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## FIXTURE LAYOUT DESIGN BASED ON A SINGLE-SURFACE CLAMPING WITH LOCAL DEFORMATION

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**Abstract**
Proposed in this paper is a novel approach to fixture layout design. The contact interface between workpiece and fixture is reduced to a single workpiece surface. This allows reliable machining of the remaining five workpiece surfaces in a single setup. Workpiece clamping is performed by inserting special elements into prepared auxiliary openings on the workpiece. Clamping is thus reduced to indenting of sharp clamping element tips into the workpiece surface. Shallow indenting is performed on surfaces which have no practical function. Special device was designed to allow experimental investigation. Experimental results point towards the efficiency of the proposed approach. Workpiece displacements were small during machining and allowed the required machining accuracy. Furthermore, the results obtained during machining indicate high surface quality. 30 refs.
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**Key Words:** *Fixture, Machining, Locating, Clamping*

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Pages 392-403

## SIMULATION AND VISUAL CONTROL OF CHIP SIZE FOR CONSTANT SURFACE ROUGHNESS

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**Abstract**
A visual cutting chip control system is designed to automatically adjust feed rate in order to maintain constant surface roughness in ball-end milling. The proposed visual control system has a modular structure, consisting of an optical vision system (OVS), an adaptive cutting chip size-control loop for a feed servo and a surface roughness in-process prediction model. The OVS is employed to acquire the cutting chip sizes form the camera. A division controller is used to control the chip size by modifying the feed rate and consequently maintaining surface roughness constant. Surface roughness is predicted based on the detected chip size. The efficiency of the chip control strategy is tested by series of simulation with various step changes in the cutter/workpiece contact area. For simulation purposes an experimentally validated milling plant simulator with an adopted feed servo drive model and a cutting chip size model is employed. An adaptive neural inference system (ANFIS) is established to effectively simulate the cutting chip size in ball end-milling. In simulation, the reference chip size and consequently the reference surface roughness are well maintained when the cutting-depth profile of a workpiece is varying step-wise or continuously. 21 refs.
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**Key Words:** *Ball-End Milling, Chip Size, Visual Control, Surface Roughness, Simulation, ANFIS*

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Pages 404-415

## OPTIMAL PRODUCTS' HAND-HANDLE INTERFACE PARAMETER IDENTIFICATION

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**Abstract**
The paper reports findings of investigating optimal interface material parameters of product handle to improve its ergonomics by increasing the user performance, comfort, and lower the risk of cumulative trauma disorder development. Optimisation methods in combination with the finite element computer simulations of a human fingertip whilst grasping a handle were used to determine an interface foam material with optimal material properties for best mechanical behaviour of the system. A single objective function was defined to determine best material parameters of the interface foam material, which has to remain firm during low grasping forces to provide stability of the product grasp and appropriately deforms when a critical contact pressure is reached to provide higher contact area. This increases comfort and lowers the contact pressure on the hand and thereby the risk of injury development. The optimisation process yielded the optimised foam thickness and its stress-strain relationship for simulated contact of fingertip model grasping a product handle. 35 refs.
(Received in November 2014, accepted in March 2015. This paper was with the authors 1 month for 1 revision.)

**Key Words:** *Ergonomics, Product Development, Foam Material, Computer Simulations, Finite Element Method, Optimisation*

Pages 416-425

## PERFORMANCE OF UNCOATED AND COATED CARBIDE TOOLS IN TURNING FCD700 USING FEM SIMULATION

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**Abstract**
This paper presents investigations on the performance of uncoated and multi-layer coated carbide tools while turning ductile cast iron FCD700. Three different squares-edged carbide tools were used, namely TiN+TiCN+$Al_2O_3$+TiN-coated carbide tools, multi-layered hard coating of 5 and 10 μm thickness and an uncoated WC/Co tool. Deform-3D FEM software is utilised to predict the main cutting force, the sliding velocity, interface temperature and interface pressure and tool wear rate on these inserts. The results show that the main cutting forces obtained with multi-layer carbide tools are smaller than the uncoated carbide tool. The simulated results for cutting forces were validated experimentally, and the maximum error between the simulation and experimental results is 8.14 %. It was found that the coated carbide tool with the highest thickness is the most suitable for turning ductile cast iron at higher cutting speeds. 20 refs.
(Received in February 2014, accepted in March 2015. This paper was with the authors 1 month for 2 revisions.)

**Key Words:** *Multi-Layer Coated Carbide Tools, Finite Element Analysis, FCD700 Ductile Cast Iron, Turning*

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Pages 426-437

## NUMERICAL SIMULATION OF MODIFIED LOW-DENSITY JET PENETRATING SHELL CHARGE

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**Abstract**
In order to solve the problem of inadequate penetration of low-density jet penetrating shell charge, the low-density PTFE are modified by adding a certain fraction of copper powder in the matrix. This treatment helps to increase the material density and jet energy, as well as to improve the static and dynamic mechanical properties of the material. AUTODYN-2D finite element software is used to simulate the process in which the low-density jet forms and penetrates shell charge. The simulation and experiment results show that in comparison to PTFE, the mechanical properties of PTFE/Cu have been significantly improved, and the jet has strong penetration capability. Under the same structural conditions, the penetration diameter of PTFE/Cu jet is about enhanced by 70 % for the panel and 30 % for the back plate compared to that of PTFE jet. As an experimental result, the penetration depth of the main armour by PTFE/Cu jet is enhanced by 5.38 % compared with that of PTFE jet. 14 refs.
(Received, processed and reviewed by the American Society of Science and Engineering.)

**Key Words:** *Explosive Mechanics, Numerical Simulation, Finite Element Model, Low-Density Jet*

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Pages 438-449

## A NOVEL FAULT DIAGNOSIS METHOD FOR ROTATING MACHINERY BASED ON EEMD AND MCKD

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**Abstract**
Incipient fault diagnosis of rotating machinery has received extensive research attention for years. However, the diagnosis remains a difficult problem since the incipient faults are generally quite weak in noisy environments. In the present work, a novel fault diagnosis method based on ensemble empirical mode decomposition (EEMD) and maximum correlated kurtosis deconvolution (MCKD) is proposed in order to solve this problem. For the incipient fault of rotating machines, EEMD is firstly performed and the signal is reconstructed based on the calculation correlation coefficient and kurtosis. The impulsive components of faults can be enhanced using the MCKD-based adaptive method, and the weak fault features can be extracted from the envelope spectrum. Finally, the diagnosis results are output. The experimental results indicate that, using the proposed method, the fault impulsive components in the obtained intrinsic mode functions (IMFs) with EEMD can be adaptively enhanced, and the weak fault signal hidden in the noise can be effectively detected. 25 refs.
(Received, processed and reviewed by the American Society of Science and Engineering.)

**Key Words:** *Maximum Correlated Kurtosis Deconvolution (MCKD), Incipient Fault Enhancement, Fault Feature Extraction*

Pages 450-462

## A NEW PRODUCTION SCHEDULING MODULE USING PRIORITY-RULE BASED GENETIC ALGORITHM

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**Abstract**
Production scheduling is an important function that determines the efficiency and productivity of a production system. Many optimization methods, techniques, tools, and heuristics have been used to solve production scheduling problems, accordingly priority rules are implemented for customers' orders in real-world applications. Simulations and heuristic methods are quite useful for making decisions, and they are used mostly to design and improve production systems by reducing their complexity. In this study, a Priority Rule-Based Genetic Algorithm Scheduling (PRGA-Sched) module was developed to provide shorter total completion time in production scheduling. The module was integrated with the Faborg-Sim simulation tool. As a case study, a heating boiler manufacturing system was analyzed and simulated with six products and customers' orders by using production data from the PRGA-Sched module in Faborg-Sim. The results showed that a shorter total completion time is obtained and saved than the initial situation by via PRGA-Sched module. 46 refs.
(Received in July 2014, accepted in April 2015. This paper was with the authors 3 months for 2 revisions.)

**Key Words:** *Simulation, Scheduling, Priority Rules, Genetic Algorithm, Faborg-Sim*

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Pages 463-474

## COMPETITION OR COOPERATION: A SIMULATION OF THE PRICE STRATEGY OF PORTS

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**Abstract**
Ports act as the nodes connecting water transport with land transport and play pivotal roles in logistics networks. The rapid rise in international freight volume has led to a faster growth in the throughputs of many ports. With the development of containerization, services provided by different ports could be substitutable with each other, especially those in the same region which are more competitive for substitutability. However, the question must be asked: is competition unchangeable? Moreover, is competition strategy always the best solution for ports? The purpose of this article is to analyse the issue of which strategy is better for ports: competition or cooperation. Using a modified Hotelling model, multiple competitors are analysed applying a competition strategy and simulations are developed of three ports with competitive and cooperative targets respectively. Research results reveal that, with the same service levels, location is a critical factor for competitive ports and, with a view to capturing greater market share, ports are motivated to form alliances. 12 refs.
(Received in August 2014, accepted in March 2015. This paper was with the authors 2 months for 1 revision.)

***Key Words:*** *Port, Competition, Cooperation, Hotelling Model*

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Pages 475-484

## ON-TIME DELIVERY ACHIEVEMENT OF HIGH PRIORITY ORDERS IN ORDER-DRIVEN FABRICATIONS

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**Abstract**
This paper proposes a new dispatching rule to achieve the on-time delivery of high priority lots in order-driven fabrications (FABs). Most of conventional dispatching rules can be considered as the variants of classical rules like ODD, EDD, and CR. Although, many of conventional dispatching rules give good performance in terms of the on-time delivery, they do not consider the existence of high priority lots. We classify orders into two types for an order-driven FAB; regular orders and high priority orders. While regular orders are typically characterized by longer cycle times, looser target due dates but lower margins, the high priority orders have shorter cycle times, tighter target due dates and higher margins. If the deliveries of high priority orders are late, the manufacturer may have to pay a significant amount of penalty charges. The proposed dispatching rule employs the concept of reservations of high priority lots, and consists of two major steps; 1) finding a high priority lot for reservation, and 2) finding a tool for reservation. The first step tries to minimize the waiting time of high priority lots, and the second step tries to maximize the utilization of tools. Experimental results show that the proposed dispatching rule is superior over conventional rules with regard to on-time delivery of high priority lots. 24 refs.
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**Key Words:** *Dispatching Rules, Factory Simulation, FAB, Job Shop Scheduling, On-Time Delivery*

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Pages 485-498

## NEW MARKETS FORECAST AND DYNAMIC PRODUCTION REDESIGN THROUGH STOCHASTIC SIMULATION

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**Abstract**
In this paper the authors analyse a double problem: the sales forecast in new foreign markets in the next five years by an Italian SME and the consequent dynamic production system redesign having the goal to maximize the Gross Margin.
Due to the high uncertainty of the variables involved, the authors approached the study in stochastic regime. The methodology is based on Monte Carlo and Discrete Event Simulation, on new Pure Experimental Error control techniques and on Response Surface Methodology Designs as the Two Level Factorial Design and the Central Composite Design. 33 refs.
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**Key Words:** *Healthcare Management, Emergency Department, Patient Flow, Capacity Planning, Decision Support System*

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Pages 499-510

## A PROMOTED HYBRID HEURISTIC ALGORITHM FOR TWO-DIMENSIONAL MULTI-DEPOTS VEHICLE ROUTING PROBLEM

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**Abstract**
In this paper, a multi-depots capacitated vehicle routing problem where client demand is composed of two-dimensional weighted items (2L-MDCVRP) is addressed. The problem calls for the minimization of the cost of transportation needed for the delivery of the goods demanded by the clients, and carried out by a fleet of vehicles based at several depots. The overall problem, denoted as 2L-MDCVRP, is NP-hard and it is very difficult to get a good performance solution in practice. We propose a quantum-behaved particle swarm optimization (QPSO) and exploration heuristic local search algorithm (EHLSA). It has been proved that particle swarm optimization is a very efficient approach for the CVRP, and the quantum-behaved can help particle swarm optimization to escape effectively from local optimum. Furthermore, we propose an exploration heuristic local search to solve the loading constraints in 2L-MDCVRP. The effectiveness of the proposed algorithm is demonstrated through computational experiments on benchmark instances. 21 refs.
(Received, processed and accepted by the Chinese Representative Office.)

**Key Words:** *Vehicle Routing, Multi-Depots, Two-Dimensional Packing, Quantum-Behaved Particle Swarm Optimization, Exploration Heuristic Local Search*

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Pages 511-524

## AN INTUITIONISTIC FUZZY-TODIM METHOD TO SOLVE DISTRIBUTOR EVALUATION AND SELECTION PROBLEM

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**Abstract**
In the collaborative planning, forecasting and replenishment (CPFR) process of supply chain management, the distributor is the leading “tie” between manufacturer and customer, a key figure in collecting marketing information, reducing the demand uncertainty and improving customer satisfaction. In the CPFR process, by making reasonable evaluations and selections the distributors can ensure smooth distribution channels and enhance the competitiveness of the entire supply chain. As a result, distributor evaluation and selection is a pivotal step in the process of supply chain management. In order to improve the validity and reliability of the evaluation and selection model, this paper proposes a decision model based on Intuitionistic Fuzzy-TODIM (IF-TODIM) and carries out example calculation and simulation analysis. Firstly, the CPFR process of the existing supply chain management method and the evaluation indicator system of the distributors were analysed. The next stage was to establish a selection criteria system (which the CPFR process requires) and then create an evaluation model based on the IF-TODIM selection model and prospect theory. Uncertainty and risk aversion were full considered in the distributor evaluation and selection model for the manufacturers. Finally an example calculation process and the simulation analysis revealed that the model displayed operability and effectiveness, can effectively solve the problem of distributor selection under uncertainty condition and help manufacturers determine the optimal distributor partners quickly, at the same time maximizing the choice of avoiding enterprise risk. 22 refs.
(Received, processed and accepted by the Chinese Representative Office.)

***Key Words:*** *Distributor Evaluation and Selection, Evaluation and Selection Indicator System, Intuitionistic Fuzzy Set, TODIM, Prospect Theory*

Pages 525-538

## A VARIABLES CLUSTERING BASED DIFFERENTIAL EVOLUTION ALGORITHM TO SOLVE PRODUCTION PLANNING PROBLEM

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**Abstract**
The scenario tree based multistage stochastic programming model is popular to describe production planning problem. However, as its high-dimensional variables and large-scale solution space, the addressed model is hardly to be solved in an acceptable time. To deal with this challenge, we propose a variables clustering based differential evolution algorithm which combines two novel strategies i.e. the children cluster based parallel evolution operations and the entirely randomized parameters for each child-individual. A case of weapons production planning is studied to validate the proposed algorithm. The results show that this algorithm has the fastest convergence and the best global searching capability in 6 test instances with different scales of the variables and the solution space, compared with classical differential evolution algorithm, genetic algorithm and particle swarm optimization algorithm. 28 refs.
(Received, processed and accepted by the Chinese Representative Office.)

**Key Words:** *Weapons Production Planning, Multistage Stochastic Programming, Differential Evolution, Variable Clustering*

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Pages 539-550

## INTER-ORGANIZATIONAL COOPERATIVE INNOVATION OF PROJECT-BASED SUPPLY CHAINS UNDER CONSIDERATION OF MONITORING SIGNALS

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**Abstract**
Assuming project-based organizations cooperate equally, this paper used principal-agent theory and game theory, to empower the general contractor to give reward and punishment to the professional sub-contractor based on a monitoring signal and constructed a model of inter-organizational cooperative innovation of project-based supply based on a monitoring signal. Based on the model, by data simulation and example analysis, as well as comparison with a traditional model, we came to the conclusion that the general contractor, through a monitoring signal, is able to collect more information on the professional sub-contractor's knowledge sharing and concealing level. Thus by adjusting the reward and punishment level, it can not only lower the professional sub-contractor's knowledge concealing level, but can also raise the knowledge sharing level, all of which will reduce the professional sub-contractor's opportunism and the blindness the general contractor may be alleviated in the design motivation mechanism. 17 refs.
(Received, processed and accepted by the Chinese Representative Office.)

**Key Words:** *Project-Based Supply Chain, Cooperative Innovation, Monitoring Signal*

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Pages 551-562

## MODELLING RISK COORDINATION OF SUPPLY CHAINS WITH PUT OPTION CONTRACTS AND SELECTIVE RETURN POLICIES

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**Abstract**
To study risk coordination of supply chains, a two-echelon supply chain with one risk-neutral supplier and one risk-averse retailer is constructed, in which the retailer behaves with waste aversion. The retailer's conservative attitude to order results in poor performance of the supplier and the whole supply chain. A new contract which combines put options and selective return policies is developed. The retailer buys option contracts when he places an order, then decides to exercise part or all of them after the sales season so that he can choose the return quantity selectively. The exercise price is equivalent to the wholesale price of merchandise. The result demonstrates that this contract can coordinate the supply chain well and be carried out normally despite the retailer's risk preference being private because the supplier's pricing policy is independent of retailer's risk aversion. The numerical analysis shows that the retailer's expected utility outperforms that of the expected utility under the classical buyback contract. 25 refs.
(Received, processed and accepted by the Chinese Representative Office.)

**Key Words:** *Risk-Averse, Put Option, Selective Buyback Contract, Supply Chain Coordination*

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