Implementation of Digital Ergonomic Applications for Workload Screening

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Abstract – Digital ergonomics as a part of micro-ergonomics is solved in practice at the company level. The basic feature of digital ergonomics is an operative approach to analysis and subsequent problem-solving. To implement digital ergonomics, it is necessary to monitor trends and new components in cooperation with the education of responsible employees. One of the ways to approach ergonomic problems effectively, quickly, and operatively is to use digital ergonomics tools. The presented article is focused on the implementation of digital ergonomic applications for the evaluation of workload, which very often occurs in the workplace. The article describes the basic fast methods of workload evaluation and their possibilities in the application of mobile devices.

Keywords – digital ergonomics, screening, mobile application, workload

- anthropometrical – workplace solutions of size and layout
- physiological – optimal using of the physical capacity of human
- the aesthetical – colour design of workplaces
- hygienic and safety – occupational safety conditions
- psychophysiological – optimal using of senses
- psychological – optimal involvement of workers

Figure 1. Basic elements of ergonomics [4]

1. Introduction

A set of criteria is used to analyse and evaluate the ergonomic system, which the individual elements of the system must meet regarding the requirement to adapt the technical elements and working conditions to the company's performance capabilities. [1], [2], [3] These criteria include:

Elements of ergonomics (Figure 1.), which deals with the work and working conditions of a worker, work on the assumption that where conditions are adapted to employees, they perform better, they have lower morbidity and better productivity indicators are recorded. Appropriate use and application of knowledge from ergonomics to the work process allows companies to save considerable sums of money, both in the short and long point of view. [4]

2. Evaluation of Workload

The workload can be characterized as a measure of the balance between a person's performance capacity and the requirements of work activity, as well as the conditions under which the work is performed. The burden is therefore the result of a mismatch between the requirements and conditions on the one hand and the characteristics and condition of the person on the other. It is, of course, an individual understanding, because each person perceives the conditions and requirements placed on his person by his objective reality. Based on the effects and consequences, the workload is divided into three categories:

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- optimal workload - all factors of workload bring satisfaction and relaxation, create a feeling of well-being, physical, mental, and social satisfaction while enabling safe and effective work; the work effort corresponds to the characteristics of the worker and there is no work fatigue yet
- acceptable workload - some load factors exceed optimally, resp. even recommended values, a person feels a disruption of well-being, reduced performance, and a premature feeling of fatigue; work effort exceeds the limit of resistance of the employee's personality traits and works fatigue can be eliminated by ordinary rest, breaks and the like
- unacceptable workload - some values of external factors exceed the permitted limits, pathological changes occur and consequent damage to the worker's health; work strain causes permanent deformation of the personality characteristics of the worker and work fatigue is chronic, difficult to remove by conventional methods and means

Several methods are used in practice to assess the workload. Physical exercise is directly affected by the position in which it is performed. The same work in different positions can cause a different reaction in the form of human effort to perform it. Therefore, one of the components of a person's workload evaluation is the working position. The working position is defined by the whole spectrum of objective conditions, such as the construction and design of technological means, dimensions, and equipment of the workplace, working movements and others. Subjectively, the position is influenced by the dimensions of the person. The basic ergonomic methods for evaluating the working position include the RULA method, the REBA method and, depending on the nature and type of the activity, the NIOSH analysis. [5], [6]

RULA is a method that has been developed to assess the exposure of individual workers to ergonomic risk factors, especially where there is a load on the upper limbs. It includes not only the evaluation of the upper limbs (wrists, arms, and shoulders), but also the neck, torso, and legs. RULA evaluates a certain posture, and the evaluation of these positions must be captured at the highest postural load (Figure 2.). This method consists of observing the activities of a worker in several work cycles. It then evaluates the positions of individual parts of the body for the deviation from the neutral position. In each part of the body are described the so-called base positions to determine the base score. It is a different range of flexions and extensions, which are scored in ascending order with increasing deviation from the neutral position. In addition, there

are descriptions of positions to obtain additional points for determining the so-called variable scores, such as rotations and bows. Strength scores are also included in the evaluation. These are the weight of the handling load and the influence of the static position at work. The obtained points for individual parts of the body together with other counted types of scores are subsequently inserted into the appropriate tables and the result is the so-called Rula score. [7]

Figure 2. RULA worksheet [7]

The second of the most used methods is the REBA method, which assesses ergonomic risks using postural analysis and evaluates the biomechanical and positional load on all parts of the body. Due to individual scoring, the body is divided into several segments with planes of movement. The method assesses the musculoskeletal system and follows from the RULA method. Both methods are a means of assessing the positional load of individual parts of the body. The individual scoring is related to the planes of movement and therefore the body is divided into sections. The evaluation needs to identify positions at risk. These may be physiologically harmful positions or work positions in which the worker remains for most of the working time. As with the RULA method, the REBA method is a point of evaluation of body parts. Points are awarded according to the movements of the limbs and other parts of the body. The resulting rating determines the weight of the load. REBA considers the effect of gripping when working with a load. This method allows the joint analysis of the position of the upper limbs (arms, forearms, wrists), torso, neck, and legs. It also defines other factors considered to be decisive for the final assessment of postures, such as the loading or processing of the load, the type of the grip or the type of the muscular activity of the worker. It allows the evaluation of static and dynamic positions and includes the possibility of sudden changes in posture or unstable positions (Figure 3.). [8]

Figure 3. REBA worksheet [8]

An important ergonomic evaluation factor in production practice is also the assessment and implementation of NIOSH equations (Figure 4.), which arose due to the evaluation of activities related to lifting loads and the occurrence of injuries in the lower back. The very output of these equations is the so-called RWL (Recommended Weight Limit). This indicator represents the value of the load that can be realized by a health worker for 8 hours. [9]

Figure 4. NIOSH worksheet [9]

3. Mobile Tools of Digital Ergonomics for Fast Workload Screening

In today's digital world, which is constantly evolving due to the ongoing pandemic of COVID-19, there is a rapid expansion of digital tools implemented in every sphere. The production area is one of those areas where digitization is advancing at a high pace. Not only production sections or workplaces are digitized, but also complex

production blocks and entire halls, where software solutions are implemented from the beginning, i.e. from research and development to the control and measurement processes themselves. The individual factor is to a large extent included in the individual processes, which also needs to be monitored, and its work activity rationalized for many reasons. It is for this reason that ergonomic rationalization is used at various levels in the manufacturing sector, which is increasingly supported using digital tools that improve and speed up evaluation processes and provide quick opportunities to address shortcomings. In addition to the standard mostly financially demanding software solutions offered by corporations, it is also possible to implement the so-called "Fast screening" evaluations carried out through freely available mobile applications. Of course, these solutions are not standardized and serve solely for a quick assessment of the underlying situation, but are easy and quick to apply in production, providing preliminary results based on which it is then possible to take a position and adopt further procedures.

For such solutions, it is possible to include the online application ErgoMine (Figure 5.) for the assessment of physical exertion using the RULA method, through which it is possible to interactively create an evaluation sheet and electronic assessment of RULA scores of both sides of the body or right and left side separately at a given time and place.

Figure 5. The main screen of ErgoMine

In the individual parts of the questionnaire, it is possible to fill in the scoring table interactively based on the current situation exactly according to the structure of the standardized RULA worksheet (Figure 6.).

Figure 6. The interactive online environment of the RULA method in ErgoMine

During the entire online completion of the worksheet, a continuous check of the created RULA score is ensured, with the subsequent possibility of exporting the achieved data in the form of an electronic report (Figure 7.).

Figure 7. Result possibilities of RULA method in ErgoMine

Another possibility of implementing digital ergonomics with the use of mobile devices is the application used to recalculate the NIOSH lifting method (Figure 8.). The simple user interface ensures an operational change of data, based on which an immediate evaluation of "lifting processes" is possible.

Figure 8. The interactive online environment of NIOSH analysis in Intergo

4. Conclusion

The application of digital ergonomics in practice is necessary, as it prevents the emergence of hazards at work, reducing the quality of work and indirectly reducing the competitiveness of the society. The presented article was aimed at providing a general overview and presentation of the possibilities of implementation of digital ergonomic applications for the evaluation of workload using mobile devices. There are several applications and software solutions, of which only selected free online tools were introduced, helping to basically screen the emerging situation. It is the digital ergonomics that is a tool based on which today's society can move forward in the digital age also in the assessment of the man-machine-environment system.

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