How can ergonomics help to decrease corporate costs? - Evaluation of Local Muscular Load

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Abstract: - In the 1990s, some authors started to examine the relationship between the work environment and the health condition of employees. They named an unsuitable work environment as being a cause of health problems of employees. They also claimed that the work environment was a crucial and often neglected part of working conditions. There is so many practical view a suitable work environment as a tool towards fulfilling corporate needs: maximum output at minimum cost. The rising costs associated with work-related injuries or occupational diseases are the most significant impacts of an inappropriate working environment. In connection with the development of work-related injuries or occupational diseases, there are several groups affected by costs: those workers where a loss of earnings, damages for pain and suffering, costs associated with treatment and material damage may occur; those employers affected by an adequate share of sickness, pensions, healthcare, costs of occupational care etc., and finally the insurance companies and the state involved in healthcare. The consequences of inappropriate working conditions are easily defined as worsening of the worker's health and economic impact on a micro and macroeconomics level. However, the work environment is also viewed as one determiner of the quality of work, performance, satisfaction, work efficiency, work-related stress and also the worker's creativity.

This paper is focused on the comparison of currently available methods how to evaluate Local Muscular Load. Based on the Czech legislative environment there is the only one method of measurement using integrated electromyography (EMG). But our article offers an overview some other functional methods that we can use for evaluation of Local Muscular Load in the world. Furthermore we described completely new and innovative method developed by Tomas Bata University in Zlin, in cooperation with other Czech universities and Institutions. This method obtained Utility model in Czech Republic and now it is in the patent process.

Key-Words: - Ergonomics, Local Muscular Load, Electromyography, Long-Term, Excessive and Unilateral Overload, Job Rotation.

1 Introduction

Ergonomics as a science uses optimization of working conditions. It plays a main role in the reduction of health costs and also in the elimination of negative influences of the work environment (Rowan and Wright, Facilities, 1995). The results are also obvious in maximizing human health, comfort and well-being while working (James and Mark, Professional Safety, 1993). Ergonomics believes that the human body is limited by range of motion, speed, endurance and strength; therefore the goal of ergonomics is to evaluate the person, work environment and working task and then to set to meet the worker's needs (Alnaser, Work, 2009). Basically, the aim of ergonomics is to understand the relation between the human and the system, which means the working environment with its risk factors, method of working, working tools, machine, technologies etc., and to fit the task to the individual, not the individual to the task (Fernandez, Facilities, 1995). Apart from to cost reduction and health protection, ergonomics has been involved in improving the worker's productivity, quality, job satisfaction, loyalty and absenteeism.

2 Health costs

Worldwide, healthcare is a very hot issue, in particular its funding. Health costs represent one part of corporate and government spending and their trend is constantly growing. Many of the reasons of increasing health costs can be defined as longer life expectancy (Polder et al., Social Science&Medicine, 2006), aging population (Schneider and Guralnik, The Journal of the American Medical Association, 1990), obesity and obesity-related diseases (Baal, Polder, Wit et al., PLoS Medicine, 2008), diabetes (Simonet al., General Hospital Psychiatry Journal, 2005), standard of living, new technologies or the work environment which is not always well defined.

In the 1990s, Becker (Prevention&Intervention in the Community, 1985) started to examine the relationship between the work environment and the health condition of employees. He named an unsuitable work environment as being a cause of health problems of employees. He also claimed that the work environment was a crucial and often neglected part of working conditions. Dul and Ceylan (Ergonomics, 2010) view a suitable work environment as a tool towards fulfilling corporate needs: maximum output at minimum cost. The rising costs associated with work-related injuries or occupational diseases are the most significant impacts of an inappropriate working environment (Rowan and Wright, Facilities, 1995). In connection with the development of work-related injuries or occupational diseases, there are several groups affected by costs: those workers where a loss of earnings, damages for pain and suffering, costs associated with treatment and material damage may occur; those employers affected by an adequate share of sickness, pensions, healthcare, costs of occupational care etc., and finally the insurance companies and the stateinvolved in healthcare.

The consequences of inappropriate working conditions are easilydefined asworsening of the worker's healthand economic impact on a micro and macroeconomics level.However,the work environment is also viewed as one determiner of the quality of work, performance, satisfaction, work efficiency, work-related stress (Hedge et al., Ergonomics, 1995) and also the worker's creativity (Dul and Ceylan, Ergonomics, 2010).

3 Problem of the Local Mucsular Load

3.1 The local muscular load

The local muscular load is a load on small muscle groups during the work performance of the upper limbs (Cesko, 2007). It is the involvement of fingers, hands and forearms while working. Most often, the local muscular load is developed by a work characterized by fine motor skills, monotony, work in unsuitable working positions of the upper limbs or by the presence of other factors (cold, vibration, etc.). The local muscular load is also viewed as a long-term, excessive and unilateral overload of muscle and outside-muscle structures of the elbow to the fingertips of the upper limbs. This load is also known as RSI - Repetitive Strain Injury. (Jirak, Buzga, Pektor, 2014)

In the Czech Republic, very often local muscular load causes the most common occupational diseases (Fenclova, Havlova et all., 2014). This is the carpal tunnel syndrome, the most common neuropathy. (Minsk, Minskova, 2014) The term neuropathy is used in connection with an indication of disease of the nervous system, specifically peripheral nerves that connect the central nervous system with organs and tissues throughout the body.

2.1.1 The Carpal Tunnel Syndrome

During the carpal tunnel syndrome, a compression of the median nerve, situated in the carpal tunnel in the wrist, occurs. Carpal tunnel is the space at the bottom and on the sides defined by wrist bones. The central nerve is the strongest nerve innervating the upper limbs. It provides the ability to bend and rotation of the hand, fingers and thumb. (Spektrum zdravi, 2013) When the median nerve is compressed, limited innervations leads to limitations of sensitivity and movement of the fingers. Other symptoms include tingling, pain and weakness of the whole hand. Currently, the carpal tunnel syndrome is connected with profession, is thus a professional neuropathy. Other reasons for its emergence may be an inherited predisposition to carpal tunnel shallow, diabetes, rheumatoid arthritis, hypothyroidism, a hormonal disease or fracture of mandrel forearm bones.

Statistics show that to 30% of workers in high-risk groups suffer from carpal tunnel syndrome (Spektrum zdravi, 2013). The most vulnerable group are definitely women in middle-age (between 40 and 50 years).

3 Problem Solution

3.1. The Integrated Electromyography

So far in the Czech Republic, integrated electromyography (EMG) is the only official method for measuring of local muscular load. Only the entities having the special permission can realize these measurements.

The expended muscle strength, the number of movements and the operating position of the limbs are identified and judged during the evaluation of local muscular load, depending on the extent of the static and dynamic parts of a person´s work during an average eight-hour shift. Equipment that is used for the measurement is a non-invasive electromyography using a Holter EMG. This personal device enables the observation of the (potential) electrical activity in the individual muscle groups of the forearm in real time. The device then stores this activity and exports it to a PC. The Holter EMG (i.e. data collection station) is shown in Figure 1.

Fig.1: Holter EMG (Gaďourek, Lebeda, 2010)

Five electrodes are placed on both upper limbs to scan the muscle activity. As the Figure 2 shows, two electrodes are located on the extensors (muscle groups on the top of the hand), two electrodes are placed on the flexors (muscle groups at the bottom of the hand) and one ground electrode on the tendon in the elbow. Concurrently, the ultrasound gel is applied to the electrodes to ensure flawless skin contact and conductivity of signals.

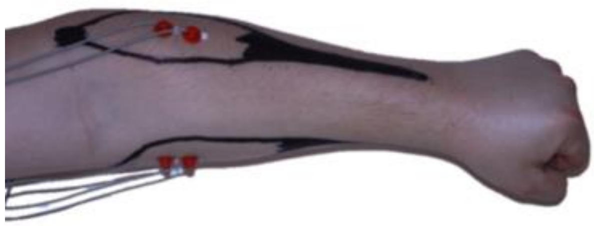

Fig.2: EMG electrodes placed on the arm (Source: authors)

Prior to starting to take measurements, it is necessary to individually determine the maximum muscle strength for each upper limb. Each limb is put into a predetermined position (upper arm parallel to the body, with the forearm held at a right angle). Measurement is performed by the analog dynamometer.

The highest activity of electrical potential is recorded as 100% Fmax for measuring the muscle groups of the flexors and extensors of the forearm. With special software (see Figure 5) it was possible to evaluate individual EMG signals, to separate them in time, calculate the average expended muscle forces (% Fmax), show the frequency analysis of individual muscle forces (0-100% Fmax), etc. is possible through the special software presented in

Figure 4. The Figure 3 shows the output of flexors and extensors of both upper limbs.

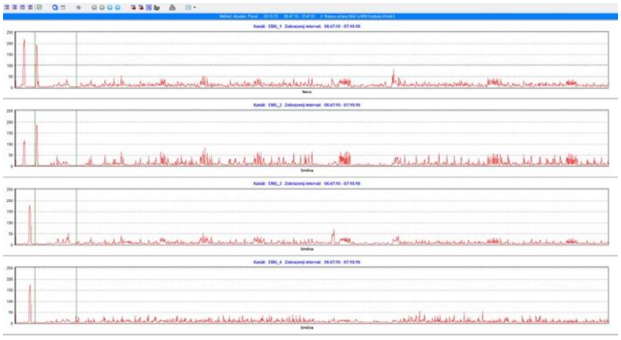

Fig.3: Output from the EMG Holter (Source: authors)

Expended muscle group in one of the two required parameters for measurement of local muscular load. The second required parameter is number movement conducted per work shift. The number of movements of the hand and forearm were determined separately for each upper limb. This activity is done directly in the workplace, or later through the analysis of audio-visual recordings made during the monitored work. The obtained values is time-weighted per average work shift, based on the time frame or by the number of finished products (the real performance, standard).

After the measurements is taken, the risk factors associated with local muscular load are objectified. The evaluation of the measured results is carried out by comparing them to the health and safety limits specified in §25 of Government Decree No. 361/2007 Coll., as amended. The health and safety limits for local muscular load are represented by the value of the expended muscle strength; the number of movements of the hand and forearm during the shift (these movements are relative to the average shift time-weighted value for expended muscle strength); and the average minute counts of movements of the small muscles of the hand and fingers in an average eight-hour shift (Cesko, 2007). The determination of work as being hazardous or non-hazardous is based on whether the work in question complied with or exceeded the legally stipulated health and safety limits.

4 Conclusion

Ergonomics brings many rules which should be followed when designing a workplace and work environment. It regards the rules to the size of the workplace (table height, amount of floor space, reach distances etc.), manual handling of loads, working positions,local muscular load, physical factors (lighting, noise, dust), chemicals and mixtures and many others.However, Cohen et al. (Elements of ergonomics programs, 1997) remark that the scope of ergonomics is much broader. Ergonomics also offers a range of tools to evaluate the work environment and to implement ergonomics principles – checklists, RULA (Rapid Upper Limb Assessment), OWAS (Ovako Working Posture Analysis System) etc. To be able to effectively implement ergonomics principles, the knowledge of many sciences such as anthropology, physiology, medicine, occupational therapy, psychology, tool design etc. are needed.

In ergonomics, prevention plays a crucial part. Exploring ergonomics after a health issue, occupational injury or illness has occurred is a very wrong strategy. Prevention programmes must be included within all activities. Ergonomics prevention prevents and decreases the risks of developing a serious health problem.An effective way of prevention in the working environment is through continuous ergonomics screening. It is a perfect and effective way of finding out risk in the workplace before the formation of an accident (Chiasson et al., Applied Ergonomics, 2011).

The mentioned claims unequivocally confirm the fact that the work environment is a key element in business and working processes, and helps tocost reduction, health improvement, productivity, effectiveness growth etc. The implementationof ergonomics rules into corporate activities is a highly topical issue and ergonomics is an excellent tool to care for the working environment and should become an essential part of all processes.

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