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SYSTEM DYNAMICS SIMULATION MODEL FOR URBAN TRANSPORTATION PLANNING: A CASE STUDY

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Abstract
This paper aims to develop an urban transportation planning through the use of system dynamics simulation model. This planning includes congestion mitigation through demand and capacity management, the improvement of public transport sector, and the urban mobility improvement. System dynamics simulation model was used to test and evaluate some alternative policies for urban transportation planning. Simulation results show that mobility depends on travel time, the fulfilment ratio of public transport supply and demand, the effectiveness of public transport transfer distance and transfer time, as well as the access time. Traffic congestion is influenced by the internal factor and external events. This study was conducted at Surabaya, East Java, Indonesia, which is the fourth most congested city in the world. The original scientific contributions of this research include model formulation and development of the daily traffic, urban mobility, and congestion; predictive analysis of the future daily traffic; scenarios development to increase mobility and reduce congestion by considering the internal and external factors. 35 refs.
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Key Words: *Model, System Dynamics, Urban Transportation Planning, Mobility, Congestion*

Pages 17-28

STRUCTURAL ANALYSIS ON IMPACT-MECHANICAL PROPERTIES OF ULTRA-HIGH HYDRAULIC SUPPORT

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Abstract
With the increase of the mining height, the operational condition of the hydraulic support is getting worse. Since the column and the balance jack are both regarded as rigid structural parts or springs with constant stiffness, this simplification cannot reflect the characteristics of each stage of the working process. To improve the analysis accuracy, a rigidity-variable impact dynamic simulation platform for hydraulic support with ultra-large mining height based on rigidity-flexibility coupling is constructed in this study. Firstly, stress states of hinge joints of the support when parallel surface loads, raising surface loads and down surface loads act on the upper beam were simulated, and critical loads of different hinge joints were recognized. Secondly, dangerous impact positions of support corresponding to different hinge joints were found. Finally, the overall influences of impact loads on stress state of the hydraulic support were summarized. Results show that under 6000 kN impact load, the maximum force variation coefficient at the hinge point of the shield beam of the support roof is 10.5, and it's the most dangerous hinged position. This study has certain guiding significance for the optimization of the support structure. 21 refs.
(Received in August 2019, accepted in January 2020. This paper was with the authors 2 months for 1 revision.)

Key Words: *Hydraulic Support, Mechanical Properties, Impact Load, Support Stability*

Pages 29-40

MODELLING OF STEEL-CONCRETE BRIDGES SUBJECTED TO A MOVING HIGH-SPEED TRAIN

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Abstract
In the present study, a method for modelling and simulating the transient vibrations of a system comprising a steel-concrete bridge, ballasted track and moving high-speed train is proposed. The proposed approach uses advanced LS-DYNA simulation software based on finite element (FE) analysis and is applied to a series of single-span simply supported steel-concrete bridges. The theoretical span lengths of the bridges are 15, 18, 21, 24 and 27 metres. The bridge–track–train system is assumed to be fully symmetric. The reinforced concrete platform is homogenized based on the quasi-uniform distribution of the rebars in the specified sections. The bridge FE model does not include transverse bracing between the steel main beams, and the track rail-line axes are rectilinear. The ICE-3 high-speed multiple-unit train is considered at service velocities ranging between 200 and 300 km/h. FE analysis reveals deflection of the bridge at mid span. The results are plotted as a function of train velocity, thus permitting an assessment of the dynamic response of the bridge for each span length. 34 refs.
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Key Words: *Railway Vehicle, Vehicle Track Interaction, Railway Track, Train Passing, Simulation*

Pages 41-52

INVESTIGATION OF CONTACT STRESSES IN THE ECCENTRIC ROLLING TRANSMISSION

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Abstract
The aim of the article is to present an analytical and a simulation model for the determination of the contact stresses in the eccentric rolling transmission. The stresses within the contact area of the eccentric unit and the cam wheel were analysed in accordance with the Hertz theory. 2D and 3D models for the finite element method (FEM) analysis were developed and the simulation results were compared with those of theoretical analyses. The influence of the eccentricity value and the dimensions of the bearing in the eccentric unit on the maximum and average values of contact stresses were investigated. The conducted research showed that, due to the contact stresses, it is advantageous to choose the bearing with the largest possible width and smallest outside diameter, and to apply low eccentricity values. 27 refs.
(Received in August 2019, accepted in December 2019. This paper was with the authors 1 month for 2 revisions.)

Key Words: *Eccentric Rolling Transmission, Contact Stress, FEM Simulation*

Pages 53-64

DESIGN AND OPTIMIZATION OF 6-DOF PLATFORM TOP PLATE UNDER REALISTIC JOINT CONDITIONS

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Abstract
In this work, an FEA based methodology is proposed for the accurate prediction of stiffness properties of top plate of special application 6-DOF platform. The effect of joint contact conditions on the static stiffness and natural frequency of the top plate is analysed and compared with experimental results. Top plate is first designed using a simplified finite element model where the joint contact is considered to be rigid. The design failed to meet the actual operating conditions when tested experimentally. The design is revised using actual loading conditions and introducing realistic joint contact formulation. The results obtained are in close agreement with experimental data. Based on the developed methodology, a Multi-Objective Genetic Algorithm (MOGA) based optimization study has been carried out to reach an optimum design meeting the desired performance with a minimum possible weight. Both size and shape of the top plate has been optimized and weight reduction of 5.08 % has been achieved using the shape optimization. The performance parameters of final design of top plate differ by only 1.43 % for static stiffness and 0.44 % for modal response when compared with the experimental results. 25 refs.
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Key Words: *Boundary Conditions, Joint Contacts, Parallel Kinematic Manipulators, Top Plate Stiffness, Optimization*

Pages 65-76

SIMULATION STUDY OF A FLEXIBLE MANUFACTURING SYSTEM REGARDING SUSTAINABILITY

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Abstract
The presented manuscript deals with the impact of manufacturing flexibility on the sustainability justification of the manufacturing system, related to manufacturing sustainable social, environmental and financial impact. Such impact is not described in the research sphere. The complexity of the optimisation parameters is reflected in the multi-objective nature that can be evaluated with the use of the simulation study method. The manuscript presents a description of manufacturing flexibility modelling, with respect to the four-level architectural model, describing an optimisation problem of high-mix low-volume production. The impact of manufacturing flexibility on the sustainability justification is presented by the new block diagram. Sustainability parameters' mathematical modelling is presented with two main optimisation parameters of energy consumption and machine scrap percentage. The impact is evaluated and described by an appropriate multi-criteria optimisation method on a sustainably justified production system. 18 refs.
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Key Words: *Manufacturing Flexibility, Sustainable Manufacturing, Simulation Modelling, Simio, Flexible Job Shop Scheduling Problem, Evolutionary Computation*

Pages 77-88

SIMULATION AND EVALUATION OF PRODUCTION FACTORS IN MANUFACTURING OF FIREPLACES

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Abstract
The paper presents quantitative approach for management decisions of the manufacturing system for production of fireplaces, related to evaluation of key parameters – productivity and throughput, which most authors and methodologies consider to be substantial. Methodology was based on creating the simulation model of the fireplace production line in software Witness; optimizing the production capacity by selecting constraints, based on results from simulation model; evaluating the simulation experiments with the goal to increase productivity; setting production to maximize sales profits using Simplex method. Simulation model was built according to a technological process of fireplaces in a semi-automated production. Improvement in a production process within theory of constraints philosophy is complemented by mathematical modelling – Simplex method, that estimate profit maximization in case the company management decides to produce more product variants. 24 refs.
(Received in October 2019, accepted in February 2020. This paper was with the authors 2 months for 1 revision.)

Key Words: *Lean Production, Simulation Experiments, Capacity Optimization, Profit Maximization, Simplex Analysis*

Pages 89-99

OPTIMIZATION OF ORDER-PICKING SYSTEMS THROUGH TACTICAL AND OPERATIONAL DECISION MAKING

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Abstract
Order picking (OP) is a process that occurs in warehouses of unitized goods and it includes all activities that follow the retrieval of demanded goods, according to demanded type and quantity, with the intention of meeting customer demands, accurately and on time, with acceptable costs. As the OP process can contribute up to 50 % to the overall warehouse operational costs, design of the order picking system (OPS) needs special attention during the warehouse design process. In existing systems, the need for improvement is often caused by the change in demands. This paper analyses the possibilities of low-level picker-to-part OPS improvement through appropriate decision making on different design levels: tactical and operational. In this paper, a simulation-analytical model is developed to evaluate different OPS scenarios based on three storage assignment policies, four routing strategies and two different OP methods. Two layout variants and the evaluation of the required workforce are considered as well. The experiment results indicate that the application of the proposed model could lead to significant improvements regarding OPS performances and resource utilization. 35 refs.
(Received in October 2019, accepted in January 2020. This paper was with the authors 2 weeks for 1 revision.)

Key Words: *Warehouse Design, Order-Picking, System Approach, Simulation*

Pages 100-111

MODELLING THE INFLUENCE OF INLET ANGLE CHANGE ON THE PERFORMANCE OF SUBMERSIBLE WELL PUMPS

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Abstract
Three groups of schemes were designed for different blade inlet angles of impellers to improve the efficiency and single-stage head of submersible well pumps. Furthermore, the hydraulic performance of the pumps was analysed using ANSYS CFX. As a result, the heads and efficiencies of the schemes were acquired. The internal flow fields of the schemes under different flow quantities were analysed, and the accuracy of the optimal scheme was experimentally verified. Results indicated that enlarging the inlet angle of the blade of submersible well pumps might improve the hydraulic performance to a certain degree. In comparison with the general design scheme with a fixed inlet angle that with an inlet angle was 26° at the front cover plate and 20° at the rear cover plate, and that in the middle was under uniform change. The incoming flow angle of the medium coincided with the inlet angle; thus, the discharge capacity of the pump had a high matching ratio with the actual discharge capacity. The head and efficiency improved remarkably relative to the initial model, and thus, the hydraulic performance of the pump improved. 27 refs.
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Key Words: *Submersible Well Pumps, Inlet Angle, Hydraulic Design, Internal Flow Field*

Pages 112-122

INDIVIDUAL WORK PERFORMANCE MANAGEMENT MODEL

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Abstract
Turbulent business environment with constant changes and challenges is forcing organizations to take actions that will allow them to become more manoeuvrable and more flexible. Long-term and holistic approach to employee development is vital for achieving the performance of individuals and of the organization as a whole. This paper aims to explore the linkages between the individual constructs of the conceptual model on individual performance management of employees. The research was performed on the sample of Slovenian service sector companies. A nonlinear structural equation modelling analysis was conducted with the WarpPLS 5.0 based on the Warp2 algorithm. The results show that the use of comprehensive employee development methods significantly positively influences employees' satisfaction at work, individual performance, and psychic well-being. 31 refs.
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Key Words: *Individual Employee Performance Management, Nonlinear Connections, Service Sector, Structural Equation Modelling, WarpPLS 5.0*

Pages 123-133

A MULTI-OBJECTIVE FLEXIBLE JOB-SHOP SCHEDULING MODEL BASED ON FUZZY THEORY AND IMMUNE GENETIC ALGORITHM

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Abstract
This paper explores flexible job-shop scheduling problem (FJSP), using the rolling window rescheduling strategy. The fuzzy delivery time was considered, which satisfies the trapezoidal delivery window of the fuzzy membership function and directly bears on consumer satisfaction. Taking machine failure as the cause of dynamic interferences, the author established a dynamic scheduling model for the FJSP with fuzzy delivery time, according to the fuzzy mathematics theory. The model has multiple objectives: minimizing energy consumption, maximum makespan and consumer dissatisfaction. Next, the immune genetic algorithm (IGA) was improved to solve the model. The established model and the improved IGA were verified through simulations, in comparison with the genetic algorithm (GA). The research results shed new light on the FJSPs in real-world scenarios. 22 refs.
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Key Words: *Flexible Job-Shop Scheduling Problem (FJSP), Fuzzy Delivery Time, Immune Genetic Algorithm (IGA), Makespan*

Pages 134-145

DESIGN AND IMPLEMENTATION OF A MULTIPLE AGV SCHEDULING ALGORITHM FOR A JOB-SHOP

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Abstract
Considering the actual needs of the job-shop, this paper establishes an experimental platform for automated guided vehicles (AGVs) with a six-wheel dual-drive mechanical structure, and designs a multi-AGV scheduling system for unmanned factories. The scheduling system works in the following steps: Firstly, the deviation of each AGV from the magnetic strip is calculated based on the data of the magnetic sensor, and the speeds of left and right drive wheels are adjusted based on the deviation, keeping the AGV moving stably on the magnetic strip. Next, the A* algorithm is called to plan a collision-free and efficient path. Finally, the conflict points and AGV priorities are determined by comparing the paths of different AGVs, and the paths are planned again if head-on collision may happen on the conflict points. In this way, multiple AGVs can operate coordinately on the same map. The proposed multi-AGV scheduling system was proved feasible through simulation and experiments. Our system can be applied widely in manufacturing factories to replace traditional manual handling and conveyor belt transmission, reduce labour cost, and improve production efficiency. 26 refs.
(Received in September 2019, accepted in January 2020. This paper was with the authors 1 month for 1 revision.)

Key Words: *Job-Shop, Automated Guided Vehicles (AGVs), Scheduling Algorithm, Path Planning*

Pages 146-156

A BI-OBJECTIVE OPTIMIZATION ALGORITHM FOR AUTOMOBILE MANUFACTURING SCHEDULING

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Abstract
In automobile manufacturing, it is a great challenge to select and execute the services with the optimal value, cost and time out of complex processes. Most traditional algorithms only optimize one objective. In this paper, an optimization algorithm for service value and time is proposed under the constraint of deadline, and denoted as SRVT. The proposed algorithm reversely derives the service with the maximum value at each time point, and adds it to the set of candidate solutions in the next iteration. Then, the optimal solutions were selected iteratively from the set. In the end, the maximum service value of the entire workflow was obtained. The proposed SRVT was compared with two traditional algorithms through a case study. The comparison shows that our algorithm can outperform the contrastive algorithms to a certain extent, and strike a balance between service time, service cost and service quality. 29 refs.
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Key Words: *Automobile Manufacturing, Workflow, Scheduling Optimization, Maximal Service Quality, Deadline*

Pages 157-168

A NOVEL SOLUTION TO JSPS BASED ON LONG SHORT-TERM MEMORY AND POLICY GRADIENT ALGORITHM

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Abstract
Based on long short-term memory (LSTM) and policy gradient algorithm, this paper proposes a novel solution to the job-shop scheduling problems (JSPs). Firstly, two LSTM networks with identical structures were established, serving as the encoding and decoding networks, respectively. Next, a pointer network was introduced to determine the job with the highest priority in the current state, creating a job sequence. Another neural network (NN) was constructed to evaluate the current job sequence. The evaluation results were taken as the baseline of the policy gradient algorithm for reinforcement learning. Then, the job sequence was optimized and updated by gradient descent. The effectiveness of our method was demonstrated through contrastive experiments on benchmark problems. 20 refs.
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Key Words: *Job-Shop Scheduling Problem (JSP), Long Short-Term Memory (LSTM), Pointer Network, Policy Gradient Algorithm*

Pages 169-177

MODELLING AND SIMULATION OF FRESH-PRODUCT SUPPLY CHAIN CONSIDERING RANDOM CIRCULATION LOSSES

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Abstract
Random circulation losses of fresh products are also a great challenge that affects the decision-making of farmers and enterprises as well as the revenue management of both parties. Considering a fresh-product supply chain (FSC) comprising a single enterprise and a single farmer with random circulation losses, we explore the optimal ordering of the enterprise, optimal planting of the farmer, and risk-sharing mechanism of both participants. After modelling the optimal decision model of centralized FSC, we solve the optimal global solutions that exist uniquely. Then, a risk-sharing contract, called a wholesale price contract, is designed that can coordinate the decentralized FSC. Finally, a simulation of sensitivity analysis using MATLAB soft is figured out to explore the influence of random risks on the optimal solutions and the contract parameters. Furthermore, some conclusions and future researches are given. 23 refs.
(Received in October 2019, accepted in February 2020. This paper was with the authors 1 month for 2 revisions.)

Key Words: *Fresh Product, Circulation Loss, Wholesale Price, Supply Chain*
