EXPERIENCE WITH OPTIMIZING VISUAL INSPECTION IN PRACTICE

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Abstract

Companies are still trying the efficiency of their processes. It leads to the reduction in their operating costs. The term of cost reduction can be understood, for example, as shortening of production times (particular operations) or increased productivity of operators in the process. The increase of effectiveness of the process also includes its control. In many cases, the assessment of conformity of products with the requirements is provided visually. In case of automated inspection by sensors and other electronic aids, the reliability of such control is much higher than visual inspection by human factor. It is therefore necessary to create such conditions in the workplace that the control by trained operators would be the most reliable.

Keywords

Process, Nonconformity, Visual inspection

Introduction

Control in production process is necessary for the customer to provide delivery of product meeting his requirements. In dependence on its nature, the product can be aimed to quantitative or qualitative properties with individual value. From this reason, the organization must use measurements, monitoring and improving to demonstrate product compliance with the requirements. By control, it is checked not only functionality of the product but also visual aspect that is in many case very important for the customer due to its further use.

As it was mentioned in the introduction, the human factor is at a disadvantage in comparison with the automated control. Optics of the inspection camera or sensor is not subject to fatigue as the human eye. Automated technique is not as susceptible to change working conditions as a person (e.g. temperature fluctuations of workplace, work at extreme temperatures, long-term load). The process of control which is provided by the operator carries a higher risk of failure and therefore there is a need to create such working conditions for people to enable them to achieve high reliability in identifying identical and non-conforming products. Enhancing the reliability of process control with the participation of the human factor is not just the issue of management but mainly of their cooperation with the operators providing this control.

Description of problem and analysis

This article presents a procedure at analysing the changes of visual control operators. Business name and product name remain confidential because of their protection. The organization deals with manufacture of products for the automotive industry which are supplied by the final car manufacturer in Slovakia and abroad.

Some components the product consists of are sensitive to electrostatic discharge. It is a so called ESD (Electrostatic Discharge) zone. The operator wishing to enter this zone can do so only with prescribed protective equipment protecting sensitive components mounted in it.
Production line consists of seven workplaces, in the first one there is mounting itself, the sixth workplace serves for control of completeness and functionality of product. The last workplace of this line serves for placing the products in transport forms that are transported by the inner logistics for visual inspection. Visual appearance is an important characteristic for this product.

The product consists of components presence, functionality, correct assembly and surface quality of which must be inspected. With the exception of functionality, all other mentioned aspects are inspected by visual inspection by the trained operators.

Visual inspection of the product is carried out at the end of the production line. Product control consists of tactile and visual parts. The operators of control have got instructions for the case of ambiguous conformity assessment. There is a sampler for the comparison of product compliance with the requirements and a lamp to provide the right light conditions for control.

The procedure of control by touch and sight (positioning and movement of your finger on the product during the inspection) is exactly specified and must be followed by the operator to detect defects that are visible only at an angle of incidence of light on the product. The surface of the product is divided into areas according to how they are visible to the customer from clearly visible to the invisible area by the customer. For each of these areas, allowable errors are defined.
Compliance of surface finishing with a piece of sampler is very important. The operator carrying out the visual inspection must be trained and at the same time must successfully pass a test of the sensitivity of colours recognition.

Observing the operators of visual inspection, it was found as follows:

- Inspection is performed only by two operators while four working tables are available!
- Break for the rest of the operators is only during lunch and in case of occurrence of controversial assessment of product defect.
- During the whole working hours, the operators assessed the products of only one colour of surface finishing that causes fatigue of eyes that can lead to eye pain and/or headache.
- Lighting of the workplace of visual inspection is different while measured values exceed upper tolerance limit of intensity of lighting by 20 to 30%, the distance of light source above the table of visual inspection is not satisfactory in terms of working instructions.
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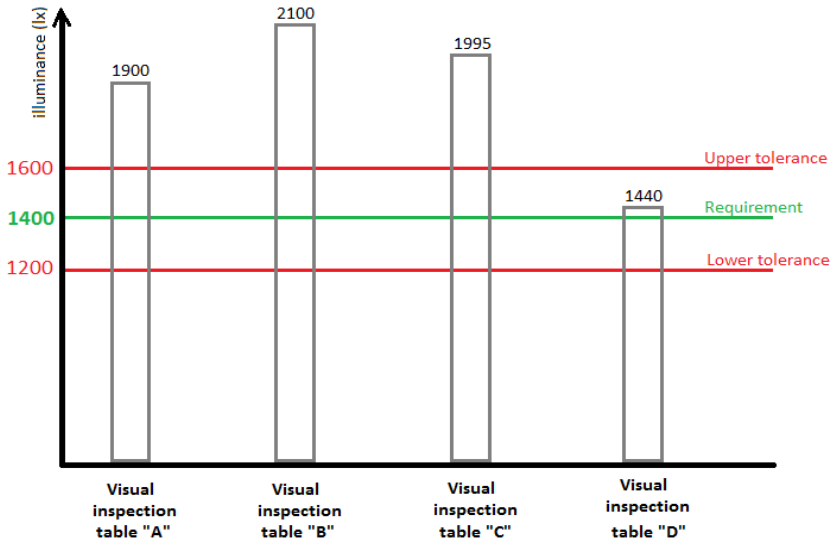

Fig.1 Measurement of illuminance in the workplace visual inspection

Proposed measures

Performance of visual inspection by only two operators was insufficient in several aspects:

- the possibilities of other operators were not used,
- the reliability of visual inspection based only on two operators,
- the disproportionate burden on the operators (eyes),
- the potential risk of occupational diseases.

By colour sensitivity testing of all operators, there were got further operators who can be trained to perform a visual inspection. This allows staff rotation in order to reduce the burden of the eye.

The workplace of visual inspection has 4 working tables on which only two operators were working until the shift work was introduced. Increasing the number of operators of visual inspection a full occupancy of the workplace was achieved while their workload was reduced. The operators do not work under such time pressure increasing so the reliability of visual inspection.

By higher number of compliant and trained operators for visual inspection, a substitutability of other operators will be achieved. Regular breaks of the operators were introduced after 4 hours they worked. The length of break was set at 20 minutes. Within these four hours, it is recommended the operators to have 3 one-minute breaks after each hour to release the eye sight from the refocusing view.

The occupational diseases present an underestimated phenomenon in the production. It is mainly such a type of load where it is difficult to prove its negative impact on the health of the operator. An illustrative example is just straining of the eye by long-term work on the PC or long-term concentrated observation of a small area (visual inspection). Before introducing the shift work, the operators complained of occasional pain of their eyes and headache that could be directly related to their performance of work. By introducing the breaks and increasing number of the operators of visual inspection, prevention of occupational diseases related to this type of work will be increased. Until now, the operators did not complain about the headache or the eye pain.

In lighting of the workplace of visual inspection, the differences in intensity were found while the measured values (Fig.1) exceeded upper tolerance limit of intensity of lighting by 20 to 30%! Improper lighting illuminated the surface of product treated with paint resulting in improper assessment of product quality. Visibility of some surface defects (scratches) was decreased. In principle, it would be expected that more light means better lighting and thus better conditions for detecting errors. However, the opposite was true. The intensity of light conditions for visual inspection was not respected. This fact was also influenced by a new phenomenon appearing in section of visual inspection, it is so called „over-quality“. Doubting worker assessing conformity of the product with the requirements rather discards the product from production as nonconforming than he should accidentally release nonconforming product. It is a moment when doubt of the worker assessing conformity of the product with the requirements is border. In either case, the unnecessary waste! In order to prevent doubts of the operators, powerful light sources were installed to achieve better conditions for the quality of products assessment. Conditions of inspections were significantly negatively influenced by such change. After revealing this fact:

- the same lights were replaced on all working tables,
- the correct and the same light sources were installed,
- the light source was set above the working table as prescribed.

Conclusion

By analysing the visual inspection of the workplace, there were several negative facts found out. This example from manufacturing practice shows to what extent the failure or resourcefulness of human factor is significant.

By introducing the described changes in the visual inspection the reliability of detection of scratches immediately increased. Considering the initial positive impacts, it will be necessary to evaluate their contribution after longer time period.

Each production organization must realize that there must be created suitable working conditions for the worker on decision of which assessment of compliant and non-compliant products depends including not only lighting or temperature but also psychological well-being at work as well as adequate staff evaluation system. The second phenomenon in manufacturing practices (and especially in the automotive industry) is a staff turnover. It also significantly influences reliability of visual inspection that cannot provide long-term stable and reliable performance if the workers in the workplace are often replaced by newer ones (just trained with minimum experience).

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