# OPINION

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

**Author of the PhD thesis:**
**Eng. Rostislav Bozhidarov Bozhkov, part-time PhD student at the Department of Furniture Production, University of Forestry, Sofia**

**Topic of the dissertation:**
**"Influence of material properties on the softness of upholstered furniture"**

**Member of the scientific jury:**
**doctor of science Nencho Stanev Deliiski, professor in professional field 5.1 "Mechanical Engineering", scientific specialty "Woodworking and furniture industry technology, mechanization and automation", University of forestry / retired, member of the jury by order of the Rector of the University of Forestry № ЗПС- 228 / 23.04.2025**

## 1. Relevance of the problem

The multiparametric studies conducted in the dissertation work on the qualitative and quantitative influence of combinations of various modern materials, used in six types of upholstery structures, on the indicators of their softness and deformation behavior, have a high degree of relevance in scientific-spplied and applied terms and are of significant interest for the actual production of upholstered furniture.

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

The literature review is presented systematically on 29 pages in the first chapter of the dissertation. It reflects sufficiently fully what has been done by other researchers in the field of the subject of this work and is an important indicator of the level of achievement of the educational goal of the dissertation by the doctoral student.

A total of 82 literary sources have been analyzed and cited, of which 25 are in Cyrillic (including 2 standards) and 57 - in Latin (including 6 standards). The review does not include modern Internet sources on the subject under consideration.

The literature review and analysis made by the doctoral student ends with 3 summaries and conclusions resulting from it, which are used as a basis for a reasoned formulation of the goal and objectives of the dissertation.

## 3. Goal, tasks and research methods. Accordance of the chosen research methodology with the set dissertation goal and tasks

The purpose of the study, as well as the 5 tasks envisaged for its implementation, are correctly defined based on the analysis and conclusions from the literature review.

In essence, they outline and summarize the research carried out, which are described in the next 2 chapters of the dissertation.

The research methodology is presented in the second chapter in a volume of 13 pages. It arises from and corresponds to the set goal and the specifics of the 5 tasks formulated for solution in the dissertation.

The approach for conducting multifactor planned experiments is described and the type and structure of multifactor regression models are determined, with which the results of these experiments are to be covered. An argumentative selection of the target parameters and the input control factors of the models is made.

The type and quantities of materials that are appropriate to be used in the experimental studies are selected, indicating 6 structures of the upholstery in which they will be inserted. A methodology for determining the deformation behavior of the main materials in the structures of the studied upholstery under load is also presented.

**4. Visualization and presentation of the obtained results**

The results obtained in the dissertation, which is 116 pages long, are illustrated relatively well with 41 figures (12 of which contain 2 components each) and also with 16 tables. This level of visualization and especially the 30 color Excel graphs in the text support the analysis and interpretation of the results obtained in the dissertation.

**5. Discussion of the results and the used literature**

The achieved results testify to a sufficiently good performance of each of the 7 formulated tasks, and thus to the achievement of the set dissertation goal.

The used literary sources in their predominant part reflect the current level of the problems treated in the dissertation. Of these, 21% were published before 2000, 19% between 2000 and 2010, and the remaining 60% after. To the latter should be added the 7 used Internet information sources.

**6. Contributions to the dissertation**

Based on the summaries and conclusions made in the conclusion of the dissertation, a number of scientific and applied contributions have been achieved, among which, in our opinion, there is one scientific contribution that is not distinguished as such, namely:

**A scientific contribution** is the compilation, using the software products QstatLab 6 and SPSS 20, based on the obtained experimental results, of multifactor regression models in coded form of their variables, reflecting the influence of different combinations of 3 out of a total of 6 studied factors on the same 5 indicators of the softness of the upholstery of upholstered furniture in 6 types of structures of such upholstery, designated as A, B, C, D, E and E.

In our opinion, the most important scientific-applied and applied contributions achieved in the dissertation are the following:

**Scientific-applied contributions**

1. Through three-factor experiments, the qualitative and quantitative influence of the following factors on 5 indicators of the softness of the upholstery (initial softness, total deformation of the backrest, total deformation of the seat, softness coefficient of the backrest and softness coefficient of the seat) was established in 6 types of upholstery structures studied:

- the number of layers of polyester wadding (1, 2, 3 pcs.) and the thicknesses of the upholstery insert layer (20, 30, 40 mm) and the layer of conventional polyurethane foam N 3540 (60, 100, 140 mm) in upholstery structure type A;
- the thicknesses of the upholstery insert layer (20, 30, 40 mm), of the polyurethane foam layer N 3030 (60, 100, 140 mm) and of the polyurethane foam layer CME 3025 (60, 100, 140 mm) in upholstery structure type B;
- the number of layers of polyester wadding (1, 2, 3 pcs.) and the thicknesses of the upholstery insert layer (20, 30, 40 mm) and of the polyurethane foam layer CME 3025 (60, 100, 140 mm) in upholstery structure type B;
- the number of layers of polyester wadding (1, 2, 3 pcs.) and the thicknesses of the upholstery insert layer (20, 30, 40 mm) and the polyurethane foam layer CME 3025 (40, 60, 80 mm) in the upholstery structure type D;
- the thicknesses of the upholstery insert layers (20, 30, 40 mm), the polyurethane foam layer CME 3025 (60, 100, 140 mm) and the polyurethane foam layer CME 3025 (40, 60, 80 mm) in the upholstery structure type D;
- the number of layers of polyester wadding (1, 2, 3 pcs.) and the thicknesses of the polyurethane foam layer N 3030 (40, 60, 80 mm) and the polyurethane foam layer CME 3530 (60, 100, 140 mm) in an upholstery structure type E.

2. Based on the experimental results, graphical dependences of the deformation behavior of the studied 6 types of upholstery structures have been constructed depending on the loading force in the range from 0 to 100 daN.

3. It has been found that upholstery structures A, B and E, which are made of conventional polyurethane foams in combination with other materials, have lower values of total deformation compared to structures C, D and E, made of flame-retardant polyurethane foams and a "Pocket" spring package in combination with other materials.

**Applied contributions**

1. The established qualitative and quantitative influence of the individual materials used in the studied upholstery structures on the indicators of their softness and deformation behavior constitutes a good basis for optimizing such structures according to their functional purpose.

2. The studied upholstery structures could be implemented directly in practice in the production of seats and/or backrests of modern upholstered furniture.

3. Sufficiently modern technical and software tools have been mastered and applied for conducting experimental research and for computer processing of the data sets obtained with them.

**7. Assessment of the personal participation degree of the PhD student in the contributions**

I consider the personal participation of the doctoral student to be decisive in achieving the contributions in the dissertation work and in its overall development.

**8. Critical remarks and recommendations**

In the relatively small volume of the dissertation work (only 116 pages), it would have been possible to add and analyze a decoded form of the variables in the compiled multifactor regression models, and also to derive equations for the deformation behavior of the 6 upholstery structures studied.

I consider the contributions in the dissertation work to be insufficiently well edited and graded in importance. Instead of the decimal point that is imposed in the scientific literature, a decimal comma is used in fractional numbers. There are no Internet information sources in the literature used and analyzed on the topic of the dissertation.

The dissertation lacks Fig. 2.1, Fig. 3.1 and Table 3.1, while the content of the missing Figure 3.1 is commented on and analyzed in its text, and nothing is mentioned at all about Fig. 2.1 and Table 3.1. The list of literary sources used is not sufficiently precise, with the titles of some of them unjustifiably written only in capital letters, the pages of the available books and some of the articles, etc., are not indicated.

In the list of publications based on materials of the dissertation, the doctoral student, in addition to his 3 independent issues, also has been included 1 collective work, a copy of which he did not attach to the materials for the procedure, which is why it is not reflected by me below in item 9.

**9. Published articles and citations**

The doctoral student has presented copies of 3 of his publications on essential parts of the dissertation work. All three are independent and have been published in Bulgarian in the proceedings of the International Scientific Congresses "Machines. Technologies, Materials", one of which in 2022, and the other two – in 2023.

The proceedings are included in the National Reference List of Contemporary Scientific Publications with Scientific Review of NACID. In accordance with the changes in the Law on RASRB made in 2020, the three publications presented on the dissertation work form a total of 60 points under the group of indicators "G" with a minimum required score of 30 points.

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

The presented abstract reflects the structure and content of the dissertation sufficiently fully and adequately.

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

## CONCLUSION

The PhD thesis represents a quite a lot 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 are directly applicable in practice.

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

All of the above gives me reason to recommend to the members of the esteemed Scientific Jury on the procedure to award the doctoral student Eng. Rostislav Bozhidarov Bozhkov the educational and scientific degree "Doctor" in professional field 5.13 "General Engineering".

**OPINION PREPARED BY:** [redacted]

/ Prof. DSc Nencho Deliiski /

Opinion delivered to: