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The Link between Ergonomics and Occupational Diseases

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Abstract**—** Ergonomics is a useful tool for creating a healthy and safe workplace. The long-term action of harmful conditions on the health of workers is the emergence of occupational disease, and the firm's increased compensation costs associated with these diseases, but is also the loss of time needed for educating and including new workers in the work process. The article deals with the link of ergonomics to occupational diseases, factors which influence these diseases. In the conclusion, a model is described to help reduce the risk of selected occupational diseases using ergonomic principles and knowledge.

Keywords**—**ergonomics, occupational diseases, optimization, workplace health

I. Introduction

PRODUCT life cycle, from the initial idea of creating something to put on the market, to its service and recycling, is closely intertwined with the human. It shapes the idea of producing something new or something to innovate, this concept gives a clear structure, purpose and a sense of use. It is not enough to produce only high quality, quickly and meet as closely as possible specific customer requirements. Employers are increasingly more aware that only through their employees are they able to meet market demands and only if they are guaranteed a safe workplace, where there is no risk of injury and where they will be able to safely carry out their tasks without detriment to their long term health.

Ergonomics is the discipline that has to change the '*mechatronic*' approach, i.e. designing the work environment without taking into account the limits of man, to the so-called '*anthropometric*' approach to the work environment, which adapts to the capabilities, skills and abilities of man. Ergonomics uses the application of appropriate methods to improve human health [1].

Health at work means creating physical, mental and social well-being at work. In terms of economic efforts to increase both quantity and quality while reducing costs, this value is not a priority, yet it is evident that health of workers makes up a significant percentage of the cost of economic losses from occupational accidents and diseases related to work performance. The European Union, when compared to other world centres, is characterized by placing equal importance on both social and economic areas in efforts to ensure sustainable growth. Resources attained in Europe are a direct or indirect source of human labour. "*That's why a healthy, productive, skilled and motivated workforce is a key element of the general socio-economic development of the EU and its Member States*" [7]. Prevention of health risks and protection and promotion of health has a positive economic effect at a national and company level, and thus the health of workers forms the foundation of effective performance at work for an employer [7].

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II. Theoretical Part

A. Ergonomics

Ergonomics is one of the youngest scientific disciplines to examine patterns of labour, and uses the knowledge of other disciplines such as psychology, work, work physiology, anthropometry, hygiene safety, etc. [4] According to the official definition by the International Association of Ergonomics, ergonomics is "*the scientific discipline to optimize the interaction between humans and other elements of the system and using the theory, knowledge, principles, data and methods to optimize human well-being and performance of the system* "[1].

Ergonomics is the study of relations in employment systems, revealing their relationship and effects and creating sets of organizational, technical and personnel measures, such as the application of relevant knowledge to the construction of labour resources, equipment and layout of workplaces, in creating an optimal healthy working environment, etc. In addition to health as the main objective, ergonomics has a significant influence on economic indicators [2].

B. Work and health in the workplace, injury

Health of workers is influenced by work and external influences and personal dispositions. The assessment of professional dispositions and lifestyle factors therefore requires a multidisciplinary approach [7]. Diseases of the nerves, muscles, tendons and supporting structures are classed as musculoskeletal disorders (MSDs) and most of them are ranked in the list of occupational diseases. Most of these are cumulative disorders caused by repeated prolonged exposure to a high workload.

The best prevention against MSDs is to implement ergonomic principles which, according to studies, may reduce disease by 30-40%. When evaluating ergonomic risk using many methods (such as ergonomic checklist, gneiss, Reba, etc.). In recent years, simulation and modelling of workplaces to match the principles of ergonomics has been used [3].

Damage to health at work is a socially undesirable phenomenon, because it brings significant economic and moral damage [7].

This paper is dedicated to occupational diseases, i.e. those illnesses resulting from the harmful effects of the working environment. In the Czech Republic the recognition of occupational diseases is subject to Government Regulation No. 209/1995 Coll. and these diseases can be recognized, provided they meet the following requirements:

- They are included in the List of occupational diseases
- They were created under the conditions specified in the List of occupational diseases

Occupational diseases in the Czech Republic are divided into six groups [5]:

- Occupational diseases caused by chemical substances
- Occupational diseases caused by physical factors
- Occupational diseases of the lung, pleura and peritoneum
- Skin diseases
- Infectious and parasitic occupational diseases
- Occupational diseases caused by other factors

Most of these diseases are caused by failure to set safety regulations. From an ergonomic point of view only a small part can be affected. For example, a chlorine leak in the workplace cannot be prevented by the use of more suitable work equipment, or re-organization of the workplace or a change in workflow. It can only be ensured that the leak does not occur, and that the maximum is done to avoid these problems, so as not to violate safety limits. The following text deals with those illnesses that may be affected by ergonomic knowledge (see Table 1). They are part of a group of diseases caused by physical factors. These diseases are either caused by vibrations from tools, or long-term unilateral excessive overloading.

	Occupational disease	Conditions of origin
1	Diseases of blood vessels in hands while working with vibrating tools and machines.	Items 1 -3: Diseases developing during work with hand-operated pneumatic tools with such values of accelerated vibrations which, according to current level of medical knowledge, are the cause of disease.
2	Diseases of peripheral nerves of upper limbs of ischemic and isthmal neuropathies while working with vibrating tools and machines.	
3	Diseases of bones and joints of hands or wrists or elbows while working with vibrating tools and machines.	
4	Diseases of tendons, tendon sheaths, insertions, muscles or limb joints caused by long-term excessive one-sided overtaxing.	Items 4 – 5: Diseases develop during work when the respective muscle groups or nerves are being overtaxed to the extent that the overtaxing or pressure, tension or torsion are, according to current medical knowledge, the cause of the disease
5	Diseases of peripheral nerves of the limbs of the constriction syndrome nature caused by long-term excessive one-sided overtaxing.	
6	Bursopathy caused by pressure	Disease develops during work performed in such a working position in which the afflicted area is under pressure for the majority of the working shift.
7	Meniscus damage.	Disease develops during work performed in kneeling or squatting position for the majority of the working shift.

TABLE I
SELECTED OCCUPATIONAL DISEASES CAUSED BY PHYSICAL FACTORS[1]

III. FACTORS INFLUENCING THE APPEARANCE OF SELECTED OCCUPATIONAL DISEASES

As noted above, thanks to ergonomic knowledge, it is possible to some extent to mitigate or even prevent these diseases. But there are a number of causes in many areas involved in their inception. We can use the Ishikawa diagram as a simple illustration of the causes and consequences. The result in this case is the emergence of diseases caused by physical factors (see Table 1). Causes are divided into six regions, each of which includes specific examples.

[1] Work by the author with reference to sources [5] and [6].

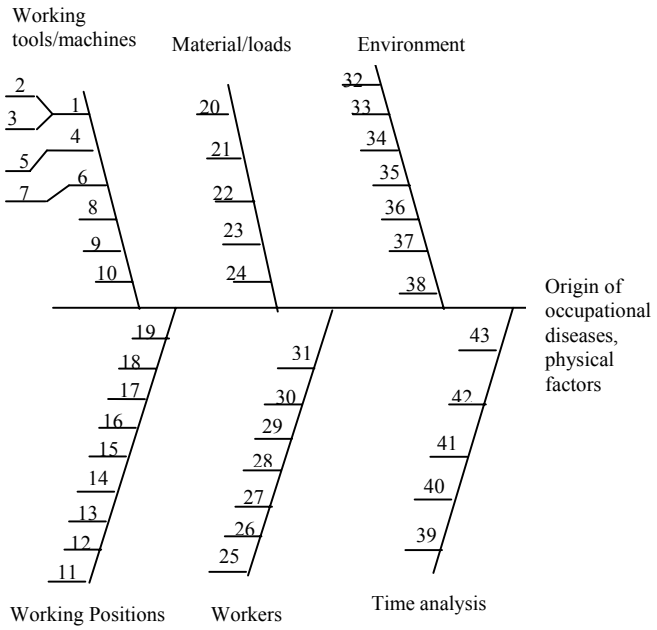

Fig. 1 Ishikawa diagram[2]

Working tools/machines

The primary cause is the working equipment, machinery and other equipment which is used. At the top of the list are damaged tools (1), which is due to of lack of checks (2) and poor maintenance (3), connected to this is cleanliness, respectively dirty equipment (4), again due to poor maintenance (5). A fundamental problem is the use of dangerous tools (6) due to lack of checks (7), which pose great risks of disease and injury to workers. Other causes are vibrating tools (8), their weight (9) and ergonomically unsuitable equipment (10).

Working positions

This category is very broad and includes a lot of awkward working positions and positions that represent a risk to workers. They are frequent kneeling and squatting (11), frequently leaning on elbows (12), carrying loads on shoulders (13), rotational movements of the hand (squeezing and screwing) (14), drilling (15), lifting with overgrip (16), painting (17) and cutting (18). Another risk can also be the employee's previous job or profession (19).

Material/loads

In this category it is mainly the weight of the load being handled (20), rigidity (21), manipulation (22), dimensions, respectively, size (23), and inappropriate storage (24).

Workers

Another factor that contributes to high rates of occupational disease (OD) are the workers themselves. There are emerging factors such as gender (25), age (26), body weight (27), the height of individual workers (28), their fitness and condition (29), and also how quickly fatigue sets in (30) and neglect of regular medical examinations (31).

Environment

The working environment itself covers a wide range of causes of OD; the temperature in the workplace (32), humidity (33), dust (34), untidiness in the workplace (35), vibration (36), area of work (37) and finally a stressful working environment (38).

Time analysis

The last area is time, respectively the time spent in an operating position (39), duration of the instrument acting on the body (40), the number of shifts (41), rotation of shifts (42) and the possibility of job rotation (43).

As can be seen, the emergence of occupational disease is influenced by many factors and many more could certainly be found. Preventing or at least reducing their occurrence means significant cost savings for businesses. Incapacity means a reduction in performance, especially if the employee is crucial and hard to replace, and other costs associated with compensation paid to workers. Replacing these workers poses problems associated with the tuition of new employees, etc.

IV. Optimization of Multidisciplinary Design and Modelling of Virtual Firm´s Production Systems

Examining the impact of ergonomics on occupational disease is part of a project called Optimization of Multidisciplinary Design and Modelling of a Virtual Firm's Production Systems, which was launched in 2008 under the auspices of the Grant Agency of the Czech Republic. This project is a collaboration between three Czech universities and its aim is to create virtual business models, enabling it to establish the criterial function for maximizing production capacity in relation to maximizing the effectiveness of virtual business.

The project focuses on usefully linking many disciplines, leading investigators to an enhanced understanding in particular areas of the effects of their proposals on the overall behaviour of a virtual company. The goal is to identify criterial features for effectively managing a virtual company on the basis of models and optimization methods.

This is a multidisciplinary perspective of the management of virtual companies starting with a creative engineering design of a product affecting not only the ability of the production system, but also the creation of a value-creating chain of virtual companies, with subsequent effects on their overall competitiveness.

The project will propose a solution that would lead to a significant reduction of specific occupational illnesses for specific types of work positions. A model will be created in collaboration with medical experts that will be able to solve this.

[2] Own processing by the author

The first step was to identify the disease, its symptoms and job types, worth considering (see Table 1). The next step is to select specific occupations, in which the research will be conducted.

These occupations can be simulated and modelled to adjust for the projected positions and thereby determine what loads may arise at work, which will assess the likely emergence of specific illnesses. The following figure represents a seamstress, who is at risk of one of the commonest long-term occupational diseases, carpal tunnel syndrome, involving excessive and unilateral overloading.

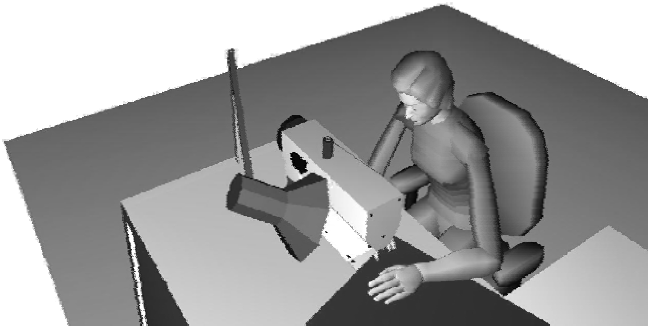

Fig. 2 Model seamstress created using ergonomic simulation software [3]

The ultimate solution will therefore be a model that can determine how likely and in what time frame the risk of occupational disease may occur, by entering the required criteria which influence the formation of OD. This would enable us to propose actions that would lead to reduction or even complete avoidance of the risk of OD.

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[3] Own processing by the author