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Application of selected quantitative analysis methods in the design of an ergonomic system

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Abstract

The article discusses the application of selected methods for analyzing value in the macroergonomic design of manufacturing systems for developing optimal working conditions for humans and optimal ways to utilize technical machinery and equipment. The selected value analysis method was used to assess the value of factors contributing to the occurrence of hazards at the workstations used by screw injection mold operators employed in a plastics processing company. The authors chose to focus on such positions as they pose the biggest threat to human life and health. An analysis relying on the Pareto method (ABC) helped define the optimization tasks as well as the degree of validity and mitigation of the assessed hazards. The conclusions present a model for adopting changes and improvements in the process of redesigning the macroergonomic system to create optimal working conditions in the company in question.

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Keywords: Value analysis; Pareto method; Macroergonomic system

1. Introduction

Optimally designed production systems and relationships among all of their parts are expected to ensure the multifaceted growth of workers who, surrounded by various sorts of technical equipment, are exposed to positive and negative influences in their working environment. The complexity of the working environment, which forms a

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realm created artificially by humans, makes it necessary to maximize benefits while minimizing the impact on humans and their environments.

Despite advances in automation and robotics, humans continue to be crucial in industry. Although they have been replaced with robots in the performance of strenuous manual labor, human operators, supervisors and controllers remain crucial in the manufacturing process [13]. The majority of small and medium-sized companies rely on humans as the supreme factor influencing processes in their organizations. The human factor in macroergonomic systems is defined as the overall relationships between humans and technology which shape the human environment and manifest themselves in the fields of human sociology, psychology, morphology and physiology [14].

In this complex corporate production system, it is the psychological and physical limitations of humans that constitute the most frequent direct and indirect cause of accidents and near misses in the work process which can be eliminated by means of macroergonomic design and construction work.

The practice shows that even simple macroergonomic improvements can boost bottom lines and give companies a competitive edge. Increased compliance with ergonomic principles in production systems will reduce losses caused by fatigue, excessive noise levels, poor lighting, excessive temperature and mitigate health issues, personnel turnover and damage to materials and tools resulting from neglectful work practices. From the viewpoint of humans, a more ergonomic workplace will also prevent moral harm associated with suffering, lack of well-being, fatigue, poor work standards, a sense of disempowerment, inertia, apathy and the abandonment of higher needs [1,15].

Ensuring ergonomic working conditions in a manufacturing system is not only about designing optimal social and environmental conditions but also about continuously adjusting and accounting for changes in workstation design and equipment. The macroergonomic design of an optimal production system requires continuous analysis and evaluation against ergonomic criteria.

2. Analysis of value in corporate production systems

Out of the wide range of techniques that support the macroergonomic optimization of workstation design and development, particular attention is due to the value analysis methods which streamline technological, administrative and auxiliary processes and structures.

L.D. Miles defined value analysis is an organized creative approach intended to effectively identify any redundant costs, i.e. costs which provide no quality enhancements, are of no functional value, do not protect lives, do not enhance appearance and do not add customer-sought features [6]. The aim of value analysis is to eliminate disfunctionality from manufacturing systems by designing them with an eye to enabling them to carry out all necessary functions at the lowest possible cost [5].

“Value analysis is a method of examining organizations which relies on scholarly thinking and rules of rational behavior to identify opportunities to cut own unit costs while maintaining or improving the quality of the subject matter of the examination” [7].

The essence of value analysis lies in focusing on the functions of an investigated production system in an effort to reduce the cost of performing functions expected in specific fields.

Value analysis should be orderly and entail, in this order:

- collecting information,
- performing analyses,
- creative thinking,
- ascertaining the scope of evolution and development,
- monitoring and reporting [6,7].

In value analysis, the established functions of a manufacturing system are turned into a set of functions to be fulfilled which, by means of their analysis, make up a set of necessary functions considered to be indispensable for optimizing an area in question.

Value analysis is a universal method, as evidenced by its applicability not only to goods but also services, processes, organizational problems and corporate management issues [5,6].