

# Assessment of the kinematics of the movement of the operator's upper limbs in terms of simulation of the implementation of the 5S method in the assembly process using the NORAXON system

W. Piątakiewicz, BSc, [Silesian University of Technology, Gliwice, Poland](#)

A. Sykała, BSc, [Silesian University of Technology, Zabrze, Poland](#)

P. Trybuszkiewicz, BSc, [Silesian University of Technology, Zabrze, Poland](#)

K. Szczyrba, MSc, [Silesian University of Technology, Gliwice, Poland](#)

Dr A. Miller-Banaś, [Silesian University of Technology, Zabrze, Poland](#)

M. Molenda, [Silesian University of Technology, Zabrze, Poland](#)

Prof. R. Michnik, [Silesian University of Technology, Zabrze, Poland](#)

Prof. M. T. Roszak, [Silesian University of Technology, Gliwice, Poland](#) (presenter)

## Abstract

**Statement of the Problem:** The effectiveness of workstations determines the ability to achieve the set goals for production processes. The study concerned the use of modern research equipment to assess the impact of implementing the 5S method on the example of a pen assembly station. An analysis was made of indicators regarding the efficiency of the assembly process and the impact on the kinematics of the operator's limbs. The kinematics of the pen folding operation were tested using the NORAXON myoMotion inertial system. This system consists of 16 inertial sensors placed on individual segments of the examined person's body. Each inertial sensor records linear accelerations, angular positions and magnetic field strength, which allows analysis of changes in the kinematics of limb work. Algorithms processing measurement data allow for determining angles in individual joints of the upper and lower limbs and angles between individual body segments. The study consisted of simulating the process of assembling pens in the number of 50 sets in four stages, differing in implementing subsequent changes by the 5S method. During the tests, the kinematics of movement of the operator's limbs were recorded when assembling the first, third and fifth ten from a set of pens. Based on the recorded measurement data, the following were determined: the average assembly time for each of the ten pens and the average values of the angles in the joints of the upper limb during the assembly of each of the ten pens. The research was conducted on a group of three people.

**Conclusion & Significance:** The analysis of the results showed differences in the assembly time of pens for individual stages corresponding to subsequent changes in the organization of the workplace in accordance with the 5S method. The shortest time for assembling pens was recorded for the fourth stage of the simulation (assembly of pens was carried out in accordance with the developed work standard). The analysis of kinematic data showed a correlation between the pen assembly time and the average angle values in the joints of the operators' upper limbs. This finding underscores the importance of the operator's role in the assembly process. It was noted that in the case of smaller values of the elbow bending angle, assembly times were shorter. For the shoulder joint bending angle, the trend was opposite, shorter assembly time occurred for larger bending angles. Figure 1 shows the test stand for the fourth stage of the study.

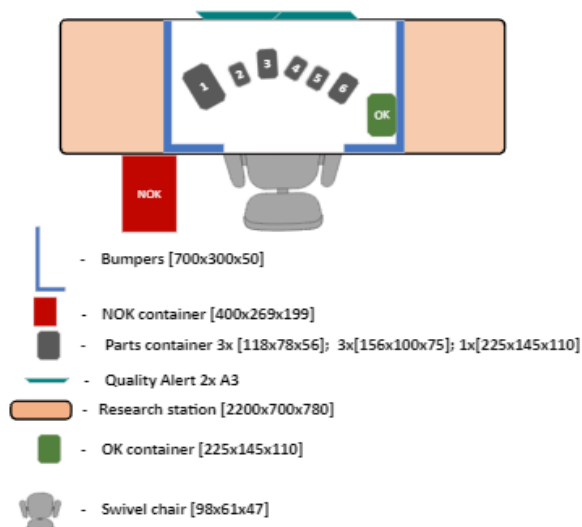


Fig. 1. Schematic of the workspace for the fourth stage of the study (own work)

## Recent publications

1. Guzik-Kopyto A., Nowakowska-Lipiec K., et al. (2022) Selection of kinematic and temporal input parameters to define a novel upper body Index Indicator for the evaluation of upper limb pathology, *Applied Sciences-Basel*, vol. 12, no 22, pp 1-19,
2. Piątakiewicz W., Sykała A., Trybuszkiewicz P., Trepiak R., Szczyrba K., Roszak M., Michnik R., Molenda M., Miller-Banaś A. (2024) Application of the NORAXON myoMotion System in the scope of 5S methodology applications. *International Students Scientific Conference TalentDetector - 2024 –Winter*, pp 386-395.
3. Agrahari R.S., Dangle P.A., Chandratre K.V. (2015) Implementation of 5S methodology in the small-scale industry: a case study. *International Journal of Scientific and Technology Research*, 4.4: pp 180-187.
4. Kobsar D., Charlton J.M., Tse C.T.F., Esculier JF, Graffos A, Krowchuk NM, Thatcher D, Hunt MA. (2020) Validity and reliability of wearable inertial sensors in healthy adult walking: a systematic review and meta-analysis. *Journal of Neuroengineering and Rehabilitation (BioMed Central)*, Vol. 17, Iss: 1, pp 1-21
5. Kumar, K. S., Akila, K., Arun, K. K., Prabhu, S., & Selvakumar, C. (2022) Implementation of 5S practices in a small scale manufacturing industries. *Materials Today: Proceedings*, 62, pp 1913-1916.5.

## Photograph



## Biography

Professor Marek T. Roszak deals with issues related to quality management, materials science, material process technology, organization and management of production processes, and a holistic view of design, supervision, and improvement of production processes. The presented research results concern a new area of combining research opportunities related to bioengineering in the field of research and analysis in the area of workplace organization. The initiated research constitutes a new area of scientific knowledge of an interdisciplinary nature.