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# BOOK OF ABSTRACT

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# SESSION 2 – Mechanical Engineering. Logistics and Emergent Technologies of Industry 5.0

# Industrial Robots in the Age of AI: From Automation to Autonomy

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## Abstract

The integration of Artificial Intelligence (AI) into industrial robotics marks a significant transition from rigid, pre-programmed automation toward more flexible, adaptive, and autonomous robotic systems. This paper presents a state-of-the-art review of AI-driven industrial robotics and its impact on sustainable and intelligent manufacturing environments. The study examines how advanced technologies such as machine learning, computer vision, sensor fusion, and predictive analytics are reshaping modern industrial processes by improving operational efficiency, flexibility, and decision-making capabilities.

AI-enabled industrial robots can optimize resource utilization, reduce energy consumption, improve production accuracy, and contribute to minimizing material waste in manufacturing workflows. Furthermore, the increasing autonomy of robotic systems allows real-time adaptation to dynamic production conditions and supports more flexible and resilient manufacturing models aligned with circular economy principles. The paper also explores the growing role of collaborative robots (cobots) in enhancing workplace safety and human-centered production by taking over repetitive, physically demanding, or hazardous tasks while enabling closer human–machine interaction. In addition, the integration of AI-based predictive maintenance techniques can reduce unexpected equipment failures, extend the operational lifespan of industrial assets, and lower operational costs. Beyond the technological advantages, the paper discusses key challenges associated with the transition toward autonomous industrial robotics, including cybersecurity risks, system reliability, ethical considerations, and workforce reskilling requirements. Overall, the study argues that AI-enabled industrial robotics represents not only a technological evolution, but also an important interdisciplinary pathway toward more sustainable, resilient, and intelligent manufacturing ecosystems.

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# Study on sustainability in the production of photovoltaic panels

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## Abstract

"Sustainability in production" refers to the practice of producing goods in a way that minimizes negative environmental impacts, conserves resources, and takes social and economic aspects into account. The photovoltaic panel manufacturing industry is undergoing a major transformation towards "green manufacturing." To make solar energy truly sustainable, companies are focusing on reducing the carbon footprint of factories, using recycled materials, and implementing circular economy principles for end-of-life modules. The transition to a fully sustainable photovoltaic industry is based on four main pillars: Renewable energy in manufacturing, Green chemistry and elimination of toxic substances, Integration of recycled silicon, and Circular economy and advanced recycling. Although the production of photovoltaic panels is resource- and chemical-intensive, the shift to "green chemistry" and the adoption of transparent and ethical manufacturing practices define the future of this industry. Manufacturers willing to embrace this change will discover opportunities for innovation.

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# A general review regarding the 3D printing process

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## Abstract

3D printing or additive manufacturing represents a process that involves some stages, as are described in figure 1, in order to fabricate three-dimensional solid objects by adding layer upon layer.

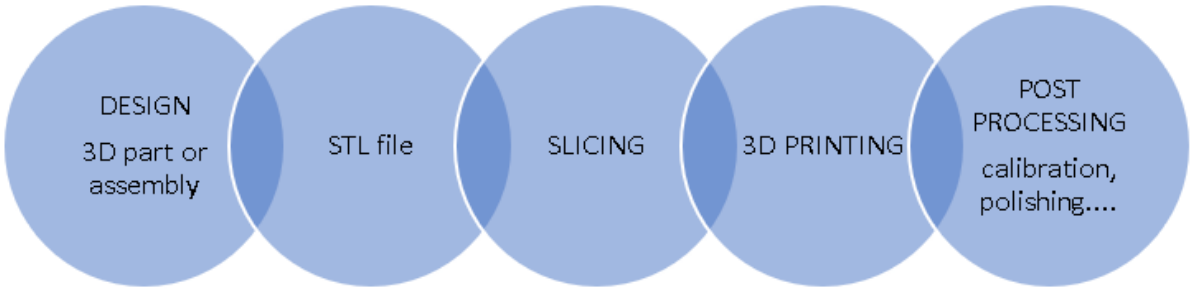



Fig. 1. A schematic representation of a 3D printing process

There are some advantages that 3D printing provide, namely: complexity and freedom in design, customization and adaptation, reduce consumption of raw materials - environmentally friendly, using of recycled materials [1,2]. There are also some limitations of 3D printing as, higher costs and low surface quality [1,2].
Regarding the materials that can be used for 3D printing, based on the final properties of the products, there are a lot of types of materials as: metals & alloys, ceramics, composites, polymers, biomaterials, smart materials, food printing materials, building materials and so on [3-5].

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# Study of the die pressing process of barium ferrite nanopowders

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## Abstract

Barium ferrites are widely used for producing permanent magnets, magnetic media, radar absorbing materials and coatings [1-5].
Structural anisotropy is achieved in the die pressing operation of the ferrite nanopowders, an operation in which, in addition to compaction, the orientation of the powder grains with the “c” axes of magnetic-crystalline anisotropy (hexagonal lattice) parallel to each other is also ensured. For this, an external magnetic field sufficiently intense (up to 20 KOe) is applied in advance to determine the rotation of the ferrite powders and their ordering with the anisotropy axes, parallel to the field lines.
Die pressing is applied to a wet mixture in order to provide the solid particles with a higher degree of mobility as a result of reducing the friction between them. It is therefore necessary for the slurry to be as fluidized as possible to satisfy the aforementioned requirements.
There were made four mixtures with different concentrations of solid as following: CS1 = 60 %; CS2 = 70 %; CS3 = 80 %; CS4 = 85 %. The liquid used was distilled water and distilled water with 3% Daxad.
The use of the additive solution (distilled water and 3% Daxad) as a slurry liquid ensures much better removal of the solution during the die pressing process, respectively in all 5 samples taken from the 5 areas, the humidity is lower, respectively the densities are higher compared to the same samples but from the slurry in which only distilled water was used as the liquid.

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# Proposal of National Strategy for Romania related to integration of AI in Higher Education

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## Abstract

AI is becoming one of the most significant forces shaping the future of higher education. Its impact will not be limited to technical disciplines or specialised research laboratories; it will influence the way universities design curricula, support teaching, guide student learning, assess knowledge, conduct research, manage institutional processes and interact with society. For this reason, the integration of AI into higher education will require a coherent, responsible and human-centred strategic approach. This document, D4.1.1. National Strategies related to AI, has been developed within WP4 – Pilot Actions, Dissemination, Communication, under T4.1. Strategic agenda for deployment AI in HE. Its purpose is to provide a structured national strategy for the integration of artificial intelligence in Romanian higher education, with a clear focus on course development, teaching, learning, assessment and feedback. The document builds on the national and European policy context, including Romania's National Strategy in the field of Artificial Intelligence 2024–2027, SMART-Edu, the Ministry of Education's strategic planning framework, the EU AI Act and international guidance issued by UNESCO and OECD.

The main objective of the strategy will be to establish a coherent national framework through which AI will be integrated into course development, teaching, learning, assessment and feedback. The strategy will also cover enabling conditions such as AI literacy, infrastructure, institutional governance, data protection, academic integrity, accessibility for SEND students, quality assurance and sustainable funding.

The proposed national strategy will position AI as a responsible, human-centred and inclusive instrument for improving course development, teaching, learning, assessment and feedback. It will also strengthen research, innovation, digital competences, employability and accessibility. The strategy will not replace teachers or academic judgement with automation; it will use AI to expand pedagogical capacity, support student learning and modernise institutional processes under clear ethical and legal safeguards.

Successful implementation will depend on governance, training, infrastructure, quality assurance and trust. Romania will need national coordination, institutional AI policies, staff and student AI literacy, assessment redesign, AI procurement standards, accessibility services, open resources and continuous monitoring. If these measures are implemented coherently, Romanian universities will be able to become active contributors to the European AI education ecosystem rather than passive consumers of external technologies.

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# Proposal of National Strategy for Romania related to integration of AI in Higher Education

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## Abstract

As the paradigm of Industry 4.0 fundamentally reshapes the professional engineering landscape, higher education faces unprecedented demands for rapid skill acquisition, continuous technological adaptation, and dynamic knowledge transfer. Consequently, the integration of targeted, highly efficient pedagogical frameworks has transitioned from an optional enhancement to an absolute institutional imperative. Traditional didactic models are increasingly challenged by the complex cognitive loads placed upon students and the accelerated pace of technological evolution. Within this context, this study explores the future of technical didactics by critically examining the strategic integration of advanced digital training methodologies with microlearning architectures. The primary objective of this research is to explicitly delineate the operational needs, current technological deficits, and future expectations of teaching professionals. Furthermore, it seeks to rigorously assess how specialized micro-educational modules can optimize knowledge retention, accelerate the learning process, and address the specific demands of contemporary engineering disciplines. Methodologically, the investigation relies on a comprehensive, multi-tiered analysis of data collected through structured questionnaires administered to faculty members and trainers operating within Higher Education Institutions and Vocational Education and Training (VET) centers across various European Union member states. This empirical foundation is corroborated by a SoA review of cutting-edge digital teaching instruments applicable to technical higher education. The analysis reveals a critical pedagogical insight: successful digital instruction fundamentally depends on overcoming the modern learner's primary obstacle, which is a severe and pervasive lack of time. To counteract this limitation, educators unanimously prioritize the development and deployment of interactive, highly accessible, and qualitatively superior micro-resources that are explicitly tailored to address the immediate cognitive needs of the learners. Crucially, the research exposes that the widespread, systemic adoption of these advanced digital methodologies is currently obstructed by profound structural impediments rather than purely technological limitations. Furthermore, educators report a distinct deficit in the availability of high-quality, European-centric online learning content and a scarcity of suitable digital tools. By synthesizing these insights, this article provides actionable, evidence-based guidelines for institutional policymakers, academic administrators, and curriculum developers. The conclusions offer a rigorous blueprint for engineering resilient, forward-looking digital education strategies capable of equipping the next generation of engineers with both the technical expertise and the digital fluency required in a rapidly evolving global landscape.

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# Transport and Dispersion of Pollutants along the Danube River

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## Abstract

The Danube River represents one of the most important transboundary watercourses in Europe, supporting navigation, industrial activities, urban development, agriculture and aquatic ecosystems. Due to the diversity of human activities carried out along its course, the river is exposed to multiple sources of pollution, including municipal wastewater, industrial discharges, agricultural runoff, accidental spills and diffuse inputs from tributary basins. In this context, understanding the transport and dispersion of pollutants is essential for assessing water quality, identifying environmental risks and supporting integrated river basin management.

This paper examines the main factors influencing pollutant transport and dispersion in the Danube River, with emphasis on hydrological, hydraulic and physical-chemical conditions. Parameters such as river discharge, flow velocity, water temperature, air temperature, dissolved oxygen, biochemical oxygen demand, pH, suspended solids, fixed residue and water hardness are considered relevant indicators for evaluating the pollution status and its spatial and temporal variability. The analysis highlights the importance of systematic water sampling and chemical monitoring in order to determine concentration variations, identify pollution trends and estimate the potential impact of contaminants on aquatic ecosystems and downstream water uses.

Particular attention is given to the relationship between pollutant behaviour and river dynamics. The dispersion process is influenced not only by the nature and concentration of pollutants, but also by flow regime, sediment transport, seasonal variations and the interaction between point and diffuse pollution sources. By correlating hydrological data with hydro-chemical indicators, the study provides a framework for understanding how pollutants are transported along the Danube and how their effects may vary across different river sections.

The paper emphasizes the need for continuous monitoring, updated environmental databases and integrated assessment methods to support pollution prevention and water resource protection. The results may contribute to a better understanding of pollution dynamics in large river systems and to the development of more effective environmental management strategies for the Danube River.

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# Transnational Action Plan to boost education on sustainability

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## Abstract

The Trans-National Action Plan (TNAP) developed within the ANGIE project (Academic Network for a Green and Innovative Europe) is a strategic framework designed to support the integration of sustainability competencies into European higher education systems. Its necessity arises from the growing challenges generated by climate change, the European Green Deal, digital transformation, and the increasing demand for green skills in the labour market. Universities can no longer operate through isolated national approaches; instead, coordinated transnational cooperation is required to prepare future professionals capable of supporting Europe's green and digital transition. The TNAP brings together six National Action Plans from Germany, Slovenia, Italy, Portugal, Romania, and Spain into a unified European framework while respecting national educational systems and accreditation regulations. The document aligns with major European strategies such as the European Green Deal, Fit for 55, the European Education Area, and the UN Sustainable Development Goals. The main content of the TNAP is structured around five strategic pillars. The first pillar focuses on curriculum reform through the integration of sustainability competencies, interdisciplinary learning, and micro-credentials. The second pillar addresses faculty development by promoting green pedagogies, digital teaching methods, and international academic cooperation. The third pillar concentrates on institutional capacity building, including digitalization, green campuses, and sustainability-oriented research infrastructure. The fourth pillar strengthens partnerships between universities, industry, and society through internships, advisory councils, and collaborative innovation initiatives. Finally, the fifth pillar establishes monitoring and evaluation mechanisms based on indicators, surveys, feedback systems, and adaptive governance. The TNAP emphasizes cross-border collaboration through shared educational resources, student and staff mobility schemes, joint research activities, common quality assurance frameworks, and coordinated implementation mechanisms designed to ensure long-term institutional resilience, knowledge transfer, and sustainable impact across the European higher education landscape.
The TNAP also proposes common mobility programmes, shared educational resources, joint research activities, accreditation pathways, risk management strategies, and implementation timelines for 2026–2030. Overall, the document serves both as a policy reference and as an operational roadmap for creating a resilient, sustainable, and innovation-oriented European higher education network.

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# Ultrasonic welding of copper wires

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## Abstract

Ultrasonic welding is one of the most efficient modern technologies for joining metallic materials, due to the fact that the process is carried out at temperatures much lower than the melting temperature of the base material. This characteristic leads to the reduction of heat-affected zones, the reduction of deformations and the preservation of the physical and mechanical properties of the joined components. In the case of multi-wire electrical conductors, ultrasonic welding is of particular importance because it allows the creation of compact connections, with low electrical resistance and high mechanical stability. By compacting and consolidating the individual wires, uniform, reliable and vibration-resistant electrical contacts are obtained, which recommends the process for applications in the electrical, electronics and automotive industries, where the quality of electrical connections is essential for the safe operation of systems. However, the welding of copper conductors poses a number of technological difficulties due to the very high thermal and electrical conductivity of the material, which favours the rapid dissipation of the energy introduced into the joint area. Also, the formation of oxides on the surface of the conductors and the tendency of multi-strand wires to deform unevenly require rigorous control of the welding parameters to obtain stable and reproducible joints.

The paper investigates the influence of technological parameters on the quality of joints on multi-wire copper conductors, made by the ultrasonic welding process. The research investigated the theoretical behaviour of copper during welding and experimentally its behaviour during ultrasonic welding. The experimental part highlighted the correlation between the amplitude of oscillations, the welding force, the activation time and the mechanical strength of the joints. The results obtained demonstrated that the use of welding regimes characterized by high ultrasonic powers and short times leads to the creation of stable connections, with minimal deformations and without significant structural damage to the base material. It was also found that the choice of the sonotrode material and the optimization of its geometry directly influence the efficiency of energy transfer and the durability of the equipment. The research confirmed the applicability of ultrasonic technology for the creation of electrical connections used in the electrotechnical and automotive industries, where reliable, fast and easily automated joints are required. Experimental conclusions demonstrate that ultrasonic welding represents a high-performance alternative to conventional processes, offering important advantages in terms of productivity, energy consumption and the quality of the joints made.

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# The Human Element in Inland Waterways Transport

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## Abstract

Inland waterways transport (IWT) is frequently discussed in terms of infrastructure capacity, technological innovation, and environmental sustainability. However, the human element — the captains, crews, lock keepers, port operators, inspectors, and trainers who animate the system — remains its most critical and often underappreciated component. This paper examines the centrality of human agency in IWT operations, arguing that investment in people is not supplementary to sectoral development but foundational to it.

The sector faces a convergence of pressing challenges: an ageing and shrinking workforce, the need to adapt training frameworks to rapidly evolving vessel technology and digital tools, demanding working conditions characterised by prolonged absences and physical strain, persistent safety risks attributable to human error, and intercultural communication difficulties arising from the international composition of crews. These challenges are compounded by the digital transformation of IWT, which, paradoxically, increases reliance on human judgement rather than reducing it. Automated systems and decision-support tools require skilled operators capable of interpreting complex data and exercising sound professional discretion — as illustrated when a captain must respond to sudden flooding or when a simulator-trained officer must provide decisive leadership in an emergency.

Beyond technical competence, soft skills — communication, teamwork, leadership, conflict resolution, and adaptability — are identified as essential determinants of operational safety and efficiency. Their systematic development requires not only modernised and harmonised training curricula, such as those being advanced through European initiatives like Erasmus+ ARIELL, but also structural improvements in working conditions, diversity and inclusion policies, fair remuneration, and the cultivation of a genuine safety culture grounded in responsibility, incident reporting, and organisational learning.

The paper concludes that the long-term sustainability and competitiveness of inland waterways transport depends on recognising the human element not as a vulnerability to be engineered away, but as the sector's greatest strategic asset. Ships may carry cargo or passengers, but it is the people who carry responsibility.

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# Simulation-Based Assessment of Inland Waterway Current Effects on Inland Tanker Manoeuvrability during Upstream Navigation

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## Abstract

The manoeuvrability of inland vessels is strongly influenced by river current, especially during upstream navigation, where the available propulsive power, rudder effectiveness, speed over ground, and trajectory-keeping capability are directly affected by the hydrodynamic interaction between the vessel and the surrounding flow. This paper presents a simulator-based study of the impact of current intensity on the manoeuvring behaviour of a river tanker operating on an inland waterway route on the Moselle River toward Koblenz.

The study was carried out using the Wärtsilä Navi-Trainer Professional 5000 Simulator, where a river tanker model was selected for the simulations, with representative inland vessel characteristics. Two navigation scenarios were configured along the same route: one with a moderate current and one with a stronger current. In both cases, the vessel was required to proceed upstream, allowing a comparative assessment of how increasing current intensity affects course stability, speed over ground, required engine load, rudder use, and the difficulty of maintaining the intended track.

The results show that stronger opposing current increases the operational demands on the navigator and reduces the vessel's manoeuvring margin. In the strong-current scenario, the tanker requires greater propulsion effort to maintain progress upstream and more frequent or larger rudder corrections to counteract drift and preserve the planned trajectory. These effects become particularly relevant in confined inland waterways, where limited fairway width, bends, bank effects, and traffic constraints reduce the available space for corrective manoeuvres. The comparison between the two scenarios demonstrates the importance of current assessment in voyage planning, simulator training, and safe inland navigation. The study confirms that simulation is an effective method for understanding current-induced manoeuvring challenges and for training navigators to anticipate vessel behaviour under different hydrological conditions.

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# Advanced processing routes for $TiB_2$-based ceramics used in ballistic protection applications

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## Abstract

Titanium diboride ($TiB_2$) has attracted considerable scientific and technological interest in recent years due to its exceptional combination of physical, thermal and mechanical properties, including high hardness, elevated melting temperature, good thermal conductivity, low density and excellent wear resistance. These characteristics make $TiB_2$-based ceramics promising candidates for advanced ballistic protection systems and lightweight armor applications operating under extreme conditions.[1] However, despite the significant potential of this ultra-refractory ceramic, the processing and densification of $TiB_2$-based materials remain major technological challenges because of the low self-diffusion coefficient, strong covalent bonding and the high temperatures generally required during sintering. The present paper provides an overview of the main advanced processing routes currently investigated for $TiB_2$-based ceramics intended for ballistic protection applications, with emphasis on the relationship between processing parameters, densification mechanisms and the resulting physical–mechanical behavior of the material. The study discusses the technological particularities, advantages and limitations of several modern processing approaches reported in recent literature, including hot pressing (HP), spark plasma sintering (SPS), microwave sintering and laser-assisted thermal processing. Among the investigated methods, hot pressing remains one of the most widely used techniques for obtaining highly dense $TiB_2$ ceramics with improved mechanical properties, although the process generally requires elevated temperatures and significant energy consumption [2]. In contrast, spark plasma sintering has emerged as a promising alternative due to its capability to produce rapid densification through the simultaneous application of pulsed electric current and uniaxial pressure [3]. The rapid heating rates associated with SPS contribute to reduced grain growth and improved microstructural control, essential for ballistic applications requiring high hardness and structural integrity. Particular attention is also given to microwave-assisted processing technologies, which demonstrate important advantages in terms of heating efficiency, reduced processing time and improved thermal uniformity [4]. Microwave sintering enables volumetric heating of ceramic materials and may contribute to lower thermal gradients compared to conventional heating approaches. In parallel, laser-assisted processing techniques have gained increasing attention for localized thermal treatment and surface modification of $TiB_2$-based ceramics. The paper further highlights the growing interest in hybrid ceramic systems based on $TiB_2$ reinforced with additional phases such as SiC, $B_4C$ and $Al_2O_3$, aiming to improve fracture toughness, impact resistance and thermal stability under dynamic loading conditions. Current research trends also emphasize the integration of numerical simulations and thermal modeling in order to better control densification behavior during processing. Overall, the analysis presented in this work underlines the importance of advanced and energy-efficient processing technologies in the development of next-generation $TiB_2$-based ballistic ceramics for modern military and defense applications.

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# Optimization of machining parameters for maximizing surface roughness in S355JR steel milling

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## Abstract

The paper presents the influence of machining parameters on the surface roughness of parts made of S355JR steel, a material widely used in the field of metal constructions. The main objective of the study is to determine the optimal values of the technological parameters of the machining process, so as to obtain the highest possible surface roughness, necessary in certain technical applications where adhesion or high mechanical contact is favored. The paper investigates the influence of the main technological parameters, such as cutting speed, feed and machining depth, on the geometric characteristics of the machined surface. The roughness evaluation is performed by measuring the specific parameters of the surface profile, using methods and equipment dedicated to quality control. Based on the experimental results, the correlations between the machining regimes and the obtained roughness values are established, and the technological conditions that lead to maximizing the surface roughness are identified. The results of the work contribute to the optimization of the technological manufacturing process and the choice of appropriate processing parameters to obtain surfaces with specific functional characteristics in the case of parts made of S355JR steel.

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# Multi-attribute analysis for the optimization of machining processes based on surface roughness, vibrations and noise level

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## Abstract

The paper presents the application of multi-attribute analysis methods in the optimization of the machining process, aiming to identify technological alternatives that ensure low surface roughness of the machined part, minimal vibrations during processing, and a reduced noise level. Within the study, several machining regimes and combinations of technological parameters were analyzed as decision alternatives, evaluated based on techno-functional criteria relevant to the quality and stability of the process. In order to determine the optimal alternative, multicriteria decision-making methods were used through the normalization of experimental values, the establishment of criteria weights, and the aggregation of alternative performances. The obtained results highlight the influence of machining parameters on surface roughness, vibrations, and noise level, as well as the possibility of selecting a balanced technological solution from the perspective of overall performance. The application of multi-attribute analysis demonstrates the efficiency of multicriteria tools in supporting technological decisions and improving the quality of manufacturing processes, contributing to the optimization of working conditions and to the enhancement of the precision of machined surfaces.

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# Sustainability in the Perception of Engineering Students

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## Abstract

Sustainability represents a fundamental aspect of contemporary engineering, having a significant impact on the training of future professionals capable of addressing current challenges related to environmental protection and the responsible management of resources. This study evaluates how students from the Faculty of Engineering perceive sustainability principles by using a structured questionnaire and a multicriteria evaluation method. The research is based on a questionnaire designed to investigate the level of familiarity with the concept of sustainability, attitudes toward environmental conservation, eco-friendly behaviours, and interest in green innovations. The results indicate that most students consider sustainability to be a vital factor in engineering and support a deeper integration of sustainable development topics into the university curriculum. The analysis suggests that practical activities and projects related to green technologies have the greatest educational impact. These findings may contribute to the development of university strategies focused on sustainability-oriented education and on building the engineering skills required for the transition toward a sustainable economy.

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# Assessment of carbon emissions in inland waterway and intermodal freight transport using EcoTransIT World: a case study on the Danube logistics corridor

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## Abstract

The decarbonization of freight transport is a key priority for logistics operators, port authorities and transport planners seeking to reduce the environmental impact of supply chains while maintaining operational efficiency. In this context, inland waterway transport represents a relevant alternative for medium- and long-distance freight movements, especially along European corridors supported by ports, inland terminals and hinterland connections. This paper assesses the carbon emissions associated with alternative freight transport scenarios on the Constanța–Vienna corridor, focusing on the role of inland waterway transport within multimodal logistics. Using EcoTransIT World as a digital emission calculation tool, the study compares three alternatives applied to the same containerized freight flow: road-only transport, rail-based transport and inland waterway/intermodal transport. The analysis considers transport distance, cargo quantity, modal composition, route structure, vehicle or vessel characteristics and first-mile/last-mile connections.

The assessment focuses primarily on $CO_2$ equivalent emissions and energy consumption, applying the same calculation framework across all scenarios to ensure comparability. The study aims to identify the conditions under which inland navigation can contribute to reducing the carbon footprint of freight transport along the Danube Logistics Corridor. The expected results highlight the environmental potential and operational constraints of inland waterway transport, while supporting evidence-based decision-making in sustainable logistics planning and reinforcing its strategic relevance within European green freight corridors.

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