Evaluating physical work load and posture during testing of welding points – case study

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Abstract

When manufacturing a car, robots are used for welding. To check if the welding points comply with the quality requirements, ultrasonic measurements are carried out. In the current situation, there are 29 measurement plans divided over 10 workstations, spread over the welding department. During his entire shift, a worker carries out one measurement plan on a certain workstation and then proceeds to another workstation. It happens that during the same shift a worker returns to a workstation, he visited earlier, to test another measurement plan.

To reduce the travel time between workstations, the company decided to concentrate the different measurement plans on 6 workstations. In the future workstations will spend more time testing welding points. In the present situation, more than 50% of the workers experienced shoulder and low back problems.

To evaluate if the future situation is ergonomically acceptable, Key Indicator Methods (KIM) was used. Reduction of workstations lead to a reduction in risk score of body movement (KIM-BM) and awkward body postures (KIM-ABP) but the intensity of the physical load stayed the same. To reduce the intensity of the physical load and the time spent in awkward body postures adjustments of the selected workstations were needed.

Introduction

In a large car assembly facility in Belgium, robots are used for welding. To check if the welding points comply with the quality requirements, ultrasonic measurements are carried out. The welding points are tested according to a measurement plan. There are 29 measurement plans divided over ten workstations, spread over the welding plant. The number of measurement plans per workstation differ from one to eleven. During his entire shift, a worker carries out one measurement plan on a certain workstation and then proceeds to another workstation. It happens that during the same shift a worker returns to a workstation, he visited earlier, to test another measurement plan.

The number of welding points to be measured varies from 25 to 143 per plan and takes 4 to 68 minutes. For 69% of the measurement plans the workers spent between 30 and 60 minutes.

To do the measurements each worker has a laptop connected to an ultrasonic measurement instrument. With two fingers the measurement unit is placed on the welding point. On the laptop the worker can see whether the welding point is good or not. To confirm the measurement results, the worker needs to press a few digits on a small numeric keypad.

Each worker has a step with a box to ride from one workstation to another. During the rides between workstations laptop and measurement instruments are in the box.

The different work stations are spread over the welding plant so that the welding points are tested close to the location where the robots weld them. When an error is found, it’s easier to repair the defect. On the other hand a lot of time is lost during a shift because of travelling between work stations.

The company decided to concentrate the testing of the welding points on six workstations, that were designed as ergonomic workstations, to reduce travel time.

Because already more than 50% of the workers experienced shoulder and low back problems, the question was raised if reducing the number of workstations would be ergonomically acceptable, and if not, what additional preventive measures should be taken.

Methodology

Both for the present and the future situation, physical workload was evaluated by observation and video recording. For the present situation a worker was observed and filmed during a normal working day. The future situation was divided in two day schedules, as would be performed in the future. Five different workstations were done in schedule 1 and four workstations in schedule 2. Each schedule was carried out by a worker, who was observed and filmed.

Based on the information we received during the observation and of the videos, different Key Indicators. Methods (KIM) were used [2]. KIM is developed by BAuA, the German Federal Institute for Occupational Safety and Health and was reviewed in 2004 by the European Social Fund lifetime holding and carrying (KIM-LHC), pulling and pushing (KIM-PP), manual work processes (KIM-MWP), whole-body forces (KIM-WF), body movement (KIM-BM) and force body postures (KIM-ABP). They are quick user-friendly tools that can be applied at the workplace itself.

The result of a KIM-tool is a risk score that can be used as an evaluation of the intensity of the load, the probability of the physical overload and the possible health consequences [2] (Table 1).

To evaluate the measuring of the welding point with ultrasonic testing, KIM-MH0 was used KIM-MH0 was used in the way with the step between workstations. Per workstation KIM-ABP was used to evaluate the body posture during measuring. This means that per observed working day several KIM-ABP, one KIM-MH0 and one KIM-BM were filmed.

Results

Comparing (Table 2) the scores of the LMM-Multi-E in the different situations, future schedule 2 has the lowest scores for KIM-ABP and KIM-BM but has the highest scores for intensity of load (KIM-MH0).

Future schedule 1 has the lowest scores for KIM-MH0 but scores in the middle for KIM-BM and KIM-ABP between present and future schedule 2. Although the scores for KIM-BM and KIM-ABP are in the future schedule 1 and 2 lower than the present, the risk score stays in the same category of load intensity: 20 – 50 slightly increased, 50 – 100 substantially increased and >100 high. With KIM-MH0 the score of future schedule 1 is in load intensity 3 while for the other situations the load intensity is 4.

By concentrating the testing of the welding points on six work stations, there is improvement score-wise for KIM-BM and KIM-ABP between the present and the future and for KIM-MH0 between the present and future schedule 1 (Table 2).

Discussion

As the results show in table 3, the risk scores for measuring the welding points are very low in the present and future situation, because the way of measuring remained the same. Only with future schedule 1 the risk score is a little lower than the rest because the total measuring time is less. But the other situations. Therefore, to reduce the intensity of the load it is advised that the welding points are tested according to a Typical working day to determine the daily load. The latter is only possible when the time spent measuring is reduced by at least 50%. This means job rotation with another task where there is no risk for repetitive work. This is in contradiction with what the workers perceive. They didn’t see the need of changing the measuring method and tools.

The risk scores for KIM-BM for the current and future situations were less than 50, indicating that the intensity of the load was low. The physical overload is possible for less resilient persons. According to the workers, moving from one work station to another was a welcome change with regard to the awkward positions they had to work in when carrying out certain measurements.

Because already more than 50% of the workers experienced low back and shoulder problems improving the body postures during measuring was the most important measure to be taken. To reduce the combined risk score of KIM-ABP it is necessary to adapt the workstations.

The two of these workstations had rotating fixtures so that the testing piece can be rotated such that the worker does not perform the testing in unacceptable postures for the different joints (low back, neck, shoulders, elbow) as mentioned in the European norm EN 1005-4 [1].

Discussion

At another work station the part to be measured could be turned around its axis but was still too high. For this workstation it was advised to provide an in adjustable work platform.

The other workstations were not adjustable. To reduce the time that workers worked in awkward body posture [6] it was advised that these workstations can be turned around.

Conclusion

When comparing the results of LMM-Multi-E for the present and future situations with the perception of the workers, there is a difference improving the working postures was the most important measure for the workers. With the LMM-Multi-E indicated that measuring instruments and work postures needed additional preventive measures to lower the intensity of the work load during measuring.

Table 1: Relationship between KIM-risk score, intensity of the load and physical overload

<table>
<thead>
<tr>
<th>Risk score</th>
<th>Intensity of Load</th>
<th>Physical overload of the load</th>
</tr>
</thead>
<tbody>
<tr>
<td>low</td>
<td>slightly increased</td>
<td>possible for less resilient persons</td>
</tr>
<tr>
<td>moderate</td>
<td>substantially increased</td>
<td>possible for normally resilient persons</td>
</tr>
<tr>
<td>high</td>
<td>Physical overload likely</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Risk score LMM-Multi-E for current and future situation

<table>
<thead>
<tr>
<th>Situation</th>
<th>KIM-MH0</th>
<th>KIM-BM</th>
<th>KIM-ABP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Future schedule 1</td>
<td>45</td>
<td>36</td>
<td>10</td>
</tr>
<tr>
<td>Future schedule 2</td>
<td>101.9</td>
<td>76</td>
<td>38.9</td>
</tr>
</tbody>
</table>

Table 3: Evaluation of working schedule

1. BAuA, Hinweise zur Nutzung des PDF-Formulars zur belastungsbezogenen Gesundheitsuntersuchung (LMM-Multi-E), (2020)
2. BAuA, Work-design/Physical workload/Formular zur Key indicator-method (KIM-INDEX) (2020)
5. Eurostat, the statistical office of the European Union. Accidents at work and other work-related health problems (source IFS, Updated: 30/02/2015)