DSM:IE 2022

5th International Conference on

Design, Simulation, Manufacturing: The Innovation Exchange

June 7-10, 2022 | Poznan, Poland

Book of Abstracts

Sumy State University

Politechnika Poznańska Poznan University of Technology

IATDI International Association for Technological Development and Innovations

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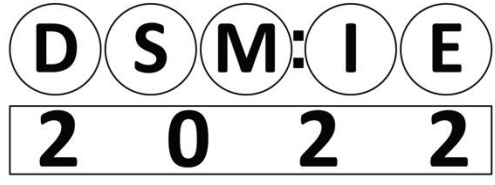
International Association for Technological Development and Innovations



5th International Conference on Design, Simulation, Manufacturing: The Innovation Exchange (DSMIE-2022)

June 7-10, 2022 | Poznan, Poland

Book of Abstracts

Sumy
2022

Editors:

Vitalii Ivanov[1], Justyna Trojanowska[2], Ivan Pavlenko[1], Olaf Ciszak[2], Oleksandr Gusak[1], Oleksandr Liaposhchenko[1]

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Design, Simulation, Manufacturing: The Innovation Exchange: Book of Abstracts of the 5th International Conference, Poznan, Poland, June 7-10, 2022 / Vitalii Ivanov, Justyna Trojanowska, Ivan Pavlenko, Olaf Ciszak, Oleksandr Gusak, Oleksandr Liaposhchenko (Eds.). – Sumy: IATDI, 2022. – 156 p.

Recommended by Coordination Board of International Association for Technological Development and Innovations (Protocol No. 2, April 4, 2022).

The content of this book is based on the 5th International Conference on Design, Simulation, Manufacturing: The Innovation Exchange (DSMIE-2022), held on June 7-10, 2022, in Poznan, Poland. This book reports on topics at the interface between manufacturing, materials, mechanical, and chemical engineering. It gives a special emphasis on smart and sustainable manufacturing, describes innovative research in design engineering and manufacturing technology, covering the development and characterization of advanced materials alike. It also discusses key aspects related to ICT in engineering education. Furthermore, it covers recent findings concerning the mechanics of fluids, solids, and structures, and numerical and computational methods for solving coupled problems in manufacturing. It reports on recent developments in chemical process technology, heat and mass transfer research, and energy-efficient technologies, describing applications in the food and energy production sector. This book provides academics and professionals with extensive information on trends and technologies, and challenges and practice-oriented experience in all the above-mentioned areas.

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Welcome Message

5th International Conference on Design, Simulation, Manufacturing: The Innovation Exchange (DSMIE-2022), held in Poznan, Poland, on June 7-10, 2022, was organized by the Sumy State University, Poznan University of Technology, and International Association for Technological Development and Innovations, in partnership with Technical University of Kosice (Slovak Republic), Kielce University of Technology (Poland), University of West Bohemia (Czech Republic), Association for Promoting Innovative Technologies – Innovative FET (Croatia), and Society for Robotics of Bosnia and Herzegovina (Bosnia and Herzegovina).

DSMIE-2022 received 159 contributions from 20 countries around the world. After a thorough peer-review process, the Program Committee accepted 84 papers written by 337 authors from 16 countries. Thank you very much to the authors for their contribution. These papers are published in the present book, achieving an acceptance rate of about 53%. Extended versions of selected best papers will be recommended for publication in scientific journals.

We would like to 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. 105 Program Committee members and 23 invited external reviewers devoted their time and energy to peer-reviewing manuscripts. Our reviewers come from all over the world, represent 19 countries, and are affiliated with more than 80 institutions.

Thank you very much to keynote speakers: Prof. George-Christopher Vosniakos (National Technical University of Athens, Greece), Prof. Dariusz Mazurkiewicz (Lublin University of Technology, Poland), Prof. Szymon Wojciechowski (Poznan University of Technology, Poland), Prof. Sahin Yildirim (Erciyes University, Turkey), Dr. Vladimir Dolgikh (Seco Tools AB, Sweden), and Mr. Krystian Kogut and Przemyslaw Pasich (InterMarium, Poland).

We appreciate the partnership with Springer Nature, iThenticate, and EasyChair for their essential support during the preparation of DSMIE-2022. Thank you very much to DSMIE Team. Their involvement and hard work were crucial to the success of the conference.

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

Vitalii Ivanov,
General Chair of the Conference

About DSMIE-2022

5th International Conference on Design, Simulation, Manufacturing: The Innovation Exchange (DSMIE-2022) is the international forum for fundamental and applied research and industrial applications in engineering.

The conference focuses on a broad range of research challenges in Manufacturing, Materials, Mechanical, and Chemical Engineering, addressing current and future trends in design approaches, simulation techniques, computer-aided systems, ICT tools, and Industry 4.0 strategy implementation for engineering tasks solving.

DSMIE-2022 brings together researchers from academic institutions, leading industrial companies, and government laboratories located worldwide to promote and popularize the scientific fundamentals of engineering.

The conference agenda includes keynote sessions and technical sessions, expert panels, an exhibition of industry partners, and more.

The official language of the conference is English.

History

The history of the DSMIE Conference Series started in 2018, and since then, DSMIE has become a regular annual event. Pursuing the goal of exchanging ideas, spreading innovations, and attracting more participants and institutions. DSMIE Conference Series changed several locations in Ukraine (Sumy, 2018; Lutsk, 2019; Kharkiv, 2020; Lviv, 2021). In 2022, due to the inhuman intervention of the Russian Federation in Ukraine, we are forced to relocate the conference from Ukraine to Poland. Thanks to long-term and reliable cooperation, Poznan University of Technology has become a venue that has allowed us to go beyond the borders of Ukraine.

We are proud of our achievements and metrics for these five years. It is a result of a reliable long-term partnership with all our partners and host institutions of the DSMIE Conference Series and due to the significant contribution of participants.

Participants	Countries	Books	Papers	Downloads	Citations
1800	30	8	424	280 000	811


КОНГРЕС-ЦЕНТР
СумДУ
Sumy, 2018


IATDI
Lutsk, 2019


Design, Simulation, Manufacturing:
The Innovation Exchange
D S M:I E
2 0 2 0
IATDI
Kharkiv, 2020


S M:I E
0 2 1
4th International Conference on
Design, Simulation, Manufacturing: The Innovation Exchange
June 8-11, 2021 | Lviv, Ukraine
Lviv, 2021
Together we can do more for science, technology, engineering, and education. © DSMIE Team

Organizers

Sumy State University

Sumy State University is located in Sumy city in the North-East of Ukraine. Its history began in 1948. Today, SumDU is a leading university of a classical type with the III-IV accreditation level in the region.

The University currently serves about 12,000 students pursuing bachelor's and master's degrees in 55 majors and 24 fields of knowledge. About 1900 international students represent about 50 countries worldwide.

The University is a signatory of the Magna Charta Universitatum and Talloires Declaration, a reliable member of the International Association of Universities, European University Association, IREG Observatory on Academic Ranking and Excellence, IIENetwork, and other international organizations.

Sumy State University cooperates with more than 300 partners from 55 countries worldwide, including the USA, Great Britain, Germany, Austria, France, Belgium, Sweden, Poland, Lithuania, Bulgaria, the Czech Republic, Slovakia, Romania, Japan, South Korea, China and other countries of the world.

SumDU is a reliable partner for joint projects in frames of international grant programs of EU (Erasmus+, Horizon 2020), United Nations Development Programme, NATO, DAAD, American Councils, British Council, the World Bank, bilateral scientific and research projects, grants of private foundations. The University accomplishes more than 300 grants annually.

The University actively develops academic mobility programs, including long-term and short-term studies, internships and placement programs for undergraduate and postgraduate students, professional development, teaching, and research mobility for staff with substantial scholarship and grant support using technologies of credit transfer and recognition of academic results.

✉ 2, Rymskogo-Korsakova St., Sumy 40007, Ukraine
💻 http://sumdu.edu.ua

Poznan University of Technology (Polish name: Politechnika Poznanska) is known as one of the best technical universities in Poland. In 1995 it became the first Polish university to become a member of the Conference of European Schools for Advanced Engineering Education and Research (CESAER), an organization comprising the best technical universities in Europe. The university is also a member of the Erasmus+ program for exchange students from all over Europe, promoting advanced engineering and a European dimension. The university is home to many organizations and student circles.

PUT was officially founded in 1955, and the first rector was Roman Kozak. But a state school had existed in Poznan since 1919, under the name of the Higher State School of Machinery. After adding a second department in 1929, its name was changed to the Higher State School of Machinery and Electrotechnics. In September 1945, the School received the title High School of Engineering and became Poznan University of Technology after ten years.

Presently, PUT is an autonomous state institution consisting of nine faculties in which institutes and chairs over one thousand academic staff members do research and run educational tasks for 14,000 students of full-time and part-time studies in more than 30 fields of study. PUT has been granted the right to confer doctorates in technical science. Moreover, it runs postgraduate studies within different faculties. In 2020, PUT became the leader of the EUNICE European University, formed by partners from 7 European universities. EUNICE (European University for Customised Education) is one of 41 Alliances created in Europe under 2 calls of the European Commission Initiative.

✉ Plac Marii Skłodowskiej-Curie 5, 60-965 Poznan, Poland
💻 https://www.put.poznan.pl

International Association for Technological Development and Innovations (IATDI) is a non-government organization and a professional community established for fostering and promoting innovations for science, technology, and education.

IATDI is aimed at the formation of the integrated relationship between individuals, local authorities, and the private sector to improve the quality of human capital, pooling of intellectual potential of members for technological development and innovation, creating a network of partners with domestic and foreign higher education institutions and international organizations, co-organizing strategies in the context of implementing innovative scientific and educational projects, training highly skilled specialists, as well as an exchange of scientific information and academic staff.

IATDI has 300+ members from 30 countries worldwide. It has a cooperation with higher educational institutions, non-government organizations, professional societies and associations, and industrial companies. The cooperation allows capacity building and strengthens the cooperation activities.

IATDI is an organizer of the DSMIE Conference Series and InterPartner Conference Series.

✉ 5/30, M. Lushpy Ave., Office 29, Sumy 40035, Ukraine
🖳 http://iatdi.org

Partners

TECHNICKÁ UNIVERZITA V KOŠICIACH

Kielce University of Technology

UNIVERSITY OF WEST BOHEMIA

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The monthly international magazine «Industry in FOCUS» has already attracted many companies who work in the industrial market. Time of feverish activity made our edition the most popular among similar journals.

The editorial policy of «Industry in FOCUS» consists of prompting information bridges between developers of technics and technical processes, producers of the industrial output, providers, and consumers. Since our market develops dynamically and our technical specialists should be well-informed, we use the authority and status of our edition to cover the field broadly and give irreversible character to those processes which are taken place in our country now.

As was observed, our edition is useful for the big circle of engineers, businessmen, and main specialists of industrial enterprises.

The Circulation of our journal is 10 thousand copies. It is circulated with the subscription in Ukraine, Russia, Czech Republic, Poland, France, Germany, Israel, and Belarus. Besides that, the «Industry in Focus» journal takes an active part in different profile exhibitions, seminars, conferences in many countries of the world where your advertisement can be matched.

✉ PO Box 2849, Kharkiv, 61085, Ukraine
💻 http://vfocuse.com.ua

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Conference Topics

Manufacturing Engineering

- CAx Technologies for Product Design and Advanced Manufacturing Processes
- Intelligent Manufacturing Systems, Automation, and Robotics
- Smart Manufacturing and Industry 4.0 Strategy
- Information Management Systems
- ICT for Engineering Education

Materials Engineering

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

Mechanical Engineering

- Mechanics of Solids and Structures
- Dynamics, Acoustics, and Vibrations
- Elasticity and Strength of Materials
- Hydro- and Aeromechanics
- Numerical Simulations of Coupled Problems

Chemical Engineering

- Chemical Process Technology and Plant Design
- Thermodynamics, Heat and Mass Transfer
- Energy-Efficient Technologies, Conversion, and Utilization
- Alternative and Renewable Energy Sources
- Industrial Ecology and Sustainable Engineering

Publishing Opportunities

Full papers of selected contributions of DSMIE-2022 were published in two volumes in the book **"Advances in Design, Simulation and Manufacturing V"**. It belongs to the Lecture Notes in Mechanical Engineering series (ISSN 2195-4356). The books of this series are published by Springer Nature, indexed by Scopus, and submitted to the Web of Science Core Collection.

Volume 1 – Manufacturing and Materials Engineering (ISBN 978-3-031-06024-3; ISBN eBook 978-3-031-06025-0; DOI 10.1007/978-3-031-06025-0)

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Vol. 1

Volume 2 – Mechanical and Chemical Engineering (ISBN 978-3-031-06043-4; ISBN eBook 978-3-031-06044-1; DOI 10.1007/978-3-031-06044-1)

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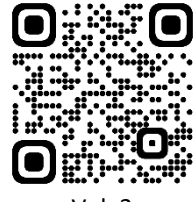
Vol. 2

To read the full papers, please visit the official webpage of the Publisher via the following link https://link.springer.com/conference/dsmie or DSMIE's website https://dsmie.sumdu.edu.ua/schedule/proceedings.html.

Extended versions of the best papers, presented at DSMIE-2022, will be considered for special issues of selected journals, subject to further review:

- Management and Production Engineering Review, Poland (ISSN 2080-8208, e-ISSN 2082-1344), http://mper.org;
- Journal of Engineering Sciences, Ukraine (ISSN 2312-2498, e-ISSN 2414-9381), http://jes.sumdu.edu.ua;
- Advances in Thermal Processes and Energy Transformation, Slovak Republic (ISSN 2585-9102), http://atpetjournal.com;
- Assembly Techniques and Technologies, Poland (e-ISSN 2450-8217), https://tiam.prz.edu.pl;
- Machines (ISSN 2075-1702), https://www.mdpi.com/journal/machines;
- Special Issue "Industry 4.0 Technologies for Sustainable Asset Life Cycle Management" (ISSN 2071-1050), https://www.mdpi.com/journal/sustainability/special_issues/Industry_asset_sustainability.

Venue

Poznan is a place where the energy of New Europe is merged with the civilization of the West. Poznan is situated in Poland's most economically developed region, a metropolis with over half a million residents.

The city is focused on achieving success, grounded on a 1000-year tradition of competence. The most ambitious of projects and the bravest of visions have a chance to succeed here. The state of Poland was born in Poznan. It was also the location of the Greater Poland Uprising, the only successful armed bid for independence in Poland and proof of the exceptional resourcefulness of its citizens.

Poznan is an important center of industry, trade, logistics, and business tourism. It is also an academic, scientific, and cultural center. Poznan managed to establish itself as one of the most significant trading areas in this part of Europe. Today, the Poznan International Trade Fair Centre successfully hosts substantial international events. Poznan is dominated by companies operating in trade and repairs, construction, manufacturing engineering, health care and social assistance, transportation and warehousing. The city authorities have also created a Business Information Point and are working on the Poznan Incubator of Advanced Technologies project.

Poznan is one of the four largest academic centers in Poland. The number of students in the city is about 140,000, ranking it the third in student population. Every one in four inhabitants of Poznan is a student. With its almost 30 universities and colleges, Poznan has the second richest educational offering in the country.

We invite you to discover the pleasure! Welcome to Poznan!

Agenda

***Polish time (GMT+2) is used for all sessions.**

Day 1 – **June 7, 2022** – Tuesday		
0^{00}–14^{00}	Day of Arrival	
14^{00}–16^{00}	City Tour	
Day 2 – **June 8, 2022** – Wednesday		
8^{00}–9^{00}	Registration	
9^{00}–9^{30}	Opening Ceremony	Conference Hall & Virtual Hall A
9^{30}–11^{00}	Keynote Session 1	Conference Hall & Virtual Hall A
11^{00}–11^{30}	Coffee Break	
11^{30}–13^{00}	Keynote Session 2	Conference Hall & Virtual Hall A
13^{00}–14^{30}	Time for Lunch	
14^{30}–15^{30}	Session 1 – Smart and Sustainable Manufacturing I	Conference Hall & Virtual Hall A
15^{30}–15^{40}	Technical Break	
15^{40}–17^{00}	Session 2 – Manufacturing Technology	Conference Hall & Virtual Hall A
18^{00}–22^{00}	Gala Dinner	

Agenda (continuation)

***Polish time (GMT+2) is used for all sessions.**

Day 3 – **June 9, 2022** – Thursday		
9^{00}–10^{40}	Session 3 – Smart and Sustainable Manufacturing II	Virtual Hall B
9^{00}–10^{40}	Session 4 – Mechanical Engineering I	Virtual Hall C
10^{40}–10^{50}	Technical Break	
10^{50}–12^{30}	Session 5 – Design Engineering	Virtual Hall B
10^{50}–12^{30}	Session 6 – Chemical Process Technology	Virtual Hall C
12^{30}–13^{30}	Time for Lunch	
13^{30}–15^{10}	Session 7 – Manufacturing Processes I	Virtual Hall B
13^{30}–15^{10}	Session 8 – Energy Efficient Technologies	Virtual Hall C
15^{10}–15^{20}	Technical Break	
15^{20}–17^{00}	Session 9 – Manufacturing Processes II	Virtual Hall B
15^{20}–17^{00}	Session 10 – Mechanical Engineering II	Virtual Hall C
Day 4 – **June 10, 2022** – Friday		
9^{00}–10^{40}	Session 11 – Advanced Materials I	Virtual Hall D
10^{40}–10^{50}	Technical Break	
10^{50}–12^{30}	Session 12 – Advanced Materials II	Virtual Hall D
12^{30}–12^{40}	Technical Break	
12^{40}–13^{30}	Session 13 – ICT for Engineering Education	Virtual Hall D
13^{30}–14^{00}	Closing Ceremony	Virtual Hall D

Day 1: June 7, 2022, Tuesday

***Polish time (GMT+2) is used for all sessions.**

10^{00}–14^{00}	**Day of Arrival**
14^{00}–16^{00}	**City Tour**

Day 2: June 8, 2022, Wednesday

***Polish time (GMT+2) is used for all sessions.**

8^{00}–9^{00}	**Registration**	
9^{00}–9^{30}	**Opening Ceremony**	Conference Hall & Virtual Hall A

Vitalii Ivanov
General Chair of the Conference
Justyna Trojanowska
Co-chair of the Conference
Olaf Ciszak
Dean of the Faculty of Mechanical Engineering, Poznan University of Technology, Poland
Oleksandr Gusak,
Dean of the Faculty of Technical Systems and Energy Efficient Technologies, Sumy State University, Ukraine

9^{30}–11^{00}	**Keynote Session I** *Chair: Olaf Ciszak* Poznan University of Technology, Poland	Conference Hall & Virtual Hall A

Laser-Based Additive Manufacturing: Long Arbitrary Path Simulation in Real-Time and Power Optimisation
George-Christopher Vosniakos
National Technical University of Athens, Greece

Digital Twin-Driven Reliability Research Challenges
Dariusz Mazurkiewicz
Lublin University of Technology, Poland

Selected Problems Related to Mechanics of Micromilling Operations
Szymon Wojciechowski
Poznan University of Technology, Poland

11^{00}–11^{30}	**Coffee Break**

11^{30}–13^{00}	**Keynote Session II** *Chair: Vitalii Ivanov* Sumy State University, Ukraine	Conference Hall & Virtual Hall A

Intelligent Mechatronic Systems Applications in Engineering
Sahin Yildirim
Erciyes University, Turkey

A People Company in the Machining Business
Vladimir Dolgikh
Seco Tools AB, Sweden

Process Simulation Technology in Modern Didactics on the Example of Decision Games Created in FlexSim Environment
Krystian Kogut & Przemyslaw Pasich
InterMarium Sp. z o.o., Poland

13^{00}–14^{30}	**Time for Lunch**

14^{30}–15^{30}	**Session 1 – Smart and Sustainable Manufacturing I** *Chair: Justyna Trojanowska* Poznan University of Technology, Poland	Conference Hall & Virtual Hall A

Motorcycle Rider Assistance System for Obstacle Detection with Visualization in the Rider's Visual Area
Vaclav Masek and Roman Cermak
University of West Bohemia, Czech Republic

Cybersecurity Validation in the Online Gambling Industry
Dragan Perakovic, Leon Cetinic, Ivan Cvitic and Marko Perisa
University of Zagreb, Croatia

8D Methodology for Solving Problems in the Production of PVC Pipes
Marta Popowska, Natalia Marzec and Justyna Trojanowska
Poznan University of Technology, Poland

15^{30}–15^{40}	**Technical Break**

15^{40}–17^{00} **Session 2 – Manufacturing Technology** Conference Hall & Virtual Hall A
Chair: Szymon Wojciechowski
Poznan University of Technology, Poland

Influence of Multi-Pin Ultrasonic Impact Treatment on Microrelief, Structure, and Residual Stress of AISI O2 Tool Steel
Dmytro Lesyk[1], Walid Alnusirat[2], Vitaliy Dzhemelinskyi[1], Andrii Burmak[1] and Bohdan Mordyuk[1,3]
[1] National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Ukraine
[2] Al-Balqa Applied University, Jordan
[3] G.V. Kurdyumov Institute for Metal Physics of the NAS of Ukraine, Ukraine

Improvement of the Milling Effectiveness by Application of Composite Milling Heads
Pavlo Kushnirov, Yuliia Denysenko, Bohdan Ostapenko, Dmytro Zhyhylii and Borys Stupin
Sumy State University, Ukraine

A Special Feature of Turbine Blade Deformation During Machining
Sergey Dobrotvorskiy, Yevheniia Basova, Serhii Kononenko, Ludmila Dobrovolska and Abou Samra Youseff Mounif
National Technical University "Kharkiv Polytechnic Institute", Ukraine

An Analytical and Experimental Study of the Grinding Process of Thermal Barrier Coatings with Highly Porous Wheels of Cubic Boron Nitride
Vladimir Lebedev, Olga Frolenkova, Tatiana Chumachenko, Alla Bespalova and Olha Dashkovska
[1] Odessa Polytechnic National University, Ukraine
[2] Odessa State Academy of Civil Engineering and Architecture, Ukraine

The Effect of Manufacturing Tolerances on the Hydrodynamic Characteristics of Plain Bearings
Yuliia Tarasevych and Ievgen Savchenko
[1] AGH University of Science and Technology, Poland
[2] Sumy State University, Ukraine

18^{00}–22^{00} **Gala Dinner**

Day 3: June 9, 2022, Thursday

***Polish time (GMT+2) is used for all sessions.**

9^{00}–10^{40} **Session 3 – Smart and Sustainable Manufacturing II** Virtual Hall B

Chair: Slawomir Luscinski
Kielce University of Technology, Poland

Design and Validation of a Feeding System for the Systematic Production of Needle Beds

Luis Freitas[1], Divo Pinto[1], Jose Vicente[2], Katarzyna Antosz[3] and Jose Machado[1]
[1] University of Minho, MEtRICs Research Centre, Portugal
[2] InsideLimits, Portugal
[3] Rzeszow University of Technology, Poland

Towards Sustainable Manufacturing: The Sustainable Packaging Redesign Case Study

Erwin Rauch[1], Matthias Rofner[1], Cristian Cappellini[1] and Dominik T. Matt[1,2]
[1] Free University of Bolzano, Italy
[2] Fraunhofer Italia Research s.c.a.r.l., Innovation Engineering Center (IEC), Italy

An Increase in the Efficiency of Selected Production Processes Using Lean Tools

Lucia Knapcikova, Matus Marticek, Jozef Husar and Jakub Kascak
Technical University of Kosice, Slovak Republic

Principles of Forming the Organizational Structure of the Enterprise Energy Management System

Liudmila Yermolenko[1], Valentyn Moiseenko[1], Vira Shendryk[2], Sergii Shendryk[3] and Oleksandr Shendryk[4]
[1] Ukrainian State University of Railway Transport, Ukraine
[2] Sumy State University, Ukraine
[3] Sumy National Agrarian University, Ukraine.
[4] National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Ukraine

Quality Control Monitoring in 3D Printing

Natalia Lishchenko, Peter Lazorik, Jakub Demcak, Jan Piteľ and Kamil Zidek
Technical University of Kosice, Slovak Republic

Mechatronic Actuator for Adaptive Machining Control
Anatoly Gushchin[1], Vasily Larshin[1], Oleksandr Lysyi[2] and Igor Dudarev[3]
[1] Odessa Polytechnic National University, Ukraine
[2] Odessa Military Academy, Ukraine
[3] Odessa State Agrarian University, Ukraine

An Automated Diagnostic and Surveillance System for Eliminating the Community Spread of Infectious Respiratory Diseases in the Industry
Milan Saga Jr.[1], Michal Bartos[1], Ivan Zajacko[1], Ivana Klackova[1] and Dariusz Wiecek[2]
[1] University of Zilina, Slovak Republic
[2] University of Bielsko-Biala, Poland

Correlation between Accidents on Selected Roads as Fundamental for Determining the Safety Level of Road Infrastructure
Piotr Trojanowski[1], Aleksandra Trusz[2] and Borys Stupin[3]
[1] West Pomeranian University of Technology in Szczecin, Poland
[2] University of Gdansk, Poland
[3] Sumy State University, Ukraine

9^{00}–10^{40} **Session 4 – Mechanical Engineering I** Virtual Hall C
Chair: Jose Machado
University of Minho, Portugal

The Behaviour of a Rod (Beam) Under the Influence of an External Power Load
Viktoriya Pasternak[1], Oleg Zabolotnyi[1], Nataliia Ilchuk[1], Jose Machado[2] and Kostiantyn Svirzhevskyi[1]
[1] Lutsk National Technical University, Ukraine
[2] University of Minho, Portugal

Stress-Strain State of the Floating Bollard's Structure for a Shipping Gateway
Ihor Sydorenko, Vladimir Tonkonogyi, Vladimir Semenyuk, Valeriy Lingur and Yunxuan Zhang
Odessa Polytechnic National University, Ukraine

Rotor Dynamics and Stability of the Centrifugal Pump CPN 600-35 for Nuclear Power Plants
Ivan Pavlenko, Vitalii Simonovskiy, Anton Verbovyi, Oleksandr Ivchenko and Vitalii Ivanov
Sumy State University, Ukraine

Organization of Transportation of a Particle by an Inclined Cylinder Rotating Around the Axis

Tatiana Volina[1,3], Serhii Pylypaka[1], Yaroslav Kremets[1], Olena Kozlova[2] and Alla Rebrii[3]

[1] National University of Life and Environmental Sciences of Ukraine, Ukraine
[2] Sumy State Pedagogical University named after A.S. Makarenko, Ukraine
[3] Sumy National Agrarian University, Ukraine

Vibration Reliability of the Turbine Unit's Housing Considering Random Imperfections

Sergey Krasnikov[1], Andrii Rogovyi[2], Igor Mishchenko[1], Andrii Avershyn[1] and Valerii Solodov[1]

[1] Kharkiv National Automobile and Highway University, Ukraine
[2] National Technical University "Kharkiv Polytechnic Institute", Ukraine

Influence of Horizontal Inertial Loads on the Operation of Overhead Crane Girders

Anatoliy Tkachev, Aleksey Tkachev, Oleksandr Fomin, Oleksandr Bondar and Elena Naidenko

Odessa Polytechnic National University

Supersonic Flow in the Blade Channel of the Nozzle with a Rotary Diaphragm at Small Degrees of Opening

Oleksandr Zhyrkov[1], Oleksandr Usatyi[2], Olena Avdieieva[2] and Yuri Torba[1]

[1] SE Ivchenko-Progress, Ukraine
[2] National Technical University "Kharkiv Polytechnic Institute", Ukraine

Mathematical Model of Lifting Particles of Technological Material by Vertical Auger

Serhii Pylypaka[1], Tatiana Volina[1,2], Iryna Hryshchenko[1], Serhii Dieniezhnikov[3] and Iryna Rybenko[2]

[1] National University of Life and Environmental Sciences of Ukraine, Ukraine
[2] Sumy National Agrarian University, Ukraine
[3] Sumy State Pedagogical University named after A.S. Makarenko, Ukraine

10^{40}–10^{50} **Technical Break**

10^{50}–12^{30} **Session 5 – Design Engineering** Virtual Hall B
Chair: Ivan Pavlenko
Sumy State University, Ukraine

An Element Deletion Algorithm for an Open-Source Finite Element Software
Zaki Alomar, Cristian Cappellini and Franco Concli
Free University of Bolzano, Italy

Conceptual Design of an Automated Workstation for the Control of Manufactured Products in Single-Purpose Machines
Martin Bohusik, Vladimir Bulej, Ivan Kuric, Milan Saga and Vladimir Stenchlak
University of Zilina, Slovak Republic

The Anti-Collapse Safety System for Hydraulically Operated Docking Levelers
Bogdan Dorel Cioroaga and Vasile George Cioata
Politehnica University Timisoara, Romania

Development of the Disk Tool Magazine with Modified Gear Drive
Oleg Krol and Volodymyr Sokolov
Volodymyr Dahl East Ukrainian National University, Ukraine

Improvement of the Computer-Aided Design for Interference Fit Based on the Generalized Design Selection Criteria
Vladimir Nechiporenko, Valentin Salo, Petro Litovchenko, Vladislav Yemanov and Stanislav Horielyshev
National Academy of the National Guard of Ukraine, Ukraine

Substantiation of the Design Calculation Method for the Vibroturning Device
Roman Obertyukh, Andrii Slabkyi, Oleksandr Petrov, Dmytro Bakalets and Sergey Sukhorukov
Vinnytsia National Technical University, Ukraine

Compositional Interpolation of Spatial Discretely Presented Curves by Harmonizing Pointed Polynomials
Victor Vereshchaga[1], Andrii Naydish[1], Yevhen Adoniev[2], Oleksandr Pavlenko[1] and Kseniia Lysenko[1]
[1] Bogdan Khmelnitsky Melitopol State Pedagogical University, Ukraine
[2] Zaporizhzhia National University, Ukraine

A New Method of Optimization Synthesis of Vibro-Impact Systems
Volodymyr Gursky, Vitaliy Korendiy, Igor Kuzio and Oleksandr Kachur
Lviv Polytechnic National University, Ukraine

10^{50}–12^{30} **Session 6 – Chemical Process Technology** Virtual Hall C
Chair: Oleksandr Liaposhchenko
Sumy State University, Ukraine

Design and Modernization of Circuit for Fuel Oil Heating and Tar Cooling
Tatiana Babak, Alexey Demirskyy, Gennadii Khavin and Irina Riabova
National Technical University "Kharkiv Polytechnic Institute", Ukraine

Design of Reactors with Mechanical Mixers in Biodiesel Production
Mikhailo Mushtruk[1], Larysa Bal-Prylypko[1], Natalia Slobodyanyuk[1], Yuriy Boyko[2] and Mykola Nikolaienko[1]
[1] National University of Life and Environmental Sciences of Ukraine, 15, Heroes of Defense St., Kyiv 03041, Ukraine
[2] National University of Food Technology, 68, Volodymyrska St., Kyiv 01601, Ukraine

Purification of Oilfield Wastewater by Inertial Methods
Oleksandr Liaposhchenko, Viktor Moiseev, Eugenia Manoilo and Houssein Seif
[1] Sumy State University, Ukraine
[2] National Technical University "Kharkiv Polytechnic Institute", Ukraine
[3] Al Khorayef Company for Sale, Maintenance and Repair of Oil Production Equipment LLC, Kuwait

Application of Low-Frequency Mechanical Vibrations for Development of Highly Efficient Continuous Extraction Equipment
Volodymyr Zavialov, Taras Mysiura, Nataliia Popova, Yuliia Zaporozhets and Valentyn Chornyi
National University of Food Technologies of Ukraine, Ukarine

Research of Wheat Fiber with Pumpkin Pectin Plant Additive
Marija Zheplinska[1], Volodymyr Vasyliv[1], Olena Deviatko[1], Sergii Ulianko[2] and Nataliia Kanivets[2]
[1] National University of Life and Environmental Sciences of Ukraine, Ukraine
[2] Poltava State Agrarian Academy, Ukraine

Comparative Evaluation of the Contact Elements Efficiency for Barium Sulfide Solution Carbonization
Yurij Masikevych[1], Musii Tseitlin[2], Valentyna Raiko[2], Oleksii Shestopalov[2] and Vladimir Panasenko[3]
[1] Bukovinian State Medical University, Ukraine
[2] National Technical University "Kharkiv Polytechnic Institute", Ukraine
[3] State Institution "State Research and Design Institute of Basic Chemistry", Ukraine

Justification of Vibroventrentic External Load During Mechanical Pressing of Glycerin-Containing Products

Igor Palamarchuk[1], Mikhailo Mushtruk[1], Igor Lypovy[2], Ievgenii Petrychenko[3] and Ivan Vlasenko[4]

[1] National University of Life and Environmental Sciences of Ukraine, Ukraine
[2] Podolsk Scientific and Technical Lyceum, Ukraine
[3] Uman National University of Horticulture, Ukraine
[4] Vinnytsia Institute of Trade and Economics of Kyiv National University of Trade and Economics, Ukraine

Hydraulic Resistance and Spray Transfer in a Stabilized Three-Phase Foam Layer

Viktor Moiseev, Eugenia Manoilo, Kalif Repko, Natalia Ponomarova and Denis Davydov

National Technical University "Kharkiv Polytechnic Institute", Ukraine

12^{30}–13^{30}	**Time for Lunch**	
13^{30}–15^{10}	**Session 7 – Manufacturing Processes I** *Chair: Katarzyna Antosz* Rzeszow University of Technology, Poland	Virtual Hall B

Prediction of Remaining Lifetime of the Mold for the Composite Manufacturing

Andrii Kondratiev[1], Svitlana Purhina[2], Anton Tsaritsynskyi[2], Maryna Shevtsova[2] and Tetyana Nabokina[2]

[1] O.M. Beketov National University of Urban Economy in Kharkiv, Ukraine
[2] National Aerospace University "Kharkiv Aviation Institute", Ukraine

Finite Element Simulation of Diamond Grinding

Janos Kundrak[1], Vladimir Fedorovich[2], Dmitriy Fedorenko[2], Yevheniy Ostroverkh[2] and Larisa Pupan[2]

[1] University of Miskolc, Hungary
[2] National Technical University "Kharkiv Polytechnic Institute", Ukraine

Impact of the Tool's Flank Clearance Angle on the Pitch Diameter Accuracy of the Tool-Joint Tapered Thread

Oleh Onysko[1], Vitalii Panchuk[1], Yaroslav Kusyi[2], Zenovii Odosii[1] and Tetiana Lukan[1]

[1] Ivano-Frankivsk National Technical University of Oil and Gas, Ukraine
[2] Lviv Polytechnic National University, Ukraine

Improvement of the Efficiency of Fine Boring for Stepped Holes with a Large Diameter Range
Alexandr Orgiyan[1], Gennadii Oborskyi[1], Vitalii Ivanov[2], Anna Balaniuk[1] and Vasyl Kolesnik[1]
[1] Odessa Polytechnic National University, Ukraine
[2] Sumy State University, Ukraine

Simulation Studies of High-Speed Machining
Vadym Stupnytskyy, Oleh Prodanchuk and Nataliya Stupnytska
Lviv Polytechnic National University, Ukraine

Deformation Zone Scheme Clarification during Deforming Broaching
Ihor Shepelenko, Yakiv Nemyrovskyi, Mykhailo Chernovol, Andrii Kyrychenko and Ivan Vasylenko
Central Ukrainian National Technical University, Ukraine

Investigation of the Surface Layer Hardness when Grinding Sintered Porous Workpieces
Oleg Zabolotnyi[1], Tetiana Bozhko[1], Tetiana Halchuk[1], Olha Zaleta[1] and Dagmar Caganova[2]
[1] Lutsk National Technical University, Ukraine
[2] Slovak University of Technology in Bratislava, Slovak Republic

Preliminary Abrasive Blasting Surface Layer and Quality Assurance of Detonation Coatings of Aircraft Engine Parts
Tetiana Loza, Serhii Nyshnyk, Anatolii Dolmatov and Oleksandr Skachkov
National Aerospace University "Kharkiv Aviation Institute", Ukraine

13^{30}–15^{10} **Session 8 – Energy Efficient Technologies** Virtual Hall C
Chair: Yuliia Tarasevych
AGH University of Science and Technology, Poland

Development of the Gas-Dynamic Cooling System for Gas Turbine Over-Expansion Circuit
Dmytro Konovalov[1], Halina Kobalava[1], Mykola Radchenko[2], Viktor Gorbov[2] and Ivan Kalinichenko[1]
[1] Admiral Makarov National University of Shipbuilding, Kherson Educational-Scientific Institute, Ukraine
[2] Admiral Makarov National University of Shipbuilding, Machine Building Educational-Scientific Institute, Ukraine

Reduction of Granular Material Losses in a Vortex Chamber Supercharger Drainage Channel

Andrii Rogovyi[1], Volodymyr Korohodskyi[2], Artem Neskorozhenyi[2], Iryna Hrechka[1] and Serhii Khovanskyi[3]

[1] National Technical University "Kharkiv Polytechnic Institute", Ukraine

[2] Kharkiv National Automobile and Highway University, Ukraine

[3] Sumy State University, Ukraine

Jet-Reactive Turbine Circular Efficiency

Tetiana Rodymchenko[1], Serhii Vanieiev[1], Stanislav Meleychuk[1], Michal Hatala[2] and Olha Miroshnychenko[1]

[1] Sumy State University, Ukraine

[2] Technical University of Kosice, Slovak Republic

Turbine Intake Air Combined Cooling Systems

Mykola Radchenko, Eugeniy Trushliakov, Serhiy Kantor, Anatoliy Zubarev and Olena Girzheva

Admiral Makarov National University of Shipbuilding, Ukraine

Innovative Hybrid Power Plant Design

Lyudmila Rozhkova[1], Marina Savchenko-Pererva[1], Oleg Radchuk[1], Sergey Sabadash[1] and Eduard Kuznetsov[2]

[1] Sumy National Agrarian University, Ukraine

[2] Sumy State University, Ukraine

Exhaust Heat Recovery in Integrated Energy Plant

Andrii Radchenko[1], Serhiy Forduy[2], Viktor Khaldobin[1], Oleksii Zielikov[1] and Oleksandr Rizun[1]

[1] Admiral Makarov National University of Shipbuilding, 9, Heroes of Ukraine Avenue, Mykolaiv 54025, Ukraine

[2] PepsiCo, Inc., Kyiv, Ukraine

Protection of Condensing Heat Exchange Surfaces of Boilers from Sulfuric Acid Corrosion

Victoria Kornienko[1], Roman Radchenko[2], Dmytro Konovalov[1], Viktor Gorbov[2] and Ivan Kalinichenko[1]

[1] Admiral Makarov National University of Shipbuilding, Kherson Educational-Scientific Institute, Ukraine

[2] Admiral Makarov National University of Shipbuilding, Machine Building Educational-Scientific Institute, Ukraine

Marine Diesel Engine Inlet Air Cooling by Ejector Chiller on the Vessel Route Line
Maxim Pyrysunko, Andrii Radchenko, Veniamin Tkachenko, Anatoliy Zubarev and Artem Andreev
Admiral Makarov National University of Shipbuilding, Ukraine

15^{10}–15^{20}	**Technical Break**	
15^{20}–16^{30}	**Session 9 – Manufacturing Processes II** *Chair: Vadym Stupnytskyy* Lviv Polytechnic National University, Ukraine	Virtual Hall B

Surface Defects Detection on Pressure Die Castings by Machine Learning Exploiting Machine Vision Features
Zoe Papagianni,
George-Christopher Vosniakos
National Technical University of Athens, Greece

Discontinuous Generating Gear Grinding Optimization
Vasily Larshin[1], Olga Babiychuk[1], Oleksandr Lysyi[2] and Sergey Uminsky[3]
[1] Odessa Polytechnic National University, Ukraine
[2] Odessa Military Academy, Ukraine
[3] Odessa State Agrarian University, Ukraine

Ensuring the Quality of Conical Mating Surfaces Processing by Diamond Honing
Eshreb Dzhemilov[1], Alper Uysal[2], Chingiz Yakubov[1] and Ruslan Dzhemalyadinov[1]
[1] Crimean Engineering and Pedagogical University named after Fevzi Yakubov, Republic of Crimea, Ukraine
[2] Yildiz Technical University, Turkey

Influence of Turning Operations on Waviness Characteristics of Working Surfaces of Rolling Bearings
Valentyn Zablotskyi[1], Anatolii Tkachuk[1], Serhii Prozorovskyi[1], Valentyna Tkachuk[1] and Marek Waszkowiak[2]
[1] Lutsk National Technical University, Ukraine
[2] Wyzsza Szkola Kadr Menedzerskich, Poland

A New Method for the Monitoring Cutters States in Finishing Turning of Hard Materials
Oleksandr Derevianchenko, Oleksandr Fomin and Natalia Skrypnyk
Odessa Polytechnic National University, Ukraine

15^{20}–16^{30} **Session 10 – Mechanical Engineering II** Virtual Hall C

Chair: Alper Uysal

Yildiz Technical University, Turkey

Reducing Working Fluid Pulsations in Planetary Hydraulic Machines by Rational Design of the Distribution Systems

Oksana Yeremenko[1], Mamadamon A. Abdullo[2], Nataliia Boltianska[1], Stepan Mikhalchenko[3]

[1] Dmytro Motornyi Tavria State Agrotechnological University, Ukraine

[2] Tajik Technical University named after academician M. Osimi, Tajikistan

[3] State Biotechnological University, Ukraine

Model of the Pneumatic Positional Unit with a Discrete Method for Control Dynamic Characteristics

Mikhaylo Cherkashenko[1], Oleksandr Gusak[2], Aleksandr Fatyeyev[1], Nadezhda Fatieieva[1] and Alexander Gasiyk[1]

[1] National Technical University “Kharkiv Polytechnic Institute”, Ukraine

[2] Sumy State University, Ukraine

Influence of the Design Features of Orbital Hydraulic Motors on the Change in the Dynamic Characteristics of Hydraulic Drives

Anatolii Panchenko[1], Angela Voloshina[1], Shahriyor S. Sadullozoda[2], Oleg Boltyansky[1] and Valeriia Panina[1]

[1] Dmytro Motornyi Tavria State Agrotechnological University, Ukraine

[2] Tajik Technical University named after academician M. Osimi, Tajikistan

Day 4: June 10, 2022, Friday

***Polish time (GMT+2) is used for all sessions.**

9^{00}–10^{40} **Session 11 – Advanced Materials I** Virtual Hall D
Chair: Jozef Husar
Technical University of Kosice, Slovak Republic

Axial and Lateral Buckling Characteristics of Basalt/Carbon Hybrid Composite Laminates
Ozkan Ozbek[1], Omer Yavuz Bozkurt[2] and Ahmet Erklig[2]
[1] Kilis 7 Aralık University, Turkey
[2] Gaziantep University, Turkey

Impact of Thermomechanical Phenomena in the Surface Layer of Functional-Gradient Materials on Quality Considering Hereditary Defects
Maksym Kunitsyn, Anatoly Usov and Yulia Sikirash
Odessa Polytechnic National University, Ukraine

Control of the Physical and Mechanical Properties of Mixtures Based on Liquid Glass with Various Fillers
Tetiana Berlizieva[1], Olga Ponomarenko[1], Igor Grimzin[2], Nataliia Yevtushenko[1] and Oleg Khoroshylov[3]
[1] National Technical University “Kharkiv Polytechnic Institute”, Ukraine
[2] Research and Production Center "European Engineering Technologies", Ukraine
[3] Ukrainian Engineering and Pedagogical Academy, Ukraine

Catalytic Growth of Carbon Nanostructures in Glow Discharge
Andrii Breus, Sergey Abashin, Ivan Lukashov, Oleksii Serdiuk, and Oleg Baranov
National Aerospace University, Ukraine

Metallographic Determination of the Number and Sizes of Grains Depending on Structural and Phase Changes in the Metal of Welded Steam Pipe Joints
Olena Harashchenko[1], Vitaly Dmytryk[1], Viacheslav Berezutskyi[1] and Tetiana Syrenko[2]
[1] National Technical University “Kharkiv Polytechnic Institute”, Ukraine
[2] Kharkiv National Automobile and Highway University, Ukraine

Influence of Additives Processed by Physical Fields on Tribotechnical Properties of Polymer Composites
Vitalii Kashytskyi, Oksana Sadova, Mykola Melnychuk, Petro Savchuk and Oleksandr Liushuk
Lutsk National Technical University, Ukraine

Mechanisms of the Structure Formation of Soldered Seams when Using Composite Solders
Vladimir Lebedev[1], Ivan Vegera[1], Eshreb Dzhemilov[2] and Ruslan Dzhemalyadinov[2]
[1] Physical and Technical Institute of the National Academy of Sciences of Belarus, Belarus
[2] Crimean Engineering and Pedagogical University named after Fevzi Yakubov, Republic of Crimea, Ukraine

Mathematical Modeling of Processes and Equipment for the Manufacture of Electrode Carbon Graphite Products
Serhii Leleka, Anton Karvatskii, Ihor Mikulionok, Victor Vytvytskyi and Olena Ivanenko
National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Ukraine

10^{40}–10^{50} **Technical Break**

10^{50}–12^{30} **Session 12 – Advanced Materials I** Virtual Hall D
Chair: Dmytro Lesyk
National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Ukraine; West Pomeranian University of Technology, Poland

An Increase in Tribocharacteristics for Highly Loaded Friction Units of Modern Equipment
Alexander Stelmakh[1,2], Ruslan Kostunik[2], Volodymyr Radzievskyi[2], Sergii Shymchuk[3] and Natalia Zaichuk[3]
[1] Beijing Institute of Technology, China
[2] National Aviation University, Ukraine
[3] Lutsk National Technical University, Ukraine

The Effect of Deposition Conditions and Irradiation on the Structure, Substructure, Stress-Strain State, and Mechanical Properties of TiN Coatings
Nataliia Pinchuk, Mykola Tkachuk, Mariia Zhadko, Hanna Kniazieva and Andriy Meilekhov
National Technical University "Kharkiv Polytechnic Institute", Ukraine

Theoretical and Experimental Studies of the Properties of Porous Permeable Materials Obtained from Industrial Waste
Oleksandr Povstyanoy[1], Nataliya Imbirovich[1], Valentyna Tkachuk[1], Rostyslav Redko[1], Olga Priadko[2]
[1] Lutsk National Technical University, Ukraine
[2] National University of Life and Environmental Sciences of Ukraine, Ukraine

Calculation of Thermal Stresses in Oxide Layers Synthesized on Cu Substrates
Oleksandr Shorinov
National Aerospace University "Kharkiv Aviation Institute", Ukraine

Protection of Paper Surface from Water Wetting by Two-Layer Siloxane (TEOS/PEHS) Coating
Nina Merezhko[1], Volodymyr Komakha[1], Olga Komakha[1], Valentyna Tkachuk[2] and Oksana Rechun[2]
[1] Kyiv National University of Trade and Economics, Ukraine
[2] Lutsk National Technical University, Ukraine

Erosion Processes on Copper Electrodes Applied to Growth of Nanostructures in Plasma
Yurii Shyrokyi and Gennadiy Kostyuk
National Aerospace University "Kharkiv Aviation Institute", Ukraine

New Technology for Producing Castings from Magnesium Alloys with Increased Corrosion Resistance
Tatiana Lysenko[1], Kyryll Kreitser[1], Evgeny Kozishkurt[1], Vadym Dotsenko[1] and Olga Ponomarenko[2]
[1] Odessa Polytechnic National University, Ukraine
[2] National Technical University "Kharkiv Polytechnic Institute", Ukraine

12^{30}–12^{40} **Technical Break**

12^{40}–13^{30}	**Session 13 – ICT for Engineering Education** *Chair: Mykola Melnychuk* Lutsk National Technical University, Ukraine	Virtual Hall D

The Design of Workplaces with Augmented Reality in Engineering Education
Jozef Husar, Lucia Knapcikova, Stella Hrehova and Michal Balog
Technical University of Kosice, Slovak Republic

Using Telegram Bots for Personalized Financial Advice for Staff of Manufacturing Engineering Enterprises
Vitaliy Kobets and Serhii Savchenko
Kherson State University, Ukraine

Development of Materials Science Virtual Laboratory Work for the Metal Grains Calculation
Kristina Berladir[1], Tetiana Hovorun[1], Oleksandr Gusak[1], Vita Pavlenko[2] and Anatoliy Ruban[1]
[1] Sumy State University, Ukraine
[2] Machine Building College of Sumy State University, Ukraine

Integration of End-to-End and Dual Learning as a Guarantee of Quality Professional Training for Future Power Engineers
Karine Gorbunova[1], Viktor Nagayev[2], Svitlana Litvinchuk[1], Kateryna Ulitina[1] and Tetiana Gannichenko[1]
[1] Mykolayiv National Agrarian University, Ukraine
[2] State Biotechnological University, Kharkiv

13^{30}–14^{00}	**Closing Ceremony** *Chair: Vitalii Ivanov* Sumy State University, Ukraine	Virtual Hall D

Looking forward to meeting you at DSMIE-2023!

Keynote Speakers

Keynote Speaker

George-Christopher Vosniakos,
Ph.D., Professor,
Director of Manufacturing Technology Laboratory,
National Technical University of Athens, Greece

George-Christopher Vosniakos studied Mechanical Engineering at the National Technical University of Athens (NTUA), Greece, and obtained an MSc. degree in Advanced Manufacturing Technology (1987) and a Ph.D. degree in Intelligent CAD-CAM interfaces (1991) from UMIST (UK). He has worked in the CAD/CAM industry in Germany and as a Lecturer at UMIST, UK. Since 1999 he has worked at NTUA, where he currently is a Professor of Manufacturing Systems and Director of the Manufacturing Technology Laboratory. He has authored 106 Journal articles, 99 refereed conference papers, 6 book chapters, and more than 180 technical reports on Manufacturing Systems and Manufacturing Technology. He is in the top 2% of scientists worldwide in the field of “Industrial Engineering/Automation” (PLOS Biology metrics). His work has been attracted in the Scopus database with 2648 citations (h-index=19). He is a member of the editorial board of 6 major International Journals. He was a member of the Sectorial Scientific Council of Engineering Sciences of Greece (2018-2019). He has been involved in 39 research and innovation projects funded by EC, EPSRC (UK), GSRT (GR), and industrial companies. His recent research interests include: Human-robot collaboration exploiting Virtual Reality, intelligent planning of manufacturing processes, and industrial robotics in manufacturing process chains.

https://www.researchgate.net/profile/George-Christopher-Vosniakos

Keynote Speech Topic

Laser-Based Additive Manufacturing: Long Arbitrary Path Simulation in Real-Time and Power Optimisation

In SLS/SLM temperature history of a given layer, which in part depends on the trajectory's topology, greatly affects the final part's quality. Physics models have been successfully employed for predictive simulations at the lower end of the layer scale (~mm). However, an actual layer typically requires much longer laser tracks (~102 m). Thus far, they have been employed mostly for trivial scanning strategies and/or small geometries. Model-based optimization of process parameters along an arbitrary laser trajectory of significant length is an open problem. Three modeling platforms of progressively increasing scope are briefly presented: Parent Model, Surrogate Model, and Power Model. The Parent Model is a macroscopic thermal FEA modeling platform optimized for efficiency in relatively short track simulations (~mm). It implements thermal shell elements and solution accelerating techniques. Its purpose is to efficiently produce large training data sets that will support the machine learning platforms developed next. The Surrogate Model is a data-driven modeling platform based on Artificial Neural Networks (ANNs), built to perform rapid simulations on very large arbitrary trajectories (>102 m). It implements a moving black-box model paradigm that follows the laser beam, predicts peak temperature, and means density evolution along the laser path. A descriptor monitors the shape of the trajectory, as well as its history within varying memory lengths. A recursive scheme allows the Surrogate Model to process entire trajectories in parallel by using an initial estimation of the temperature feedback vector and subsequently refeeding and refining its results. The Power Model extends the Surrogate Model by incorporating variable laser power in the input vector, thus exposing an independent variable for temperature regulation. A one-step-ahead algorithm is initially conceptualized to serve as an efficiency benchmark. Then, an improved adaptive control law is implemented, which can be applied to the entire power profile in parallel. The proposed framework successfully leverages the extreme efficiency of the developed data-driven model to provide an innovative solution for dynamic process optimization.

Keynote Speaker

Dariusz Mazurkiewicz,
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DSMIE Conference Series

Dariusz Mazurkiewicz is a professor of mechanical engineering at the Lublin University of Technology, Poland. His research interests include production engineering, especially regarding maintenance and technical infrastructure reliability. He is the Editor-in-Chief of the quarterly “Eksploatacja i Niezawodnosc - Maintenance and Reliability”. He is also the Advisory Board or Board of Editors member of such journals as “Heliyon: Engineering” (Elsevier), “Aviation Journal”, “Advances in Military Technology”, “Archives of Transport”, “International Journal of Reliability and Safety”, and “Applied Sciences” section “Mechanical Engineering”. Previously he was a visiting scholar or research fellow of the Cambridge University Engineering Department (Cambridge, UK), Kobe University (Kobe, Japan), and the System Research Institute (Polish Academy of Sciences, Warsaw, Poland). His research skills and experience are in maintenance and reliability, predictive maintenance, IIoT, numerical modeling, transportation systems (including mining technology), mining engineering technology, production engineering, data mining, artificial neural networks and fuzzy logic, innovation, and regional innovation policy. He is an expert of the European Commission, Research Executive Agency. Member of the Scientific Committee of the Motor Transport Institute (Warsaw, Poland), nominated by the Minister of Infrastructure and Construction of the Republic of Poland. A visiting professor at the Beihang University (China), Poznan University of Technology (Poland), and a visiting research fellow at the Sumy State University (Ukraine). He was a keynote speaker at several international conferences.

https://www.researchgate.net/profile/Dariusz-Mazurkiewicz

Keynote speech topic

Digital Twin-Driven Reliability Research Challenge

Manufacturing companies operating in today's competitive business environment are forced to constantly meet the needs of their customers, offering them the highest quality products while ensuring the best sustainable results (economic, environmental and social). In order to achieve this, the decision-makers who have an impact on the functioning of enterprises need to make efforts to continuously monitor and improve a production process. In contrast, the difficulty of the production management process constantly increases. On the one hand, this is caused by a number of factors that the decision-makers should consider in the production management process, both external (e.g., competition activities, changing customer and legal requirements) and internal (the need to constantly reduce production costs and increase productivity). On the other hand, the amount of information that the decision-maker has to take into account also influences the difficulty of the decision. The implementation of automation for data analysis and interpretation has become inevitable. The ongoing technological revolution has established the need for proper and effective analysis of big datasets collected by the systems to monitor machine and machinery component conditions. There is no doubt that effective and intelligent manufacturing data source integration, connection, as well as-in particular-intelligent data processing, and information exchange with automatically performed executive actions are highly required by innovative factories. Therefore, many experts point out that future research directions in engineering will focus on creating intelligent sensors and their integration by means of digital systems and intelligent platforms. It has consequently led to a growing interest in the concept of a digital twin, its capabilities, and potential applications due to the fact that the digital twin is known as a key enabler for digital transformation. All the above also applies to the area of reliability, thus fostering the creation of smart maintenance, i.e., a subset of the smart manufacturing system represented by self-learning and smart machines that predict failure, make diagnoses, and trigger maintenance actions, also with DT support. From this point of view, some important aspects of production systems reliability management based on time series modeling with digital twin support will be discussed and presented.

Keynote Speaker

Szymon Wojciechowski,
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Faculty of Mechanical Engineering,
Poznan University of Technology, Poland

Szymon Wojciechowski is an associate professor and a Vice Dean for Science at the Faculty of Mechanical Engineering, Poznan University of Technology, Poland. His scientific interests concern mainly the modeling of dynamic phenomena and technological effects of precise/micro-cutting of difficult-to-cut materials. The result of scientific work is the authorship or co-authorship of over 85 publications indexed by the Web of Science and Scopus databases (e.g., publications in such journals as: International Journal of Machine Tools and Manufacture, Wear, Journal of Cleaner Production, Composites Part A, Applied Surface Science), participation in many scientific projects, patents, and industrial implementations, as well as many Polish and international awards for scientific activities. Moreover, professor Szymon Wojciechowski is an expert in Polish and European scientific organizations, including the Polish Ministry of Education and Science and the Hungarian National Research Development and Innovation Office.

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Keynote speech topic

Selected Problems Related to Mechanics of Micromilling Operations

The development of the precision and micromachining processes results from a growing demand for reduced mass and dimensions of manufactured products and the highest surface quality and dimensional accuracy while reducing production costs. Nowadays, the main application area of these techniques involves the production of elements made of titanium alloys and stainless steels, intended for the biomedical industry, such as bone and joint implants and parts for the neurovascular system. These technologies are also used to produce microelectrodes and microforms from hardened alloy steels and elements of bio-microelectromechanical systems (bio-MEMS). The extreme requirement towards a surface quality constitutes the fundamental objective of the precision and ultra-precision manufacturing processes. Therefore, recognizing specific physical phenomena occurring during these techniques and selecting input parameters that enable simultaneous improvement of a machined surface quality together with process stability and tool life are of high scientific importance. This presentation discusses the fundamental aspects of micromilling mechanics, including the chip decohesion process, ploughing and shearing forces, and the chip thickness accumulation phenomenon. The discussed problems are presented using analytical, numerical, and experimental approaches.

Keynote Speaker

Sahin Yildirim,
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Sahin Yildirim received the MSc. degree in Mechanical Engineering in 1990 from Erciyes University, Turkey. He received his Ph.D. degree in 1998 from System Engineering Department, Cardiff University, UK. He established Mechatronic Engineering Department in 2005 in Kayseri, Turkey. He is Head of the Mechatronic Engineering Department and Head of the Foreign Relations Office of Erciyes University. He lectured the control theory, robotics, and neural network applications in engineering at Erciyes University, Turkey. He has supervised some national and international projects such as mobile nurse robot design and control, active vehicle system design and control, 2 legged walking robot control. He has reviewed more than 100 papers. He is also the author of more than 140 journal and conference papers. He is currently supervising more than 30 Ph.D. and MSc. students. His research area consists of Neural Networks, Control Theory and Applications, Mobile and Industrial Robots, Vehicle Dynamics and Control.

https://www.researchgate.net/profile/Sahin-Yildirim-2

Keynote speech topic

Intelligent Mechatronic Systems Applications in Engineering

This paper presents some experimental applications using intelligent systems such as sensors, controllers, robotic systems, and crane systems. A Mobile robot design, path planning, and applications in real-time are proposed for blind people. A proposed A* algorithm is used for path planning of the mobile robot. Moreover, an image processing structure predicts the path without touching obstacles. An industrial robot is used with image processing to classify universal materials.
On the other hand, a new walking performance six-legged mobile robot control is proposed to analyze the stability and walking conditions of the robot by using an open, dynamic engine solution. Furthermore, a designed and controlled crane system is proposed for vibration and amplitude analysis of the double bridge crane system. On the system, a prosed neural predictor is used to analyze performance. Analysis and control of the welding position of an industrial robot are also utilized to compare with the operator-based welding process structure. The results improved that all the proposed analysis has superior performance in real-time applications for all approaches.

Keynote Speaker

Vladimir Dolgikh,
Ph.D.,
Global Course Owner and Trainer,
Seco Tools AB, Sweden

Vladimir Dolgikh obtained an MSc. degree in “Machine Building Technology” at Sumy State University in 1999. Then he got a Ph.D. degree at the National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute” in “Metal Science and Heat Treatment”. In 2005 he joined Seco Tools as a technician. Since that moment, he has taken various positions, and now he is working as a “Global Course Owner and Trainer” at the Learning and People Development Department of Seco Tools (Sweden). The primary responsibilities of Dr. Vladimir Dolgikh are: to develop and deliver competitive training programs and courses (offline and online), maintain the training programs according to the company strategy, and support people in their professional and personal development in all their subsidiaries worldwide.

“I believe in people and expect that they want to contribute when they get the chance. I’m proud to be a part of such a great company – Seco Tools”.

Keynote speech topic

A People Company in the Machining Business

Seco Tools is a global company with roots and headquarters in Fagersta, Sweden. We are presently in more than 75 countries and employ about 4,200 employees. Our company's name comes from Latin; it means 'I cut'. Our solutions are based on our high-quality tools in indexable milling, solid milling, stationary, holemaking, and tooling systems. We match and exceed your expectations with products, services, knowledge, and experience by working in close partnerships and adding a personal touch: "You are special, we see your needs, and we try to do something extra when solving your problems." Seco Tools makes the difference for you. Making your lives less complex is key to us. We support the entire manufacturing journey through the products and services we offer, from promises made to you to final delivery.
We aim to be recognized for responsible manufacturing and resolute actions on sustainability. Our solutions and our technical advice ensure high-precision machining and high-quality output. We love to help our customers with this, support them, share experiences and solve technical challenges. This engagement follows that we should assist manufacturers through the next manufacturing era. Making our customers' lives less complex will be essential. And we should help them make their manufacturing faster, easier, and more sustainable. We are not just a product company nor a software or service company. We aim to be a faithful people company. A company where we collaborate well and where we inspire and challenge each other. Seco has a unique culture that involves leadership and a strong sense of belonging and purpose among employees. The employee experience we want to encourage everyone is empowered to drive development, supportive collaboration, mobility, and global opportunities, inspiring personal development, and making a valuable contribution to society. We believe that this type of company attracts and excites people. The belief in people and the expectation that they want to contribute when they get the chance. The future of manufacturing: any shape in a day, sustainable in every way.

Keynote Speaker

Krystian Kogut,
M.A., B.A.,
Member of the Board and International Sales Director, InterMarium Sp. z o.o.,
Member of the Board, IntermariuM Foundation, Poland

Mr. Kogut is a Management Board Member and International Sales Director at InterMarium company – the exclusive FlexSim Simulation Software distributor in Central and Eastern Europe. He is also a Member of the Board at the IntermariuM Foundation. Mr. Kogut's professional efforts are focused on promoting the use of advanced process simulation technology, as one of the core elements of Industry 4.0, in various business areas and education. With IntermariuM Foundation, he also promotes the integration and cooperation of Central and Eastern European countries.

Przemysław Pasich,
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Simulation Engineer,
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Mr. Pasich is a simulation engineer at Flexsim InterMarium. He received his degree in Manufacturing Engineering from Cambridge University. His professional interest revolves around employing digital simulation to solve various production flow and logistical problems.

Keynote speech topic

Process Simulation Technology in Modern Didactics on the Example of Decision Games Created in FlexSim Environment

Even though computer-aided simulation, in general, has been known and applied for decades, we have seen an increase in the popularity of this technology in recent years. Simulation became a crucial part of Industry 4.0 (Smart Manufacturing) in leveraging real-time data and mirroring the physical world in a virtual model, including machines, products, and humans, thereby allowing to, e.g., drive down machine setup times. The simulation focuses on processes and process improvement. It is a core component for making operations systems better. It supports problem-solving and decision-making activities during the design and management of operations systems by predicting a system's performance under a variety of conditions, thus facilitating the comparison of alternatives. It also provides a valuable means for helping all stakeholders understand and assess a system's behavior, especially the operational dynamics that result from internal changes in work methods, requirements, layout, resource availability, etc., and external changes in product definition, product mix, due dates, resource availability, etc. One of the leading simulation tools is FlexSim. It is a comprehensive simulation modeling and analysis environment with extensive capabilities. The basic operation of FlexSim involves the creation and execution of events that are based on the logic specified in a model. The events generate actions and activities that occur over time. The simulated events and the model's current state define the flow of the items within. Throughout a simulation, information on the conditions (or states) of a system is gathered, summarized, and displayed for analysis. Typically, the summary information, such as average state values, is used to compare the performance of alternative systems. FlexSim is a tool used widely in universities around the world. It is helpful in research, didactics, and student projects or theses. It also provides an additional platform for cooperation between education and business. An example of using a FlexSim environment in modern education is decision-making simulation games developed by InterMarium, also operated with the help of VR devices.

Abstracts
Part I
Smart and Sustainable Manufacturing

Mechatronic Actuator for Adaptive Machining Control

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The paper discusses the principles of operation and fundamentals of the theory of a lineal mechatronic actuator for adaptive machining control (cutting, grinding, polishing, etc.). Structurally, the actuator is made according to the scheme of a linear DC electric motor containing a fixed stator field winding and a movable armature winding. Both windings (fixed and movable) are located coaxially on one cylindrical ferromagnetic core and interact in such a way that the movable armature is in a dynamic equilibrium state under the action of two oppositely directed forces: electromagnetic and electrodynamic ones. The electromagnetic force is due to the non-symmetrical arrangement of the armature winding on the ferromagnetic core relative to the center of its mass. The electrodynamic force is caused by the action of the magnetic field of the field winding on the armature winding through which the regulated current flows. The armature winding is rigidly connected to an axially displaced actuating element carrying a cutting or pressing tool, including a rotating one. It is established that the electromagnetic force is proportional to the difference in the magnetic permeability of the ferromagnetic core and the vacuum, and the electrodynamic force is proportional to the magnitude of the currents in the field and armature windings. The mechatronic actuator operating characteristics showing the effect of the regulated currents on the axial force are experimentally constructed.

Keywords: Industrial Growth, Process Innovation, Linear Actuator, Power Mechanism, Dynamic Equilibrium, Reciprocating Motion, Cutting Force, Field Winding, Mechanical Machining.

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Design and Validation of a Feeding System for the Systematic Production of Needle Beds

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With the increasing quality standards of the electronic industry, especially in Printed Circuit Boards, the In-Circuit-Test Machines are becoming one of the most important systems on the production lines. Higher requirements are being set, pressing the In-Circuit-Test Machines production process to meet the necessary quality parameters, mainly precision and reliability. One of the possible approaches to update the manufacturing process of the In-Circuit-Test Machines is to automatize the process from a technological point of view. The automation of the process was divided into several sub-functions, one of them and the paper's focus, the feeding system. To achieve a desirable solution, the problem was analyzed, several solutions were studied within the state of the art, and two original solutions were proposed to solve the problem. The decision process followed engineering criteria through simulation and efficiency parameters, and it culminated in the proposal of a final solution. A prototype for the final solution was tested, and the results were presented.

Keywords: Industrial Growth, Product Innovation, In-Circuit-Test Machines, Machine Design, Feeding Systems.

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An Increase in the Efficiency of Selected Production Processes Using Lean Tools

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The uncertainty of today's globalized economy requires prompt responses by companies, responding to rapid changes in customer demand. The last thing a company wants is an inflexible production system that cannot respond quickly. Companies' situation largely depends on reacting promptly to changing customer requirements. Of course, all these activities must also generate some profit for society. In achieving its objectives, the company must pay particular attention to reducing production costs. Therefore, improving production processes is becoming increasingly important. The improvement consists in identifying and eliminating losses that occur in production. Managing and improving business processes is a regular part of a successful company, no matter which segment the company operates. With increasing competition in a market economy, it is essential to optimize production processes. The textile market is oversaturated, supply exceeds demand, and companies have to put an even bigger stop on streamlining internal processes. It is mainly a matter of eliminating waste from various sources and does not add value for consumers' willingness to pay. This paper aims to use selected lean manufacturing tools to minimize inefficient work activities and time losses.

Keywords: Lean Tools, Manufacturing, Efficiency, Production Process, Industrial Innovation.

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Quality Control Monitoring in 3D Printing

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Online monitoring of the 3D printing process is one of the keys to ensuring product quality and improving the efficiency of the printing process. The technological system of 3D printing presented in the paper can be considered as an information system that has basic parameters: input, state, and output. The analysis of sensors and devices of online monitoring systems was summarized in two directions, as their state parameters or output parameters. In contrast to the first one, the second direction has excellent prospects since it allows direct monitoring of the object quality parameters. Still, the decision-making algorithms must be fast and reliable. A computer vision approach has become widespread to implement the direction of online monitoring of surface quality. The detection of defects using computer vision at various stages of the printing process, especially at the initial stage (the formation of the first layer), will help to take timely corrective measures and prevent the printing of low-quality parts. A defect "stringy first layer" is often observed in the FDM method. Computer vision method to detect this defect has been investigated. The method allows determining the defect presence quickly and quantifying it by the number of detected pixels. This method can successfully serve the purpose of real-time quality monitoring of a 3D printing process.

Keywords: Additive Manufacturing, 3D Printing, FDM Method, First Layer, Quality Monitoring, Process Innovation, Sustainable Manufacturing.

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Motorcycle Rider Assistance System for Obstacle Detection with Visualization in the Rider's Visual Area

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This work describes a design study of motorcycle rider's assistant system. The main reason was to design affordable and useful safety devices for every motorcycle rider. The study includes a detailed design of a sensory unit placed on the motorcycle and a visualization unit with HUD (Head-Up Display) placed on the rider's helmet. The sensory unit contains an infrared sensor for range detection of vehicles in front of the motorcycle, a camera for pedestrian detection and traffic sign recognition, and a combination of IMU (inertial measurement unit) and GPS (global positioning system) sensors for independent speed determination both in open and enclosed areas. Displaying unit contains two displays and a head-up display with a single combiner without a collimating lens. The microcontroller of the sensory unit is Raspberry Pi 3b+ and of displaying unit is ESP 32. Mutual communication is via Bluetooth connection. Work contains stress analysis and fatigue analysis of stress parts, and modal analysis of sensory unit. An ergonomic study of the rider's field of view is also included. The general software design of control software is also described.

Keywords: Sustainable Manufacturing, Product Innovation, Advanced Rider, Assistance System, Head-Up Display, Prevention, Sensor Fusion, Design, Simulation, Raspberry Pi, ESP 32, OpenCV.

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Surface Defects Detection on Pressure Die Castings by Machine Learning Exploiting Machine Vision Features

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Detection of surface defects in high-pressure aluminum die castings is of paramount importance for maintaining product quality. Visual inspection by humans is time-consuming and subject to errors and oversights. A machine vision system has been set up to capture part surface images in this work. Afterimage quality enhancement using standard transformations and filtering Regions of Interest were defined in the areas where defects are expected to appear. Noise elimination extended edge extraction followed. Corresponding descriptors were employed to identify statistical features associated with defective parts. An advanced learning process has been developed to classify parts as defective or normal, based on Feedforward Artificial Neural Networks (ANNs), which were compared to typically used Support Vector Machines. Different combinations of descriptors were tried as input to determine the best four ANNS, which were used as an ensemble to enhance robustness at overall positive recognition rates of the order of 90% despite the restricted dataset.

Keywords: Die Casting, Surface Defects, Machine Vision, Artificial Neural Networks, Support Vector Machines, Industrial Innovation.

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Cybersecurity Validation in the Online Gambling Industry

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With the development of information and communication technologies and their application in the field of the gambling industry, consequently, there is a development and expansion of the electronic form of this type of service, better known as online gambling, which can be observed as a part of Industry 4.0 concept. Significant progress in online gambling has been monitored during the COVID-19 pandemic and numerous lockdowns worldwide. In such conditions, this form of service is growing in popularity, accompanied by a sharp increase in users. This also increases the risk of numerous cyber-attacks, the successful implementation of which can cause several negative consequences for end-users and the service provider. One example of maintaining security is penetration testing, in which an expert is placed in the role of an attacker to find security vulnerabilities within the system. This research aims to establish a straightforward penetration testing process applicable in the online gaming environment. Periodic and high-quality defined penetration testing can timely detect cyber vulnerabilities, mitigate cyber threats and reduce cybersecurity risks.

Keywords: Penetration Testing, Methodology, Attack Vectors, Online Gambling, Online Betting, Smart City, Industrial Growth.

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8D Methodology for Solving Problems in the Production of PVC Pipes

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The paper aims to apply the 8D methodology in problem-solving in the production process. The research project has been carried out at a manufacturing site of PVC pipes. The authors propose a methodology that eliminates deviations from the company's work standards and helps achieve a new target state. The 8D methodology, extended by additional steps, was proposed to find effective solutions based on the lean management concept. Extension of the 8D methodology with additional steps has facilitated the building of a team with key competencies necessary for solving the identified problem, clear definition of goals, and analysis of the sequence in which the proposed solutions have been implemented, to ensure that the return on investment is achieved within the shortest possible time. The implemented solutions improve the pipe extrusion process by reducing the amount of generated waste by 12.6% and shortening the extrusion head gap adjustment process during the start-up of the manufacturing line by 16.5%.

Keywords: 8D Methodology, Problem Solving, Production Process, Process Innovation.

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Towards Sustainable Manufacturing: The Sustainable Packaging Redesign Case Study

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In the past decades, research was predominantly conducted to increase the operational efficiency and productivity of production processes. Currently, from a global perspective, a profound change in values in society is discernible. Starting from purely economic objectives of the last years, preserving the environment and a human-oriented design of socio-technical systems such as factories are becoming more and more important. In the future, this change emanating from society will also represent a major challenge for manufacturing companies to design processes and systems more sustainably. The organization's objectives are changing so that manufacturing should be more resource-efficient, generate less or no waste, and allow a safe, ergonomic, and ethically correct work environment for employees. In this article, the authors show an example of the future symbiosis between economic, ecological, and social sustainability using the example of a case study from a real SME manufacturer. This case study aims to identify more sustainable alternatives for polystyrene-based packaging and thus contribute to more sustainable manufacturing.

Keywords: Sustainability, Sustainable Manufacturing, Dual Transformation, Case Study, Industry 4.0.

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An Automated Diagnostic and Surveillance System for Eliminating the Community Spread of Infectious Respiratory Diseases in the Industry

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The article focuses on the definition of risk management in industry, which is linked to developing an automated diagnostic and inspection system based on artificial intelligence designed to eliminate risks in industrial companies. The thesis outlines the risk management process according to the current ISO standard, and the following section of the article summarizes the risk management options available to businesses. The article also discusses the numerous strategies that can be used to lessen the risk of working with automated systems in industrial settings. A critical element in the spread of COVID-19 is the failure to maintain a sufficient distance between people (workers) and the late detection of the symptoms of this disease. Monitoring unjustifiable aggregation of workers and early detection of symptoms such as characteristic cough and temperature makes it possible to reduce or significantly eliminate the spread of this disease in the engineering company.

Keywords: Engineering, Industry, Safety, Sustainable Manufacturing, Industrial Growth.

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Correlation between Accidents on Selected Roads as Fundamental for Determining the Safety Level of Road Infrastructure

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The objective of the present publication was to determine whether the application of a statistical tool, analysis of the correlation between accidents that occur on roads before and after their modernization, can constitute the basis for creating a method for assessing the safety level of road infrastructure. It constitutes an entirely new approach to the methods used so far, aiming to determine high-risk zones/sections based solely on the number of accidents in the area covered by the analysis. Due to the general availability of data, the presented method can be both widely applied in practice and a tool to verify the correctness of specific risk factors contributing to the occurrence of undesirable road incidents. The conducted research allowed us to determine the correlation between the average number of accidents on alternative roads before the expressways/motorways were constructed and the average number of accidents on alternative routes after their completion is high. The situation is different in the case of the correlation between the average annual number of accidents on an alternative road before the completion of an expressway/motorway and the yearly average number of accidents on newly constructed sections. The results of our research suggest that the analysis of the correlation between accidents may constitute the basis for the development of a new method for assessing the level of road infrastructure safety.

Keywords: Industrial Growth, Transport, Transportation Engineering, Transport Systems, Highway Engineering.

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Principles of Forming the Organizational Structure of the Enterprise Energy Management System

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The paper describes the problems and contradictions description in the formation of the organizational structure of energy management systems. This work covers the Ukrainian regulatory acts and international standards that are providing methodologies of implementation and evaluation of effective energy management systems. Problems of implementation of these systems are highlighted. The effectiveness of enterprise energy management is provided by the common use of information systems, which can only increase through flexible data management and adopting the basic principles of organizational methods. To reduce the influence of the 'human' factor, it is necessary to transfer to the lower level the issues of monitoring or control and the issues of decision-making, thereby changing the concept of building and developing the system. In such conditions, the energy management process does not become a unique process established to achieve specific goals - it becomes an integral part of any production, technological, social process in which energy resources are directly or indirectly involved. Modern trends in energy management demand integration between the existing informational subsystems providing support to the decision-making process at the operational level and at the strategic management level to create a comprehensive Enterprise Energy Management System.

Keywords: Industry 4.0, Energy Efficiency, Energy Consumption, Enterprise Energy Management System, Organizational Structure.

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Part II
Design Engineering

An Element Deletion Algorithm for an Open-source Finite Element Software

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In a fracture analysis, predicting the fracture location and the progression of the failure is of high importance. An element deletion algorithm is a powerful tool used to visualize the failure evolution and get rid of the distorted elements that prevent the simulation from converging. Primarily, such an algorithm is only found in commercial software such as Abaqus. A similar algorithm was developed and implemented into the Code_Aster platform in this work. The algorithm's effectiveness was tested through a non-linear analysis on a Cor-Ten specimen with notches under uniaxial tension. The element deletion functionality was implemented by defining a virtual material with low stiffness to the deleted elements. The results obtained demonstrated the code's capability in accurately representing the failure progress along the notches. Moreover, by assigning a virtual material to the deleted elements, a complete fracture of the specimen is observed without facing any convergence issues. Overall, the shape of the fracture for a notched specimen conforms well to the physical failure of a ductile material such as Cor-Ten.

Keywords: Code_Aster, Fracture Modeling, Numerical Analysis, Sustainable Manufactucturing.

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Conceptual Design of an Automated Workstation for the Control of Manufactured Products in Single-Purpose Machines

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The article describes the solution of an automated line for the industrial company, where there was a requirement for inspection of manufactured parts and inspection of assembly of parts, including the design of an automated workstation (robotic workcells, assembly stations, inspection stations, operators, etc.). Camera systems that use artificial intelligence to determine the contour can check the shape of the gears involved. The main requirement to control production by camera systems arose because of human resources' time-consuming nature of the visual inspection. The article provides an overview of camera systems used in engineering companies that capture images of objects, and then these images are further processed in detail through software tools. Properly designing the automated workplace inspection through cameras consisted of collecting data from the company - lighting in production, material reflectivity, etc. Based on the obtained data, specific types of cameras from specific manufacturers were selected and placed at the necessary locations in the automated production.

Keywords: Sustainable Manufacturing, Camera Systems, Automated Manufacturing, Machine Vision, R&D Investment.

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The Anti-Collapse Safety System for Hydraulically Operated Docking Levelers

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During the crossing of the docking leveler by the logistics equipment, there is a risk that the truck stationed in the docking station will advance far enough so that the support lip of the leveler will no longer be in contact with the floor of the truck causing the leveler to fall while being crossed by the forklift. The paper focuses on sizing a security system that eliminates the risk presented. This system consists of installing a safety valve that blocks the flow of fluid through the hydraulic motors that operate the leveler. Valve blockage occurs when a limit flow is reached. The maximum drop at the tip of the leveler's lip is h=6% of the docking leveler platform length (in the vertical plane) until the valve is blocked. It must be taken into consideration that the safety valve should not be actuated during the operation of the leveler not to influence its operating sequences. The paper presents the kinematic diagram of the docking leveler, its functional sequences, the calculation of the actuation and sizing of the safety valve, and the indication of a type of valve recommended following the sizing calculations of the safety system. This paper aims to solve a problem in the industry of docking levelers and their operation in safe warehouses.

Keywords: Product Innovation, R&D Investment, Valve, Flow, Kinematic, Velocity, Leveler, Safety, System, Hydraulic.

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Development of the Disk Tool Magazine with Modified Gear Drive

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The problems of modeling and research of disk tool magazines of drilling-milling-boring machining centers are considered. Three-dimensional modeling of the tool magazine structures and auto operator devices (manipulator) as the main components of the automatic tool change system during processing body parts has been carried out. The integrated computer-aided design system and specialized applied libraries in the express mode of 3D modeling were used. A new approach to improving the drive device of the tool magazine is proposed, based on the modification of the gear drive design using an incline-arched profile of the teeth. The design technique of its closest analogue – a cylindrical gear transmission with helical teeth according to the criterion of contact endurance of the teeth as the main method for the calculation was adopted. An experiment is carried out to assess the main kinetic-geometric parameters of spur gears with incline-arched teeth. The relationship between the engagement parameters and the size of the gear cutting head has been established. The extreme values of the inclination angles for the incline-arched teeth for the given basic dimensions of the transmission have been determined. Dependences for calculating the longitudinal curvature and length of the cut teeth are obtained to research the bending strength of the transmission teeth.

Keywords: Disk Tool Storage, 3D Modeling, Gear Transmission, Teeth Profile, Incline-Arched Form, Product Innovation.

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Improvement of the Computer-Aided Design for Interference Fit Based on the Generalized Design Selection Criteria

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The paper proposes an improved approach to finding a rational combination of numerical values of geometric parameters (diameter and working length) of interference fit in the process of their analysis based on a scientifically grounded universal criterion in the automated design of the test joint. The mentioned search was carried out within the analytically described mathematical model, which is the most important in practical terms, of the area of existence of the fit parameters of the multiparametric complex, developed by the authors in previous publications. In this case, the object of the study is geometric spatial images, which are volumetric bodies of the specified complex in the quadrants of three-dimensional space. The influence of the values of the required parameters on other values of the specified complex of models was thoroughly studied. For the first time, a generalized criterion for selecting the final design solution (standard interference fit) for a shroud joint during its thermal assembly and operation was formulated. For the selected criteria, the mathematical apparatus of the theory of *R*-functions was used together with the authors' computer software that plays the role of an effective research tool. The specific numerical and analytical results presented in work can be used to modernize the software for the computer-aided design of interference fits.

Keywords: Product Innovation, Mathematical Modeling, Area Existence, Theory *R*-Functions, Complex Parameters, Multi-Parametric Model.

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Substantiation of the Design Calculation Method for the Vibroturning Device

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The method of design calculation of the hydropulse device for radial vibration turning with the built-in generator of pressure pulses is presented in work. The structure is built based on a hydropulse vibrating drive, which provided a large specific power on the cutting tool and high compactness of the construction. The device's design calculation method is based on the results of experimental and theoretical studies of vibrating machines. The proposed method of construction calculation provides the ability to calculate the basic power, geometric, and energy parameters of the device for vibratory turning and can be used to calculate similar hydropulse devices for vibratory cutting and deformation hardening surfaces of machine parts. Based on the dependencies used in the proposed design calculation method, it is possible to optimize the design for a particular parameter, such as the speed of operation of the pressure pulse generator or the device's dimensions.

Keywords: Hydropulse Device, Ring Spring, Frequency, Amplitude, Device, Manufacturing Innovation.

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Compositional Interpolation of Spatial Discretely Presented Curves by Harmonizing Pointed Polynomials

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This study defines the point calculus Balyuba-Naidysh (point BN-calculus). The principle of the geometric interpolation method, which is carried out only based on harmonized point polynomials, is explained. A record of the characteristic function is given in general. The sequence of transition from the characteristic function to BN-coordinates, which are components of harmonized point polynomials, is presented. To solve the problem of global interpolation of spatial discrete represented curves (DPC), the definition of the metric operator of three points (MOTP), the geometric scheme of its calculation, and one of its properties, which is the basis for calculating the length of segments in space, is provided. An interpretation of the terms composition and geometric composition is given. They define how they should be understood and applied in this study. Using the MOTP, a generalized record for determining the length of the section is shown, a record of the length of the section is shown in point form, and calculation formulas are given in the coordinate form, using which its length is calculated. It is indicated that the interpolation nodes are the vertices of the accompanying broken line (ABL), which is built on the basic points of the DPC through which the interpolation curve will pass in the form of a point polynomial. The CF harmonization method for forming a harmonized point polynomial continuously interpolates the spatial DPC.

Keywords: Point BN-Calculus, Geometric Composition, Characteristic Functions, Curve, Industrial Growth.

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Part III
Manufacturing Technology

A New Method for the Monitoring Cutters States in Finishing Turning of Hard Materials

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To the quality of parts finishing turning are presented high requirements. The process of hard materials finishing turning is characterized by the emergence of different cutters defects. That's why necessary to monitor cutters' states. The scientific novelty consists of creating a new method for monitoring cutters states in finishing turning of hard materials. This method makes it possible to detect a complex of defects in the cutting part of the tool, which appeared as a result of its wear and making tolls adjusting: formation of cutting tools adjusting on the wear value; formation correction, taking into account nose radius changing; formation and analysis of a section of cutting layer and calculation the necessary correction the feed value (S); estimation the state of flank face, estimate the distance from the extreme groove to the top, calculation the necessary termination of processing. The practical usefulness of the developed method consists of providing the possibility of adjusting the cutting toll and correction of cutting conditions (following results of monitoring cutters states) by the Computer Numerical Control (CNC) system of the machine tool.

Keywords: Concentrated Wear, Nose Radius Changing, Radial Wear, Cutting Stability Loss, Sustainable Manufacturing, Industrial Growth.

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A Special Feature of Turbine Blade Deformation During Machining

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Significant obstacles in machining surfaces of thin-walled parts are their deformation and oscillatory processes directly during machining. The same parameters subsequently determine the intensity of noise from aircraft engines and, accordingly, the amount of noise at airports. The work aimed to study the influence of the conditions of fixing the blade in the fixture during finishing machining on the change in its natural vibration frequencies. The article developed an approach to analyzing this problem based on the comparison of analytical and digital models. Computer simulation and determination of natural vibration frequencies of a turbine blade are carried out when fixed in the turbine disk lock and fixed to flat surfaces in a fixture. The distributions of stresses and deflections are determined by the distributed load increase. It turned out that the discrepancy between analytical and digital models calculations reaches 12-15%. It is concluded that the natural vibrations of the blade airfoil during machining strongly depend on the conditions of its fixation in the clamping device and differ significantly from the natural vibrations of the blade fixed in the turbine lock. Therefore, at the stage of creating a manufacturing process, it is necessary to determine the natural vibration frequencies and maximum deviations of the blade airfoil to avoid the occurrence of resonance vibrations when the machining conditions change and to carry out machining within the tolerance.

Keywords: Energy Efficiency, Turbine Blade, Free Mode, Machining, Process Innovation, Deviation, Aircraft Noise.

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Ensuring the Quality of Conical Mating Surfaces Processing by Diamond Honing

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Diamond honing is the dimensional treatment of various surfaces using honing heads that rotate and reciprocate while simultaneously feeding stones in a radial direction. The high durability of diamond stones, low temperatures in the cutting zone, and low cutting forces can improve the accuracy and productivity of processing, reduce the roughness of the machined surface, apply active control, automate the honing process and increase the durability of the machine parts and mechanisms. In contrast to the processing of cylindrical surfaces, honing of tapered holes takes place with a constant change in the contact area of the tool with the machined surface, which leads to uneven removal of the allowance. This work aims to ensure the quality of tapered surface processing by honing. The experiments were carried out on industrial equipment. Considering the influence of contact pressures on the surface quality, the correction factor of the generatrix of the conical hole was experimentally determined, and the dependences of the change in the depth of penetration of the cutting grains were obtained.

Keywords: Honing, Conical Hole, Contact Pressures, Correction Factor, Roundness Deviation, Process Innovation.

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Prediction of Remaining Lifetime of the Mold for the Composite Manufacturing

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Performance capabilities of the structures made of polymeric composite materials depend on the manufacturing accuracy of the part contour. To give the specified contour to the part, it is necessary to ensure the constancy of the shape and dimensions of the tools throughout their operation, considering the peculiarity of accumulation of residual stresses by shaping surface during service. The refined model of the temperature stress-strain behavior of the tools in the process of composite products' molding to determine the equipment lifetime was developed, with the determination of the impact of properties of the material, dimensions, and shape of the shape-generating molding tools on their life. Composites provide a longer equipment lifetime at equal dimensions of the shape-generating molding tools made of different materials. A twofold increase in the thickness of the shaping surface ensures higher stiffness and, as a result, four times and three times the longer lifetime of molding tools for the metallic shaping surfaces and composites, accordingly. It was found that the physical and mechanical characteristics of the molded composite package may have a significant effect on the stiffness of the shaping surface and reduce the lifetime of extensive tools by more than three times. Based on the obtained results, the methods for increasing the lifetime can be developed for composite manufacturing.

Keywords: Life-Cycle Analysis, Manufacturing Innovation, Molding Cycles, Shaping Surface, Residual Stress-Strain Behavior.

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Finite Element Simulation of Diamond Grinding

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The paper focused on the static and dynamic modeling of difficult-to-machine materials' multi-parameter diamond grinding process. The simulation was carried out using SolidWorks Simulation, ANSYS, and LS-DYNA software packages. The influence of diamond wheels' qualitative and quantitative indicators on the stress-strain state in the cutting zone of the "bond – metal phase – grain – processed material" system was studied. The simulation considered the diamond grains' characteristics (concentration, size, depth in a bond, wear area, composition, shape, and size of metal inclusions) and the wheels bond (composition and porosity). The equivalent stresses σeq were determined depending on the total thermal and force loading. The propagation volumes of destruction stresses in the grain and the bond were analyzed according to the selected criteria. Simulation of the diamond grin-ding process allowed determining the optimal combinations of physical and mechanical properties of the bond, as well as the required characteristics of diamond grains. The conditions for rational grinding modes ensuring the self-sharpening of the wheel grains were determined. The concentration of diamond grains Cg in the diamond-bearing layer was identified as one of the most influencing factors. The Cg value should be limited to 50 % to improve the process stability and reduce the cost of diamond abrasive tools.

Keywords: Grinding Wheel, 3D Modeling, Diamond Grains, Ceramic Bond, Self-Sharpening, Manufacturing Innovation.

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Discontinuous Generating Gear Grinding Optimization

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Gear grinding on the MAAG machines allows obtaining a high degree of accuracy of gears but is characterized by a considerable investment of time. In contrast to the copying method, with MAAG discontinuous generating gear grinding, the contact zone of a grinding wheel with a flank of a tooth has a small area. As a consequence, a large number of gear grinding strokes are required to remove the unevenly spaced gear grinding stock allowance. In this regard, there is a need to optimize the gear grinding parameters, i.e., to increase these parameters so that the resulting burn layer does not exceed the remaining stock allowance for gear grinding. An optimization model is created and studied for two successive stages of the life cycle of gear: at the pre-production stage (gear grinding operation designing) and at the stage of production itself, i.e., at the gear grinding with optimal parameters - both mode parameters (grinding depths) and gear grinding power ones. The primary attention is paid to the pre-production stage, where optimization is a method of operation design. The MAAG machine is equipped with an automatic gear grinding power control system at the production stage. As the input of this system, the specified gear grinding power setpoints were found at the pre-production stage. Automatic robust gear grinding power control allows "continuing optimization" at the production stage to consider random factors that cannot be considered at the pre-production stage. Therefore, such optimization continuing at the production stage is a control method.

Keywords: Smart Manufacturing, Hierarchical Control, Optimization Model, Objective Function, Machine Time, Grinding Depth, Control System, Process Innovation.

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An Analytical and Experimental Study of the Grinding Process of Thermal Barrier Coatings with Highly Porous Wheels of Cubic Boron Nitride

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Thermal barrier coatings are widely used to protect heat-resistant alloys from high-temperature oxidation. Under the requirements arising during operation, practical application found a coating of ZrO_2. Zirconia-based ceramics are highly durable and crack resistant. In the grinding process, high contact temperatures arise, which are comparable to operating temperatures or slightly higher than these temperatures. The task in the design of the grinding process is primarily to control the thermal treatment mode to maintain it within such limits when the residual stresses have values that do not pose a danger to the durability of the sprayed layer. In addition, if the contact temperature of grinding reaches 1200 °C, the sintering of the sprayed layer begins, leading to the loss of thermal barrier properties. The main results of this work are – when grinding with highly porous CBN wheels with a structure 26 and 40, the unit cutting forces are 15–20% higher, the total cutting forces are 7–10% lower, contact temperatures are 10-15% lower. The residual stresses arising under the action of contact temperatures on the surface during grinding of pure zirconium oxide and stabilized with yttrium oxide reach values of the order of 60 MPa. However, these values are much lower than the tensile strength of the thermal barrier layer and do not lead to cracks, an increase in roughness by 1 category can be expected, grinding modes can be increased by 20–25%.

Keywords: Manufacturing Innovation, Highly Porous Wheels, Unit Force, Total Force, Unit Temperature, Contact Temperature, Temporary Stresses, Residual Stresses.

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Preliminary Abrasive Blasting Surface Layer and Quality Assurance of Detonation Coatings of Aircraft Engine Parts

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Analysis shows that one of the most rational methods of cleanings and strengthening is abrasive blasting because, in this case, a comprehensive solution to the problem occurs: developed surface relief is created, and the density of active centers increases. The urgent problem determining solid particle velocity in the Laval nozzle and beyond is solved by analytical methods in the theoretical part of the work. Expressions are obtained that make it possible to calculate velocity and particle energies when it collides with a substrate based on the kinematics of theoretical investigation studies particle propelled by a gas flow in a nozzle. The simulation of the interaction process of a particle with a substrate is carried out. Influence of energy parameters abrasive processing on the surface quality of titanium alloys parts was held in the experimental part of the work. It can be concluded that the gas flow rate and the processing time significantly affect the value of microhardness and roughness surface. Recommendations have been developed for expanding the technological capabilities of the titanium alloys' gas detonation processing.

Keywords: Process Innovation, Coating Deposition, Abrasive Blasting, Abrasive Particle Velocity, Strain Hardening, Dislocation Densities.

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Improvement of the Milling Effectiveness by Application of Composite Milling Heads

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The problem of providing the possibility of processing flat surfaces of large-sized workpieces with different widths was considered. An alternative option for multi-pass milling is the use of composite milling heads. They were designed with three face-milling cutters with intersecting blade paths. The spindle block of composite milling heads with face face-milling cutters has the ability to rotate to any angle, so it is possible to change and set the required milling width. The authors proposed a scheme for obtaining a symmetrical milling width. The rotation of the spindle unit was carried out around the central face-milling cutter, so the milling width changes symmetrically, which simplifies the preparation of the machining process. The article provides an example of a dependency of the milling width on the angle of indexing (0° – 360°) of the spindle carrier of composite milling heads containing three face mills with a diameter of D_{mill} = 315 mm. The use of the proposed composite milling head makes it possible to increase the effectiveness of the milling process based on the same cutting modes.

Keywords: Process Innovation, Industrial Growth, Face-Milling Cutter, Flat Surface, Milling Width, Spindle Carrier Rotation, Symmetrical Adjustment.

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Deformation Zone Scheme Clarification during Deforming Broaching

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The deformation zone scheme during deforming broaching is considered and clarified. It is shown that the theoretical model of the deformation zone makes it possible to reliably calculate the area dimensions of the deformation zone only for a workpiece with a wall thickness less than the critical one. It is proved that in the presence of critical contact pressures in the contact zone, zones of local plastic deformation appear at the joints of non-contact zones, considering the contact. Moreover, the front zone is an influx that increases the length of the contact area, and the rear – a step of the processed material flowing from the contact zone under the action of critical contact pressures. Experimental confirmations of these zones' presence are presented. It was found that in the presence of pressures in the contact zone less than critical, the deformation zone scheme corresponds to the scheme, which includes a contact area and two non-contact zones adjacent to it. It is shown that the local zones formation of plastic deformation has a negative effect on such parameters of processed products quality as the accuracy of the processed product, especially on the axis bending when processing parts of increased length, as well as on the resource of residual plasticity, which is especially important when processing products from low-plastic materials.

Keywords: Process Innovation, Deforming Broaching, Deformation Zone, Contact Area, Non-Contact Zone, Local Zone, Modeling, Theoretical Model.

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Impact of the Tool's Flank Clearance Angle on the Pitch Diameter Accuracy of the Tool-Joint Tapered Thread

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The profiling of high-precision tool-joint tapered threads is inextricably linked with technological aspects of their turning. It includes the geometric parameters of the turning cutting tool. Among these parameters, there is one that depends on the design of the thread. This parameter is called the cutting-edge inclination angle, and it corresponds to the helix angle of inclination of the thread. The accuracy of the threads is mainly regulated by three parameters: the accuracy of the profile, the accuracy, the pitch's accuracy, of the pitch diameter. The precision of the pitch diameter is investigated in this article in its functional dependence on the geometric parameter of the cutting tool – the cutting-edge inclination angle. Studies have shown that the magnitude of the change in the pitch diameter increases with an increasing parameter of the cutter and the helix angle of inclination. In turn, the helix angle of the inclination of the thread depends on its diameter, which means that for tool-joint tapered threads of small sizes, the change in the pitch diameter is more apparent. Theoretical research and predictive algorithms based on them have shown that for lock threads of small diameters, the deviation from the value of the pitch diameter can reach 8% of its tolerance. For the largest drilling tool-joint, this deviation is zero.

Keywords: Pitch, Threading Lathe Tool, Geometric Modeling, Convolute Screw, Process Innovation.

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Improvement of the Efficiency of Fine Boring for Stepped Holes with a Large Diameter Range

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The results of experimental studies of the efficiency of boring two-step holes with a large difference in diameters are described in this paper. Boring was carried out with unique cantilever boring bars, ensuring recommended cutting speed at different steps. These machining conditions increase the boring efficiency due to the same wear rate of cutters with the recommended geometry. The unique boring bar has steps of the same length, which results in an average value of the influence coefficients between the cutters. The results of studies of conventional and stepped boring bars are compared. The paper is devoted to the possibility of fine boring of stepped holes with a large difference in step diameters and unique boring bars providing the same recommended cutting speed. Due to such boring, the wear of the cutters is practically the same, which leads to an increase in boring accuracy, the stability of the roughness values and deviations from roundness, as well as boring at one setup, which makes it possible to reduce the time for adjusting the cutters.

Keywords: Process Innovation, Industrial Growth, Wear Resistance, Two-Stepped Boring Bar, Boring Cutter, Roughness, Accuracy, Roundness Deviations.

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Simulation Studies of High-Speed Machining

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The research described in the article aims to analyze high-speed machining processes by carrying out cutting simulations in DEFORM 2D software using the finite-element method. The simulation of high-speed cutting processes is very complex because the dimensionality of the modelling problem increases tenfold compared to medium-speed cutting processes! Therefore, the solution of this problem is characterized primarily by methodological novelty. The proposed approach enables a comprehensive analysis of force and thermodynamic processes occurring in the tool and chip formation zone during high-speed cutting. The results of cutting force dynamics and thermal loads at different machining speeds are described in the article. The analysis of tool wear rate for different geometrical designs of a cutting edge is carried out. The correct geometry of the cutting edge reduces friction load on the tool rake face and thus reduces cutting force and tool wear. The phenomenon of excessive growth of cutting force with the increase of machining speed is explained. Guidelines for selecting cutting parameters are described.

Keywords: High-Speed Machining, Cutting Force, Simulation Study, Finite Element Analysis, Cutting Parameters, Manufacturing Innovation, Industrial Growth.

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Influence of Turning Operations on Waviness Characteristics of Working Surfaces of Rolling Bearings

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The formation of micro and macro geometric parameters of conjugate cylindrical surfaces of parts is technological movements of equipment that provide the specified quality characteristics of parts. The waviness of the part's surface is one of the critical geometric characteristics, which provides the functional features of the unit as a whole, as it affects the vibration processes that occur during operation. The ripple is formed under the influence of dynamic processes of processing of details which are characteristic of metalworking machines, depending on changes in system machine-tool (cutting)-part (MTP). Mechanical perturbations during cutting occur due to forced oscillations, self-oscillations, deformation of the rings due to the action of cutting forces. Self-oscillations occur due to the loss of properties of a given motion during cutting and forced oscillations due to external factors. The undulation of the surface is formed due to forced oscillations of the metal-cutting system due to periodic perturbations that occur due to disbalances of the MTP system's parts. The ratio of the oscillation frequency for relative motions of the tool and the part can change the law of oscillating motion and the shape of the surface. The decisive factor influencing the formation of geometric errors of the part is the ratio of the frequency of harmonic oscillations of the tool and the workpiece to the frequency of rotation of the machine tool's spindle.

Keywords: Formation, Harmonic, Heredity, Roller Bearing, Spectral Analysis, Workpiece, Process Innovation, Industrial Growth.

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Investigation of the Surface Layer Hardness when Grinding Sintered Porous Workpieces

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The essential properties of sintered powder materials are porosity and hardness. It is established that a part made through powder metallurgy methods is exposed to external factors during the finishing stages. It leads to changes in the surface layer's characteristics of the part. The experimental research program provided definitions of the influence of transverse feed, cutting speed, and porosity on the hardness of a surface layer and its consolidation. The optimal modes of grinding porous workpieces acquired by isostatic pressing of powder materials with further sintering were obtained. Their surface layers are compacted mainly due to the grinding of porous workpieces. The treatment of porous iron parts by grinding increases the microhardness of the surface layer, yet increasing the transverse feed reduces it. Also, it was found that increasing the hardness of the surface layer of the porous workpiece after grinding is possible because of additional movements of the tool without transverse feed.

Keywords: Isostatic Pressing, Sintered Powder Material, Porosity, Cutting Modes, Microhardness, Surface Characteristics, Processing Quality, Manufacturing Innovation, Process Innovation.

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Part IV
Advanced Materials

Control of the Physical and Mechanical Properties of Mixtures Based on Liquid Glass with Various Fillers

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The paper presents the results of a study of the main properties of mixtures with liquid glass (LG) and furfuryl oxypropyl cyclocarbonate (FOPCC) for mixtures based on various fillers (chromite compounds, mixtures of quartz sand with chromite and quartz sands). The parameters such as gas generation ability, compressive strength, gas permeability, friability, and residual strength were studied and determined by standard methods. The optimum content of the FOPCC multi-purpose additive in a mixture based on chromite and quartz sands was evaluated. The experimental results showed that the chromite sand-based mixture's compressive strength and gas generation ability is higher than those of the quartz sand-based mixture. The friability and gas permeability is higher with respect to quartz sand-based mixtures. It was found that the breakdown ability of chromite sand-based mixtures is better than that of quartz sand-based mixtures. A technological process for preparing cold hardening mixtures (CHM) based on chromite and quartz sands was developed. As a result, the surface quality of the molds was improved, and burn marks on the castings were reduced.

Keywords: Cold-Solidifying Mixture, Soluble Glass, Furfuryl Oxypropyl Cyclocarbonates, Chromite Sand, Quartz SandProduct Innovation.

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Catalytic Growth of Carbon Nanostructures in Glow Discharge

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Glow discharge ignited between a graphite cathode and a copper anode was applied to conduct a process of carbon nanostructure growth in an argon atmosphere. During the first stage of the experiment, the samples mounted on the cathode were heated up till turning red, which significantly increased the thermionic emission and caused the formation of cathode arc spots on the sample surface. The arcing with a period of 3 to 5 s was maintained for 5 more minutes. As a result, a number of craters were observed on the samples, which were investigated using the SEM technique. Carbon nanotubes and bundles of them were found along the whole surface of the samples, and the tips of the nano- and microsized structures were capped by the copper particles, which states in favor of the catalytic growth. The yield of the carbon structures was richer in the craters and the regions at the proximity to them. In addition, a carbon deposit was taken from the anode and studied by use of TEM. In this case, typical nanostructures resemble the branches of spruce trees or balls of rolled nanotubes with a diameter of about 15 to 30 nm; at that, the anode nanostructures do not show any traces of the copper catalyst. Thus, the proposed setup is suitable to grow various carbon nanostructures in a catalytic process in the presence of copper.

Keywords: Industrial Growth, Carbon, Nanostructures, Plasma Growth, Glow Discharge.

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Metallographic Determination of the Number and Sizes of Grains Depending on Structural and Phase Changes in the Metal of Welded Steam Pipe Joints

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Research results of the number and size of structural components grains in a metallographic analysis of metal samples of welded steam pipe joints considering the operating life are presented. The number of grains and their sizes were determined based on a statistical analysis of their boundaries intersections with given measured lines (cutting lines method according to ISO 643:2019) on metallographic images. Software implementation of the statistical analysis of features obtained due to the intersection of conditional boundaries of structural components in the images of microsections by straight lines is carried out. The computer system was tested for a number of samples cut from sections of steam pipes with different operating times under creep and low-cycle fatigue conditions. Required number of measured lines was found to obtain the statistical characteristics necessary for comparative analysis of metallographic images of various samples. Comparative analysis of features for images of microsections of various metal sections with different operating times of steam pipes is carried out. The research was carried out for the heat-affected zone areas, base metal, weld, and substrate. As a result, an influence of operating life on the changes in boundaries of structural components in the metal of welded steam pipe joints was confirmed. This is based on analyzing statistical characteristics of research features distribution obtained by cutting lines.

Keywords: Sustainable Manufacturing, Steam Pipes Metal, Welds, Metallographic Analysis, Structural Boundaries, Number of Grains, Heat-Affected Zone, Industrial Innovation.

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Influence of Additives Processed by Physical Fields on Tribotechnical Properties of Polymer Composites

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The influence of specific load on the intensity of weight and linear wear is determined in the article. The coefficient of friction and temperature in the zone of tribocontact of polymer composites, the components of which were processed in physical fields, were studied. The study of polymer composites with different content of components carried out at a constant sliding speed of 0.5 m/s. Epoxy resin and polyethylene polyamine hardener were used as a matrix to form polymer composites. To ensure increased heat resistance of the polymer matrix, a modifying additive (organosilicon varnish) was used. For the first time, the processing of organosilicon varnish in an electromagnetic field was applied, which allowed removing part of the solvent. Discrete aramid and glass fibers were used as reinforcing additives. For the first time, ultrasonic treatment of fibers in acetone was used, which allowed cleaning the surface of the fibers from contaminants and lubrications. Because of the use of the modifying additive and treated discrete fibers, the wear resistance of polymer composites increased by 30% due to the improvement of the adhesive interaction between the components of the system and the reduction of structural defects of the material. Removal of lubrication from the surface of the fibers and the solvent from the modifying additive increased by 0.1-0.15 the coefficient of friction of the polymer composites and will improve their service life. Friction polymer composite materials with high density and improved tribotechnical properties are designed for manufacturing brake systems of scooters.

Keywords: Epoxy Composite Material, Friction, Wear Intensity, Coefficient of Friction, Sliding Speed, Friction Load, Product Innovation, Industrial Growth.

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Impact of Thermomechanical Phenomena in the Surface Layer of Functional-Gradient Materials on Quality Considering Hereditary Defects

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When studying the mechanical properties of wear-resistant coatings, it was assumed that during dimensional processing with a technological tool, the occurrence of defects of technological origins, such as chips and cracks, occurs directly in the localized area of processing with the tool under the influence of thermomechanical stresses. In this regard, a mathematical model was proposed to determine the separation conditions for the exfoliated coating depending on the properties of materials and considering previous types of processing. In this case, hereditary inhomogeneities were formed that affected the crack resistance of the treated surfaces and were based on a quantitative analysis of the thermal and stress state. The dependences obtained in the article allowed us to simulate the process of machining parts with a wear-resistant coating, considering the requirements for the quality of the treated surfaces. As a result, criteria relations were obtained that link the grinding temperature, the intensity of the heat flow, the stress-strain state of the processed surface of the products with technological parameters that allow controlling the quality of processing to prevent peeling of the coating from the main matrix. The results can be used to process materials containing structural inhomogeneities and having low crack resistance characteristics. The prospects of using the model are associated with expanding the scope of application. For example, the models constructed in this article can be used to analyze the development of defects in welded joints and not only.

Keywords: Industrial Growth, Coating, Stresses, Temperature, Material, Grinding, Cracks, Defect.

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Mechanisms of the Structure Formation of Soldered Seams when Using Composite Solders

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This study shows the results of experimental studies of the mechanism of formation of the structure of soldered joints during high-frequency heating (49 kHz). The magnetic-dynamic effect of a high-frequency electromagnetic field on iron-nickel particles can lead to a redistribution of iron particles in suspensions flux - phosphorous copper, copper - iron, flux - copper-phosphorus melt - iron due to the movement of iron particles to the surface of the holder. The heating of iron particles under a high-frequency electromagnetic field changes the mechanism of dissolving particles in a copper-zinc melt. An increase in the particle temperature increases the solubility of iron in the melt of the diffuse boundary layer and, at the same time, the solubility of copper and zinc in iron. A diffusion boundary layer with an iron concentration exceeding the value of iron solubility in the surrounding melt is formed around the particles. It is shown that the main factors affecting the structure of a brazed joint are the heating rate of the composite solder and the solubility of more refractory components.

Keywords: Process Innovation, Brazing Alloys, Soldering, Flux, Hard Alloys, Solders, Brazed Tool.

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Mathematical Modeling of Processes and Equipment for the Manufacture of Electrode Carbon Graphite Products

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Production of electrode carbon-graphite products is one of the most energy-intensive chemical and metallurgical industries. One of the ways to reduce the energy intensity of electrode carbon-graphite products is to improve the energy efficiency of the furnace equipment of its main processes. A mathematical model of the combustion process of synthesis gas and natural gas in the working space of a rotary kiln was formulated. Two numerical models were developed. The first one is to study the heat-hydrodynamic state of a rotary kiln during natural or synthetic gas. The second one is to study the thermal parameters of a rotary kiln during the combustion of synthesis gas together with natural gas. Calculations were carried out to determine the synthesis gas consumption as a substitute for natural gas. It was established that at the expense of partial or complete replacement of natural gas by synthesis gas during operation of a calcining rotary kiln, it is possible to decrease natural gas consumption up to 100%. A complete replacement of natural gas with synthetic gas instead of 192 nm^3/h of natural gas, it is necessary to burn 908 nm^3/h of synthetic gas, which is significantly less than the synthetic gas capacity of the rotary kiln cooling drum.

Keywords: Carbonaceous Filler, Calcination, Rotary Kiln, Physical Fields, Natural Gas, Synthetic Gas, Energy Efficiency, Numerical Simulation, Product Innovation, Process Innovation.

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Influence of Multi-Pin Ultrasonic Impact Treatment on Microrelief, Structure, and Residual Stress of AISI O2 Tool Steel

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AISI O2 tool steel specimens were hardened by an ultrasonic impact treatment (UIT) technique to increase the surface integrity. This paper focuses on studying the effect of the multi-pin UIT treatment on the surface layer characteristics of the peened surface. The UIT treatment with a seven-pin impact head was performed by varying vibration amplitude of the ultrasonic horn and ultrasonic peening time. Surface roughness/waviness, hardness, and residual stress in the UIT-peened specimens were measured. The effect of vibration amplitude and UIT duration on the 3D surface texture and hardening intensity of tool steel was also examined. The results demonstrated that the multi-pin UIT treatment induced the high-dislocated and fine-grained structure fixed by nanoscale vanadium carbides and compressive residual stress. The multi-pin UIT process formed the wavy microrelief on the surface with average surface waviness Wa parameter ~0.7 µm at optimum regimes. The UIT promotes a significant reduction in surface roughness. An increase in the vibration amplitude or UIT duration adversely affected surface roughness.

Keywords: Ultrasonic Impact Peening, Roughness, Waviness, Structure, Hardening Intensity, Macrostress, Process Innovation, Industrial Growth.

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New Technology for Producing Castings from Magnesium Alloys with Increased Corrosion Resistance

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In this work, the schemes of production of magnesium alloy AZ91 using flux-free gas protection of alloys based on sulfur dioxide are investigated. A series of experiments were performed to determine the effect of a mixture of shielding gases on magnesium alloys' oxidation (corrosion resistance). Flux-free smelting of magnesium alloys is not used in the foundries of Ukraine. In Europe, almost all responsible parts of magnesium alloys for aerospace, power tools, electronic devices use flux-free melting. Therefore, the paper compared these two types of protection. Also, this method of protecting magnesium alloys from ignition helped reduce the consumption of protective gases. This has greatly improved the economic efficiency and quality of the metal. The paper presents the results of atmospheric tests on samples of magnesium alloy ML5 with dimensions of 40x40x1 mm, obtained by two technologies: in a protective environment of a mixture based on protective gases and under a layer of protective flux VI2.

Keywords: Magnesium Alloy, Flux-Free Casting, Metallography, Control System, Gas Protection, Manufacturing Innovation.

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Protection of Paper Surface from Water Wetting by Two-Layer Siloxane (TEOS/PEHS) Coating

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The scheme of forming protective two-layer coatings for paper based on siloxanes containing Si-O groups as an adhesive sublayer and polyethylhydridesiloxane as the primary protective layer is proposed. The mechanism of formation and interaction between the coating components was investigated by the methods of IR spectroscopy and complex thermal analysis. It was found that the presence of a chemical interaction involving the ≡ Si – H bond of PEHS with – OH and ≡Si – OC2H5 groups in the TEOS and the fundamental possibility of regulating the level of completion of these processes. It is shown that the maximum of the main exothermic effect of the thermal oxidation process can be shifted from 350-570 to 630-650°C. The influence of treatment with two-layer siloxane coatings on the reaction efficiency of paper concerning water is investigated. A quantitative assessment of the application (by the nature of thermal destruction, the edge angle of wetting the surface with water, the degree of shielding) of such coatings for paper protection in wet conditions is provided. The efficiency of using a two-layer organosilicon coating for a paper operated in high humidity conditions has been proven. Two-layer siloxane-based coatings applied to the surface of unbleached cellulose paper have a higher degree of shielding and, as a result, water repellency.

Keywords: Process Innovation, Paper Protection, Adhesive Sublayer, Protective Layer, Water Repellency, Wetting Angle.

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Axial and Lateral Buckling Characteristics of Basalt/Carbon Hybrid Composite Laminates

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The objective of this work was an experimental investigation of the buckling performance of basalt/carbon hybrid composite laminates. To this end, the laminates fabricated via vacuum-assisted resin transfer molding were prepared at five different stacking sequences (B6, B5C1, B3C3, B1C5, and C6). To perform the hybridization process, carbon layers were replaced with basalt ones from inner to outer layers. The samples with twelve layers were subjected to axial and lateral buckling loads, applying fixed-fixed and fixed-free boundary conditions. Furthermore, failure modes were discussed to analyze the damage mechanisms of the samples. The findings demonstrated that the buckling performance of basalt composites was improved with the introduction of carbon layers. B6 samples showed the lowest values in critical loads, while the samples with totally carbon fiber reinforced samples (C6) had the highest values for both buckling experiments. The maximum critical buckling loads in axial and lateral directions were 1560 N and 76.7 N, respectively, which were 358.8% and 200.6% higher than B6 samples. Hybrid configurations exhibited critical loads between the results of the non-hybrid carbon and non-hybrid basalt fiber-reinforced composites. Furthermore, failure modes were observed as matrix fragmentation and delamination from the microscopic views of the samples.

Keywords: Basalt Fiber, Carbon Fiber, Hybridization, Axial Buckling, Lateral Buckling, Industrial Growth.

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The Effect of Deposition Conditions and Irradiation on the Structure, Substructure, Stress-strain State, and Mechanical Properties of TiN Coatings

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The influence of the displacement potential and the radiation factor on the features of the formation and mechanical properties of titanium nitride coatings obtained by the vacuum-arc method has been established. Important indicators of the process of bombardment by charged ions of the coating surface and the growing surface itself are determined, namely, at the maximum penetration depth of ions reaches (1.5–5 nm) and the number of vacancies (0.45–1.35). The simulation results are compared with actual experiments, and it is established that the above changes do occur. The hardness of TiN coatings was 42–45 GPa. The relaxation process of residual stresses is observed at U_i=-1200 V. As a result, the level of microdeformation is reduced to the value of 0.61 %, the size of the crystallites reaches 23 nm. The analysis of the reasons for the observed structural changes is carried out based on the mechanism of formation of surface layers of vacuum-arc coverings in the conditions of the implantation processes stimulated by giving negative potential on a substrate. Irradiation with accelerated argon ions leads to a decrease in the physicomechanical characteristics of the coating (a decrease in the hardness (22–29 GPa) and elastic modulus (~410 GPa)). The changes are more pronounced in coatings TiN applied under high-voltage pulsed conditions.

Keywords: Industrial Innovation, Modeling, Impulse, Macrostrain, Radiation Damage, Hardness, Relaxation.

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Calculation of Thermal Stresses in Oxide Layers Synthesized on Cu Substrates

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The paper presents the results of analyzing the nature and magnitude of residual thermal stresses in the oxide layer of Cu2O synthesized on a substrate of pure copper using a known analytical model for calculating thermal stresses in multilayer and single-layer coatings. The operating temperatures of the formation of thin-film oxide layers are the main technological parameter on which the values of thermal stresses depend. After the synthesis, the coated substrates are cooled to ambient temperature. A significant difference in the coefficients of thermal expansion of the oxide layer materials and the coating leads to compressive residual stresses. The stress-strain state during the cooling of the substrate-coating system free from external forces was investigated. The mathematical model assumed that the resulting deformations do not exceed the elastic limit, i.e., the residual stresses lie in the region of elastic deformations, and the temperature in the thickness of the material does not change. It should also be noted that the values of thermal expansion coefficients, elastic modulus, and Poisson's ratios are constant, i.e., they do not depend on temperature changes. The paper presents the main analytical dependences of thermal stresses on the physical and mechanical properties of coating materials and the substrate and their thicknesses.

Keywords: Oxide Layers, Residual Stress, Strain, Elastic Modulus, Manufacturing Innovation.

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Erosion Processes on Copper Electrodes Applied to Growth of Nanostructures in Plasma

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The paper describes a theoretical model of erosion processes in electrode spots during vacuum discharge. The proposed model considers the sources and drains of heat in the electrode spots. Temperature fields near the spots and the rate of evaporation of the material during the life of the spot are determined. In turn, this made it possible to determine the erosion coefficient for the electrode spot. To verify the adequacy of the model, calculations were performed for copper electrodes. The dependence of the erosion coefficient on the lifetime of the spot and the current density at the electrodes is obtained. When the current density is more than 10^9 A/m^2, the probability of material emission in the liquid state increases, preventing nanostructures' appearance. For both the stationary and moving spots, the dependences of the erosion coefficient on the lifetime are obtained. The dependencies reveal a significant decrease in the erosion rate with increasing the velocity of the spots. The calculated values of the arc current density coincide in order with the experimental values. The model can be used to find the critical values of technological parameters in obtaining nanostructures for different electrode materials.

Keywords: Industrial Innovation, Electrodes, Vacuum Arc, Electrode Spots, Erosion, Nanostructures.

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An Increase in Tribocharacteristics for Highly Loaded Friction Units of Modern Equipment

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The paper highlights the methodological problem of neglecting the presence of air microbubbles in the oil film during the study of the contact of tribological pairs. This phenomenon is usually explained as hydrodynamic bubbling. To eliminate this effect, special additives are used. An installation for research of a two-phase oil-vapor-gas mixture modified by a diffuser pump-generator has been developed. An express method of testing lubricants is proposed. The device for controlling an aggregate-phase condition of an oil environment is made. Comparative tribological tests of homogeneous liquid oil and its oil-vapor-gas suspension are carried out. The ways of controlling the current aggregate-phase state of lubricating media are revealed. The presence of low-pressure microbubbles in the lubricating medium, which occur in the diffuser areas and are delivered to all friction nodes, leads to their setting and damping of currents in the confusing areas and their easy expansion - in the diffuser areas of tribocontact. The study opens the way for the production of high-performance two-phase lubricants and methods to control their current physical and phase state in circulating lubrication systems, which is still an unresolved and urgent problem of the new field of knowledge about unstable environments such as two-phase oil-vapor mixture.

Keywords: Product Innovation, Bubbles, Circulation, Liquid, Lubrication, Mixture, Phase State, Physical State.

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Theoretical and Experimental Studies of the Properties of Porous Permeable Materials Obtained from Industrial Waste

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This article theoretically and experimentally investigates the scientific and technical problem of using multilayer porous permeable materials from industrial waste with controlled functional and technological characteristics by predicting the composition, structure, properties using computer information technology. These porous permeable materials (PPM) from industrial waste are suitable for the purification of technical liquids and gases, which has increased the efficiency of using products in various fields of mechanical engineering. The method of computer modeling proposed by the authors will allow not only to determine the porosity distribution of the filter material but also to determine the relationship between technological and structural parameters. The results of this scientific work are used to develop porous permeable products - filters - for the purification of technical, industrial water, lubricants, and fuels from mechanical impurities contaminants. Developed multilayer porous permeable materials have a higher coefficient of permeability, resource, and dirt capacity with similar single-layer.

Keywords: Product Innovation, Porosity, Forecasting, Properties, Permeable, Filtering, Industrial Growth.

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Part V
ICT for Engineering Education

Development of Materials Science Virtual Laboratory Work for the Metal Grains Calculation

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In a global pandemic, distance learning is becoming increasingly important. In this aspect, virtual laboratory work and simulators in teaching by creating electronic software products make it possible to conduct classes at a higher level in the educational environment. The paper describes developing a virtual laboratory work «Methods for Detection and Determination of Grain Size», used in both classroom and distance education. The methodology for the development and implementation of virtual laboratory work on three methods for determining the grain size in steels is described in detail, following the relevant current standard of Ukraine. The C# programming language is the choice of most developers working with applications of this type. Visual Studio was chosen among the development environments, one of the best among competing analogs used to develop these technology applications. The program designed for materials science students to perform laboratory work to determine the size of the grain of metals was created to calculate the grain score and avoid random errors in mathematical calculations more conveniently and accurately.

Keywords: Industrial Growth, Virtual Laboratory Work, Education Quality, Distance Education, Steel Grain, Counting Method, Comparison Method.

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Integration of End-to-End and Dual Learning as a Guarantee of Quality Professional Training for Future Power Engineers

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This article substantiates the organization of end-to-end learning in combination with dual learning in the professional education of future power engineers to ensure the competence and competitiveness of future specialists in the dynamic labour market. Theoretical and empirical methods (monographic analysis, synthesis, modeling, experiment, observation, forecasting) were used in the research. An applied model of end-to-end professional training in combination with dual education for future specialists of the agricultural sector at master's level is proposed through the example specific topic in which an important role belongs to the research work of higher education learners. In order to more fully assess the depth of such an organization of professional training of future power engineers, based on end-to-end training in combination with dual learning, the established level of readiness of higher education learners for future professional activity is analysed which will provide the labour market with highly qualified and competent specialists for the fuel and energy complex of Ukraine. Research results confirmed the acceptability of the model of the professional competence forming process of power engineering students during their professional training. Implementation of the model of end-to-end training in combination with dual training provides visualization of pedagogical conditions of activating didactic processes, along with organizational and technological procedures and, as a result, improves the quality characteristics of specialists' training.

Keywords: End-to-end Training, Dual Education, Future Power Engineers, Job Training, Professional Training, Model, Instruction Quality, Sustainable Development Education, Educational Policies.

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The Design of Workplaces with Augmented Reality in Engineering Education

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The article deals with the possibility of using augmented reality on the principle of marker target for student education. The whole proposed concept consists of the principle of displaying 3D models of machines, equipment, robots, conveyors, and accessories above the markers depicting an actual device. The first part of the article was focused on the 3D model software tools and was presented a step-by-step procedure for creating an AR application. We will describe a specific strategy for building a 3D model, creating a marker in the Vuforia engine interface. Subsequently, the procedure for working in the Unity development interface up to the final export of the final application was presented. The second part of the article was focused on the developed application and the possibilities of its deployment in the educational process. The initial tests were used by university students on the subject "Digitalisation of Production and Services". The gained results show the innovativeness of the proposed solution. In this article, an AR application was implemented in the educational process as a new distance education tool during the COVID-19 pandemic. This new way of presenting 3D models using AR falls under the concept of Industry 4.0, which is becoming a necessity today and brings many benefits in education and practice.

Keywords: Augmented Reality, 3D Model, Application, Unity, Sustainable Manufacturing, Industrial Innovation, Educational Policies.

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Using Telegram Bots for Personalized Financial Advice for Staff of Manufacturing Engineering Enterprises

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This paper covers the research on using instant messengers' chatbots to provide automated financial advice to manufacturing engineering enterprises employees in the scope of a chatbot application, which helps to calculate personal savings programs to ensure a constant level of consumption. The paper aims to develop telegram bots for personalized financial advice of manufacturing engineering enterprises staff. The application uses a model of life-cycle hypothesis and generates a customized saving plan based on the information provided by a user. The factors affecting decisions regarding advice include previous satisfaction with decision-making, investors' preferences, perceived difficulty, the relationship between financial literacy, expertise, and confidence. Different approaches to developing messengers' bots have been compared. The paper also gives a brief overview of the life-cycle approach, which suggests that finance managers plan consumption and savings behavior over the whole life cycle of their personnel. The research is focused on the Telegram platform and includes an overview of Telegram Bot API and the process of chatbot development using Java programming language.

Keywords: Instant Messenger, Chatbot, Savings Plan, Life-Cycle Analysis, Educational Financial Aid.

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Part VI
Fluid, Solid and Structural Mechanics

Vibration Reliability of the Turbine Unit's Housing Considering Random Imperfections

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The solution to the problem of the power turbines vibration reliability at failures arising as a result of resonant frequency hit in the operating range of a rotor considering the randomness of the support rigidity change on the foundation is considered. The study finds a complex machine-building object - the steam turbine housing on the foundation. The subject of the study is the failure as a result of vibration resonance in the operating frequency range. The reason for failures can be various design and technological imperfections. They can be divided into two groups: imperfections resulting from design and creation, and on the other hand - deviations from the design parameters as a result of the long-time operation. A special factor in the occurrence of various imperfections (deviations) is the time over which the probability of trouble-free operation decreases. To solve the problem, the methods of oscillation theory, reliability, and the widely used finite element method are used. Based on experimental data on the accumulation of rigidity imperfections on the foundation, the series of calculations of natural frequencies and forms, which are once again compared with experimental data, is carried out. The obtained results determined the probability of failures in the operating frequency range from the most dangerous resonances.

Keywords: Industrial Growth, Steam Turbine, Stiffness, Fatigue Failures, Eigenvalue, Reliability, Energy Efficiency.

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The Behaviour of a Rod (Beam) Under the Influence of an External Power Load

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This paper justifies the primary conditions for the strength, rigidity, and stability of the part's structural elements (a mechanism). They presented the theoretical and practical part of the conditions for checking the strength of a beam (Rod). Graphically presented the stress σ_n, τ_n in height. We investigated the behavior of the rod (beam) model when calculating the tensile-compressive strength. Based on the results obtained, plots of longitudinal forces were constructed. It was found that at each point of the cross-section, internal bonds (forces-N) arise, which are evenly distributed. It should be noted that the constructed plots of tensile forces were carried out based on improved equilibrium equations. In this case, the axial force formed on the first section was determined by the algebraic sum of all forces located only on one side of the section. We investigated the strength conditions that did not exceed the limits of permissible limit norms. We also investigated the main parameters and limits of permissible norms of reference reactions, confirming a reliable test for all three main strength conditions. It should also be noted that the SolidWorks software product performed computer modeling based on strength analysis, which made it possible to design the main structural elements of this part. Also, to study the behavior of the calculated beam model under various influences in terms of static, part stability, natural frequency fluctuations, and external load application.

Keywords: Detail, Deformation, Reference Reactions, Strength Conditions, Cross-Section, Statistical Equations, Plots, Numerical Analysis, Manufacturing Innovation.

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Stress-Strain State of the Floating Bollard's Structure for a Shipping Gateway

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The floating ballard is one of the main elements of the mooring equipment included in the lock. The reliability of this element largely determines the performance of this complex hydraulic unit and reduces the costs associated with the accident rate of both the lock itself and the ships passing through it.The close relationship between the reliability of the bollard and the magnitude of external forces (acting on its structure) requires a deep analysis of the stress-strain state of both the bollard elements and their connection places. The article deals with studying an actual composite welded structure of a ship's lock floating bollard under short-term action of loads exceeding the nominal load due to the dynamics of mooring operations and weather conditions.The studies were carried out on the developed 3D model of the device, and the analysis of the stress-strain state of its elements and the places of their conjugation. Some simplifications were applied, and the finite element method was used. A graphical representation of the results of the study made it possible to establish a general picture of the stress-strain state of the bollard elements, as well as to establish the local places of probable damage. Based on the results obtained, appropriate conclusions are drawn that determine possible solutions to the identified problems.

Keywords: Ship Lock, Mooring Equipment, Floating Bollard, Stress-Strain State, Finite Element Method, Industrial Growth.

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Rotor Dynamics and Stability of the Centrifugal Pump CPN 600-35 for Nuclear Power Plants

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The paper ensures the vibration reliability of the centrifugal pump CPN 600-35 for the water supply of an industrial circuit at nuclear power plants by improving its technical designs. The main aim of the research is to develop an approach for parameter identification of rotor dynamics and analyze the dynamic stability of the rotor movement. For this purpose, the modified design of the centrifugal pump CPN 600-35 was developed. Also, the main parameters of the rotor dynamics model (e.g., equivalent stiffness and discrete mass) were evaluated based on the parametric identification approach. Moreover, the eigenfrequencies and the corresponding mode shapes of free oscillations were obtained based on the finite element method. Finally, the dynamic stability of the rotor movement was studied based on the developed mathematical model of its oscillations considering the circulating and internal friction forces. Finally, based on the Routh-Hurwitz criterion, the stability region of rotor movement in terms of the dimensionless frequency and friction coefficient was analytically obtained.

Keywords: Energy Efficiency, Oscillations, Critical Frequency, Discrete-Mass Model, Parameter Identification, Circulating Force, Internal Friction, Routh-Hurwitz Criterion, Industrial Growth.

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Influence of Horizontal Inertial Loads on the Operation of Overhead Crane Girders

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Crane spans with prestressed girders operate under the same conditions, modes, and load capacities as conventional cranes. The load-carrying capacity of their spans must be provided with high strength and stiffness in two planes - in the main vertical plane and the horizontal plane. However, studies of the stress-strain state of a crane with a prestressed bridge operating in the horizontal plane have not been conducted. A mathematical model of the pre-stressed main beam has been developed in the paper. An analysis of its deformed state from the plane of cargo suspension and under the simultaneous influence of vertical and horizontal forces has been carried out, which allowed establishing. The obtained results can be further used to design bridge-type cranes with prestressed span beams to increase their lifting capacity and extend their service life without disassembly. As well as improving the existing structures and engineering methods of calculation, both at the design stages and under real operating conditions.

Keywords: Industrial Growth, Bridge Crane, Stress-strain State, Prestressed Beams, Beam Deflections.

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Organization of Transportation of a Particle by an Inclined Cylinder Rotating Around the Axis

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The movement of a material particle on the inner surface of an inclined cylinder rotating around its axis with a constant angular velocity is investigated in the article. When a particle hits the surface of a horizontal cylinder, it begins to oscillate in the cross-sectional plane of the cylinder with a certain amplitude in the angular dimension. Its value depends on the incidence point, friction coefficient, and initial absolute velocity. Differential equations of movement in projections on the axis of a fixed coordinate system are compiled. They are solved numerically. Under the appropriate initial conditions, which are determined analytically, the particle in absolute movement can be stationary, being at a point on the cylinder at a certain distance from the lower point in the angular dimension in the direction of the rotation of the cylinder. Some movement cases are described when the angle of inclination of the cylinder's axis to the horizontal plane is greater, equal, or less than the friction angle on the cylinder’s surface. An analytical solution for the last case that describes the particle's movement after stabilization is found. Visualization of the obtained results is made.

Keywords: Angular Velocity, Horizontal Cylinder, Differential Equations, Axial Direction, Friction Force, Industrial Growth.

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Supersonic Flow in the Blade Channel of the Nozzle with a Rotary Diaphragm at Small Degrees of Opening

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The article presents a study of the flow of supersonic flow in the interscapular duct of a nozzle with a rotating aperture at low degrees of opening. Modeling and calculation of the working fluid flow were carried out using the Fluent software package. The construction of computational domains, limited by one interscapular channel, for different degrees of opening of the nozzle diaphragm has been carried out. Grids for computational domains have been built. A numerical study of the flow in the interscapular channel of the C-9013R airfoil lattice at $\pi = 0.3$ $\delta = 0.3$ was carried out using the Reynolds Stress turbulence model. A numerical study of the spatial flow in the interscapular channel has been carried out. As a result of the calculations performed, the flow patterns in the interscapular channel and behind it were obtained. The distribution of the kinetic energy loss coefficients along the grating front at various degrees of opening of the diaphragm at the inlet to the nozzle apparatus. The results obtained in this work will develop a method for multi-parameter optimization of cogeneration steam turbines with controlled steam extraction.

Keywords: Supersonic Flow, Rotary Diaphragm, Blade Channel, Energy Efficiency.

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Part VII
Numerical Simulations of Coupled Problems

Model of the Pneumatic Positional Unit with a Discrete Method for Control Dynamic Characteristics

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At present, it appears that systems of pneumatic units with discrete and analog control, in which the required analog law of motion of the output member is provided with the help of discrete switchgear, offer a promising potential. When developing the schemes of positional hydraulic-pneumatic units, the parameters of the movement of the hydraulic-pneumatic unit are studied, namely: the value of displacement, speed, and acceleration of its output member. To carry out the simulation, a design based on discrete switchgear was taken as the basis for the pneumatic positional unit. Solving the inverse problem, i.e., with the law of motion of the output member of the pneumatic unit (specifying the positioning function) known, we determine the mandatory law of change in the effective areas of the control line and represent each equation of the dynamic model as block diagrams. A mathematical model of the system of pneumatic positional units with program control was developed. It considers the features of the system of pneumatic units and consists of mathematical models of the actuator, a real-time control line model, and a real-time control system. The proposed algorithm for analysis of dynamic characteristics using the MATLAB simulation environment confirms the adequacy of the mathematical models describing the operation of a positional pneumatic unit implemented on discrete pneumatic equipment. The developed algorithm is advisable to analyze the operation of the existing one and for designing new technological equipment.

Keywords: Dynamic Model, Discrete Switchgear, Positioning Function, Block Diagram, Process Innovation.

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A New Method of Optimization Synthesis of Vibro-Impact Systems

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The paper presents comprehensive research synthesizing inertial and stiffness parameters of two-mass vibratory systems of increased operational efficiency with nonlinear stiffness characteristics. A generalized optimization criterion is proposed considering a wide range of technological and dynamical requirements for implementing energy-efficient vibratory equipment for different technological purposes (screens, crushers, grinders, breakers, mills, vibrating tables, etc.). To simplify the process of synthesizing the optimal piecewise linear stiffness characteristics, two independent coefficients were introduced into the formulas for determining the corresponding stiffness factors. The synthesis was performed based on simultaneous numerical solving of the optimization problem and the simplified system of nonlinear differential equations that did not consider the dynamics of the drive. In the next stage, the generalized system of differential equations of the synthesized vibro-impact system was considered considering the equations describing the operation of the drive. The dynamic analysis of the system was carried out to provide the corresponding characteristics specified during the synthesis process. The study of dynamic stability of the considered system described by the system of nonlinear differential equations of the second order was performed by reducing to the Hill and Mathieu differential equations. The improved design of the vibro-impact machine was implemented in practice and experimentally tested for vibration deposition of metal layers onto the surfaces of various machine parts.

Keywords: Resonance, Dynamic Analysis, Stability, Operational Efficiency, Stiffness Characteristic, Optimization Criterion, Energy Efficiency, Industrial Growth

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Influence of the Design Features of Orbital Hydraulic Motors on the Change in the Dynamic Characteristics of Hydraulic Drives

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The operation of power hydraulic drives of self-propelled vehicles is accompanied by oscillatory processes associated with the technical imperfection of the actuating elements of the hydraulic drive. In this regard, the issue of stabilizing the dynamic characteristics of hydraulic drives is an urgent problem. As a result of the research, the initial data and conditions have been substantiated, making it possible to simulate the transient processes occurring in the hydraulic drives of self-propelled vehicles. A structural-functional diagram and a mathematical apparatus have been developed to reveal the dynamics of changes in the characteristics of a hydraulic drive of self-propelled equipment, considering the conditions of its operation. Changes in the stability of the dynamic characteristics of hydraulic drives of self-propelled vehicles, under the influence of the design features of orbital hydraulic motors, have been determined. The acceleration time of the hydraulic motor No. 2 is 12% less than that of the hydraulic motor No. 1, while the pressure and torque fluctuations during steady motion are less by 34% and 17%, respectively. Such changes are due to a decrease in the gap between the teeth of the rotors of the hydraulic motor No. 2 and the elimination of fluctuations in the flow area of its distribution system.

Keywords: Energy Efficiency, Transient Processes, Acceleration, Dynamic Characteristics, Output Parameters, Structural and Functional Diagram, Industrial Growth.

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Mathematical Model of Lifting Particles of Technological Material by Vertical Auger

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This research aims to investigate the transportation of a material particle by a vertically placed auger limited by a cylindrical casing. The surfaces are coaxial. When the auger rotates, the particle moves to the periphery and interacts with the cylindrical casing. The particle simultaneously slides on both surfaces and rises in absolute movement. Its relative motion is sliding along the periphery of the auger. Differential equations of particle movement in projections on a moving coordinate system that rotates with an auger were compiled. Numerical methods have solved the equations, and graphs of kinematic characteristics were built. The limit value of the rising angle for the helical line was found as the periphery of the auger. At such a position, the rise of the particle stops at a given angular velocity of the auger. It was found that the velocity of particle rising is influenced by constructive and technological parameters. In particular, for a given radius of the cylindrical casing, friction coefficients, and the edge angle of the auger, there is a minimum value of the angular velocity of its rotation. Then the particle "sticks" and rotates together with the auger, describing in absolute motion a circle on the inner surface of the cylindrical casing.

Keywords: Material Particle, Frene Trihedron, Cylindrical Casing, Sliding Trajectory, Transportation, Industrial Growth.

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The Effect of Manufacturing Tolerances on the Hydrodynamic Characteristics of Plain Bearings

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Plain bearing systems are widely used in rotor systems due to their efficiency, simplicity, long life, silent operation, low friction and wear, and in many cases, good heat dissipation. Despite the fact that a significant number of research have been published in the field of calculation and design of plain bearings, the proposed mathematical models and methods for calculating the characteristics do not consider the random changes of some geometric and operating parameters of these complex systems. The thickness of the lubricating film, which is one of the main operational parameters, is determined by the corresponding tolerances for the manufacturing of parts and assembly of the machine and a random variable. This work considers the effect of random changes in middle clearance and eccentricity values on pressure distribution based on the Reynolds equation. It is shown that the possible value of hydrodynamic force in such bearing can substantially differ from calculated under the deterministic models.

Keywords: Plain Bearing, Random Parameters, Mean Value, Film Thickness, Hydrodynamic Pressure, Industrial Growth, Process Innovation.

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Reducing Working Fluid Pulsations in Planetary Hydraulic Machines by Rational Design of the Distribution Systems

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The work studied the influence of changing the throughput of distribution systems on the output characteristics of planetary hydraulic machines to ensure their stabilization at the design stages. A design scheme a mathematical apparatus have been developed, and the initial data have been substantiated, which make it possible to study the effect of changing the geometric parameters of the distribution system on the pulsation of its flow area. The pulsation coefficients of the distribution system throughput and the rotational speed of the hydraulic motor shaft, the pressure of the working fluid, and the torque on the hydraulic motor shaft have been investigated. The starting conditions for the design of distribution systems are substantiated, which exclude pulsations of the working fluid in planetary hydraulic machines for kinematic schemes 5/4, 7/6, 9/8, 11/10, and 13/12. The angular gap between the distribution windows was taken as 0 °, 0°25'30", and 0°51". The number of additional unloading windows in the distribution system was taken as 0, 2, 3, and 4.

Keywords: Energy Efficiency, Ripple Coefficient, Output Characteristics, Flow Area, Stabilization, Output Parameters, Industrial Growth.

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Part VIII
Chemical Process Technology and Heat and Mass Transfer

Design and Modernization of Circuit for Fuel Oil Heating and Tar Cooling

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The solution to the scientific and practical problem of the modernization of the fuel oil heating department was proposed. The modernization provides two main tasks solutions: maximum heat recovery and existing equipment in the new technological scheme. The limitation of the hardware implementation is the clause of two cross-flow heat exchangers of the Compabloc type presence and two spiral heat exchangers with given surfaces of heat transfer areas. The study's primary goal is to achieve the assigned task of heating fuel oil by using the existing heat exchange equipment and redistributing the flows. In this case, the flow rates, temperatures, and pressure losses indicated in the formulation of the problem are rigidly fixed, but the possibility of installing additional heat exchange equipment is allowed. The original requirement for recuperative heating with the available apparatuses was not feasible. A new scheme of the heating department with an additional spiral heat exchanger installation was proposed to accomplish this task.

Keywords: Energy Efficiency, Heat Recovery, Cross-Flow Heat Exchangers, Spiral Heat Exchangers, Fuel Oil Heating.

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Protection of Condensing Heat Exchange Surfaces of Boilers from Sulfuric Acid Corrosion

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The method of metal protection of boiler condensing heat exchange surfaces can be successfully used in stationary and ship boilers, which burn fuel oils containing sulfur. The proposed method includes the operation of coating with a protective film against sulfur corrosion of the boiler heat exchange surface at a wall temperature below the dew point temperature of H_2SO_4 vapor. A passive layer of iron oxides is used as a protective film. It is obtained by passing physicochemical processes of passivation over the entire condensing surface from the beginning of sulfuric acid vapor condensation by pretreatment of exhaust gas flow with ionizing electron beams with a capacity of about 1 Mrad, ozone water-fuel emulsion combustion with a water content of about 30 %. The metal surface is under the protection of a very thin passive film, which has a reliable connection with the metal at the level of the crystal structure and eliminates direct contact of the metal with the aggressive environment. The protective film constantly occurs naturally under the condition of creating an equimolar ratio of nitrogen oxides NO_2:NO (50:50) % in front of the condensing surface in the gas flow. The protection provides a significant increase in the boiler's efficiency (by 4 to 6 %) when sulfur fuels combustion in their furnaces and deeper exhaust gases heat utilization in internal combustion engines and gas turbines (to 70 %).

Keywords: Energy Efficiency, Industrial Innovation, Water-Fuel Emulsion, Exhaust Gases, Boiler, Condensing Heat Exchange Surface, Passivation.

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Purification of Oilfield Wastewater by Inertial Methods

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Today, industrial ways of oil field development need new apparatus and machines with a significant cleaning result and a single ability, impenetrability, and ease of engineering produce and installation. The article represents an explanation of a hydrocyclone unit for handling wastewater from oilfields based on the application of inertial swirling flows. A new type of installation for wastewater treatment from oilfields has been developed. Due to the radial action in the hydrocyclone and the turbulent flows of the water stream, the oil droplets are damaged, they are increased, and the monodispersity of the liquid phase is growing. In systems with similar types of pollution, it is advisable to use multi-product multihydrocyclones and separators-coalescer with plates having holes and curves both for the removal of petroleum products and for the removal of suspended solids with a density higher than the density of water. Local treatment equipment, consisting of an average of four product hydrocyclones and separators with coalescent plates, will organize water purification systems at wells and use purified wastewater for formation pressure maintenance systems.

Keywords: Energy Efficiency, Industrial Growth**,** Oil Wastewater, Purification, Separation, Process Innovation, Multihydrocyclone, Hydrocyclone-Separator Unit, Coalescing Plate.

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Comparative Evaluation of the Contact Elements Efficiency for Barium Sulfide Solution Carbonization

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The article presents the results of an experimental study aimed at obtaining scientifically valid data on the kinetics of absorption of carbon dioxide by a barium sulfide solution and the effect of the design of contact elements (trays) on the mass transfer coefficient in this process. The work was carried out using a laboratory model of the absorber, in which it was possible to install trays of various types. Analysis of literature sources showed that the process of a BaS solution carbonization takes place in two stages, sharply differing in pH. An experimental study of CO_2 absorption kinetics under the conditions of the first stage of the process made it possible to identify the most significant factors influencing its rate. It was also found that the limiting stage of mass transfer is the resistance in the gas phase. The carbonization rate at the second stage is significantly lower than at the first stage and is controlled by the kinetics of the chemical reaction of CO2 hydration. Mathematical processing of the results of testing models of the cap, sieve, and double-flow trays made it possible to obtain formulas for calculating the mass transfer coefficients for each of them. In the studied range of gas velocities, the mass transfer coefficient on a dual-flow tray was 1.5-2 times lower than on a sieve tray and 2-2.5 times lower than on a cap tray. The data obtained were used in the design of the absorption apparatus.

Keywords: Process Innovation, Absorption, Carbon Dioxide, Barium Sulfide Solution, Mass Transfer Kinetics, Mass Transfer Ratio, Cap Tray, Sieve Tray, Dual Flow Tray.

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Hydraulic Resistance and Spray Transfer in a Stabilized Three-Phase Foam Layer

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One of the promising areas for intensifying the mass transfer process is the improvement of separation columns using a stabilized foam mode of interaction of gas-liquid flows, including movable nozzle bodies. A new design of the stabilizer with a sizeable free volume and a spherical movable nozzle was developed. The advantage of the proposed design is the transition to a structured foam mode of operation at relatively low gas speeds and a developed phase contact surface. After experimental studies of the hydrodynamic characteristics of the combined contact element, empirical data on hydrodynamic resistance and experimental indicators of spray attribution for a contact stage with combined contact elements were obtained. As a result of research, it was found that when using foam layer stabilizers, the spraying ratio at the contact stage is reduced, which leads to a more stable operation of the device. An empirical equation for determining the value of the spray attribution is given.

Keywords: Hydrodynamics, Stabilization, Foam Layer, Hole Plate, Turbulization, Movable Nozzle, Spray Removal Reducing, Energy Efficiency.

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Design of Reactors with Mechanical Mixers in Biodiesel Production

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Theoretically substantiated prerequisites for improving the production process of liquid biofuels from technical animal fats (TAF) and fat-containing wastes from food and livestock products, which makes it possible to design reactors for the production of liquid biofuels. A mathematical model for converting coolant and fat-containing waste into diesel biofuel has been developed. The feasibility of its use in the design of batch reactors with mechanical mixers has been proved. Turbulence models and their parameters are determined, which adequately characterize the velocity fields in reactors with turbine stirrers and provide an adequate description of the kinetic energy dissipation rates in different technological zones of reactors for the production of biofuels from TAF and fatty waste. It was found that the change in the distance between the stirrers and their diameters leads to a significant change in the rate of kinetic energy dissipation, which allows to unambiguously determine the place of introduction of alcohol-catalytic solvent and affect the degree of dispersion of reagents. The proposed ratio for determining the power criterion for reactors with two-stage six-bladed turbine stirrers and four baffles. Rational relations between the diameters of stirrers and the distance between them ensure the maximum yield of biofuels from the TAF and fatty waste from the food and processing industries. The technique of designing reactors with mechanical mixers for the production of diesel biofuel has been developed and substantiated

Keywords: Industrial Growth, Reactor, Model, Mixer, Biofuel, Technique, R&D Investment.

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Justification of Vibroventrentic External Load During Mechanical Pressing of Glycerin-Containing Products

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The research results established possible ways of using pharmacopeial or distilled glycerin in confectionery, microbiological, pharmaceutical, enzymatic, and other processing industries. The analysis of research in dehydration of dispersed materials shows that the technological process of glycerol purification is quite complex. It was established that all physical and mechanical properties of the final product and technical and economic characteristics of the equipment can significantly impact the quality of glycerol dehydration. The mechanical dehydration method of glycerin by giving the working drums planetary motion and additional oscillations in the horizontal plane was substantiated. The value of the pressure arising in the drum of the vibrating-planetary installation was determined. A comparative analysis of the vibrating component's influence on the pressure was studied depending on the angular velocities of water and drum and the loading degree. Existing schemes of moisture transportation and methods of dehydration of viscous and liquid materials were investigated. The analysis of diffusion, mechanical and thermal mechanisms, and their influence on moisture-binding properties of raw materials and the comparative analysis of driving force and speed of processes were carried out.

Keywords: Glycerin, Dehydration, Vibration-Planetary Motion, Driving Force, Pressure, Process Innovation

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Reduction of Granular Material Losses in a Vortex Chamber Supercharger Drainage Channel

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Increasing the reliability and durability of superchargers in pneumatic and hydraulic transport is possible due to vortex chamber jet superchargers. Their efficiency significantly exceeds pumping bulk mediums in pneumatic transport using direct-flow jet ejectors. However, the pumped medium losses in the vortex chamber supercharger drainage channel do not allow it to be widely used in such systems. Based on experimental and numerical studies, the influence of the density of the granular material on the losses in the drainage channel has been determined. Mathematical modeling was done by solving the Reynolds-averaged Navier-Stokes (RANS) equations with the Shear Stress Transport (SST) turbulence model. Rational densities of the medium can be varied by changing the vortex chamber height or swirling the inlet flow using a swirler. The design changes are explained by the kinematic features of the solid particle motion. If the vortex chamber height is small, then the particle does not have time to start rotating near the chamber axis and enters the supercharger drainage channel. The absence of the drainage channel in the design will lead to the outlet pressure decrease. As a result of the research, the granular material losses in the supercharger drainage channel have been reduced by 50 %, with a twofold increase in the swirl number.

Keywords: Vortex Chamber Supercharger, Experiment, Numerical Simulation, Drainage Channel, Granular Material Losses, Energy Efficiency, Process Innovation.

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Application of Low-Frequency Mechanical Vibrations for Development of Highly Efficient Continuous Extraction Equipment

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Research results of the regularities of pulsating turbulent flows distribution generated with the transport elements of a vibrating extractor for solid-liquid systems with a small difference in phase densities in a non-flowing liquid medium are presented. The experimental results in the entire investigated range of hydrodynamic operating modes of the apparatus are summarized by the dependences by which it becomes possible to determine the distance between vibro-mixing devices, the dimensions of the apparatus, the height of the unloading device for removing the meal, to choose the design of the transporting open element of the plate, to optimize and scale the process. The proposed operating parameters of the apparatus make it possible to effectively use the energy of mechanical vibrations to intensify mass transfer and countercurrent phase separation of the working mixture. Mathematical models have been developed that can be used for the scaling and design of vibration extraction equipment. For the industry, a new design of the vibroextractor with a conveying system has been proposed, which ensures effective phase separation under conditions of countercurrent vibroextraction of target components from plant materials.

Keywords: Industrial Innovation, Vibroextraction, Mathematical Model, Scaling, Hydrodynamics, Pulsating Flow, Phase Separation.

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Research of Wheat Fiber with Pumpkin Pectin Plant Additive

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The scientific work presents the results of improving the technology of making cooked sausages with the addition of wheat fiber with pumpkin pectin. The advantage of improving the technology of sausages was determined, particularly increasing their quality for the consumer and the prospects of using plant additives to improve their nutritional value. This paper explores the possibility of adding the combined plant additive of wheat fiber and pumpkin pectin to minced meat. A rational grinding mode is 3–4 minutes to fractions of 500–600 µm was established, which ensured the homogeneity of the plant additive and would contribute to its uniform distribution in minced meat in the cooked sausages production. The influence of the plant additive grinding level on the functional properties was presented, which showed that the best results for water-holding, water-binding, and fat-holding capacity are provided by particles of a size of 600 µm. Rational parameters for preliminary preparation of the plant additive for mixing with the minced meat associated with hydration at hydromodule were determined. This stage of the technological process provides the highest water-holding capacity, and the 1:3 ratio of the plant additive to refined oil provides a high fat-holding capacity. The solution to this problem improves the biological value and therapeutic and preventive properties of cooked sausages.

Keywords: Fat-holding Capacity, Grinding, Hydromodule, Plant Additive, Water-binding Capacity, Water-holding Capacity, Water Resource.

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Part IX
Energy Efficient Technologies

Development of the Gas-dynamic Cooling System for Gas Turbine Over-Expansion Circuit

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One of the ways to increase the efficiency of a gas turbine is an additional expansion of combustion products below atmospheric pressure in an auxiliary turbine installed after the main (power) turbine, that is, the use of an overexpansion turbine. The power received in the overexpansion turbine is spent on pressing the exhaust gases to atmospheric pressure by the compressor. Excess power can be transferred to mechanical or electrical energy. To cool the gas in the overexpansion circuit, it is promising to use a thermopressor, in which an increase in the total gas pressure occurs due to heat removal from gas. The removal of heat from the gas flow is carried out in the process of dispersed water evaporation, injected into the airflow, which is moving at near sound speed (gas-dynamic cooling). The thermopressor is a compact device. Therefore, using it in the gas turbine overexpansion circuit as a compressor and a cooler is advisable. Gas-dynamic cooling in the overexpansion circuits of a low-power marine gas turbine provides a pressure reduction in the overexpansion turbine by $0.725\text{-}0.765 \cdot 10^5$ Pa with a corresponding increase in the main (power) turbine power by 60 to 100 kW.

Keywords: Energy Efficiency, Thermopressor, Overexpansion Turbine, Gas Cooler.

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Marine Diesel Engine Inlet Air Cooling by Ejector Chiller on the Vessel Route Line

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The fuel efficiency of marine slow-speed diesel engines with cooling the air at the turbocharger suction by ejector chiller that recovers the waste heat of exhaust gas and scavenge air was analyzed. The application of ejector chiller is caused due to its the simplest design that enables easy it's assembling in free space of engine room and reliable operation in a marine application. An assessment was made of air temperature drops in the air cooler at the inlet to the turbocharger of a marine diesel engine and a reduction in fuel consumption under variable climatic parameters along the Odesa-Yokohama-Odesa route. The application of an ejector chiller provides reducing the engine intake air temperature by about 10 ºC with a corresponding decrease of specific fuel consumption by 1.0…1.2 g/(kWh) when using only the heat of exhaust gas. The fuel reduction of the marine diesel engine is increased practically twice when additional heat of scavenging air is used by an ejector chiller (ECh). The corresponding schemes of the systems for cooling the air at the turbocharger suction by ejector chiller are proposed.

Keywords: Internal Combustion Engine, Ejector Chiller, Energy Efficiency, Fuel Consumption, Exhaust Gas, Scavenge Air.

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Exhaust Heat Recovery in Integrated Energy Plant

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The combined refrigeration, heat, and power generation (trigeneration) gained widespread application. The reciprocating combustion gas engines are used as drive engines. They are the most adapted to match the actual refrigeration, heat, and electricity needs and manufactured as cogenerative engine modules equipped with heat exchangers to release the heat of exhaust gas, scavenge gas-air mixture, engine jacket, and lubricant oil cooling water to produce hot water converted to refrigeration for technological, space conditioning and heating duties. The efficiency of recovering the heat released from gas engines in a typical integrated energy plant with an absorption lithium-bromide chiller has been analyzed. Issuing from monitoring data on the parameters of heat utilization circuit, the reserves for utilizing the heat usually not recovered by absorption chiller and removed to the atmosphere by radiator are revealed. The advanced heat recovery system that transforms the heat, typically extracted to the atmosphere, by ejector chiller to generate supplementary refrigeration for gas engine intake air cooling was developed as the simplest and expedient solution for implementation at a typical integrated power plant.

Keywords: Energy Efficiency, Gas Engine, Waste Heat, Utilization, Absorption Chiller, Ejector Chiller, Industrial Innovation.

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Turbine Intake Air Combined Cooling Systems

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The application of absorption lithium-bromide chillers (ACh) for turbine inlet air cooling (TIC) is very effective in hot climatic conditions due to enlarged ambient air temperature drops and fuel reduction. But in temperate climatic conditions, the efficiency of TIC by ACh of a simple cycle is considerably reduced decreased ambient air temperature drops cause that. The last is limited by a comparatively raised temperature of chilled water of about 7°C that makes it unable to cool ambient air lower than 15°C. The application of low boiling refrigerants as a coolant enables deeper turbine inlet air cooling to 10°C and lower. Therefore, the low boiling refrigerants can be used for subsequent cooling air after its pre-cooling in ACh. A refrigerant ejector chiller (ECh) is the most simple in design and cheap and can be applied for subcooling air from 15°C to 10°C. Such deep cooling air to 10°C in combined absorption-ejector chiller (AECh) provides about twice the annual fuel reduction in temperate climate compared with conventional TIC to 15°C by ACh. The method to determine rational refrigeration capacity of AECh and distribute it between ACh and ECh that provides practically maximum annual fuel reduction at reduced design refrigeration capacity by about 20 % is developed. With this current excessive refrigeration, capacities are used to cover peaked loads.

Keywords: Energy Efficiency, Gas Turbine, Fuel Efficiency, Inlet Air, Chilled Water, Refrigerant.

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Jet-Reactive Turbine Circular Efficiency

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The Ukrainian power generation industry is a fundamental branch for developing the state economy and keeping its sovereignty. A significant problem is the reasonable use of Earth's power resources today. Ukraine has been trying to resolve this issue, which is proved by the implemented program “Safety, Energy Performance, Competitiveness (the Ukrainian Power Strategy till 2035)”. It provides a shift from the old energy industry model to the new one with a larger competitive space and opportunities to increase energy performance via renewable and alternative power sources. A sensible way to complete this task is waste energy recycling. Turbine-generator sets can decrease pressure and utilize potential energy of gas or steam pressure to produce electricity. It is another economic and technological challenge for Ukraine and the whole world. Simultaneously, that opens new prospects for introducing innovative projects. The article is devoted to studying gas-dynamic processes in jet-reactive turbine (JRT) flow ducts. The research assesses the off-design traction nozzle influence on the JRT circular efficiency. There are detected dependencies between circular efficiency and dimensionless velocity $\lambda_{Wout.t}$ by certain feed-in nozzle inlet pressure during design (S = 1) and off-design conditions (S >1). Diagrams of circular efficiency against blade wheel velocity ($\overline{U}$ = 0…1) are drawn. The research established that the feed-in nozzle inlet pressure rise causes the circular efficiency to fall. The efficiency optimum is defined by the blade wheel velocity for design and non-design circumstances. The highest efficiency is found by design traction nozzle operation (S = 1).

Keywords: Energy Efficiency, Jet-Reactive Turbine, Circular Efficiency, Relative Velocity, Absolute Velocity, Moving Moment, Gas Mass Flow, Characteristics, Sustainable Development, Industrial Growth.

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Innovative Hybrid Power Plant Design

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Currently, humanity is beginning to experience difficulties with unlimited energy consumption since there are fewer and fewer opportunities to increase capacity generation. The use of renewable energy sources is an effective method of solving the problem of shortage of energy sources. One way to do this is to develop a wind-solar power plant, called a "hybrid", which simultaneously uses both wind and solar energy. For such a hybrid power plant, it is suggested to use a new type of medium-speed vertical axial wind power station, with a high utilization coefficient of wind energy and improved strength characteristics. Wind turbine models proposed for vertical axial wind power stations were tested in a wind tunnel. A comparison of the capacity of the specific vertical axial wind power station and the proposed wind turbine confirms the value of the wind utilization coefficient at the level of world samples with an average speed coefficient. The simultaneous working wind power station analysis and solar cells and energy utilization are performed. It is indicated that the feasibility and cost-effectiveness of solar cells should be analyzed in each specific case. Formulas for determining the amount of energy produced by a hybrid power station over a certain period are proposed.

Keywords: Energy Efficiency, Industrial Growth, Wind-Solar Power Plant, Wind Turbine, Solar Cells.

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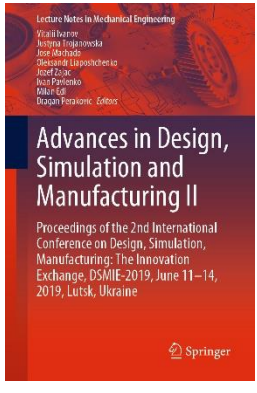

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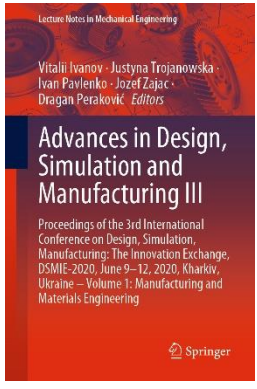

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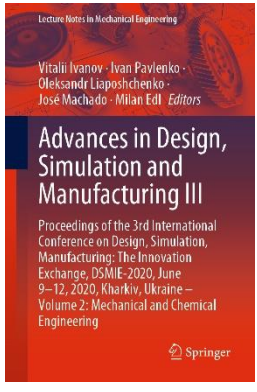

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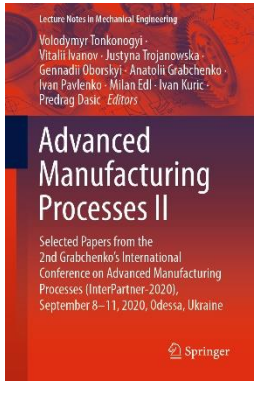

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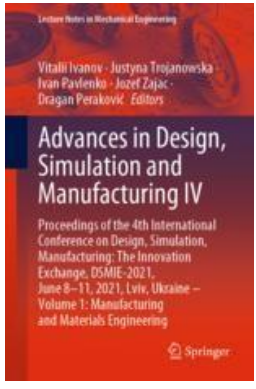

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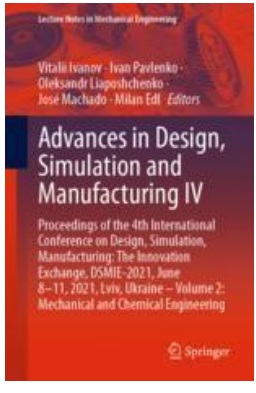

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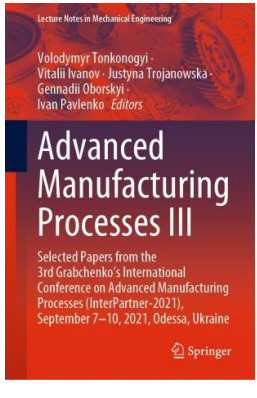

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Volume 2 - Mechanical and Chemical Engineering