Приложение 13

ABSTRACTS

of Assoc. Prof. Eng. Georgi Yordanov Vukov Ph. D.

Presented for participation in a competition for occupying the academic position „professor“ Field of higher education 5. Technical Sciences, Professional field 5.13. General Engineering, Scientific specialty Applied Mechanics in the discipline „Mechanics “, promulgated in State Gazette, issue 101 / 27.12.2019, procedure code: WWI-P-1119-28

B3 Monographs

Vukov G. (2017), *Vibrodiagnostics and Monitoring of the Technical Equipment in the Forest Industry*, Avangard Prima, Sofia, 130 p., ISBN 978-619-160-902-4,
Reviewer Assoc. Proff. Zhivko Gochev Ph.D, COBISS.BG-ID - 1284819428

The monograph is dedicated to the specifics, characteristics, methodology and practice of conducting vibrodiagnostics and monitoring of technical equipment in the forest industry. It is based on the theory and basic concepts of technical diagnostics and, in particular, of vibrodiagnostics. Concerning this, the author develops his original views and understandings in a systematic row. They are represented in a large number of specific studies aimed at the practical conduction of vibration diagnostics and monitoring in the type of equipment under consideration. Original, theoretically grounded and practically proven methodologies and strategies for modeling and investigating typical malfunctions of this equipment are proposed. Particular attention is paid to the modeling and investigation of the equipment's characteristic modes of operation with an increased level of vibration, leading to a temporary impairment of the equipment's operability. The specific requirements for the optimal technical and hardware implementation of the systems for vibration diagnostics and monitoring of equipment in the forest industry are formulated.

G7. Publications referenced in Web of Science or SCOPUS

7.1. Vukov G., Zh.Gochev (2018), *Modelling of the Influence of Wearing of Saw Unit Elements of a Wood Shaper on Its Vibration*, Acta Facultatis Xylologiae Zvolen, 60(1): 2018, pp. 129−135, DOI: 10.17423/afx.2018.60.1.14, ISSN 1336-3824

Mechanic-mathematical model of the saw unit of the wood shapers developed by the authors is presented in the paper. This model is designed for studying the influence of wearing and change of parameters of saw unit elements on the accuracy and quality of the production. Wearing and changes of elastic and damping parameters of a belt drive are the first factors analysed and accounted in the model. A variable torsional moment of an electric motor formed by inevitable deviation from correct stator shape and rotor imbalance is the second considered factor. The third factor taken into account is a variable torsional moment of a cutting tool of a wood shaper. These three factors affect machine torsional vibrations and its precise work directly. The mechanic - mathematical model developed by the authors allows numerical investigation of free and forced torsional vibrations of a saw mechanism in this type of machines.

7.2. Vukov, G., Zh. Gochev, V. Slavov (2012), *Torsional Vibrations in the Saw Unit of a Kind of Circular Saws. Numerical Investigations of the Natural Frequencies and Mode Shapes*. Proceedings of Papers, 8th International Science Conference “Chip and Chipless Woodworking Processes”, Zvolen, 2012, pp. 371 – 378, ISBN 978-80-228-2385-2.

A numerical investigation of the natural frequencies and mode shapes of the circular’s saw unit is presented in this study. The research is done on the base of a mechanic-mathematical model for investigation of free torsional vibrations of a circular saw developed by the authors. The model presents features in the construction of a kind of circular saws. As a result this study allows the determination of the resonant work regimes. The determination of these regimes is important for introduction of adequate measures which can guarantee their using.

The results of the investigation can be used as a base for making some recommendations concerning the increase of reliability of the machine.

7.3. Vukov G., P. Vichev, Zh. Gochev (2019), *Spatial Vibrations of a Single Spindle Moulder Caused by the Unbalance of Drive Electric Motor's Rotor*, Proceedings 30th International Conference on Wood Science and Technology (ICWST 2019) "Impementation of Wood Science in Woodworking Sector", Zagreb, pp. 225-234, ISBN 978-953-292-062-8

This study investigates the forced spatial vibrations of a woodworking shaper, caused by rotor's unbalance of its drive electric motor. The investigations are done on the base of an original mechanic-mathematical model, developed by the authors. A system of matrix differential equations is compiled and analytical solutions are derived. Numerical calculations are carried out by using the developed model and modern computer programs. The calculations use the parameters of a machine used in the practice. As a result of the whole study, the forced spatial vibrations of a woodworking shaper caused by rotor's unbalance of drive electric motor are obtained and illustrated. These results allow clarifying the influence of the considered unbalance on the work of the main elements of this machine.

7.4. Gochev Zh., G. **Vukov** (2017), *Influence of the Wearing of the Saw Unit Elements of the Wood Shaper on the System Vibration*, Acta Facultatis Xylologiae Zvolen, 59(2): 2017, pp. 147−153, DOI: 10.17423/afx.2017.59.2.14, ISSN 1336-3824

The article deals with the issue of vibration of lower one-spindle milling cutter. There are analyzed the causes of vibrations origin and their influence on the process of wood working. A particular attention is paid to the dependence of vibrations on the machine wear. A complete numerical model of vibration detection including a description of input variables is applied on a universal wood formating machine with a spindle in a lower position on the FD-3. The model is applied under the alternative without damping as well as under forced torcional vibrations which were caused by wear of the woodforming machine after long-term use, especially for the rotor of the electric motor, the pulley mounted on the motor shaft, the pulley mounted on the spindle and the cutting tool. At the end, there are summarized the influences of forced torsional vibrations caused by the wear of the wood working machine and their practical effects on the quality of the worked surface

7.5. Todorov, M. D., G. Y. **Vukov** (2011), *Modal Properties of Drive Train in Horizontal Axes Wind Turbine*. Romanian Review Precision Mechanics, Optics & Mechatronics, No. 40, Bucharest, pp. 267 – 275, ISSN 1584-5982, ISSN e2247-8418

The staring point in the research of the vibrations is the finding of natural frequencies and mode shapes, which indicate the frequency range of interest. A dynamic multibody model for determination of the torsional vibrations of a wind turbine drive train is presented in this paper. The model of a wind turbine consists of a rotor with rigid blades, elastic shafts, a drive train and a generator. The drive train has a gearbox with three gear stages. The gear stages include two high-speed stages (helical gear pairs) and a low-speed planetary gear stage (three identical planets with spur teeth, sun and a fixed ring wheel). The model consists of 10 bodies and has 11 degrees of freedom. The model takes into account the stiffness of the engaged tooth pairs and shafts. Computer simulation is performed by MATLAB. The natural frequencies and vibration modes are obtained for an industrial wind turbine.

7.6. Todorov, M. D., G. Y. **Vukov** (2011), *Investigation of the Parametric Torsional Vibrations of a Drive Train in Horizontal Axes Wind Turbine*. Proceedings of the 4th International Science Conference "Woodworking Techniques", Prague, Czech republic, 7-10 September 2011, pp. 328 – 336, ISBN 978-80-213-2182-3.

A dynamic multibody model for determination of vibrations of a wind turbine drive train is presented. The model of a wind turbine consists of a rotor with rigid blades, elastic shafts, a drive train and a generator. The drive train has a gearbox with three gear stages. The gear stages include two high-speed stages (helical gear pairs) and a low-speed planetary gear stage

(three identical planets with spur teeth, sun and a fixed ring wheel). The model consists of 10 bodies and has 11 degrees of freedom. The model takes into account the stiffness of the engaged tooth pair as time functions. In this model the aerodynamic and generator torques are applied as variable external loads. The calculation permits to obtain time series of torsional vibrations and amplitude-frequency characteristics for an industrial wind turbine. The results of numerical investigation of the wind turbine with constant wind and constant angular velocity of rotation of the rotor in the time domain and in the frequency domain are presented.

7.7. Slavov V., G. **Vukov** (2019), *Modelling and Researching of Forced Spatial Vibrations of Axial Fans*, MATEC Web of Conferences - 6th International BAPT Conference "Power Transmissions 2019", vol. 287, p.5, Article Number 03006, DOI: 10.1051/matecconf/201928703006, eISSN: 2261-236X

This work presents a mechanic - mathematical matrix modelling of the forced spatial vibrations of an axial fan. The axial fan is considered as a mechanical system consisting of three rigid bodies and with 18 degrees of freedom. The differential equations of the forced vibrations are derived. They take into account the mass, inertial, elastic, damping and geometric characteristics of this mechanical system. Algorithms are developed for computer calculating, analysis and synthesis of the design of this axial fan. These algorithms are a prerequisite for achieving the required operational properties of the fan and its compliance with the standards and regulations for vibrations' impact on the human body. Calculations and results of the forced spatial vibrations are provided for specific parameters of an axial fan.

7.8. Gochev Zh., P. Vitchev, G. **Vukov** (2019), *Determination of Performance Index and Effective Power for Sharpening of TC Planer Knives with PCD Abrasive Wheels*, Proceedings 30th International Conference on Wood Science and Technology - ICWST 2019, Zagreb, pp. 53-60, ISBN 978-953-292-062-8

This paper presents experimental results of sharpening of planer knives part of cutter head. The knives have TC (tungsten carbide) edges type K40 and K20 according to ISO grade classifications. The sharpening process do with abrasive wheels from polycrystalline diamond (PCD). Performance indicator and effective power for both direct and reverse motion are determined. The grits of PCD abrasive were with common heightened durability, anti-stick properties with organic and metal/organic binder. Based on the results of the research, the relevant conclusions and recommendations are made.

7-9. Vitchev P., Zh. Gochev, G. **Vukov** (2019), *Influence of Some Factors on the General Vibrations Generated by Woodworking Spindle Moulder Machine*, Proceedings 30th International Conference on Wood Science and Technology - ICWST 2019, Zagreb, pp. 266, ISBN 978-953-292-062-8

This study investigates the general dynamic behavior of a woodworking milling machine with a lower working shaft location, determined by the mean square value of the vibration speed measured on the shaft bearings. The results show that the mounting of a cutting tool increases the overall vibration of the machine in idling. Among the measured factors, the cutting speed has the greatest influence on the vibration intensity, followed by the feed rate and the thickness of the cut-out layer. Based on the presented graphical relationships, the optimal values of the studied factors can be determined in order to reduce the overall vibration of the machine, which is an important prerequisite for the good work of the cutting tool and for improving the quality of the machined surfaces.

G8. Publications referenced in other databases or not referenced

8-1. **Vukov**, G. Y. (2010), *On the Modelling of the Variable Loads of the Work of the Class Wind Turbines*. Forestry Ideas, Vol. 16, №1 (39), University of Forestry, Sofia, pp. 115 – 120, ISSN 1310-5639.

This paper investigates some possibilities for suitable modeling of variable external loads

in a regime of exploitation of a kind of wind turbines. On the base of the developed original model of wind turbines it is possible to study dynamical processes in different specific work regimes of this kind of wind turbines. This model allows to examine the behavior of the system in extraordinary situations and different work regimes and to define some recommendations for more effective work of that kind of wind turbines.

8-2. Vukov, G. (2016), *Study of the Variable Inertia Forces of the Tool Slide of the Carved Veneer Machines*. Management & Sustainable Development, 2/2016, y. 18, V 57, University of Forestry, Sofia, pp. 75 – 78, ISSN 1311-4506

The work presents a study on the formation of variable inertia forces of the tool slide of the carved veneer machines. An analysis of the reasons for the generation of these forces is conducted. The cause for appearance of the variable inertia forces is the variable acceleration of the tool slide. The considerable mass of the tool slide and its high-speed operation determine large amplitudes of these forces. A dependency is deduced in this study. It shows that the generated at work inertia forces include two periodic components. The first component has a frequency equal to that of rotation of the flywheels, and the second component has a frequency equal to their doubled frequency. The amplitudes of the two components depend on the mass of the tool slide, the rotational speed of the flywheels raised on the second power and the geometric parameters of the elements of the mechanism. The results of the study are applicable to the development, design and dimensioning of new machines of this type, as well as reconstruction and modernization of existing ones.

8-3. Vukov, G. (2017), *Study on Some Characteristics of Dynamic Loads in the Components of the Saw Unit of the Carved Veneer Machines.* Management & Sustainable Development, 2/2017, y. 19, V 63, University of Forestry, Sofia, pp. 79 – 83, ISSN 1311-4506

This work presents a study on some basic characteristics of dynamic loads in the components of the saw unit of the carved veneer machines in work regime. The change of the particular forces, formed this loads, are studied. After that their joint actions are studied. Several separate periods in the formation of the load are defined. These periods have specific characteristics and duration. Thus considered load can be conditionally divided into parts with the purpose of a more complete and accurate analysis. A carefully study of a single period provides an opportunity to analyze in detail the prerequisites for the arising of increased load in connection with a specific reason. The results of the study are applicable to the development, design and dimensioning of new machines of this type. They are useful in reconstruction and modernization of existing ones.

8-4. Vukov, G. (2018), *Study on Dynamic Loads of Cutting Mechanism's Drive Shaft of the Saw Unit of the Carved Veneer Machines.* Management & Sustainable Development, 2/2018, y. 20, V 69, University of Forestry, Sofia, pp. 51 – 55, ISSN 1311-4506.

This work presents a study on dynamic loads of cutting mechanism's drive shaft of carved veneer machines in work regime. The variable torsional moments that form these loads are examined. These moments are caused by faults of the driving electric motor; inertial forces formed by the operation of the cutting mechanism; variable force from the cutting process. The applied variable moments form intense torsional vibrations in the drive shaft. They generate an extra dynamic moment that is superposed on the transmitted constant torque. A strategy is proposed and dependencies are derived for determining the extra dynamic moment. Determining the actual moment is a prerequisite for proper shaft dimensioning.

8-5. Vukov, G. Y. (2005), *On the Parametric Torsional Vibrations of the Driving Mechanism of a Carved Veneer Machine*, Proceedings of the 10TH Jubilee National Congress on Theoretical and Applied Mechanics, Varna, 2005, pp. 92–96, ISBN-10: 954-322-123-5, ISBN-13: 978-954-322-123-3, ISSM 1313-9665 (print)

A dynamical model for investigation of the parametric torsional vibrations of the driving

mechanism of a carved veneer machine is given in this study. The model enables to investigate the actual behavior of the mechanism in different operating conditions. Numerical studies are presented. The matter about variation and improvement of the structure of this mechanism is considered. The results of this study are applicable to the designing and the dimensioning of these mechanisms.

8-6. Vukov, G. (2018), *Study of the Natural Frequencies and Mode Shapes of the Torsional Vibrations of Woodworking Shapers*, International Journal of Latest Research in Engineering and Technology (IJLRET), Budaun, India, Vol. 04, No. 04, 2018, pp. 32 – 38, ISSN*:* 2454-5031.

An investigation of the natural frequencies and mode shapes of the woodworking shaper's saw unit is presented in this study. This study is done on the base of a mechanic-mathematical model for investigation of free torsional vibrations of a woodworking shaper's saw developed by the author. The main features in the construction of a kind of wood shapers are rendered an account of this model. The two most commonly used driving mechanisms are modeled – with a wedge belt and with a ribbed belt. The studies allow a comparison of the vibration behavior of the mechanism for both drives. The results of this study allow the determination of the resonant work regimes.

8-7. Vukov, G., M. Todorov (2019), *Dynamic Analysis of a Wind Turbine's Drive Train Wth Teeth Defects.* Management & Sustainable Development, 2(75)/2019, University of Forestry, Sofia, pp.87 – 92, ISSN 1311-4506.

This work presents the application of a developed multi-body model of a wind turbine with complex drive train. The model is adapted for studying the drive train dynamics in the presence of the most common defects of its elements – a tooth cracking and tooth pitting. These defects are modeled by theoretically justified reduction of the amplitude of the respective stiffness of the planetary gear mechanism. As a result of the studies of the gear and available defects, time series of torsional vibrations of the wind drive train hull are obtained and graphically presented.

8-8. Vukov G., Zh. Gochev (2018), *Modeling of the Free Spatial Vibrations of Wood Shaper and its Spindle*, Innovations in Woodworking Industry and Engineering Design, INNO, vol. VII, 2/2018, Sofia, pp. 19÷26, p ISSN 1314-6149, e ISSN 2367-6663.

The proposed study deals with the modelling of the free spatial vibrations of a woodworking shaper and its spindle. A mechanical - mathematical model of woodworking shaper and its spindle, developed by the authors, is presented in this work. The model provides the opportunity to explore the free undamped space vibrations. A system of matrix differential equations is compiled and analytical solutions are presented. The natural frequencies and mode shapes for a specific machine can be obtained with their help. The model is supplemented in order to investigate the free damped space vibrations of the considerate system. The new model takes into account the damping properties of machine's elements. A new system of matrix differential equations is developed and the relevant analytical solutions are presented. Numerical solutions and graphs can be obtained with the help of the developed models. These solutions and graphs are necessary for analyzing the free undamped and the free damped space vibrations of a particular considerate machine.

8-9. **Vuko**v, G., Zh. Gochev (2013), *Possibilities for Improvement of the Control of the Technical State and Determination of the Serviceability of Carved Veneer Machines*, Proceedings International Scientific Conference "WOOD TECHNOLOGY & PRODUCT DESIGN", Ohrid, Republic of Macedonia, pp. 93 – 98, ISBN 978-608-4723-00-4

Some problems of improvement of vibration control methods and passing serviceability of a carved veneer machine are discussed in this paper. Criterion for estimation of the technical state and determination of passing serviceability is formed on the base of the investigation of torsional vibrations by using an original dynamical model. Special features in the construction

and peculiarities of the work regimes in exploitation of these machines are modeled. Investigations indicate that regular diagnostics increase the reliability and the effectiveness and decrease the expenses of the repair and service. It guarantees the precision and the quality of the production with carved veneer machines at the same time

8-10. Vukov, G., Zh. Gochev (2015), *Investigations of the Influence of the Wearing and the Belt Drive Parameters' Changes Over the Forced Torsional Vibrations in the Saw Unit of a Wood Shapers*, Innovations in Woodworking Industry and Engineering Design, INNO, vol. IV, 1/2015, Sofia, pp. 50 – 58, ISSN 1314-6149

The proposed study presents an investigation of the influence of the wearing and the belt drive parameters' changes over the forced torsional vibrations in the saw unit of a wood shaper. These changes affect the elastic and damping coefficients of the machines' elements. The research is done on the base of a concrete mechanic-mathematical model developed by the authors. The main features in the construction of the wood shapers are rendered an account in this model. Work's conditions in the practice are modeled with the variable moments on the drive electric motor and the wood shaper's saw. The conclusions based on the numerical investigations are confirmed by the real conditions.

8-11. Vukov, G., Zh. Gochev, V. Slavov (2014), *Investigations of the Natural Frequencies and Mode Shapes of the Circular Saw with Compensating Slots and Low Noise Slots by the Finite Elements Method*, International Scientific Journal "Wood, Design & Technology", Vol. 3, No. 1, Skopje, pp. 59 – 67, ISSN 1857-8381, eISSN 1857-9140

This paper shows the methodic and results of the simulative investigations of the circular saw with compensating and low noise slots. The investigations are an extention of the previous ones of the authors. The natural frequencies and mode shapes of this kind of circular saws are obtained as results of the investigations. The estimation is done by the application programme Cosmos Works. Physical and mechanical properties of the materials are taken into account. The adequate mechanic-mathematical model is used for the aims of the study. The typical characteristics of the construction of this kind of circular saws are taken into account in the model. The circular saw is drawn in 3D by the application programme Solid Works and it is modeled with four nodes 3D finite elements. The results of this investigation prove the practical significance of the model.

8-12. **Vukov**, G., Zh. Gochev, V. Slavov (2013), *Investigations of the Natural Frequencies and Mode Shapes of the Circular Saw with Compensating Slots by the Finite Elements Method*, International Scientific Journal "Wood, Design & Technology", Vol. 2, No. 1, Skopje, pp. 53 – 61, ISSN 1857-8381, eISSN 1857-9140

This paper shows the methodic and results of the simulative investigations of the circular saw with compensating slots. The investigations are an extension of the previous ones of the authors. The natural frequencies and mode shapes of this kind of circular saws are obtained as results of the investigations. The estimation is done by the application programme Cosmos Works. Physical and mechanical properties of the materials are taken into account. The adequate mechanic-mathematical model is used for the aims of the study. The circular saw is drawn in 3D by the application programme Solid Works and it is modeled with four nodes 3D finite elements. The results of this investigation prove the practical significance of the model.

8-13. Vukov, G., V. Slavov, G. Kovachev (2014), *Investigations of the Forced Torsional Vibrations in the Saw Unit of a Kind of Wood Shapers, Used in the Wood Production*, Innovations in Woodworking Industry and Engineering Design, INNO, vol. III, 1/2014, Sofia, pp. 62 – 69, p ISSN 1314-6149, e ISSN 2367-6663

The proposed study presents a numerical investigation of the forced torsional vibrations in the wood shaper's saw unit caused by the variable moments on the drive electric motor and the wood shaper's saw. The influence on the vibrations of the blades' number of the saw, which really work, is investigated. This research is done on the base of a concrete mechanic-

mathematical model. The investigation`s results can be used as a base for making some concrete and well-founded recommendations concerning the operation of these machines. These recommendations are important for increase of reliability of the wood shaper.

8-14. **Vukov**, G., Zh. Gochev, V. Slavov (2013), *Investigations of the Natural Frequencies and Mode Shapes of the Circular Saw Using Finite Elements Method. Part I: Mechanic-Mathematical Model*, Proceedings International Scientific Conference "WOOD TECHNOLOGY & PRODUCT DESIGN", Ohrid, Republic of Macedonia, 2013, pp. 18 – 22, ISBN 978-608-4723-00-4

This study focuses on a mechanic-mathematical model for investigation of free vibrations of a circular saw. The model presents features in the construction of a kind of circular saws. It also gives an opportunity to make simulative investigations which can be used for studying circular saw's natural frequencies and mode shapes. The research is done by the Finite element method. As a result this study allows the determination of the resonant regimes. The determination of these regimes is important for introduction of adequate measures which can guarantee their using.

8-15. **Vukov**, G., Zh. Gochev, V. Slavov (2013), *Investigations of the Natural Frequencies and Mode Shapes of the Circular Saw Using Finite Elements Method. Part II: Numerical Investigations*, Proceedings International Scientific Conference "WOOD TECHNOLOGY & PRODUCT DESIGN", Ohrid, Republic of Macedonia, 2013, pp. 52 – 59, ISBN 978-608-4723-00-4

This paper shows the methodic and results of the simulative investigations of the circular saw. The natural frequencies and mode shapes of the circular saw are obtained as results from the investigations. The estimation is done by the application programme Cosmos Works. Physical and mechanical properties of the materials are taken into account. The circular saw is drawn in 3D by the application programme Solid Works and it is modelled with four nodes 3D finite elements. The results of this investigation prove the practical significance of the model.

8-16. Vukov, G., Zh. Gochev, V. Slavov, G. Wieloch (2013), *Investigation of the Forced Torsional Vibrations in the Saw Unit of a Kind of the Circular Saws. Part I: Mechanic-Mathematical Model*, Annals of Warsaw University of Life Science – SGGW, Forestry and Wood Technology № 81, pp. 279÷285, ISSN 1898-5912.

A model for investigation of the forced torsional vibrations of the circular's saw unit is presented in this study. The mechanic-mathematical model allows lots of simulative studies. The model presents features in the construction and operation of the circular machines. This model takes into account the characteristics of the interaction between the cutting tool and work piece. The model also gives possibilities for modeling and analysis of the effects of a number of defects.

8-17. Vukov, G., Zh. Gochev, V. Slavov, G. Wieloch (2013), *Investigation of the Forced Torsional Vibrations in the Saw Unit of a Kind of the Circular Saws. Part II: Numerical Investigations*, Annals of Warsaw University of Life Science – SGGW, Forestry and Wood Technology № 81, pp. 286÷292, ISSN 1898-5912.

This study presents a numerical investigation of the forced torsional vibrations in the saw unit of a class of circular machines. The natural frequencies and mode shapes are determined. The free damped vibrations of the mechanism are investigated and analyzed. Some investigations of the forced vibrations of the cutting mechanism, due to the presence of defects in the drive electric motor, are conducted. The amplitude-frequency characteristics of the system are obtained. The results are important for the vibrocontrol of circular machines and they are of unquestionable benefit in conducting vibration analysis of the system.

8-18. Vukov G., V. Slavov, P. Vichev, Zh. Gochev (2019), *Investigations of the Free Space Vibrations of a Woodworking Shaper, Considered as a Mechanical System with Three*

Main Bodies, Proceedings 4th International Scientific Conference "WOOD TECHNOLOGY & PRODUCT DESIGN", Ohrid, Republic of Macedonia, pp. 127 – 135, ISBN 978-608-4723-02-8.

Investigation of the free undamped spatial vibrations of a woodworking shaper, considered as a mechanical system with three main bodies, is the object of the proposed study. An model developed by the authors is presented. In this model the woodworking shaper, the spindle and the electric motor's rotor are regarded as rigid bodies, which are connected by elastic elements with each other and with the motionless floor. A system of matrix differential equations is compiled and analytical solutions are derived. Numerical calculations are carried out by using the developed model and modern computer programs. The calculations use the parameters of a machine used in the practice. As a result of the whole study, the natural frequencies and the mode shapes of the free spatial vibrations of the studied mechanical system are obtained and illustrated.

8-19. Vukov G., P. Vichev, V. Slavov, Zh. Gochev (2019), *Free Damped Space Vibrations of a Woodworking Shaper, Considered as a mechanical system with three main bodies*, Proceedings 4th International Scientific Conference "WOOD TECHNOLOGY & PRODUCT DESIGN", Ohrid, Republic of Macedonia, pp. 136 – 145, ISBN 978-608-4723-02-8.

This study investigates the free damped spatial vibrations of a woodworking shaper, which is considered as a mechanical system with three main bodies. It presents a model of these shapers, developed by the authors. In this model the shaper, the spindle and the electric motor's rotor are regarded as rigid bodies, which are connected by elastic and damping elements with each other and with the motionless floor. A system of matrix differential equations is compiled and analytical solutions are derived. Numerical calculations are carried out by using the developed model and modern computer programs. The calculations use the parameters of a machine used in practice. As a result of the whole study, the free damped spatial vibrations of the studied mechanical system are obtained and illustrated.

8-20. Vukov G., Zh. Gochev, V. Slavov, P. Vitchev, V. Atanasov (2017), *Mechanic-Mathematical Model for Investigations of the Forced Spatial Vibrations of Wood Shaper and its Spindle, Caused by Unbalance of the Cutting Tool*, PRO LIGNO, Transilvania University Press Brasov, Romania, Vol. 13, №4, 2017, pp.148÷153, Online ISSN 2059-7430, ISSN-L 1841-4737.

A mechanic - mathematical model of wood shaper and its spindle, developed by the authors, is presented in this work. The model provides the opportunity to explore the forced space vibrations of this type of machinery, caused by unbalance of the cutting tool. In this model the wood shaper and its spindle are regarded as rigid bodies, which are connected by elastic and damping elements with each other and with the motionless floor. The model takes into account the necessary mass, inertia, elastic and damping properties of the elements of the considered system. A necessary system of matrix differential equations is compiled and analytical solutions are presented.

8-21. Vukov G., Zh. Gochev, V. Slavov, P. Vitchev, V. Atanasov (2017), *Numerical Investigations of the Forced Spatial Vibrations of Wood Shaper and its Spindle, Caused by Unbalance of the Cutting Tool*, PRO LIGNO, Transilvania University Press Brasov, Romania, Vol. 13, №4, pp. 154÷161, Online ISSN 2059-7430, ISSN-L 1841-4737

This study presents the results of the numerical investigations of the forced spatial vibrations of a wood shaper and its spindle, caused by unbalance of the cutting tool. The paper is based on the model, developed by the authors. This study renders an account the mass, inertia, elastic and damping properties. The results of the numerical investigations are presented and illustrated. They are obtained through modern software and by using parameters of a particular machine.

8-22. Vukov, G., Zh. Gochev, V. Slavov, P. Vichev, V. Atanasov (2016), *Mechanic-*

Mathematical Model for Investigations of the Natural Frequencies and Mode Shapes of the Free Spatial Vibrations of Wood Shaper and its Spindle, Proceedings of the 10th International Science Conference „Chip and Chipless Woodworking Processes", Slovakia, Technical University in Zvolen, 10(1), 2016, pp. 203 – 209, eISSN 1339-8350, pISSN 2453-904X

An original mechanical - mathematical model of wood shaper and its spindle, developed by the authors, is presented in this work. The model has 12 DOF's and provides the opportunity to explore the free space vibrations of this type of machinery. It takes into account the characteristics in the construction of wood shapers. In this model the wood shaper and its spindle are regarded as rigid bodies, which are connected by elastic elements with each other and with the motionless floor. A necessary system of matrix differential equations is compiled and analytical solutions are presented.

8-23. Vukov, G., Zh. Gochev, V. Slavov, P. Vichev, V. Atanasov (2016), *Numerical Investigations of the Natural Frequencies and Mode Shapes of the Free Spatial Vibrations of Wood Shaper and its Spindle*, Proceedings of the 10th International Science Conference „Chip and Chipless Woodworking Processes", Slovakia, Technical University in Zvolen, 10(1), 2016, pp. 211 – 216, ISSN 1339-8350 (online), ISSN 2453-904X (print)

This paper presents the results of the numerical investigation of the natural frequencies and mode shapes of the free spatial vibrations of a wood shaper and its spindle. The study is based on the model, developed by the authors. The necessary mass, inertia and elastic properties of the elements of the considered system are taken into account. The results of the numerical investigations are presented. They are obtained with modern software and by using parameters of a particular machine. The calculated natural frequencies are necessary for the definition of the resonant modes.

8-24. Slavov V., G. **Vukov** (2018), *Free spatial vibrations of axial fan,* Innovations in Science, Engineering & Education, vol. 3, iss. 1/2018, Sofia, pp. 29 – 34, ISSN 2534-8507 (print), 2534-8515 (on line)

This work presents a mechanic - mathematical modelling of the free undamped spatial vibrations of an axial fan and the obtained results from performed calculations. The considered mechanical system is consisted of three rigid bodies and it has 18 degrees of freedom. The transformation matrix is defined. The vectors of the position and the vectors of the linear velocities of random points of the bodies are deduced. The kinetic energy and the potential energy of the system are determined. The differential equations of free vibrations are deduced. They take into account the mass, elastic and geometric properties of this mechanical system. The natural frequencies and the mode shapes are determined and illustrated during small vibrations of this fan with concrete parameters.

8-25. Slavov V., G. **Vukov** (2018), *Free damped spatial vibrations of axial fan*, Innovations in Science, Engineering & Education, vol. 3, iss. 1/2018, Sofia, pp. 35 – 41, ISSN 2534-8507 (print), 2534-8515 (on line).

This work presents a mechanic - mathematical modelling of the free damped spatial vibrations of an axial fan and the obtained results from performed calculations. The considered mechanical system is consisted of three rigid bodies and it has 18 degrees of freedom. The differential equations of the free damped vibrations are deduced. They take into account the mass, inertial, elastic, damping and geometric properties of this mechanical system. Computer algorithms which are applicable for analysis and synthesis of its design, are developed. Solutions are received and illustrated for the free damped spatial vibrations at specific values of the mechanical system's parameters.

8-26. Todorov, M. D., G. Y. **Vukov** (2002), *Torsional Oscillations of the Helicopter Transmission*. Proceedings of the Fifth World Congress on Computational Mechanics (*WCCM V*), Vienna, pp. ID 80344 /1–10/, ISBN 3-95015544-0-6

The torsional oscillations of the helicopter transmission are considered in this work. An

original dynamical model of the helicopter transmission is built for this investigation. The moments of gasturbine engine and tail rotor, linkage elasticity and two cardan shafts are given into account. On the basis of the present dynamical model the natural and excited oscillations of a helicopter with total mass of 11 100 kg, two gasturbine engines TV3-117VM and tail rotor (two blades, airfoil NACA-230) are investigated.

8-27. Todorov, M. D., G. Y. **Vukov** (2009), *A Dynamic Multiboby Model to Determine Vibrations in a Drive Train in a Wind Turbine*. Proceedings of the 11TH National Congress on Theoretical and Applied Mechanics, Borovets, Paper ID: 77–323–1–PB, ISSN 1313-9665

A dynamic multibody model to determine vibrations of a wind turbine drive train is presented. The model of the wind turbine consists of a rotor with rigid blades, elastic shafts, a drive train and a generator. The drive train has a gearbox with three gear stages. In the multibody model of a drive train, each body represents an individual drive train component, which translates in three directions and rotates around three axes (six DOF's) in the same directions. The different bodies are connected by using appropriate joints or stiffnesses. The model also takes into account the stiffnesses of the bearings in the drive train. This model contains 11 bodies and has 53 DOF's.

8-28. Todorov, M. D., G. Y. **Vukov** (2010), *Parametric Torsional Vibrations of a Drive Train in Horizontal Axes Wind Turbine.* 1ère Conférence Franco-Syrienne sur les énergies renouvelables "CFSER 2010", Damas, Syrie, pp. 31-1 – 31-17. DOI: 10.13140/2.1.1561.6963

The authors propose a dynamic multi-body model of a wind turbine which includes a rotor, a drive train and an electrical generator. The drive train has a three-stage gearbox which contains two high-speed parallel gear stages and a low-speed planetary gear stage. The model consists of 10 bodies and has 11 degrees of freedom. The model takes into account the stiffness of the engaged tooth pairs as time functions. In this model the aerodynamic and generator torques are applied as external loads. The calculation permits to obtain time series of torsional vibrations and amplitude-frequency characteristics for an industrial wind turbine. The results show that transient loads in the gearbox have complex character and require special attention. The modeling can be used for fault and wear gear diagnostic.

8-29. Todorov, M., G. **Vukov** (2015), *Torzione vibracije prenosnog mehanizma vetrogeneratora sa greškama u usklađivanju krutosti,* Zbornik Međunarodne konferencije o obnovljivim izvorima električne energije – MKOIEE, 2015, pp.27-1 – 27-9, (*Parametric Torsional Vibrations of a Drive Train of a Wind Turbine with Faults in Meshing Stiffness.* Proceedings of the International Conference on Renewable Electrical Power Sources – ICREPS, 2015), ISBN 978-86-81505-87-8

The parametric torsional vibrations of a drive train of a wind turbine with faults in meshing stiffness are investigated in this study. The dynamic multi-body model of the wind turbine includes a rotor, a drive train and an electrical generator. The drive train has got a three-stage gearbox that contains two high-speed parallel gear stages and a low-speed planetary gear stage. The model consists of 10 bodies and has got 11 degrees of freedom. The model takes into account the stiffness of the engaged tooth pairs. The obtained results are compared to system without damages.

8-30. Kovachev G., G. **Vukov** (2013), *Study of Bearing Loads of the Cutting Mechanism in Woodworking Shaper*, Proceedings International Scientific Conference "WOOD TECHNOLOGY & PRODUCT DESIGN", Ohrid, Republic of Macedonia, pp. 74 – 80, ISBN 978-608-4723-00-4

This study presents theoretical and experimental investigations of the bearing loads of the main shaft of cutting mechanism in woodworking shaper machine. The case of the drive mechanism with the ability to use different pinion gears is examined. Emphasis is placed on the advantages and disadvantages of the machine using different type belts at certain work regimes.

8-31. Todorov, M., G. Y. **Vukov**, I. Dobrev (2007), *A Dynamic Multiboby Model for Determination of the Torsional Vibrationsof of Wind Turbine*. Механика на машините, кн. 2 (68), Варна, стр. 32 – 35, ISSN 0861-9727

A dynamical model to determine the torsional vibration of wind turbine is presented. The model of the wind turbine consists of a rotor with rigid blades, elastic shafts, a drive train and a generator rotor. The drive trains in modern wind turbines typically have a gearbox with three gear stages. The gear stages include two high-speed gear stages (spur gear pairs) and low-speed planetary gear stage (three identical planets with spur teeth, sun and fixed ring wheel). The model consists of 10 bodies and has 8 degrees of freedom. The natural frequencies and the mode shapes which indicate the frequency range of interest are determined.

8-32. Genchev J., G. **Vukov**, V. Slavov (2013), *Modeling and Analysis of the Elements and Structure of the Armchair for a Rest*, Innovations in Woodworking Industry and Engineering Design, INNO, vol. II, 1/2013, Sofia, pp. 105 – 110, p ISSN 1314-6149, e ISSN 2367-6663

Upholstered furniture consists of supporting structure (skeleton) and upholstery. The proposed work presents modeling and analysis of the elements and structure of an armchair for a rest. The study is done on the base of modern software products, using traditional research of this type of sizes and load schemes According to the study, some necessary recommendations for the design optimizing concerning its practical implementation with specific parameters are given.

8-33. Gochev Zh., **G. Vukov**, V. Atanasov, P. Vitchev (2018), *Study on the Power – Energetic Indicators of a Universal Milling Machine*, Innovations in Woodworking Industry and Engineering Design, INNO, vol. VII, 1/2018, Sofia, pp. 18 – 24, p ISSN 1314-6149, e ISSN 2367-6663

Experimental studies during milling of solid wood were carried out. The current study was performed at the Laboratory of Woodworking Machinery, University of Forestry, Sofia. The measurements were carried out using universal milling machine FD – 3 (ZDM – Plovdiv). The correlations between fundamental factors influencing the milling process and target functions, such as cutting force and power, specific cutting work, specific power consumption have been investigated. On the basis of the analysis of the obtained results, practical recommendations have been proposed.

8-34. Gochev, Zh., G. **Vukov**, G. Kovachev, P. Vichev, V. Atanasov (2017), *Influence of the Number of Belts Over the Performance of the Cutting Mechanism in a Woodworking Shaper*, Proceedings Third International Scientific Conference "WOOD TECHNOLOGY & PRODUCT DESIGN", Ohrid, Republic Macedonia, pp. 48 – 54, ISBN 978-608-4723-02-8.

This study presents theoretical and experimental investigations of the influence of the number of belts over the performance of the cutting mechanism in a woodworking shaper. The motion of the cutting mechanism was investigated by means of one and two V-belts. The vibration speed (r.m.s.) of the cutting mechanism was measured in three directions both empty and in stroke. The conducted experimental research provides a comparative analysis of the impact of the numbers of belts over the performance of the cutting mechanism. The obtained results can be used to optimize the number of the belts used to drive the cutting mechanism of the woodworking shapers

8-35. Gochev, Zh., G. **Vukov**, P. Vichev, V. Atanasov, G. Kovachev (2017), *Study on the Vibration Severity Generated by Woodworking Spindel Moulder Machine*, Proceedings Third International Scientific Conference "WOOD TECHNOLOGY & PRODUCT DESIGN", Ohrid, Republic of Macedonia, 2017, pp. 55 – 60, ISBN 978-608-4723-02-8.

The aim of this study was to investigate and determine the vibration severity, generated by a woodworking spindle moulder machine at different rotation frequencies and with different cutting tools. The assessment was based on the root mean square value of the

vibration velocity (v) $mm.s^{-1}$ (r.m.s.) measured in two mutually perpendicular radial directions in each of the bearing housings of the driving shaft of the machine (four measuring points).

8-36. Gochev Zh., **G. Vukov**, P. Vitchev, V. Atanasov, G. Kovachev (2017), *Influence of the cutting mode on the overall vibrations generated by the woodworking milling machine*, Annals of Warsaw University of Life Science – SGGW, Forestry and Wood Technology № 98, pp. 33÷42, ISSN 1898-5912

Factors influencing the cutting power in longitudinal milling of solid wood. Some factors which affect the cutting power during longitudinal milling process of solid wood are studied in this paper. These factors are: the cutting speed, the feed speed and milling area. The input power of the cutting mechanism in idle and power motion is measured for the purposes of the study. Modern equipment with corresponding for this study software is used. The present studies have been conducted in the processing wood details from beech (Fagus sylvatica L.). A comparative analysis of these results and the results obtained in the treatment of details from pine (Pinus sylvestris L.) is made. The obtained results are analyzed and some recommendations that support the practice of longitudinal milling of wood are propose

8-37. Gochev Zh., **G. Vukov**, V. Atanasov, P. Vitchev, G. Kovachev (2018), *Factors influencing the cutting power in longitudinal milling of solid wood*, Annals of Warsaw University of Life Science – SGGW, Forestry and Wood Technology № 102, pp. 103÷111, ISSN 1898-5912

The current study investigates the changes in the overall vibrations, generated by the universal woodworking spindle moulder machine in relation to some fundamental parameters characterizing the cutting mode: the cutting speed (V), the feed speed (U) and the thickness of the out-cut layer (h). On the basis of these experiments and the obtained results we determined the degree of influence of the investigated parameters on the intensity of the vibrations generated by this type of machines.

8-38. Gochev, Zh., P. Vichev, G. **Vukov** (2019), *Determination of Performance Indicators and Quality of TCT Knives when Sharpened wit PCD Grinding Wheels*, Proceedings 4TH International Scientific Conference ”WOOD TECHNOLOGY & PRODUCT DESIGN”, Ohrid, Republic of Macedonia, pp. 119 – 126, ISBN 978-608-4723-02-8.

This article presents experimental results in respect of planer knives sharpening made of TCT, type K40 according to ISO grade classifications with abrasive tools from Polycrystalline Diamond (PCD). The specific consumptions of PCD abrasive was defined. The grits of PCD abrasive were with common heightened durability, anti-stick properties and organic bonded. Some qualitative indices when sharpen planer knives were studied.

8-39. Atanasov V., Zh. Gochev, **G. Vukov**, P. Vitchev, G. Kovatchev (2018), *Influence of Some Factors on the Cutting Force in Milling of Solid Wood*, Journal “Chip and Chipless Woodworking Processes”, Zvolen, 11(1), pp. 9 – 15, pISSN 2453-904X, eISSN 1339-8350

The paper examines the impact of factors cutting speed V, feed speed U and milling area A over the cutting force P when operating with a universal woodworking milling machine with a lower spindle position. For this purpose, a planned three-factor regression analysis was carried out. Modern testing equipment and relevant software products were used to process the obtained values. The selected wood is beech (Fagus sylvatica L.). A regression equation was obtained. It can be used to calculate the cutting force P at different levels of considered factors. The results are analyzed and practical recommendations are proposed

8-40. Vukov G. (2007), *Improvement of the Vibration Control Methods with a View to Raising of the Effectiveness, Economy and Reliability of the Equipment in the Woodworking and Furniture Production.* Management & Sustainable Development, 3-4/2007, University of Forestry, Sofia, pp. 361–365, ISSN 1311-4506

This paper discusses the problem of vibration control methods and means of the equipment

in the woodworking and furniture production. The criterion of the technical state evaluation is formed on the base of the structure and operation of this equipment. The investigation indicates that the vibration control methods increase the reliability and the effectiveness and decrease the expenses of the repair and service. That is the way, which guarantees the precision of the manufacturing process. That is connected with the increase of the quality of the finished products and decrease of their prices. It is clear, that the availability of methods for prediction of the technical state of the equipment has a significant economical effect.

8-41. Vukov G. (2013), *Increase in the Effectiveness of the Machines in the Forestry Industry by Limiting of Certain Dangerous Work Regimes*. Management & Sustainable Development, 6/2013, University of Forestry, Sofia, pp. 125–129, ISSN 1311-4506

Some possibilities for increase in the effectiveness of the work of machines in forestry industry are examined in the proposed study. Emphasis is placed on the need to limit the dangerous work regimes which raise shock loads. Analytical relationships describing the adverse process in these mechanisms are analyzed. Some based recommendations are formed to prevent such practices. In the same time it becomes possible to find out some derivations appeared in parameters and to take up necessary actions. All this concerns decreasing in expenditure for idle time, service and repair work. It is necessary to do a preliminary test of the work process by using modern equipment. In this way the dangerous work regimes can be optimized and it can lead to increase in the efficiency of the whole machine.

8-42. Vukov G. (2014), *Raising of the Serviceability of the Circular Saws by Limiting of Certain Dangerous Work Regimes.* Management & Sustainable Development, 6/2014, University of Forestry, Sofia, pp. 133 – 137, ISSN 1311-4506

This work includes an investigation of some opportunities for improving the serviceability of the circular saws. The importance of the study of dangerous work regimes, associated with the occurrence of impact loads, is upholded in this investigation. Some important analytical relationships are derived. The negative processes, which disturb the serviceability of investigated machines, are analyzed by these analytical relationships. A succession of actions is proposed. It can be used to study the probability of rise of impact loads. Along with this, based recommendations for prevention from such practices can be defined. A conclusion of the importance of advance study of the work of the circular machine with modern methods is made. Thus the dangerous regimes, leading to the loss of serviceability, can be limited. In this way the circular saws' effectiveness of the work and the product quality are increased.

8-43. Vukov G. (2015), *Study of the Factors Leading to Increased Wear of the Wood Shapers' Belt Drive.* Management & Sustainable Development, 5/2015, University of Forestry, Sofia, pp. 5 – 9, ISSN 1311-4506

The work presents a study of the major factors leading to increased wear of the belt drive in the wood shaper's saw unit. Traditionally presented factors for increased wear of the belt drive are a deviation from the true location of the pulleys and their shafts. These factors are rendered an account in the study, but it focuses on the reasons related to the formation of variable torques of the drive electric motor and the cutting tool. It considers the variable torque of the electric motor caused by the inevitable deviation from the correct shape of the stator, as well as the unbalance of its rotor. The variable torque on the cutting tool, formed by different sizes of forces on its separate cutters, is examined. The reason for the difference in the size of these forces is given and based.

8-44. Vukov G. (2008), *Torsional Vibrations of the Driving Mechanism of a Carved Veneer Machine. Amplitude – Frequency Spectrum.* Mechanics of Machines, 3 (75), Varna, pp. 13 – 16, ISSN 0861-9727

The amplitude–frequency spectrum of the torsional vibrations of driving mechanism of a carved veneer machine is investigated in this study. The investigation is based on the original dynamical model with four degrees of freedom. The model enables to investigate the actual

behavior of the mechanism in different operating conditions. The investigation of the amplitude–frequency spectrum of the torsional vibrations of the driving mechanism represents particular interest for the aid of the vibrodiagnostics. The results of this study are also applicable to the designing and dimensioning of driving mechanisms of a carved veneer machine.

8-45. Vukov G. (2009). *Influence of the Changeable Stiffnes of the Gear Engagement on the Stability of the Torsional Vibrations in the Last Step of the Mechanical Drive of a Kind of Wind Turbines,* Proceedings scientific papers – Second scientific-technical conference Innovation in woodworking industry and engineering design, Yundola, pp. 176 – 179, p ISSN 1314-6149, e ISSN 2367-6663

This paper investigates the changeable stiffness of the gear engagement in the last high-speed step of wind turbines. It offers a method for modeling and investigation of influence of that stiffness on the stability of the tensional vibrations in the mechanical drive of that kind of wind turbines. Investigation results can be used in learning of dynamical processes as well as in the last high-speed step and in the whole dynamical study of the behaviour of mechanical drives of that kind of wind turbines.

8-46. Vukov G. (2009), *Influence of Inaccuracies and Faults in a Profile of Teeth of the Gear on Torsional Vibrations in a Driving Mechaanism of a Carved Veneer Machine.* "Woodworking and furniture production", 2/2009, University of Forestry, Sofia, pp. 8 – 12, ISSN 1311-4972.

This paper investigates the inaccuracies and faults in a profile teeth in a gear drive in a driving mechanism of a carved veneer machine. As a result, there are some dependences which describe characteristics of dynamical processes and torsional vibrations that are generated by these factors. The paper also analyses influence of inaccuracies and faults in a profile teeth on work of a driving mechanism of a carved veneer machine. Results can be used in modeling and investigation of torsional vibrations and dynamical processes in driving mechanisms of carved veneer machines, as well as for diagnostic of their technical state.

8-47. Vukov G., D. Georgieva (2008). *Application of Current Control Methods for Increase of Effectiveness, Economy and Reliability of the Equipment in the Woodworking and Furniture Production*. Management & Sustainable Development, 1/2008, University of Forestry, Sofia, pp. 245 – 249, ISSN 1311-4506

This paper discusses some questions concerning to current methods for control of technical state and definition of the moment workability of the equipment in the woodworking and furniture production. The assessment of the technical state and moment workability is done on the base of accurate criterion. It is formed on the base of investigation of peculiarity in a construction and regimes in exploitation of the considered equipment by using current means for computer modeling. The investigation indicates that the implemention of accurate diagnostics allow to increase the reliability and the effectiveness and decrease the expenses of the repair and service.

8-48. Vukov G., D. Georgieva (2009). *Application of Monitoring and Diagnostics Systems to Increase the Effectiveness, Economy and Reliability of Equipment in the Woodworking and Furniture Production.* Management & Sustainable Development, 1/2009, University of Forestry, Sofia, pp. 196 – 201, ISSN 1311-4506

This work deals with the modern systems for monitoring and diagnostics of the technical state of the equipment in the woodworking and furniture production. In these systems, the criteria for assessing the technical condition and the moment workability are formed while simultaneously analyzing several different parameters of the system. In addition to vibrations and noise at characteristic points that are traditionally monitored, monitoring of temperature changes, recording of impulse levels, changes in the pressure of lubricants and coolants, etc., is also important. The study of the design features and operating modes of the equipment in

question allows selecting the optimal parameters and the points at which they can be monitored. Research shows that monitoring and diagnostics systems help to increase reliability and efficiency, reduce repair and maintenance costs.

8-49. Vukov G., D. Georgieva (2012). *Trends in the Development of the Technical Systems Providing Effectiveness in the Work of the Equipment in the Woodworking and Furniture Production.* Management & Sustainable Development, 3/2012, University of Forestry, Sofia, pp. 112 – 117, ISSN 1311-4506

This paper discusses current trends in the development of the technical systems for monitoring, management and diagnostics of the technical state of the equipment in the woodworking and furniture production. It analyzes advantages and difficulties in the introduction and use of high-level systems. It comes to conclusion that it is necessary to make some investigations in advance and to evaluate the kind and quality of the used system. As a result, a significant economical effect of use of this system is guaranteed.

8-50. Vukov G., R. Bonova (2009). *Modelling of Torsional Vibrations in Output Stage of Mechanical Gears of Wind Turbine*. Scientific Papers XVIII International Scientific Conference "Young Scientists", University of Forestry, Sofia, pp. 105 – 109, ISSN 1314-4669, (ISBN 954-323-057-9)

This study presents a model for an investigation of the dynamical processes and torsional vibrations in an output stage in mechanical gears of wind turbine drive train. It investigates the influence of some basic factors such as stiffness of gear catching, deviation in the main stage, inaccuracy and damages in the gear outline. The method of Lagrange is used to obtain the equations of the vibrations. The obtaining results can be used in computing simulate investigation of dynamical processes in an output stage in mechanical gears of wind turbine drive train.

8-51. Vukov G., B. Marinov (2008). *Identification of the Typical Defects of the Driving Mechanism of Carved Veneer Machines Using Vibrodiagnostics.* Proceedings scientific papers – Scientific-technical conference „Innovation in woodworking industry and engineering design", Yundola, pp. 166 – 169, p ISSN 1314-6149, e ISSN 2367-6663

The questions concerning the identification of the typical defects of the driving mechanisms of carved veneer machines are investigated in this paper. The main aim is finding the existing defects on time using current methods of vibrodiagnostics. Learning of typical defects and forming adequate signs for identification is necessary in defining criterion for assessment of the technical state and definition of the moment workability of the investigated machines. The investigations show that the accurate diagnostics and identification of the typical defects on time allow increasing the reliability and effectiveness of carved veneer machines and decreasing expenditure for service and repair works

8-52. Vukov G., M. Todorov, D. Georgieva (2010). *Raising of the Effectiveness and Reliability of the Wind Turbines' Work*. Management & Sustainable Development, 1/2010, University of Forestry, Sofia, pp. 365 – 369, ISSN 1311-4506

This paper discusses the effectiveness and reliability of wind turbines' work in their work regimes which are typical for their exploitation. It also analyses the possibilities for increase of their effectiveness and reliability. The conclusion about necessity of using of current systems for management, monitoring and diagnostics of wind turbines' work is done. These systems give exact information about the technical state of the aggregate as well as they avoid failures and ineffectiveness in regimes. This allows finding some deviations in parameters and take actions which lead to decrease expenditures for downtime, service and repair. Discussed systems are an extra assumption for safe work of the staff.

8-53. Vukov G., M. Todorov, D. Georgieva (2011). *Some Possibilities for Optimization of the Work of Wind Turbines and Increase of Their Reliability*. Management & Sustainable Development, 1/2011, University of Forestry, Sofia, pp. 334–339, ISSN 1311-4506

This paper discusses the optimization of the work and management of wind turbines by using of current systems of management, monitoring and diagnostics of their work. The conclusion is that the crucial factor for the effectiveness of these systems is defining the exact criteria to control the state and work of wind turbines in specific conditions. These criteria base on adequate mathematical methods and they require a detailed simulative model of the examined wind turbines. These systems are useful not only for the main task – avoiding failures and ineffective regimes, but they also give current information about the technical state of the aggregate.

8-54. Vukov, G., Zh. Gochev, V. Slavov, (2010). *Torsional Vibrations in the Saw Unit of a Kind of Circular Saws. Mechanic-Mathematical Model*. Proceedings scientific papers – Third scientific-technical conference Innovation in woodworking industry and engineering design, Yundola, pp. 185 – 188, p ISSN 1314-6149, e ISSN 2367-6663

This study focuses on an original mechanical-mathematical model for investigation of torsional vibrations in the saw unit of a kind of circular saws. This model allows investigating of dynamical processes in circular saws in specific work regimes. The model also gives an opportunity to find out and analyze reasons for appearance of vibrations and noise. As a result, it becomes possible to make some recommendations about decrease of vibrations and noise during the work of these machines

8-55. Vukov G., V. Vlasev, M. Todorov, B. Marinov, (2003). *Numerical Investigation of the Torsional Vibrations of the Driving Mechanism of a Carved Veneer Machine.* Proceedings scientific papers – International scientific conference "50 Years University of Foeestry", Sofia, pp. 167 – 171.

This study presents a dynamic model for investigation of the torsional vibrations of the drive mechanism of a carved veneer machine. An application program work out in Matlab was developed on the basis of this model. The results of the numerical study are presented. The results of this study are applicable to the designing and the dimensioning of the driving mechanisms of a carved veneer machine.

8-56. Marinov K., **G**. **Vukov** (2011). *Analysis of Screw Presses Parameters Used in the Production of Biomass Briquettes*. Management & Sustainable Development, 1/2011, University of Forestry, Sofia, pp. 346 – 353, ISSN 1311-4506

The production of energy from renewable sources is one of the main aims in the European Union's strategy in the sphere of the stable development and safety of the environment. According to this strategy, by 2020 20 % of the energy in Europe will be produced from renewable sources, including biomass. The production of briquettes from wood and plant fragments is one of the ways for usage of produced biomass. This paper focuses on investigations, made on screw presses that are used for production of briquettes from wood fragments. Some basic parameters of screw presses, which influence the work of these machines, are also determined.

8-57. Marinov B., **G**. **Vukov** (2004). *Arising of Impulse Loads in Some Classes of Circular Machines*. Mechanics of Machines, 2 (51), Varna, pp. 54 – 59, ISSN 0861-9727

Circular machines are used for woodworking, performing various functions. During an operation, there can be impacts that burden the units and assemblies of the machine. The paper analyzes the impulse loads that occur during cutting in some classes of circular longitudinal cutting machines. The conditions for their occurrence and the effect of these impulses on the basic elements of the machine are investigated. The cutting process is optimized so that the impact of these loads is minimized.

8-58. Marinov B., **G**. **Vukov** (2009). *Maximal Deflections of Circular Shafts DrivingBig Circulars Saws*. Woodworking and furniture production, 1/2009, University of Forestry, Sofia, pp. 29 – 30, ISSN 1311-4972.

The influence of the deformations of circular shafts, driving big circular saws, on their

work is studied in this paper. Theses deformations are generated by the external loading and depend on its kinematic and mass characteristics. The maximal deflections of circular shafts are studied. The maximal deflections in two mutually perpendicular planes can be established from the obtained analytic expressions. Dependences for the full maximal deflections are obtained, too. The optimizational task is resolved as the parameters of the machines can be chosen in such a way that the deformations to be minimal.

8-59. Marinov B., **G**. **Vukov** (2003). *Determination of the Zones of Variable Critical Angular Speeds of Circular Machines for Longitudinal Cutting.* Proceedings scientific papers – International scientific conference "50 Years University of Foeestry", Sofia, pp. 162 – 166.

The variable critical angular speeds of circular machines for longitudinal cutting are investigated in this paper. The derived theoretical expressions in this study allow choosing suitable linear dimensions (diameters and lengths). In this case the mechanical system will work reliably in stable working mode avoiding coincidences between the work speeds and the critical angular speeds and the natural frequencies of the transverse vibrations. The developed theory allows to continue the investigations for other circular machines.

8-60. Vlasev V., **G**. **Vukov** (2003). *Determining Errors in Straightening Workpiecis on 4-sides' Throughfeed Planer Moulders.* Proceedings scientific papers – International scientific conference "50 Years University of Foeestry", Sofia, pp. 162 – 166.

This work determines the maximum error in the form of machined parts with a four-sided longitudinal-milling machine without a band-shaped base and with a distributed flow chart. The influence of the number of cutting tools on the machine and the performance of its base and compression mechanisms are taken into account.

8-61. Todorov M., **G**. **Vukov** (2007). *A Numerical Investigation of Torsional Vibrations of Wind Turbine Drive Train*. International Scientific Journal Machines, Technologies, Materials, Issue 8-9, стр. 6 – 9, ISSN 1313-0226, ISSN 1314-507X (online)

A numerical investigation on the base of a dynamical model for determination of the torsional vibration of a wind turbine is presented. The model of the wind turbine consists of a rotor with rigid blades, elastic shafts, a drive train and a generator. The drive train has a gearbox with three gear stages. The gear stages include two high-speed gear stages (spur gear pairs) and a low-speed planetary gear stage (three identical planets with spur teeth, sun and fixed ring wheel). Lagrange's equations are used to obtain the equations of the vibrations of a wind turbine. The Blade Element Momentum Theory (BEMT) is used to calculate the aerodynamic forces acting on the blades of the wind turbine. The dynamics of the generator is described by Kovacs' method.The investigation is done by MATLAB.

8-62. Todorov M., **G**. **Vukov** (2009). *Torsional Vibrations of Wind Turbine Drive Train. Amplitude-Frequency Characteristics*. Mechanics of Machines, 1 (80), Varna, pp. 66 – 69, ISSN 0861-9727

In this paper, on the base of a dynamical model of wind turbine drive train, the amplitude-frequency characteristics of the torsional vibration are determined. The model of the wind turbine consists of a rotor with rigid blades, elastic shafts, a drive train and a generator. The drive train has a gearbox with three gear stages. The gear stages include two high-speed gear stages (spur gear pairs) and a low-speed planetary gear stage (three identical planets with spur teeth, sun and fixed ring wheel). The obtained results show that the highest amplitude is observed in the second gear. This explains the relatively rapid wear and tear on this element of the wind turbine drive train.

8-63. Marinov K., **G**. **Vukov** (2010). *Graphanalytical Dependences for Definition of the Speed Transportation of Bulk Materials With Screw Mechanisms, Equiped with Resistance Valves or Opposition Devices at the Outlet*. Proceedings scientific papers – Third scientific-technical conference Innovation in woodworking industry and engineering design, Yundola, pp. 189 – 195, p ISSN 1314-6149, e ISSN 2367-6663

Screw mechanisms with outlet resistance valves are used in a lot of transport and technological processes. The process of movement of dispersive materials on the screw surface with an opposition of the outlet of transporting mechanisms is complicated and it is not known enough. Therefore, empirical dependences are mainly used for solution of practical tasks. This paper focuses on an investigation whose aim is the construction of graph-analytical models for definition of the basic movement parameter which depends on the applied resistance. These dependences allow theoretical definition of average speed transportation of bulk materials in screw mechanisms with applied resistance at the outlet opposition. The obtaining dependences are used for analytical definition of the productivity of screw and auger mechanisms with applied resistance at the outlet opposition.

8-64. Stefanov S., **G**. **Vukov**, M. Petrov, B. Stoychev (2008). *On Some Topics Connected with Strenght of Materials – Strains in Different Directions and Generalized Hooke's Law* Mechanics of Machines, 3 (75), Varna, pp. 9 – 12, ISSN 0861-9727

An original, deductive method for deduction of the second part of the general Hooke's law and the dependence for the strain in the different directions is suggested in this study. It is clearer, stricter and mathematical and methodical more attractive than the used traditional inductive manner because it is connected with the common stressed state. Its use will make learning this subject easier for students.

8-65. Blaskova G., **G**. **Vukov**, N. Bardarov, V. Dimitrova (2003). *Defining of the Module of the Linear (E) and the Angle (E) Deformation*. International Scientific Conferense "50 Years University of Forestry", Sofia, pp. 55 – 58, (*NACID ID № 2979/1.10.2019*)

It has been investigated wood of the five different kinds – the density, the modul of the linear and angle deformations are defined. These investigations have been performed in the Laboratory in Physics in Universiti of Forestry. The values of *E* are close to the ones in the tables, but the others for the angle deformations *G* are different.

E18. Participation in scientific projects

18-1. Sokolovski S., N. Deliyski, **G. Vukov**, N. Staneva, K. Panchev (№46/2009). *Automated circular saw unit for horizontal band saw*. University of Forestry

The aim of this project is to design and prepare a machine-construction documentation of a suitable for the industrial installation automatic circular device for a horizontal band saw, as well as elaboration of a working model of such a device and its wide use in the educational process.

18-2. Gochev Zh., G. **Vukov**, P. Vichev, V. Atanasov, G. Kovachev (№22/2016), *Modelling and experimental study of the processes in longitudinal milling of solid wood.* University of Forestry

The possibilities for increasing the quality of milling of furniture pieces were studied through modelling, numerical and experimental study of the milling processes. Experimental studies have been carried out on the power-energy performance of the machine underconsideration.

18-3. Minkov K., V. Abadjiev, A. Kazakov, B. Marinov, M. Todorov, G. **Vukov** (2004), *Mechanic-mathematical and computer modeling of geometry and motion of real mechanical systems of bodies*, BAS

Studies have been carried out on the construction of mechanic-mathematical models and the creation of computer simulation models concerning the geometry and motion of complex mechanical systems. These mechanical systems include a number of rigid bodies.

18-4. Minkov K., V. Abadjiev, A. Kazakov, B. Marinov, M. Todorov, G. **Vukov,** Y. Tsankov (2007), *Mechanic-mathematical and computer modeling of real machines, mechanisms and automats as systems of solid bodies*, BAS

Some studies are carried out on the construction of mechanic-mathematical models and the compilation of computer simulation models of real machines, mechanisms and automats. They are regarded as mechanical systems of interconnected rigid bodies.
18-5. Abadjiev V., A. Kazakov, B. Marinov, D. Petrova, E. Abadjieva, M. Todorov, G. **Vukov** (2010), *Investigation of the processes determining the mechanical behavior of systems of rigid bodies, oriented towards their analysis and synthesis*, BAS
Some of the processes that determine the dynamic behavior of complex mechanical systems of rigid bodies are investigated. Mechanic-mathematical modeling of mechanical systems performing spatial transformations is considered. The research results are applicable to the analysis and synthesis of these mechanical systems.
18-6. Zahariev E., A. Kazakov, B. Marinov, G. Tsvetkova, K. Mladenova, M. Todorov, G. **Vukov** (2011), *Modeling and investigating of the interaction of systems of rigid bodies*, BAS
Methods and algorithms are developed to model the dynamics of rigid and elastic multi-link systems. Experiments related to the analysis and simulation of the movements, the loading and the deformation of constructions subjected to a specific load are carried out.
18-7. Zahariev E., A. Kazakov, B. Marinov, G. Tsvetkova, K. Mladenova, M. Todorov, G. **Vukov** (2014), *Mechanics, modeling and control of systems of rigid and elastic bodies*, BAS
Some dynamic and vibration impact processes in different kinds of machines (transport machines and woodworking machines) are investigated in order to guarantee their normal work and reduce energy losses in different operating modes.
18-8. Zahariev E., A. Kazakov, B. Marinov, G. Tsvetkova, K. Mladenova, M. Todorov, G. **Vukov** (2017), *Dynamics of mechatronic systems*, BAS
Models and algorithms for control of systems with variable stiffness in free motion and in contact are developed. Formulas for control are composited that are able to simultaneously and accurately track the desired and independent trajectories of the systems under consideration.

E20. Scientific projects management

20-1. Vukov G., N. Staneva, R. Bonova, V. Mihaylov, M. Stoykova (№40/2009). *Investigation of the torsional vibrations in a mechanical gear of grade wind turbines.* University of Forestry
An mechanic-mathematical multi-body model of a kind of wind turbines is developed. The model can be used for diagnostic of some faults as well as for control on the wearing of gears and bearing units. This allows finding out any deviation in parameters and taking necessary actions. Therefore, it is important for the effectiveness and reliability of wind turbines.
20-2. Vukov G., D. Dimitrov, G. Ivanov, T. Stanev (ФГП-2018-Ю-4/19.03.2018), *Investigation of the main factors causing vibrations and noise in the work of the woodworking machines.* University of Forestry
The subject of this project is the study of vibrations and noise, invariably accompanying the work of machines in the forestry industry, and the establishment of a system of measures for their control and reduction. Some specific recommendations and substantiated proposals, based on these investigations, are formulated. They are addressing to reducing the level of vibration and noise at work of these machines in practice.

E23. Published university textbooks

23-1. Vukov G. (2004). *Theoretical mechanics - statics, kinematics, dynamics*, University of Forestry, Sofia, ISBN 954-8783-96-7, 160 p., COBISS.BG-ID - 1042513636.

The textbook, which is studied by students at the University of Forestry - Sofia, is relevant to the curriculum of the course "Theoretical Mechanics". The three sections - statics, kinematics, dynamics - include sixteen topics. The theory presented in each of the topics is illustrated with examples.
23-2. Vukov G. (2010). *Mechanics – statics and strength of materials*, Avangard Prima, Sofia, ISBN: 978-954-323-639-8, 180 стр. COBISS.BG-ID - 1234926052
The textbook, which is studied by students at the University of Forestry - Sofia, is relevant to the curriculum of the course "Mechanics", which teaches students in the specialty "Engineering Design". It can also be useful for students in all other specialty who study this discipline. The textbook covers the basic questions of statics and of strength of materials. The theory is illustrated by a significant number of examples related to the technical application of derived formulas in engineering practice.
23-3. Vukov G. (2010), *Strength of materials*, Avangard Prima, Sofia, ISBN: 978-954-323-599-5, 122 p., COBISS.BG-ID – 1234750948.
The textbook, which is studied by students at the University of Forestry - Sofia, is relevant to the curriculum of the course "*Strength of materials* ", which teaches students in the specialties "Wood Technology" at the University of Forestry - Sofia. Twelve topics are included. The theory presented in each of the topics is illustrated with examples.
23-4. Vukov G. (2011). *Theoretical mechanics*, (2011), Avangard Prima, Sofia, ISBN: 978-954-323-808-8, 216 p. COBISS.BG-ID - 1235121636
The textbook covers the main questions in the sections of statics, kinematics and dynamics. Twenty six topics are included.The theory is illustrated by a considerable number of examples related to the technical application of derivatived formulas in engineering practice.
23-5. Vukov G. (2009), P. Ugrinov, *Strength of materials – short course*, Avangard Prima, Sofia, ISBN: 978-954-323-515-5, 110 p. COBISS.BG-ID - 1229804772
The textbook is intended for students from the specialty "Industrial thermal energy" of the College of Energy and Electronics - Sofia at the Technical University - Sofia. It can also be useful for students in all other majors who study the subject "Strength of Materials"
23-6. Vukov G. (2011), P. Ugrinov, *Short course in theoretical mechanics*, Avangard Prima, Sofia, ISBN: 978-954-323-788-3, 154 p. COBISS.BG-ID - 1235060
The textbook is intended for students from the specialty "Industrial thermal energy" of the College of Energy and Electronics - Sofia at the Technical University - Sofia. It contains nineteen chapters and can also be useful for students in all other majors who study the subject "Theoretical mechanics".

E24. Published university seminar course book

24-1. Vukov G.. *Solved examples in theoretical mechanics* (2006), University of Forestry, Sofia, ISBN 10: 954-332-018-7, ISBN 13: 978-954-332-018-9, 74 p. COBISS.BG-ID - 1045155044.
The seminar course book covers the main questions in the sections of statics, kinematics and dynamics. It contains 18 topics. Each of them includes a solved example with instructions and ten different variants (sketches). The required data is individual for each student.

Prepared:……
Assoc. Prof. Georgi Vukov, Ph.D.