ELIMINATION OF NON-VALUE-ADDING OPERATIONS AND ITS EFFECTS ON EXPOSURE VARIATION AT AN ORDER-PICKING WORKPLACE

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The elimination of non-value-adding operations is a common measure to increase efficiency. However, this can lead to monotonous working procedures and one-sided workload. Aim of the present paper was to examine if, for the example of an order-picking workplace, the elimination of non-value-adding operations leads to a more one-sided workload. For the study a Predetermined Time System (MTM) was combined with a working posture analysis (OWAS). It was shown, that non-value-adding operations can provide an opportunity for exposure variation. This aspect should therefore be considered in the ergonomic risk assessment.

Introduction

The reduction of time losses and non-value-adding operations is often achieved by splitting up the work into simple, standardized work tasks. However this can result in fewer opportunities for variation and recovery. It is generally believed, that variation in biomechanical exposure is beneficial to musculoskeletal health and well-being (Wells, 2007), though empirical evidence for this assumption is low (Mathiassen, 2006). Visser (2006) showed, that without sufficient recreation periods, muscles can be damaged. In a laboratory study, Sundelin (1993) found out, that short breaks reduce muscle fatigue, even if the total amount of work remains constant. Further studies show, that the introduction of repetitive, short cycled work can lead to an increase of musculoskeletal disorders (Fredriksson, 2001; Moreau, 2003). In the present paper the workers body posture at an order-picking workplace was analysed. It is examined whether the elimination of non-value-adding operations leads to a more one-sided workload. Socio-technical aspects (as defined by Cherns, 1987) are not scope of the study.

Method

For the study a Predetermined Time System (MTM), which is used to describe the temporal order of operations, was combined with the OWAS-method for continuous posture logging. Commonly used workload-assessing-techniques, for instance EAWS (Schaub, 2012) are not suitable here, as they do not consider the temporal order of tasks, or consider only single aspects of physical exposure, for example liftings (Waters, 2007). Workers were video-taped during their regular work at the observed workplace. Afterwards, work-processes were converted into OWAS-codes and described in terms of the MTM-1-system, using the recordings. The worker walks down a corridor with storage racks on both sides and a belt-conveyer in front of one of the storage racks. He has to search the correct box, put an adhesive label on it and then put the box on the belt conveyer. The sequence of operations and classification into value-adding and non-value-adding operations for one pick is presented in table 1. For the study an exemplary order of 14 picks was analysed.

Table 1: Classification of value-adding and non-value-adding operations

Task	Classification
search for the next box	non-value-adding
walk	non-value-adding
put label on box	value-adding
put box on conveyer belt	value-adding

This workplace is compared with a virtual workplace, at which all non-value-adding operations are eliminated. In the following the original, “real” workplace will be referred to as “workplace 1”, the “virtual, optimized” workplace will be “workplace 2”.

Results

The following observations could be made for the different body-regions. In the following, the numbers in brackets refer to the OWAS code as defined by Karhu (1977). For workplace 1 the “neutral” back posture “straight (1)” offered opportunities for short, recreational rests for this part of the body. These opportunities were smaller in numbers at workplace 2. Regarding the upper limbs, workplace 2 shows an increased portion of “limbs above shoulder level” compared to workplace 1. Concerning the lower limbs, workplace 1 is mostly characterized by the alternation of “standing (2)” and “walking (7)”. Workplace 2 in contrast, is very one-sided as it mostly consists of “standing”. The factor “load” was not observed due to the fact, that the weight of the boxes is below 10kg and the OWAS method makes no distinction between 0 and 10kg.

Discussion

Non-value-adding operations serve as an opportunity for recreational rests between work-phases that require bad working postures. When analysing the temporal distribution of working postures, it was conspicuous that at workplace 2 the block lengths of single postures were generally more homogenous in length, than at workplace 1 (see fig.1). As an example, back postures during the first 60s of work cycles at workplaces 1 & 2 are shown in figure 1.

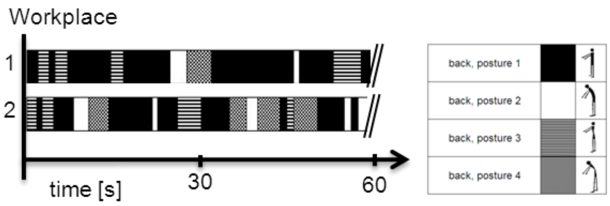

Figure 1: Example of temporal distribution of body postures (back, 60s)

Mathiassen (2006) stated that a reasonable way to quantify exposure variation would be the use of common statistical measures, as this would provide a possibility to compare different studies and workplaces. Thus, a possibility to quantify this aspect of exposure variation would be the coefficient of variation (CV) of the block length for each body-region. The CV is defined as the ratio of the standard deviation σ to the arithmetic mean μ of a distribution. The CV makes data sets with different means comparable, because it is a normalized measure.

In this special case:

$$CV = \frac{\sigma}{\mu} = \frac{standard\ deviation\ of\ the\ block\ length}{mean\ block\ length}$$

As a possible interpretation of the CV, the following thoughts can be made. High values of σ, and going along with it high values of CV, stand for high differences in the actual lengths of different postures. In other words, the worker sometimes stays in a certain posture for longer, and sometimes for shorter periods, which can be interpreted as a feature of a workplace with a high posture variation. The other way round, low values of CV can be seen as a characteristic of a highly repetitive workplace. The application of the CV on the here described workplaces shows the following results (*CV for workplace 1, CV for workplace 2*): For the categories *back (0.83, 0.66)* and *upper limbs (1.85, 1.62)* the values of CV were lower for workplace 2 than for workplace 1. For the *lower limbs (0.82, 0.83)* no significant change was observed. Results are shown in figure 2.

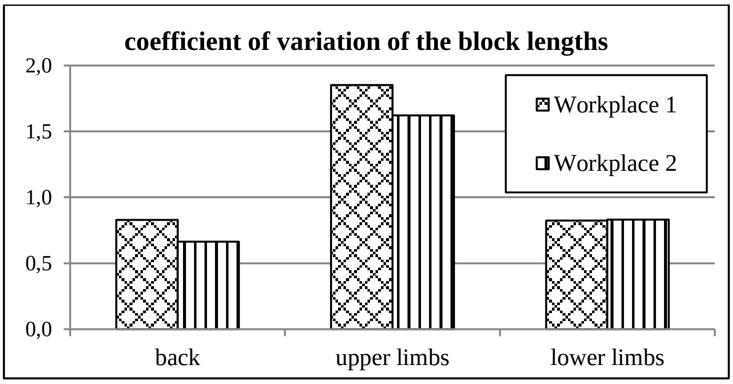

Figure 2: comparison of the CVs of workplace 1 and 2

We would like to point out, that block length variation covers only one aspect of exposure variation. Standing alone, it is not an adequate criterion for the assessment of exposure variation. Regarding posture logging with the OWAS method (as shown in Fig.1) the following further aspects of variation should be considered. First, the mean block length, as a measure for the time spent in one posture, second, time ratios for all posture categories. For example, this would allow investigating whether a worker has a variation between standing, walking and sitting, or not.

Conclusion

It was shown, that the change of the temporal sequence of tasks, particularly the elimination of non-value-adding work, can have a significant influence on the physical workload. Existing ergonomic methods do not consider this aspect. The here presented approach is a contribution to fill this gap. The results for the examined example are promising, yet further validation is necessary. The CV seems to be a useful indicator when analysing exposure variation, but covers only a single aspect of exposure variation. Further research could therefore lead to a set of key figures for the quantification of exposure variation.

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