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Analysis of the Quality of Bearing Housing and Improving the Method of Identifying the Root of Incompatibility

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Abstract. In improving the quality of a product, it is important to use actions which allow for identifying problems and their root, which is possible by using adequate techniques. In industrial practice the non-destructive tests are used, because they are effective in the product quality assessment. By their use, it is possible to identify the incompatibility of a product, but not the root of its occurrence. Therefore, it is effective to integrate the non-destructive test with other methods that allow for it. The aim of the study was to identify the root of linear indications detected by the FPI method on a bearing housing using the sequence of quality management techniques. An enterprise localized in the Podkarpacie had a problem with not identified root of incompatibility. In the enterprise, linear indications were often identified on different types of products, and the root of this problem was not known. To solve the problem and identify the root of linear indications, a sequence of selected techniques was used. These methods included the fluorescent method inspection (FPI), Ishikawa diagram and 5Why method. A bearing housing made from 410 steel, on which linear indications were often identified was the subject of the research. By using the Ishikawa diagram, the potential and main causes were identified (production errors and bad storage). By the 5Why method the root of the linear indications was identified - it was faulty material from the supplier. It was shown that integrating the sequence of quality management techniques with the FPI method is effective to identify the root causes of a product. These sequences can be used to quality analyze other types of products and also to identify the root of other types of incompatibilities.

Introduction

Quality management techniques have applications in improving the process of quality analysis of a product. A complex analysis of the problem by using the quality management techniques is possible when the selected techniques are used in a sequential way [1, 2]. It is possible by using, for example, the Ishikawa diagram with the 5Why method [3, 4]. By the Ishikawa diagram, the potential causes of a problem can be pointed and next the main causes of the problem can be selected [5, 6]. But for a complex quality analysis, the most important is to identify the root of the problem. So, in the next steps, it is effective to use the 5Why method, which allows for it. This strategy in using these quality management techniques to identify the root of the problem is known and often used [7]. But it is very useful to show that this simple and effective strategy can be used like an integrating technique with some non-destructive test. It is a way to improve the process of the quality analysis of a product when it is possible to identify the incompatibility but

its root is not known [4, 8]. The integration quality of management techniques (Ishikawa diagram and 5Why method) was proposed in an enterprise localized in Podkarpacie.

The aim of the study was to identify the root of linear indications detected by the FPI method on a bearing housing using a sequence of quality management techniques. In the enterprise, the linear indications were often identified on different types of products, and the root of this problem was not known. So, it was important to propose this sequence to analyze the quality of the bearing housing and improve the method of identifying the root of incompatibility.

This approach, presented in this article, may also be used in those types of industrial activities where the identification of the sources of non-compliance is of particular importance, e.g. biotechnology [9, 10], fatigue failures in mechanics [11, 12], hydraulics in heavy-duty machines [13], protective coatings [14, 15] deployed by electro-spark deposition [16, 17] and enhanced by laser machining [18]. It may also be used to detect errors in research analyzes involving largely subjective human judgment, e.g. nonparametric models [19] or image analysis [20, 21].

The subject of research and material

A bearing housing, which was made from 410 steel was the subject of the research. The bearing housing allows for simple exploration and change, so by using the bearing housing it is possible to fix a product in the machine well [8]. The 410 steel is nickel alloy which is heat and corrosion-resistant. Selected properties of 410 steel are shown in the subject of the literature [22-24]. The choice of the subject of research depended on often identified types of incompatibilities (linear indications).

Method

In order to identify the root of the incompatibility on the bearing housing, a sequence of selected techniques was used. These techniques included the fluorescent method (FPI), Ishikawa diagram and 5Why method. The choice of these techniques was conditioned on their effectiveness in identifying the incompatibility on the product in the first part of the method (fluorescent method) and, in the second part of the method, the potential causes of the incompatibility (Ishikawa diagram) and its root (5Why method) [25-27]. Also, the choice of the fluorescent method was dependent on the individual needs of the customer who ordered product inspection and the type of product material.

In the first part of the method, the fluorescent method was applied to check the quality of the product (bearing housing). The fluorescent method is one of penetrant tests. In this method, the penetrant has a colorant, so the indicators can be identified by ultraviolet radiation. To make analysis using the FPI, it is necessary to darken the test stand [28-30]. The method of FPI has been presented in the literature [31]. After applying the FPI, the incompatibility on the bearing housing was identified, and it was linear indications. In order to identify the causes of the linear indications, in the second part of the method, the Ishikawa diagram was prepared. The Ishikawa diagram allows for the analysis of a problem using the main categories of the causes of a problem, i.e.: man, material, method, machine, management and environment [3, 5]. And these categories were used to analyze the problem with linear indications on the bearing housing because they were adequate to this problem. Potential causes were noted to each of the categories, from which the main causes were selected (these were two main causes of the linear indications). These main causes were used in the next analysis – the 5Why method. The 5 Why method was applied to identify the root of incompatibility. In this method, the analysis of the root of the problem began from the problem and the main causes of the problem, which were identified by the previous methods (FPI and Ishikawa diagram). In the 5Why method, the

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"Why?" question was asked until the root of the problem was identified [3, 5]. After identifying the problem, improving actions were proposed.

Results

After the analysis of the quality of the bearing housing using the fluorescent method, the incompatibilities were identified. These incompatibilities were linear indications which are shown in Figure 1.

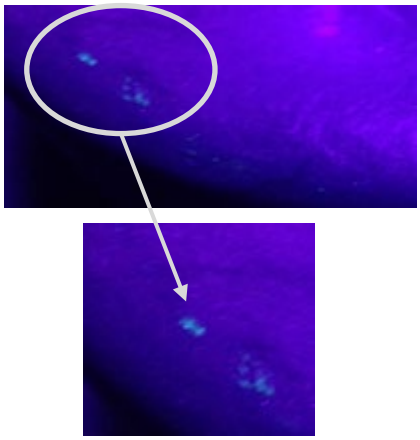

Fig. 1. The linear indications on the bearing housing.

In the next part of the method, in order to identify the potential and main causes of the linear indications on the bearing housing, the Ishikawa diagram was prepared, which is shown in Fig.2.

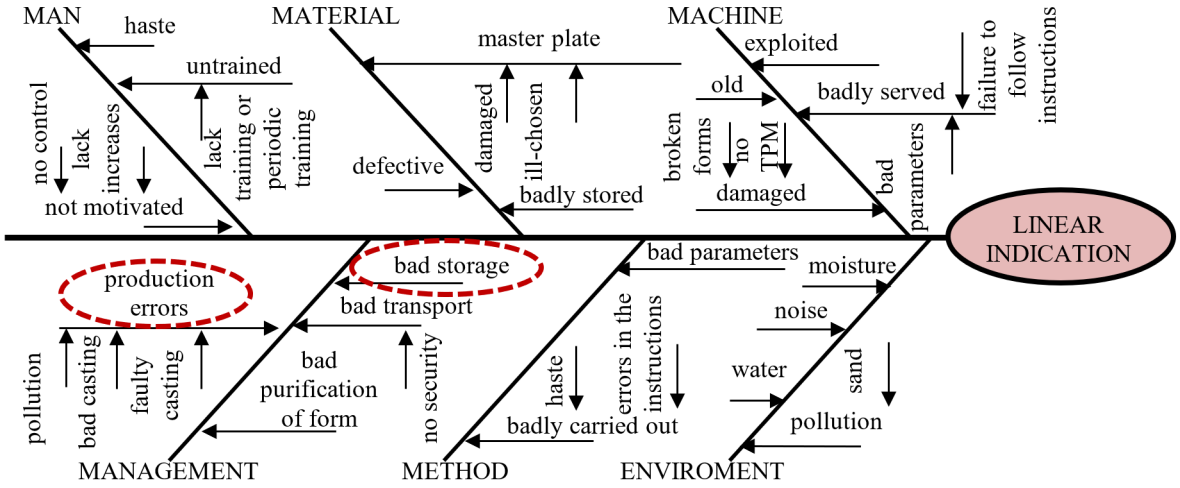

Fig. 2. The Ishikawa diagram for the linear indications on the bearing housing.

The main causes which were selected were production errors and bad storage, and these causes were used in the next part of the analysis with the 5Why method, which is shown in Figure 3.

After the analysis of the problem with the 5Why method, the root causes of the problem were identified. The root cause of the linear indications on the bearing housing was the faulty material from the supplier. In order to eliminate or minimalize the problem with linear indications on the product, improvement actions were taken, which informed the supplier about the root of the problem.

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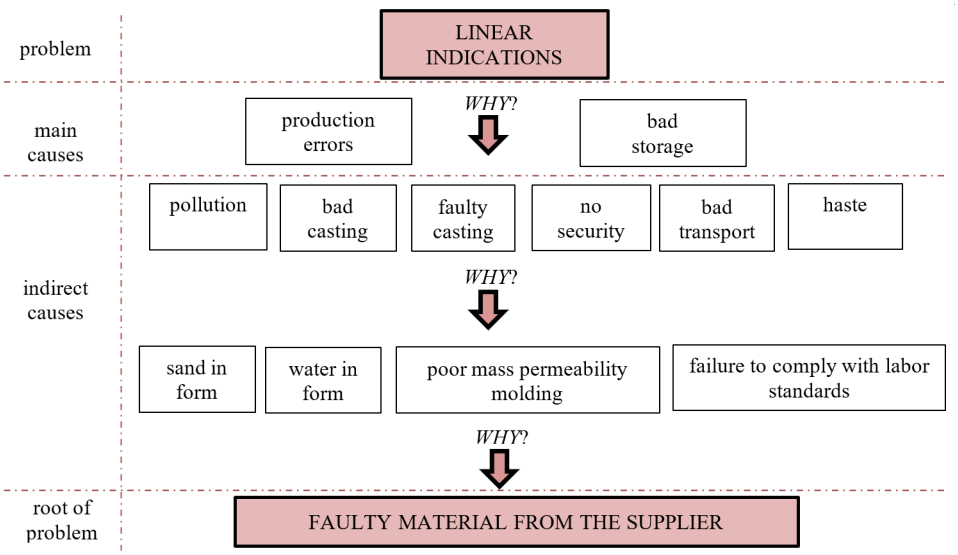

Fig. 3. The 5Why method for the linear indications on the bearing housing.

Summary

Improving the quality of products is an important step for manufacturing companies. In order to make a complex analysis of a product, it is necessary to use adequate techniques that allow for it. The main part of the quality analysis of the product are non-destructive tests, which allow for identifying the problem on the product without destroying it. But it is not effective when the root of the problem is not known. So, to identify the root of the problem it is necessary to use other techniques, i. e. Ishikawa diagram and 5Why method. The use of these techniques was proposed in an enterprise localized in Podkarpacie. In the enterprise, non-destructive tests were applied to different types of products. It was noted that the problem with linear indications on products is often repeated. In order to identify the root of the linear indications, a sequence of the techniques (FPI, Ishikawa diagram and 5Why method) was proposed to use. The aim of the study was to identify the root of linear indications detected by the FPI method on a bearing housing using a sequence of quality management techniques. In the first part of the method, the FPI was made, after which the problem on the bearing housing was identified – linear indications. In order to identify the root of the linear indications, the sequence of selected techniques was used. In the second part of the method, using the Ishikawa diagram the potential causes of the problem were identified from which two main causes were pointed. The main causes were production errors and bad storage, and these main causes were used in the next analysis of the problem (in 5Why method). Therefore, in order to identify the root of the linear indications, the 5Why method was applied. After the analysis of the incompatibility (linear indications) on the product (bearing housing) with the 5why method, it was concluded that root causes were the faulty material from the supplier. In order to eliminate or minimalize the problem with linear indications on the product, improvement actions were taken, which informed the supplier about the root of the problem. It was shown that integrated sequence of quality management techniques with the FPI method is effective to identify the root causes of a product. These sequences can be used to quality analyze other types of products and also to identify the root of other types of incompatibilities.

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