InterPartner

Grabchenko's International Conference
on Advanced Manufacturing Processes

6th Grabchenko's International Conference on Advanced Manufacturing Processes

September 10-13, 2024 | Odesa, Ukraine


iATDi
International Association for Technological Development and Innovations

Book of Abstracts

International Association for Technological Development and Innovations

6th Grabchenko's International Conference on Advanced Manufacturing Processes (InterPartner-2024)

September 10–13, 2024| Odesa, Ukraine

Book of Abstracts

Sumy
2024

Editors:
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Advanced Manufacturing Processes: Book of Abstracts of the 6th Grabchenko's International Conference on Advanced Manufacturing Processes, Odesa, Ukraine, September 10-13, 2024 / Volodymyr Tonkonogyi, Vitalii Ivanov (Eds.). – Sumy: IATDI, 2024. – 120 p.

Recommended by the Coordination Board of the International Association for Technological Development and Innovations (Protocol No. 5, February 1, 2024)

This book offers a timely snapshot of innovative research and developments at the interface between design, manufacturing, materials, mechanical and process engineering, and quality assurance. It covers various manufacturing processes, such as grinding, turning, drilling, milling, broaching, and gear machining, including additive manufacturing, strengthening, electro-mechanical processing, vacuum technology, and deforming broaching. It focuses on computer and numerical simulation, mathematical and reliability modeling, and machine learning models for manufacturing systems and processes. It describes innovative cutting and abrasive processes and combined technologies. It also investigates the electrical resistance, self-sharping effect, strengthening, heat treatment, surface peening, and heat resistance of various coatings and materials. Gathering the best papers presented at the 6th Grabchenko's International Conference on Advanced Manufacturing Processes (InterPartner-2024), held in Odesa, Ukraine, on September 10–13, 2024, this book provides a comprehensive and up-to-date examination of design, manufacturing, mechanical, materials, and process engineering, as well as quality assurance trends and technologies. Yet, it also aims to foster international and interdisciplinary communication and collaborations, offering a bridge between the academic and industrial sectors.

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Welcome Message

6th Grabchenko's International Conference on Advanced Manufacturing Processes (InterPartner-2024), held in Odesa, Ukraine on September 10-13, 2024, was organized by the Odesa Polytechnic National University, National Technical University "Kharkiv Polytechnic Institute", Sumy State University, and International Association for Technological Development and Innovations in partnership with Poznan University of Technology (Poland), Springer Nature, iThenticate, and International Innovation Foundation.

InterPartner Conference Series promotes research and developmental activities, intensifying scientific information interchange between researchers, developers, and engineers.

InterPartner-2024 received 141 contributions. After a thorough peer-review process, the Program Committee accepted 73 papers written by authors from 16 countries. Thank you very much to the authors for their contribution. The full-text papers are published in the book series Lecture Notes in Mechanical Engineering under the title "Advanced Manufacturing Processes: Selected Papers from the 6th Grabchenko's International Conference on Advanced Manufacturing Processes (InterPartner-2024), achieving an acceptance rate of 52%.

We thank members of the Program Committee and invited external reviewers for their efforts and expertise in contributing to reviewing, without which it would be impossible to maintain the high standards of peer-reviewed papers.

Thank you very much to keynote speakers Prof. Yuriy Vnukov (USA) and Prof. Alexandr Orgiyan (Ukraine).

The editors appreciate the outstanding contribution of all the authors. We are deeply convinced that the research papers presented in the book will be helpful to scientists, industrial engineers, and highly qualified practitioners worldwide.

Thank you very much to the InterPartner Team. Their involvement, devotion, and hard work were crucial to the success of the conference.

InterPartner's motto is **"Science unites people together"**.

***Volodymyr TONKONOGYI**,*
General Chair of the Conference

***Vitalii IVANOV**,*
Co-Chair of the Conference

Conference Committees

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Co-Chair

Vitalii Ivanov	Sumy State University, Ukraine

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Justyna Trojanowska	Poznan University of Technology, Poland

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Nicolae Ungureanu	Technical University of Cluj-Napoca, Romania
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Predrag Zivkovic	University of Niš, Serbia
Justyna Zywiolek	Czestochowa University of Technology, Poland

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Vladyslav Andrusyshyn	Sumy State University, Ukraine
Ivan Dehtiarov	Sumy State University, Ukraine
Andrii Dovhopolov	Sumy State University, Ukraine
Andriy Dzyubuk	Lviv Polytechnic National University, Ukraine
Lyudmyla Dzyubuk	Lviv Polytechnic National University, Ukraine
Nikolaos Karkalos	National Technical University of Athens, Greece
Vladyslav Kondus	Sumy State University, Ukraine
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InterPartner Team (in alphabetical order)

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Volodymyr Tonkonogyi	Odesa Polytechnic National University, Ukraine
Justyna Trojanowska	Poznan University of Technology, Poland

Conference Topics

Manufacturing Engineering

- Advanced Manufacturing Processes
- CAD/CAE/CAPP/CAM Systems for Design, Manufacturing, and Assembling Technologies
- Information Management Systems for Manufacturing Enterprises
- Intelligent Manufacturing Systems and Industry 4.0 Strategy
- Automation and Robotics
- Engineering Education

Mechanical Engineering

- Engineering Design and Optimization
- Computer Modeling of Fracture, Failure, and Fatigue
- Computational Techniques in Machine Mechanics and Dynamics
- Numerical Methods for Dynamics, Acoustics, and Vibration
- Computational Methods for Control Theory
- Numerical Simulation of Nonlinear Dynamic Systems

Materials Science

- Theoretical Fundamentals and Mathematical Modeling
- Numerical Simulation and Optimization
- Methods and Technologies for Additive Manufacturing
- Resource-Saving and Energy Efficient Technologies in Materials Science

Quality Assurance

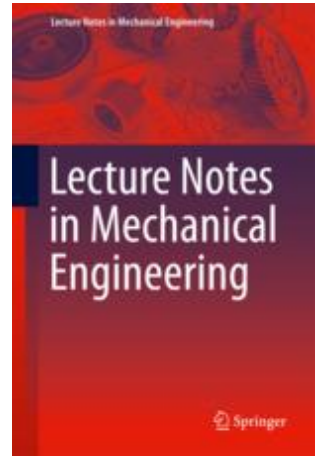
- Theoretical Fundamentals
- Mathematical Modeling
- Standardization and Certification

Publishing Opportunities

Full papers of selected contributions of InterPartner-2024 will be published in Lecture Notes in Mechanical Engineering series (ISSN 2195-4356), Springer Nature under the title "**Advanced Manufacturing Processes VI**". The books of this series are indexed by Scopus and EI Compendex and submitted to the Web of Science Core Collection (Conference Proceedings Citation Index).

Editors:

Volodymyr Tonkonogyi, Odesa Polytechnic National University, Ukraine
Vitalii Ivanov, Sumy State University, Ukraine
Justyna Trojanowska, Poznan University of Technology, Poland
Gennadii Oborskyi, Odesa Polytechnic National University, Ukraine



The previous conference proceedings of the InterPartner Conference Series can be found here: **https://link.springer.com/conference/interpartner**.

Extended versions of the best papers, presented at InterPartner-2024, will be recommended for publication in cooperating journals, subject to further review:

- **Assembly Techniques and Technologies**, Poland, https://journals.prz.edu.pl/tiam;
- **Journal of Mechanical Engineering and Manufacturing**, Australia, https://www.sciltp.com/journals/jmem;
- **Journal of Engineering Sciences**, Ukraine, http://jes.sumdu.edu.ua.

Conference Venue

Odesa is the third most populous city in Ukraine, and it is a major tourism center, seaport, and transport hub located on the northwestern shore of the Black Sea. It is also a multiethnic cultural center. Odesa is sometimes called the "Pearl of the Black Sea", the "South Capital", and "Southern Palmyra".

In 1794, the city of Odesa was founded by a decree of the Russian empress Catherine the Great. From 1819 to 1858, Odesa was a free port. During the Soviet period, it was the most important trade port in the Soviet Union and a Soviet naval base. On 1 January 2000, the Quarantine Pier at Odesa Commercial Sea Port was declared a free port and free economic zone for 25 years.

Odesa's historical architecture is more Mediterranean and heavily influenced by French and Italian styles. Some buildings are built in various styles, including Art Nouveau, Renaissance, and Classicist.

Odesa is a warm-water port. The city of Odesa hosts Port of Odesa and Port Yuzhne, a significant oil terminal in the city's suburbs. Another notable port, Chornomorsk, is located in the same region, southwest of Odesa. Together, they represent a major transport hub that integrates railways. Odesa's oil and chemical processing facilities are connected to European networks by strategic pipelines.

Agenda

Day 1 – **September 10, 2024** – Tuesday	
9^{30}–10^{00}	Registration (for in-person participants)
10^{00}–10^{15}	Opening Ceremony
10^{15}–12^{00}	Keynote Session
12^{00}–13^{00}	Time for Lunch
13^{00}–14^{45}	Session 1 – Design Engineering
14^{45}–15^{00}	Technical Break
15^{00}–17^{00}	Session 2 – Machining Processes
Day 2 – **September 11, 2024** – Wednesday	
10^{00}–12^{00}	Session 3 – Manufacturing Technology
12^{00}–13^{00}	Time for Lunch
13^{00}–14^{45}	Session 4 – Manufacturing Processes
14^{45}–15^{00}	Technical Break
15^{00}–17^{00}	Session 5 – Manufacturing Engineering
18^{00}–22^{00}	Gala Dinner
Day 3 – **September 12, 2024** – Thursday	
10^{00}–12^{00}	Session 6 – Mechanical Engineering I
12^{00}–13^{00}	Time for Lunch
13^{00}–14^{45}	Session 7 – Process Engineering & Engineering Education
14^{45}–15^{00}	Technical Break
15^{00}–17^{00}	Session 8 – Advanced Materials
Day 4 – **September 13, 2024** – Friday	
10^{00}–11^{45}	Session 9 – Mechanical Engineering II
11^{45}–12^{00}	Technical Break
12^{00}–13^{15}	Session 10 – Quality Assurance
13^{15}–13^{25}	Technical Break
13^{25}–13^{45}	Closing Ceremony

Day 1: September 10, 2024, Tuesday

9^{30}–10^{00}	**Registration**
10^{00}–10^{15}	**Opening Ceremony**

Volodymyr Tonkonogyi
General Chair of the Conference
Gennadii Oborskyi
Rector of Odesa Polytechnic National University
Vitalii Ivanov
Co-Chair of the Conference

10^{15}–12^{00}	**Keynote Session** *Chair: Volodymyr Tonkonogyi* Odesa Polytechnic National University, Ukraine

Experimental Studies of Vibration Excitation Conditions During Cutting with Cutting Tools
Yuriy Vnukov
Independent scientist, USA

Non-Stationary Dynamic Systems of Machine Tools: Computational and Experimental Analysis of Stability and Oscillations
Alexandr Orgiyan
Odesa Polytechnic National University, Ukraine

12^{00}–13^{00}	**Time for Lunch**
13^{00}–14^{45}	**Session 1 – Design Engineering** *Chair: Olaf Ciszak* Poznan University of Technology, Poland

Heuristic Analysis of the Accident on the Ship's Rudder-Propeller Columns: Case Study
Viktor Ivanov, Tetiana Melenchuk, Svitlana Ivanova, Dimitar Karaivanov and Mariia Volkova

Economic Justification of High-Rotational Submersible Pumps Development for Water Supply Facilities
Vladyslav Kondus, Vladyslav Andrusiak, Mykola Sotnyk, Oleksandr Ratushnyi and Serhii Antonenko

Analysis of Power Consumption of a Wheeled Platform Actuated by a Centrifugal Vibration Exciter

Vitaliy Korendiy, Oleksandr Kachur, Olena Lanets and Rostyslav Predko

Increasing the Service Life of the Pressure Block of the Planetary Hydraulic Motor

Anatolii Panchenko, Angela Voloshina, Mykola Pryhodii, Viktor Drankovskiy and Irina Tynyanova

Optimal Geometrical Dimensions of Drainless Vortex Chamber Ejector of Homogeneous Medium

Andrii Rogovyi, Sergey Krasnikov, Oleksandr Lomeiko, Lyidmila Kiurcheva and Maksim Svynarenko

Substantiation of the Spring-Cam Retarder Brake Design and its Main Parameters Determination

Volodymyr Semenyuk, Oleksandr Vudvud and Valeriy Lingur

Application of Modified Kinematic Graphs to Analyze the Structures of Passive Relaxation Shock Absorbers

Ihor Sydorenko, Victor Kurgan, Volodymyr Semenyuk, Valeriy Lingur and Vladyslav Borysov

14^{45}–15^{00}	**Technical Break**
15^{00}–17^{00}	**Session 2 – Machining Processes** *Chair: Vasyl Larshin* Odesa Polytechnic National University, Ukraine

Modeling the Dynamics of Centerless Mortise Grinding on Rigid Supports

Vasyl Chalyj, Serhii Moroz, Anatolii Tkachuk, Valentyn Zablotskyi and Oleg Zabolotnyi

Increasing The Continuous Operation Time of the Diamond Cutting Disk When Using Various Cooling Media

Tetiana Chumachenko, Alla Bespalova, Olha Dashkovska, Oleksij Knush and Tatiana Nikolaeva

Development of a Simulator Program for Studying the Effect of Cutting Modes on Cutting Temperature

Vladimir Gugnin, Liudmyla Perperi, Gennadii Oborskyi, Ganna Goloborodko and Volodymyr Goloborodko

CoCoSo Method-Based Evaluation of Cutting Parameters in Turning of AISI 1040 Steel under Plain and Nano MoS2 Reinforced Cutting Fluid Assisted MQL Methods

Yusuf Günay, Yusuf Furkan Yapan, Ruslan Dzhemalyadinov, Eshreb Dzhemilov and Alper Uysal

Modeling and Optimization of the Process of Drilling Holes in Carbon Fiber Reinforced Polymer Parts

Oleksandr Matoshyn, Sergii Vysloukh, Viktor Antonyuk and Oksana Voloshko

A Method for Determining the Forces and Coefficient of Friction on the Back Surface of Cutting Tools and Their Dependence on Processing Conditions

Mykola Mazur and Volodymyr Mylko

Analytical Determination of Height Parameters of Surface Roughness during Abrasive Processing and Conditions for Their Reduction

Fedir Novikov, Dmytro Novikov, Oleksii Yermolenko, Valeriy Zhovtobryukh and Svitlana Shevchenko

The Influence of the Dynamics of Multi-Spindle Finishing Boring Machines on Processing Accuracy

Anna Balaniuk, Alexandr Orgiyan, Olexandr Badovskyi, Volodymyr Tonkonogyi and Sergii Myronenko

Day 2: September 11, 2024, Wednesday

10^{00}–12^{00} Session 3 – Manufacturing Technology

Chair: Vitalii Ivanov
Sumy State University, Ukraine

A Combined Approach for Determining Tool Cutting Part States Using Machine Learning Models
Oleksandr Derevianchenko, Oleksandr Fomin, Natalya Volkova, Oleksiy Tataryn and Isak Karabegovich

Increasing the Accuracy of Part Obtained by Selective Laser Sintering by Shrinkage Compensation
Yaroslav Garashchenko, Vladimir Fedorovich, Andrii Poharskyi, Nataliia Kozakova and Nataliia Riazanova-Khytrovska

A Simulation Study of DDMRP and MRP Manufacturing Planning and Control Systems
Nelson Guedes, Luís Pinto Ferreira, Francisco Silva, Nuno Fernandes and Sílvio Carmo-Silva

Analysis of the Surface Layer of Aluminium Alloy Castings at their Machining by the Surface Homogeneity Criterion
Yaroslav Kusyi, Olha Kostiuk, Andrij Kuk, Iryna Taras and Tetiana Lukan

Strain in ANSYS Simulation and Real Testing
Natalia Lishchenko, Garret O'Donnell, William Dempsey, Vasily Larshin and Victor Marchuk

Vacuum Technology for Magnesium Alloys During Die Casting of Radiators
Oleg Stalnichenko, Tatiana Lysenko, Olga Ponomarenko, Kyryll Kreitser and Evgeny Kozishkurt

Reliability Prediction for Robotic Machines with Parallel Kinematics
Valentin Tikhenko, Gennadii Oborskyi, Aleksandr Volkov and Raul Turmanidze

Study of the Roughness of A36 Steel with TiAlN Coated Inserts
Sandino Torres, Cristian Redroban, Edisson Calderon, Alex Barrionuevo and Roberto Ortega

12^{00}–13^{00} Time for Lunch

13^{00}–14^{45} Session 4 – Manufacturing Processes

Chair: Oleh Onysko
Ivano-Frankivsk National Technical University of Oil and Gas, Ukraine

Strengthening of Aerospace Inconel 718 Alloy Fabricated by LPBF: Hardening Mechanisms Induced by HIP, Heat Treatments and Surface Peening Treatment
Dmytro Lesyk, Silvia Martinez, Aitzol Lamikiz, Oleksii Pedash and Bohdan Mordyuk

Formation of Coatings on Titanium Alloys Saturated with Biocomponents by the PEO Method
Nataliia Imbirovych, Oleksandr Povstyanoy, Inna Boiarska, Tamara Nykoliuk and Nazar Redko

Calculation and Study of the Stress State of the Antifriction Coating Applied to the Working Surface of The Car Cylinder Liner
Ihor Shepelenko, Yakiv Nemyrovskyi, Mykhailo Krasota, Sergii Mahopets and Ivan Vasylenko

Corrosion, Electrochemical and Cavitation-Erosion Properties of Titanium and Its Alloys
Myroslav Stechyshyn, Aleksandr Dykha, Viktor Oleksandrenko, Myroslav Kindrachuk and Andrii Martyniuk

Stress-Strain State During Deforming Broaching of Workpieces Made of Plastic Materials
Yakiv Nemyrovskyi, Valentin Otamanskyi, Oleksandr Melnyk, Ihor Shepelenko and Volodymyr Nochvai

Influence of Stochastically Distributed Defects on Crack Formation on Grinding Surfaces of Materials Prone to Cracking
Anatoly Usov, Vitalii Ivanov, Maksym Kunitsyn and Yulia Sikirash

The Use of Plasma Coatings to Increase the Reliability of Equipment at Agribusiness Enterprises
Mikhailo Mushtruk, Volodymyr Vasyliv, Igor Stadnyk, Andriy Derkach and Yuriy Boyko

14^{45}–15^{00}	**Technical Break**
15^{00}–17^{00}	**Session 5 – Manufacturing Engineering** *Chair: Yaroslav Kusyi* Lviv Polytechnic National University, Ukraine

Modeling of the Process of Single-Pass Multi-Point Turning of the NC12 Tapered Thread
Oleh Onysko, Volodymyr Kopei, Lubomyr Borushchak, Volodymyr Pavlyk and Oleksandr Lukan

Development of a Six-Spindle Turret Head of a Multioperational Machine with a Modernized Drive
Oleg Krol, Vladimir Sokolov and Oleksandr Logunov

Composite Impeller for Centrifugal Compressors
Vasyl Martsynkovskyy, Kostyantyn Liubchenko, Andrii Prokopenko, Genadii Nezhibetskiy and Andrii Lazarenko

The Concept of Digital Description of Structural Elements of Technical Systems
Borys Prydalnyi

Contribution of Artificial Intelligence and Simulation to Building Evacuation
Luis Pinto Ferreira, Catarina Costa, Ana Luísa Ramos and Maria Valero

Efficiency Improvement of the Jet-Slit Homogenizer in the Food Engineering
Kyrylo Samoichuk, Alexandr Kovalyov, Vitalii Koshulko, Dmytro Tymchak and Nataliia Sova

Experimental Verification of the Impact of Phase Shift Between Neighboring Waves on the Intensity of Regenerative Oscillations During Continuous Cutting
Pavlo Tryshyn, Yuriy Vnukov, Serhiy Dyadya and Olena Kozlova

Experimental Research on Regenerative Self-Oscillations During Turning
Yuriy Vnukov, Pavlo Tryshyn, Serhiy Dyadya and Olena Kozlova

18^{00}–22^{00}	**Gala Dinner**

Day 3: September 12, 2024, Thursday

10^{00}–12^{00} Session 6 – Mechanical Engineering I

Chair: Milan Edl
University of West Bohemia, Czech Republic

Simulation of the Shaft Surface Strengthening as a Result of Discrete Electro-Mechanical Processing
Kostyantyn Holenko, Aleksandr Dykha, Volodymyr Dytyniuk, Maksym Dykha and Orest Horbay

Dynamics Analysis of Elevator Winches with Thyristor Control System
Andrii Boiko, Elena Naidenko, Oleksandr Besarab and Oleksandr Bondar

Qualitative States of Operating Fluid in the Chamber of the Auto-balancing Device
Ilona Drach, Maksym Dykha and Dmytro Marchenko

Method of Accelerated Tests of Axial Piston Pumps by Intensification of Fatigue Damage Accumulation Process
Oleksandr Fatyeyev, Nadiia Fatieieva, Serhii Sushko, Vasil Mitkov and Valerii Poliakov

Development and Substantiation of Proposals for Modernization of Plate Rolling Mill
Oleksandr Kurpe and Volodymyr Kukhar

Stability of Arched Rod Structural Elements of Machines
Viktor Orobey, Oleksandr Lymarenko, Anastasia Bazhanova, Vadim Khamray and Andrii Ponomarenko

Method for Variation of Deformations and Stress Under Natural Vibrations
Taisiia Pokhlebina, Oleksandr Lymarenko, Anna Balaniuk, Anastasia Bazhanova and Vadim Khamray

Dynamics of Nonlinear Vibration Isolator: Parametric Analysis
Volodymyr Puzyrov, Nataliya Losyeva and Nina Savchenko

12^{00}–13^{00}	**Time for Lunch**
13^{00}–14^{45}	**Session 7 – Process Engineering & Engineering Education** *Chair: Natalia Lishchenko* Trinity College Dublin, Ireland

The Camberline Optimization Procedure for Mixed Inflow Turbine Rotor
Mohammed Amine Chelabi, Yevheniia Basova, Sergey Dobrotvorskiy, Dmytro Trubin and Oleksandr Kharchenko

Modeling of Gas-Dynamic Processes of Wave Low-Temperature Heat Generators Dynamic Gas Distribution
Dmytro Dymertsov

Use a Vibration Machine to Obtain Ammonia Water for Plant Feeding
Anatolyi Hordeev, Ihor Sydorenko, Oleksii Matvieiev, Victor Kurgan and Yurii Yeputatov

The Use of Vibromechanical Intensification to Optimize Heat Exchange in Transport and Technological Machines
Igor Palamarchuk, Mikhailo Mushtruk, Yuriy Boyko, Igor Stadnyk and Andriy Derkach

Professional Situations Modeling for Bachelors in Information Technology Training
Serhii Kulieshov, Muhaiyo Alamshoeva and Anna Ostapenko

Diagnostic Assessment of Professional Competence Levels of Engineering Teachers
Petro Luzan, Olena Titova, Iryna Mosia, Tetiana Pashchenko and Tetiana Ishchenko

Quality Management of Training of Engineering Personnel in the Conditions of Developing their Management Competence
Viktor Nagayev, Nataliia Moisieieva, Viktoriia Novikova, Tetiana Mitiashkina and Sergii Chervonyi

14^{45}–15^{00}	**Technical Break**
15^{00}–17^{00}	**Session 8 – Advanced Materials** *Chair: Mykola Melnychuk* Lutsk National Technical University, Ukraine

Ensuring Heat Resistance of Aviation Materials Through the Use of Protective Coatings Based on ZrO2

Nataliia Zaichuk, Oleksandr Umanskyi, Sergiy Shymchuk, Ruslan Kostunik and Oleksandr Terentiev

Calculation of the Electrical Resistance of a Cone Microelectrode for Electrochemical Studies of Coatings

Andriy Bandura, Liubomyr Ropyak and Mykola Romaniv

RF Magnetron Sputtering of Biocompatible Coatings

Khrystyna Berladir, Tetiana Hovorun, Oleksandr Oleshko and Svetlana Radchenko

Composite Powder Materials and Coatings with Self-Sharpening Effect for Strengthening, Restoring, and Manufacturing Parts and Working Bodies of Agricultural Machinery

Mykola Denisenko, Olena Deviatko, Roman Yakovenko and Nataliia Kanivets

Physical and Chemical Processes in the Surface Layers of Metal Materials in Contact with an Oxidizing Environment

Olena Deviatko, Mykola Denisenko, Nataliia Kanivets, Ievgenii Petrychenko and Anatoliy Holovatyuk

Analysis of the Casting Methods Influence on the Microstructure of High-Speed Steel

Tatiana Lysenko, Oleksandr Derevianchenko, Vadym Dotsenko, Maksim Tur and Kirill Kiselyov

Architecture of Online Laboratory for Modeling and Studying the Properties of Structurally Heterogeneous Materials

Volodymyr Serhieiev and Viktor Rud

Investigation of ZhS3dk-VI Alloy as a Material of Gas Turbine Engines Cast Blades

Dmytro Tomkin, Oleksii Pedash, Olena Naumyk, Valeriy Naumyk and Eduard Kondratiuk

Day 4: September 13, 2024, Friday

10^{00}–11^{45} Session 9 – Mechanical Engineering II

Chair: Yevheniia Basova
National Technical University "Kharkiv Polytechnic Institute", Ukraine

Design of a Helical Shredding Drum Blade and Determination of its Unfolding
Serhii Pylypaka, Vyacheslav Hropost, Tetiana Kresan, Tetiana Volina and Svitlana Semirnenko

Contact Interaction of a Ball with a Toroidal Running Track with a Closely Shaped Power Law Profile
Mykola Tkachuk, Andrey Grabovskiy, Mykola Tkachuk, Iryna Hrechka and Hanna Tkachuk

Modeling Dynamic Response and Stability of the Combined Mechanical System with Two Degrees of Freedom
Milica Tufegdzic, Sergiy Kovalevskyy, Predrag Dasic and Aleksandar Miskovic

A Fundamental Solution of the Dynamics of Thin Isotropic Plates Lying on an Elastic Base
Oleh Vietrov, Olha Trofymenko and Vira Trofymenko

Superconductivity of Friction Pairs of Brake Devices
Dmytro Volchenko, Vasyl Skrypnyk, Dmytro Zhuravlov, Iryna Bekish and Serhiy Nikipchuk

Superconductivity of Metal Friction Elements of Brakes
Oleksandr Vudvud, Mykola Ostashuk, Volodymyr Malyk, Tetiana Volobueva and Kateryna Kostrubina

Stress and Strain State of Bar in the Space Between the Stands of a Continuous Shape Rolling Mill
Maksym Shtoda

11^{45}–12^{00} Technical Break

12^{00}–13^{15}	**Session 10 – Quality Assurance**
	Chair: Slawomir Luscinski Kielce University of Technology, Poland

Application of the Dynamic Programming Method in Process Measurement Problems When Assessing Interoperability

Kostiantyn Dyadyura, Igor Prokopovich, Vitalii Khamitov, Tetiana Sikach and Oleksandr Vershkov

Monitoring the Accuracy of Manufacturing Elements of the End Distribution System of a Hydraulic Motor Planetary Type

Sergey Kiurchev, Volodymyr Kyurchev, Oleksandr Radkevych, Oleksandr Fatyeyev and Iryna Hrechka

Improvement of the Technology of Production of Packaged Mineral Sodium Chloride Water Using the Principles of Risk Management

Alona Kysylevska, Igor Prokopovych, Tatiana Bezverkhniuk, Aleksandr Levinskiy and Predrag Dasic

Improving the Quality of Emulsions Dispersion in the Pulsation Homogenizer Using Computer Simulation

Nadiia Palianychka, Kyrylo Samoichuk, Valentyna Verkholantseva, Nataliia Sova and Iryna Kholobtseva

Simulation of Processes in Composite Materials Under Thermometrical Control Taking into Account Their Heterogeneity

Volodymyr Tonkonogyi, Maryna Holofieieva, Yurii Morozov, Anatoly Usov and Isak Karabegovich

13^{15}–13^{25}	**Technical Break**
13^{25}–13^{45}	**Closing Ceremony** *Chair: Volodymyr Tonkonogyi* General Chair of the Conference

Keynote Speakers

Yuriy VNUKOV, DSc., Professor,

Academician of the Higher School and the Academy of Engineering Sciences of Ukraine

Retired

Prof. Vnukov started his scientific career in 1973 during his studies at a Ph.D. course at Kharkiv Polytechnic Institute under the supervision of Prof. Mykhailo Semko and Assoc. Prof. Anatolii Grabchenko. He successfully defended his Ph.D. thesis in 1977 and his DSc. thesis in 1991. From 1977 to 1994, he worked as Head of the laboratory "Quality and Rational Use of High-Speed Steels» at the Ukrainian Research Institute of Special Steels and Ferroalloys in Zaporizhzhia. In 1994-1997 Prof. Vnukov worked as the Head of the Department of Metal-Cutting Machines and Tools at the Zaporizhzhia State Technical University. In 1997 he was promoted to Vice-Rector for Scientific Work of the Zaporizhzhia National Technical University. He made a significant contribution to science, particularly the manufacturing engineering area, being in this position until 2017. In 2008 Prof. Vnukov was awarded the State Prize of Ukraine in the field of science and technology. He was a member of Specialized Academic Councils and Government Commissions. 1 DSc. and 16 Ph.D. students were defended under his scientific supervision. He is the author of 240 scientific articles, 11 textbooks, and 36 patents.

Alexandr ORGIYAN, DSc., Professor

Professor of the Department of Digital Technologies in Engineering

Odesa Polytechnic National University, Ukraine

Prof. Alexandr Orgiyan graduated from the Odesa Institute of Technology named after M.V. Lomonosov in the specialty "Dynamics and strength of machines" in 1969. He defended his Ph.D. thesis in 1974, and his DSc. thesis in 2002. During 1980-2008, he worked at the Odesa Academy of Food Technologies as Vice-rector for Economic Development and Head of the department. From 2008 to 2013, he was the Head of the Department of Construction Machinery at the Odesa State Academy of Civil Engineering and Architecture. Since 2013, he has been working at the Odesa Polytechnic National University. From 2013 to 2021, he was the Head of the Department of Manufacturing Engineering named after A.O. Matalin. Prof. Orgiyan achieved the most significant scientific results in manufacturing technology. Namely, he founded the new scientific direction "Technological dynamics". Prof. Orgiyan is an author and co-author of 3 monographs, more than 250 scientific articles, and 25 patents. The research area of Prof. Orgiyan is oscillations and stability of technological systems, as well as dynamics of fine turning (boring). He is actively engaged in scientific research in the design and dynamics of machine tools. He is a member of the Editorial Board of the journal "Scientific Works of Odesa Polytechnic". Prof Orgiyan is a member of the International Association for Technological Development and Innovations since 2019.

Abstracts
Part I
Design Engineering

Contribution of Artificial Intelligence and Simulation to Building Evacuation

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M. R. Valero[4]

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Evacuation procedures in buildings during emergencies demand advanced systems capable of ensuring swift and safe evacuations amidst increasingly complex (e.g., factories) and densely populated (e.g., urban) environments. Integrating advanced simulation and artificial intelligence (AI) algorithms into decision support systems (DSS) for evacuation processes has emerged as a promising approach to optimize and customize evacuation plans according to specific situational and people's needs. This paper analyses the role, main challenges, and opportunities of AI and simulation in building evacuation. In the context of DSS, AI enables dynamic adaptation of evacuation strategies in real-time, considering psychological and social factors in decision-making, whereas advanced simulation models facilitate the evaluation and refining of evacuation strategies by identifying critical points and optimal approaches. While challenges such as algorithm accuracy, managing large data volumes, and privacy concerns remain, this study shows how technological developments such as smart sensors, autonomous emergency vehicles, and communication technologies hold significant promise in supporting the integration of AI to enhance evacuation efficiency and inclusivity, thereby improving overall building safety.

Heuristic Analysis of the Accident on the Ship's Rudder-Propeller Columns: Case Study

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The usual causes of failure of marine transmissions are added natural weather factors, overboard water into the housing and improper crew actions in extreme conditions. The strength and stiffness of transmission elements can be assessed based on standards implementing generally accepted engineering methods, numerical modeling methods, and maritime registry rules. The wide range of causes for failures and the various assessment methods pose challenges when determining the root causes of accidents and evaluating the legal responsibilities of different parties involved, including the shipyard, ship-owner, and crew. In such circumstances, it could be discovered that employing heuristic methods becomes the sole means of resolving the problem. A specific case of accidents involving a number of rudder-propeller columns of identical design on various ships was considered. The cause of the failure was found using a heuristic method that combines a design structure matrix and a morphological matrix of damage
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Economic Justification of High-Rotational Submersible Pumps Development for Water Supply Facilities

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The amount of pumping equipment energy consumption is critical in various industries, as it directly affects operating costs, efficiency, and environmental friendliness. The required energy can be a significant part of the total energy consumption (up to 20% or more) in industrial and commercial settings. As the industry strives for sustainability and reduced environmental impact, optimizing energy use in pumping operations remains a crucial area of focus, critical to achieving the UN Sustainable Development Goals (SDGs). Therefore, the main aim of the research is to increase the market competitiveness of pumping equipment for the needs of the water supply sector by reducing its life cycle cost. In the research, the authors considered and divided the line of existing submersible pumps into groups. The average pump energy consumption indicator and material capacity indicator were calculated for these groups. A new promising submersible pump ZN 8-63-150 with an increased rotation frequency from 3000 rpm to 6000 rpm has been developed to replace the existing ECV 10-63-150 pump. The economic effect of the developed ZN 8-63-150 pump introduction compared to the existing ECV 10-63-150 pump was determined to be ≈ 28 thousand EUR during the complete pump life cycle (30 years). The payback period for measures to replace the existing ECV 10-63-150 pump with the developed ZN 8-63-150 is calculated, which ranges from 4 months to 1 year.

Analysis of Power Consumption of a Wheeled Robot Actuated by a Centrifugal Vibration Exciter

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Currently, there is considerable interest in the principles of locomotion driven by vibrations, particularly in the field of mobile robotics. Among the various types of robotic chasses, wheeled ones are the most commonly utilized. The primary objective of this research is to define the dynamic and force characteristics of a wheeled vibratory robot driven by an imbalanced rotor (centrifugal exciter) and equipped with overrunning clutches providing one-way rotation of the robot's wheels. The latter allows the robot to move in a single direction. The research methodology contains several main stages: developing the dynamic diagram of the robot's mechanical system and deducing the locomotion equations; modeling (simulation) of the robot's dynamic behavior in Mathematica software under specific operational conditions; creating the 3D design of the wheeled platform in SolidWorks software; and finally, constructing the laboratory prototype of the vibration-driven robot and carrying out the full-scale experimental investigations. The obtained outcomes illustrate the time dependencies of the platform's speed, displacement, and consumed power under specific operating conditions. The primary scientific contribution of this research is establishing the relationships between the parameters of the platform's mechanical system and its dynamic and force characteristics at specific operating conditions. The investigations can be valuable for designers and researchers who work on mobile vibration-driven robotic vehicles, capsule-type robots, pipeline cleaning systems, vessel inspection devices, and similar applications. Further research on the considered topic may be focused on optimizing the excitation conditions to maximize the average locomotion velocity and minimize the power consumption.

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Development of a Six-Spindle Turret Head of a Multioperational Machine with a Modernized Drive

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The research was carried out on the multi-operational drilling-milling-boring machine design with a six-spindle turret head. A 3D project of a multi-operational machine tool was proposed in the Creo Parametric computer-aided design system environment. Advanced CAD Creo "Inheritance" functionality was used to build three-dimensional models of cast housing parts, considering the casting process's features. For parts with complex contours of mechanical transmissions of the machine drive and turret head, using the "Rounding" element in forming a multistage profile is considered. An innovative design of a V-belt drive transmission with a modified side profile is suggested. The research results of a transmission with a V-belt, the cross-section of which is a curved trapezoid. An analytical apparatus and methodology for determining the basic geometric parameters of a belt provided the curvilinear cross-section of a modified belt drive is equal to that of a standard trapezoidal profile, are proposed. An analysis of the belt height's influence on the belt drive's reliability characteristics was performed. An experimental calculation of the main geometric characteristics of the belt-modified version and comparison with similar characteristics of standard designs was conducted. Comparative analysis with standard V-belts showed potential transmission advantages in terms of belt durability and pressure on shafts and bearings without increasing the belt cross-sectional dimensions. A set of sections for a new type of V-belt similar to the current standard is offered.

Composite Impeller for Centrifugal Compressors

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The article discusses the designs and methods of manufacturing centrifugal compressor impellers. The main disadvantages of welded and welded-brazed structures are highlighted. As an alternative, the authors of the article proposed the design and manufacturing technology of a composite impeller. The advantages of this design are given. The results of calculations of the stress-strain state of the impeller are presented. A comparative analysis of manufacturing technologies for a composite impeller made of steel 36NiCrMo4 and welded impellers made of steel X5CrNiCuNb16-4 and AISI 301 was carried out. The cost of the proposed alternative impeller is estimated in comparison with welded structures. The manufactured composite impeller was tested on an acceleration stand. The tests were conducted with a simulated fit of the impeller on the rotor shaft with interference. This simulation provides the impeller with a load equal to the interference fit on the rotor shaft. The developed technical solution for a composite impeller of a centrifugal compressor makes it possible to use materials not intended for welding, eliminate metal embrittlement, maintain the isotropy of the mechanical properties of the materials used, control the stressed state of the components, eliminate the main stress concentrators on the cover disk and reduce the stress level in the concentrators on the main disk, improve manufacturability and reduce the cost of the finished product. At the same time, the permissible maximum peripheral speed and efficiency increase in comparison with welded.

Increasing the Service Life of the Pressure Block of the Planetary Hydraulic Motor

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The magnitude of the diametrical gap, as a parameter that determines the service life of the pressure block, is determined by the geometric error of the toothed surface of its outer rotor. Analysis of literary sources shows that the issue of increasing the service life of the pressure block of a planetary hydraulic motor remains unsolved and is, therefore, a relevant scientific area. The studies showed that for a serial external unit, the shape error is E = 0.12...0.18 mm due to its manufacturing technology. The proposed design of the modernized external rotor ensures an error in the shape of its toothed profile within the limits of E = 0.03...0.06 mm due to changes in manufacturing technology. Changing the design of the external rotor made it possible to significantly reduce the error in the shape of the gear profile during manufacturing. It has been established that the critical value of the diametrical gap G_d of the serial pressure block equals G_d = 0.12 mm. For the modernized pressure block, it is equal to G_d = 0.37 mm, which increases the service life of the pressure block of the planetary hydraulic motor by more than three times.

The Concept of Digital Description of Structural Elements of Technical Systems

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The paper presents a novel approach to describing the elements of technical system structures, which offers new avenues for enhancing the automation of this information processing. This facilitates improving the conditions for the initial stages of technical systems' development, which pertain to synthesizing their structures and schemes and are currently conducted exclusively by humans. The paper proposes a methodology for forming a digital description of the characteristics of structural elements that can be combined into a single structure of a specific technical system. This description is based on creating a multidimensional vector, which can be further processed using appropriate mathematical tools. This provides the possibility of processing this information by using mathematics. A methodology for forming vectors of description of structural elements of technical systems is proposed following the requirements for their effective use in algorithms implemented by computer programming. The presented approach establishes the foundation for the development of mathematical algorithms for processes related to the creation of technical system structures, their classification, efficient storage in the form of a database, efficient search by a large number of features, and other related tasks.

Optimal Geometrical Dimensions of Drainless Vortex Chamber Ejector of Homogeneous Medium

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Wear and reduction of blowers' efficiency with moving working bodies makes it suitable to use jet devices in many technological processes. Using swirling flow properties, such as pressure reduction on the axis, created vortex ejectors, but their energy performance and efficiency were reduced. So, they required further optimization of geometrical parameters and study of flow in them. This paper aims to optimize the geometrical dimensions of the vortex chamber and supply channels to improve the energy performance of a homogeneous medium vortex chamber ejector based on design experiment methods. After experimental studies and verification of the mathematical model, the planning of the numerical experiment was carried out, the factors and the target function (ejector efficiency) were selected, and the regression equation was obtained, which allowed to determine the maximum efficiency and the geometrical parameters of the ejector corresponding to it. The numerical experiment was carried out based on solving the equations of fluid motion using the OpenFoam software. In contrast to the vortex chamber ejector with a drainage channel, it was determined that the height of the vortex chamber has a significant effect on the ejector efficiency and should be minimized. Along with linear effects, interaction effects were also significant. To increase efficiency, it is necessary to strive to decrease vortex chamber height and supply tangential channel diameter by decreasing the diameter of the vortex chamber.

Efficiency Improvement of the Jet-Slit Homogenizer in the Food Engineering

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Lack of energy efficiency in mechanical engineering, particularly food and processing mechanical engineering, is a factor holding back integration into the European and world space. Implementing the jet-slit milk homogenizer with a separate cream supply is possible to improve the energy efficiency of homogenization and dispersion processes, which are the most energy-consuming in the milk processing industry. The essence of its work is based on creating conditions for the disruption of milk fat particles when high local changes in the speed of cream and skim milk appear, which determines its high efficiency. Analytical studies were based on the dependencies of classical hydrodynamics and parameter modeling in the ANSYS complex. It has been established that to obtain a high-quality milk emulsion, the shape of the inner surface at the zone of highest speed should have a conical profile. The simulation results show that to ensure the hydrodynamic conditions necessary for the disruption of fat globules, lower operating pressure values should be set, and the diameter of the zone of highest speed should be less than 4 mm. The results of experimental studies carried out on the developed laboratory equipment indicate a slight influence on the dispersion of the diameter of the confusor in the range of 2-4 mm. At the same time, the speed of supplying skimmed milk should be within 30-110 m/s. The data obtained during experimental studies correlate well with the results of modeling. It is possible to ensure high dispersion while simultaneously reducing the energy costs of dispersing at a feed speed of skim milk of 60 – 90 m/s. The experimental homogenizer meets the requirements of modern milk processing technology, as it provides high dispersion of the product at the level of valve machines.

Substantiation of the Spring-Cam Retarder Brake Design and its Main Parameters Determination

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The paper discusses how to improve the efficiency and reliability of cranes, with a focus on the braking system and braking devices. Critical requirements for braking devices are emphasized, such as high reliability, stability of action, provision of sufficient braking torque and smooth braking. Special attention is paid to the dynamic loads occurring during braking with classical friction brakes, and a design scheme of a spring-cam retarder is proposed, which ensures safety and efficiency of operation. The new spring cam brake retarder is characterized by a simple and compact design, which provides smooth braking, and the application of the principle of multithreading can increase the braking torque. The proposed retarder uses a cam mechanism, which provides smooth braking by gradually increasing the force acting on the friction pads. The dependencies for determining the braking torque of the spring cam retarder are given. The study confirms that the proposed design can effectively minimize dynamic loads, which significantly improves the safety, durability and overall performance of cranes. Thus, a new solution for crane braking systems is proposed, which combines simplicity of construction and high efficiency, which makes it promising for further application and development in this field.

Application of Modified Kinematic Graphs to Analyze the Structures of Passive Relaxation Shock Absorbers

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Increasing requirements for reducing the negative manifestations of vibrations in technical systems have created a fairly large number of different designs of passive relaxation shock absorbers with expanded functionality. The expansion of these devices' functionality results from the introduction of mechanical and non-mechanical elements into their structures for controlling damping characteristics. Considering the approach to implementing the target damping characteristic common to all such devices, it should be noted that they all have some structural similarities and, at the same time, have specific differences in their structure. Identifying existing differences is an urgent task when determining specific priorities. The paper presents the research results on the analysis of the structures of existing types of passive relaxation shock absorbers made using modified kinematic graphs, making it possible to identify and classify the existing structural differences of such devices. When analyzing the structures of these mechanisms based on graph models, it is shown that comparison criteria are identified in the form of the number and integrity of cycles of the corresponding graph. Using the elimination method, the degree of a graph vertex is alternately reduced in graph models, and certain vertices are excluded. With parallel control of the integrity of cycles, the accuracy of the analysis results of the structures under consideration can significantly increase. The proposed structure analysis approach can be proposed for other passive mechanisms with expanded functionality.

Part II
Manufacturing Technology

The Influence of the Dynamics of Multi-Spindle Finishing Boring Machines on Processing Accuracy

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The work studied the influence of dynamic interactions during multi-spindle machining on the accuracy of finishing fine boring. The static and harmonic influence coefficients were experimentally determined during the transmission of disturbances between two spindle heads. The harmonic influence coefficient at the natural frequency of the spindle mainly determines the waviness of the cross-section of the borehole. Deviations from roundness and roughness of the surfaces of boring holes were determined during the operation of one, two, and three spindle heads of the first and third standard sizes. When boring with two spindle heads, the mutual influence of the spindles was also studied for two rotation drive schemes. Workpieces made of steel C45 (EN), gray cast iron EN-GJL-150 (EN), and AlSi7Mg were bored. The boring bars were equipped with carbide cutters and CBN cutters. Cutting conditions v=180-360 m/min, s=0.06 mm/rev, t=0.35 mm. The spindle heads of the first standard size had approximately the same stiffness diagrams; the head of the third standard size had lower radial rigidity and a different orientation of the compliance ellipse. From the oscillograms of free-damped oscillations, the natural frequencies of oscillations of the spindle-boring bar system and the machine bridge, with spindle heads installed on it, were also determined. The boring quality was studied when working with one spindle head and then when boring with two spindle heads. The boring quality was also studied when working with different hard heads of the same and different standard sizes.

A Combined Approach for Determining Tool Cutting Part States Using Machine Learning Models

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Every year, new requirements are imposed on modern industrial production, which relate to improving technological processes and product quality. A special place in new developments is occupied by research devoted to increasing the performance and durability of the cutting part of tools in automated production conditions. The authors have developed a new approach to improving the recognition quality of cutting part tool states with machine learning models. The article aims to create a new combined approach to improve the recognition quality of tool states with the machine learning models used. The scientific novelty consists of developing a segmentation method for automating the cutting part of tools segmentation that considers different features of cutting part tools with the machine learning models used. Practical usefulness consists in improving the quality of recognition of cutting part tool states with the machine learning models used. The vector-difference approach is used in the work to determine textural features. This approach makes it possible to obtain a specific texture feature - as a vector transformation of the features of different textures- based on vector algebra.

Increasing the Accuracy of Part Obtained by Selective Laser Sintering by Shrinkage Compensation

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Additive manufacturing via selective laser sintering (SLS) makes it possible to create parts by fusing successive layers of powdered material, forming surfaces with significant dimensional inaccuracies and shape deviations. To improve the accuracy of products made using SLS, the objectives were to identify the primary components of the shape formation error that arises during the layered building and to describe the influence of the main factors on them analytically. A structural mathematical model has been developed to describe the formation of part dimensions obtained by layered building. Compensation for the relative dimensional error of products caused by shrinkage is done by applying a technological transformation (non-proportional scaling along the *X*, *Y*, *and Z axes,* considering the specified functions) of the triangulated 3D model at the stage preceding materialization. As a result of the analysis of the structural model of part dimension formation, a parametric model has been developed that considers the product's dimensional states, the transition between which is influenced by the primary shape formation errors and parameters of technological preparation of triangulated models. The sufficiently high adequacy of the obtained model for the Vanguard HS Si2 system has been experimentally confirmed. As a result, it was possible to improve shape formation accuracy by applying preliminary technological transformation.

A Simulation Study of DDMRP and MRP Manufacturing Planning and Control Systems

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Demand Diven Material Requirements Planning (DDMRP) is a manufacturing planning and control system for fast response to customer requirements in varying and volatile demand and supply markets. DDMRP is an extension of the Material Requirements Planning (MRP) approach that explores the principles of Lean and Theory of Constraints production philosophies to reduce manufacturing response time and make good use of manufacturing resources. It achieves this by promoting flow through selective, reduced, and continuously adjusted inventory levels to synchronize manufacturing and supply with customer market demand. Only a few studies compared the performance of both approaches. However, these studies have not fully addressed the relationship between inventory and service levels. Therefore, this research contributes to a better understanding of this relationship by evaluating and comparing the performance of these two approaches in a multi-product, multi-stage production system. The results of a discrete-event simulation study show that DDMRP outperforms MRP regarding the work-in-process and finished-goods-inventory levels required to achieve a given service level.

Analysis of the Surface Layer of Aluminium Alloy Castings at their Machining by the Surface Homogeneity Criterion

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The regulated quality parameters of the products are ensured by different technologies. In particular, sustainable manufacturing provides important requirements and main tasks for Industry 4.0/5.0. The priority directions to improve the sustainability of product manufacturing are associated with the simulation of machining processes by cutting, complex assurance of the technological system at parts machining, and the development of practical techniques for reliable measurement of the technological parameters of products. In the paper, a developed technique is implemented to estimate the surface layer of aluminum castings after step-by-step machining using rough and finish milling using the LM-hardness method. The degree of the degradation of the surface material of the workpieces is analyzed comprehensively using indicators of the criterion of surface homogeneity: coefficient of variation ν; Weibull homogeneity coefficient (m), and indicators related to it: material constant A_m, technological damageability D, and the intensity of increasing of the technological damageability j_D. It is established that step-by-step machining of workpieces by rough and finishing milling does not change the structurally homogeneous state of the material of the blanks. An increase in power loads at rough milling with manual feed of the working table of the metal-cutting machine creates a gradient structure in the workpieces. It increases the susceptibility to damage of the surface layers of workpiece material. Reduction of power characteristics at finish milling with automatic feed of the working table of the metal-cutting machine reduces the number of structural stress concentrators that ensure regulated parameters of products. Further investigations in that research direction are offered.

Strain in ANSYS Simulation and Real Testing

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The correct choice of modes of technical operation of vehicles is based on considering the patterns of changes in the stress state of their structural elements. The paper develops and implements a method for assessing one of the stress state parameters, namely strain. To measure it, NI LabVIEW hardware and software were used. A methodology has been developed for studying the stress state in two main directions: on an experimental rig when measuring the actual stress state of a cantilever beam with strain gauges during its bending and during ANSYS simulating of the specified object. The optimal interaction between the ANSYS and SolidWorks simulating programs was found, which consists of preliminary modeling in Solid-Works and subsequent study of the model in the ANSYS program. The bending strain measurement results were compared with the corresponding ANSYS simulating results. It was found that the discrepancy between the measurement and simulating results does not exceed 12.7 % with a point load up to 49.05 N. The influence of finite element analysis (FEA) mesh type and size on the simulation accuracy was investigated. The tetrahedral mesh was justified though there are five other mesh types. It is shown that despite the lower initial accuracy of the correspondence between the measured and calculated strain values, the tetrahedral mesh allows adjusting the mesh size depending on the required accuracy of the calculated strain determination.

The Use of Plasma Coatings to Increase the Reliability of Equipment at Agribusiness Enterprises

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The wear and corrosion patterns of parts in technological environments of food production result from the influence of random factors. These factors include environmental conditions, load, speed, other external influences, and material characteristics such as hardness and yield strength. As these parameters are random variables, predicting the reliability of machines and equipment should be based on assessing the probability of failure-free operation and service life. The use of plasma coatings in friction units of food equipment operating without lubrication and in acidic environments was examined. The study investigated the impact of aggressive corrosive-active environments on the wear resistance of coatings, which could potentially be used to protect equipment parts in the meat and fish processing industry. The research demonstrated the possibility of controlling the process of corrosion-mechanical wear of equipment parts by polarizing the friction zone. Test results confirmed that the process of corrosion-mechanical wear of eutectic coatings can be managed by adjusting the potential of the friction zone with an external current source. Additionally, the electrochemical characteristics of the coatings in aqueous environments were identified, explaining the process of corrosion-mechanical wear. The level of protection offered by the investigated coatings under simultaneous mechanical loads and working environments was evaluated.

Vacuum Technology for Magnesium Alloys During Die Casting of Radiators

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The article considers a new technology of magnesium alloy vacuumization during high-pressure casting. For its creation, the technology of casting magnesium radiators in machines with hot chamber high-pressure pressing was taken as a basic one. Magnesium alloys have high characteristics, one of the main ones being their high thermal conductivity, making them ideal for creating efficient radiators compared to traditional aluminum radiators. However, magnesium's problems, especially its low corrosion resistance, prevent it from being used for such castings. Therefore, improvements in vacuum technology allow the AZ91D magnesium alloy radiator to solve the problems with its corrosion resistance and achieve higher performance than the basic version. Its uniqueness lies in the use of labyrinth air suction from the mold. This solution prevents magnesium from evaporating during vacuuming. Experimental studies demonstrate the high efficiency of the proposed technology, opening new perspectives for mass production. It should also be noted that this vacuumization technology is used as one of the stages of a larger-scale technology of pulsed supply of shielding gases. The combination of these systems allowed to achieve new successes in casting magnesium alloys.

Reliability Prediction for Robotic Machines with Parallel Kinematics

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The article discusses the current problem of ensuring the reliability of technical systems, which is one of the important indicators of quality and competitiveness. The purpose of this article is to consider the problem of predicting the reliability of robotic machines with a parallel structure (parallel kinematics) at the initial stages of design. An important parametric characteristic of robotic machines is the positioning accuracy of the working element, its stability and the preservation of values within specified limits over time. A methodology for predicting the parametric reliability of a robotic machine, which is designed according to a hexapod (Stewart platform) with electro-hydraulic control, is considered. The method of independent expert assessment or the method of rank correlation, which is based on statistical and heuristic processing of expert opinions, was used. Experts assigned each factor a corresponding rank, depending on the degree of its influence on the parametric reliability of the robotic machine. The arithmetic mean weight, the average relative weight, the standard deviation of the factors and the coefficient of variation were calculated. Conclusions about the consistency of expert opinions are formulated based on the general set of characteristics and factors using the concordance coefficient (Kendall criterion). The considered methodology can be used to predict and assess the reliability of all types of robotic machines.

Study of the Roughness of A36 Steel with TiAlN Coated Inserts

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This research aims to conduct an experimental design using the Taguchi Robust Design, in which the specimens resulting from CNC lathe machining are subjected to roughness testing. An experiment was carried out using the Taguchi technique and an orthogonal matrix L27, where the parameters were analyzed: cutting speed, feed speed, depth of cut at three different levels, and their influence on surface roughness. The objective was to assess the roughness surface using TiAlN-coated inserts by considering the interactions among the cutting parameters for machining steel A36. The results will be analyzed by calculating the averages of the respective interactions in the Taguchi design using Minitab 21 statistical software. The feed rate factor was the most significant among the results obtained, with a p-value of less than 0.05, indicating its importance in processing. Additionally, it was concluded that the TiALN-coated insert exhibits good workability and durability when obtaining samples of this type. Moreover, the analysis focused on determining the best machining parameters.

Part III
Machining Processes

Modeling the Dynamics of Centerless Mortise Grinding on Rigid Supports

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The paper examines the influence of the dynamic parameters of the machine and the geometry of the adjustment of rigid supports on the formation of undulations of the surfaces of roller bearing rings. A complex mathematical model of the machine tool system for centerless mortise grinding was developed, and the influence of the dynamic parameters of the machine tool and the geometry of the setup of rigid supports on the formation of undulations of the processed surfaces was analyzed. The SWaAGL-50 mortise centerless grinding machine's technological system is presented as a linear mechanical model, and the elastic movements along the OX axis are considered. Based on the equations of kinetic and potential energies compiled in the form of Lagrange, the equations of motion of the relevant elements of the technological system were obtained. The formula of the dynamic accuracy function was found, which characterizes the inconsistency of the movement of the grinding wheel and the part.

Increasing The Continuous Operation Time of the Diamond Cutting Disk When Using Various Cooling Media

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When processing natural and artificial building materials, it is important to obtain precise cuts and perfect edges (especially when processing ceramic products). A diamond-cutting disc on a metal base can do this job. During high-speed cutting and grinding, a large amount of heat is generated, and the disc heats up to 650 0C and higher. At such temperatures, graphitization of diamond grains occurs, and, as a natural result, cutting stops. In addition, the diamond blade becomes deformed, causing it to jam in the workpiece. Cooling of the cutting disc can be partially accomplished by blowing a boundary layer of air. However, this is ineffective in significantly reducing the wheel's temperature and increasing the time of continuous operation of the cutting disc. Reducing the temperature of the cutting disc is possible by replacing the air boundary layer with another type of cooling medium. The possibility of replacing the air boundary layer with another type of cooling medium using a Ranque-Hilsch tube was investigated. This allows you to extend operating time by 15%. Cooling the cutting disk with a finely atomized cooling medium (mist) using an ejector tube allows you to create a "new" boundary layer and reduce the disk's temperature by 25%. These measures allow you to continuously increase the time required to operate the disk.

Development of a Simulator Program for Studying the Effect of Cutting Modes on Cutting Temperature

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The article presents a developed simulator program, created in the Scilab software environment, for the automated calculation of the cutting temperature, the basis of which was the natural thermocouple method. The proposed model for calculating the cutting temperature for different materials and process conditions considers the influence of the physical basis of the cutting processes of material processing. An algorithm for calculating this value was developed to obtain a graph of the temperature change during the cutting process depending on the processing modes, the diameter of the part and the "processing material – tool material" pair. The change in the position of the current point on the graph relative to the theoretical value of the cutting temperature, due to the influence of physical processes, is realized by the introduction of random fluctuations superimposed on the surface profile, which are produced by a random number generator according to the law of normal probability distribution. The method of processing the array of coordinates of profile points to obtain the measured value of the cutting temperature was described. The program has implemented the possibility of constructing three-dimensional and two-dimensional graphs of the dependence of the cutting temperature on the cutting and feed speeds, which can be used to study the effect of processing modes on the cutting temperature depending on the combination of "processing material – tool material".

CoCoSo Method-Based Evaluation of Cutting Parameters in Turning of AISI 1040 Steel under Plain and Nano MoS_2 Reinforced Cutting Fluid Assisted MQL Methods

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The variation in the machining performance of different types of nanoparticles and cutting fluids on various materials requires investigation. In this study, machining performance was evaluated in terms of resultant force, cutting temperature, surface roughness, and material removal rate using three different cutting speeds and three different feed values under vegetable cutting oil minimum quantity lubrication (MQL) and nano MoS_2-added vegetable cutting oil MQL (N-MQL) in turning AISI 1040 steel. Afterward, the appropriate process parameters were sorted and selected, and the combined compromise solution (CoCoSo) method was applied. Resultant force, cutting temperature, and surface roughness are all improved by 54.2%, 28.2%, and 72.1%, respectively, when employing N-MQL rather than MQL cutting environments. When the resultant force, cutting temperature, surface roughness, and material removal rate are weighted equally, the most suitable cutting parameters are determined as 160 m/min cutting speed and 0.08 mm/rev feed value, and the best cutting environment is N-MQL.

Modeling and Optimization of the Process of Drilling Holes in Carbon Fiber Reinforced Polymer Parts

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The article deals with modeling the quality parameters of holes while drilling carbon fiber-reinforced polymer parts. It is noted that the mechanical processing of polymer composite materials is the most challenging operation due to the anisotropic properties of the material, the heterogeneous structure, and the abrasive nature of the fibers. It was established that the determining factors of the quality of the surface layer of the composite are delamination and roughness of the treated surface, for the determination of which mathematical dependences on drilling modes and drill parameters were researched in the work. A mathematical model of the drilling process of parts from carbon fiber-reinforced polymer is provided. The optimality criterion is the maximum productivity of processing holes with restrictions on their quality parameters. The proposed model allows you to determine the optimal drilling modes for the given parameters of the processed material and processing conditions. The practical implementation of solving the problem of optimizing carbon fiber reinforced polymer drilling modes, which ensures obtaining the necessary quality parameters – hole delamination and surface roughness, has been carried out.

A Method for Determining the Forces and Coefficient of Friction on the Back Surface of Cutting Tools and Their Dependence on Processing Conditions

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The paper considers the problem of determining the forces and friction coefficient on the back surface of the cutting tool, the variable nature of which at each point of contact does not allow it to be used for modeling processes in the cutting zone. The paper offers an experimental express method that allows you to determine the cutting force and friction coefficient behind the cutting tools' back surfaces. The equipment, the installation, and its main requirements are described to ensure the practical implementation of the proposed method of determining the forces and coefficient of friction. It is shown that the proposed method correlates well with other previously known methods. The dependences of the change of the coefficient of friction on the back surface of the cutting tool with coatings and without coatings were obtained. The effect of the lubricating and cooling liquid on the change in the coefficient of friction on the rear surface was investigated.

Analytical Determination of Height Parameters of Surface Roughness During Abrasive Processing and Conditions for Their Reduction

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The work aims to establish new generalized theoretical solutions and develop practical recommendations for the technological provision of roughness parameters of machined surfaces under grinding conditions, traditionally achieved in labor-intensive processing operations with free abrasive. A mathematical model has been developed to determine the parameters of surface roughness during abrasive processing Ra, Rmax and the ratio Ramax. Calculations have established that with an increase in the number of abrasive grains involved in the formation of the roughness of the treated surface, the parameters Ra, Rmax decrease and Ramax increases. It has been shown that during grinding Ramax takes values of 4...8, during abrasive polishing - more than 30. Such large values of the Ramax ratio during abrasive polishing is due to a significant increase in the number of working grains and the excess of the cut width over the cut thickness, transition - home from micro-cutting to the processes of friction and plastic deformation of the processed material. It has been shown that it is possible to significantly reduce the height parameters of surface roughness during grinding (to the level achieved when processing with a free abrasive) and simultaneously increase processing productivity by using a diamond wheel with grains having flat tops. This is consistent with experimental data and makes it possible to combine preliminary and final grinding in one operation, eliminating labor-intensive machining operations with free abrasive.

Modeling of the Process of Single-Pass Multi-Point Turning of the NC12 Tapered Thread

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Limited freshwater resources require a very careful attitude. This especially applies to their underground mining, carried out by constructing special wells. To a large extent, resource-saving in artesian drilling is achieved by increasing the accuracy of threaded connectors for drill pipes. The technology of manufacturing such threads is mainly carried out using turning operations. However, it would be more effective to use multi-point cutters rather than simple tools. The drill-string tapered thread model is obtained as a result of finishing one pass using four-thread comb turning. The study of the possibility of their application from the point of view of technological possibilities and especially the accuracy of the obtained thread is the object of research. The resulting calculated value of the longitudinal deviation does not exceed 0.012 mm, which is 10% of the tolerance. The conducted studies show the complete possibility of using turning multi-point cutting-tool for the manufacture of tool-joint threads, starting from their smallest nomenclature size.

Experimental Verification of the Impact of Phase Shift Between Neighboring Waves on the Intensity of Regenerative Oscillations During Continuous Cutting

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This study presents experimental findings regarding the influence of phase shift between adjoining waves on the cutting surface and its impact on the intensity of regenerative self-oscillations during continuous cutting without the influence of coordinate coupling. The study was conducted using an original design of a cutter-oscillator with one degree of freedom. The importance of the obtained results lies in the possibility of verifying the fundamental principles of regenerative oscillation theory, presented by developers in the past century, which could not previously be confirmed due to limitations in experimental capabilities. The study revealed the absence of a connection between the magnitude of the remainder from the whole wave and the phase shift of adjoining waves, as well as the absence of influence of these parameters on the intensity of regenerative self-oscillations. These results contradict previously accepted notions and indicate the need to refine theoretical models. However, a significant correlation was found between the frequency of regenerative self-oscillations and the phase shift of adjoining waves. This suggests that vibration during continuous cutting is a self-organizing process. It is noted that the obtained results pertain only to continuous cutting conditions, and further research is planned to expand the investigation to intermittent conditions, such as turning with longitudinal grooves or protrusions, for a more comprehensive understanding of the influence of cutting parameters on oscillation processes. The results of the experimental verification are valuable for optimizing cutting processes to enhance efficiency and processing quality. The article aims to experimentally verify two fundamentally important statements formulated by the developers of the theory of regenerative oscillations for continuous cutting.

Experimental Research on Regenerative Self-Oscillations During Turning

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The paper discusses the results of experimental investigations into regenerative self-oscillations during longitudinal turning using the original design of a cutter-oscillator. This design allows the measurement of oscillations exclusively along the axis of force F_x, coinciding with the direction of the cut thickness variation during cutting along the vibration trace on the cutting surface. In this case, one of the primary sources of self-oscillations - coordinate coupling - is eliminated. It has been established that three-speed zones can be distinguished during longitudinal turning. In the first zone, characterized by low cutting speeds, growth formation is observed. In the second zone, as cutting speeds increase, regenerative self-oscillations are excited up to their maximum level, followed by a subsequent decrease. In the third zone of high speeds, degeneration of regenerative self-oscillations and the realization of vibration-free cutting conditions are observed. Various characteristics were determined during the experiments, including the static deflection of the cutter-oscillator from the position of initial equilibrium, amplitude, and frequency of self-oscillations, the phase shift of waves of neighboring revolutions, length of one wave, and the number of waves on the cutting surface. The research results indicate that the developers of the theory of regenerative self-oscillations and stability lobe diagrams did not consider the influence of a basic mechanism of chip formation, specifically the process of shifting the chip element under an angle. This omission necessitates additional experimental studies to refine the recommended stability lobe diagrams. This article aims to formulate and experimentally verify the general principal differences between dynamic cutting conditions and static ones and, based on this knowledge, investigate ways of increasing the resistance to vibration excitation for each type of machining.

Part IV
Advanced Materials

Calculation of the Electrical Resistance of a Cone Microelectrode for Electrochemical Studies of Coatings

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Methods of protecting metals from corrosion and wear are considered. The focus is on protective coatings and electrochemical research. The relevance of using microelectrochemical studies for studying corrosion processes and determining the electrical resistance of microelectrodes is highlighted. The goal is an analytical study of the electrical resistance of microelectrodes of various shapes. The problem of electrical resistance of a microelectrode in the form of an obliquely truncated cone is considered. Numerical integration methods are used for calculations. An analytical expression for the total electrical resistance of such an electrode is found in the form of the sum of a fractional rational function and two integrals. Both the function and the integrals depend on the following parameters: the radius of the smaller base of the cone, its height, the angle of inclination of the cutting plane to the smaller base of the cone, and the angle between the cone's face and the vertical axis. The problem of minimizing such sums of integrals for the angle of inclination of the cutting plane at specific values of the other parameters is investigated. Two of these integrals turned out to be non-conforming integrals of the second kind, which are not taken in finite squares. The results of calculating the electrical resistance of microelectrodes of different designs are presented. The calculations revealed a sharp decrease in resistance if the cone is truncated with a slanting plane.

RF Magnetron Sputtering of Biocompatible Coatings

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The work is devoted to obtaining calcium-phosphate (Ca/P) coatings based on hydroxyapatite using the RF magnetron sputtering method and conducting SEM, TEM, and X-ray structural analysis. It was established that the power of the RF discharge, the bias voltage on the substrate, the working gas atmosphere, and the sputtering time determine the Ca/P ratio in the coating and its structure. Controlling the basic parameters of sputtering, changing the coating structure from amorphous to crystalline components, and improving the ratio of the main elements are possible. The morphology of the formed coatings was studied, and the average grain size was measured. For all types of coatings, rectilinear and curvilinear crystal boundaries were found, which correspond to arbitrary orientations of neighboring blocks. A common feature was the formation of a nano-sized subgranular structure within each columnar crystallite with extinction contours, demonstrating the coating material's highly stressed state. Calcium-phosphate coatings on oxidized and non-oxidized samples of stainless steel and titanium obtained by RF magnetron sputtering of hydroxyapatite targets in various gas environments were characterized by high nanohardness (8.4−11.9 GPa) and elastic recovery (41−52 %), which is a favorable factor for implants working under load.

Composite Powder Materials and Coatings with Self-Sharpening Effect for Strengthening, Restoring, and Manufacturing Parts and Working Bodies of Agricultural Machinery

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Restoration and hardening worn parts are paramount for agricultural and general engineering, which helps increase their efficiency and reliability during subsequent maintenance. Various methods are used to restore the worn layer, such as spraying, surfacing, or thermal coating, to extend the service life of the part and the machine as a whole. Composite materials are multicomponent hetero-phase materials consisting of a polymer, metal, ceramic, or another base (matrix) reinforced with fillers made of fibers, filamentous crystals, and finely dispersed particles. The matrix gives the desired shape to the part, influences the formation of the properties of the composite material, and protects the reinforced phase from mechanical damage and other environmental influences. The parametric characteristics of technological processes and the specificity of agricultural machinery designs are determined by the laws of interdependence between the aggregates of the effects of the functional surfaces of the working bodies of these machines and the reactions to these effects of the abrasive environment during technical operation. Adding chromium, silicon, and titanium as alloying elements or chromium carbide, silicon carbide, and titanium carbide as a strengthening element to the restoration layer can significantly increase the wear resistance and durability of the product. Wear-resistant impurities are introduced into the composition of powder composite materials to increase the reliability and durability of parts and assemblies of agricultural machinery. The analysis results of the structure and properties of a composite material with a self-sharpening effect are presented.

Physical and Chemical Processes in the Surface Layers of Metal Materials in Contact with an Oxidizing Environment

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The processes of formation and destruction of oxide films are often used as a basis for building models of the wear process. The work investigates the mechanism of wear, which consists of the formation and destruction of Fe_2O_3 films (moderate temperatures) or Fe_3O_4 films (elevated temperatures). The surface layers of the materials were studied by EOS and SEM methods on an Auger spectral microprobe JEOL JAMP – 10S under the following conditions: primary electron energy 5 keV, modulation amplitude 2-4 V, angle between the primary beam and the surface plane 90º, Auger electron registration angle 45º. The research results proved that in terms of mechanical properties and strength of adhesion to the base, oxidation films formed directly by friction (secondary structures) differ significantly from films formed thermally. A comparative analysis of the obtained data of the structures of the surface layer allows us to state that the contact of metallic materials with an oxidizing medium has a discrete nature of contact, as a result of which local stresses significantly exceed mechanical ones. It has been proven that the wear process in the oxidation mode does not lead to the formation of a fragmented surface layer of significant thickness, and the formation of a corresponding relief in a limited area indicates that the friction process at an arbitrary moment in time is accompanied by a deformation that does not cover the entire friction surface.

Formation of Coatings on Titanium Alloys Saturated with Biocomponents by the PEO Method

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In the work, the influence of the composition of the electrolyte on the electrophysical parameters of the synthesis of coatings with increased biocompatible properties was studied. It was established that under conditions of increased electrolyte concentration, the voltage at which the coating is synthesized decreases. This effect can be explained by the thermodynamic Gibbs conditions. According to these conditions, the system needs more energy when the medium contains more elements, which must consume a certain amount of energy. The authors found that sodium salts increase the conductivity of the working environment. This effect affects the speed of the synthesis process and can reduce the cost of the energy reserve of the system as a whole. Spectral analysis established that during the synthesis of a titanium alloy in an alkaline electrolyte, an equilibrium non-degenerate quasi-ideal plasma is realized in the discharge channel with a temperature of $(1...1.1)\cdot10^4$ K and an electron density of $(3.2...3.4)\cdot10^{22}$ m^{-3}. Under these conditions, molecules dissociate into ions and interact with the electrolyte's components, leading to oxidation of the surface of valve metals and the formation of stable compounds with high biocompatible properties.

Strengthening of Aerospace Inconel 718 Alloy Fabricated by LPBF: Hardening Mechanisms Induced by HIP, Heat Treatments and Surface Peening Treatment

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The laser powder bed fusion (LPBF) 3D printing technology opens up new opportunities for additive manufacturing of heat-resistance superalloys. At the same time, the LPBF method needs to be improved for critical applications. In addition, post-processing techniques for the LPBF-built Inconel alloys should be developed and integrated. This work focuses on observing the structural and strengthening mechanisms in the LPBF-produced Inconel 718 alloy subjected to thermomechanical post-processing. Various heat treatments combined with a hot isostatic pressing (HIP) were applied to provide the required grain-size microstructure and phase state, increasing the hardness and material density. Furthermore, the surface layers of the heat-treated samples were finished and hardened by an ultrasonic impact treatment (UIT) to form the grain-size nanostructure and compressive residual macro-stresses in the near-surface layers. The yield strength, hardening intensity, and local plasticity magnitudes were theoretically evaluated for the LPBF-printed and thermomechanically post-processed Inconel 718 superalloy, considering the microhardness and structure/phase/chemical composition using transmission electron microscopy (TEM), scanning electron microscopy (SEM), and X-ray diffraction (XRD) analysis. The outcome of this study shows the formation of a pore-free microstructure with a more homogeneous distribution of Nb in solid solution, γ'' precipitation, and MC carbides after HIP combined with heat treatments, increasing the hardening intensity by 35–38%. UIT severe plastic deformation increased the subsurface hardening intensity by 58–68% of the heat-treated 718 alloy samples due to the grain refinement and increase in dislocation density.

Analysis of the Casting Methods Influence on the Microstructure of High-Speed Steel

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The study focused on analyzing the influence of casting methods on the microstructure of high-speed steel castings. The research revealed significant differences in the microstructural characteristics of steel twist drills manufactured through various casting techniques. The results demonstrated that the casting method significantly affects the distribution and arrangement of carbides within the microstructure. Specifically, the analysis showed that castings produced by different methods exhibited distinct carbide mesh structures, with carbide size, distribution, and alignment variations. These findings highlight the importance of selecting the appropriate casting method to optimize the microstructural properties of high-speed steel castings for enhanced cutting tool performance. The article describes a specialized software package developed by the authors for processing and analyzing digital images of microstructures. Visual and quantitative results of the study of microstructures of twist drills obtained by various casting methods are presented. The influence of the technology of casting into a water-cooled chill mold and investment casting on the formation of the microstructure and properties of high-speed steel castings is shown. The main technological parameters for casting drill blanks into water-cooled chill molds have been identified.

Architecture of Online Laboratory for Modeling and Studying the Properties of Structurally Heterogeneous Materials

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Structurally heterogeneous materials, both inorganic and organic, are widely used. The development of new materials represents a significant interest in engineering. Simulation-based, computer-aided modeling has proved to be time and cost-saving and has already been used in modeling and studying the properties of different classes of materials. This paper proposes the online laboratory's architecture for modeling and studying the properties of structurally heterogeneous materials. The SDLC methodology designs system modules, Use-Cases and UI/UX framework. As the outcome, the deployment diagram is proposed with a separate Web user interface, backend simulation engine, and persistent data storage. Such web applications could help researchers and students perform simulation experiments using state-of-the-art Monte Carlo methods with the support of classical and quantum computer hardware. As we begin to reach the limits of classical computing methods, quantum computing algorithms could broaden the reach of simulation modeling. The schematics of random number generation according to the normal distribution law using an IBM quantum computer is described as one of the possible improvements to classical Monte Carlo.

Investigation of Zhs3dk-VI Alloy as a Material of Gas Turbine Engines Cast Blades

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The material quality of the fan turbine third stage rotor blades, cast from heat-resistant nickel alloy ZhS3DK-VI according to serial equiaxial crystallization technology, has been studied. It was established that the material of the experimental blades and samples, in parameters of chemical composition, macro- and microstructure, mechanical and heat-resistant properties, complies with OST 1 90126-85 requirements. The dimensions of the structural components and the distance between the second-order axes of dendrites in the feather blade are approximately ~1.5 times smaller than in the tail section. According to the results of bending tests, it was established that the blades' angle of bending, measured after unloading, is from 105 to 110°. No cracks were found in the bend zone. Studies of the original ZhS3DK-VI alloy's structural stability, carried out using well-known calculation and analytical techniques, indicate its sufficient balance in terms of the alloying elements complex and, consequently, its wide suitability for further modification in various ways.

Ensuring Heat Resistance of Aviation Materials Through the Use of Protective Coatings Based on ZrO_2

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The issue of improving the performance of aircraft is constantly attracting the attention of researchers, and research teams and large scientific institutions are working on their solutions. This is an urgent problem of our time. This scientific article discusses possible ways to solve this scientific and applied problem by improving the performance of aircraft engine parts by applying heat-resistant protective coatings. Such coatings are proposed to be used based on ZrO2 with an appropriate amount of Ni (in this study, 10 and 30 % Ni were added to the base coating to stabilize and improve plasticity, respectively) and CaO. The coatings were applied to the base material by plasma sputtering on the working surfaces of the parts. These so-called plasma zirconium coatings can be applied to parts of various shapes and materials. As part of our study, these coatings were applied to 100Cr6 steel and tested for heat resistance, preventing working surface oxidation and scale formation (scale resistance). The tests were carried out at 1000 ^{o}C, 1100 ^{o}C, and 1200 ^{o}C. The scientific results obtained will facilitate the selection of heat-resistant materials for the relevant parts using the import substitution principle, if necessary. They will allow controlling the gaps of joined parts within acceptable limits, knowing the changes in size and weight due to the formation of oxides.

Part V
Mechanical Engineering

Dynamics Analysis of Elevator Winches with Thyristor Control System

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An analysis of the features of the dynamic operating modes of a "traditional" elevator winch with a worm gearbox, a two-speed asynchronous motor, and a thyristor control system has been carried out. When operating a traditional geared elevator hoisting mechanism with a non-adjustable control system, the car acceleration values are 30–150% higher than the normalized values in the initial phases of starting and braking the lifting mechanism motor. When using an adjustable thyristor control system, the maximum acceleration values of a passenger elevator car in the start-up mode are 70–100% less than the maximum permissible values over the entire load range. Limiting not only the maximum acceleration value but also the jerk is possible. To do this, after turning on the winch motor, its torque must change according to an exponential law. The patterns for forming control actions to obtain standardized modes of a passenger elevator are universal for all elevator winches of "traditional design" with a worm gearbox, a two-speed asynchronous motor, and a thyristor control system.

Qualitative States of Operating Fluid in the Chamber of the Auto-balancing Device

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The rotor is the most important component of the rotating equipment, and the vibration caused by the imbalance of its mass affects the operation of the machine. The article considers an effective balancing technology - rotor balancing using a liquid-type passive automatic balancing device (ABD). Such ABDs are designed as a chamber in the form of a rigid cylindrical ring or torus, partially filled with liquid. To achieve the effect of redistribution of the rotor masses, this technology uses the movement of the operating fluid in the chamber cavity in the direction opposite to the imbalance of the elastic-deformation rotor or the rotor on elastic supports, where there is a phase difference between the direction of the force from the imbalance and the deflection of the rotor or the movement of the rotor. The liquid auto balancer is a direct action regulator and does not require a power supply and the creation of control systems for moving the correcting fluid. The article presents the results of modeling the movement modes of the operating fluid in the ABD chamber; estimates of the angular speeds of rotation of the rotor system are substantiated. Model verification was performed on the experimental material, which was obtained with the help of unique stands with developed experimental samples of ABD and experimental installations that model rotors on elastic supports with a vertical and horizontal rotation axis and an axis inclined at an angle to the horizon line.

Method of Accelerated Tests of Axial Piston Pumps by Intensification of Fatigue Damage Accumulation Process

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The main element of the hydraulic system is the pump, the reliability of which largely determines the reliability parameters of the entire hydraulic system. To ensure a high level of pump quality, it is necessary to carry out tests at different stages of production: design and prototype development, construction modernization, and development of new pump models. Since most of the time is spent on testing, the urgent task is to reduce testing time and improve the quality of hydraulic equipment. This work aims to evaluate the factors determining pump longevity while ensuring the equivalence of accelerated and long-duration resource testing of pumps. The reduced wear of parts should be used to compare the technical condition of pumps subjected to accelerated and long-duration tests. The effect on the wear of the increase in the friction path per unit of time during accelerated tests must be considered. When comparing pumps that have undergone accelerated and long-duration tests, there will be some discrepancy in the parameters compared, the extent of which is used to conclude a positive or negative test result. A positive result of the conducted tests can be considered if none of the specific types of failure occurred during the testing process and if no fundamentally new defects are found during the examination of the developed pump. This methodology can guide accelerated tests of axial piston pumps: regulated and non-regulated with valve distribution at 320 bar, regulated pumps with end distribution at 200 bar, and regulated pumps with end distribution at 160 bar.

Simulation of the Shaft Surface Strengthening as a Result of Discrete Electro-Mechanical Processing

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The purpose of the research is electro-mechanical processing (EMP), which is based on the symbiosis of thermal and mechanical loads on the upper layer of the part during its surface strengthening. Powerful current flows through the contact point at low voltage, raising the temperature at the point of interaction to 600–900°C and more. The simulation was carried out in the Ansys Static Structural and Coupled Field with the original boundary conditions that are the subject of scientific novelty, together with the designed mathematical stress prediction algorithm. The suggested multifactor EMP model (load, temperature, experiment time, convection, etc.) is promising for developing optimal surface-strengthening technologies. Two cases of mechanical pressuring with the tribocontact of curved surfaces were considered: rolling a shaft at 22°C (surface plastic deformation – SPD) and modeling the contact spot body with the finite elements of 0.05 mm size under 900°C (EMP). In the 1st case, despite the slight difference in vertical rod movement (0.143 mm for 4000 N and 0.119 mm for 1000 N), which signals plastic deformations, the magnitude of max stress varies considerably: 521.79 vs 130.56 MPa. In the 2nd case, being 10 times less loaded (400 N) but heated up to 900 °C, the model has demonstrated twice the stress – 1082.9 MPa. The formation of the so-called "white" layer at a depth of about 0.2 mm was observed.

Development and Substantiation of Proposals for Modernization of Plate Rolling Mill

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The modernization options for the heavy plate rolling mill of one of the Italian metallurgical enterprises are considered the necessity to expand the assortment of new sizes of hot-rolled plates steel grades with high mechanical properties and, of course, to produce high-quality products with reduced operating costs. The target parameters for the product mix of the plate rolling mill after modernization are the thickness range of 5.0–150.0 mm for steel grades up to S900MC according to EN 10149-2. This work compares the technical parameters of an actual rolling mill and two modernization options: option 1 is a two-high rolling mill with increased working roll diameters; option 2 is a four-high rolling mill. Both options consider that the weight of work rolls and backup rolls with chocks will not exceed the existing crane load capacity of 80 t. When comparing option 1 and option 2, option 2 is preferable because it enables the production of low-thickness products of reference steel grade S900MC with fewer passes and assures more engineering strain. Option 2 for the rolling mill parameters provides more yearly capacity with lower electricity consumption. The efficiency of using a rolling mill with option 2 parameters is 37.8% higher than option 1 and 62.1% higher than the available rolling mill. As a result of the comparison calculation, it is obvious that a more efficient layout conception is one with four high rolling mill parameters of option 2.

Stress-Strain State During Deforming Broaching of Workpieces Made of Plastic Materials

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The study of the stress-strain state in the deformation zone of workpieces made of plastic materials machined through plastic deformation is presented. The stress-strain state of an axisymmetric workpiece made of plastic material was studied by modeling the process of deforming broaching. It is established that in the contact zone, the material of the workpiece is in a state corresponding to volumetric compression, and on the outer surface of the workpiece, the stress state corresponds to biaxial tension. It is shown that the intensity of deformation is maximum at the inner surface and minimum at the outer surface. It is shown that the deformed state in the deformation zone changes with increasing wall thickness. The ways of optimizing the workpiece shaping scheme have been established, consisting of the technological influence of broaching modes and tool geometry on the axial dimensions of the machined workpiece and allowing changes from shortening to lengthening. This fact can be used in the development of technology for the restoration of worn parts.

Stability of Arched Rod Structural Elements of Machines

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The academic contribution of the work is the development of a theory of the stress state of circular arched structures. Providing the necessary parameters for the strength and rigidity characteristics of parts of mechanical engineering structures leads to large ratios of axial moments of inertia and large overall dimensions of cross-sections. A mechanical engineering object must meet regulatory requirements for strength and rigidity, but there is still a danger of losing the stability of a flat bending shape. Having lost stability, the rod experiences two bends and torsion. Large lateral movements often lead to various accidents. Therefore, the problem of preventing such phenomena remains relevant. The paper presents a sequence of actions to solve the boundary value problem of the stability of a plane-bending form of mechanical engineering structures. A system of two differential stability equations for the indicated structural elements – circular arches – has been integrated. Fundamental orthonormal functions for differential stability equations for a circular rod are presented in two versions. It is proposed to solve stability problems using the boundary element method.

Method for Variation of Deformations and Stress Under Natural Vibrations

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A feature of testing complex products is that there are a lot of points for measurements - strain gauges. Multichannel strain gauges and an information-measuring system for strength tests are used for these purposes. This paper explores the method of penalty functions. In those problems where many local solutions are assumed, different versions of existing calculation methods can be used to find the scale minimum of the functional. The expediency of using such options is explained by the fact that the problem being solved is nonlinear. It has been established that if the objective function is continuous, and the allowed area of restrictions forms a closed set, then this will not be enough to determine the optimal parameters when designing machine parts. All parameter values of complex loaded parts, presented as constraints, are divided into sections and intervals. In this case, the interval corresponds to the corresponding segment. When considering a nonlinear system of constraints, the method of penalty functions should be applied. The paper proposes a method for finding the optimal parameters of complex components under load. The study proposes an option for determining the direction of the main axes of the so-called strain tensor, principal strains, and stresses by determining the strains in parts with complex loading.

Dynamics Of Nonlinear Vibration Isolator: Parametric Analysis

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The task of suppressing unwanted vibrations has been one of the most pressing tasks of modern technology for many decades. Increasing demands on the accuracy and efficiency of various mechanisms, instruments, and measuring devices pose new challenges to engineers and researchers. External periodic influence, even of very small amplitude, may cause the disruption of the normal functioning of the system, which leads to unnecessary wear or breakdown of equipment. Among various means of counteracting such vibrations, passive vibration isolation devices occupy an essential place. They have a relatively simple design, are not very expensive, and are somewhat effective in operation. However, a comprehensive study of the dynamics of these systems is not a simple task since the corresponding model is multi-parameter, and the use of numerical methods does not always provide all the answers desired. Therefore, an important part of developing such systems is the parametric analysis of the system's dynamics under study. The present paper considers the basic nonlinear model of a vibration isolator with one degree of freedom. Analytical relationships have been obtained that make it possible to optimize the parameters that determine the operation of the isolator in the vicinity of resonance. The proposed approach is demonstrated using the two examples of mechanical systems.

Design of a Helical Shredding Drum Blade and Determination of its Unfolding

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In forage harvesters, drum devices equipped with fixed blades are used to shred mowed plant mass. The length of the shredded particles is determined by the number of blades and the diameter of the drum. While flat blades are easy to manufacture, they can cause uneven loading when installed parallel to the drum axis. Angled or helical blades are more complex to manufacture but offer solutions to this issue. Using a sectional drum to arrange blades can help minimize impact loads. Additionally, helical knives, which are outlined along a helical line, offer a solution by providing a constant cutting angle and even loading. However, they are more complex to manufacture. This research focuses on designing a helical knife to optimize the shredding process based on specific geometric parameters. Parametric equations for the knife surface are formulated, and an approximate unfolding is constructed due to the non-developable nature of the surface. Calculations are based on given geometric parameters to optimize the shredding process. For the given parameters $\tau=20°$, $\phi=65°$, $R=0.25$ m, $L=0.72$ m, and $uo=0.1$ m, the flat blank of the knife will be a part of a ring, which is determined by the central angle $\psi=0.08$ rad and bounded by the arcs of circles $Ro=9.55$ m and $ro=9.45$ m.

Calculation and Study of the Stress State of the Antifriction Coating Applied to the Working Surface of the Car Cylinder Liner

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The research identifies the main stress state changes in the contact zone of an internal combustion engine's cylinder liner, whose working surface is coated with an antifriction layer. The research methodology involves developing analytical dependencies to determine stress tensors in the contact zone of the cylinder liner's working surface. Equations have been derived to calculate the stress state of a cylinder liner with an antifriction coating, which has elastic properties different from those of a cast-iron liner. The occurrence of stress concentration peaks at the contact boundaries between the "cylinder liner – piston ring" and the antifriction coating of the liner's working surface was established. Calculations of the liner surface's stress state, subjected to tangential friction stresses in the contact zone, were conducted to analyze the causes of these stress concentration peaks. This analysis revealed that contact friction forces lead to stress peaks at various boundaries of the contact areas. To enhance the durability of antifriction coatings, it is proposed to increase the length of the contact area and reduce friction forces between the rings and the liner, which can be achieved by selecting the appropriate antifriction coating material.

Stress and Strain State of Bar in the Space Between the Stands of a Continuous Shape Rolling Mill

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The article describes the results of a complex of experimental and theoretical studies of continuous section rolling in calibers of the "oval-circle" system. In the first part of the research, an inverse analysis was performed, which made it possible to choose contact conditions in the simulation of the section rolling process in QForm that corresponded to the real process. In the second part of complex studies, based on a comparison of calculated and practical results, the adequacy of QForm models of the rolling process with front tension is shown. An empirical formula has been obtained to calculate the coefficient of metal broadening when rolling round strips of oval caliber with front tension. Comparison of the results of calculations by the empirical formula and as a result of mathematical modeling in QForm with experimental data showed that in both cases, the error does not exceed the engineering accuracy of the calculations. The last part of the comprehensive study examines the influence of the deformation and speed conditions of rolling on the stressed state of the strip between the mill stands. It has been shown that during continuous rolling in stands with a group drive, the accuracy of setting the gaps between the rolls affects the dimensions of the finished profile to the same extent as the discrepancy in speeds when rolling in stands with an individual drive.

Corrosion, Electrochemical, and Cavitation-Erosion Properties of Titanium and Its Alloys

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The work aimed to study the patterns of cavitation-erosion destruction of steels and titanium alloys. Electrochemical measurements were carried out on an installation with a magnetostrictive vibrator using the technique of potentiostatic measurements. Polarization curves were recorded at a constant temperature of 296 K under static conditions and with the application of ultrasonic vibrations for steels and a group of titanium alloys. The research was carried out using sodium chloride solutions. Tests were also carried out in hard water to obtain comparative data. A new approach was proposed for assessing the cavitation-erosion resistance of various metals and alloys. It consists of analyzing polarization curves obtained under static conditions, applying ultrasonic vibrations, and comparing them with the results of corrosion tests. It was established that high corrosion resistance, in combination with the strength characteristics of titanium alloys, provides high cavitation resistance in sodium chloride solutions. During electrochemical studies, an increase in the speed of anodic processes under all modes of cavitation influence and a narrowing of the area of passivation of the studied materials were established. All the metals tested in NaCl solutions and hard water can be conditionally divided into three groups. For the manufacture of equipment parts prone to cavitation-erosive wear in sodium chloride solutions, it is recommended to choose materials from the 3rd group and primarily titanium and its alloys.

Contact Interaction of a Ball with a Toroidal Running Track with a Closely Shaped Power Law Profile

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The influence of the surface shape of contacting bodies on the distribution of contact pressure between them and the stress-strain state of these bodies is studied in the paper. The case study covers contact interaction between a ball piston and a running track of a radial hydro volumetric transmission. The elastostatics problem is reduced to the contact of bodies of revolution: a sphere and a toroid. The profile of the axial section of the toroid is given in the form of a power function defined by two variable parameters. These parameters determine the distribution of contact pressure between these bodies and its magnitude. The regularities of this influence have been established. The dependency of the maximum value of the contact pressure and the equivalent von Mises stresses on varied parameters are established. Constructed parametric contact interaction models make it possible to perform multivariate calculations of the stress-strain state of contacting bodies. Analyzing the obtained results makes it possible to build a specialized research database. In turn, this database is the basis for the justification of project decisions when creating progressive structures, which include complex profile details. Accordingly, rational profiles of contacting bodies are determined according to the strength criterion.

Modeling Dynamic Response and Stability of the Combined Mechanical System with Two Degrees of Freedom

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A combined translational and rotational system with different combinations of elements is used to find time-domain solutions and observe the forced response of a mechanical system with two degrees of freedom. Mathematical models for all four proposed cases are derived, and the proper outputs are plotted with the aid of MATLAB® and its numerical simulation tool Simulink®. The obtained results in graphs representing translational and rotational movements are analyzed and compared to study the dynamic behavior of the combined mechanical system. The results indicate oscillatory motions for all cases. The influence of removing some elements, like springs and damper, is also investigated. The systems are also modeled in the complex domain, and the proper transfer functions are created. Zeroes and poles of these functions are determined, and the stability of the systems is examined through Bode plots and Nyquist diagrams. The results indicate that all observed systems will remain stable after closing the feedback loops, even in cases of increased gains.

Influence of Stochastically Distributed Defects on Crack Formation on Grinding Surfaces of Materials Prone to Cracking

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Our study takes a unique approach by considering the joint influence of defect sizes, orientations, placements, and distributions of processed materials, which are usually determined randomly. This statistical nature of crack formation on treated surfaces, manifested by a thermal fluctuation mechanism of destruction, is a critical factor in our analysis of crack formation phenomena on processed surfaces during finishing operations. This approach is relevant for selecting technological conditions for defect-free processing of products and has significant practical implications for the manufacturing industry. Our research aims to develop a probabilistic-statistical model of crack formation on the grinding surfaces of parts made of materials prone to this type of defect. We strive to propose probabilistic criteria for the appearance of grinding cracks and the selection of technological conditions for their elimination based on them. The statistical characteristics of cracks are calculated by thermal influence on the treated surface. Our study shows that the increase in material homogeneity increases the value of the thermal current, corresponding to the fixed probability that cracks occur on the treated surface. We recommend using the statistical characteristics obtained from limiting heat flow with a large number of crack-like defects in the surface layer of the material being processed as a criterion for the crack formation process during grinding to select technological parameters for defect-free processing.

A Fundamental Solution of the Dynamics of Thin Isotropic Plates Lying on an Elastic Base

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The article is devoted to constructing fundamental solutions to the dynamic equations of a thin isotropic plate, which lies on Pasternak's elastic foundation. The corresponding differential equations are obtained based on the classical small-deflection theory of thin plates. In solving applied problems, the technical theory is the most widespread since it allows for the correct solutions for a wide class of real problems, such as thin plate theory. This model allows for the simplifying of mathematical formulations considerably and the carrying out of investigations by analytical methods. The method of fundamental solutions is an effective method for solving equations of the theory of plates in partial derivatives in the case of action on a body of static and dynamic loads of different natures. The constructed fundamental solutions are of independent interest as solutions to problems about the action on a plate. The presence of appropriate fundamental solutions makes it possible to significantly simplify the study of the response of a plate to local loads distributed over a certain area. The fundamental solutions are the basis for the method of boundary integral equations, which reduces the problem's dimensionality by one and does not require discretization of the whole domain. This approach increases the efficiency of solving a whole class of applied problems in mechanics. The algorithm proposed in the work for constructing fundamental solutions of plate dynamics is based on the joint use of Fourier and Laplace integral transforms and the theory of special hypergeometric functions. The described technique can be easily extended to the case of material anisotropy, the construction of fundamental solutions to the theory of thin shells, and the case of taking into account some physical properties of the environment in the model.

Superconductivity of Friction Pairs of Brake Devices

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The article is devoted to the superconductivity of friction pairs of brake devices, which is possessed by the entire body of the metal friction element and the surface layer of the polymer lining. In them, a special role is played by the so-called thread-like structures in the nodes of the crystal lattices of friction pair materials, which have a reasonably high conductivity due to their low electrical resistance. The use of one-dimensional, two-dimensional, and three-dimensional conductive polymers with different superconductivity efficiencies installed in polymer pads from its downward surface to the advancing one will make it possible to equalize the surface energy load on the arc of the pad's girth during electrothermal-mechanical friction. The external discreteness of the contacts of the microprotrusions of the brake friction pairs is characterized by internal discrete energy levels, which have an essential feature - they break up into groups representing zones of different widths with unequal mobility of electrons in them. Theoretical and experimental studies have determined that when microprotrusions of friction pairs vibrate, a Cooper pair of electrons breaks with the absorption of an electromagnetic field quantum (photon) and a sound quantum (phonon).

Superconductivity of Metal Friction Elements of Brakes

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The article addressed the following issues: general principles of superconductivity conditions in braking pairs; E. Schrodinger equation and F. Bloch law; superconductivity of 1st and 2nd kind in braking pairs; and discussion of results. The first group includes so-called superconductors of 1st kind, cooling with surface positive energy ($E_п > 0$). The negative sign of surface energy ($E_п < 0$) characterizes the superconductors of the second group. The top layers of the working surface are induced by the action of friction forces (F_{Ti}) and pulsed regular forces (N_i), between which the equation $(0,35 – 0,6)\ Ni = F_{Ti}$; is correct; in this case, they interact with the crystal lattice. The lower layers, located on the non-operational side of the surface, experience the internal interaction between the paired Cooper electrons and the crystal lattice. Electrical, magnetic, and thermal gradients decrease magnitude from external to internal exposure. The presence of various types of contacts and their transformation associated with electrical resistance promotes superconductivity of the local character of 1st kind. A characteristic feature of electric current is the appearance of a vortex magnetic field.

Part VI
Quality Assurance

Application of the Dynamic Programming Method in Process Measurement Problems When Assessing Interoperability

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The lack of unified approaches to creating various complex organizational and technical systems and the processes accompanying them gives rise to a problem associated with general rules for assessing and ensuring the interoperability of such systems. Complex systems are characterized by multiple states. Each state is defined by a particular set of parameters. Changing the values of parameters that characterize a separate element of the system can lead to changes in the output parameters of the system as a whole and its state. The latter, along with the presence of complex functional dependencies, significantly complicates formalization when describing the functioning of such systems. Attempts to organize the joint functioning of systems that have not reached a certain level of quality according to a set of critical characteristics often have the opposite effect. The research results are intended to provide a basis for assessing process quality performance. The assessment results can be used to improve process performance, benchmarking, or identify risks associated with the application of processes.

Monitoring the Accuracy of Manufacturing Elements of the End Distribution System of a Hydraulic Motor Planetary Type

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Currently, the mechanical engineering industry has accumulated quite a lot of experience in producing elements of distribution systems of gear and axial-piston positive displacement hydraulic machines. This experience cannot be used in producing planetary hydraulic machines due to the specific features of their distribution systems, which are designed to create a rotating hydraulic field of the working fluid. The precision of manufacturing of the elements of the liquid system distribution determines the uniformity of the working fluid supply. It has been established that the issues of monitoring the accuracy of manufacturing elements of distribution systems remain open, and the development of measures to control the accuracy of manufacturing distributors is an urgent task. As a result of the research, the controlled parameters of the elements of the contact surfaces of the distributors were substantiated, and a calculation scheme for determining the flow section area was developed. The influence of the accuracy of the location of the holes of the movable distributor on the amplitude and frequency of pulsation of the working fluid in the distribution system has been studied this makes it possible to ensure the stability of the functioning of the hydraulic motor planetary type even at the design stage. A reasonable tolerance of ± 10' on the angular arrangement of the working holes of the movable distributor makes it possible, with a constant pulsation frequency of the flow area, to limit the increase in its amplitude to 1.3 times.

Improvement of the Technology of Production of Packaged Mineral Sodium Chloride Water Using the Principles of Risk Management

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The technology for the production of packaged mineral sodium chloride water was improved through risk management. Elements of the food safety management system were developed under ISO 22000:2018. The risks of contamination of packaged mineral water at all stages of the technological process were assessed. The water at the well contains ammonium, which can form nitrite through nitrification, a strictly regulated indicator. Three critical control points of the packaging technology have been identified: water intake from the source (nitrate, nitrite, ammonium content), saturation, and bottle capping (pathogenic microorganisms). For these points, the critical limits of controlled indicators have been set, and corrective actions have been developed in case of non-compliance. To reduce the content of nitrite in finished products and to inhibit the development of ammonifying bacteria, it is proposed to reduce the temperature of water for packaging (up to 5…7 °C), increase the level of carbon dioxide saturation (up to 0.5…0.6 %). The results of the work provide a basis for applying an organizational approach and technological solution for the packaging of mineral waters of medium and high mineralization containing ammonium. To prevent the risk of mineral water contamination during the production process.

Improving the Quality of Emulsion Dispersion in the Pulsation Homogenizer Using Computer Simulation

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This work is devoted to researching technological equipment for homogenization. It has been found that the devices for obtaining finely dispersed emulsions, which exist today, need to be modernized to reduce the energy indicators of homogenization and increase the quality characteristics of the finished provision. As a result of the study, it has been established that the pulsating homogenizer allows for obtaining high homogeneity of the dispersed phase with low energy costs for the process. Although this study was conducted on a milk emulsion, the results can be used for other binary dispersion emulsions. The emulsion is dispersed in the pulsating homogenizer using the emulsion velocity gradient caused by the pulsating vibration of the shock piston. To calculate the hydrodynamic parameters of milk emulsion pumping speed, computer modeling was performed using software that allows for effective analysis of the homogenization process and has a special software package for this purpose - Ansys Workbench. With the help of computer modeling and calculations in ANSYS Workbench, the quality of homogenization due to processing milk in the pulsation homogenizer was determined. Experimental studies have shown that the average diameter of milk fat globules after homogenization in the pulsation homogenizer is 0.8 μm, which fully meets today's requirements.

Simulation of Processes in Composite Materials under Thermometrical Control Taking Into Account Their Heterogeneity

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Today, one of the trends in industry development is replacing traditional structural materials with non-metallic heterogeneous structures. This makes it possible to obtain materials with planned properties. At the same time, it is necessary to study the organizational mechanisms of the structure of such materials at each large-scale level. In this case, non-destructive control methods play a significant role. For products from heterogeneous materials, methods of active thermal control are promising. The processes in materials of this class are of interest when they are monitored by the acoustic infrared thermometric method. It can also be noted that the specifics of the method of non-destructive testing application, as well as the physical phenomena that appear in non-metallic heterogeneous materials during the vibration effect on them, have not been fully studied for its practical application. The article is devoted to the mathematical modeling of these processes. However, for a comprehensive analysis of strength characteristics, it is necessary to consider the coupling of thermoelastic fields, i.e., it is necessary to determine the temperature and deformation fields simultaneously.

Part VII
Process Engineering

The Camberline Optimization Procedure for Mixed Inflow Turbine Rotor

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The primary function of a turbocharger is to compress air within the engine cylinder, thereby increasing mechanical power and enhancing overall combustion efficiency. This technology allows for the downsizing of engines, reducing both volume and saving fuel. Historically, mixed inflow turbines have been utilized as turbocharger drive mechanisms, with the rotor's geometry crucial for determining turbine efficiency. The aerodynamic profile of turbine blades, defined by the camberline, plays a pivotal role. These profiles are streamlined shapes with a thick, rounded leading edge and a thin trailing edge. Properly designed and aligned in the flow, they generate more lift than drag, significantly influencing rotor performance. This paper focuses on optimizing the camberline of mixed inflow rotor blades. Initially, the study verified the trailing edge optimization of type A blades (constant inlet blade angle), previously tested experimentally at Imperial College London. The optimization involved varying position coefficients using a fourth-degree Bezier polynomial mathematical model. Subsequently, improvements were made to the leading edge by adjusting the reference camber angle and the intersection of the leading and trailing edges. All geometric parameters in the meridian plane and deviation angle were held constant to maintain rotor casing consistency. The study utilized ANSYS CFX 15 to solve averaged Na-vier-Stokes equations governing flow through the turbine. This research underscores the significance of aerodynamic blade profiles and their geometric optimization in enhancing turbine efficiency. By refining both trailing and leading edges, significant advancements in turbocharger performance can be achieved, contributing to more efficient and economical engine designs.

Modeling of Gas-Dynamic Processes of Wave Low-Temperature Heat Generators Dynamic Gas Distribution

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With the development of modern technologies, the application of mathematical modeling in studying various physical processes has become a very relevant topic for researchers. The rapid change of physical processes does not allow for studying the process more deeply, which is precisely what prompts the researcher to use modeling and sequential programming of mathematics. Developing the theory of nonlinear oscillations of real systems encountered various difficulties; therefore, experiments of gas-dynamic oscillations on simple models are quite relevant. Analyzing the development of refrigerating technology and mathematical modeling, a promising method of obtaining cold was chosen based on the oscillating process of gases arising in blocked tubes. These processes are included in the operation of cold wave generators. The simplicity of constructions and the quick change of processes in the generator made it possible to use mathematical modeling, allowing you to study the processes of generators perfectly. Low temperatures and mathematical modeling together went through different stages of development, as a result of which they penetrated various spheres of human activity. The operation of generators is quite interesting from the point of view of the cryogenic and refrigerating direction of the development of machine-less gas-dynamic methods of obtaining low temperatures. This device combines simplicity and reliability of the design, unlike other refrigerating machines, as it has simple moving parts in its design or does not have them at all. Wave generators have found their application in energy, the food industry, and others.

Use a Vibration Machine to Obtain Ammonia Water for Plant Feeding

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The essence of various processes of extracting nitrogen from the air and obtaining ammonia water and liquid fertilizers is considered. The vibrating machine for obtaining ammonia water for feeding plants, as the conducted studies have shown, allows the process of saturating the liquid with air and the formation of active radicals in the treated water, which take part in chemical gas phase reactions of the formation of the NH_3 compound in the cavitation cavity in the presence of a mixture of $N^*_2 + H_2$, as well as the formation of nitrogen oxide NO_2 in the presence of $N_2 + O_2$. Reactions are also carried out with the participation of disturbed N_2 molecules and N_2 ions. experimental studies show an increase in ammonia concentration in tap water by 120%, in pond water by 160%, and in pre-treated water (bydistelate) by 500%. The technical result of the use of the vibration machine for obtaining ammonia water for plant feeding is a significant reduction in the number of component devices and their sizes and a significant reduction in energy costs, which during the operation of the vibration machine machines are 300 W and the temperature regime is significantly reduced (the process takes place at a temperature of 20-25°C), and atomic nitrogen from the air is used as a reagent and does not need an additional source of it.

The Use of Vibromechanical Intensification to Optimize Heat Exchange in Transport and Technological Machines

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Investigation of various technological processes for the implementation of transport movement using vibratory conveyor machines for heat exchange processing of bulk materials was carried out, which showed the effectiveness of drive mechanisms with a combined unbalanced vibration system. Graphoanalytical analysis of power and moment disturbances during the generation of working vibrations made it possible to predict and ensure the necessary trajectory of bulk material movement without an additional transport device. With the help of the developed research vibrating dryer with a flexible transport body, the kinematic and energy characteristics of the exciter were experimentally obtained, which confirmed the results of mathematical modeling and substantiated the main parameters of the operating mode for advancing the technological load along the processing zone. Comparative studies of the characteristics of the movement of loose masses of rapeseed and soybeans, conducted on a research model and a classic belt conveyor, showed an increase in the speed of raw material transportation by almost two times and a decrease in energy consumption for the process using the vibration wave scheme by 1.6 times.

Part VIII
Engineering Education

Professional Situations Modeling for Bachelors in Information Technology Training

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The article deals with the problem of modeling classes in the educational process of training bachelor in Information Technology. The article aims to analyze successful practices in the framework of competence-based learning used at leading US higher education institutions and to identify the most effective methods and forms used for high-quality professional training of bachelors in Information Technology. The authors have analyzed such examples of modulated educational situations as virtual laboratories, real-world projects, research and development activities, and simulation games. Real-life examples of integrating simulation into the structure of a course at US universities have also been analyzed. The examples have been based on modern approaches to teaching in the field of Information Technology, which allow students to develop the necessary competencies for innovative professional activities and research in this area. The article also highlights the peculiarities of each of the methods of educational situation modeling and specifies their impact on the effectiveness of the educational process. Based on the analysis, further research is planned on the possibility of successful implementation of educational situation modeling in the framework of professional training of students.

Diagnostic Assessment of Professional Competence Levels of Engineering Teachers

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The research was devoted to substantiation, development, and validation of the diagnostic tool for assessing the teacher's professional competence development. The self-assessment was focused on five professional development components (Motivation and Value, Cognitive-information, Behaviour, and Activity, Personal Reflection, Emotion, and Volition) and was realized according to the Motivational, Cognitive, Activity, Reflection, and Volition criteria with the corresponding indicators. A small-scale experiment was provided to validate the diagnostic tool. It included 52 Ukrainian agricultural and technical college teachers who passed the self-assessment in the first stage of the experiment and the expert assessment in the second stage. Statistical processing of the data showed no significant difference between the results of the expert evaluation and self-assessment. That proved the validity of the developed diagnostic tool. A full-scale experiment in 2023 included 882 engineering teachers from Ukrainian technical colleges. The results demonstrated high levels of motivational and value, behavior and activity, personal reflection, and emotion and volition components, as well as a lower level of cognitive-informational components of teachers' professional development. That demonstrated the need for engineering teachers to have advanced knowledge in the educational process organization, innovative methods and forms of teaching engineering students, and designing up-to-date content of learning.

Quality Management of Training of Engineering Personnel in the Conditions of Developing their Management Competence

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The purpose of the study is to design didactic mechanisms for the formation of managerial competence of engineers in the system of technological quality assurance of the management process of their professional training. In the study, the contradictions of solving the pedagogical problem of quality management of the professional training of engineers were determined, and the pedagogical conditions for their solution were substantiated. An engineer's managerial competence is a systemic formation representing professional, administrative, psychological, and creative aspects of synergistic development. The process of professional training of engineers in the system of management of educational and creative activities of applicants is analyzed. Didactic means of forming a creative educational environment under the conditions of implementation of the pedagogical technology "Management-education" were considered. The stages of quality control of the formation of the engineer's managerial competence were studied. The criteria and indicators of the quality of professional training of engineers are determined, considering the influence of factor characteristics. The results of pedagogical experiments to determine the impact of a creative educational environment on the level of formation of managerial competence of engineers are analyzed. The effectiveness of the proposed quality management system for the professional training of engineers in the conditions of the "Management-education" pedagogical technology has been proven.

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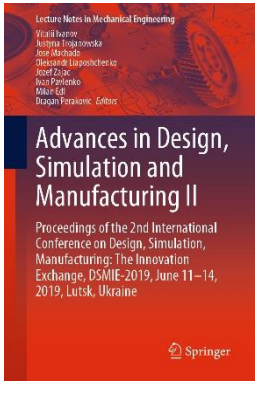

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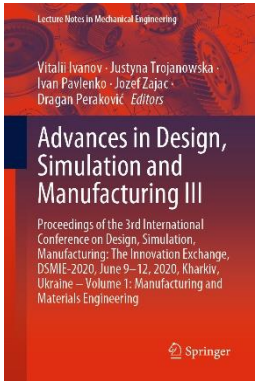

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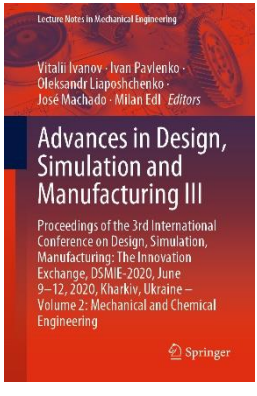

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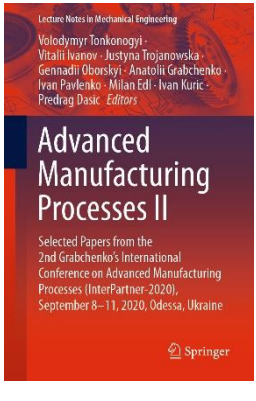

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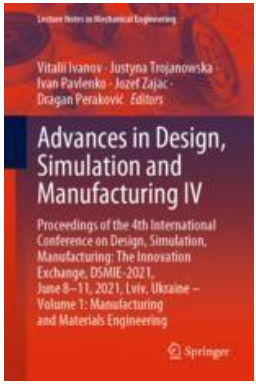

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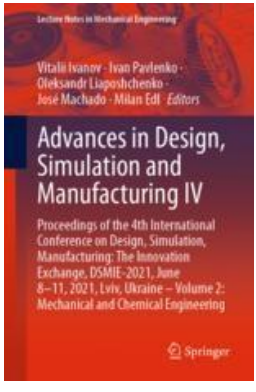

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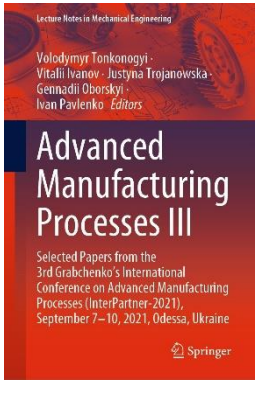

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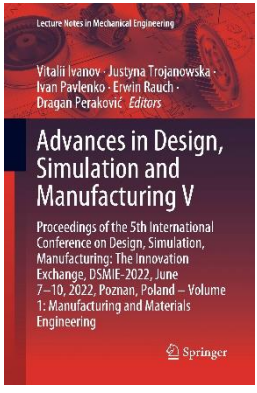

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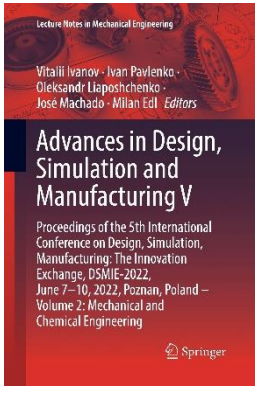

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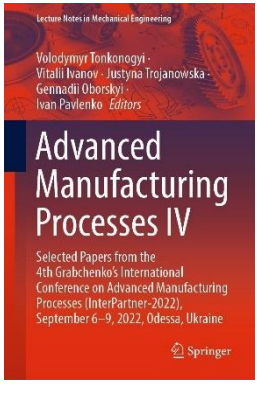

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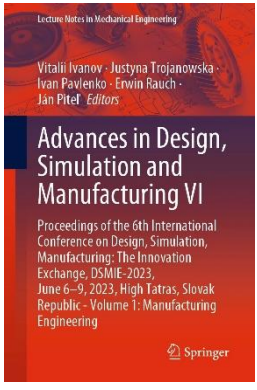

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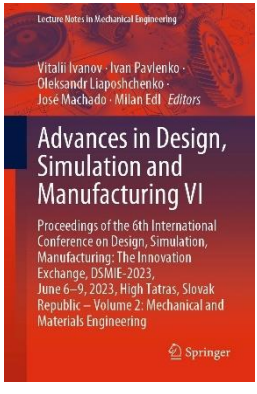

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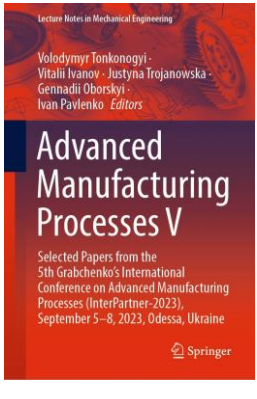

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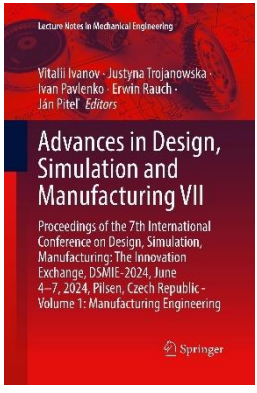

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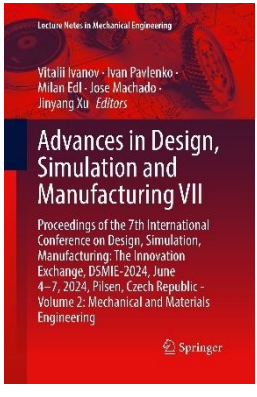

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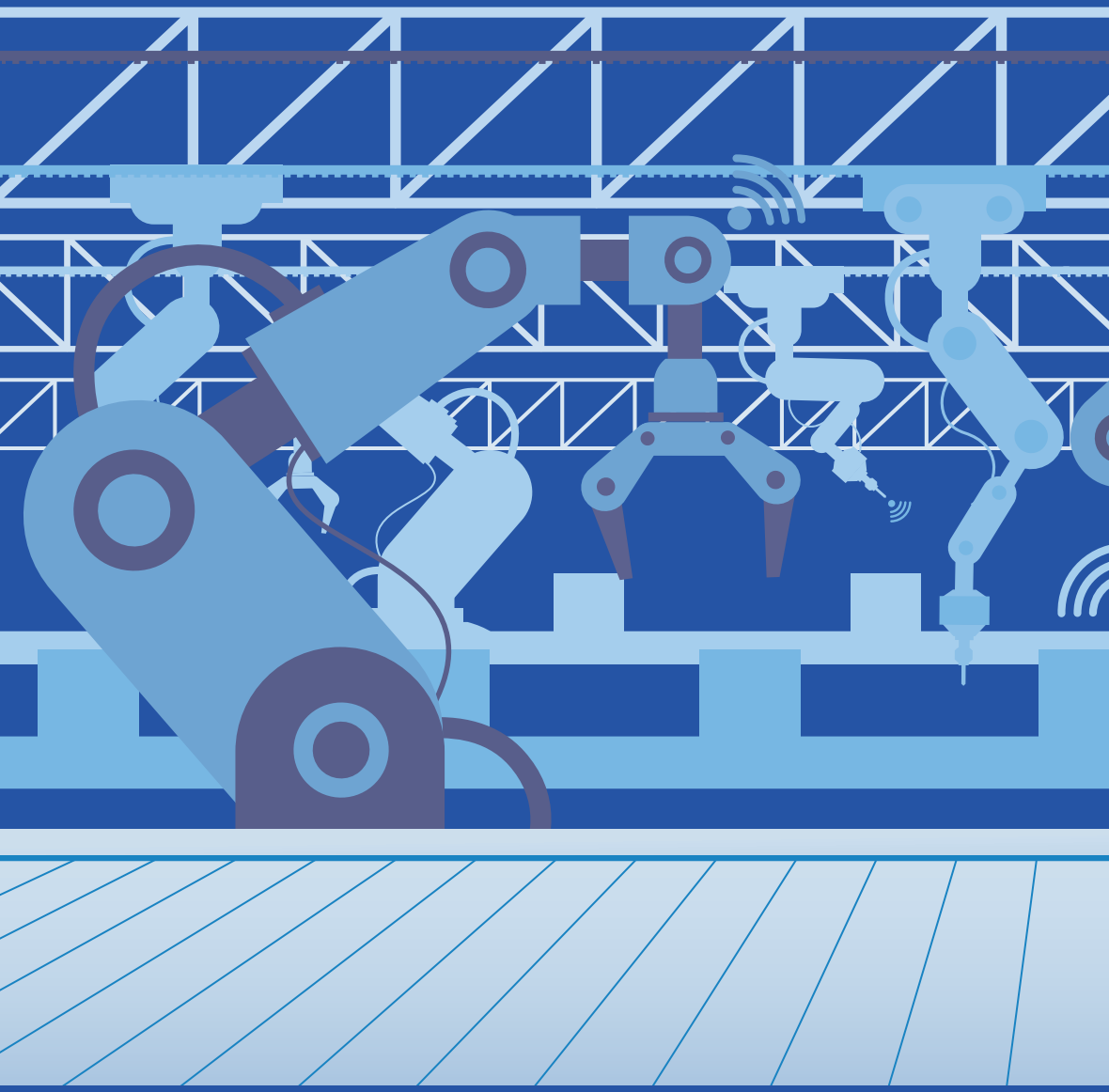

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