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AN ERGONOMIC APPROACH ON THE BURRING PROCESS

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Abstract: *Low performance of industrial processes can be improved by identifying the most productive use of human capabilities and by making sure that jobs fit the persons who perform them, thus maintaining human health and well-being. This paper is a case study regarding the ergonomics problems from the burring process. The work tasks were examined within the frame of this particular work system. The work constraints were identified and practical solutions were proposed.*

Key words: *ergonomic risks, postures, fatigue, distress, musculoskeletal disorders.*

1. PROBLEM DESCRIPTION

In order to perform efficiently, work systems must be designed accordingly to the abilities and limitations of the humans. The work system generally comprises the human component, the machine component and the environment. Ergonomics applies scientific knowledge about human characteristics in the design and management of the work system components, thus improving not only the comfort, the health and the security of people involved in the work, but also the efficiency of the whole system.

The paper presents an ergonomic study of the work constraints of the burring process in a factory from the county of Cluj. There have been recorded many functional problems, such as low efficiency and heard human labor.

The worker from the burring installation faces problems like pains in the shoulders, arms and back, general fatigue, lack of attention, distress and headaches. The burring process can be analyzed to determine the ergonomic risks that contribute to low efficiency, discomfort and musculoskeletal disorders, including the assessment of the work postures, material handling workspace layout, noise environment.

2. APPLICATION FIELD

Ergonomics principles can be applied in every field of activity where people and machines work together. The concept of the work system composed by the human component, the machine component and the environment represents an adequate standardized model for describing a system at work.

The man-machine-environment model can be used to evaluate activities in every field, because it doesn't refer to any particular application field [1, 5].

Ergonomics has generated designing guides and general recommendations, which are available for the engineers.

The role of the specialist in ergonomics is to use the basic knowledge of the human sciences for the interpretation of the general guides, so that they could match to a particular work system.

3. RESEARCH STAGES

Modern ergonomics contributes to the design and evaluation of work systems and products. It has an important role not only in the designing stage of the work system or product, but also during their functioning.

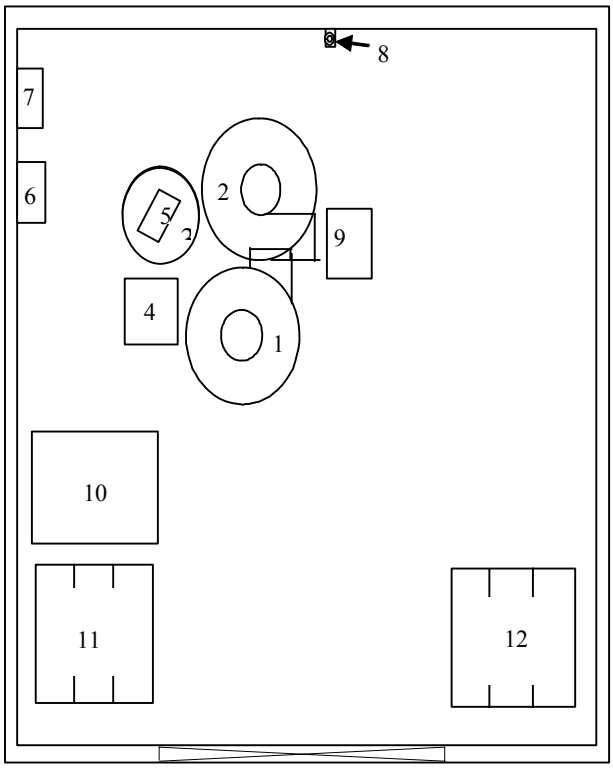
Nowadays, ergonomics researches in industrial production processes focus on the interaction of technological and work situation with the human being [3]. There are identified the most productive ways to use human capabilities and to maintain human health and well-being by making sure that job fits the person who performs it.

4. INVESTIGATION METHOD

The method used for the ergonomic investigation of the burring process consists of analyzing the work tasks themselves to identify potential ergonomic problems and of determining if jobs present ergonomic risks [2, 4]. This analysis takes into account the interaction between the human being and the other components of the work system during the performance of tasks. The human-machine-environment approach enables key areas to be identified and all the work related constraints to be discovered. The description of the work system and its boundaries is the first step of research. It enables to specify the goal and the content of the ergonomic application. The machine component (the burring installation), the human component (the worker) and the environment (the workspace, the noise environment etc.) are defined, thus producing a good frame for the second step of the research. It comprises the description of the tasks performed by the worker with his machine in the local environment, providing an accurate view over the interactions between the components and over the constraints that lead to the work problems.

4.1. Technical information about the machine component and the local environment

The burring installation is placed in the mechanical department of the factory in a separate room, dedicated to this operation. The burring process takes place in a liquid medium by using pyramidal abrasive bodies.



Legend:
1. burring recipient
2. cleaning and drying recipient
3. pump
4. centrifuge
5. control panel for the pump and centrifuge
6. control panel for burring
7. control panel for cleaning and drying
8. tap
9. table
10. place for empty boxes
11. mat for pieces with burrs
12. mat for finished pieces

Fig. 1. Layout of the burring installation in the burring workplace.

After removing the burrs, the pieces are cleaned and dried. Fig. 1 presents the burring installation and the distribution of its components in the corresponding workspace.

The installation consists of a large burring recipient (1) on springs, which is drawn into a movement of special vibration, a cleaning and drying recipient (2), a pump for the water recycling (3), a centrifuge (4) and a panel (5) for controlling the water recycling pump, the centrifuge and the burring time.

The panel for controlling the burring recipient (6) and the panel for controlling the cleaning and drying (7) are placed near the wall, on the left side of the workspace. The tap (8) used for cleaning of the centrifuge vat is behind the installation.

The workspace is also provided with a table (9) for loading the finished pieces, placed near the cleaning and drying recipient, a place for empty boxes (10), a mat for pieces with burrs (11) and a mat for finished pieces (12). The burring process generates vibration and a lot of noise, so that the acoustic environment is annoying.

4.2. The human component of the work system

The installation is served by one middle aged man who works in the factory for more than 5 years. His duties are the following:

- Receiving the pieces with burrs;
- Dozing and feeding with pieces;
- Liquid starting;
- Liquid centrifuging;
- Selecting the work times;
- Selecting the temperature;
- Verifying the burring quality;
- Verifying the cleaning and drying quality;
- Evacuation of the finished pieces, with manual arrangement of the pieces in the boxes;
- Stocking and dispatch.

The worker also performs activities connected to the removal of depositions from the centrifuge vat, checking and replacing the liquid, the absorbent material, abrasive bodies. Some of the activities imply physical effort because of the manual material handling. By speaking with the employee, his input about the existence of ergonomic problems related to his particular work tasks was highlighted. The worker considered that some of his work tasks are physically demanding and he felt tired after some hours of work, experiencing pains in the low back and arms. He often had headaches and felt uncomfortable and distracted. The worker was asked to accept the survey of his activity and to cooperate at the analysis of the work situations and of the constraints that determine ergonomic problems.

4.3. Data about the work tasks

The tasks performed by the worker were recorded by direct observations of the activities accomplished by the employee during the day. The records must be objective, bringing into light facts about the ways, the means, the timing of doing things. Some of the worker's tasks are the following:

a) The worker checks the quality of the absorbent material, the level of the liquid, the abrasive bodies etc.
b) He selects the time and temperature of the burring process and sets the vibrating mechanism of the burring recipient on the feeding-evacuation mode.
c) He goes to the mat with pieces with burrs.
d) He lifts the box with his arms.
e) The worker carries the box to the burring recipient.
f) He lifts the box and overturns the pieces into the burring recipient.
g) He goes with the empty box to the store place of empty boxes and returns to the installation, near the control panel of the pump.
h) He starts the pump, the centrifuge and sets the vibration mechanism of the burring recipient on working mode.
i) He surveys the functioning of the burring installation.
j) The worker verifies the time (on the control panel), the quality of the pieces surface and sets the vibrating mechanism of the burring recipient in the feeding-evacuation mode.

k) The worker helps the evacuation of the pieces from the recipient by using the hands.

The records continue until all the tasks are noticed in the chronological order.

4.4. Hypothesis about the origins of the problems

The analysis of the tasks performed by the worker step by step reveals the constraints that action on the worker during his interaction with the machine and the work-space. The links between the constraints and the problems become obviously. The tasks involving the manipulation of the filled boxes (for example tasks d and f) and carrying of the boxes to the installation (task e) or to the storing mat of finished pieces may determine musculoskeletal disorders, especially pains in the arms and upper body and low back pains. These constraints are also active during the removal of the depositions from the centrifuge vat and during its manipulation.

The lifting of heavy boxes and vat tasks but also the work bent posture adopted by the worker during tasks like arranging the cleaned pieces into the boxes, removing the depositions from the vat, washing the vat may cause lumbar pains. The continuous standing position during the whole work day contributes to the general fatigue and generates low back pains.

The vibrations and the noise environment influence the worker during most of the work time. They are responsible for the lack of attention, the distraction, the headaches and also the general fatigue of the employee.

4.5. Verifying the hypothesis

The hypothesis about the origin of the problems resulted after a qualitative analysis of the burring process. Quantitative measurements of the time corresponding to the tasks may confirm if the maintaining time of the effort or stressor represents a real risk for the worker. The manipulated burdens or the frequency of repetitive movements are also evaluated, if needed. The tasks have been reunited in groups of activities characterized by the same type of constraints. They are the following:

- Manipulation (*M*) represents 16% of the total work time and groups all the activities implying lifting and lowering the boxes with pieces (each box weighting about 30 kg), and the centrifuge vat (about 10 kg) from the ground level (the mat with boxes) to about 1250 mm high (the level of the feeding point of the burring recipient). The worker manipulates daily about 750 kg.
- Control (*CT*) represents about 2% of the total work time and reunites activities demanding the attention of the worker for checking the quality of the burring, cleaning and drying phases of the process, for checking the level of the liquid and for controlling the process from the panels.
- Cleaning (*C*) takes 9% of the work time and consists of the tasks performed for removing the depositions from the centrifuge vat with a spatula and then washing the vat. The employee works in a bent posture (the vat is placed on the ground, near the tap) and uses a spatula with a narrow blade and short handle).

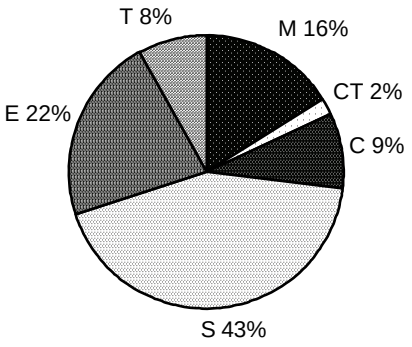


Fig. 2. The activities chart.

- Survey (*S*) groups the tasks of attending the burring installation, without having the possibility to leave the workplace. The worker stands near the installation and pays attention to the possible disorders in the functioning during 43% of the work time.
- Evacuation (*E*) occupies 22% of the work time and consists of the tasks performed by the employee to evacuate the pieces from the cleaning and drying recipient, including the arrangement of the finished pieces in the boxes. The worker is constrained to work in a bent posture.
- Transport (*T*) groups the tasks of manual carrying of the boxes with a total daily weight of about 550 kg, representing about 8% of the total work time.

Fig. 2 shows the participation of each group of activities at the total work time.

5. RESULTS

The investigation of the work activities connected the constraints which generate the work problems to the effective risks. The solution proposed to each problem eliminates or diminishes the constraints at their origin.

(a) The risks of pains in the arms and shoulders are related to several activities.

One cause of the problem proved to be the manual carrying of the filled boxes. The solution could be the use of a rotary crane for transporting the burden. The new layout of the workspace to accommodate with this device is illustrated in Fig. 3. The box design have to change, a new transverse handle with a blocking system is needed for the mechanical manipulation.

The second cause of this problem is the manipulation of the boxes and the vat at different heights. The rotary crane can eliminate the manual lifting and the corresponding risk.

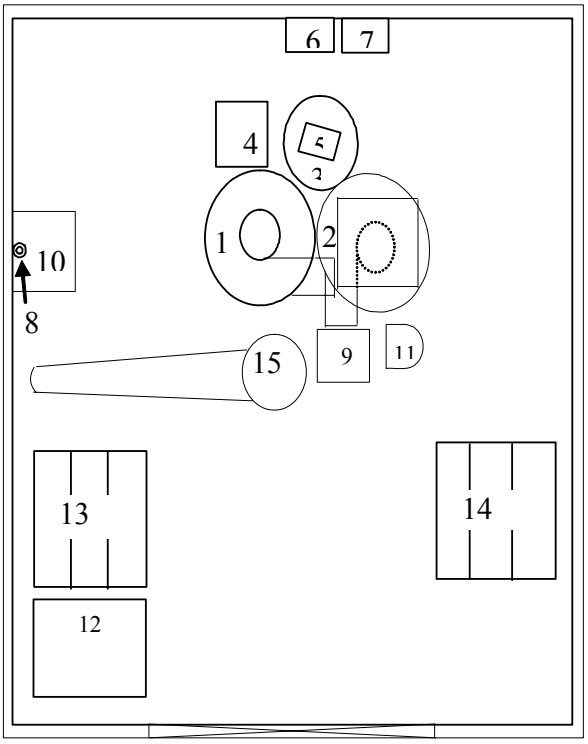
The third cause is associated with the removing of the depositions from the centrifuge vat. The tool is not fitted to task, therefore a specialized tool with a longer handler and a wider blade would be more efficient.

(b) The risk of lumbar pains is associated with the manual transportation of the boxes and with the lifting of the heavy boxes and the vat. The solution is to eliminate the manual handling of the burdens by using the rotary crane.

Another cause of low back pains proved to be the bent work posture adopted by the worker while removing the depositions and while washing the centrifuge vat. The solution is to arrange a special place, with a support of about 700 mm height for sustaining the vat (Fig. 3). The bent position of the worker while arranging the finished pieces in the boxes can be improved by placing a higher table (of about 800 mm) under the box.

The continuous standing posture of the worker also causes lumbar pain. After examining the work tasks, several activities were found to be proper for the sitting position on an adjustable chair with legs support.

(c) The lack of attention, the distress and the headaches which can affect all the activities, but especially the control tasks due to the noise generated by the burring installation. The use of some audio protectors could diminish the level of sound pressure at the ears of the worker.



Legend:
1. burring recipient
2. cleaning and drying recipient
3. pump
4. centrifuge
5. control panel for the pump and centrifuge
6. control panel for burring
7. control panel for cleaning and drying
8. tap
9. table
10. washing station
11. chair
12. place for empty boxes
13. mat for pieces with burrs
14. mat for finished pieces
15. rotary crane

Fig. 3. New layout of the burring installation in the burring workplace.

6. FURTHER RESEARCH

It is advisable to conduct further investigation regarding the noise environment. Noise surveys with a noise level meter will evaluate the distribution of noise in the working area and the exposure of workers.

Further research must review and analyze injury and illness records to determine whether there is a pattern of ergonomic-related injuries in these certain work tasks.

Next investigation might determine the common contributing conditions within the burring process in industry.

7. CONCLUSION

Low efficiency of work systems associated with discomfort and health problems of the employees are a source of financial and human loss. Ergonomics approach for assuring the safety, the health and efficiency of humans is to investigate the components of the work system and to identify the work constraints that action on the human component. The analysis of the work content within the frame of the work system enables the identification of constraints and of the most suitable solutions for the ergonomic-related problems.

REFERENCES

[1] Cărean, M., Cărean, Al. (2001). *Principii şi metode ergonomice de proiectare şi analiză*, Edit. Dacia, ISBN 973-35-1112-9, Cluj-Napoca.

[2] Chung, M., Lee, Y., Choi, K. (2005). *Physiological workload evaluation of carrying soft drinks beverage boxes on the back*, Applied Ergonomics, vol. 36, no. 5., September 2005, pp. 569–577, ISSN 0003-6870.

[3] Dempsey, P., Mathiassen, S. (2006). *On the evolution of task-based analysis of manual material handling and its applicability in contemporary ergonomics*, Applied Ergonomics, vol. 37, no. 1, January 2006, pp. 33–43, ISSN 0003-6870.

[4] Larring, J., Forsman, M., Kadefors, R., Ortengren, R. (2002). *MTM-based ergonomic workload analysis*, International Journal of industrial ergonomics, vol. 30, no. 3, September 2002, pp. 135–148, ISSN 0169-8141.

[5] Wilson, J., Corlett, E. (1992). *Evaluation of human work. A practical ergonomics methodology*, Taylor and Francis, ISBN 0-85066-479-9, London.

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