

University of Applied Sciences in Nowy Sącz

II International Scientific Conference
INDUSTRY 4.0

ABSTRACTS

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EVALUATION OF THE MUNICIPAL WASTE MANAGEMENT CONSIDERING THE NEW CONCEPT OF ECONOMY AND POPULATION PERCEPTIONS

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Waste management, in the context of the new economy, refers to the strategies related to principles of sustainability and resource efficiency. By adopting these principles and practices, waste management aims to minimize waste generation, maximize resource recovery, and create sustainable and circular system that reduces environmental impacts. To implement an integrated waste management system, two main entities need to be involved: waste generators and those responsible for the entire "neutralization" process. There are numerous waste management methods around the world, influenced by various factors. This article presents some of the results obtained from a survey conducted among the population of a neighborhood of Bacau City. The location stands out as it is a residential area where waste collection is carried out from door to door. The parameters identified as inputs for our study were: the age, gender, and educational background of the respondents. The parameters of interest were the price of waste collection services, the information and awareness activities carried out by the waste collection operator regarding selective waste collection, and agreement regarding the calculation of waste collection fees based on the collection method. After analyzing the 191 questionnaires obtained from the population, the following observations were made: most respondents were between 36-50 years old (54 respondents); the proportion of male respondents was approximately 10% higher than female respondents, and about 50% of those interviewed had completed high school. Regarding the price they pay for waste collection services, 89.5% considered it to be very high, high, or medium. Concerning the billing method for this activity, 112 respondents would accept a calculation based on the collection method.

AGILITY CULTURE IN THE LOGISTICS OF PASTA PRODUCTION ON THE EXAMPLE OF SMES

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The logistics of pasta production in small and medium-sized enterprises (SMEs) plays a key role in the efficient management of production processes, especially in the food industry. SMEs in the pasta production sector need to focus on efficient planning and management of the supply of raw materials, such as flour and eggs. The next step is to manage staff optimally for the efficiency of the production process and also to coordinate the distribution of the finished product to sub-suppliers and final customers. In this context, information technologies, such as supply chain management systems can significantly improve storage, transportation and inventory monitoring processes. In addition, monitoring of the production process, including the performance of individual employee shifts, and efficient storage of raw materials and finished products enable SMEs in the food industry to minimize operating costs and improve customer service. In this aspect the application of a broadly defined culture of agility positively affects the image of the company and allows it to increase its competitiveness in relation to other companies operating in the market. Cooperation with suppliers of intermediate products and continuous monitoring of indicators related to productivity are key elements of effective supply chain management in pasta production and can contribute to generating more revenue for SMEs. In the context of SMEs involved in pasta production, verification of the efficiency and productivity of the production process including the packaging process is an integral part of effective business management. Systematic evaluation of the efficiency of pasta production is crucial for maintaining competitiveness in the food market. Productivity verification includes monitoring of key indicators, such as the amount of pasta produced and packed in a certain period of time, raw material consumption or waste rates (especially in the case of manual packaging of pasta this is an important indicator). In addition, productivity analysis includes an assessment of the efficiency of the use of individual employees and machines, identifying potential areas for optimization. The implementation of production monitoring systems, including the use of IT tools to collect, analyze and interpret data, allows SMEs to correct planned activities on ongoing basis, minimize losses and improve the entire production process. In this way, meticulous verification of efficiency and productivity contributes to increased competitiveness, improved product quality and efficient resource management in the SME pasta sector. Therefore, it seems important to apply new innovative agile production management methods, which will also optimize logistics processes. In SMEs involved in pasta production, the application of agile methods can bring significant benefits, both in terms of flexibility in the production process and in responding to market changes

that may occur in a turbulent environment. Agile methodology, known primarily from the IT industry, is also gaining popularity in the manufacturing sector, especially in SMEs. In the context of pasta production, agile methods can be applied at both the planning and implementation stages of production processes, and, in the case of the selected SME, also during the manual packaging of pasta, which is a critical point in the entire production process. Using an iterative approach, SMEs have the ability to quickly adapt to changing consumer preferences and stringent industry standards. Flexibility in production planning and the ability to quickly adapt to new market trends become key assets, allowing SMEs to successfully compete in the challenging food market. In addition, agile methods promote communication within the production team, which promotes effective coordination of activities and shortens the time to market new products or scheduled production of products already on offer. As a result, the application of agile methods in pasta SMEs can help increase the adaptability, innovation and efficiency of the production process, which is crucial in a changing market environment. The research presented in this paper focuses on evaluating the pasta production process in a selected SME. A study of the production process was carried out, including verification of production efficiency and expectations of employees who are responsible for this production. In addition, changes and the introduction of agile methods of managing production processes and logistics were proposed, which should positively affect the broader culture of the pasta company. Productivity problems in a pasta company, mainly the packaging process, can be offset by using methods such as the Kanban board, Shu Ha Ri methodology and Lean Manufacturing. These are agile methods to support the production process, which allow it to be structured, monitored and maximize the use of resources that are in the company. The Shu Ha Ri methodology allows not only to optimize the production process, but also positively influences the relationship between employees and their skills because it leads to continuous improvement of employees. This is an important aspect occurring in manufacturing companies, where a large part of the process depends not on machines and equipment, but on employees. This is also true in the case under consideration, since the packaging process, due to the product (pasta), is a manual process, and its efficiency and quality depends mainly on the employees of the SME.

**STUDY OF PHYSICOCHEMICAL PARAMETERS
OF THE QUALITY OF SURFACE WATER
IN NOWY SĄCZ IN THE CONTEXT
OF INDUSTRIALIZATION AND URBANIZATION
OF URBAN-RURAL AREAS
IN ORDER TO CONTROL WATER RESOURCES –
PRESENTATION OF PRELIMINARY RESULTS**

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Physicochemical parameters constitute a tool enabling the assessment of water quality, providing, among others, the necessary information about the chemical substances contained in it. The study determined the quality of surface waters of the Dunajec, Poprad, Kamienica Rivers and the Łubinka Stream, which are tributaries of the Dunajec River flowing through Nowy Sącz. The collected water was tested in particular for the content of metals, chlorides, sulphates, pesticides, Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), turbidity and suspended solids. These studies allowed to obtain information on raw water parameters in terms of water quality in the context of industrialization and urbanization of urban-rural areas in the Nowy Sącz commune.

USING ADVANCED INDUSTRY 4.0 TECHNOLOGIES IN THE STRAIGHTENING PROCESS OF SLENDER HOLLOW PRODUCTS

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The technological process of molding and heat treatment of a long material with a circular cross-section, can cause the workpiece to curve. One of the basic methods of counteracting this phenomenon is the introduction of a straightening procedure into the technological process, while the basic parameter determining the value of the curvature of the workpiece is the straightness control. The problem becomes even more difficult when we realize that the axis of the hole is not always in line with the axis of the outside diameter and, consequently, straightening cannot be based on the external measurement of the workpiece, but on the problematic measurement of the hole whose diameter is between 6-25mm.

At Zakłady Mechaniczne Tarnów (a mechanical plant), the straightening and straightness control process are checked manually, based on employees' experience, using a dial sensor. The Łukasiewicz Research Network – Poznań Institute of Technology, together with Zakłady Mechaniczne Tarnów, have built a groundbreaking prototype device based on an expert recommendation system, within the framework of a joint project, for automatic straightening of long hollow products with a high variability of cross-section (bore diameter of 6-25mm) and a large range of length (500-3000mm).

An intelligent, learning-algorithm-based inference and a recommendation system collect and process straightening process data (initially from semi-automatic straightenings), and then determine the optimal values of straightening process parameters based on these data.

During the implementation of the project, technological challenges were encountered, such as the development of a method for automated measurement of straightness in a long bore, a methodology for predicting the degree of workpiece backspacing depending on the stage of production and thus on the geometric form and mechanical properties, optimization of the amount of deflection for reducing straightening time, among others.

PRACTICAL APPLICATIONS OF AI FOR AUTOMATING THE GENERATION OF STATISTICAL DATA SETS DESCRIBING THE EXECUTION OF THE DESIGN PROCESS IN ENGINEERING DESIGN COMPANIES

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In today's engineering design firms, the use of ERP systems for enterprise management is becoming increasingly prevalent. The primary process within engineering companies is design, where tasks assigned to engineers are standardized, allowing for the creation of dictionaries of typical tasks and the determination of norms for hourly budgets and overall timeframes. However, the use of predefined dictionaries can be limiting, restricting the flexibility in task definitions and making it difficult to align with the syntax imposed by investors. Consequently, in many cases, the Work Breakdown Structures (WBS) of projects are manually defined. Therefore, there is a need for an easy way to combine manually created tasks with predefined dictionaries of engineering activities to facilitate the generation of statistical data. In multi-disciplinary engineering projects, the number of tasks can reach thousands, making it a highly labor-intensive task to categorize each task correctly. This task can be automated using available AI algorithms. This paper presents a practical solution based on the Wayman ERP management system, enabling the use of AI to reduce the time required for data segmentation while allowing for the verification of algorithm results before the final input into the statistical database.

GAS AND LIQUID CHROMATOGRAPHY AS A TOOL FOR THE RESEARCH ON LIQUID PRODUCTS OF MICROWAVE-ASSISTED PYROLYSIS

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The development of renewable energy sources in recent years is the result of the increased interest of many countries and world organizations in protecting the natural environment, which is an integral part of the human existence system. The topic of solid biomass research is related to subsequent legal acts – European Union Directives requiring an increase in the share of renewable energy sources in transport and energy. The EU Directive on the promotion of the use of biofuels or other renewable fuels in transport is Directive 2009/28/EC promoting an increase in the share of energy from renewable sources in various sectors of the European Community. The use of biomass in the Polish energy plan is one of the main areas of interest of the country's energy policy and is consistent with the goals set by the European Union and adopted by the member states. The material contains the results of solid biomass testing using chromatographic methods and microwave pyrolysis techniques. The research used a gas chromatograph with a GC-FID Thermo Electron Corporation flame-ionization detector, Trace GC Ultra model, as well as a gas chromatograph with a GC/MS mass detection system, Perkin Elmer model 500/560D. Thanks to the use of combined gas chromatography and mass spectrometry techniques in conditions analogous to those obtained using the gas chromatography technique with flame-ionization detection FID, it was possible to conduct tests on bio-oils obtained from various types of solid biomass. Thanks to the appropriate selection of the chromatographic column, it was possible to separate the complex mixture of organic compounds such as bio-oil. The use of various detection systems, made qualitative identification and quantitative determination of individual components possible.

INDUSTRY 4.0 INNOVATIONS USED IN THE FORGING PROCESS OF CONSTRUCTION ANCHORS USED IN REINFORCEMENTS

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The demand reported by the market for the delivery of construction anchors in a minimum time of small and medium-sized production series, without the need to order larger quantities and their storage, while increasing labor costs, forces the search for solutions that can replace a manual forging machine. At the Lukasiewicz Research Network – Poznań Institute of Technology, an automated machine for forging construction anchors was designed and put into operation, which was equipped with an industrial robotic arm, an eccentric press with a self-clamping forging device, a bar feeder, a vertical magazine for forgings, and two induction heaters. The automated forging machine, as opposed to a manual one, allows one-sided and two-sided shaping of the roughs and heads on the ends of ribbed bars with a maximum diameter of up to 25 mm, in the length range from 405 mm to 1005 mm. The biggest challenge of the autonomous machine is to ensure continuous operation with constant geometry of the obtained heads. The biggest problem is the geometry of the feedstock in the form of ribbed bar, which has a large tolerance in core diameters (from – 6% to 4%) leading to a large spread in the size of head diameters. The high dispersion of the diameter of the core of the ribbed bar also affects the appearance of disturbances in the form of the volume of the heated part, which leads to overheating or underheating of the charge and translates into a dispersion of the diameter of the forged heads (different flow resistance of the material). The problems encountered contributed to the development of a system for continuous monitoring and regulation of the forging process based on neural network. As a result, a system of self-adjusting bumpers based on servo mechanisms has been designed, as well as a system for adjusting the parameters of the induction heater in real time, based on data from an expert recommendation system. The expert system will acquire data from the developed hot coarsening measurement systems as well as from the measurement of the volume of the charge subjected to induction heating. On this basis and on the basis of historical data, it will look for the results similar to the obtained (required head size). The data will be sent in the form of a file with setting data of current, heating time, etc.

APPLICATION OF RAPID PROTOTYPING TECHNOLOGY IN THE RAILWAY INDUSTRY

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The design of modern rail vehicles such as passenger carriages or locomotives is mainly based on computer system tools. During the construction of these vehicles, CAD computer-aided design systems, computer-aided analysis (CAE) systems and computer-aided manufacturing (CAM) systems are used. Thanks to these tools, three-dimensional models of individual components of a rail vehicle are developed, such as: steel body, interior construction, pneumatic and electrical installations, trolleys, HVAC ventilation ducts, etc. On the basis of these 3D models, 2D construction documentation is created, which includes details, assembly and assembly drawings, as well as various types of analyses, e.g. gauges. Recently, however, another tool supporting the designer's work has become the RP (Rapid Prototyping) method. It is most commonly used for additive prototyping methods. It allows for the production of three-dimensional physical models of the designed parts, significantly accelerating design and implementation work. Rapid prototyping techniques include: stereolithography (SLA), selective laser sintering (SLS), fused deposition modelling (FDM) and 3D printing. It is the latter method that is most used in the railway industry thanks to its universal character. The RP rapid prototyping system is also characterized by the ease of automating the processes of additive shaping of objects. They are designed for direct integration with computer-aided CAD construction. Rapid prototyping of rail vehicle parts allows to refine the concept of building a given component before the vehicle is built, thus saving not only time but also money. There are cases where an element printed in a 3D printer is mounted on a real vehicle thanks to the availability of plastics compliant with the strict requirements of the railway fire safety standard PN-EN 45545. This gives an even greater spectrum of availability of technologies for the production of often complex details, which would be technologically impossible to produce with conventional methods due to hardware limitations.

DESTRUCTION OF FUNCTIONAL SYSTEMS OF A DIESEL ENGINE RESULTING FROM THE FORMATION OF PM DEPOSITS

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Optimization of the fuel combustion process in a diesel engine with multi-stage HPCR fuel injection determines the main directions of research in the field of thermodynamic stability of fuels with the addition of FAME, including the processes of PM (Particulate Matter) formation. These particles absorb heavy metals, sulfur and nitrogen compounds and PAH (Polycyclic Aromatic Hydrocarbons), among which there are carcinogenic substances. Therefore, it is necessary to precisely control the recirculated exhaust gas stream to achieve a reduction in NO_x emissions. Diagnostic tests showed the formation of PM deposits in both the EGR (Exhaust Gas Recirculation) and DPF (Diesel Particulate Filter) systems, which requires the use of interdependent OBD diagnostic tests.

Analyzes of the XRF spectrum in relation to determining the share of elements constituting PM, together with the IR spectrum of infrared spectroscopy, showed the share of organic compounds of FAME origin. The addition of FAME promotes the formation of IDID (Internal Diesel Injector Deposits) deposits due to acidic impurities during production formed in the autocatalytic division of fatty esters with the participation of metal ions. The deposits created in this way may cause the surfaces of moving elements to stick together and intensify corrosion processes.

Using a dedicated tester, diagnostic procedures were carried out, including the assessment of the operating parameters of the 2.0 DCi MR engine of a passenger car showing an emergency condition signaled by the MIL indicator. An ineffective effect of the DPF filter regeneration process was demonstrated due to the accumulation of non-removable PM layers, leading to an excess differential pressure value and error codes DF315 and DF890. Also, the excess value of the sediment mass indicated the low effectiveness of DPF regeneration, which usually results from the use of the vehicle over short distances. The degree of opening of the EGR valve determines the mass of exhaust gases to ensure the instantaneous value of the recirculation degree XEGR. The error range is strictly defined and exceeding this value determines a fault, leading to the engine failure status being signaled via the MIL and the error codes DF647 and DF647 being stored. The reason for this condition is a large amount of carbon deposits in the area of moving elements and the EGR valve seat.

The operating parameters of the interdependent systems should be fully presented as characteristics in relation to the diagnostic test time base – mainly the correction doses of individual injectors in order to assess the correctness of their operation and not only focus on individual symptoms or replace engine equipment components, according to the error codes.

APPLICATION OF FDM ADDITIVE MANUFACTURING IN RAIL VEHICLE REPAIR PROCESSES

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The paper presents in practice the application of the FDM (Fused Filament Fabrication) method during inspections and repairs of rolling stock. The authors discuss the use of additive manufacturing technology using a 3D printer with a heated chamber in the temperature range from 20 to 100°C. They pay particular attention to the practical advantages of such a solution, citing examples of elements that have been manufactured for the needs of vehicle repairs. Issues related to the requirements of the EN45545 flammability standard at the HL1, HL2, HL3 levels are also discussed. This standard is currently required for assembled components during the production of modern rolling stock. Thanks to the introduction of new filaments, among others, ABS-45545 with certificates of the above-mentioned standard in recent years, the applications of 3D printing in the rail vehicle industry have been significantly increased. In the summary, the authors present the achievements and experiences in the transport industry to date. They discuss further directions of development in this area, citing current tests of filament flammability and plans for new materials.

PARADIGMS OF INDUSTRY 4.0

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The paper presents the concept and scope of Industry 4.0. The essence and characteristics of manufacturing excellence are discussed. Attention was drawn to the current problems of the Polish economy and the necessary competencies of a contemporary engineer. Potential barriers to enterprise development were characterised in light of these requirements. The concept of technological and organisational transformation of enterprises and the required characteristics of leading enterprises were presented. The concept of enterprise capital was defined in broader terms. The scope and conditions of quality management in Industry 4.0 and the role of digital tools were defined.

HYDRAULIC OIL TESTING UNDER OPERATION CONDITIONS BEFORE AND AFTER MICROFILTRATION

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The article presents issues related to filtration and microfiltration of hydraulic oil from metallic impurities and the presence of water, which deteriorate the properties of the oil in long-term operation. Tests carried out on oils have shown that periodic oil replacement in machines or vehicles in accordance with their maintenance documentation ensures that the system is emptied of 95% of impurities from the old oil before pouring the new one. The remaining part, i.e. 5% of impurities, together with the oil remaining on the walls of the pipes or inside other hydraulic devices, will mix with the new oil, reducing its cleanliness class. Periodic replacement of hydraulic oil will not allow for complete cleaning of the system. In extreme cases, poor oil condition may cause disruptions in the operation of the machine with the hydraulic system or its downtime for oil replacement or repair. Filtering the oil in the system while the machine is running will clean the oil from impurities and water, extend the oil's service life, without disabling the hydraulic system. The article includes, among others, the justification for the use of microfiltration of hydraulic oil with portable filtering devices in order to extend the service life of the oil until the next replacement is presented. The main purpose of the article is to present the methodology for testing hydraulic oil in accordance with the requirements of ISO, NAS and SAE in order to assign the oil to a given cleanliness class. Additionally, the results of testing the oil cleanliness class in various periods of operation of the machine with the hydraulic installation on a portable measuring device were presented.

LONG-TERM FORECASTING IN TECHNICAL FACILITY CONTROL SYSTEMS

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The article analyzes the parameters characterizing the security level of a technical facility. To identify factors that constitute external hazardous events, forecasting methods for such events are used. All possible events are divided into two types. Events whose impact, when detected using forecasting, can be eliminated, and events that have a stronger negative impact on the technical facility, which leads to a reduction in the facility's safety level. The forecasting method is implemented in two stages. In the first stage, starting from the final state of the facility, the transition takes place in separate steps, starting from the critical state to the initial state of the facility's security level. This procedure is carried out based on the use of data obtained at the stages of testing and experimental operation of the facility. The second stage involves the use of indirect forecasting for each subsequent cycle of the technical operation of the facility. A certain number of changes in the state of an object lead to the object's transition to a critical state. The implementation processes of both stages are represented by two lines in a phase system. In the long-term forecasting process, the past results of interim forecasting, the current significance of the facility's safety parameters and the distance from the appropriate points of the curve obtained at the first stage and the current point of the facility's state curve at the second stage were used.

ASSESSMENT OF THE IMPACT OF SELECTED LOGISTIC FACTORS ON THE EFFICIENCY OF MUNICIPAL WASTE COLLECTION – A CASE STUDY

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This article presents the results of research over 12 months on municipal waste export, assessing the load capacity of the export fleet and taking into account the impact of selected logistic factors on the efficiency of waste transport. The service range covered an area with a population of over 100 000 inhabitants. The highest average net weight of collected waste of 8.72 Mg with a standard deviation of 3.60 Mg was characteristic of a vehicle with the highest capacity in the study. The analysis of deviations from the maximum payload was also significant, showing over 20% underutilisation of the vehicles' payload. A full correlation was present between the net weight and filling of separated waste. The developed model is considered an essential tool in designing and controlling waste disposal, which, through its adjustment, is determined by the filling variable through the variable net mass. Based on the analysis, the selection of vehicles with a specific capacity should take into account optimising municipal waste transport parameters using tools for intelligent waste logistics management.

NEW TECHNOLOGIES FOR CONSTRUCTING BUILDINGS, IN THE FACE OF REQUIREMENTS FOR ENERGY DEMAND, WASTE MANAGEMENT AND ENVIRONMENTAL NEUTRALITY

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Construction regulations including the WT 2021 standard and the Energy Performance of Buildings Directive (EPBD, or so-called "Buildings Directive") require a drastic reduction in the cost of heating houses and also a reduction in carbon dioxide emissions into the atmosphere. From 2028, all new buildings must be zero-carbon, so there is a need for a different approach to both heating and insulation design for residential buildings. The most popular methods of insulating buildings are based on materials such as polystyrene foam, polyurethane foam or mineral wool with a relatively large carbon footprint – about several tens of kilograms of CO₂ per cubic meter of product. Also, the subsequent disposal of these materials is difficult due to the low recycling rate, located at a maximum of 30% for polyurethane foam and polystyrene foam, and about 50% for mineral wool.

R&D work realized by Kingdomy Ltd. has made it possible to develop a natural, bio-based material with a low thermal conductivity coefficient and high recycling rate, and to create a technology for its application. It is a material created on the basis of straw and clay, with additives such as lime or cement – used to obtain specific properties of the insulation. The spraying of the insulation allows a controlled adjustment of the proportion of the fraction of straw in relation to the fraction of clay, and specially made spray heads allow the insulation to be injected even into hard-to-reach places, eliminating spaces and ensuring a uniform, homogeneous structure of the wall. The thermal conductivity coefficient obtained for the tested materials is higher than for artificial materials, but already for a wall 55 cm thick, the values required for a building to meet the criteria for classification as passive can be obtained. An additional advantage is the high recycling rate of more than 95% for the material used.

The research work was realized as part of the project "Development of ecological and biodegradable energy-efficient buildings based on the application of KINGDOMY technology using hybrid materials of natural source and self-clamping prefabricated beam elements", Project Number: POIR.01.01.01-00-1880/20, Realized under the 2014-2020 financial support of Structural Funds in the Operational Program – Intelligent Development from European Regional Development Fund, competition Fast Track.

DEVELOPMENT OF THE RAPID ASSEMBLY SYSTEM FOR PIPING SYSTEMS, IN THE FIELD OF TECHNOLOGY FOR PREPARING, ASSEMBLING AND WELDING STEEL PIPELINES

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The construction of high-pressure steel industrial pipelines used in the oil, gas, chemical, metallurgical or power generation industries, is associated with the need to meet many requirements, especially in terms of resistance to high pressure of the transported medium (liquid, steam, gas). The place most exposed to the loss of tightness is the welds connecting the individual sections of the pipeline. Conventionally, pipelines are made of pipes with diameters DN32 to DN300 and wall thicknesses up to 20 mm. Welding of pipelines can be carried out with automatic welding machines or manually. Wherever there is a possibility, automatic welding is preferred, where there is no such possibility the only alternative is manual welding.

Correct welding operations performed manually require precise positioning of individual pipeline sections. Currently, a pipeline is assembled on an ongoing basis and then welded section by section. This approach requires a cyclic work of the assembly team and the welder, thus generating unnecessary costs and downtime. Pipe positioners available on the market do not have the required rigidity and strength for the possibility of building an entire pipe structure on them.

MSE Ltd. has developed a new type of positioner that allows the construction of a complete pipeline connection without the need to weld it during assembly, the so-called Quick Assembly System (SSM connectors). In order to significantly reduce the production costs of SSM connectors, their design was simplified, thus eliminating milling, turning and welding operations and concentrating on laser-cut parts fastened with screw connections. This approach significantly simplified the production of the prototype, and allowed rapid replacement of damaged parts. Parts that could not be made from steel sheet were manufactured from machined metal blocks, and durable 3D printed polymers. A comparative and cost analysis of these two manufacturing technologies for demanding structural components was carried out.

The research work was realized as part of the project "Development of a Rapid Assembly System for rigid pipe fittings, representing a breakthrough innovation in the technology of preparation, assembly and welding of steel pipelines", Project Number: POIR.01.01.01-00-1183/18, Realized under the 2014-2020 financial support of Structural Funds in the Operational Program – Intelligent Development from European Regional Development Fund, competition Fast Track.

QUALITY CONTROL SYSTEM FOR WELDED STEEL COMPONENTS, PAINTED IN AN AUTOMATIC POWDER COATING LINE

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To achieve a product with high esthetical values and the required quality that is reflected in the time of failure-free use requires the manufacturer to monitor production continuously and correct improperly running operations. This is particularly important, in the manufacture of welded powder-coated steel components, because defects resulting from improperly carried out production may become visible after several years.

One of the common quality control methods is the statistical control system, based on a randomly taken sample. This is a low-labor and low-cost method that allows for reasonable verification of the production process. However, while this method allows for the identification of a defective product, it often does not lead directly to the identification of the cause of the defect. Even the use of 100% inspection, which is much more time-consuming and costly, also does not always lead to the cause of a product defect.

The solution is the Expert System, which collects data from the production process, and allows for analysis, diagnosis, predictions and guidance – tasks that can only be carried out by an expert. As a part of the research, an Expert System was developed to collect information about materials, processing and products manufactured at BARAN Ltd. These are primarily welded steel fence components. The inference algorithms were built in example using Artificial Neural Networks.

In addition, as part of the powder coating line, a product quality vision inspection system has been launched. System bases on the KEYENCE hardware and software. The system allows for maintenance-free, continuous production control of galvanized and coated wickets, spans, posts, gates and fence panels. The system also allows identification of the size of the defect, and notification of defective product. The identification of products is based on previously developed patterns nevertheless KEYENCE's system is so flexible that it is possible to detect defects on products on which no calibration has been carried out. In order to fully control quality of materials, semi-products and products, a laboratory, integrated with the Expert System, has been set up. In the laboratory, strength tests on steel and finished products, chemical analysis, and aging and corrosion resistance tests are possible to obtain. An evaluation program has also been launched to evaluate products installed at customers' sites, which will make it possible to verify the actual life of the product. The research work was realized as part of the project "Development and launch of a comprehensively monitored technology for the production of galvanized powder-coated steel components", Project Number: POIR.01.01.01-00-0736/18, Realized under the 2014-2020 financial support of Structural Funds in the Operational Program – Intelligent Development from European Regional Development Fund, competition Fast Track.

INNOVATIVE PRODUCTION PROTOTYPING PROCESSES AND LOW-COST SMALL VOLUME PRODUCTION – ELECTRIX SERIES BLOCKS

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Optimizing the cost of manufacturing complex prototypes of plastic-made devices is crucial for cost-effective implementation and production costs. This is particularly important for small volume or variant scales, where mass-scale manufacturing technologies are not economically reasonable. In the case of manufacturing products from polymeric materials, 3D printing methods are becoming increasingly popular. The popular FDM printing, for example, or industrial printing using SLS or SLA technologies can be specified. The Electrix series of bricks is a development of the idea proposed in the series of wooden, LEGO Technic-compatible QUBTRIX bricks, which allow building advanced marble tracks. The series of basic Electrix bricks, is based entirely on polymer structure. Specialized bricks equipped with electro-mechanical systems, controlled via a mobile app, have also been developed. In creating the prototype, advanced manufacturing methods were used, allowing to reduce the cost of manufacturing the pad and shorten the design -> prototype -> testing cycle.

The first prototypes were produced using a CNC milling machine controlled by the popular Mach3 software by Artsoft. Further tests were conducted using a Seron CNC plotter with manual tool changing, and a CNC plotter with full automation. Limitations related to the inability to make complex shapes, and problems with attaching parts forced the use of other manufacturing methods.

The next test models were produced in FDM 3D printing technology, using a Zortrax M200 printer and a professional Boson GROUP printer. This allowed us to dramatically reduce the prototyping time for subsequent versions of the models, but even here, manufacturing small key structural elements was not possible. Components less than 10 mm in size were prototyped using SLS technology. This is a more time-consuming and costly method compared to FDM printing, but it allows for the fabrication of a component of virtually any shape.

Flat parts were made using CO2 laser cutting – a relatively cheap and the fastest method by far, which is only applicable to 2D parts. For small polymer parts, the demand for which exceeded 10,000 pieces, injection molding technology was selected to be used. For all the above-mentioned manufacturing technologies, a comparative analysis of the cost and time of manufacturing, and the precision of the parts, depending on the size, shape complexity and strength requirements, was performed.

The research work was realized as part of the project “Development of ELECTRIX wooden blocks characterized by compatibility with the LEGO standard and operating with the "connected toys" philosophy", Project Number: RPMP.01.02.01-12-0110/19, Realized under the 2014-2020 Regional Operational Program of the Malopolska Region.

HIGH-TECH METHODS OF DESIGN, CONTROL AND MANAGEMENT OF THE PRODUCTION PROCESS – QUTRIX SERIES BLOCKS

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The launch of a production line for a new product is often followed by the time-consuming and often costly stage of preparing a prototype, which allows checking design objectives, estimating manufacturing costs, testing the functionality of the new solution and, above all, preparing the final version of the product. A key role is played by the time required to move the project to the production phase, which is related to the availability of tools that allow shortening the prototyping phase.

The discussed case relates to the development of technology for manufacturing LEGO Technic-compatible wooden blocks for building marble tracks. The challenges that had to be addressed were in four main areas.

The first area was the repeatability of manufacturing wooden components. Due to the non-uniform structure of beech wood and its tendency to deform under changes in temperature and humidity, it was necessary to ensure consistent processing parameters through, among other things, quality control of the raw material. Initial evaluation of the graining was carried out through visual inspection of the timber planks, while the strength parameters of the wood were measured using a tensile tests.

The second area was related to the quality control of manufactured parts. For this purpose, random inspection of the blocks was carried out, using GOM's ATOS Compact Scan 8M optical scanner. Using CAD production models and GOM Inspect software, a comparative analysis was carried out, allowing a precise assessment of the quality of the manufactured block.

The third area was the optimization of the manufacturing process to maximize the reduction of the production cycle, without excessive tool usage. The production process of a single pad requires the use of 7 to 10 types of cutting tools. Ongoing monitoring of their condition makes it possible to achieve a smooth block surface, increase the operating time of cutters and minimize the risk of tool damage. The study of the state of tool wear, in direct terms, was carried out using the KEYENCE Series IM-8020 digital measuring projector. In indirect terms, surface roughness was monitored using the KEYENCE Series VHX-7000 digital microscope. The load on cutting tools was monitored by measuring the lateral forces acting on the cut piece using strain gauges and the HBM QUANTUM MX440A measuring amplifier.

The final area was the development of a methodology for managing wood production waste (zero waste production), including wood cutting trimmings, blocks damaged during production, wood chips generated during planning, and dust generated during milling. The research work was realized as part of the project "Development of interactive wooden blocks compatible with the LEGO standard for education through play", Project Number: POIR.01.01.01-00-0044/19, Realized under the 2014-2020 financial support of Structural Funds in the Operational Program – Intelligent Development from European Regional Development Fund, competition Fast Track.

ADVANCEMENTS AND CHALLENGES OF MACHINE LEARNING AND NEURAL NETWORKS IN PARTICLE PHYSICS

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Machine learning is a field within computer science that has emerged from the study of artificial intelligence, specifically in pattern recognition and computational learning theory. It has found widespread application in various aspects of physics research, ranging from experimental design and optimization to data acquisition and analysis. Machine learning techniques are now being utilized in numerical simulations and theoretical studies as well.

In my presentation, I will demonstrate the utilization of machine learning techniques throughout different stages of the ATLAS experiment at CERN. I will particularly highlight the remarkable progress achieved in data analysis through the implementation of deep neural network techniques. Additionally, I will showcase an example from a medium-sized experiment, HADES at GSI/FAIR, where machine learning can be effectively applied to detect signal events from numerous contributing channels.

In conclusion, I will discuss the significant challenges posed by the vast amount of data collected for detecting very rare signals. Machine learning techniques have become indispensable tools for successful data analysis in such scenarios.

IMPROVING THE PROPERTIES OF LOW TEMPERATURE ESTERS METHYL FATTY ACIDS

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The development of alternative energy sources is still of great importance due to limited oil resources and the increasing emphasis on environmental protection. Biodiesel, usually fatty acid methyl esters (FAME), is an alternative to or component of conventional diesel fuel. The introduction of FAME as a stand-alone fuel and the increasing share of FAME as a component of diesel fuels have caused manufacturers and designers of diesel engines to set high quality requirements for the produced biofuels. FAME, like classic petroleum fuels, crystallizes at low temperatures, which results in the formation of crystals in the form of plates or needles with dimensions from several to several hundred micrometers, then three-dimensional crystal structures are also formed, the holes of which contain liquid fuel molecules. This process causes the fuel to lose fluidity and solidify, thus limiting the use of FAME in winter. In the European Union, stringent requirements regarding quality parameters and test methods for fatty acid methyl esters (FAME) are summarized in the EN 14214:2012+A2:2019 standard.

The presentation presented the general characteristics of the use of FAME biofuel in classic, petroleum-derived diesel oil, indicating the advantages and disadvantages of biofuels, and provided information on methods for improving the low-temperature properties of FAME.

The research part of the presentation presented research on obtaining modified FAME, characterized by improved low-temperature properties. The tested fatty acid methyl esters (FAME) were subjected to a solvent dewaxing process with methyl isobutyl ketone and a methyl isobutyl ketone-methyl methyl ketone mixture.

It was found that the process was carried out under similar conditions to solvent dewaxing, used as a standard procedure for dewaxing oils and deoiling of slack derived from crude oil, usually used in refinery industrial installations, allowing the achievement of the assumed goal.

Modification of two different types of FAME in the dewaxing process using MIBK-MEK and MIBK solvent allows for improvement of the low-temperature properties of the obtained FAME modification, consisting in obtaining improved cloud, flow and CFPP temperatures. Analyzes of fatty acid profiles show a clear increase in the content of saturated acid glycerides in the separated sediment, compared to the filtrates from the dewaxing process, which confirms that the selectivity of the dewaxing process for the unusual raw material, which are fatty acid methyl esters, is maintained.

STUDIES ON THE POSSIBILITY OF USING TPU-93A FILAMENT IN THE ADDITIVE MANUFACTURING PROCESS FOR THE PRODUCTION OF SEALS FOR THE NEEDS OF INDUSTRIAL HYDRAULICS AND PNEUMATICS

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The paper presents the results of research on the use of TPU-93A filament for hydraulic and industrial pneumatics applications. The tests were carried out on samples additively produced from a material which, according to the manufacturer's data sheet, has the characteristics of resistance to greases and oils. The paper presents, among others, such tests as resistance to high pressure in the research hydraulic system on the performed samples. Parameters related to hardness, absorbency and resistance to friction forces of the samples were also tested. The summary presents the results of the research and the conclusions, answering the questions resulting from the assumptions of the subject matter.

ANALYSIS OF THE FUNCTIONING OF FIBER OPTIC SYSTEMS

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Thanks to optical fibers, information transfer on a global scale becomes lightning fast. Optical fiber, made of a mixture of glass and silicon, is currently the most effective medium for transmitting data. Its applications include not only telecommunications, but also medicine, automotive industry, and lighting. Optical fibers, with a diameter of only 125 μm , are also becoming more and more common in households, thanks to FTTH technology.

The study focuses on fiber optic technology, its applications, and the fiber joining process. Research includes the analysis of losses resulting from optical fiber connections and the examination of various fiber parameters. Operations such as fiber splicing require advanced equipment such as fiber optic splicers that automatically align and thermally connect fibers.

The aim of the work is to investigate losses resulting from connections and bends in the fiber optic line. The characteristics of fiber optic connectors, analysis of their efficiency, and tests of splice parameters are presented. The research also includes macrobending of optical fibers and detachable mechanical connectors. The entire work focuses on the technical side of optical data transfer.

An important element of the work is the analysis of various types of single-mode and multimode fibers, with particular emphasis on their applications in telecommunications networks. It also presents methods and parameters of fiber joining together with statistical analysis.

Research indicates the validity of using uniform optical fibers and high-quality connectors to minimize losses. Fiber optics are a key element of modern networks, offering stability and speed of data transfer. Thanks to the work, it is possible to develop procedures to analyze power losses in various sections of the fiber optic network, which is important for designers and operators of telecommunications networks.

TEST OF THE MECHANICAL AND ACOUSTIC PARAMETERS OF THE ELECTRIC GUITAR BODY

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Wood is a heterogeneous, anisotropic material with a porous structure and a system of capillary spaces. Those properties make it the preferred material for soundboards in musical instruments.

The aim of the work is a mechanical and acoustic analysis of electric guitar bodies. Cubes made of ash, oak, walnut, linden and fir were selected for mechanical tests – with constant moisture, made of late wood and free from defects. The tests were carried out on the Brinell device to determine wood hardness and on the MCT3 machine from Anton Paar to determine microhardness and elastic moduli. The elastic properties of wood are determined by its anisotropy and have different values depending on the direction of force in relation to the fibers. Wood showed the greatest stiffness along the fibers, and in the case of forces acting perpendicular to the fibers, the stiffness was much lower. Sound transmission tests of selected acoustic parameters were carried out. They involved measuring and analyzing the vibration frequency of guitar bodies using a special vibration sensor with a piezoelectric membrane. The acoustic parameters of a guitar body experimentally made from walnut were compared with those of a mass-produced Ibanez guitar made of ash wood. Each species of wood has its own characteristic blend of physical properties, such as grain structure, density, weight and strength, which influence the final tonal power of the guitar. The test results of various wood species indicate significant strength and acoustic-resonance differences, which determine the absorption of vibrations, sound amplification and sound transmission. The use of specific wood for a guitar's resonance board is related to the musician's artistic vision and the purpose of the instrument for a specific function in the band.

ENVIRONMENTALLY FRIENDLY WIND POWER PLANT

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Wind energy is one of the most important renewable energy sources that use the power of the wind to generate electricity. Wind power plants, also known as windmills or wind turbines, are among the most recognizable symbols of renewable energy. Recently, increasing awareness of climate change and environmental pollution has led societies around the world to look for alternative and more sustainable energy sources. Among these solutions, wind farms have gained particular recognition as a key element in the fight against climate change and reduction of greenhouse gas emissions. Wind farms are an example of a technology that uses the potential of nature to produce clean electricity. By converting the kinetic energy of the wind into electricity, these impressive structures not only reduce harmful emissions, but also contribute to reducing dependence on non-renewable energy sources such as coal and oil.

The aim of the work is to construct a home wind farm using simple, low-cost materials and environmentally friendly technology, according to the applicable Renewable Energy Sources Act. Appropriate elements were selected and designed, such as the mast, the type of turbine and the type of power generator. The specific terrain and the average wind speed and direction were taken into account. Calculations were made of the rated power of the turbine modeled on the Savonius turbine and its efficiency. A comparison was made of the energy utilization coefficients of the designed turbine and different types of wind turbine rotors.

In the final part of the work, the parameters of a generator in the form of a disc generator with a SEMA winding that generates direct current were designed and calculated, and the annual yield of electricity generated by this turbine was determined.

TESTING OF HYDRAULIC OIL UNDER OPERATING CONDITIONS BEFORE AND AFTER MICROFILTRATION

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Hydraulic oil as a working medium in hydraulic drives is widely used in industrial machinery, construction machinery and means of transport. The condition of the hydraulic oil affects the operation of the equipment as well as the durability of the hydraulic system components. The genesis of taking up the problem related to cleaning hydraulic oil without changing it is the growing interest of vehicle and machine users in testing the condition of hydraulic oil and its re-filtering. The hydraulic oil filtration technique was already known abroad in the 1990s, but in Europe and Poland it became widespread at the beginning of the 2000s. However, in many cases and opinions, it is still considered that the entire oil should be changed periodically. It should be noted, however, that in this way the oil is changed only from the tank, and a large part of the dirt remains on the walls inside the hydraulic system.

The aim of the article is to present the methodology of hydraulic oil tests in field (operation) conditions in accordance with the requirements of ISO, NAS and SAE in order to assign the oil to a given cleanliness class. In addition, the article presents the results of hydraulic oil tests after a certain period of use without and with the use of microfiltration.

COMPARATIVE TESTS OF TENSILE MECHANICAL PROPERTIES OF 3D PRINTS MADE OF ABS-42 FILAMENTS WITH ABS-45455 MEETING FLAMMABILITY STANDARDS EN45545 ON HL1, HL2, HL3 LEVELS

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The paper presents comparative results of tests of two ABS filaments. The authors presented a research hypothesis whether a material containing flame retardant compounds for the purposes of certification according to the EN45545 standard used in the railway industry contributes to a decrease or increase in tensile strength. The tests were carried out on samples of two tested materials, which were made in three variants of production. In each of the variants, a different angle of inclination of the layer in relation to the Z axis was used. The comparison between the tensile strength of printing in angles of 0 degrees, 45 degrees and 90 degrees in regard to the printing area and produced some unexpected results that were coherent between both materials. In conclusion both material and the printing settings have a great impact on strength of an end result object and have to be considered carefully to perfectly meet our requirements.

APPLICATION OF ADDITIVE MANUFACTURING BY FDM IN PROCESSES REPAIR OF RAIL VEHICLES

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The paper presents in practice the application of the FDM (Fused Filament Fabrication) method during inspections and repairs of rolling stock. The authors discuss the use of additive manufacturing technology using a 3D printer with a heated chamber to temperatures between 40 and 100°C. They pay particular attention to the practical advantages of such a solution, citing examples of elements that have been manufactured for the needs of vehicle repairs. Issues related to the requirements of flammability standards used in the railway industry and the possibilities of printing are also discussed. In the summary, the authors present their achievements so far and their experiences with them. They discuss the directions of development in this area, citing current research on railway flammability and the research planned for new materials.

SELECTED ISSUES OF ENERGY CONSUMPTION BY RAIL VEHICLES

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The article presents an overview of design solutions for brake discs of rail vehicles in terms of their structure, ventilation and cooling after the braking process. The authors paid particular attention to three types of structures of ventilated brake discs, i.e. with ventilation blades, ventilating rods and ventilating oval connectors. The article presents the influence of the type of ventilation of these discs on energy losses understood as energy consumption in the ventilation process (fan losses). On the one hand, forced ventilation of brake discs shortens the cooling time after intensive and long-term braking, on the other hand, it causes energy losses due to forced ventilation when the brakes are not used, e.g. while driving. The article presents the state of knowledge in the field of cooling efficiency of brake discs as a result of forced ventilation and presents a method for calculating the energy consumption generated by the brake disc depending on the rotational speed. In the article, energy losses are divided into inertia losses from the rotating mass in rotation and losses from the fan. The presented methods make it possible to determine the energy losses generated by the brake disc for one operating point, i.e. a given rotational speed and known geometric dimensions of the disc. Carrying out calculations for the remaining operating points makes it possible to determine the energy consumption characteristics of the brake disc as a function of rotational speed.

ENERGY EFFICIENCY IN INDUSTRY

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The rapid growth of global industry in recent decades translates directly into increased energy consumption in technological processes, which accounts for about 37% of global energy consumption. At the same time, 50% of the energy consumed is inefficiently used, among other things, in heat exchange processes and electricity consumption for conversion into other types of energy. The energy intensity ratio of Polish manufacturing industry in 2020 was 0.110 kgoe/euro, while in the European Union countries it accounted for 0.094 kgoe/euro. The highest energy intensity in 2020 in Poland was shown by the metallurgical industry, which amounted to 2.23 kgoe/€, by comparison, the value for the machinery industry was 0.03 kgoe/€. In order to reduce the energy intensity of the various industrial sectors in Polish companies, it is necessary to implement solutions to increase the energy efficiency of processing and production processes. This includes large-scale implementation of digitization and operational optimization of processes as a result of automation, machine learning and artificial intelligence. These measures will directly reduce energy consumption, which will reduce the exploitation of energy resources, consequently and reduce greenhouse gas emissions. Economic analyses show that investments in new, intelligent technologies and systems that enable real-time energy management can bring about a 15% reduction in the cost of business operations, while reducing the consumption of energy used in production processes.

BIONIC INSPIRATION IN THE RANGE OF MECHANICAL ENGINEERING

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Bionic is an interdisciplinary science which investigates life organisms, materials and processes occurring in the nature in order to apply results of this research for technical solutions.

In our paper we try to prove that such activity make it possible:

- Improve the quality of the outside surface layer of the machines and measurements equipment details,
- Designe optimal shape of machines details or tools,
- Increase the accuracy of mechanical details.

ENGINEERING OF NON-METALLIC INCLUSIONS IN STRUCTURAL STEELS WITH IMPROVED MACHINABILITY

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The results of research on the morphology of non-metallic inclusions in two groups of structural steels have been presented in this paper. The first group includes the steels deoxidized by aluminum with low sulfur content $S < 0.08\%$ and modified by calcium addition. The second group consists of steels without the addition of aluminum and with an increased sulfur content of $0.15\% < S < 0.30\%$. These steels were modified with the addition of lead, bismuth or tellurium. These are known as so-called free cutting steels. Detailed microscopic examinations of the inclusions using the scanning electron microscope equipped with an EDS X-ray micro-analyzer were performed. Measurements of the geometric parameters of non-metallic inclusions on metallographic samples taken from both groups of steels using a computer aided image analyzer were carried out. In addition, the machinability of these materials using a Volvo test was tested. Quantitative characteristics for both groups of the steels in the general form as $Bi = f(HV, Ws)$ using the Statistica programme where the following were taken into account where: Bi-cutting index, HV-steel hardness, Ws-generalized index of the geometry of non-metallic inclusions.

EVALUATION OF THE POSSIBILITY OF APPLYING METHODS OF RAPID PROTOTYPING IN THE CONSTRUCTION OF CNC MACHINERY WITH THE USE OF MSA METHOD IN THE EVALUATION OF PRODUCTION CAPACITY

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The facilities of the Faculty of Engineering Sciences of the University of Applied Sciences in Nowy Sącz allowed the use of methods of rapid prototyping in the production of parts for the construction of CNC machinery by additive methods. Devices operating in FDM and SLS technology were used for the manufacture of parts. The manufacture of components using rapid prototyping methods allows the build of a technological machine with arbitrarily selected structural characteristics. The components manufactured by incremental methods allow the replacement of structural components produced in series. Lisa Pro and F123 devices allow, according to the manufacturer, to produce components with acceptable strength and geometric characteristics. In this regard, the elements of the MSA analysis and the Taguchi Quality Loss methodology can be used to determine the capacity of the manufacturing process, to provide information regarding the focus of the production process on the target value of the quality characteristic, and to establish adjustments in the process.

SURFACE INTEGRITY AFTER SEQUENTIAL MACHINING

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The paper presented the impact of sequential machining on the surface integrity. Sequential machining involves turning and ball burnishing, which serves two primary purposes. The first is to smooth the surface and achieve good load-bearing capacity, and the second main objective is to strengthen the surface layer and introduce beneficial compressive stresses.

The main goal of the study is to assess residual stresses after sequential machining, including turning and ball burnishing of high-strength steel. Experimental research allowed for determining the influence of burnishing process parameters on the value of residual stresses on the machined surface, taking into account the technological memory effect and the influence of surface preparation during turning.

The intensification of the manufacturing process, based on the application of sequential machining, is one of the possibilities to minimize production costs. The utilization of this technology and understanding its capabilities in terms of rationalizing the burnishing process and shaping the quality of the surface integrity is the subject of investigation in the presented study.

THE IMPACT OF MINIMUM QUANTITY LUBRICATION (MQL) ON THE FRICTION OF COATED CARBIDE AGAINST TI6AL4V ALLOY

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The main goal of the study was to replicate the friction behavior occurring during the turning of titanium alloy under dry machining conditions and with the application of minimal MQL lubrication. The paper presented the results of tribological investigations of the Ti6Al4V titanium alloy in against sintered carbide with different coating configurations. Experimental studies were conducted using a pin-on-disc tribometer, allowing the interaction of the tribological pair in the sample-counter-sample system. The test was conducted for variable sliding speeds, constant normal force (the force pressing the sample against the counter-sample), and friction distance. Comprehensive tribological tests were conducted on friction pairs, measuring the friction force, normal force, and thermoelectric forces (FTE) as a function of sliding distance. The FTE values were used to calculate the temperature in the friction area using a natural thermocouple calibrated specifically for the tribological pair being tested. The changes in the integrity of the surface layer of the examined friction pairs were assessed based on surface replication using optical methods and SEM imaging along with EDS analysis.

EVALUATION OF MANUAL MEASUREMENT SYSTEMS AND VERIFICATION OF THE POSSIBILITY OF IMPLEMENTING AUTOMATIC DEVICES

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The article presents the procedure for introducing new processes and products into series production and the importance of selecting appropriate control and measuring instruments in a manufacturing company. The article presents the types of manual control and measurement instruments and the measurement methods used in a manufacturing company. The measurement system was also found to be subject to error, which was also shown in the research carried out. Losses and wastages during the current production process were also shown. In this article, in line with the concept of Industry 4.0, a measurement system is proposed that will eliminate the negative influence of the operator and, at the same time, eliminate losses, thus allowing decisive savings in the production company.

INNOVATIONS IN ROAD TRANSPORT AS A PROCESS TO ENHANCE EFFECTIVENESS AND SAFETY OF THE ROAD TRANSPORT INDUSTRY

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In the transport industry, innovation is of great importance both for transport companies and for road transport itself. The pursuit of new solutions that improve the quality of services and products, while simultaneously increasing the efficiency of logistics operations, offers companies in the automotive sector the ability to tailor these services to the individual needs of their customers. The growing demands of customers pose challenges for transport companies, which can be met through innovation. Route optimisation, process automation, the use of advanced management systems, and modern technologies are some of the innovations that contribute to the success of transport companies.

Here are a few examples that are either already contributing or will soon contribute to changes in the functioning of this industry:

- Electric delivery vehicles: The shift to electric-powered delivery vehicles is crucial for the sustainable development of the transport industry. They enable the reduction of greenhouse gas emissions and the lowering of air pollution in cities.
- Autonomous vehicles: The development of autonomous technology offers new possibilities in transport. Autonomous vehicles can contribute to increased road safety, reduced operational costs, and optimised logistics processes.
- Internet of Things (IoT) in transport: The use of IoT technology allows for real-time monitoring and management of vehicle fleets. Sensors and devices enable the tracking of parameters such as location, fuel consumption, technical condition, and more, resulting in better control and operational efficiency. Experts predict that by 2025, around 22 billion devices will be connected to the IoT.

The implementation of these initiatives must take into account the European Union's guidelines set out in Regulation 2019/2144 on the requirements for the type approval of motor vehicles and their trailers, as well as systems, components, and separate technical units intended for such vehicles, with regard to their general safety and the protection of vehicle occupants and vulnerable road users.

AUTOMATION AND INTEGRATION OF PRODUCTION SYSTEMS IN A MIXED MANUFACTURING ENVIRONMENT

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Industry 4.0 turns into a reality, automation and robotisation of processes are inevitable. Industrial robots, autonomous carts, additive manufacturing, Internet of Things, augmented reality, Big Data, analytics and artificial intelligence are becoming more commonplace. Effective and efficient implementation of Industry 4.0 elements is a major challenge for manufacturing companies.

A particularly difficult task for production is the implementation of Industry 4.0 in companies with a wide range of products, including both those customised and standard ones, produced using a variety of manufacturing technologies. Considering such a situation, it is particularly challenging to integrate different manufacturing systems by implementing uniform methods of production management, ordering, planning and billing. Another important and extremely difficult issue is to organise consistent flow of materials throughout the supply chain so as to have complete real-time data to effectively manage the flow of various processes and the timeliness of customer orders. All this has to be planned and implemented in such a way as to achieve cost optimisation and order processing within the deadlines expected by the customer.

FAKRO is an example of a company that successfully addresses these challenges. The company's product range is very broad and includes many different products such as wooden windows, aluminium clad-plastic windows, flashings for windows, access roof lights, internal and external blinds, awning blinds, vertical windows, garage doors, control systems and smart home solutions. A number of different manufacturing technologies is used in the manufacturing processes. Wood processing, starting from log cutting, lumber drying and final processing through impregnation and varnishing is just one of many technologies used. Others include glass processing and production of glazing units, processing of steel sheets, aluminium profiles and plastic elements, production of electronic components and automatic control elements. Manufacturing processes run through several production facilities and over a dozen different departments. The entire supply chain to the customer is even more complicated as it passes through distributors and sales branches at home and abroad.

In order to effectively manage a wide product range and satisfy the growing market expectations, FAKRO implements and develops elements of Industry 4.0 not only in the field of automation and robotisation, but largely in creating unique solutions for vertical and horizontal system integration.