

Content

125 – 130

**Transformation Methods of Production Organization from the Far East to the Metal Industry in Poland**

*Stanisław Borkowski, Paweł Szklarzyk, Krzysztof Knop*

130 – 136

**Abrasive Wear Resistance of Wood**

*Milan Brožek*

136 – 141

**On the Modelling of Contact Forces in the Framework of Rigid Body Dynamics**

*Radek Bulin, Michal Hajzman*

141 – 145

**Analysis of Simple Mechanism Using MSC Adams**

*Ingrid Delyová, Darina Hroncová, Peter Frankovský*

145 – 149

**Method for Determining of the Anti-adhesion Ability of Cutting Fluids**

*Andrey Dugin, Jan Jersak, Alexey Popov*

149 – 153

**Method for Determining the Tribological Properties of the Cutting Fluid**

*Andrey Dugin, Jaroslav Votocek, Alexey Popov*

153 – 160

**3D Simulation of Vibrating Diamond Grinding**

*Anatoly Grabchenko, Vladimir Fedorovich, Ivan Pyzhov, János Kundrák*

160 – 166

**Identification of Intermetallic Phases in the Alloy AlSi6Cu4**

*Marko Grzincic, Ivan Lukac*

166 – 172

**Monitoring the Air Quality in Conventional Wet Machining**

*Julia Hricova, Erika Sujova, Petra Semanova*

172 – 178

**Recycling Process of the Aluminium Cans as an Element of the Sustainable Development Concept**

*Manuela Ingaldi, Stanisław Borkowski*

178 – 185

**Evaluation of Surface Milling Strategies Using Selected Elements of Machined Shapes of Forging Die Cavities**

*Peter Izol, Michal Fabian, Melichar Kopas, Gabriel Fedorko, Jana Fabianova*

186 – 193

**R-Test Static Measurement of The 5-axis CNC Machining Centre Rotary Axis Kinematic Centre Error**

*Jerzy Jozwik, Paweł Lonkwić, Milan Saga, Ivan Kuric*

193 – 199

**Surface Integrity at Reaming Operation by MT3 Head**

*Karel Kouril, Robert Cep, Adam Janasek, Antonin Kriz, Dana Stancekova*

199 – 206

**Capacitor Discharge Welding of Aluminium Studs**

*Tomáš Kramár, Ladislav Kolařík, Marie Kolaříková, Martin Sahul, David Pospíšil*

206 – 213

**A Method for Planning the Cutting Ability of CBN Tools**

*Janos Kundrak, Laszlo Raczkovi, Karoly Gyani, Istvan Deszpoth*

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Content

213 – 217

**Prediction of Surface Product Quality and Operation Reliability of Grinding Machines**

*Imrich Lukovics, Jiří Čop, Ladislav Fojtl, Petr Lukovics, Vladimír Pata*

217 – 222

**The Use of the Matrix Model of Sustainable Development (MSD) in the Production Sector**

*Karel Macik, Theodor Beran, Sarka Findova*

223 – 228

**Monitoring Methods the Properties and Structure of Grey Iron Castings**

*Iva Nova, Jiri Machuta*

228 – 234

**Applied Load and Calibration of the Hardness Tester**

*Jozef Petrik, Marek Solc, Vojtech Miklos*

234 – 238

**Advantages of Express-Methods in Investigation of Mechanical and Physical Properties of Aluminum Alloys**

*Maxim Puchnin, Evgeniy Anisimov, Jiří Cejp, Igor Kunka, Sébastien Vicens*

238 – 244

**Microstructure and Properties of Magnesium Alloys Working at Elevated Temperatures**

*Jan Serak, Milena Voderova, Dalibor Vojtech, Pavel Novak*

245 – 252

**Method of immediately cutting process stoppage**

*Karol Vasilko, Zuzana Murčinková*

JUNE 2014, Vol. 14, No. 2 – INTERNATIONAL REVIEWERS AND EDITORS LIST

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## Transformation Methods of Production Organization from the Far East to the Metal Industry in Poland

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## Abrasive Wear Resistance of Wood

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## On the Modelling of Contact Forces in the Framework of Rigid Body Dynamics

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**The modelling of dynamical systems with mutual interaction through normal and tangential forces between surfaces is one of the most important tasks in the current computational research. The paper deals with the formulation of the equations of motion in dynamics of multibody systems and subsequent usage of various contact force models. Four types of normal force calculations are introduced and their behaviour is demonstrated using a simple example of a sphere moving towards a plane. The parametric study of the contact models with respect to the coefficient of restitution and an exponential parameter is performed. In order to show a more practical usage the simplified dynamic model of a nuclear reactor control assembly is created and its dynamic response is discussed. The model is characterized as a falling rigid body in a narrow channel filled by a fluid.**

**Keywords:** multibody dynamics, equation of motion, normal force, friction force, control assembly

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## Analysis of Simple Mechanism Using MSC Adams

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**In addressing the motion of machine parts, machines and equipment it is necessary to first create a kinematic model. Kinematic model of a device schematically captures all its properties which are essential in kinematic analysis. This article deals with kinematic analysis of a simple mechanism executing a rotational movement. We analyzed the movement of its end points. Numerical solution was implemented by classical kinematics using different coordinate systems, while model mechanism has been also modeled and solved in the program MSC Adams. The result of the computer simulation is designation of the searched kinematic parameters and the other required parameters of the solved model. Solutions are time kinematic variables over time, which are shown graphically.**

**Keywords:** Kinematics, Analytical solution, Numerical solution, Simulation

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## Method for Determining of the Anti-adhesion Ability of Cutting Fluids

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461 17, Studentská 1402/2, Liberec 1, Czech Republic. E-mail: andrey.dugin@seznam.cz, jan.jersak@tul.cz, alespopov@yandex.com.

**In most cases, the use of cutting fluids increases machining productivity while cutting different types of materials. Anti-adhesion ability is one of the main properties of cutting fluids increasing the tool life. Companies producing cutting fluids need to acquire information on anti-adhesion abilities of the cutting fluids as well as on anti-adhesion abilities of individual substances and effects for future development of their products. Consequently, methodology for evaluating anti-adhesion ability of cutting fluids was designed. The substance of the method consists in the evaluation of differences in the size of the wear area created under otherwise identical cutting conditions while using different cutting fluids at the front surface of the cutting tool where adhesive wear occurs during the cutting process under certain cutting conditions. The methodology was verified using 11 process fluids.**

**Keywords:** Machining, Cutting fluid, Adhesion, Wear

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## Method for Determining the Tribological Properties of the Cutting Fluid

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**Application of cutting fluids is one of the most widely accepted methods of increasing not only the efficiency of machining but also the quality management of the working surface that is used in industry. The cutting fluid market is large enough, and different manufacturers produce their own cutting fluids in several product lines which differ as to their chemical composition and their properties. When creating a cutting fluid, the manufacturer is particularly interested in the study of its individual properties as well as studying the effect of various chemical components on the final properties of the cutting fluid. Different methods are used to study various properties of cutting fluids. This article presents the method for the study of the tribological properties of cutting fluids. This method has been applied while comparing 5 different cutting fluids.**

**Keywords:** Machining, Cuttingfluid, Orthogonalcutting

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### 3D Simulation of Vibrating Diamond Grinding

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**Keywords:** 3D simulation, finite element model, diamond grinding wheel, vibrating diamond-abrasive machining

**A method of 3D simulation of vibrating diamond-abrasive machining based on a finite element model of the process is worked out. Calculation of the deflected mode of grinding area is the evidence that high-frequency vibration has a considerable effect on the amount of fractured material. Equivalent stress in the grinding zone increases up to 1.5-2.0 times. By means of FEM simulation of ultrasonically assisted grinding it is found that when grinding without imposing high frequency vibrations the maximum load is concentrated on a certain face of diamond grain. This can lead to the fracture of a grain in contact area with a bond and subsequent untimely shedding of the grain from the bond. However, uniform distribution of the stresses along the grain when imposing high-frequency vibrations improves retention of the grain in bond.**

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## Identification of Intermetallic Phases in the Alloy AlSi6Cu4

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**Presented work focuses on the influence of Mn and Fe in different ratios on the structural characteristics of AlSi6Cu4 alloys and identification of present intermetallic phases by means of EDX analysis in addition to the light microscopy. The intermetallic phases whatever of type never contribute to strain transfer in matrix and in this view are harmful in the structure. From an economic perspective it is desirable to use cheaper secondary alloys, but to guarantee the required strength properties of the material used for castings, it is needed to control the morphology of intermetallic phases. From the professional literature and practice, relationship between the content of iron and manganese ( $Mn/Fe \geq 0.7$ ) is well known to guarantee the exclusion of intermetallic Fe in the form/shape of a "Chinese script characters" and not dangerous spindles (needles). It was discovered that this ratio affects the presence of Mn/Fe also in the intermetallic phases. With increasing Sr content in the experiments conducted, the percentage of Mn/Fe ratio in intermetallic phase in form of "Chinese script characters" reduces. It was found that under certain circumstances, also the ratio  $Mn/Fe = 0.7$  does not guarantee the presence of intermetallic Fe phases only in the form of "Chinese script characters" in areas of highest stress of castings, i.e. on the castings of cylinder heads in the area of combustion chambers.**

**Keywords:** Casting alloy, AlSi6Cu4 (A319), ratio Mn/Fe, intermetallic phase, EDX analysis

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## Monitoring the Air Quality in Conventional Wet Machining

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**Metalworking fluid (MWF) aerosols are generated continuously during conventional machining operations and can have a number of adverse health effects. Exposure to the aerosols has often been reported to cause acute respiratory difficulties including asthma, hypersensitive pneumonitis and lung cancer. Aerosol measurement data was conducted to identify the major determinants that may affect exposure to aerosol fractions during turning of a cylindrical work piece on an uncovered conventional lathe. The aerosol mass concentration was investigated as function of spindle speed, fluid flow rate and sampling position. Synthetic fluid, mixed at 5% concentration with water, was applied via nozzle centred above the work piece at a distance of 70 mm. The aerosol mass concentration was determined gravimetrically and particle size analysis was performed by optical method. The results show that aerosol mass concentration increases with increasing the fluid flow rate and decreases by increasing the spindle speed. Moreover, the particle size analysis detected that a high quantity of particles smaller than 0.2 mm is generated at higher spindle speeds.**

**Keywords:** Metalworking Fluid, Aerosol, Mass Concentration, Particle Size, Turning

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## Recycling Process of the Aluminium Cans as an Element of the Sustainable Development Concept

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**Introduction into problems – An idea of recycling is related to the sustainable development concept, which enforces this process. One of the most often recycled material is aluminium. It is recovered primarily from used beverage cans. These cans are normally back on supermarket shelves as new beverage cans in 6-8 weeks. With a growing percentage of the cans made from aluminium, because of its lightweight qualities, this ensures a healthy market for aluminium can recycling. In the paper characteristics of aluminium and the process of its recycling are presented. Its recovery rate in Poland is shown. The analysis of possible use of preformed granules of aluminium scrap into liquid steel deoxidation was also conducted. The results of the research carried out in laboratory conditions clearly showed that the sample 4 from the third supplier, from the viewpoint of the cost of the technology used in steel deoxidation, is the least favourable.**

**Keywords:** Aluminium, Used Beverage Containers, Recycling, Liquid Steel Deoxidation

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## Evaluation of Surface Milling Strategies Using Selected Elements of Machined Shapes of Forging Die Cavities

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The shaping tools or shaping moulds are applied in such production processes like forging, pressing, casting or injection moulding. These technological processes are described by Groover in [1] and Kalpakjian in [2], as well as in the other professional works, e.g. in [3, 4, 5]. A quality of the shaping tools influences also quality of the produced components. This fact is an important aspect in the framework of the whole production chain. The shaping tools and moulds are expensive. An important role is playing the selected production technology of the given shaping tool. If there are applied machining technologies specified for production of the shaping tool, it is necessary to take into consideration also the suitable machining strategies for such technological operation. The term “machining strategy” represents a pre-definition of such tool trajectory in the CAM-system, which is optimised for machining of the various shaped surfaces in order to produce the final product with the highest possible efficiency.[5]

**Keywords:** surface milling, shaping tools, CAM

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## R-Test Static Measurement of The 5-axis CNC Machining Centre Rotary Axis Kinematic Centre Error

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**This paper presents static measurements results of the kinematic pair centre of the C-rotary axis of the 5-axis machine tool at digitised angle positions of the machine rotary table. The measurements were conducted with the application of R-test calibration and measuring system. The article discusses the test sequence as well as the evaluation of the kinematic centre location of the rotary axis, relative to linear X, Y-axis. The summary formulates guidelines covering the compensation of the axis location. Measurement results were presented in diagrams and tables.**

**Keywords:** manufacturing, errors of CNC machine tool, diagnostic systems, calibration, R-test

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## Surface Integrity at Reaming Operation by MT3 Head

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**Surface integrity reflects the properties of a material after it has been subject to some type of manufacturing process or modification during machining process and surface integrity can also have a great impact on a parts function. The changes limit the component quality or in the same cases performed the surface as an unacceptable. It has long been known that the method of surface finishing and combination of surface roughness, residual stress, cold work, or phase transformations strongly influence the service performance of manufactured parts as fatigue or corrosion. The main aim of the article is testing a high-productive reaming tool type MT3 with respect to different values of tool-life because holes making among the most important operation in machining and one of the most common in drilling operation.**

**Keywords:** Machining, Surface Integrity, Reaming, Testing

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## Capacitor Discharge Welding of Aluminium Studs

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The paper deals with capacitor discharge welding of aluminum studs type AlMg3 on two different materials (aluminum sheet of the same chemical composition with a thickness of 1.5 mm, and the magnesium sheet, material AZ61 and thickness 1 mm). Influences of welding parameters on the mechanical properties of the weld joints and the creation of typical defects were examined. For assessing the quality of weld joints, a series of tests were made: micro hardness test, bend test, torque test, test of macro and microstructure and SEM analysis on the electron microscope. The results are presented in the paper including suggestions for welded joints of required quality.

**Keywords:** Aluminum Alloy; Magnesium Alloy; Stud; Stud Welding

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## A Method for Planning the Cutting Ability of CBN Tools

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**Cutting shop-floor experience often shows that after machining one lot the insert is changed and the next lot is started with a new insert. Thus the tool life of the cutting tool is not fully used. Therefore we analysed how to determine, after machining a lot with a given number, the number of pieces of the next lot that can be machined with the same insert. Based on the cutting experiments we determined wear curves for some specific parts. With the introduction of two new definitions (equivalent number of pieces and equivalence ratio) we elaborated a method with which the machinable number of pieces of the next lot can be determined – even if a lot is machined by other cutting parameters – until the tool life criterion is reached. Based on this method and using nomograms or an algorithm the further machinable number of pieces can also be determined.**

**Keywords:** CBN inserts, hard turning, tool wear, tool life

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## Prediction of Surface Product Quality and Operation Reliability of Grinding Machines

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**High quality products require modern and precise production machines, technologies and quality equipment of industrial metrology. Research paper discusses the possibility of vibration detection at production machines because of process conditions changes. Furthermore, paper also provides a methodology for assessment of vibration amplitude using non-contact laser interferometer, which uses Michelson principle for evaluation. Paper also provides information about a method of vibration amplitude evaluation by contact method using a piezoelectric vibration sensor connected to Balantron 2001 device. The effect of technological conditions on the quality of functional areas expressed by the arithmetic average roughness is experimentally and statistically determined. Experimental study also evaluates the influence of technological conditions during surface grinding on the amplitude of vibration of grinding spindle and provides a correlation between the vibration amplitude of grinding machine and product quality. Moreover, the change of vibration amplitude during three years of production is observed and production capabilities and accuracy of the machine during five years of manufacturing were predicted.**

**Keywords:** Vibration, Grinding, Surface quality, Roughness

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## The Use of the Matrix Model of Sustainable Development (MSD) in the Production Sector

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**The paper deals with the practical use of matrix model of sustainable development, the MSD (Matrix of Sustainable Development) in Industrial Management and an introduction to possible problems in implementation. The method is based on expert evaluation, the output of the relational matrix are values of importance, resp. the overview of the priorities of the problem, i.e. the individual social requirements and the factors of quality products. The implementation of the MSD model contributes to the holistic understanding of the product's life cycle. The results reveal the model on the one hand in it is the real importance, and, on the other hand, the possible shortcomings of some hitherto unknown factors. The benefit is also involved in research in the field of quality management and a focus on customer requirements.**

**Key words:** sustainable development, relational matrix, social requirements, quality factors, expert.

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## Monitoring Methods the Properties and Structure of Grey Iron Castings

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Flake graphite cast irons are very used construction materials, which are characterized by good sliding and damping properties. Graphite and character matrix affects the properties of cast iron. It is also important to the size distribution of the graphite. Compressive strength graphite cast iron with lamellar graphite is very good, is 3 to 4 times greater than the tensile strength. The various types of cast iron with lamellar graphite is possible only in the tensile strength. Flake graphite cast iron are widely used in mass production where they use their good casting properties. With sophisticated sand moulds can produce a very complex shape castings with excellent mechanical properties and relatively low production costs. For this reason, cast iron with lamellar graphite are constantly used in the automotive industry for blocks, heads, engines, brake drums and discs, insertion loss cylinders, piston rings. At our department of Engineering Technology, Technical university of Liberec (Czech Republic – Europe) has long been focused on prediction methods of production quality castings for the automotive industry.

**Keywords:** Grey cast iron, Structure, Prediction quality, Mechanical properties, Simulation

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## Applied Load and Calibration of the Hardness Tester

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**Introduction into problems - It is expected that the measured value of the hardness will not be dependent on the applied test load and operators carried out the measurement. The Vickers hardness tester was calibrated by three operators using loads between 49.03 and 980.7 N and one CRM (standard) for a full load range. The uncertainty of obtained results was calculated in accord with standard ISO 6507-2 and tolerances analyze method. The capability of the calibration was evaluated by GRR method of the Measurement systems analysis (MSA). The method of total dispersion zone was used for estimation the impact of the variability between operators at particular loads on the measured value of the hardness. The influence of the load on the hardness expressed by Meyer's index "n" excluded ISE (indentation size effect). The influence of operators on the resultant hardness is weak, and the impact of applied load is ambiguous. The values of uncertainty calculated in accordance with the standard and by tolerance analysis are comparable.**

**Keywords:** Vickers hardness test, calibration, uncertainty, capability

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## Advantages of Express-Methods in Investigation of Mechanical and Physical Properties of Aluminum Alloys

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**The investigation of mechanical properties of aluminum alloys by using express-methods is discussed in the present paper. Such properties are hardness, elastic modulus E and yield strength Rp0.2. Tensile test with extensometer and automated ball indentation test (ABI) with 5 mm ball indenter performed in order to obtain the correlations for the basic mechanical properties of aluminum alloys. The results of newly developed method of revealing the microstructure, which involves plastic deformation, show its potential of applicability in engineering practice when measuring the microstructural and submicrostructural features.**

**Keywords:** Automated ball indentation, tensile test, submicrostructure, grain size, EBSD

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## Microstructure and Properties of Magnesium Alloys Working at Elevated Temperatures

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**Most of magnesium alloys are usually used for applications at ambient temperature. The significant decrease in mechanical properties is observed already at the temperatures higher than 150°C. This is the reason for the effort to prepare a new low-priced magnesium based alloys with improved mechanical properties at elevated temperatures, e.g. for components of combustion engines. The microstructure and mechanical properties of selected commercial magnesium alloys AZ31, EZ23, ZE41 and WE43 with relatively new MRI153 alloy for use at elevated temperature were compared. Brinell hardness, yield strength and tensile strength at the temperatures of 20, 150 and 200°C were studied. It was found, that relatively low-priced MRI153 alloy appears to be very good alternative alloy for use at elevated temperatures.**

**Keywords:** magnesium alloys; mechanical properties

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## Method of immediately cutting process stoppage

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**The paper dealt with method of immediately cutting process stoppage, process of chip formation and the non-linear finite element analysis. To be able to follow the process of chip formation and machined surface during machining, it is necessary to stop this process immediately, if it is possible. The paper provides results of non-linear numerical experiment for presented method. The state of plastic deformation in machined material and in front of the tool cutting edge enables to follow the intensity of deformation, friction process between the tool, chip and workpiece, sources of heat in the machining zone. Knowing these processes enables to select optimal tool geometry, cutting conditions, mainly cutting speed, cutting environment, tool material so that cutting process could run with minimal energy consumption and required quality of machined surface could be reached. To understand the process of chip formation is important for the theory and practice of machining of materials.**

**Keywords:** machining, cutting conditions, chip formation, plastic deformation

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