

**REVIEW**  
**on dissertation work**  
**for the acquisition of the educational and scientific degree “Doctor” in**  
**field of higher education – 5. Technical Sciences**  
**professional direction – 5.1. Mechanical Engineering**  
**doctoral program – „Mechanical Engineering Technology”**

**Author:** Eng. Nikolay Penkov Kolev

**Topic:** „Optimization of technological processes for machining parts on CNC machines with robotic feeding”

**Reviewer:** Professor Jordan Maximov, DSc, PhD

**1. Relevance and novelty in the dissertation work**

The hardenable steel 42CrMo4 is one of the most widely used low-alloy structural steels in the heat-treated state in the world industry. The maximum potential is reached after successive normalization, quenching and high-temperature tempering, in which high static strength is combined with high impact toughness. Chromium increases static strength, and molybdenum prevents the reduction of hardness in the tempering process. Optimization of the cutting processing of this heat-treated steel is associated with overcoming problems related to wear of the cutting wedge, formation of a white layer, etc. Adding the fact that the research was conducted in production conditions using a robotic system for servicing the process, the relevance of the dissertation work is beyond doubt.

**2. Cited literature**

The literature used contains a total of 126 sources, of which 7 are in Cyrillic, distributed as follows: 1) in Cyrillic: textbooks - 5, books - 1, conference reports - 1; 2) in Latin: books - 9, articles - 64, conference reports abroad - 9, websites - 33; conference reports in Bulgaria - 2; PhD dissertations - 1; software instructions - 1.

There are cited articles in high-level journals from Elsevier, Springer and Taylor and Francis, such as the International Journal of Machine Tools and Manufacture, Journal of Materials Processing Technology, International Journal of Advanced Manufacturing Technology, Materials and Manufacturing Processes. However, the articles are only cited, there is no specific analysis of those of them that are directly related to the problem posed in the dissertation.

**3. Research method**

Given the specificity of the problem being treated, the main research method is the field experiment.

#### **4. Brief description of the material on which the contributions are formulated**

Chapter 1 outlines the area in which the dissertation is positioned: trends in the development of CNC machine tools, robots and robotic systems (at length and in detail) and their application in the servicing of CNC systems. Conclusions are drawn and on this basis the goal of the dissertation and the tasks, the solution of which will achieve the goal, are defined.

Chapter 2 investigates the influence of the controlling factors of the turning process of improved (i.e., hardened and tempered) 42CrMo4 steel on the roughness parameter Ra, the durability of the cutting inserts and the productivity, under the conditions of robotic feeding of a CNC lathe.

In Chapter 3, a multi-objective optimization of the turning process was performed using two approaches: Pareto front search; and scalarization of the vector optimization criterion (in this case, an optimistic approach was used).

In Chapter 4, a methodology for determining the number of cutting tools to ensure a continuous work process is developed.

#### **5. Contributions of the dissertation work**

The PhD student has formulated the contributions concisely and precisely, which is commendable. I have edited, summarized, and classified the contributions that I have acknowledged as follows:

##### *A. Scientific-applied contributions*

##### A.1. Creation of new classifications, methods, constructions, models, methodologies, algorithms

- ◆ Experimental models of the Ra parameter of roughness, productivity and durability of cutting inserts.
- ◆ Methodology for determining the number of cutting tools to ensure a continuous work process.

##### *B. Applied contributions*

- Optimal cutting modes when turning improved steel 42CrMo4 on CNC lathes with robotic stations.
- Algorithm for a software product for controlling the operation of CNC lathes with robotic feeding, ensuring a continuous workflow for a given batch of parts.

#### **6. Publications on the dissertation**

The author has made a total of 7 reports at scientific conferences, as follows:

- 1) Five reports at scientific conferences in Bulgaria (3 in Gabrovo and 2 in Varna);
- 2) 2 reports at a scientific conference abroad (Rezekne, Latvia).

In one of the reports, presented in Gabrovo, the doctoral student is the sole author.

Based on the above data, it can be concluded that the results of the dissertation authored by Eng. Nikolay Penkov Kolev have been disseminated and discussed well enough.

## 7. Notes on the dissertation

The dissertation is well structured and written. The fact that the details of the regression and variance analyses are separated into a separate appendix makes a very good impression.

I was a reviewer of the version of the dissertation presented at the pre-defense. This version contained numerous weaknesses, which I had described in detail in the previous review. The doctoral student took into account all my comments, answered the questions posed, and made the necessary revisions. The result was a nice, concise dissertation with a clearly experimental character, with clearly highlighted conclusions and contributions. However, there are some points that the doctoral student should pay attention to in his future work:

- The introduction is too one-sided, as it focuses only on robotization: in general, on CNC machines, and specifically for powering CNC lathes. There is no analysis of the latest achievements in the research of the turning process of heat-treated 42CrMo4 steel, which was used further: 1) effects of control factors on the obtained surface integrity (SI), i.e. the simple correlation “process – SI”; 2) effects of wear of the cutting insert (especially flank wear) on SI; 3) formation of a white layer during turning and its influence on the operational behavior of the machined surface; 4) the full correlation “process – SI – operational behavior”, etc. This is necessary to justify the need for the study and the novelty.

The doctoral student refers to the industrial revolutions, but besides robotization, there are even more important problems for humanity, related to human health and environmental protection (from the harmful effects of lubricating and cooling fluids, for example). These problems are overcome through the development of the so-called "sustainable manufacturing".

- Statements such as “roughness has been studied” should be avoided. In fact, 36 roughness parameters are known, divided into several groups, therefore the specific parameters studied should be indicated.

- Section 2.3.1.1. The third governing factor (number of parts) takes only integer values. It makes practical sense if the governing factors are only the cutting speed and feed. Then an optimized turning process is implemented and the dependence of the roughness parameter  $R_a$  on the wear (flank wear), respectively, on the number of machined parts, is found. In addition, this is a more economical and more universal approach in the future.

- Formula (2.4): The plan used is of the form  $3^2$ . No unnecessary explanation needed

- The conclusions on page 52 are known and expected.

- All experimentally obtained values of the roughness parameter  $R_a$  depend on the wear of the cutting insert, most notably on the flank wear parameter  $VB$ , which should be explained in the text.

## **8. Other questions**

I firmly believe that the educational function of doctoral training has achieved its goal. The doctoral student has significantly increased his knowledge of the problem studied in the dissertation.

## **9. Conclusion**

I believe that the presented dissertation work "Optimization of technological processes for machining parts on CNC machines with robotic feeding" with the author Eng. Nikolay Penkov Kolev meets the requirements of the Act on the Development of Academic Staff in the Republic of Bulgaria. The achieved results give me reason to propose to the esteemed scientific jury to award the educational and scientific degree "Doctor" to Eng. Nikolay Penkov Kolev, in the field of higher education 5. Technical Sciences, Professional Field 5.1. Mechanical Engineering, doctoral program "Technology of Mechanical Engineering".

03.06.2026

Reviewer:

Prof. Jordan Maximov, DSc, PhD