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TEMPERATURE AT THE TOOL-CHIP INTERFACE IN CRYOGENIC AND DRY TURNING OF AISI 4340 USING CARBIDE TOOL

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Abstract
A localized high temperature area occurring at the tip of the tool during a cutting process can be detrimental and lead to a rapid wear mechanism. This paper presents the effect of a cryogenic application during the machining process on the temperature generated at the tool-chip interface, compared to a dry environment in the turning of the AISI 4340 alloy steel using a coated carbide tool. The cutting temperature was estimated using the Third Wave AdvantEdge software, which then was validated with the turning experiments. A significant reduction of the cutting temperature and the steeper temperature gradients on the cutting edge and the chips were observed in the cryogenic machining, which indicates more effective heat removal from the cutting zone. The sudden cold of -196 °C caused the chips to become hard and brittle, which enhanced the chip breakability during the machining process. 25 refs.
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Key Words: *Cryogenic, Heat Transfer Coefficient, Temperature Gradient, Finite Element Analysis*

Pages 213-222

CONCEPTS OF SIMULATION MODEL SIZE AND COMPLEXITY

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Abstract
Simulation modelling is the business of reducing complexity of the real world. Keep your models small and simple, is the basic heuristic found in simulation & modelling literature; yet the modellers are developing models of increasing size and complexity. Simulation model size and complexity is generally a less debated and poorly understood area. Despite the importance of model simplification and its relation with size and complexity; only a handful of papers, addressing the size and complexity of simulation models, can be found. This paper reports on general concepts of simulation model size and complexity held by expert modellers and proposes a framework to understand the origins of simulation model size and complexity. Size and complexity are two most important contextual factors that may affect simulation practice. Increased understanding of concepts of simulation model size and complexity held by the modellers will potentially underpin simulation methodology research and help us in addressing the issues raised by increasing size and complexity of simulation models. 15 refs.
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Key Words: *Simulation Model Size, Model Complexity, Context, Methodology*

Pages 223-235

LAYOUT AND MATERIAL FLOW OPTIMIZATION IN DIGITAL FACTORY

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Abstract
The ability to realize customized products, in particular for engineering-to-order companies, is a key factor in order to be competitive in modern market without incurring any additional cost and respecting customer lead time. In this ever-changing environment the layout optimization is a fundamental issue requirement, hence the development of a virtual layout, according to the Digital Factory concepts, can be very useful to identify and to solve potential problems during the planning phase, before realize it. The main aim of this paper is represented by the proposal of a layout reconfiguration and a technological solution for the parts feeding system of the industrial plant analysed in order to reduce the production lead times.

In the first phase, an overview of the Digital Factory applications is provided. In the second phase, after data analysis in an Italian manufacturing company, a simulation model has been designed and tested using Simio simulation software. Simulations results concerning production and queue times obtained from different orders have been compared with actual configuration data.

Research results indicate that the surveyed company has had an improvement in terms of reduction of waiting times and increase of customers satisfaction due to total production lead time reduction. 39 refs.
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Key Words: *Digital Factory, Layout Optimization, Manufacturing and Simulation Model, 3D Simulation*

Pages 236-248

TIRE-PAVEMENT COUPLING DYNAMIC SIMULATION UNDER TIRE HIGH-SPEED-ROLLING CONDITION

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Abstract
The coupling effect between tire and pavement is an intensively researched subject to analyse the dynamic interaction of the vehicle-pavement system. By considering the 11.00 R20 tire and expressway asphalt pavement, ABAQUS software was employed in this study to establish an improved model for simulating the coupling effect, in which the tire rubber was taken as a neo-Hookean material and the pavement was taken as a multilayer structure. The coupling was achieved by considering the equilibrium equation and continuity conditions of the contact surface. The tire rolling, which was modelled by the "steady-state transport" method provided by ABAQUS software, was imported to the tire-pavement coupling for the explicit dynamic computation. Numerical results indicate that the pavement deformation obviously weakens the tire vibration in comparison with the non-deformable assumption, in which the variance of the vertical acceleration at the tire centre is reduced by 25 % and the power spectral density is decreased by 52 %. The influence of the horizontal contact stress (CSHEAR) is considered by taking different friction coefficients. Compared with the case without the CSHEAR, the stresses in the longitudinal and lateral directions within the contact area on the pavement surface are increased by approximately 45 %. This study simulates a more realistic situation, including the contact stress and high-speed-rolling tire, thus the conclusions provide a reference for the optimization and design of vehicles and pavement structures. 23 refs.
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Key Words: *Tire-Pavement Coupling System, Finite Element Method, Wheel Load, Dynamic Simulation*

Pages 249-261

SIMULATION OF PUBLIC PROCUREMENT'S IMPACT ON INNOVATIVENESS OF EU COUNTRIES

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Abstract
Recently a lot of research has been devoted to studying the impact that public procurement can have on innovation. The phenomenon has been widely recognized as the effect of public procurement for (of) innovation (PPI). The purpose of this paper is to further explore the previous results of the econometric panel analysis by employing simulation modelling to check the robustness of the results and to add firmer arguments for evidence-based innovation policies.

The main results for the 28 EU countries show that PPI and economic (GDP) growth are significant factors that affect the level of a country's innovativeness. By applying simulation models, the possible size of the impact in terms of changing the size of PPI on a country's level of innovativeness, can be seen. These results can have practical implications for officials in charge of innovation policies, because the recent crisis has stretched their budgets, meaning that they have to choose policy instruments that will have a significant impact. 41 refs.
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Key Words: *Public Procurement, Innovation Policy Instruments, Innovativeness, Panel Analysis, Simulation*

Pages 262-274

ANALYSIS OF A NOVEL NOZZLE USED FOR PULSE JET FILTRATION USING CFD SIMULATION METHOD

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Abstract
The nozzle is one of the most important components of pulse jet systems. The optimization of a pulse jet system and its optimal operation condition are barely known because of the complicated turbulent mixing, compressibility effects, and even flow unsteadiness, which are generated in the nozzle system. In this study, a three-dimensional numerical model of a pulse jet system was established to analyse its operation characteristics by using computational fluid dynamics (CFD). The CFD simulation results were validated with existing experimental data. The flow dynamics of the pulse jet gas around the cleaning nozzle was numerically explored to predict the effects of nozzle shape and dimensions on the pulse cleaning performance in terms of pressure distribution, velocity distribution, primary mass, secondary mass, and entrainment ratio. The influences of the convergent ratio in the narrow (R_{ch}) and wide (R_{cw}) directions, as well as that of the divergent ratio (R_{dw}) in the wide direction, for the nozzle were discussed. Results show that the flow dynamics are most sensitive to changes of R_{ch} among of R_{ch}, R_{cw}, and R_{dw}, The entrainment ratio (R_{en}) increases with R_{ch}, R_{dw}, and R_{dw}. The primary and secondary masses decrease with increasing R_{ch} and R_{dw}. The primary and secondary masses increase with R_{dw}. The conclusions obtained in the study provide guidelines for designing a rectangular slot nozzle for pulse jet cleaning of the filter elements. 17 refs.
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Key Words: *Numerical Simulation, Three-Dimensional Model, Rectangular Nozzle, Pulse Cleaning, Entrainment Effect*

Pages 275-287

OPTIMISATION OF MACHINE LAYOUT USING A FORCE GENERATED GRAPH ALGORITHM AND SIMULATED ANNEALING

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Abstract
This paper presents a novel heuristic method for machine layout optimisation, developed in the course of an internal factory logistics optimisation project. The method is developed from a force-directed graph drawing algorithm, and integrates random permutations using simulated annealing to avoid local minima. The method was verified and validated with a discrete event simulation (DES) model of a furniture development factory consisting of 140 machines. The DES model was developed for manufacturing system analysis as well as design and testing of optimisation methods. The main optimisation goal was reduction of transport costs by minimising the total distance the products travel between the machines. The optimisation problem extends the quadratic assignment problem (QAP) by allowing arbitrary granularity of locations, facility sizes and fixed facilities. The resulting method can be used to solve a wider range of problems by altering the optimisation function or adding new feasibility conditions. 31 refs.
(Received in June 2015, accepted in December 2015. This paper was with the authors 1 month for 2 revisions.)

Key Words: *Layout Optimisation, Heuristics, Discrete Event Simulation, Force-Directed Graphs*

Pages 288-301

PERIOD BATCH CONTROL - A PRODUCTION PLANNING SYSTEM APPLIED TO VIRTUAL MANUFACTURING CELLS

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Abstract
Period Batch Control (PBC) system has been known for its implementation with the classical group technology (GT) cells, and it has been known for its simplicity. The main production planning decisions concern the choice of the period length and the stage number and contents. Also, in order to better integrate the production planning with the application of GT cells at the shop floor, the concept of virtual manufacturing cells has been applied. Since virtual cells configurations are changing periodically, a model for implementing the PBC system into virtual manufacturing cells environment is developed. The model enables alignment of the PBC principles and rules with virtual cell design goals. Model is tested on the case study of furniture production. With the use of scheduling software, different scheduling rules were simulated for four production weeks. The experimental results from these for production weeks show how the choice of PBC parameters impacts the virtual cells configurations, machine sharing and utilization. 35 refs.
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Key Words: *Period Batch Control, Virtual Cell, Schedule Simulation*

Pages 302-312

PATH PLANNING AND CO-SIMULATION CONTROL OF 8 DOF ANTHROPOMORPHIC ROBOTIC ARM

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Abstract
In this research article a kinematic equation for 8 Degrees of Freedom (DOF) anthropomorphic robotic arm was developed and it is modelled using Pro-E software and invoked in ADAMS software tool for further analysis. A cubic path planning algorithm is mathematically derived for actuating the joints and simulated using the MATLAB environment for proper joint motions. With the help of MATLAB/ADAMS Co-Simulation environment the robotic arm invoked in ADAMS model is actuated using the path planning algorithm written in MATLAB environment. The robotic arm traversed the desired trajectory effectively, which confirms the effectiveness of the path planning and control algorithm. These simulated results were used to analyse the dynamic behaviour of the robot arm and gave us a clear insight about the parameters like torque, joint position, velocity and acceleration of the robotic arm and the results have been discussed in detail. This research article is a part of a real time humanoid robot research project titled – RALA (Robot based on Autonomous Learning Algorithm). 17 refs.
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Key Words: *Robotics, Humanoid Arm, Dynamic Analysis of Robot Arm, MATLAB / SIMULINK, ADAMS, 8 Degrees of Freedom*

Pages 313-326

MODELLING FOR EMERGENCY MANUFACTURING RESOURCES SCHEDULE TO UNEXPECTED EVENTS

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Abstract
This paper addresses an emergency scheduling for manufacturing resources (ESMR) problem and a method based on event-driven rolling optimization according to the production task priority is developed for solving it. A mathematical model aiming to maximum resource scheduling satisfaction, minimize tardiness penalties and minimize crash cost is proposed firstly. Then, the priority of the tasks in rolling window is analysed based on production system vulnerability. An adaptive multi-objective dynamic resource scheduling algorithm is proposed as a solution of the model above. Analytic results show that it is not only able to effectively reduce the complexity of ESMR, but also to reveal influence of task importance on ESMR. With the analysis, it can provide way of measuring the overall emergency impacts on the systems, and allow the decision-makers to respond to unexpected events that what the best way of resources scheduling is. 22 refs.
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Key Words: *Emergency Decision-Making, Manufacturing Resources Scheduling, Rolling Optimization, Vulnerability, Resource Scheduling Algorithm*

Pages 327-340

RESEARCH ON CROWN & FLATNESS ALLOCATION STRATEGY OF HOT ROLLING MILLS

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Abstract
In order to present the reasonable crown of hot rolling mills, the bend force and shift position should be pre-computed in a reasonable manner, while maintaining a good profile. How to search the optimal crown trajectory in ratio crown range is the key problem. Crown and flatness allocation strategy is researched based on dynamic programming method which has been improved and optimized by the algorithm. The key parameters have been calculated by finite element method and regression calculation method, which can regress the equation of the mechanical crown. Comparing with a real production hot rolling mills, the result of state transition equation shows a perfect availability. Additionally, the parallel computing model and look-up table method have been utilized in dynamic programming calculation program. The results show that the bend force normalization population standard deviation fell from 0.2 to 0.06 and the continuously variable crown (CVC) roll shift position normalization population standard deviation fell from 0.3 to 0.15. The consequences show that the crown and flatness allocation strategy has a better application effect and the computing time is only 16 ms, which proves that the model can be applied online. 24 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *Hot Rolled Strip, Profile, Allocation Strategy, Finite Element Method, Rapid Dynamic Programming*

Pages 341-351

COOPERATIVE R&D CONTRACT OF SUPPLY CHAIN CONSIDERING THE QUALITY OF PRODUCT INNOVATION

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Abstract
This paper researches the conditions where the manufacturer focuses on development of core components and outsources development of supporting components to the supplier in the collaborative R&D of the supply chain. The manufacturer needs to consider the impact on market revenue of innovation quality when they design contracts in order to avoid unethical behaviour of suppliers. The manufacturer should not only offer the suppliers a certain fixed payment, but also share the market revenue from the products with the suppliers. This study research arrives at several conclusions. First, the optimal revenue sharing coefficient has a negative correlation with the impacting coefficient of the success of product innovation, which is affected by the efforts put into core components development by the manufacturer. Second, the optimal revenue sharing coefficient has a positive correlation with the impacting coefficient of the success of product innovation success, which is affected by the efforts put in development of supporting component by the supplier. Third, the optimal revenue sharing coefficient has no correlation with the fixed payment and innovation quality of product. Fourth, the optimal fixed payment has positive correlation with the cost coefficient of developing the core components and supporting component by both sides in the supply chain, and it has negative correlation with innovation quality of products. 20 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *Supply Chain, Collaborative R&D, Innovation Quality of Products, Contract*

Pages 352-364

MULTI-PRODUCT MULTI-PERIOD INVENTORY ROUTING OPTIMIZATION WITH TIME WINDOW CONSTRAINS

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Abstract
The concept of the green supply chain leads to the recent expansion of the green logistics investigation. Under the mode of VMI (vendor managed inventory), integrating the inventory and routing of the supplier and the customer as a whole is vital to achieve the optimization of total distribution cost in distribution logistics systems. In this paper, the inventory routing problems on a two-echelon logistics system composed of a single distribution centre and multiple customers for multi-product in multi-period with time constrains is studied under the conditions of VMI strategy. Both inventory costs and distribution costs are considered in the logistics system, and an improved fuzzy genetic algorithm is proposed to solve the optimization model of IRP (inventory routing problems) for multi-product in multi-period with time constrains. It has been proved that the proposed algorithm is a very efficient approach for the IRPs. Finally, the effectiveness of the proposed algorithm and the optimization model are demonstrated through simulation of computational experiments. 36 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *IRP (Inventory Routing Problems), VMI (Vendor Managed Inventory), Fuzzy Genetic Algorithm, Multi-Product, Multi-Period*

Pages 365-376

COOPERATIVE INVENTORY STRATEGY IN A DUAL-CHANNEL SUPPLY CHAIN WITH TRANSSHIPMENT CONSIDERATION

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Abstract
Aimed at the possibility of stock-out of the traditional retail channel under stochastic demand in a dual-channel supply chain, we propose a cooperative inventory strategy, in which the excess demand of the traditional retail channel is complemented by the excess inventory of the manufacturer's direct channel through transshipment. We establish a newsboy model to analyse each supply chain member's order quantity decision making process, and prove the unique existence of pure-strategy Nash equilibrium under the uncooperative inventory strategy and the cooperative inventory strategy. We go on to discuss the impacts of the wholesale price, the channel substitution rate and the transshipment cost on optimal order quantities under each inventory strategy. Numerical simulation shows that when values of the wholesale price and the transshipment price satisfy certain conditions, the cooperative inventory strategy can not only lead to an increased supply chain profit but also achieve Pareto improvements of both the manufacturer and the retailer. 23 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *Supply Chain, Dual Channel, Inventory Cooperation, Transshipment, Game Theory*

Pages 377-387

MODELLING AND SIMULATION OF A MINING MACHINE EXCAVATING SEABED MASSIVE SULFIDE DEPOSITS

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Abstract
In this research, the mechanical characteristic parameters of the seabed massive sulfide (SMS) are obtained quantitatively using laboratory uniaxial compression strength (UCS) test and triaxial compression strength (TCS) test. A three-dimensional discrete element (DEM) model of the SMS is developed in the EDEM simulation environment and are then validated by numerically simulating the laboratory UCS and indirect tensile strength (Brazilian disc) tests. A new counter-rotating pick-type drum cutter for excavating the SMS is proposed, and a corresponding DEM model for the excavation process is established. Numerical simulations for the new counter-rotating cutter and a traditional single-rotating cutter are conducted, and the cutter forces in three orthogonal directions and the torques are obtained and compared. By integrating the new counter-rotating cutter, a three-dimensional multi-rigid-body dynamic model of a SMS mining machine is developed in the RecurDyn simulation environment, and simulations are conducted to evaluate its trafficability and mobility performance under the effect of the excavating cutter on the seabed complex terrain. This research can provide valuable and effective modelling methods for seabed mineral excavation process simulation, mining tool optimization and design and mining machine performance evaluation. 19 refs.
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Key Words: *Seabed Massive Sulfide, Seabed Mining Machine, Laboratory Mechanical Tests, Excavation Cutter, Discrete Element Model, Numerical Simulation*