CASE STUDY

The use of modern tools of ergonomics for identification and elimination of health risks in the process of mechanical engineering production.

❖ Identification

***Country*:** Slovakia
Sector (s): Productions of Screws
Time and Duration: January – February 2012 (8 weeks)
Budget: Commercial project. Project was financed by customer.
Organization(s) Involved:
CEIT joint stock company, digital factory division (CEIT, a.s.)
Slovak Ergonomic Association (SES)

This Case Study was prepared by the SLCP (Slovak Productivity Center) in cooperation with partners CEIT, a.s. (Central European Institute of Technology) and SES, o.z. (Slovak Ergonomic Association).

Joint stock company CEIT, a.s. focuses mainly on education support, support of research, development and commercialisation of innovation through cooperation of all partners from the created knowledge community. CEIT Group is an innovative aggregation of the companies which brings new high sophisticated solutions to the market through research and development. CEIT Group offers to the clients – industrial partners – increasing of their efficiency by product innovation, technology innovation, increase humanization of work, increase safe and health at work, process innovation and service innovation. CEIT Group supports innovative development and entrepreneurship by creation and utilisation of the new knowledge. CEIT Group wants to belong to the most important and most investigated partner in innovation area. We will support the development and propagation of the newest technologies. The goal of this effort is a keeping of permanent economic growth and life quality growth. We want to achieve an increasing number of spin off companies – mainly in area of massive growth potential.

The Slovak ergonomic association (SES) is a voluntary association of citizens and organizations interested in improving the level of ergonomic products, manufacturing equipment and processes, the humanization of work and working conditions and improve safety and health at work. Joint action is the SES involved in the development of knowledge in the field of ergonomics and relaying them to the level of academic, business in the area of public life of individuals. SES develops its activity in the following areas: development of ergonomics in Slovakia educational, promotional and informational activities, advice, expertise and Validation activities organization of professional and scientific events in this area publications, cooperation in developing standards, ordinances and regulations in this area. The main aim is increasing humanization and safety in relation to productivity and quality of human labor. Activities are implemented by the association members and partners, which are industrial companies, consulting companies, research organizations, university departments, occupational health services and the individuals working in these areas.

❖ Description

Introduction

Productivity means the rate, which reflects how well resources are used to create products. Currently, businesses must find new ways to ensure the necessary productivity growth. Way is to improve the basic factors that affect it, which include largely ergonomic factors and factors of safely. Workplace and work processes in manufacturing should be designed so that they are not only highly productive, but also beneficial fot workers who operate in it.

The actual branch of science industrial engineering in essence created the foundations of human performence management, which stressed the importance of full exploitation of human potencial in production. Over time , he began to place greater emphasis on self-control over the production with all the aspects of production and logistics. Next stage in development, which interferes up to the present time, the design of workplaces in relation to the human factor. The present efforts of the industrial engineer is to adapt the production process so as to have the least negative impact on humans and does not cause any harm to his health. To do this, in order to improve working conditions for the operator to increase productivity, it is necessary to a proper understanding of the links between ergonomics, productivity and the essence of workplace design. The necessary penetration is currently a functional tools of modern ergonomics and software support. Detailed analysis and synthesis methods of ergonomics is input in this area.

The pressure enforcement of ergonomics and safety in the practice and development of ergonomics in Slovakia was the impetus for the project solution DPEP, which further introduce. The purpose of the project was the application of ergonomics in the work process with the aim that the detailed design of workstations esing modern ergonomic tools is not ending and only in the process of applying ergonomics into the procss and improved working conditions for employees, but also economic improvement through increased productivity and reduced labor intesity.

Aim(s)

The aim of our project was to identify risk activities which affect the ergonomics and occupational health and propose alternative solutions that eliminate the identified risks and the same time will have a positive impact on labor productivity in the orgnization.

What was done and how?

The project was implemented in a company that is a supplier of special binding material for the European automotive, aerospace and consumer industries with a dňfocust on small and medium series production with almost 2000 types of products. The main production program is strength parts especially bolts made of wire by cold forming.

The project was implemented with a focus on:

- labor produktivity,
- quality of processes,
- ergonomics and safety of the work.

According to the nature of production and work activities performed by employeed in production werw analyzes focused on the following areas:

- evaluation of working postures at work in relation to anthropometry and workplace layout,
- evaluation of physical activity due to handling of loads,
- evaluation of physical activity due to the cyclical repetition of activities,
- complex evaluation of the working environment.

Specifically analyzes were implemented on the basis of identification the specific risks at individual workplaces. The complex evaluation of the work environment was implemented for the relevant production hall as a whole.

Used methods and tools

Model DPEP was used in solving, which is shown in Fig. 1. It was an existing production, we used the procedure in the left part of the DPEP flow chart.

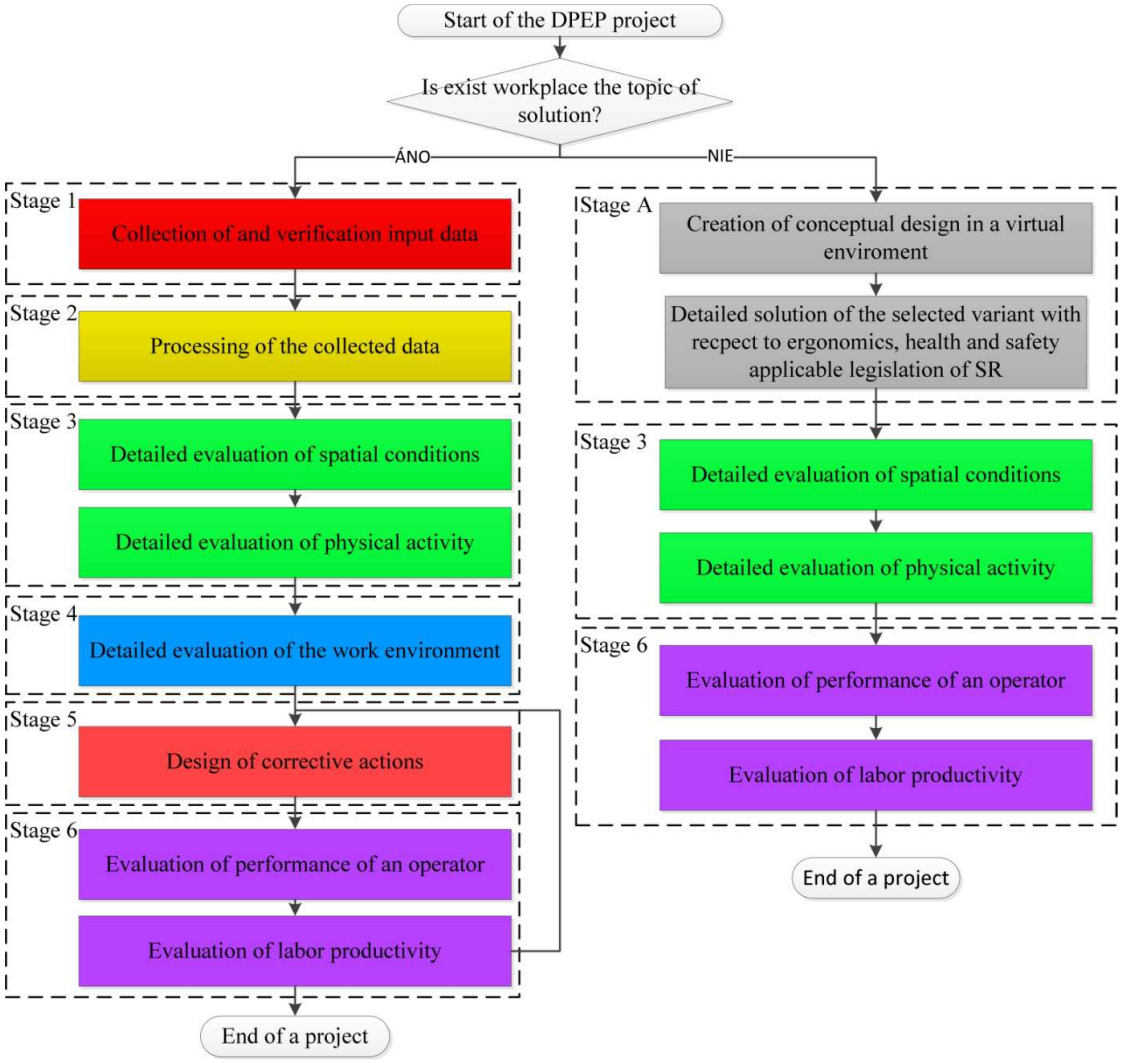

Fig. 1 DPEP flow chart (source: author)

At the various stages of DPEP flow chart used methods and tools below.

Evaluation of working postures
Evaluation of working posture was realized by analyzing OWAS. Positions of employees were evaluation in relation to dimensional characteristics used elements of the workplace, such as: desk, chair, buffer and shelving, machinery and so on. Also these positons were evaluation in relation to human anthropometry.

Evaluation of physical activity due to handling of loads
Because on the more workplaces there is handling of loads,such works were assessed by the character handling of loads following methods:

- NIOSH – easy lifting and placing.
- Snook & Ciriello – lifting, laying, pulling, pushing and carrying even in difficult conditions.
- KIM – pulling, pushing, rollťahanie, tlačenie, roll and manual handling general due to accuracy of location.

Evaluation of physical activity due to cyclic repetition of activities
This evaluation has been used in work activities, which are repeated during the work and part of the work may be a manipulatioevaluationn of objects or working tools. Evaluation of cyclic repetition of activities identified risks of creating CTD (Cumulative Trauma Dicorder). Methods that will be used:

- RULA – analysis of the load of the upper limbs, neck and trunk
- REBA – analysis of the load of the upper limbs, neck and trunk with an increased emphasis on the legs and method of gripping of manipulated object.

The complex evaluation of the woring environment
The complex evaluation of the woring environment will be implemented by the method of coefficients. Basic base of data will represent measurement, which certified company realized in company, and which has company available. The following parameters will be evaluated:

- noise intensity,
- light intensity,
- temperature,
- humidity.

What was achieved?

Submitter of the project required evaluation of working posture, physical activity and work environment in relation of the elimination of risk. Evaluation departments were forming, trim away, washing, ring and hand rolling, maintenance, tool shop, grinding, workplace with gauges, sorting, inspection, cutting operation and administrative departments. Together were evaluated 52 workplaces. Realized by the combination of stages 1→2→3→4→5 DPEP model.

First stage: The collection of input data and verification
In the introductory stage of collecting of input data were collected characteristics of work organization and technological documentation. The company has provided 2D layout, Fig. 2, the workplace and detailed layouts of selected parts. Evaluation was made of the existing 2D drawings. It was found the deviation of documentation and stocking of machines from the real situation in the workplace, and the output was actual characteristics of the workplace.

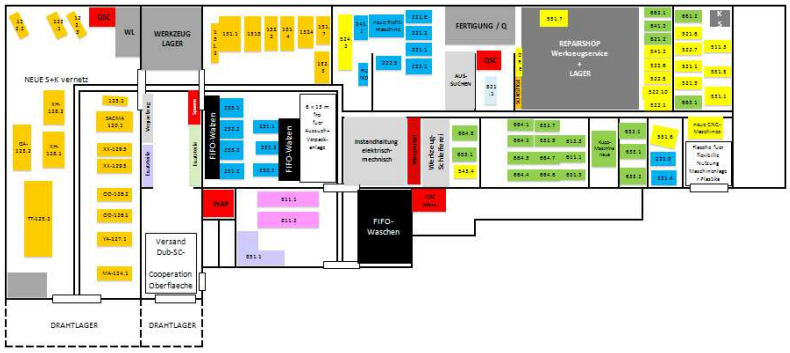

Fig. 2 Example of 2D layout of the company (source: company)

To characterize subjective state of employees strain was used a modified questionnaire Nordic Quesionnaire. It was used technique Face to face. This technique differs from the conventional in that interviewer completed the questionnaire with each respondent separately by interview and asked questions of the questionnaire, which is modified according to character of work in the company. Group of respondents were production workers and masters in manufacturing companies. Real physical activity was measured using the digital load cell, as appropriate were used calculated weight of loads according to the number and weight of the components. In this way, they were gained the characteristics of force for manual handling. The company had an interest about comparison of relevant data from the measurements of the parameters of the working environment measured by accredited the company and data of measurements which were carried out in this project. During the project mentioned data have not been supplied, the characteristics of parameters of the working environment were derived entirely from the resulting values of measurements using the measuring device Voltcraft DT 8820 .

Second stage: Processing of the data

After the measured and obtaining of the all necessary input data, it is possible to pass the second stage in solving, that is processing of the data. Based on the video of operators work activities (as appropriate stereoscopic, Fig. 3), of processed data from questionnaires Nordic Questionnaire and of course watching the activities of production workers, can be identified critical risk factors, Fig. 4. The gross inventory concerned workspace, physical activity and work environment together.

Fig. 3 Example of stereoscopic video in production and viewed record on the 3D monitor with systems to analyze activities (source: author)

For more detailed evaluation of selected hazardous workplaces were these workplaces modeled and created animations risky activities based on simple models of elements workplace. It is used, according to the proposed methodology as input to the third stage and also for the implementation of the proposed remedial measures in the fifth stage.

Inventory of potential adverse risk factors
work in uncomfortable, forced position
excessive noise
inadequate personal protective equipment
handling of a load
performing the same operations - monotone
coldness and excessive air flow - in winter
insufficient free unstopped floor space to work
inappropriately organized workplaces
long term work in the same positions (standing, tilt)

Fig. 4 Example of an inventory of potential negative risk factors at work (source: author)

Stage Three: Detailed evaluation of spatial conditions and physical activity

According to the legislation and evaluation of spatial requirements (phase 3 of the methodology - Part 1) was performed also the layout modification at the workplace identified as rolling machinesand in the workplace inspection. In the third stage was checked floor area, the space for working hands and footwork in accordance with applicable legislation. At this stage, acted mainly in accordance with the decree no. 542/2007 Z. of. and NV no. 391/2006 Z. z. valid in SR and harmonized with EU regulations. In the implementation of the analysis of physical activity were used as prepared worksheets as well as software Tecnomatix Jack, Fig. 5

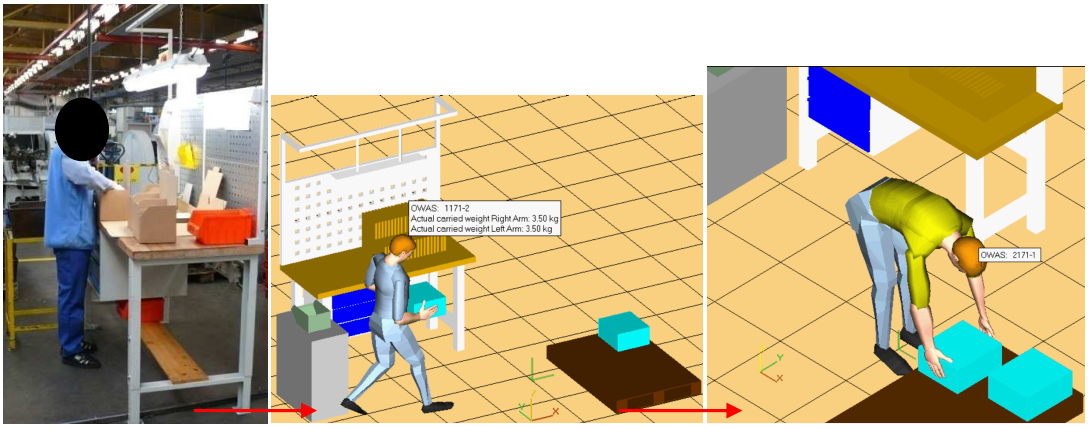

Fig. 5. Example of real situation at the workplace inspection and model in Tecnomatix (source: author)

During the creation of the list of potential negative risk factor at work was prepared the catalog of corrective actions, which is given to the submitter of the project at the end of the project after its presentation. During the project implementation are critical activities by departments, their demonstrations and resulting values of the realized analysis added to catalog in the implementation of the third stage. As stated in the procedure DPEP were carried

out ergonomic analyzes and the analysis LBA. With the use these analyzes, it can be pointed precisely at the critical position of the operator in the activities for which we talk about the maximum load on the intervertebral discs L5/S1. Analysis can determine compressive strength, shear strength, also load of muscles of back and as the load decreased due to the new layout of the workplace. The analysis LBA was used as support the analysis of NIOSH.

Fourth stage: Detailed evaluation the work environment

In this phase was rated lighting, noise, temperature and humidity in the workplace by the method of coefficients. The input were measured parameters of the working environment and a list of potential negative risk factors at work, Fig. 6. According to subjective opinion of employees the anticipated risks related to the working environment temperature, and according to company management to noise and humidity. The first step was to designate measurement places of the factors of the working environment. When assessing noise exposure (measurement and evaluation) we distinguish measurement of noise in the workplace, in the workspace, or the individual noise load. In this project was measured noise in the work area, because there is larger number of different noise sources in the production hall and employees rotate their jobs. To redraw the layout company X2 were recorded each measurement locations and were assigned the measured values to these locations (point). For every workplace (forming, washing, maintenance, etc.), were prepared workplaces sheets that include detailed evaluation of the working environment by comparing the measured values with the values resulting from legislation. In particular, based on NV SR no. 115/2006 Z. z.,where were used examples of activities and division into groups of works by noise exposure. The competent NV SR also includes the action values of normalized sound level LAEX, 8h. Furthermore, used NV SR. 339/2006 Z.z. and other applicable laws in Annex 26.

Processed materials (workplaces sheets) are part of the final catalog of corrective actions to be given to the sponsor of the project. After this analysis of the working environment was possible to summarily name the real risks in the workplace in relation to the performance of the work environment and to determine the reasons for these risks, Fig. 6

Final inventory of negative risk factors in the working environment
noise in the workplace named rolling machines - risks from category IV, exceeded the upper action value on average of 2 dB
lighting in the workplace named rolling machines - workbenches - possibility of persistent effects on human health
noise in the workplace named grindery - risks inherent from the category III
noise in the workplace named turning - risks inherent from the category IV. - possibility of persistent effects on human health
noise in the workplace named administration in production - risks inherent from the category II
noise in the workplace administration in production - possibility of easy effects on human health

Fig. 6 Example of the final inventory of negative risk factors in the working environment (source: author)

Lighting in the production hall was pooled and combined. The reason of low light was primarily arrangement of machines and jobs, regardless of the location of the lights in the hall of the company. In the procedure DPEP, the 4th stage was addressed the question whether they are use of OOPP after this the evaluation to individual risk factors in the working environment sufficient. In detail, we also addressed in this section, Fig. 7.

Fig. 7 Example ear protectors used in the company and their parameters (source: / / www.e-and-r.com)

Fifth stage: Proposal for remedies

In the fifth stage were summarized all the negative risk factors for individual workplaces. Humidity and temperature in general meet values under current legislation. Due to noise the company had to take additional corrective actions. In addition to the lack of damping ability earplugs was also found that the employees were not sufficiently instructed and motivated to use individual personal protective equipment. It was designed more corrective actions, such as elimination of noise using a coating chutes machine by thin insulating layer of rubber at the exit of products. The same rubber insulating should be used on the walls and bottom of the boxes. This reduces the sound pressure level on average about value 15 dB.

Ergonomics evaluation and any corrective actions have been implemented in relation to man - the operator, which means that the ergonomic solutions were not made with respect to the workplaces but with more focus on individual workers assessed workplaces. After creating a draft correction action again conducted analysis for the evaluation of physical activity of the third stage and verify the resulting level of risk after correction action.

In table. 1 is stated summary of all the activities carried out in the company project. Total number of analyzes that were carried out within the project in a company is the sum of realized ergonomic analyzes and evaluations of physical factors of the work environment in relation to workplaces.

Tab. 1 Summary overview of the activities in the company (source: author)

Summary overview of the activities			
Company			X2
Type of workplaces			manufacturing
Used stages of the methodology			1→2→3→4→5
Numbers of evaluable of workplaces			15
Digitisation			no
Number of identified critical activities			130
Number of corrective actions			135
Number of implemented ergonomic analysis	RULA	before NO	45
		after NO	42
	OWAS	before NO	29
		after NO	26
	KIM	before NO	13
		after NO	13
	Snook & Ciriello	before NO	5
		after NO	5
	REBA	before NO	19
		after NO	18
	NIOSH	before NO	3
		after NO	3
Number of implemented ergonomic analyzes together			221
Number of measurements of physical factors of the working environment			143
The the number of performed analysis, measurements and evaluation in the project in the company X2.			364

❖ Exploitation and Transferability

Utilization of solution is for companies that require evaluation of impacts on the health of employees in facilities with risk parameters of the working environment and also more heavier operating conditions. The procedure can be used for medium and small companies in the field of engineering such as metal processing whether metal industry. The advantage are the relatively low cost of implementation and independence of specialized software and hardware solutions, which increases the availability of solutions for medium and small companies in terms of cost.

❖ Further information

In the case study, we did not name the company because of the confidentiality of information. Because we used sensitive business data, were selected only those that can be published.

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