

## **DIGITAL ERGONOMICS – A PART OF INDUSTRY 4.0 STRATEGY**

Darina Duplakova<sup>1</sup>, Jan Duplak<sup>1</sup>, Svetlana Radchenko<sup>1</sup>, Enes Sukic<sup>2</sup>

<sup>1</sup>Technical University of Kosice, Faculty of Manufacturing Technologies with a seat in Presov, Bayerova 1, 0801 Presov, Slovakia

<sup>2</sup>Faculty of Information technology and engineering - FITI, University Union - Nikola Tesla, Jurija Gagarina 149a, 11070 Belgrade, Serbia, darina.duplakova@tuke.sk

### **ABSTRACT**

The current trend in the field of industrial solutions is progress in the sense of Industry 4.0, ie among other things, in the digitization of comprehensive production solutions, systems and processes. Digitization is becoming a part of any area - manufacturing or non-manufacturing, while also intervening in the HSE Management area, with connected to ergonomics. Given the undeniable benefits of digitization, it is essential to pay attention to it and focus on the main aspects of its application. This article provides the presentation of the digital ergonomics issue, which has become part of the Industry 4.0 concept in the development of technology, processes, and systems. Also, this article provides a summarization of current trends in this field and a description of its basic idea concept. This research was supported by research grant VEGA 1/0431/21 and KEGA 014TUKE-4/2020.

**Keywords:** Digital ergonomics, Industry 4.0, Software solution.

### **INTRODUCTION**

In industry, the ergonomic system contains three basic elements - human, machine, and environment, which are based on the solution of input attributes - material, energy, information, and output attributes - production waste, heat gains, change information, finished products. (Behunova, Behun, & Knapcikova, 2018). To determine the proper functioning of the production process, the stability and reliability of the whole complex in which man is the limiting link should be ensured.

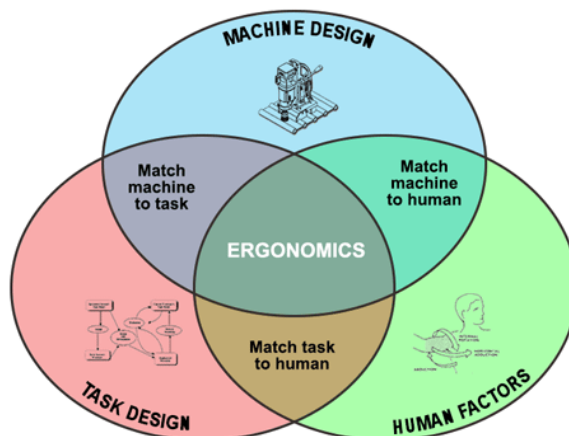


Figure 1. Interaction of subsystems in Ergonomics (Study Corgi, 2020).

The established ergonomic tasks in individual subsystems should be solved by implementing the methodical procedure of ergonomic analysis and evaluation of the system. This methodological

procedure can be summarized in five basic steps as follows (Romero, Castro, Ortiz, Khalaf, & Vargas, 2021):

- design of the ergonomic task
- data collection and classification
- data analysis and determination of solutions
- creation of comprehensive design solution
- implementation of design solution and feedback

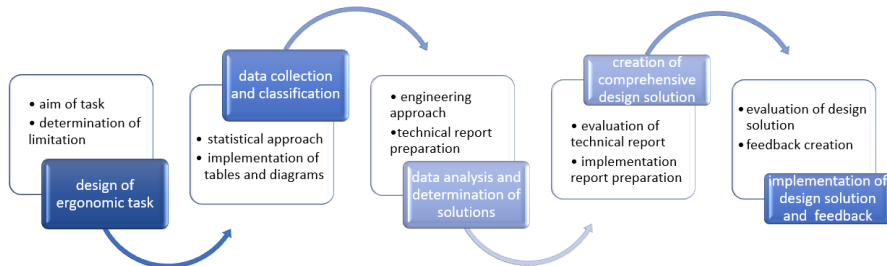


Figure 2. Methodical approach to ergonomic tasks (Romero et al., 2021).

The ergonomic system enables the implementation of several activities (Flimel, 2012):

- Ergonomic rationalization - searching for the most advantageous behaviour of the already existing work system.
- Ergonomic modelling - predicting the behaviour when changing the boundary conditions of an existing known system.
- Ergonomic analysis - experimental investigation of the behaviour and structure of the existing work system.
- Ergonomic design - creating a new work system with the required behaviour.

The above-mentioned concepts of ergonomic activities are currently implemented within the concepts of Industry 4.0, whose basic characteristics and specifications are presented in the following part of the article.

### **APPROACH TO INDUSTRY 4.0**

Industry 4.0 represents significant progress towards to digitization of industry, digitization of automation and robotization of production, based on the cyber interconnection of production information systems in industrial enterprises, ie digitization in all attributes of the production process - software, equipment and people.



Figure 3. Interpretation of Industry 4.0.

The involvement of technologies in the process of increasing the quality of the working environment and thus the reliability of the product is the result of rapid developments in science and technology and strong competitive pressure. Based on the necessary parametric inputs, it is possible to define the exact model of the human employee with his technical and human characteristics in the work process and at the same time, there is the possibility to monitor the ergonomic analysis of the created digital system online (Gášová, Gašo, & Štefánik, 2017).

An important role in the Industry 4.0 concept is played by the initialization of the Digital Factory process with a focus on securing and creating a Digital twin with the implementation and cooperation of processes and the use of innovative digital ergonomics methods (Liu, Fang, Dong, & Xu, 2020).

The basic tasks of implementing Digital twin include:

- Creation of 2D or 3D objects of a production product, system, or production hall,
- Collection of real data from the real production plant,
- Implementation of collected data into simulation software,
- Simulating with continuous data evaluation,
- Verification of results and their implementation in a real production environment.

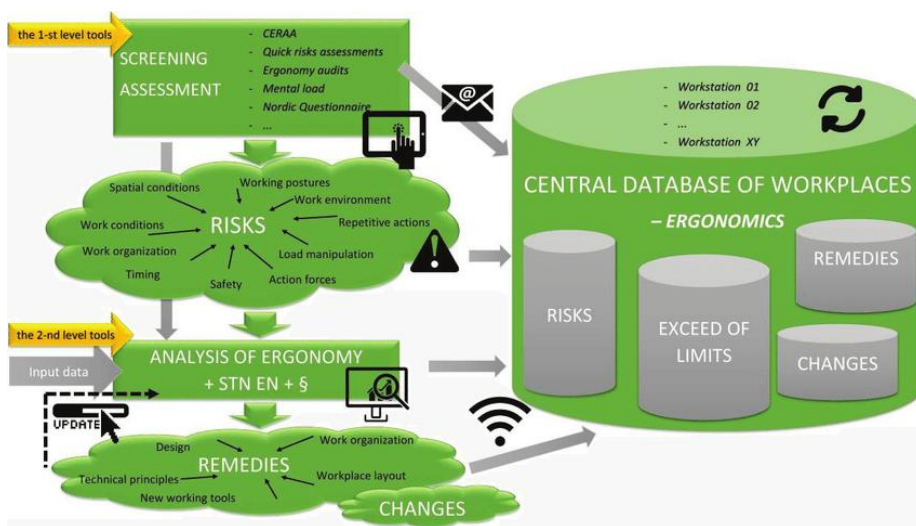


Figure 4. Ergonomic parameters in the Industry 4.0 (Gášová, et al., 2017).

Innovative methods in the digital ergonomics concept are presented by supporting tools of software solutions. Individual software solutions are implemented in practice according to the possibility of their use. (Mgbemena, Tiwari, Xu, Prabhu, & Hutabarat, 2020) The following part of the article describes digital ergonomics from the point of view of software solutions in practice.

## **DIGITAL ERGONOMICS - SOFTWARE SOLUTION IN PRACTICE**

Digital ergonomics can be implemented in engineering practice within various production processes. One of the possibilities is the assessment of the ergonomic load within the welding workplace. The following figure shows the assessed working position, which was analysed in the first case by a standard RULA form.



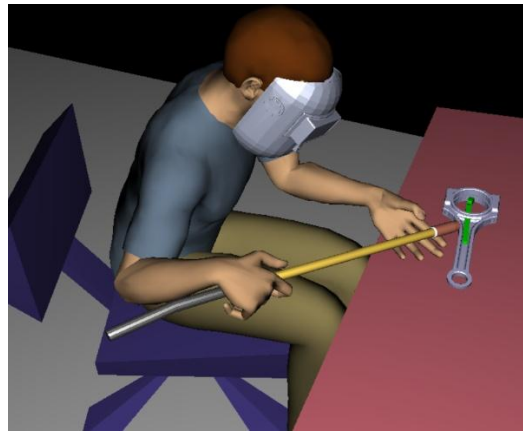


Figure 7. Digital model of working posture.

Based on the possibilities provided by the implemented simulation tool, the RULA method was the first to be implemented, through which the verification of the correctness of the compiled model was also created. The results obtained by this analysis confirmed the correctness of the compiled model.

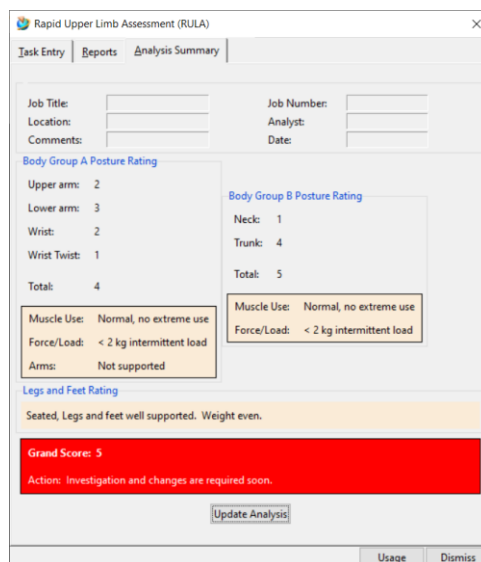


Figure 8. RULA evaluation of working posture.

After verifying the correctness of the compiled model, other ergonomic analyses were performed, through which it is possible to analyse the working position in more detail and create its correct rationalization. A preview of the ergonomic analysis is shown in the following figure.

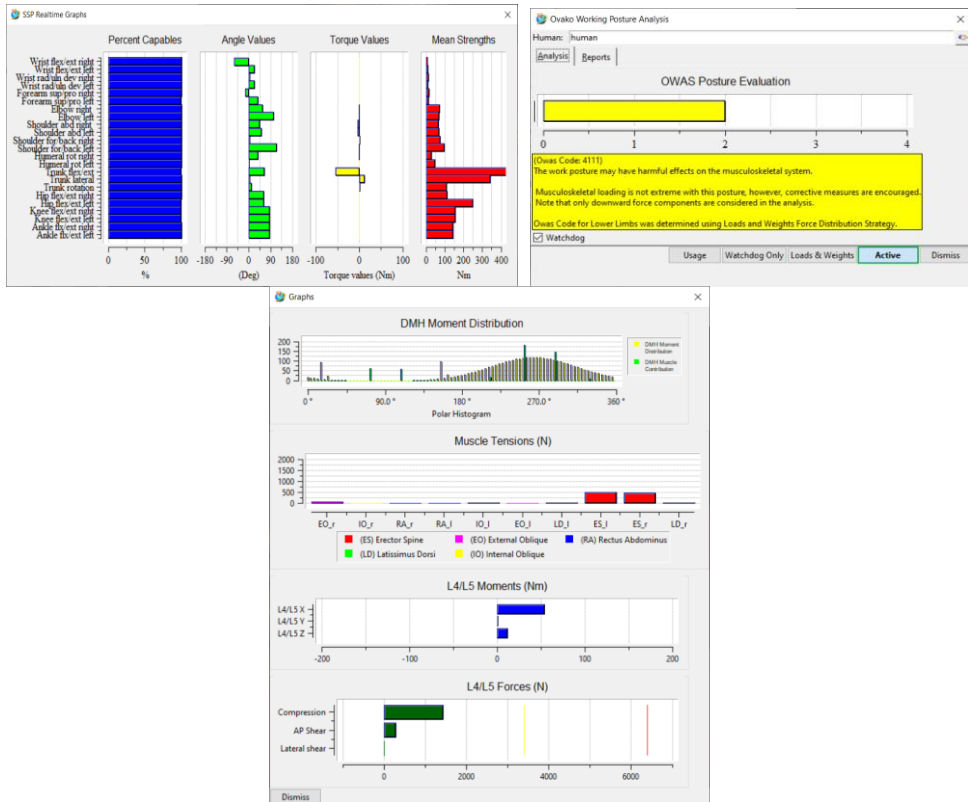


Figure 9. Ergonomic analysis of working posture using digital ergonomics.

## CONCLUSIONS

The presented article provides one of the forms and possibilities of implementing digital ergonomics as a part of the Industry 4.0 concept. In its main part, it points to the connection of the Industry 4.0 strategy with the basic principles of ergonomics and then describes the possibilities of its implementation directly in practice to assess the working position in the engineering industry for the welding process. Based on the study, the benefits of implementing digital ergonomics in the manufacturing sphere and industry can be considered, among other things, shortening the time required to perform ergonomic analyses and cost-effectiveness in solving ergonomic tasks.

## ACKNOWLEDGEMENT

This research was supported by research grant VEGA 1/0431/21 and KEGA 014TUKE-4/2020.

## LITERATURE

- Behunova, A., Behun, M., & Knapcikova, L. (2018). Simulation software support of manufacturing processes in engineering industry. *TEM Journal: Technology, Education, Management, Informatics*, 7, 849-853.
- Flimel, M. (2012). Analysis of selected ergonomic problems of left-handed workers in production activity. *Annals of the Faculty of Engineering Hunedoara*, 10(2), 83.
- Gášová, M., Gašo, M., & Štefáňik, A. (2017). Advanced industrial tools of ergonomics based on Industry 4.0 concept. *Procedia engineering*, 192, 219-224.
- Liu, M., Fang, S., Dong, H., & Xu, C. (2020). Review of digital twin about concepts, technologies, and industrial applications. *Journal of Manufacturing Systems*, 58, 346-361.

- Mgbemena, C. E., Tiwari, A., Xu, Y., Prabhu, V., & Hutabarat, W. (2020). Ergonomic evaluation on the manufacturing shop floor: A review of hardware and software technologies. *CIRP Journal of Manufacturing Science and Technology*, 30, 68-78
- Romero, C. A. T., Castro, D. F., Ortiz, J. H., Khalaf, O. I., & Vargas, M. A. (2021). Synergy between Circular Economy and Industry 4.0: A Literature Review. *Sustainability*, 13(8), 4331.
- Study Corgi. (2020, September 8). *Ergonomics and Its Effects at Kenya Plant*. Retrieved June 2, 2021, from <https://studycorgi.com/ergonomics-and-its-effects-at-kenya-plant/>.