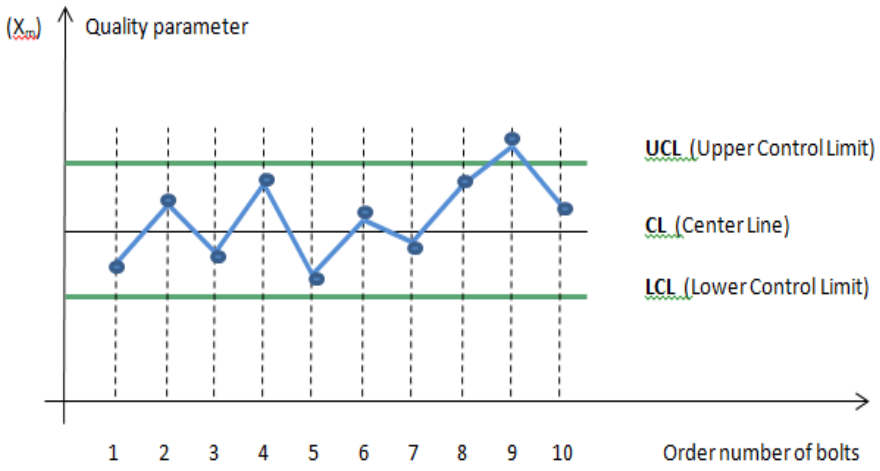

Fig. 6. The construction scheme of a control sheet (medium value sheet)

3. Conclusions

Organizations have an important goal that is to maintain the quality of products and services in order to meet the requirements of beneficiaries. Quality management has developed a number of methods, tools and techniques that contribute to quality improvement. In this paper we have presented some of the quality management tools that can be applied for the analysis and evaluation of quality problems The use of quality management tools is useful for substantiating quality improvement decisions. The causes that determine negative effects on the quality of the products can be identified and they can be corrected based on the established solutions by using appropriate methods.

in the case of mechanical processing by cutting a batch of n bolts. We studied the possibility of applying the following tools: Histogram, Layer Analysis, Cause-Effect Diagram, Pareto Diagram, Tree Diagram, Control Sheets. Also, in the paper we presented the construction schemes for diagrams and graphical representations specific to each method, thus showing the applicability of these tools in the proposed case study.

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