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IMPROVING PROCESS OF QUOTATION CREATION THROUGH VALUE STREAM MAPPING AND SIMULATION

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Abstract
Nowadays many companies are applying the lean philosophy and value stream mapping (VSM) tool to eliminate and reduce losses and show possible places for further implementation of the lean concept. Since the system change takes place as a consequence, it is very useful to confirm the future system design performance before the actual implementation. This paper presents an application of VSM and computer simulation in a company for manufacturing and distribution of heating, cooling and neutral equipment for catering and trade industry. To improve the quotation creation process, the product configuration system is introduced. The performance of the new system design was confirmed using the discrete event simulation. Simulation results show several performance improvements. Conducted simulation experiments emphasize the better performance of new system design in terms of the accepted quotations, resource utilization, delivery time, work in process, non-value-added time and number of required operators. 30 refs.
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Key Words: *Value Stream Mapping (VSM), Lean Concept, Product Configuration System, Process Improvement, Simulation*

Pages 574-585

COMPARISON OF DIFFERENT CLUSTERING ALGORITHMS VIA GENETIC ALGORITHM FOR VRPTW

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Abstract
In this paper, Vehicle Routing Problem with Time Windows (VRPTW) with known customer demands, a central depot and a set of vehicles with limited capacity, is considered. The objectives are both to minimize the total distance and the total waiting time of the vehicles while capacity and time windows constraints are secured. The applied solution techniques consist of three steps: clustering, routing and optimizing. By using K-means, Centroid-based heuristic, DBSCAN and SNN clustering algorithms in the initial population generation phase of genetic algorithm, the customers are divided into feasible clusters. Then feasible routes are constructed for each cluster. Lastly, the feasible route solutions are taken as the initial population and genetic algorithm is utilized for the optimization. A set of well-known benchmark data is used to compare the obtained results. According to the results of the study it is observed that using K-means clustering algorithm in generating the initial population of the genetic algorithm is more effective for the handled problem. 22 refs.
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Key Words: *Vehicle Routing with Time Windows, Genetic Algorithm, Clustering, Multi-Objective Optimization, K-means Clustering Algorithm*

Pages 586-595

DESIGN AND FINITE ELEMENT ANALYSIS OF NOVEL TWO-STAGE MAGNETIC PRECESSION GEAR

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Abstract
The paper presents a comparison of known magnetic gear constructions in terms of torque density and range of gear ratio. The theoretical bases, concept and the principle of operation of novel two-stage magnetic precession gear have been provided. The advantage of proposed gear is ability to obtain greater transmission ratios than currently known magnetic gears. Moreover, geometrical and kinematical relations between particular components of proposed gear were determined and the analyses of optimal gear ratio, which depends on the number of permanent magnets on the particular gear wheels, have been performed. For detailed analysis of the proposed gear performance the complex 3D FEM model of the precession transmission was created. Research was focused on determining distribution of magnetic flux density in air gaps as well as calculation of the torque waveforms acting on the output and input shafts as a function of the input shaft rotation angle. Selected results of the simulations showing proper operation of the proposed precession transmission system were presented and discussed. 20 refs.
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Key Words: *Magnetic Gear, Magnetic Flux, Transmitted Torque Analysis, Precession Gear*

Pages 596-607

SHIPS SHORE SERVICE OPTIMIZATION USING THE QUEUEING THEORY

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Abstract
This paper is presenting a solution for simplifying shore maintenance service teams scheduling procedure in the maritime industry. Shore maintenance service teams scheduling procedure in the past required either advanced mathematical knowledge in the area of the queueing theory or adequate computerized software for the calculation. That action in the past was usually outsourced; companies did not have personnel capable of solving the queueing theory nor the software needed for the calculation. The solution, presented in the paper, enables in-house scheduling of the shore maintenance service teams using only basic knowledge of the theory, without the use of the specially designed software. The scheduling is performed using a simplified Excel template for Queueing theory, inserting the data from ship's Computerized Planned Maintenance System. The Excel template, after filling the data, determines the optimal number of teams for the fleet and performs the calculation according to the desired or optimal service level. Simplified Excel template for Queueing theory cut the costs for the calculation and scheduling enabling additional savings in the industry. 23 refs.
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Key Words: *Queueing Process, Arrival Rate, Service Time, Service Team, System Utilization, Maintenance, Costs*

Pages 608-619

COOPERATION OF SIMULATION AND DATA MODEL FOR PERFORMANCE ANALYSIS OF COMPLEX SYSTEMS

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Abstract
Modelling and simulation (M&S) is one of the fundamental methods of performance analysis. In other words, how well a modeller builds a model is a key point of a successful performance analysis. Before such a performance analysis, a model for prediction should be constructed. There are two types of models: data model and simulation model. Data model represents correlational relationships between one set of data and another. Conversely, simulation model represents causal relationships between a set of controlled inputs and corresponding outputs. This paper identifies the characteristics of each modelling method and presents a cooperative model development process for performance analysis of complex systems. The cooperative method contains conceptual modelling, model classification, and model integration/implementation. The model classification method effectively reflects and maximizes the features compared earlier. Then, they are modelled respectively and integrated. This paper also applies the proposed modelling to develop a model of Hadoop using artificial neural network (ANN) and discrete event systems specification (DEVS). To demonstrate the validity of the case study, it presents experiments to show the possibility of a proposed approach. 32 refs.
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Key Words: *Cooperative Model Development, Data Modelling, Simulation Modelling, Artificial Neural Network, Discrete Event Systems Specification (DEVS), Hadoop*

Pages 620-631

SIMULATION METHOD FOR DROPPER DYNAMIC LOAD CONSIDERING HORIZONTAL VIBRATION BEHAVIOUR

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Abstract
Dropper is the key component of catenary in high-speed railways. The prediction of the fatigue life of dropper is accomplished using alternating load characteristics. Simulation method for obtaining the dynamic internal load of the dropper in previous studies was insufficient for accurate requirements in predicting dropper life. According to realistic working conditions in the simulation environment, this study proposed a simulation method considering horizontal vibration behaviour for the dropper. The horizontal vibration phenomenon of a dropper was determined on the basis of observing and measuring a real high-speed railway. Moreover, a test for the reappearance of horizontal vibration in the laboratory was performed. The dropper was modelled with multibody dynamics. Finally, the horizontal vibration behaviour of the dropper on-site was reproduced in a laboratory test and computer simulation. Results demonstrated that the coefficient of association between the virtual sensor load in a simulation environment and the real sensor load in a laboratory test is 0.9578. The proposed method provides an accurate approach to simulating the load of the droppers under real working conditions. 26 refs.
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Key Words: *High-Speed Railway, Catenary, Dropper, Horizontal Vibration, Simulation Model*

Pages 632-642

MULTI-CRITERIA OPTIMIZATION OF TURNING OF MARTENSITIC STAINLESS STEEL FOR SUSTAINABILITY

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Abstract
A modern production strategy faces the increasing challenges of practicing green production without sacrificing machining performance. Thus, this paper compares emulsion cooling, minimum quantity lubrication without and with a Ranque-Hilsch vortex tube when turning martensitic stainless steel X20Cr13. Experimental tests were organized corresponding to Taguchi orthogonal array $L_{27}(3^4)$. The Taguchi based entropy weighted grey relational analysis was exploited to acquire the optimum combination of cutting speed, feed, depth of cut and cooling method that concurrently minimize surface roughness and tool life while maximizing material removal rate. The combination of minimum quantity lubrication with Ranque-Hilsch vortex tube confirmed to be the best cooling method. Hence, the use of classic metalworking fluids when turning martensitic stainless steels can be excluded, which is important for reducing environmental pollution and hence for machining sustainability. 34 refs.
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Key Words: *Turning, Martensitic Stainless Steel, Sustainability, Multi-Criteria Optimization, Entropy Weighted Grey Relational Analysis, Taguchi Method*

Pages 643-653

SIMULATION STUDY ON THE FORMATION OF PLGA MICRO-STRUCTURE USING HOT-PRESSING METHOD

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Abstract
A novel controlled drug delivery system was proposed, which contains a micro-structure for drug loading fabricated by using Poly(lactic-co-glycolic acid) (PLGA) via the hot-pressing method. The integrity of the PLGA micro-structure is the basis of the drug release control, but the visco-elastic property of PLGA causes the incomplete formation in the hot-pressing process. To obtain the improved hot-pressing parameters, the hot-pressing model of PLGA materials was established by using a 5-unit generalized Maxwell model. The influence of different hot-pressing parameters on the forming quality was studied. Simulation results show that the PLGA micro-structure was completely formed at the temperature of 75 °C, 1 mm base thickness, 30 N pressure, and 150 s maintenance time. The simulation results were validated by the hot-pressing fabrication. This study could lead theoretical basis for the preparation of visco-elastic polymer micro-structure by using the hot-pressing method and lay a foundation for the further optimization of hot-pressing process parameters. 24 refs.
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Key Words: *Visco-Elastic Property, PLGA Micro-Structure, Hot-Pressing Method, Process Parameters*

Pages 654-665

AN AGENT-BASED SIMULATION APPROACH TO MODEL HOSPITAL LOGISTICS

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Abstract
The increasing rate of hospital admissions has resulted in a commensurate increase in the number of treatments and surgeries performed, as well as resource and material usage, and requires planners to improve hospitals' internal logistics. Logistics modelling of internal goods and corresponding material handling systems and simulating future scenarios can provide planners with necessary decision support. Introducing an agent-based simulation model using historical data generated by an automated guided vehicle (AGV) in a case hospital facilitates analysing the goods delivery system's current status and potential countermeasures to improve internal logistics. In comparison with other industries, such as manufacturing, AGVs utilised in hospitals have to interact with persons, patients and elevators, transport several different types of goods and cover a sizeable multi-floor area. By including these factors, the simulation model represents an appropriate method to test different scenarios and improve delivery performance and AGV utilisation. The study highlights the constraints related to operating AGVs in dynamic environments, such as those encountered in hospitals. 33 refs.
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Key Words: *Logistics, Hospital Logistics, Automated Guided Vehicle, Agent-Based Simulation, Performance Analysis*

Pages 666-677

JOINT PROGRAMMING OF PRODUCTION-MAINTENANCE TASKS: A SIMULATED ANNEALING-BASED METHOD

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Abstract
Integrated production-maintenance programs are an attractive area given their practical benefits and complexity. This has motivated the development of approximate methods providing good solutions in a reasonable time. This paper introduces a heuristic method for the joint programming of production-preventive maintenance tasks in an environment of identical parallel machines minimizing the makespan. Unlike other proposals, this assumes the time between interventions is unknown, and that the start time of these constitutes a decision variable. It also considers that not all jobs may be available to begin processing at the beginning of periods. The heuristic possesses two phases; the first generates an initial solution based on the LPT dispatch rule with a slight modification allowing it to consider the randomness of equipment failures and their impact on the task's execution time. A dispatch rule called rj-LPT is proposed complying with one of the heuristics' steps. The second phase is based on the Simulated Annealing approach that helps refining the initial solution found. 21 refs.
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Key Words: *Production and Maintenance Programming, Preventive Maintenance, Heuristic Method, Longest Processing Time Rule (LPT), Pseudo-Code, Simulated Annealing*

Pages 678-688

AN INTELLIGENT OPTIMIZATION ALGORITHM FOR BLOCKING FLOW-SHOP SCHEDULING BASED ON DIFFERENTIAL EVOLUTION

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Abstract
Owing to its large scale, the blocking flow-shop scheduling problem (BFSP) cannot be solved effectively by traditional optimization methods. To solve the problem, this paper develops a novel intelligent optimization algorithm based on differential evolution (DE) for the BFSP with a single objective: minimizing the total flow time (TFT). On the one hand, a new heuristic method was introduced to balance the quality and diversity of the initial population. On the other hand, a new operator was adopted to update the acceleration, velocity and position of each particle. In this way, the population will not converge prematurely to local optimums, and the local and global search abilities are perfectly balanced. Simulation on standard test set proves that our algorithm outperformed most commonly used methods in solving the BFSP. 31 refs.
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Key Words: *Blocking Flow-Shop Scheduling Problem (BFSP), Differential Evolution (DE), Intelligent Optimization Algorithm, Gravitational Search Algorithm (GSA)*

Pages 689-698

BATCH OPTIMIZATION IN INTEGRATED SCHEDULING OF MACHINING AND ASSEMBLY

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Abstract
To survive the fierce market competition, many manufacturing enterprises have applied integration measures at all levels of the production process. Against this backdrop, this paper mainly establishes a job-shop scheduling problem (JSP) that aims to minimize the makespan of products through integrated scheduling of machining and assembly under batch production environment. Then, the established problem was modelled considering the influence of different batch number on the makespan. In view of the complexity and discreteness of the established problem, a genetic algorithm (GA) was designed to obtain the optimal scheduling sequence in different batch production situations. The effectiveness of our problem model and algorithm was verified through the analysis on an example with different batch conditions. The research findings help to design a realistic and feasible scheduling plan for manufacturing enterprises. 18 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *Integration of Machining and Assembling, Equal-Batch Splitting, Genetic Algorithm (GA), Batch Production*

Pages 699-707

A NOVEL JOB-SHOP SCHEDULING STRATEGY BASED ON PARTICLE SWARM OPTIMIZATION AND NEURAL NETWORK

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Abstract
This paper innovatively introduces particle swarm optimization (PSO) and neural network (NN) to solve the job-shop scheduling problem (JSP). Each particle in the swarm was treated as a connection in the NN. Then, the connection weight was iteratively updated according to the latest position of the corresponding particle. In this way, the NN no longer falls into the local optimum trap. Then, the PSO-optimized NN was applied to solve the JSP with a single objective: minimizing the maximum makespan. Through experiments on benchmark problems, it is confirmed that the proposed strategy outperforms the other scheduling methods in fulfilling the optimization objective. 20 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *Job-Shop Scheduling Problem (JSP), Particle Swarm Optimization (PSO), Neural Network (NN), Maximum Makespan*

Pages 708-719

SPLIT-DELIVERY VEHICLE ROUTING PROBLEMS BASED ON A MULTI-RESTART IMPROVED SWEEP APPROACH

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Abstract
The vehicle routing problem (VRP) with split delivery is an important branch of the classic VRP. The objective is to reduce the transportation distance and number of vehicles used. This study proposes a two-stage algorithm based on an improved sweep heuristic approach to solve this problem. We cluster customer points into a minimum number of groups through a multi-restart-iteration sweeping algorithm (MRISA). The load demands and split point in each group are fine-adjusted using the load rate and threshold coefficient. To reduce the travel distance in each group, an optimal route is produced by a tabu search algorithm (TSA). The computational simulation results demonstrate that the proposed method in this study is feasible and efficient, and the near-optimal performance of the proposed method is achieved regarding the transportation distance and computation time to the instances with a scattered distribution geographical characteristic; however, the strategy of "the maximum-minimum distance clustering first, and MRISA + TSA executing later" is much more useful for instances with a clustered-distribution geographical characteristic. 26 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *Fine-Tuning, Multi-Restart Improved Sweep Algorithm, Tabu Search, VRP*

Pages 720-731

NOISE PREDICTION OF TRACTION GEAR IN HIGH-SPEED ELECTRIC MULTIPLE UNIT

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Abstract
The dynamic characteristics of traction gear transmission system have great influence on the safety, comfort and reliability of EMU. Base on acoustic-structural coupled theory, the noise radiation characteristics of gear transmission system in high-speed train CRH380A are researched by finite element-boundary element method. Based on the multi-body dynamics theory, the dynamic meshing characteristics of the gear transmission system are revealed by RecurDyn. The natural frequency and the natural mode of vibrating are analysed for system by finite element method, and the vibration response curves of transmission gears under continuous working conditions are solved by modal superposition method. Furthermore, the radiated noise is predicted based on the acoustic radiation analysis model constructed by the acoustic BEM and Helmholtz boundary integral equation. The research results can provide theoretical basis for the optimization design of the low noise gear in EMU. 19 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *Traction Gear of EMU, Dynamic Characteristics, Acoustic BEM, Noise Prediction*