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## Micro CT Analysis of Geopolymer Composites

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There are many situations when you need information about the internal structure of the materials. Computed Tomography (CT) is a non-destructive method of evaluating the internal structure, which was originally used for medical examination of the human body. Today it is already used in many different fields, where the aim is the examination of the internal structure of the material. Geopolymer is a term for all inorganic polymeric materials which are prepared from alumino-silicate materials by geopolymerization in alkaline environment at normal temperature and pressure. Computed tomography (CT) is an advanced method that allows the study of the structure based geopolymer composites with short fibers or nanoparticulate reinforcement.

**Keywords:** computerized tomography (CT), non-destructive method, internal structure, geopolymer

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## Influence of Preheating and Heat Treatment after Welding According to the EN 13445 and ASME Code on the Hardness Level of Welded Joints for the Pressure Vessel Plates

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The paper deals with an analysis of preheating and heat treatment after welding and their influence on the final hardness level in case of welded joints for common materials applied for manufacture of pressure vessel plates. During the welding process, the higher values of hardness and simultaneously decreasing of plasticity was observed and measured in the heat affected zone. Therefore, there was necessary to preheat the base material, or to apply the heat treatment after welding, or to suggest any combination of both mentioned ways. First of all, the groups of tested plates with required parameters were chosen for the application of the submerged arc welding method (according to ČSN EN ISO 4063), and preparation of samples for hardness measurement (ČSN EN ISO 6507) as the next step. The main goal of this experiment was to determine the hardness level for two fine grained steel grades after welding with the given parameters, as well as to adjust or to eliminate the heat treatment process (preheating, post-heating), if they are not necessary.

**Keywords:** welding, heat treatment (pre-heating, post-heating), hardness level, EN 13445, ASME Code

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## CNC Milling and Manufacturing of Groove Shapes for Light Reflection Measurement

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Light reflection of materials depends on many factors, mainly on their colour and type, angle of light incidence and surface structure. This paper is focused on evaluation of the surface shape influence of expanded polyvinylchloride on light reflection. For this reason polyvinylchloride samples with different shapes, depths, widths and numbers of surface grooves were produced on CNC milling machine. The light reflection of the investigated material samples was experimentally measured by means of illuminance ratio. The samples were subsequently compared in terms of their ability to reflect light. A part of the work deals with mathematical simulation of the daylight factor for definite surface shapes. The simulations were performed using Wdls 4.1 software. It was found that the surface shape has an influence on the light reflection and on the illuminance in a given point too. The light reflection of the tested material is in general influenced by shape, depth, width and number of surface unevennesses.

**Keywords:** Light Reflection, CNC Milling, Daylight Factor, Surface Shape, Polyvinylchloride.

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## Working Variables Optimization of Resistance Spot Welding

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Resistance welding ranks among progressive and in practice often used manufacturing techniques of rigid joints. It is applied in single-part production, short-run production as well as in mass production. The basis of this method is in the utilization of the Joulean heat, which arises at the passage of current through connected sheets at collective influence of compressive force. The aim of the carried out tests was the optimization of the resistance spot welding working variables, concretely the determination of the dependence between the rupture force of spot welds made using sheets of different thickness and different welding conditions. For carrying out of this aim 650 assemblies were prepared. The test specimens of dimensions 100 x 25 mm and thickness of 0.5 mm, 1.0 mm, 1.5 mm, 2.0 mm, 2.5 mm and 3.0 mm were made from low carbon steel. In the place determined for welding the test specimens were corundum blasted and then degreased. The welding of two specimens always of the same thickness was carried out using the welding machine type BV 2,5.21. At this type the welding current value is constant ( $I_{\max} = 6.4$  kA). The welding time (the time of the passage of the current) was changed in the whole entirety, namely 0.10 s, 0.15 s, 0.20 s, 0.25 s, 0.3 s, 0.4 s, 0.6 s, 0.8 s, 1.0 s, 1.3 s, 1.6 s and 2.0 s. The compressive force was chosen according to the thickness of the connected sheets in the range from 0.5 to 2.4 kN. From the results of carried out tests it follows that using the working variables recommended by the producer we obtain the quality welds. But if we use the longer welding times, we can obtain stronger welds, namely of 5 to 35 % compared to welds made using working variables recommended by the producer.

**Keywords:** Resistance welding; steel sheet; laboratory test; shear testing resistance spot welds

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## Study of Surface Quality after Turning of Steel AISI 304

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**Accurate and effectively machining of steel class AISI is in the fact of its chemical composition and mechanical properties often a significant problem. Effort to preserve the economical efficiency of whole production process is necessary to have behavior of the cutting tools in the process of machining these steels. Food industries all over the world use this type of steel as a basic construction material of machines and equipments designed for this type of industry. Ability to consistently know these steels is the way how to effectively machining. Small and medium manufacturing enterprises not have the means to experiment with this material and wasted, because it belongs to more expensive. For this reason in order to create high-quality machined surface while minimizing defects of products in production is significantly increased time of machining and producing product from this steel is economically inefficient. Paper deals with study of surface quality after machining of steel AISI 304. Outputs of realized experiment should help to small and medium companies to improve knowledge of steel AISI and its machining and also better understand how to effectively and profitably produce products of these steels.**

**Keywords:** AISI 304, roughness, surface, turning.

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## Ecological Production of Cores - Example from Automotive Branch

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**The paper informs readers about the latest trends in ecological production of cores for the most demanding castings made of aluminum alloys on example of cylinder heads for combustion engines of the passenger cars. Although the cores bonded with silicates are known since the 60th years of the 20th century, only in recent years the technical progress has undergone such level that the leading producers of cylinder heads are able to deploy the system in serial production. Nemak started solving inorganic systems 12 years ago and today it delivers selected products to its customers and during their production there are cores being used which are joined by ecologic systems. The contribution analyses limiting technical aspects at application of inorganic systems. They replace systems of cold-box and hot/warm-box and it presents in details the benefits of ecological solutions which may be found in final product features. At the same time, it also points at difficulties which are still necessary to be solved.**

**Key words:** casting, core, binder, inorganic, ecology

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## Usage of Track Link Dynamic Motion Simulation

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**The article describes mathematical model and possible usage of results of dynamic loading simulation of the chassis of track vehicle. The computational model is designed for computational simulating system MSC.ADAMS.AVT. Possibilities of research results usage are described in the article mainly. Results of simulation calculations were used for make-up of constructional parameters parts file of vehicle chassis and findings of influence their changes on changes of directional vehicle stability by running at first. Make - up of approximate relations for transaction of fast orientation calculations is second described possibility of results simulation calculations usage. The possibility of usage of results simulation to do verification of mathematical model is third possibility of usage results simulation calculations. The optimization of influence changes of several design value together is fourth possibility of usage of results simulation calculations that is described in this article.**

**Keywords:** dynamic properties simulation, computation modeling

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## Improvements of the Dressing Process of Super Abrasive Diamond Grinding Wheels

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**Grinding is the most common finishing process for components that require high accuracy and surface quality. Process performance depends on many factors related to process conditions, workpiece material, grinding fluid but grinding wheel is of special interest. Grinding wheel performance plays a major role on workpiece quality and process efficiency; preparation of the grinding tools and the creation of specific topography of the wheel surface is in direct relation to grinding wheel performance. Questions connected to the possibility to increase production efficiency of diamond dressers owing to technological changes of their production and simplification of preliminary selection of initial samples of diamond are considered. Furthermore, recommendations on improvement of the dressing process of abrasive wheels are made using 3D FEM simulations. The results of theoretical and experimental investigations which cover the development and research on electrochemical dressing of working surface of diamond grinding wheels with metal bonds are also provided.**

**Keywords:** diamond dresser, abrasive ability, wheel dressing, 3D simulation, metal bond of grinding wheels

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## Tests of Drills during Drilling Holes into Alloy Wheels

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**This article is interested about drilling the holes to the alloy wheels. Tested were drills to drilling holes for screws and service holes. For screw holes was tested the three-stage drill with inserts from polycrystalline diamond. Drilled are two different diameters and the transition spherical or conical surface. The service holes were drilled with cemented carbide drill available from Mapal labeled Mega-drill-Alu-180. During test, was modified the geometry of the drill and we watched what will be the effect of applied modification. Tested was seven variants of regrinding the drill. We evaluate the surface roughness, but also if the drill has the right position and not be pushed away from its axis. Finally was tested drill with three edges. This drill bit is from company Mapal labeled Tritan.**

**Keywords:** drilling, drill, alloy wheels, aluminum alloy

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## The Issue of Calculating Elliptic Trajectories

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**The design of elliptic trajectories of kinematic mechanisms by classical method is a challenge. New method is proposed. Theoretical tests were conducted on a method. It can not be used for scaling and rotation. Some limitations are revealed as well. Geometric modeling showed the method can be applied to arbitrary curves. It should be noted that the theoretical and modeling researches of arbitrary curves is not full. Simple robot was designed for processing ellipses. The design of the stand was assembled from aluminum profiles, linear modules and fasteners RK Rose + Krieger. Experiments have shown a difference between the theoretical and actual trajectory less than 5%. The error of stationing was 8,5% before using of the direct analytical method.**

**Keywords:** Kinematic mechanisms, Geometry, Calculation of trajectory, Arbitrary curves

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## A Method of Carbon Footprint Calculation for the Product Life Cycle

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**This paper proposes a concept model for product life cycle to present the characteristics of material flow, energy flow and waste flow in a manufacture system. Furthermore, two energy consumption calculation methods are provided according to the different components of the manufacture system, one is e-p method based on the processes of the system, and the other is e-f/s method based on the functions and statuses of the system. Then a carbon footprint calculation method is proposed on the basis of the characteristics of material flow, energy flow and waste flow in a manufacture system, and the energy consumption calculation above. Input-output analysis is carried out to establish the carbon emission calculation information table.**

**Keywords:** Carbon footprint, Emissions, Energy, Material, Input-output analysis

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## Identification of Internal Residual Stress of Steel after Milling by Ultrasound

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**Article is focused on detection internal residual stress caused by machining with variant spindle speed of milling tool and also in the article is represented new method of residual stress measuring using by ultrasound with verification method using RTG diffraction. Effect of residual stress have in industry important place because large number of structures requires a clearly described process of the occurrence and intensity of internal residual stresses, which directly affect the quality and equipment life. Nowadays are mostly used destructive methods, which can occur changes in functionality of the products or non destructive methods are used, which require to measure residual stress outside of the workplace and those methods are often lengthy. In the article is presented new method base on ultrasound, which provides opportunity to measure residual stress in same place in a short time.**

**Keywords:** Residual stress, Measurement, Ultrasonic, Spindle speed, RTG diffraction

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## Optimization of Surface Treatment of Carbon Steel in Area of Adhesive Bonding Technology with Application of Quik-Setting Adhesives

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**A production stroke has to be taken into regard also at using bonding methods. A limit in an area of the adhesive bonding technology is long hardening time which is needed for reaching a handling strength. Second solution is using quick hardened adhesives (cyanoacrylates). Second limit is a necessity to treat the adhesive bonded surface which is regarded in production companies as another cost and a problem in an area of a waste economy. The paper deals with the necessity to mechanically treat the adhesive bonded surface, that means an influence of links in the boundary of the adhesive bonded material and the adhesive. The aim of the research is to set the influence of the mechanical and chemical surface treatment of the steel surface at an application of cyanoacrylate adhesives on a strength of the adhesive bond.**

**Keywords:** Adhesive bond strength, Cyanoacrylates, Deformation, Failure area, Structural steel

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## Application of Cooling by Liquid CO<sub>2</sub> for the Die Casting Moulds Cores

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Quality of high-pressure castings is influenced by many factors. Structure and mechanical properties of these castings are mostly influenced by properties of casted material, technological parameters and thermal conditions in die casting mould. Thermal conditions in system casting – die casting mould is ensured by tempering system. However there is problem with thin cores and thin protrusions of die casting mould which is not possible to keep on the optimal temperature during casting by commonly available methods. Thus there is overheating in these places. It leads to the porosity of casting and also to the insufficient treatment of critical places of moulds which causes the lowering of their service time. With regard to the increasing requirements on the castings quality in practice searching still new possibilities how to cool down these critical places. One of the possibilities is to ally cooling by liquid CO<sub>2</sub> into such places. This paper deals with the monitoring liquid CO<sub>2</sub> cooling effect that is applied into the die casting mould core.

**Keywords:** high pressure die casting, cooling, core, CO<sub>2</sub>

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## The Effect of Thermal Shocks on Wear of Exchangeable Sintered Carbide Inserts during the Cutting Process

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**The article deals with testing of exchangeable cutting inserts from sintered carbide and determining of suitable chemical composition for their production. The experimental part was based on evaluation of cutting edge insert resistance against heat waves and thermal shocks during the milling process of commonly used stainless steel 1.4301 (X5CrNi18-10). It was determined amount, types and measured lengths each cracks occurred because of heat waves during the milling process for evaluation of proper chemical composition, grain size and content of cobalt for their production.**

**Keywords:** sintered carbide insert, cutting, stainless steels, thermal shocks, heat cracks

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### 3D Measurement of Surface Texture Parameters

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**The article focuses on the issue of 3D measuring surface parameters using optical measuring devices, designing a statistical experiment and following evaluation. The development non-contact surface texture measurement methods lead to new possibilities for describing the surface of machine parts. But cannot be to rely only on the obtained the measured parameters values, and it is true that it is necessary to prepare the measurement. The processes of measurement enter many influences. Some of these effects can manage it, and then we call those factors. At the output of the receive process feedback. Method DOE (Design of Experiments) is used to locate a combination of factors that provide the most favorable response. The proposal described experiment compares and evaluates various surface roughness parameters of two different materials and machining technologies samples. Measurements were done by two operators, and each measurement was carried out three times. Measurement took place on a confocal laser microscope LEXT OLS 3000.**

**Keywords:** surface, measurement, DOE, roughness

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## Dynamics Analysis and Simulation of Roll Grinder Components

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**This essay aims to identify the composite motion and the cutting force between the grinding wheel and roller of the roll grinder. Based on the analysis of roll grinding mechanism, this essay further uses Newton's law which describes linear motion and Euler equation which describes rotation to build rolling components' Newton-Euler dynamics equation. Then the essay simplifies rolling components' virtual prototype, and uses the dynamic analysis function of ADAMS to do dynamics simulation analysis of rolling components. Finally, based on the formula to calculate grinding force, this essay testifies that calculated results are consistent with simulation results, thus providing reference data for optimization.**

**Keywords:** Roll grinder, Rimulation, Dynamics analysis, ADAMS

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## Design of Material Composition and Technology Verification for Composite Front End Cabs

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**Presented research paper is focused on the development of train front end cab, specifically on choice of material composition and production technology. Experimental part deals with a selection of the most appropriate multiaxial fabric based on its saturation by resin and type of polyester resin most suitable for low-pressure vacuum infusion. This technology is chosen with respect to dimensions of the part, resin savings (compared to hand lay-up technology) and also production cost of the cab. Prepared samples are evaluated regarding to the progress of production technology, part face quality (voids, dry spots, and delamination) and technological properties. As a result, optimal material composition for front end cab production is chosen and fabrication of prototype cab is conducted.**

**Keywords:** Train Cab, Vacuum Infusion, Fiberglass Composite, Multiaxial Fabric, Polyester Resin

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## Introduction to Processing of CT Clinical Metadata of Disabled Part of Patient Knee Joint

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**This article focuses on an analysis and a transfer process of CT clinical metadata of a real patient gained within a cooperation, research and development of an individual knee joint implant at Clinique of Display Methods in Saint Anna's Teaching hospital in Brno. The first part of the article is aimed at the application of a software 3D-DOCTOR that enables gaining of demanded output data (e.g. a model of patient bone part, i.e. knee joints) from scanned input CT metadata in DICOM format (*Digital Imaging and Communications in Medicine*). The output data are gained in format \*.stl (*Stereo Lithography*) to further possible usage (e.g. a design and a production of individual total joint prosthesis). The second part of the article concentrates on an application of software RP MiniMagics that enables editing, modification and the whole optimization of polygon net by which models of distal part of femur and proximal part of tibia are described.**

**Keywords:** Knee Joint, CT Metadata, 3D-DOCTOR, Technology, RP MiniMagics

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## Sprinkback Research of V-type Sheet Metal forming based on the Adjustable Drawbead and Variable Blank-holder Force Cooperative Control Technology

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**Springback of v-type sheet metal must be controlled during the high precision forming process. While, variable blank-holder force technology is an effective measure to control sheet metal springback, but it only overall control the stampings. The project was put forward through the v-type sheet's variable blank-holder force and adjustable drawbead to control springback, which is place electric adjustable step drawbead around the blank- holder. Changing the blank-holder force, meanwhile, adjusting the height of the drawbead according to the needs of the stamping real time, so as to control the quality of sheet forming. To get the optimal combination of variable blank-holder force and adjustable drawbead, this rearch for the technology to control the springback, which has carried on the theoretical analysis and numerical simulation, then providing test for it.**

**Keywords:** v-type sheet metal forming, variable blank-holder force, adjustable drawbead, springback, numerical simulation

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## Study on Springback Rule of AZ31B Magnesium Alloy Axisymmetric Part's Warm Single Point Incremental Forming without Mould

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**It is necessary to study and master the springback rule of single point incremental forming of magnesium alloy on different process parameters, which has important theoretical and practical application value to complement and perfect the springback control technology of single point incremental forming of magnesium alloy. Taken the variable angle truncated cone as the research object, used the ANSYS/LS-DYNA as research tool, viewed the springback amount as research criteria, the influence of different process parameters to the springback of single point incremental forming is studied in this paper, which includes forming temperature, friction conditions and tool diameter. The results show that the springback could be effectively controlled when the forming temperature is 250°C, the static friction coefficient is 0.2, the coefficient of kinetic friction is 0.1 and the diameter of the tool is between 10mm and 12mm.**

**Keywords:** AZ31B magnesium alloy, single point incremental forming, springback, numerical simulation

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## Mechanical Properties of Epoxy Resins Filled with Waste Rubber Powder

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A material usage of waste rubber powder in the polymeric composites increases their significance. Material recycling is very important ways of dealing with waste. The paper deals with laboratory tests of polymeric particle composites based on the waste – rubber powder which was gained as one of outputs of a recycling line. The paper describes mechanical properties of these composite systems such as: hardness (Shore D, Brinell), tensile strength (cohesive strength of filled epoxy resins) and it is also focused on the lap-shear tensile strength in the boundary adherend. Adding waste rubber powder into the epoxy resins and into other plastics materials and adhesives is a way for the material recycling which is inexpensive and sensitive to the environment. The inclusion of filler lead to the fall of lap-shear tensile strength values with an increasing amount of filler and to stabilizing on the level 5-20 vol.% filler in the epoxy matrix.

**Keywords:** Hardness, Lap-shear tensile strength, Recycling

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## Study on Q245 Steel fatigue crack growth behaviors at high temperature

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**Q245 steel was once widely used in the pressure vessel industry. At present, the high temperature fatigue performance of Q245 steel was tested and analyzed. According to the relevant standards, the pre-crack specimens were tested at 25°C and 400°C respectively. The a-N curves, the  $da/dN - \Delta K$  curves and the Paris formula of Q245 steel at both room temperature (25°C) and high temperature (400°C) were obtained. Finally, the high temperature fatigue fracture analysis was done. The fatigue crack growth occurred along the grain at high temperature. A large number of acicular oxide appear in the fracture surface and the fatigue striations could not be observed at high temperature.**

**Keywords:** High temperature; Fatigue crack; Fatigue crack growth threshold

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## Dynamic Analysis for High-speed Cutters of Five-axis CNC Milling Machine

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Cutter vibration characteristics of five-axis milling machine in high-speed milling process were studied. Finite Element Modal Analysis for high-speed cutters with different parameters is conducted using finite element software. The impact of tooth number, extended length, diameter and material of milling cutter on the mode shapes and natural frequencies of milling cutter is researched in detail. Harmonic response curves of High-speed cutter under different frequency are calculated. Based on the response curve, the resonance frequency range of high-speed cutter is obtained in order to achieve high-precision milling and longer life of the tool. Analysis shows that: mode shapes of milling cutter are divided into strong vibration mode shapes and weak vibration mode shapes and its natural frequency become smaller with the increase of the cutter teeth number. Natural frequency of milling cutter decreases with the increase of extended length of milling cutter. The number of strong vibration mode is smaller with the increase of milling cutter diameter so that the milling cutter with large diameter can play a role of anti-vibration. Natural frequency of the high-speed steel cutter is lower than that of the diamond and carbide cutter. This research provides theoretical basis for the design of high speed milling cutter and reducing milling chatter.

**Keywords:** High-speed cutter, Vibration characteristics, Modal shape, Harmonic response analysis

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## Design and Calculation of Multi-angle and Stepping Transmission of Sucker Rod Forging

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The paper puts forward structure design and parameter analysis of the multi-angle and stepping transmission device, and this paper focuses on design and analysis of the multi-angle steering parts in the device. According to mathematical calculation and simulation analysis, the parts size of steering component is simulated and designed by the double cam-linkage mechanism. Though the design of these critical components of the steering device, the rods can be rotated in the specified angle (45° and 90°) by their relative motion without any external force, and the steering device is simulated by SolidWorks Motion. The results show that the multi-angle and stepping transmission device realizes the upset forging process requirements, improves the mechanization level of the sucker rod forging. The device will be used for the rod head machining operation in narrow space in automatic production line, and it also can be extended to other cylindrical rod's multi-angle and multi-position automatic machining operation.

**Keywords:** Multi-angle, Stepping Transmission, SolidWorks Motion, sucker rod forging.

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## Principles of Cutting Process Modelling and New Algorithm Proposal

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Nowadays the pressure to increase the efficiency of the machining processes is constantly growing. The efficiency of the machining process can be pursued from two basic perspectives – enhancing the cost-effectiveness of the process (decreasing production costs) or increasing production in time. Via these approaches alone, manufacturers of parts as well as suppliers of machine tools and cutting tools try to improve their position in a highly competitive market. One of the approaches to increase efficiency is the correct choice and subsequent optimal exploitation of the potential of cutting tools and machine tools as well as a reduction in the energy intensity of the cutting processes for a given component. That is what led to the idea of creating an analytical-material model for determining the force interaction between the cutting tool and workpiece, energy intensity and machining process efficiency. The result will be an application that helps technologists in practice to choose correctly the appropriate types of cutting tools, operations, machine tools and also quickly determine the main parameters of the cutting process so that there is the possibility of comparing their results with other variants. The first step and goal is to create an overview of the cutting processes and the associated cutting process modelling, compare their advantages and disadvantages, and then propose an approach of our own.

**Keywords:** machining, modelling, cutting forces, cutting power, specific cutting force

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## An Evaluation of Changeability of Parameters Describing Abbot Curve during a Wavelet Decomposition Process

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**Results of signals analysis was done using wavelet transform, which have different curves of wavelets and depend on the basic wavelet, which were applied. Thus, it is sometimes not possible to conduct a wavelet transform of a given profile with the use of any basic wavelets and to obtain results that are similar to the measured signal. The aim of this work was an optimization of a basic wavelet selection used for an analysis of surface roughness. In the work an analysis of Abbot-Firestone curve parameters was performed on subsequent decomposition levels and for various basic wavelets.**

**Keywords:** wavelet transform, Abbot-Firestone curve, decomposition

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