



REVIEW

on dissertation for obtaining the educational and scientific degree "Doctor" in: field of higher education 5. "Technical Sciences", professional field 5.13 "General Engineering", scientific specialty "Woodworking and furniture industry technology, mechanization and automation"

Author of dissertation: Aleksnader Vladev Doychinov, part-time doctoral student at the Department "Woodworking machines" at the University of Forestry (UF), Sofia, Bulgaria

Dissertation topic: Research into the milling processes of parts processed on a CNC machine

Reviewer: Nencho Stanev Deliiski, DrS., professor in field of higher education 5. "Technical sciences", professional field 5.1 "Mechanical Engineering", scientific specialty "Woodworking and furniture industry technology, mechanization and automation", appointed as a member of the scientific jury by Order No. RD-491/17.09.2025 of the Rector of the UF

1. Brief introduction of the candidate

Eng. Alexander Doychinov was born on 07.05.1978. In June 2019, he graduated with a bachelor's degree at the Faculty of Forestry Industry of the University of Forestry with a specialty "Wood and Furniture Technology", and in December 2020 he received a master's degree with an overall grade point average of 5.79 in the same specialty in the specialization module "Woodworking Machines and Equipment". In the period from 09.03.2021 to 18.02.2025, he worked as a woodworking technologist at the woodworking production base at the University of Forestry. On 15.03.2022, he was enrolled as a doctoral student in part-time study at the Department of "Woodworking Machines" at the Faculty of Forestry Industry, and on 15.01.2025, he was discharged with the right to defend his dissertation. From 18.02.2025 to the present he is an assistant in the department of "Woodworking Machines". Before and during his studies at the UF he worked as follows: from 1999 to 2004 as a buyer at "Stoykov and Son" Ltd.; from 2004 to 2010 as a manager at "Aisberg" Ltd., from 2010 to 2016 as a sales manager at "Rositsa-Stefan Batlachki" Ltd. and from 2016 to 2021 as a supply manager at "Furtuneli" Ltd. In the above positions he has acquired good communication skills and the ability to effectively interact in a team, versatile competencies in working with woodworking machines and tools, as well as in the creative use of the Internet and Word, Excel and Power Point from the Microsoft Office package. He has very good skills in working with the Auto CAD software package and with CNC machines and technologies in the furniture industry.

2. Relevance of the problem

The dissertation is a current study aimed at establishing the qualitative and quantitative influence of the combinations in the variation in wide ranges of the rotation frequency of 4 constructive varieties of the cutting tool of the increasingly

widely used in furniture production CNC machines, as well as the feed rate and the thickness of the removed layer on the quality (roughness) of milled surfaces of solid pine and oak wood and medium density fiberboard (MDF).

The extensive experimental studies conducted in the dissertation and the subsequent regression analysis of the obtained results have a high degree of relevance in scientific and applied terms and are of considerable interest for practice.

3. Degree of knowledge of the state of the problem and creative interpretation of the literature review

The literature review is presented in a systematic and conceptual manner mainly in the first chapter of the dissertation, but individual sources that are essential for the research conducted are also cited in the following chapters of the dissertation.

A total of 99 literary sources are cited, of which 12 are in Cyrillic and 70 in Latin. In addition to them, 7 standards, 1 product catalog and 7 Internet sources are also the subject of the study. The nature of the review of achievements is an important indicator of the level of achievement of the doctoral student of the educational goal of the dissertation. The narrow scientific field treated has broad interdisciplinary connections, with the mastery of which he has done well.

The in-depth literature review made by the doctoral student in the volume of 43 pages in the first chapter ends with 9 summarizing conclusions organically arising from it, which are used as a basis for a reasoned formulation of the goal and objectives of the dissertation.

4. Aim, objectives, hypotheses and research methods. Relevance of the chosen research methodology to the stated aim and objectives of the dissertation

The purpose of the study, as well as the tasks set for its implementation, are correctly defined and essentially summarize the research carried out, which are described in the next 2 chapters of the dissertation.

The research methodology is set out in the second chapter in a volume of 14 pages. It arises from and largely corresponds to the set goal and the specifics of the 5 tasks formulated for solution in the dissertation work. At the beginning, the device and technical and operational characteristics of the CNC drilling center used in the experimental studies and its 4 constructive varieties of cutting tools are described. For the conduct of these studies, 2 wood species of interest for science and practice (1 coniferous - white pine and 1 deciduous - oak), as well as unprocessed medium density fiberboard (MDF) were selected with good reason. The experimental solid wood samples are glued laminated timber panels measuring 600 x 200 x 22 mm for white pine and 600 x 200 x 20 mm for oak, while those made of MDF measure 600 x 200 x 18 mm.

It is assumed that the quality of the surfaces of the test specimens processed by milling on the CNC center should be evaluated in the standardized manner for such studies, namely by measuring and subsequent mathematical processing of the change in the roughness parameter R_z of the surfaces depending on the influencing factors. As such, the rotation frequency n of the cutting tool of the CNC machine, the feed rate V_f , the thickness of the removed layer h , the type of wood

material being processed and the geometric characteristics of the cutting tool were correctly chosen. The roughness values R_z were measured with precise equipment across the wood fibers when processing the edges of the solid wood samples and in the central layer of the edges of the MDF samples.

The planning of a series of three-factor experiments with varying the factors n , V_f and h , as well as the subsequent regression analysis of the obtained results, is methodically correctly described. The results are presented in 3 appendices at the end of the dissertation in a total of 12 tables with 20 rows and 11 columns each.

In the third chapter, in a volume of 79 pages, the results of the extensive experimental studies conducted in accordance with the methodology described in the second chapter are presented and mathematically processed using the specialized software product *Qstat-Lab*.

5. Visualization and presentation of the results

The results obtained in the dissertation, which has a total volume of 188 pages, are well illustrated with 80 predominantly multi-colored figures, 31 tables (19 in the text and 12 in appendices) and 32 equations.

This level of visualization facilitates the understanding of the analyses and interpretations of the results obtained in the dissertation.

6. Discussion of results and literature used

The achieved results testify to the good implementation of each of the 5 formulated tasks, and thus – to the achievement of the goal set in the dissertation work.

There is a thorough knowledge of the issues on the topic of the dissertation. The literary sources used in their significant part reflect the modern level of the problems treated in the dissertation. Sources from the last 10-15 years predominate and only 18 of them (i.e. 18% of the total 99 sources) were published before 2010.

7. Contributions of the thesis

Based on the conclusions at the end of the third chapter of the dissertation, the achievement of 3 scientific and applied and 7 applied contributions is argued, namely:

Scientific and applied contributions

1. By processing the results obtained from numerous active three-factor experiments, a total of 12 quadratic regression equations in coded form have been derived, adequately reflecting the influence of the rotation frequency n of the cutting tool of the CNC machine, the feed rate V_f , the thickness of the removed layer h , the type of material being processed and the geometric characteristics of 4 cutting tools of the CNC machine.

2. The qualitative and quantitative influence of the combinations between n of the 4 structural varieties of the cutting tool in the range from 12000 to 18000 min^{-1} , V_f in the range from 2 to 5 $\text{m} \cdot \text{min}^{-1}$ and h in the range from 1 to 3 mm on the

roughness R_z of milled surfaces of solid wood of white pine and oak, as well as MDF, has been established.

3. Facts established by other researchers about the influence of the factors mentioned above in the contribution on the roughness R_z of milled wood surfaces have been experimentally confirmed in qualitative terms, and their influence has also been specified in quantitative terms in relation to the 2 studied wood species and MDF.

Applied contributions

1. The 12 regression equations derived from the experimental results in coded form have been converted into 12 of their analogues in explicit form, allowing relatively easy (with a calculator or Excel) calculation of the roughness R_z of milled surfaces of pine and oak wood and MDF with each of the 4 cutting tool designs studied for any arbitrary values of n , V_f and h in the ranges from 12000 to 18000 min^{-1} , from 2 to 5 $\text{m} \cdot \text{min}^{-1}$ and from 1 to 3 mm, respectively.

2. With the derived regression equations, the change in R_z of milled surfaces of test samples of pine and oak wood and MDF depending on n , V_f and h and the geometric characteristics of the cutting tools has been calculated and graphically presented on a total of 42 Excel figures.

3. It has been established that increasing the rotation speed n from 12000 to 18000 min^{-1} at the average studied values of $V_f = 3.5 \text{ m} \cdot \text{min}^{-1}$ and $h = 2 \text{ mm}$ causes an increase in the quality of the milled surfaces, i.e. a decrease in their roughness R_z , with the ranges of variation of R_z for each of the 4 designs of the cutting tools being indicated.

4. It has been established that increasing the feed rate V_f from 2.0 to 5 $\text{m} \cdot \text{min}^{-1}$ at the average studied values of $n = 15000 \text{ min}^{-1}$ and $h = 2 \text{ mm}$ causes an increase in the roughness R_z of the milled surfaces with the ranges of variation of R_z for each of the tools being indicated.

5. It was found that increasing the thickness of the removed layer h from 1 to 3 mm at the average studied values of $n = 15,000 \text{ min}^{-1}$ and $V_f = 3.5 \text{ m} \cdot \text{min}^{-1}$ causes a multidirectional change in the roughness R_z of the milled surfaces, with the increase in R_z prevailing and only in two cases – one in oak wood processed with the CH-1 tool and the other in MDF processed with the CH-2 tool – the roughness R_z decreases.

6. Based on the comparative analysis of the results obtained, it was found that end mills with positive and negative (combined) spirals, other things being equal, provide the best quality of the wood surfaces processed with them.

7. A methodology for conducting experimental studies on the quality of milled wood surfaces has been modified and improved, which is consistent with the characteristics of the technological equipment and with the requirements for conducting an active three-factor experiment and regression analysis of the results obtained.

8. Assessment of the extent of the dissertator's personal involvement in the contributions

I consider the personal participation of the doctoral student to be decisive in achieving the contributions in the dissertation and in its overall development under the guidance and good professional expertise of his or her scientific supervisor.

9. Critical comments and questions

Overall, the dissertation is well structured and formatted, and only the following 3 notes should be taken into account by the doctoral student when preparing his future publications: 1. The captions under Excel figures, similar to those in the third chapter, should be significantly shorter without writing the full names of the variables, but only their symbols. 2. Excel figures should be given without a frame. 3. The multipliers of the type $E-7$ participating in the regression equations in an explicit form should be presented as 10 to the corresponding power (in this case -7).

10. Published articles and citations

The doctoral student has presented 3 publications on his dissertation work. One of them is independent, and the other 2 are co-authored with his scientific supervisor, and in both he is in first position. One of the collective publications is in Bulgarian, and the other 2 are in English. The article in Bulgarian was printed in 2022 in the collection of scientific reports from the 11th scientific and technical conference "Innovations in the forest industry and engineering design", and the second collective publication is in the journal Journal Applied Researches in Technics, Technologies and Education (ARTE), 2025. The independent publication was accepted for publication in 2025 in the journal Innovations in Woodworking and Engineering Design, 28(2). The collection of scientific reports and the journals are included in the National Reference List of Contemporary Scientific Publications with Scientific Review of NACID.

11. Assessment of the publications on the dissertation: number, nature of the publications in which they are printed. Reflections in science - use and citation by other authors

The presented abstract sufficiently fully and adequately reflects the structure and content of the dissertation work, as well as the results obtained from the conducted research and the contributions achieved.

In accordance with the changes in the law on the development of the academic staff in the Republic of Bulgaria, made in 2020, the three publications on the dissertation work form a total of 60 points under the group of indicators "G" with a minimum required of 30 points.

The materials provided for review do not indicate citations of the publications on the dissertation

CONCLUSION

The dissertation represents a completed study in fulfillment of the set goal and the tasks arising from it. Scientific-applied and applied results sufficient for the requested educational and scientific degree "doctor" have been obtained, some of which have immediate applicability in practice.

In an educational aspect, the doctoral student has expanded and deepened his existing and has mastered new interdisciplinary knowledge that was necessary for the development of his dissertation. In a scientific aspect, he has built on what has been done so far in the thematic area of the dissertation, using the experience he has studied.

Based on the various research methods mastered and applied by the doctoral student, the correctly conducted experiments, the generalizing conclusions made and scientific-applied and applied contributions, I believe that the presented dissertation meets the requirements of the Law on Forestry and Forestry Research and the Regulations of the University of Forestry for its application, which gives me reason to evaluate it **POSITIVELY**.

This gives me reason to recommend to the members of the esteemed Scientific Jury on the procedure to award the doctoral student, Eng. Alexander Vladev Doychinov, the educational and scientific degree "Doctor" in professional field 5.13 "General Engineering".

10.11.2025

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