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EDITORIAL

SPECIAL SECTION

Machine modelling and simulations

Marek MACKO[1], Izabela ROJEK[2*], Milan SÁGA[3], Tadeusz BURCZYŃSKI[4], and Dariusz MIKOŁAJEWSKI[2]

[1] Department of Mechatronics, Kazimierz Wielki University, ul. Kopernika 1, 85-074 Bydgoszcz, Poland
[2] Institute of Computer Science, Kazimierz Wielki University, ul. Chodkiewicza 30, 85-064 Bydgoszcz, Poland
[3] Department of Applied Mechanics, Faculty of Mechanical Engineering, University of Žilina, 010 26 Žilina, Slovakia
[4] Institute of Fundamental Technological Research, Polish Academy of Sciences, ul. Pawińskiego 5B, 02-106 Warsaw, Poland

The aim of the Special Section *Machine modelling and simulations* is to present the latest developments and applications in the following topics:

- Methods and systems in machine design
- Modelling and simulation, design optimization
- Machine dynamics and simulation of multibody systems
- Advanced applications in industry, automotive and green energy
- Experimental mechanics, identification, and validation
- Modelling of structural materials, composites, and nanomaterials
- Physical and chemical properties of materials
- Theoretical and applied mathematics in engineering
- Applications of artificial intelligence (AI) and computational intelligence (CI) in mechanical engineering.

The topic of the Special Section follows the current research trends in the discipline of mechanical engineering. It integrates 25 years of experience of the researchers and participants of the Polish-Slovak Scientific Conference on Modelling and Simulation of Machines, MMS 2020 with the latest trends in the discipline, in particular with the research in the field of Industry 4.0 [1–3].

The overall concept of integrating intelligent machines, systems and making changes in production processes to increase production efficiency and the possibility of flexible changes in the product range are just some of the areas presented by the researchers from Slovakia, the Czech Republic, and Poland. Industry 4.0 concerns not only technology but also new methods of work and the role of man in the industry, integrating people and digitally controlled machines with the Internet and information technologies. The materials manufactured or used for production can always be identified, they also can communicate independently with each other. Information flows vertically: from individual components to the company's IT department, and from the IT department to the components. The other direction of information flow is done horizontally – between the machines involved in the production process and the company's production system.

Machine modelling and simulation is the use of models (e.g. a physical, mathematical, or logical representation) as a framework for simulation to develop the data used to make technical decisions, in the field of mechanical engineering. This technology belongs to the toolbox of engineers of all application domains and has been incorporated into the body of knowledge of engineering management. Modelling and simulation reduce costs, improve the product and system quality, and document any conclusions drawn. Additionally, models can be updated and improved using the results from real-world experiments.

AI and CI are increasingly important in building these models and they are concerned with methods for solving problems that cannot be efficiently solved algorithmically. These methods play an important role in the development of inference and intelligent systems. The application of modern methods (AI and CI) in the field of mechanical engineering is particularly interesting due to its research and practical character and very strong references to Industry 4.0 [4–6]. AI-based optimization and prediction, thanks to the application of digital twins, can significantly change the performance even within older factories since their computational upgrade of control systems is possible thanks to the application of the Internet of Things sensors and cloud computing.

*e-mail: izarojek@ukw.edu.pl

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The state of the art of machine modelling and simulations is included in a review article [7]. In the following papers, we can find application aspects of machine modelling and simulations. Thus, for example, in the work of D. Ondrušova *et al.* [8], an oriented modification of the composition of polymeric systems using two different types of alternative fillers is presented. The first type of alternative filler (SVD) was obtained from the power industry, where it is formed as a by-product of flue gas desulfurization. The second alternative filler (KAL) used is based on the waste from glass production. The main result of the work is a new formulation of an elastomeric system for industrial applications with high reflection elasticity and low rolling resistance, which is the subject of an international patent.

The improvement of effective methods of plastic recycling, which are crucial for the environmental protection and saving of non-renewable resources, is described in the work by R. Rogulski *et al.* [9]. Special attention has been paid to the concept of an electrostatic separator designed as a dedicated test stand for the separation of various plastics. The proposed concept and design of the test stand makes it possible to carry out research and technological tests of the separation process and allows to study the influence of the position of the high voltage electrodes, the value and polarity of the high voltage, the variable speed of the feeder and drum, as well as triboelectrification parameters (such as time and intensity), among others. In addition, a dedicated computer vision system was developed.

The work of I. Grega *et al.* describes the model nonlinear behaviour of vibrating systems, in which the Taylor expansion with integer powers are often used. The approach presented here provides a simple way to estimate the natural frequency of the main oscillation in the systems with a restoring force with a power exponent. Two independent, non-dimensional groups are created and a functional relationship between them is sought using numerical simulations. When this relationship is known, the main frequency of the free vibration can be easily determined for any system properties and any initial conditions [10].

The paper by D. Varecha [11] presents the results of a study of heat flow in the braking system during braking of an Automated Guided Vehicle (AGV). The paper aims to compare the amount of heat generated during braking in two different braking systems and considering two driving modes. The heat flow problem is solved in the computational program Matlab using the derived partial Fourier differential equation for non-stationary heat conduction.

The paper by D. Czarnecka Komorowska *et al.* leads into the issues of organic recycling by offering interesting results on the degradation of polylactic acid (PLA)/alloyed nanotubes (HNTs) biocomposites based on short degradation composting simulations. The selected properties of PLA/HNTs biocomposites and the effect of composting process from 30 to 90 days on the behaviour of the composites were investigated. The results confirmed the favourable biodegradable properties of PLA/HNTs nanocomposites which may contribute to the replacement of environmentally harmful polymers, i.e. polyolefins and others, due to their non-biodegradability in the coming years [12].

The aim of the paper by I. Rojek *et al.* [13] is to demonstrate an intelligent system that contains the knowledge, models, and procedures to support company employees within machining and 3D printing. Special attention has been paid to the development of an intelligent system to support the planning of technological processes. It is assumed that such a system should work similar to human experts in their fields of knowledge and should be able to collect the necessary expertise and draw conclusions to solve problems. This can be achieved using AI methods.

The work of K. Kazimierska-Drobny [14] outlines the advantages of Poly(vinyl alcohol) (PVA) excellent chemical resistance, physical properties, and complete biodegradability, among others, which have led to wide practical applications. The presented non-contact method shows that the PVA polymer gel, physically crosslinked by freezing and defrosting, shrinks and swells under temperature, which is a reversible phenomenon.

The subsequent article deals with the design of slewing rings (slewing bearings). A fully parametric, 3D virtual model of a ball slewing ring with four-point contact was created in the PTC/Creo Parametric CAD system. This model was then used for a finite-element analysis using Ansys/Workbench CAE software. The purpose of FEM analysis was to determine the axial stiffness characteristics. Results of FEM analysis were experimentally verified using a test bench [15].

The work by Drelich *et al.* confirms the usefulness of the applied ultrasonic method for testing macroscopic inhomogeneity of corrugated fibre-cement boards. Experiments were performed using a laboratory non-contact ultrasonic scanner. The tests were conducted on a reference plate board and corrugated boards. Lamb waves were generated in the tested materials using a transmitter excited by a chirp signal with a linearly modulated frequency. The maximum amplitude of the transmitted Lamb waves was selected as the main descriptor to evaluate the quality of tested boards. The significant role of boundary effects and frequency of waves was noticed [16].

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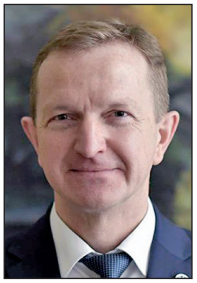
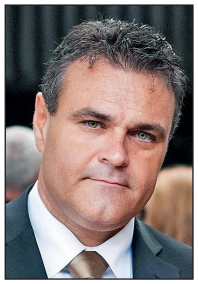


Marek Macko works as a university professor at the Faculty of Mechatronics of Kazimierz Wielki University in Bydgoszcz. He deals with the discipline of mechanical engineering and focuses on the design of shredders for polymers and biological materials. The topic of his habilitation thesis concerned the methods of selection of multi-edge-shredders for processing polymers. He has several times been a manager and main project executive in research projects financed by the Ministry of Science and Higher Education. He is a member of the Polish Academy of Sciences/Lublin, Bydgoszcz Scientific Society, Association of Polish Mechanical Engineers and Technicians, American Society of Mechanical Engineers (ASME). Since 2016, he has been an active reviewer of EU HORIZON research projects under the programmes "Raw materials innovation for the circular economy" and Clean Sky 2 Joint Undertaking "The Smart, Green and Integrated Transport Challenge".
e-mail: mackomar@ukw.edu.pl

Izabela Rojek received an MSc degree in computer science and a PhD (2000) degree in mechanical engineering and operation from Poznan University of Technology. She received the DSc Habilitation degree in mechanical engineering and operation in 2017. Since 2018, she has worked as an associate professor at Kazimierz Wielki University in Bydgoszcz. She is a Member of the Production Engineering Committee of the Polish Academy of Sciences (since 2020), Member of the Polish Information Processing Society (since 2004), Member of the Polish Association for Knowledge Management (since 2003), Vice President of the Bydgoszcz IT Cluster (since 2015), and Member of the International Association of Engineers (since 2016). Her main research interest is in knowledge discovery, intelligent support systems, applications of artificial intelligence in the enterprise, designing technological processes of machining and additive machining, and exoskeleton creating.
e-mail: izarojek@ukw.edu.pl



Milan Sága works as a university professor at the University of Žilina (Slovakia). In 1995, he completed his doctoral studies with the dissertation thesis Optimum Design of Chosen Parameters of Track Maintenance Machines. In 1999 he became an associate professor in Applied Mechanics with the habilitation thesis Analysis and Synthesis of Nonlinear Mechanical Systems with Random Inputs. In 2006 he was inaugurated as a professor in Machine Elements and Mechanisms. Since 2004 he has been the vice dean of the Faculty of Mechanical Engineering of the University of Žilina and since 2005 the head of the Department of Applied Mechanics. Since 2012 he has been the dean of the Faculty of Mechanical Engineering of the University of Žilina. His principal fields of research and pedagogical activities are special algorithms for structural optimization, multi-axial fatigue life prediction, stochastic vibration, fuzzy analysis of mechanical systems with uncertain parameters, and in recent years also the research of composite structures properties. He is an author and co-author of more than 250 scientific papers, several patents and utility models, 9 textbooks, and 6 scientific monographs.

e-mail: milan.saga@fstroj.uniza.sk

Tadeusz Burczyński, full Professor of Institute of Fundamental Technological Research of the Polish Academy of Sciences, Director of the Institute, Ordinary Member of the Polish Academy of Science (PAS) and the European Academy of Sciences and Arts. His main area of activity is inter- and multi-disciplinary scientific research on Information and Computational Science, especially in Computational Intelligence, Computational Mechanics, and Computational Materials Science. He dealt with an application of intelligent computational systems based on evolutionary algorithms, artificial neural networks, artificial immune systems, swarm algorithms, and fuzzy sets in global scalar and vector optimization and identification of structures. He was also the co-author of the original concept an application of artificial immune systems to classification and clusterization of data problems, analysis of multidimensional biological data, coupling artificial immune systems and the game theory, and the concept of random ordered fuzzy numbers. He developed a methodology and computer programs for multiscale materials modelling, especially in the field of optimization and identification problems with the use of intelligent systems and elaborated an intelligent computational methodology for the design of new 2D nano-materials.

e-mail: tburczynski@ippt.pan.pl

Dariusz Mikołajewski received a PhD degree in biocybernetics and biomechanical engineering from Maciej Nałęcz Institute of Biocybernetics and Biomedical Engineering of the Polish Academy of Sciences in Warsaw (2015). Since 2019, he works as an associate professor at Kazimierz Wielki University in Bydgoszcz, Head of the Department of ICT and Electronic Devices in Institute of Computer Science. He is a Member of the Polish Information Processing Society. His main research interest is in knowledge discovery in clinical data sets, applications of artificial intelligence in biomedicine, computational models of brain processes, AI-based optimization of additive machining, and rehabilitation robots including exoskeletons. He is an author and co-author of 10 books and 200 scientific papers, He has also participated in more than 20 research projects.

e-mail: dmikolaj@ukw.edu.pl