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DESIGNING A LAYOUT USING SCHMIGALLA METHOD COMBINED WITH SOFTWARE TOOL VISTABLE

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Abstract
In this paper, a design of optimal facility layout, for already existing factory, using a Schmigalla method combined with software tool visTABLE for layout modelling and optimization is presented. It is called static facility layout planning. Schmigalla method belongs to heuristic type of methods. These method types should be combined with some other methods or tools. Combination of this method in conceptual phase and software visTABLE for layout modelling and optimization in optimization phase is presented. For real-world industrial application, this particular combination is obtaining significant improvement results. Layout designing was realized on a real production process example with 15 different products. In the first part of the paper, a production process with all the data is presented. After that, in the second part, a theoretical and mathematical model of Schmigalla method as a base for layout modelling was used. Then, in the third part, Schmigalla method layout transformation was practically (virtually) realized with software visTABLE. In the fourth part, after layout realization of a virtual layout model, software visTABLE was additionally used (manually and automatically) for finding an optimal layout solution. 21 refs.
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Key Words: *Facility Layout Problems, Schmigalla Method, visTABLE, Layout Optimization*

Pages 386-398

CFD SIMULATION OF OBSTRUCTED VENTILATION PORTS IN A SUBWAY TUNNEL SECTION

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Abstract
A CFD simulation of the air velocity in a subway tunnel section of 1400 m in length is presented. In this case of study; the simulation compares the air velocity changes when two of six natural ventilation ports are totally obstructed. They are required for hot air exhaust, smoke release and fresh air intake. The mechanical ventilation system is located inside the tunnel at 650 m from the end of a passenger platform and 750 m from the other, it is a non-symmetrical scenario. The simulation was carried in ANSYS® Fluent compared with NFPA calculation and considering geometries and dimensions of an actual subway section of the Mexico City. Four different numerical models were created to analyse eight different cases. The results indicate that the obstruction of the ports create a non-homogeneous distribution of the flow velocity inside the passenger platform with an approximate difference of 1.5 m/s. This value is very important in cases when the backlayering effect has to be avoided as in the case of smoke transportation, exhaust of smoke and the transport of dust or some other contaminant. The emergency procedures and the design of escape routes can be improved by considering the physical changes occurring when the ventilation ports are obstructed. Since the atmospheric pressure influence the direction and velocity of the flow coming from the non-obstructed vents. 29 refs.
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Key Words: *Obstructed Ports, Fan Deflector, Critical Velocity, Subway, CFD*

Pages 399-411

A SIMULATION APPROACH TO ASSESS PARTNERS SELECTED FOR A COLLABORATIVE NETWORK

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Abstract
Manufacturing enterprises are increasingly more aware of the importance of establishing collaborative relationships with their network partners, due to the advantages associated to collaboration. Nevertheless, the participation in a collaborative network (CN) comes with associated challenges, namely the need to reduce the potential for conflicts among partners. A CN consists of heterogeneous partners, each one defining its own objectives and activating its own strategies. In this context, the ability to quickly identify partners with aligned strategies is crucial for smooth operation of the CN. The main aim of this paper is to address the partners' selection problem in the context of Virtual organizations Breeding Environments (VBE) that facilitate and enable the creation of Virtual Organisations (VO), as one type of CN. In a first stage, the sets of enterprises, characterised by having the required competencies to create the VO, are identified among different potential candidates within the VBE. In a second stage, the strategies alignment approach, based on the system dynamics simulation method, is used for the partners' selection process, identifying the best set of enterprises. In this paper, the final stage of partners' selection process is addressed by obtaining the degree of alignment of the business strategies formulated by each set of enterprises. In the light of this, a system dynamics-simulation model, in AnyLogic, is presented to obtain the set of enterprises that have higher levels of alignment in its strategies. The proposed system dynamics-simulation model is applied to a case in the building industry, to deal with the partners' selection problem in a VBE with the aim of forming a stable and sustainable VO. 30 refs.
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Key Words: *Collaborative Networks, System Dynamics, Partners' Selection, Strategies Alignment, Values Alignment, Trust*

Pages 412-421

DEVELOPING COMPETENCIES WITH THE GENERAL MANAGEMENT II BUSINESS SIMULATION GAME

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Abstract
The paper describes a solution to the need to find adequate ways of developing management-related competencies for students and trainees, which we consider a relevant pursuit for both literature and education practitioners knowledge. It is based on the case study method, describing the experience of the authors with the TOPSIM General Management II (GM2) business simulation game and the outcome regarding the development of competencies for participating students from two master programs from the Faculty of Engineering in Foreign Languages in Bucharest/Romania in the last 8 years, exploring the development of 21 management-related competencies. The chosen competencies and individual characteristics are: analytic thinking, strategic thinking, team work, defining goals, opportunity recognition, problem recognition, problem solving, decision making, proactive thinking, time management, communication, intuitive thinking, responsibility, argumentation, creativity, delegation, diplomacy, conflict management, flexibility, courage and self esteem. By showing the positive impact of students' GM2 participation in the development of management-related competencies from both professors and students point of view the paper adds a valuable best practice insight that can be used in universities and companies at an international level. 16 refs.
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Key Words: *Business Simulation Games, Competence Development, Games Based Learning*

Pages 422-434

APPLICATION OF EXTENDSIM FOR IMPROVEMENT OF PRODUCTION LOGISTICS' EFFICIENCY

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Abstract
The article deals with the use of computer simulation approach in order to streamline production logistics within a specific production company. The computer simulation from its very beginnings has undergone a long and significant evolution. The current possibilities of computer simulation approach enable to mimic the real processes of production logistic activities as well as of the actual production. This article is focused on the question, how to effectively utilise the available tools of computer simulation approach to analyse and streamline a particular simulation system. Therefore also the presented solution is the actual description of a practical application of a computer simulation approach used for the needs of one specific production company within one specific industry area. The intention is to showcase the practical aspects of simulation modelling, in this case utilising the EXTENDSIM simulation system. The simulation approach will be used for the needs of a production company, that produces car components and accessories made of wood for the automotive industry. 19 refs.
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Key Words: *Computer Simulation, Production Logistics, Production System, Processes, EXTENDSIM*

Pages 435-447

SIMULATION OF TANK TRUCK LOADING OPERATIONS IN A FUEL DISTRIBUTION TERMINAL

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Abstract
Tank truck loading operations in fuel distribution terminals have particular characteristics which are challenging to simulate. Demands for different fuel types are correlated rather than independent. In addition, queuing policies which do not address the current state of the terminal may increase equipment idleness and trucks' lead time. We propose a decomposition of the joint probability distribution of fuel types and a procedure to simulate it. We also propose a new queuing policy aimed at reducing equipment idleness and trucks' lead time. The procedures are tested and validated through a discrete-event simulation model of a real fuel distribution terminal. We simulate alternative scenarios in which we increase fuel flow rate as well as the number of loading arms and test a new queuing policy. Results show the effectiveness of the simulation procedure in replicating real performance indicators. Moreover, the proposed idleness-based queuing policy resulted in lower idleness and lead time compared with a first-come-first-served policy. 27 refs.
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Key Words: *Tank Truck, Fuel Loading Operations, Scheduling, Queuing Policy, Discrete-Event Simulation*

Pages 448-457

DYNAMIC BEHAVIOUR OF DIFFERENT HYDRAULIC DRIVE CONCEPTS – COMPARISON AND LIMITS

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Abstract
Improvement in regard to machine energy efficiency is one of the more important goals throughout all fields of research. This is especially true for hydraulically driven machines with large installed power. The use of the appropriate drive concepts, along with a suitable control concept, can result in quite substantial energy savings. Equipping a hydraulic machine with a speed-variable drive and a variable displacement pump enables maximum efficiency tracking for all operating points, represents the most promising drive concept in regard to energy savings. For each operating point, there is an optimal pump setting; consequently, the hydraulic system is able to ensure hydraulic power with minimum losses if the drive components are selected thoughtfully and the system controlled properly. However, in the desire to maximise the system efficiency, the system's responsiveness is too often overlooked.

The paper summarises the principle of different drive concepts, along with the drive controller, in terms of the dynamic response and the drive efficiency. Although the speed-variable drive concepts are the most efficient, they have some disadvantages, which are also presented. 21 refs.
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Key Words: *Hydraulic, Power Unit, Drive Concepts, Control Strategies, Simulation, Dynamic*

Pages 458-470

MULTI-BODY DYNAMICS AND VIBRATION ANALYSIS OF CHAIN ASSEMBLY IN ARMOURED FACE CONVEYOR

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Abstract
For armoured face conveyors (AFC) in coal mines, fracture and jam phenomena of the chain are common failure patterns in the chain assembly. These failure patterns are caused by chain's severe vibrations from uneven loads on the conveyor. However, due to limitations of harsh operating environment in coal mines, performing underground experiments is difficult to obtain real vibration signals. Multi-body dynamic simulation is an efficient approach to analyse the complex dynamic behaviour of chain assembly in the AFC. In order to determine the actual dynamic properties of chain assembly in the AFC under different operating conditions, multi-body simulation was used to analyse the vibration properties of the chain assembly. In this study, theoretical analysis of contact force between horizontal and vertical rings, and between sprocket wheel and rings in the chain assembly was initially performed. Rigid and rigid-flexible coupling models of the chain assembly were then established. Dynamic simulations through two types of models, that is, rigid and rigid-flexible coupling models were conducted under full-, half- and empty load conditions using the ADAMS software. Trends of contact force, stress, and velocity of horizontal and vertical rings under various working conditions were obtained, and vibration properties of the chain assembly were analysed based on the corresponding curves. Results indicate that the maximum velocity is 1.75 m/s in the rigid simulation, whereas the maximum velocity is 3.0 m/s in the rigid-flexible coupling simulation. The rigid-flexible coupling method is proven to be more accurate and feasible in describing the dynamic properties of the chain assembly than the rigid method. The proposed method should be preferentially utilized in performing multi-body dynamic simulation of the chain assembly in the AFC. This study provides references for the structural optimization and design of the chain assembly in mining AFC. 20 refs.
(Received in January 2017, accepted in May 2017. This paper was with the authors 2 months for 1 revision.)

Key Words: *Vibration Properties, Multi-Body Dynamics, Chain Assembly, Armoured Face Conveyor*

Pages 471-483

COLLABORATIVE SUPPLY MODEL AND CASE SIMULATION IN A TWO-LEVEL ASSEMBLE-TO-ORDER SYSTEM IN THE CONTEXT OF GLOBAL PURCHASING

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Abstract
The lack of collaboration between overseas and local suppliers in global purchasing is a major challenge in assemble-to-order (ATO) supply chain management. This study established a collaborative supply chain model with a single manufacturer and multiple suppliers to explore the collaborative supply strategy in a time–price-sensitive ATO system. The method adopted the cost–benefit analysis with time constraints. The profit functions of the manufacturer and local suppliers were given in decentralized decision mode, and the Nash equilibrium solution of supply chain decision was obtained. The strategy combination of collaborative supply was then determined. Herman Miller (Ningbo), Inc. was taken as an example, and a numerical simulation was discussed to illustrate the proposed approach. Different scenarios of the delivery time of overseas suppliers and the time sensitivity coefficient of customers were considered. Results confirm that supply collaboration has a significant impact on the ATO supply chain performance in global purchasing. The collaborative supply strategy combination determined by model optimization can improve the expected profits of the manufacturer and local suppliers. The conclusion of this study can provide a theoretical basis and a decision-making reference for supply chain enterprises to develop effective global purchasing strategies in time–price-sensitive markets. 19 refs.
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Key Words: *Assemble-to-Order (ATO), Global Purchasing, Collaborative Supply, Case Simulation*

Pages 484-496

REDUCING THE TIME OF TASK EXECUTION WITH EXISTING RESOURCES – COMPARISON OF APPROACHES

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Abstract
Today, success represents sustainability in introducing new standards and orientation toward the customer, to the quality and price of products, to flexibility, agility and promptness, to economising in resources and protection of the environment. This is not easy to achieve, especially in an environment, where it is natural desire to keep resources busy, in particular the critical resources. This usually results in unfavourable outcomes, usually experiencing significant degradation in performance of company and a lot of firefighting inside the company.

This paper outlines three approaches for manufacturing scheduling, starting with traditional push approach (MRP) and continuing with Kanban (pull) and Theory of Constraints (pull/push), regarding performance and throughput improvement. It determines how resources should be scheduled within a system in order to enhance performance, provide stability and predictability of products. Simulations demonstrate that 200 % to 600 % of improvement is possible at inventory level (work in progress) and the same at lead time, based on the number of completed tasks over a given period of time. 22 refs.
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Key Words: *Scheduling, Kanban, Theory of Constraints, Comparison, Lead Time, WIP*

Pages 497-505

FLEXIBLE JOB-SHOP SCHEDULING PROBLEM BASED ON HYBRID ACO ALGORITHM

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Abstract
For an enterprise to survive the fierce market competition, efficient production scheduling is a must as it improves economic efficiency and reduces cost. As an important branch of production scheduling, the flexible job-shop scheduling problem (FJSP) is a mixed blessing. It accurately reflects the characteristics of the actual production, but adds to the difficulties in problem solving. With the ant colony algorithm as the basic optimization method, this paper proposes the hybrid ant colony algorithm based on the 3D disjunctive graph model by combining the elitist ant system, max-min ant system and the staged parameter control mechanism, optimizes the FJSP problem to minimize the longest completion time, the early/delay penalty cost, the average idle time of the machine, and the production cost, and verifies the effectiveness of the model and algorithm by an example. 22 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *Flexible Job-Shop Scheduling Problem (FJSP), Multi-Objective Optimization, Hybrid Ant Colony Algorithm*

Pages 506-516

A MULTI-OBJECTIVE SCHEDULING OPTIMIZATION MODEL CONSIDERING PRODUCT BLOCKAGE AND MACHINE FAULTS

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Abstract
Considering problems like product blockage and machine faults in the batch scheduling of product assembly lines, this paper proposes a multi-objective flow shop batch scheduling model taking these problems into account, and by comparing with the traditional flow shop scheduling model, it verifies the feasibility and superiority of this model. The results show that, regarding the product blockage problem, this paper improves the MWH heuristic algorithm, leading to better quality of the initial population produced; and that it also proposes a new ISBOX crossover operator algorithm, which is used in combination with the nondominated solution information to calculate the new solution for offsprings, improving the local search capability of the algorithm. In order to address machine faults, this paper obtains new solutions by optimizing the maximum completion time and the early completion time, takes the new solutions as the initial population, and uses the proposed model to optimize the robustness and stability of the existing algorithm. By comparing the proposed model and the traditional scheduling model in terms of product blockage and machine fault, this paper finds that the proposed algorithm has high local and global convergence, and generates high-quality nondominated solutions. According to the re-scheduling strategy, this algorithm can effectively reduce the effects of product blockage and machine faults on the objective function. 26 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *Flow Shop, Optimized Scheduling, Multi-Objective, Machine Fault, Blockage*

Pages 517-526

RESEARCH ON THE MULTI-OBJECTIVE OPTIMIZED SCHEDULING OF THE FLEXIBLE JOB-SHOP CONSIDERING MULTI-RESOURCE ALLOCATION

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Abstract
Targeting at the problems existing in the multi-objective scheduling of traditional flexible job shop and the complexity of multi-resource allocation, this paper establishes an improved calculation model considering the optimization of such four targets as completion time, labour distribution, equipment compliance and production cost. The multi-objective integrated constraint optimization algorithm is designed and the Pareto solution set following different rules based on the NSGA-Π algorithm is finally obtained. The research results show that the centralized selection of processing equipment and low efficiency of the job sequencing in the scheduling of traditional flexible job shop get improved. The personnel scheduling in the flexible working resources is highlighted, and multi-rule dynamic programming is introduced to get the optimal completion time and personnel allocation program. The optimal scheduling program can be quickly searched out using the NSGA-Π algorithm, which effectively improves the search efficiency. The batch production within certain range can reduce the product processing time, but at the same time, it will increase the manufacturing costs. The use of smooth movement can reduce the overall processing time, but a too small movement volume will cause the increase in the number of movements. The exact match between the operators, numerical control equipment and the product processing procedures contributes to the feasibility of the pre-production operation plan. 21 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *Flexible Job Shop, Scheduling, Multi-Objective Optimization, Improved NSGA-Π Algorithm, Multi-Resource*

Pages 527-540

EFFICIENT SMOOTHNESS-PRESERVING FUSION MODELLING METHOD FOR MESH MODELS

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Abstract
The essential process of preserving the smoothness of stitched meshes in mesh model fusion is challenging. This paper proposes an efficient mesh model fusion method to preserve the smoothness of the stitched surface along two stitching meshes. We first cut parts of the stitched meshes from source mesh models and then extract their boundary contours. Subsequently, the boundary contours are aligned manually and projected onto parallel planes for contour vertex triangulation. Triangular meshes obtained from the stitched meshes by loop subdivision are interpolated using a compactly supported radial basis function to smooth the stitched surfaces. The experimental results on public graph models demonstrate the effectiveness and efficiency of our method in mesh model fusion and smoothness. 25 refs.
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Key Words: *Modelling, Mesh Fusion, Mesh Smoothing, Triangulation, Interpolation*

Pages 541-554

FINDING KEY FACTORS AFFECTING THE LOCATIONS OF ELECTRIC VEHICLE CHARGING STATIONS: A SIMULATION AND ANOVA APPROACH

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Abstract
In this study, we aim to find the key factors affecting the location of electric vehicle charging stations. We first developed a Non-deterministic Polynomial (NP) model that aims to minimize the total travel distance of cars. Second, we applied an agent-based simulation algorithm to determine the optimized location for charging stations. Finally, we conducted multi-simulation and statistical analysis of passenger priority, car mileage, electric vehicle distribution and passenger distribution using a one-way analysis of variance (ANOVA). The results of this study show that priority is not a factor affecting the location of electric vehicle (EV) charging stations and that mileage, the EV distribution and the passenger distribution are factors affecting the location of EV charging stations, with exogenous variables such as the type of circuit and the voltage drawn as constants. The proposed model can help provide a reference for the location of charging stations in urban areas. 20 refs.
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Key Words: *Electric Vehicle, Location, Key Factors, Simulation, ANOVA*