

# **Lecture Notes in Mechanical Engineering**

**Lecture Notes in Mechanical Engineering (LNME)** publishes the latest developments in Mechanical Engineering—quickly, informally and with high quality. Original research reported in proceedings and post-proceedings represents the core of LNME. Volumes published in LNME embrace all aspects, subfields and new challenges of mechanical engineering. Topics in the series include:

- Engineering Design
- Machinery and Machine Elements
- Mechanical Structures and Stress Analysis
- Automotive Engineering
- Engine Technology
- Aerospace Technology and Astronautics
- Nanotechnology and Microengineering
- Control, Robotics, Mechatronics
- MEMS
- Theoretical and Applied Mechanics
- Dynamical Systems, Control
- Fluid Mechanics
- Engineering Thermodynamics, Heat and Mass Transfer
- Manufacturing
- Precision Engineering, Instrumentation, Measurement
- Materials Engineering
- Tribology and Surface Technology

More information about this series at <http://www.springer.com/series/11236>

Vitalii Ivanov · Yiming Rong  
Justyna Trojanowska · Joachim Venus  
Oleksandr Liaposhchenko  
Jozef Zajac · Ivan Pavlenko  
Milan Edl · Dragan Perakovic  
Editors

# Advances in Design, Simulation and Manufacturing

Proceedings of the International  
Conference on Design, Simulation,  
Manufacturing: The Innovation Exchange,  
DSMIE-2018, June 12–15, 2018,  
Sumy, Ukraine

*Editors*

Vitalii Ivanov  
Department of Manufacturing Engineering,  
Machines and Tools  
Sumy State University  
Sumy, Ukraine

Jozef Zajac  
Faculty of Manufacturing Technologies  
with a seat in Presov  
Technical University of Kosice  
Prešov, Slovakia

Yiming Rong  
Department of Mechanical  
and Energy Engineering  
Southern University of Science  
and Technology  
Shenzhen, Guangdong, China

Ivan Pavlenko  
Department of General Mechanics  
and Machine Dynamics  
Sumy State University  
Sumy, Ukraine

Justyna Trojanowska  
Department of Manufacturing  
and Production Engineering  
Poznan University of Technology  
Poznan, Poland

Milan Edl  
Faculty of Mechanical Engineering  
University of West Bohemia  
Pilsen, Czech Republic

Joachim Venus  
Leibniz Institute for Agricultural  
Engineering and Bioeconomy  
Potsdam, Brandenburg, Germany

Dragan Perakovic  
Department of Information  
and Communication Traffic  
University of Zagreb  
Zagreb, Croatia

Oleksandr Liaposhchenko  
Department of Processes and Equipment  
of Chemical and Petroleum-Refineries  
Sumy State University  
Sumy, Ukraine

ISSN 2195-4356 ISSN 2195-4364 (electronic)  
Lecture Notes in Mechanical Engineering  
ISBN 978-3-319-93586-7 ISBN 978-3-319-93587-4 (eBook)  
<https://doi.org/10.1007/978-3-319-93587-4>

Library of Congress Control Number: 2018946821

© Springer International Publishing AG, part of Springer Nature 2019

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Printed on acid-free paper

This Springer imprint is published by the registered company Springer International Publishing AG part of Springer Nature  
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# Preface

This volume of Lecture Notes in Mechanical Engineering contains accepted papers presented at the International Conference on Design, Simulation, Manufacturing: The Innovation Exchange (DSMIE-2018), held in Sumy, Ukraine in June 12–15, 2018. The conference was organized by the Faculty of Technical Systems and Energy Efficient Technologies, Sumy State University, in partnership with Technical University of Kosice (Slovak Republic), Kielce University of Technology (Poland), University of West Bohemia (Czech Republic), Association for Promoting Innovative Technologies—Innovative FET (Croatia). The DSMIE-2018 was organized under the patronage of Prof. Anatoliy Vasylyev, Rector of Sumy State University and Dr. Oleksandr Gusak, Dean of the Faculty of Technical Systems and Energy Efficient Technologies.

DSMIE-2018 is the international forum for fundamental and applied research and industrial applications in manufacturing. The conference focuses on a broad range of research challenges in the fields of Manufacturing, Mechanical and Chemical Engineering, addressing current and future trends in design approaches, simulation techniques, computer-aided systems, software development, ICT tools and Industry 4.0 strategy implementation for solving engineering tasks. DSMIE-2018 brings together researchers from academic institutions, leading industrial companies, and government laboratories located around the world for promoting and popularization of the scientific fundamentals of manufacturing.

The book was organized into three parts, according to the main conference topics. Each part is devoted to research in design, simulation and manufacturing in the areas of Manufacturing and Materials Engineering, Mechanical Engineering and Chemical Engineering.

DSMIE-2018 received 91 contributions from 14 countries around the world. After a thorough peer-review process, the DSMIE-2018 Editorial Board accepted 55 papers, written by authors from 11 countries. Thank you very much to all authors for their contribution. These papers are published in present book, achieving an acceptance rate of about 60%. Extended versions of selected best papers will be published in journals: Management and Production Engineering

Review (indexed by ISI/ESCI, Scopus), Archives of Mechanical Technology and Materials (Poland) and Journal of Engineering Sciences (Ukraine).

We would like to take this opportunity to thank members of Program Committee and invited external reviewers for their efforts and expertise in contribution to reviewing, without which it would be impossible to maintain the high standards of peer-reviewed papers. Fifty-three Program Committee members and 14 invited external reviewers devoted their time and energy for peer-reviewing manuscripts. Our reviewers come from all over the world and represent 17 countries and affiliated with 41 institutions.

Thank you very much to all keynote speakers, who came from Poland, Slovak Republic, Czech Republic and Ukraine, and share their knowledge and experience.

We appreciate the partnership with Springer, Unicheck and EasyChair and our sponsors for their essential support during the preparation of DSMIE-2018.

Thank you very much to DSMIE-2018 Team. Their involvement and hard work were crucial to the success of the DSMIE-2018 conference.

DSMIE-2018's motto is "Together we can do more for science, technology, engineering and education."

June 2018

Vitalii Ivanov  
Yiming Rong  
Justyna Trojanowska  
Joachim Venus  
Oleksandr Liaposhchenko  
Jozef Zajac  
Ivan Pavlenko  
Milan Edl  
Dragan Perakovic

# Organization

## Steering Committee

### General Chair

Vitalii Ivanov Sumy State University, Ukraine

### Co-chairs

Oleksandr Gusak Sumy State University, Ukraine

Oleksandr Liaposhchenko Sumy State University, Ukraine

Ivan Pavlenko Sumy State University, Ukraine

## Program Committee

Volodymyr Atamanyuk	Lviv Polytechnic National University, Ukraine
Michal Balog	Technical University of Kosice, Slovak Republic
Shahzad Barghi	University of Western Ontario, Canada
Jozef Bocko	Technical University of Kosice, Slovak Republic
Dagmar Caganova	Slovak University of Technology, Slovak Republic
Robert Cep	VSB-Technical University of Ostrava, Czech Republic
Radu Cotetiu	Technical University of Cluj-Napoca, Romania
Alina Crisan	University of Agricultural Sciences and Veterinary Medicine, Romania
Milan Edl	University of West Bohemia, Czech Republic

Sulaymon Eshkabilov	Tashkent Institute of Design, Construction and Maintenance of Automobile Roads, Uzbekistan
Renata Gnatowska	Czestochowa University of Technology, Poland
Mathieu Gautier	National Institute of Applied Sciences, France
Oleksandr Gusak	Sumy State University, Ukraine
Michal Hatala	Technical University of Kosice, Slovak Republic
Siamak Hoseinzadeh	Islamic Azad University, Iran
Vitalii Ivanov	Sumy State University, Ukraine
Bozena Kaczmarek	Kielce University of Technology, Poland
Alisher Khusanov	M. Auezov South Kazakhstan State University, Republic of Kazakhstan
Oldrych Kodym	College of Logistics, Czech Republic
Dmytro Kryvoruchko	Sumy State University, Ukraine
Oleksandr Liaposhchenko	Sumy State University, Ukraine
Zbigniew Lis	Kielce University of Technology, Poland
Slawomir Luszczyński	Kielce University of Technology, Poland
Jose Mendes Machado	University of Minho, Portugal
Mykola Melnychuk	Lutsk National Technical University, Ukraine
Ronald L. Mersky	Widener University, USA
Abdullah J Mohammed	Al-Farabi University, Iraq
Marek Ochowiak	Poznan University of Technology, Poland
Vitalii Pasichnyk	National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”, Ukraine
Ivan Pavlenko	Sumy State University, Ukraine
Dragan Perakovic	University of Zagreb, Croatia
Marco Perisa	University of Zagreb, Croatia
Oleksandr Permiakov	National Technical University “Kharkiv Polytechnic Institute”, Ukraine
Jan Pitel	Technical University of Kosice, Slovak Republic
Mustafa Al Rammahi	Al-Farabi University, Iraq
Yiming Rong	Southern University of Science and Technology, China
Saad Nadi Saleh	Tikrit University, Iraq
Vsevolod Sklabinskyi	Sumy State University, Ukraine
Dusan N. Sormaz	Ohio University, USA
Marcin Sosnowski	Jan Długosz University of Częstochowa, Poland
Michael Storck	University of Stuttgart, Germany
Volodymyr Tonkonogyi	Odessa National Polytechnic University, Ukraine
Justyna Trojanowska	Poznan University of Technology, Poland
Leonid Ulyev	National Technical University “Kharkiv Polytechnic Institute”, Ukraine
Nicolae Ungureanu	Technical University of Cluj-Napoca, Romania
Leonilde Rocha Varela	University of Minho, Portugal
Jerzy Winczek	Czestochowa University of Technology, Poland



Joachim Venus	Leibniz Institute for Agricultural Engineering and Bioeconomy, Germany
Emil Hristov Yankov	Angel Kanchev University of Ruse, Bulgaria
Jozef Zajac	Technical University of Kosice, Slovak Republic
Viliam Zaloga	Sumy State University, Ukraine
Volodymyr Zavalov	National University of Food Technologies, Ukraine
Jan Zdebor	University of West Bohemia, Czech Republic

## **Invited External Reviewers**

Vaclav Cerny	University of West Bohemia, Czech Republic
Liviu Adrian Crisan	Technical University of Cluj-Napoca, Romania
Maryna Ivanova	National Technical University “Kharkiv Polytechnic Institute”, Ukraine
Svitlana Lugova	JSC “NASOENERGOMASH Sumy”, Ukraine
Ievgen Mochalin	Zhejiang Normal University, China
Dawid Myszka	Warsaw University of Technology, Poland
Andrii Rogovyi	Kharkiv National Automobile and Highway University, Ukraine
Ioana Roman	University of Agricultural Sciences and Veterinary Medicine, Romania
Malgorzata Sokala	Kielce University of Technology, Poland
Anastasiia Symonova	Kremenchuk Mykhailo Ostrohradskyi National University, Ukraine
Iurii Sysoiev	National Aerospace University named after N.E. Zhukovsky «Kharkiv Aviation Institute», Ukraine
Viktor Tkachenko	National Science Center Kharkov Institute of Physics and Technology, Ukraine
Josef Voldrich	University of West Bohemia, Czech Republic
Przemyslaw Zawadzki	Poznan University of Technology, Poland

# Contents

## **Manufacturing and Materials Engineering**

<b>Implementation of CALS-Technologies in Quality Management of Product Life Cycle Processes</b> . . . . .	3
Yuliia Denysenko, Oksana Dynnyk, Tetiana Yashyna, Nina Malovana, and Viliam Zaloga	
<b>Variation Coefficient and Some Distribution Laws in the Context of Cutting Tools and Other Technical Objects Reliability Modeling</b> . . .	13
Mykhaylo Frolov	
<b>Measurement of Non-rigid Tools Action Force During Finishing</b> . . . . .	23
Natalia Honchar, Oleksiy Kachan, Dmytro Stepanov, Mark Kuchuhurov, and Olena Khavkina	
<b>Implementation of Material Flow Simulation as a Learning Tool</b> . . . . .	33
Jozef Husar, Lucia Knapcikova, and Michal Balog	
<b>Process-Oriented Approach to Fixture Design</b> . . . . .	42
Vitalii Ivanov	
<b>Technological Assurance of Complex Parts Manufacturing</b> . . . . .	51
Vladyslav Karpus, Vitalii Ivanov, Ivan Dehtiarov, Jozef Zajac, and Viktoria Kurochkina	
<b>Modeling of Foundry Processes in the Era of Industry 4.0</b> . . . . .	62
Jacek Kozłowski, Robert Sika, Filip Górski, and Olaf Ciszak	
<b>Ansys Simulation of the Joint Strength with the Interference Fit in the Presence of the Shape Geometry Error</b> . . . . .	72
Oleksandr Kupriyanov	
<b>Adaptive Profile Gear Grinding Boosts Productivity of this Operation on the CNC Machine Tools</b> . . . . .	79
Vasily Larshin and Natalya Lishchenko	

<b>Provision of the Quality of Manufacturing Gear Wheels in Energy Engineering</b> . . . . .	89
Vladimir Lebedev, Vladimir Tonkonogyi, Alexey Yakimov, Liubov Bovnegra, and Nataliya Klymenko	
<b>Combined Laser-Ultrasonic Surface Hardening Process for Improving the Properties of Metallic Products</b> . . . . .	97
Dmytro Lesyk, Silvia Martinez, Bohdan Mordyuk, Vitaliy Dzhemelinskyi, and Oleksandr Danyleiko	
<b>Influence of the Scale Factor of Fibers and the Temperature of Structuring on the Physical and Mechanical Characteristics of Hemp Fiber Biocomposites</b> . . . . .	108
Mykola Melnychuk and Oksana Andrushko	
<b>On the Application of N-2-1 Locating Principle to the Non-rigid Workpiece with Freeform Geometry</b> . . . . .	117
Hadi Parvaz and Seyyed Ali Sadat	
<b>Information and Communication Technologies Within Industry 4.0 Concept</b> . . . . .	127
Dragan Peraković, Marko Periša, and Rosana Elizabeta Sente	
<b>Computer Modeling Application for Predicting of the Passing of the High-Speed Milling Machining Hardened Steel</b> . . . . .	135
Alexander Permyakov, Sergey Dobrotvorskiy, Ludmila Dobrovolska, Yevheniia Basova, and Maryna Ivanova	
<b>Computer Simulation of the Processes of Mixing in Multilayer Nitride Coatings with Nanometer Period</b> . . . . .	146
Oleg Sobol, Andrey Meylekhov, and Anna Postelnyk	
<b>Model of Thermal State of the System of Application of Coolant in Grinding Machine</b> . . . . .	156
Mykhaylo Stepanov, Larysa Ivanova, Petro Litovchenko, Maryna Ivanova, and Yevheniia Basova	
<b>Technology of Effective Abrasive Jet Machining of Parts Surfaces</b> . . . .	166
Viktor Sychuk, Oleg Zabolotnyi, and Dmytro Somov	
<b>Choice of the Optimal Parameters of the Ultra-Fine Grained Cooper Machining</b> . . . . .	177
Anastasiia Symonova, Valerii Havin, and Dmitrii Savelov	
<b>Obtaining of Porous Powder Materials by Radial Pressing Method</b> . . . .	186
Oleg Zabolotnyi, Viktor Sychuk, and Dmytro Somov	
<b>Methods for Calculating the Grain Boundary Adsorption Capacity of Nanostructured Copper Based Condensates</b> . . . . .	199
Maria Zhadko, Oleg Sobol, Galina Zelenskaya, and Anatoly Zubkov	

**Investigation of the Influence of Electro-Impulse Current on Manganiferous Liquid-Alloy** . . . . . 207  
 Olena Zhbanova, Levan Saitgareev, Igor Skidin, Nonna Shapovalova, and Genadiy Gubin

**Forecasting Real Option Price Model by Means of Evolutionary and Genetic Algorithms** . . . . . 214  
 Mykyta Zubrii, Anastasia Mazur, and Vitaliy Kobets

**Mechanical Engineering**

**Experimental Study of the Power Characteristics Influence on the Hydraulic Efficiency** . . . . . 227  
 Pavlo Andrenko, Iryna Grechka, Sergey Khovansky, and Maksym Svynarenko

**Increase of Efficiency of Turbine Setting Based on Study of Internal Flows** . . . . . 237  
 German Bondarenko, Serhiy Vanyeyev, Vadim Baga, Tetiana Rodymchenko, and Iryna Bashlak

**Effect of Abnormal Operation of Turbine Generator on the Resource of Steam Turbine Shafting** . . . . . 247  
 Anatoliy Bovsunovsky

**Experimental Investigation of Physical and Tribological Properties of Engine Oil with Nano-particles Additives**. . . . . 255  
 Manoj K. Gaur, Sumeet K. Singh, Akash Sood, and Dharamveer S. Chauhan

**Simulation and Analysis of Passive vs. Magneto-Rheological Suspension and Seat Dampers** . . . . . 269  
 Sulaymon Eshkabilov, Hamdam Jumaniyazov, and Davron Riskaliev

**A Semi-implicit Generalized Finite Differences Approach to Simulate Natural Convective Viscous Flows** . . . . . 280  
 Felix Raymundo Saucedo-Zendejo and Edgar Omar Resnediz-Flores

**Optimal Management of Small Hydroelectric Plants Power Generation in Local Electrical Systems** . . . . . 289  
 Petro Lezhnuk, Olexander Rubanenko, and Iryna Hunko

**Effect of Phase Composition on Cavitation Resistance of Ceramics** . . . . . 299  
 Alexander Litvinenko, Yuriy Boyko, Bohdan Pashchenko, and Yuriy Sukhenko

**System Dynamics Model for Continuous Review Inventory System in Demand Shock Conditions** . . . . . 306  
 Sławomir Luściński and Dariusz Dobrowolski

<b>Numerical Study of Outlet Blade Angle Effect on Impeller Characteristics of Double Entry Centrifugal Pump</b> . . . . .	317
Viktoriia Miltykh and Mykola Sotnyk	
<b>Application of Artificial Neural Network for Identification of Bearing Stiffness Characteristics in Rotor Dynamics Analysis</b> . . . . .	325
Ivan Pavlenko, Vitalii Simonovskiy, Vitalii Ivanov, Jozef Zajac, and Jan Pitel	
<b>Movement of the Particle on the External Surface of the Cylinder, Which Makes the Translational Oscillations in Horizontal Planes</b> . . . . .	336
Sergiy Pylypaka, Mikola Klendiy, and Tatiana Zaharova	
<b>Influence of the Passive Flow Initial Parameters on the Efficiency of Liquid-Vapor Ejectors</b> . . . . .	346
Serhii Sharapov, Vyacheslav Arsenyev, Maxim Prokopov, and Viktor Kozin	
<b>Constitutive Equation for Numerical Simulation of Elastic-Viscous - Plastic Disperse Materials Deformation Process</b> . . . . .	356
Evgenii Shtefan, Bohdan Pashchenko, Serhii Blagenko, and Serhii Yastreba	
<b>Determination of Transfer Functions for Electrohydraulic Servo Drive of Technological Equipment</b> . . . . .	364
Volodymyr Sokolov and Oleg Krol	
<b>Influence of the Stochastic Nature Parameters of Throttle Channels on Characteristic of Automatic Balancing Device of the Centrifugal Pump</b> . . . . .	374
Yuliia Tarasevych, Nataliia Sovenko, and Ievgen Savchenko	
<b>Comparative Tribological Tests for Face Impulse Seals Sliding Surfaces Formed by Various Methods</b> . . . . .	382
Viacheslav Tarelnyk, Ievgen Konoplianchenko, Vasyl Martynkovskyy, Aleksey Zhukov, and Piotr Kurp	
<b>Effect of the Parameters at the Inlet to the Rotor of the Jet-Reactive Turbine on Its Efficiency</b> . . . . .	392
Serhiy Vanyeyev, Stanislav Melechuk, Vadim Baga, and Tetiana Rodymchenko	
<b>Chemical Engineering</b>	
<b>Modeling of the Heating for Cladded Powder in Plasma Jet at Spraying of Coating</b> . . . . .	405
Andrii Andreytsev, Igor Smirnov, Andrii Chorny, Mykhailo Yelysieiev, and Nikolay Dolgov	

<b>Information Support of Optimization Calculation of Vortex Type Granulation Devices</b> . . . . .	412
Artem Artyukhov	
<b>The Carrier Development for Biofilms on the Basis of Technogenic Wastes for Pollutants Treatment in the Environmental Protection Technologies</b> . . . . .	422
Yelizaveta Chernysh and Leonid Plyatsuk	
<b>The Use of Waveguides with Internal Dissectors in the Process of Regeneration of Industrial Adsorbents by Means of the Energy of Ultrahigh-Frequency Radiation</b> . . . . .	433
Sergey Dobrotvorskiy, Ludmila Dobrovolska, Borys Aleksenko, and Yevheniia Basova	
<b>Obtaining of Multilayer Granules in a Vortex Gas Flow: Automated Complex for Technological Calculation</b> . . . . .	443
Andrii Ivaniia and Artem Artyukhov	
<b>Simulation and Design of Welded Plate Heat Exchangers with Channels of Different Corrugation Height</b> . . . . .	453
Gennadii Khavin	
<b>Granulation Process of the Organic Suspension: Fluidized Bed Temperature Influence on the Kinetics of the Granule Formation</b> . . . . .	463
Ruslan Ostroha, Mykola Yukhymenko, Andrii Lytvynenko, Jozef Bocko, and Ivan Pavlenko	
<b>Design and Study of Conical Pressure-Swirl Atomizers</b> . . . . .	472
Marek Ochowiak, Olha Lytvynenko, Sylwia Włodarczak, Magdalena Matuszak, and Anđželika Krupińska	
<b>Investigation of the Process of Saturation of the Filter Liquid of Soda Production with Ammonia and Carbon Dioxide in the Production of Ammonium Chloride</b> . . . . .	481
Inna Pitak, Valery Shaporev, Oleg Pitak, Alina Hrubnik, and Viktor Moiseev	
<b>Modelling of Liquid's Distribution and Migration in the Fibrous Filter Layer in the Process of Inertial-Filtering Separation</b> . . . . .	489
Vsevolod Sklabinskyi, Oleksandr Liaposhchenko, Ivan Pavlenko, Olha Lytvynenko, and Maryna Demianenko	
<b>CFD Simulation of Ammonium Nitrate Melt in a Perforated Rotating Bucket</b> . . . . .	498
Maksym Skydanenko, Vsevolod Sklabinskyi, and Saad Saleh	

**Mathematical Model of Corrosive-Mechanic Wear Materials  
in Technological Medium of Food Industry** . . . . . 507  
Yuriy Sukhenko, Vladislav Sukhenko, Mikhailo Mushtruk,  
and Alexander Litvinenko

**Light and Heavy Pollutant Removal by Modified Swirl Sedimentation  
Tank – Design and Study** . . . . . 515  
Sylwia Włodarczak, Marek Ochowiak, Małgorzata Markowska,  
Szymon Woziwodzki, and Magdalena Matuszak

**Investigation of Hydrodynamics During Continuous Vibroextraction  
in a Liquid–Solid Body System** . . . . . 524  
Vladimir Zavialov, Taras Misyura, Nataliya Popova, Yuliya Zaporozhets,  
and Vadim Dekanskiy

**Author Index** . . . . . 537