

OPTIMAL COMPUTING BUDGET ALLOCATION FOR OPERATIONS OF A ZONE-PICKING SYSTEM

Kim, S.; Kim, H.; Park, C.; Jeong, J.; Yang, H. & Kong, S.

Department of Industrial Engineering, Hanyang University, Seoul, 04763, Republic of Korea

E-Mail: parkcj@hanyang.ac.kr

Abstract

This paper discusses a case study of a zone-picking system in a distribution centre. In particular, we designed a basic simulation model for analysing the system using Simio and connected the model to the MySQL database using the existing and new steps in Simio. A ranking and selection problem was subsequently formulated to determine the capacity of the system that maximises the expected throughput while satisfying the constraints on: (1) the expected maximum utilisation, (2) expected time-averaged number of boxes in the main conveyor, and (3) expected flow time. To solve the problem under a limited simulation budget, we implemented an optimal computing budget allocation procedure, which may work in the presence of stochastic constraints. The experimental results demonstrate that our approach can more efficiently and effectively determine the capacity of the system than the equal allocation scheme. 23 refs.

(Received in July 2023, accepted in February 2024. This paper was with the authors 4 months for 2 revisions.)

Key Words: *Zone-Picking System, Simio, Database, Optimal Computing Budget Allocation*

SIMULATION-BASED ALGORITHM FOR CONTINUOUS IMPROVEMENT OF ENTERPRISES PERFORMANCE

Pervaz, J.; Sremcevic, N.; Stevanovic, B. & Gusel, L.

University of Novi Sad, Faculty of Technical Sciences, Trg Dositeja Obradovica 6, Novi Sad, Serbia

E-Mail: nextesla@uns.ac.rs

Abstract

The printing company's process performance depends on the possibility of providing requested products and managing the existing constraints of fixed machine layouts and high setup times between different products. Process inefficiencies caused by these factors reflect on throughput, production times, and resource utilization. The changes that improve one part of the production system usually affect other parts, needing additional optimization, and it is very useful to test the feasibility of proposed solutions with simulation before implementation. This paper presents a new algorithm for continuous improvement of enterprises performance, combining the lean approach with cellular manufacturing, and simulation. The performance is observed in a way that a certain setup influences the system in its entirety, rather than on a specific part of that system. The results are presented through models developed within the production optimization phase, representing various ways in which the continuous improvement algorithm can unfold. Each of them comes with its advantages and disadvantages, all intending to create more efficient production processes that generate less production waste. 25 refs.

(Received in August 2023, accepted in February 2024. This paper was with the authors 1 month for 1 revision.)

Key Words: *Printing Process, Lean Management, Product Groups, Manufacturing Cells, Simulation, Continuous Improvement*

USING ADAPTIVE NEURAL NETWORKS FOR OPTIMISING DISCRETE EVENT SIMULATION

Raska, P.; Ulrych, Z.; Baloun, J.; Malaga, M. & Lenc, L.

Department of Industrial Engineering – FME, University of West Bohemia, Univerzitní 22, Pilsen 306 14, Czech Republic

E-Mail: praska@fst.zcu.cz

Abstract

The paper presents the use of adaptive neural networks for carrying out simulation optimisation using digital models (discrete event simulation models) created in accordance with the Industry 4.0 concept. The digital models reflect different problems in industrial engineering. The simulation optimisers use an adaptive neural network to find the best settings of the digital models according to defined objective functions for each model. We compared the effectiveness (using different evaluation criteria) of the adaptive neural network (ANN) optimisation method used on 6 different discrete event simulation models. We compared adaptive neural networks with 11 optimisation methods – pseudo gradient, metaheuristic, evolutionary and swarm optimisation methods (and their combinations). The ANN method demonstrated the ability to efficiently find the global optimum of the objective function in different cases of the objective function – the ANN method is in the top 5 best tested methods from the 12 optimisation methods. 20 refs.

(Received in November 2023, accepted in April 2024. This paper was with the authors 3 weeks for 2 revisions.)

Key Words: *Adaptive Neural Network, Comparison of Optimisation Methods, Discrete-Event Simulation Models, Simulation Optimisation*

Rihar, L. & Jenko, M.
University of Ljubljana, Faculty of Mechanical Engineering, Aškerčeva 6, 1000 Ljubljana, Slovenia
E-Mail: marjan.jenko@fs.uni-lj.si

Abstract

Influences of hydropower plant water turbine operational parameters on turbine operational economics, reliability and lifetime are ranged with a new type of QFD method that includes parameter distribution densities and probabilities. In our method, each dominant i.e., main parameter coexists with associated side parameters. Their contribution to effects, usually attributed to the main parameter only, is modelled by a) probability density of the side parameter contribution to the main parameter effects, and by b) side parameters' Bernoulli distribution since association of side parameter to the dominant parameter effects is in the realm of probability and not all side parameter effects are associated with the main parameter effects at all times. Analysis results are probability densities of dominant parameters influence measure on the turbine operating attributes. A simulation tool was built to establish relations amongst influential parameters and turbine's economics, reliability and lifetime. We obtained technical data associated with turbine operation attributes from turbine senior designers having led successful projects within last 30 years. Simulation results have been validated with existing turbine-projects maintenance data. 28 refs.

(Received in December 2023, accepted in April 2024. This paper was with the authors 2 weeks for 1 revision.)

Key Words: *Hydropower Turbine Maintenance, Parameter Probability Density, Predictive Analysis, QFD, QFD SR, Sensitivity Analysis*

Pages 251-262
INVENTORY MANAGEMENT SUPPORTED BY TECNOMATIX PLANT SIMULATION TOOL

Pekarcikova, M.; Trebuna, P.; Matiscsak, M. & Kopec, J.
Technical University in Kosice, Faculty of Mechanical Engineering, Department of Industrial and Digital Engineering,
Nemcovej 32, 04 200 Kosice, Slovakia
E-Mail: miriam.pekarcikova@tuke.sk

Abstract

The presented article deals with the issue of inventory management optimization through modelling and simulation in the software Tecnomatix Plant Simulation. Based on an in-depth analysis of the supply chain with an emphasis on inventory management, a simulation model was developed. It was optimized using the inventory theory methodology in combination with a discrete-event simulation approach. Dynamic simulation made it possible to perform experiments and optimize the existing state. The solution to the problem is elaborated on a case study to achieve the efficiency of the supply process of a specific operation of a clothing retail chain, which is struggling with the problems of excessive and inaccurate supply. 25 refs.

(Received in December 2023, accepted in May 2024. This paper was with the authors 1 month for 2 revisions.)

Key Words: *Inventory, Analysis, Modelling, Simulation, Consumption*

Pages 263-274
PRESSURE EVOLUTION OF OVERLYING ROCK STRATA USING GRADUAL INCREASE SUPPORT MINING METHOD

Zhou, S. & Shi, H.
Xin'an Mine of Jizhong Energy Fengfeng Group, Handan 056200, China
E-Mail: zhoushuai8808@163.com

Abstract

To improve the recovery for corner coal left over in mines, taking the Xin'an Mine in China as the research object, the gradual increase support mining method for recovering corner coal is proposed in this study and the evolution of the overlying strata pressure is investigated. The dynamic process of the overburden roof in the corner coal and the hydraulic support were simulated by using FLAC3D software. Results show that, under the gradual increase support mining, the abutment pressure over the mining working face is less than 21 MPa. The overlying rock over the coal seam roof forms a periodic breaking-collapse cycle with a periodic pressure step distance of 10 m and the hydraulic support load is 13–25 MPa. Based on that, the gradual increase support mining method including a scheme of three supports and three chutes adding for every 9 m is designed and the corner coal is fully recovered. The obtained conclusions provide a significant reference for predicting strata movement over the corner coal, which can help aid in designing such mining method in engineering applications. 32 refs.

(Received in February 2024, accepted in April 2024. This paper was with the authors 1 month for 2 revisions.)

Key Words: *Corner Coal Mining, Increasing Hydraulic Support, Numerical Simulation, Overburden Strata Movement, Field Application*

MODELLING AND INVESTIGATION OF A DRIVER SEAT SUSPENSION WITH NEGATIVE STIFFNESS STRUCTURE

Turan, M. K.; Erzan Topcu, E. & Karpat, F.

Bursa Uludağ University, Faculty of Engineering, Department of Mechanical Engineering, Bursa, Turkey

E-Mail: karpat@uludag.edu.tr

Abstract

In this study a narrow suspension seat with negative stiffness structure (NSS) was investigated. First, this suspension seat's fundamental equations were detected, and then a simulation model was created using Altair Inspire software and validated by a literature study. Inspire software was used for the first time for suspension seat with NSS in the literature vis-a-vis the authors' literature search. Afterward, the case design was created via the Taguchi method to determine parameter effects of NSS of suspension seat. Signal-to-noise ratio (S/N) and ANOVA were used to examine simulation results, thus, parameter effects of NSS of suspension seat were examined comprehensive statistically for the first time in the literature vis-a-vis the authors' literature search. Therefore, it was seen that the spring ratio is a much more effective parameter than the spring preload value for vibration isolation. In addition, optimal parameters of NSS were detected. Finally, with frequency response and road input results, it was observed that the suspension seat with NSS, which crated via optimal values, showed much better isolation performance than the other passive suspension seat. 28 refs.

(Received in February 2024, accepted in April 2024. This paper was with the authors 2 weeks for 1 revision.)

Key Words: *Vibration, Suspension Seat, Negative Stiffness Structure, ANOVA, Taguchi*

A SIMULATION METHOD OF SITE SELECTION FOR LIQUID AMMONIA TANKS

Zeng, Z.; Lan, F. Y. & Wang, Y. S.

School of Management Engineering, Zhengzhou University of Aeronautics, Zhengzhou, 450046, China

E-Mail: 798280676@qq.com

Abstract

To decrease liquid ammonia leakage-induced casualties of ammonia chemical enterprises, a simulation comparison method of liquid ammonia toxicity leakage and crowd evacuation was proposed, a spatial model was constructed with Pyrosim software, using 8 liquid ammonia tanks as a layout example. The ammonia diffusion path under eight leakage scenes was analysed with FDS software by setting eight ammonia leakage points. The personnel evacuation model was built with the Pathfinder software, obtaining the crowd evacuation time under the eight scenes. Finally, the optimal site for liquid ammonia tanks in this case was determined through a comparison of ammonia diffusion path and evacuation time. Results show that among the eight candidate sites for ammonia tanks, the Leakage Scene 4 shows the longest time (78 s) for diffusion to the two evacuation exits, which is longer than the crowd emergency evacuation time (73 s) in the scene. Therefore, the Leakage Scene 4 can be used for the setting of liquid ammonia tanks. The obtained conclusions provide a safe suggestion for the scientific planning of the liquid ammonia storage sites of chemical enterprises. 24 refs.

(Received in February 2024, accepted in May 2024. This paper was with the authors 2 months for 2 revisions.)

Key Words: *Ammonia Leakage, Gas Diffusion, Crowd Evacuation, Site Selection for Liquid Ammonia*

APPLICATION OF SIMULATION MODELS FOR DECISION-MAKING PROCESSES IN AVIATION COMPANIES

Tobisova, A.; Kalavsky, P.; Senova, A. & Rozenberg, R.

Technical University of Kosice, Faculty of Aeronautics, Rampova 7, 041 21 Kosice, Slovakia

E-Mail: alica.tobisova@tuke.sk

Abstract

Simulation methods are currently widely used, from simulations of various experiments to the calculation of certain integrals to the solution of differential equations. We can also use them in the economy and business operations. A specific industry, such as air transport, currently applies simulations to decision-making processes only to a small extent. The aim of the article is to point out the applicability of Monte Carlo simulation in the area of risk assessment of projects and investment activities, which is an important factor in achieving business sustainability. Through stochastic and deterministic modelling, simulations were performed using the Crystal Ball software tool. The simulation criterion is Net Present Value (NPV), modelled in different variants of variables in the form of own and foreign sources of financing. Simulation research in the field of financial decision-making is practically unknown and not applied to aviation companies. The process of planning investments and simulating their development in order to ensure sustainability for the future should become an integral part of all companies in aviation. 29 refs.

(Received in March 2024, accepted in April 2024. This paper was with the authors 2 weeks for 2 revisions.)

Key Words: *Simulation, Aviation, Financing, Investment, Monte Carlo, Crystal Ball*

Pages 311-322

SIMULATION STUDY ON DYNAMIC ENVELOPE AND INTERFERENCE CHECK OF STITCH WIRE

Chen, J. Q.; Guan, J. F.; Liu, J. D.; Wu, J. Q. & Chen, W. R.
School of Electrical Engineering, Southwest Jiaotong University, Sichuan Chengdu 611756, China
E-Mail: kwan_swjtu@foxmail.com

Abstract

Abnormal wear of stitch wires due to interference poses a serious threat to railway safety. To avoid this scenario, the concept of the dynamic envelope of the stitch wire was proposed, accompanied by an interference check method. A multi-node beam model of the stitch wire was established using the finite element method, employed to simulate the pantograph and catenary system, and validated by field test. The dynamic behaviour of the stitch wire was studied, and the concept of dynamic envelope was introduced. Moreover, factors affecting this envelope were analysed, and an interference check method was proposed. Results demonstrate that, the vibration of the stitch wire mainly occurs in the vertical direction and intensifies with increasing speed. Its vertical vibration increases from 70 mm to 137 mm as the train speed goes from 300 km/h to 400 km/h. Cantilever assembly errors and dropper installation issues are the main causes for the abnormal wear of stitch wires. A 100 mm assembly error reduces the clearance from 67 mm to 14 mm, while a 2 m dropper installation error eliminates the clearance entirely. This study provides valuable insights for enhancing the safety of catenary system. 22 refs.
(Received in March 2024, accepted in May 2024. This paper was with the authors 1 month for 1 revision.)

Key Words: *Catenary, Stitch Wire, Dynamic Envelope, Interference Check*

Pages 323-334

CONTINUOUS PATH PLANNING FOR MULTI-ROBOT IN INTELLIGENT WAREHOUSE

Shen, G. C.; Liu, J.; Ding, Y. L.; Zhang, C. & Duo, J. Y.
School of Information, Beijing Wuzi University, Beijing 101149, China
E-Mail: duojingyun@bwu.edu.cn

Abstract

In smart warehouses, logistics robots need to continuously execute tasks, and therefore traditional one-time multi-robot path planning cannot meet practical needs. To address this challenge, we proposed Pre-judgment Conflicts Search (SPC) algorithm. The SPC algorithm is divided into two layers: the higher layer allocates tasks to robots based on priority rules, and the lower layer plans paths for these robots with an improved A* algorithm, which includes vertex and edge collision checks during path searching and effectively prevents collisions among robots. We simulated SPC and Conflict-Based Search (CBS) on random maps and warehouse maps. The results show that compared to CBS, SPC provides nearly optimal paths with a significantly reduced computation time. Additionally, as the number of robots increases, SPC exhibits better scalability, offering a practical solution for continuous multi-robot path planning in smart warehouses, with the potential to enhance logistics efficiency. 24 refs.
(Received in December 2023, accepted in March 2024. This paper was with the authors 1 month for 2 revisions.)

Key Words: *Intelligent Warehouse, Continuous Path Planning, Pre-Judgment Conflict Search, Priority*

Pages 335-346

SIMULATION AND ANALYSIS OF A PREEMPTIVE TRANSPORTATION MODEL USING FLEXSIM SOFTWARE

Sun, P. F.; Zhang, Y.; Wu, X. J.; Du, J. Y.; Hou, R. R. & Liu, J.
Air Combat Service Academy, Naval Aviation University, Yantai, Shandong, China
E-Mail: hjhy_lj@163.com

Abstract

This paper presents a simulation model for a preemptive transportation system where vehicles can have tasks dynamically reassigned to optimize overall efficiency. The model, built using Flexsim software, includes 9 storage areas and 8 vehicles. Exponential distributions, validated with real logistics warehouse data, generate stochastic task arrivals. Recursive logic implements the preemption algorithm. Comparative analysis over a 10-hour duration shows that the preemptive mode increases average transport volume by 13 % and reduces vehicle travel distance by 13 % compared to a non-preemptive baseline. The results demonstrate the value of preemptive transportation in enhancing system responsiveness and operational efficiency. 24 refs.
(Received in January 2024, accepted in March 2024. This paper was with the authors 2 weeks for 1 revision.)

Key Words: *Preemptive Mode, Transport Efficiency, Process Flow*

FINANCING GREEN INNOVATION: A SIMULATION APPROACH FOR MANUFACTURING ENTERPRISES

Wang, Y. L.; Song, M. L.; Yang, L.; Chen, J. H. & Li, P.

Research Center for Enterprise Management, Chongqing Technology and Business University, Chongqing 400067, China
E-Mail: lznxliping88@126.com

Abstract

Companies face complex decisions when considering investing in green technology innovation versus traditional products. Key factors include financial constraints, risk of failure, and retailer demand uncertainty and risk aversion for new green products. This study constructs three financing models to analyse green tech manufacturer financing strategies and how the likelihood of success and risk tolerance impacts stakeholder behaviours and profits. Results demonstrate interdependencies between financing model chosen, investment willingness, order volumes, and participant earnings based on the success probability and risk appetite towards unproven green innovations. The models provide nuanced insights into investor and retailer uncertainties surrounding green technology, highlighting how perceived chances of success alongside risk preferences influence funding availability, production scales, and profit outcomes. By quantifying these relationships, the study aims to guide manufacturer decisions and promote suitable financing structures to support wider adoption of sustainability-focused technological innovations. 25 refs. (Received in February 2024, accepted in March 2024. This paper was with the authors 1 week for 1 revision.)

Key Words: *Financing Strategy, Manufacturing Enterprises, Green Technology Innovation, Risk Aversion*

MULTI-OBJECTIVE OPTIMIZATION FOR RESOURCE ALLOCATION IN INTELLIGENT MANUFACTURING

Mou, J. B.

Department of Mathematics, School of Education, Xizang Minzu University, Xianyang 712082, China
E-Mail: jbmou@xзму.edu.cn

Abstract

As intelligent manufacturing expands globally, efficient resource allocation strategies are critical for optimizing production efficiency, costs, and quality. Although multi-objective optimization algorithms can handle conflicting objectives, traditional approaches struggle with complex manufacturing systems. This research proposes an optimization model integrating an enhanced Non-dominated Sorting Genetic Algorithm II (NSGA-II) with the Fishbone layout for intelligent manufacturing resource allocation. The Fishbone-based model provides efficient decision support, while the enhanced NSGA-II improves solution efficiency and quality. Flexsim simulation demonstrates the practical value of the proposed method in optimizing resource allocation. This work extends the application of multi-objective optimization in intelligent manufacturing and offers a novel tool for resource allocation optimization in the manufacturing industry. 18 refs. (Received in March 2024, accepted in April 2024. This paper was with the authors 2 weeks for 2 revisions.)

Key Words: *Intelligent Manufacturing, Resource Allocation, Multi-Objective Optimization, Non-Dominated Sorting Genetic Algorithm II, Fishbone Layout, Flexsim Simulation*

MODELLING AND SIMULATION OF PURCHASING DECISION BY DATA-DRIVEN DEMAND

Fang, X. & Wang, Y.

Collaborative Innovation Center for Chongqing's Modern Trade Logistics & Supply Chain, Chongqing Technology and Business University, Chongqing 400067, China
E-Mail: xin_f@ctbu.edu.cn

Abstract

This paper constructs a data-driven demand purchasing confidence rule-based model based on the theory of evidential reasoning to address the problem of purchasing decision bias in which the decision maker anchors the prior demand. First, we apply a synthetic algorithm to reason about the confidence structure distribution of the purchasing decision and then iteratively optimize the purchasing quantity according to the confidence structure distribution to minimize the cost loss function. Finally, we choose the average cost loss and service level value as the evaluation indexes to explore the purchasing confidence rule model. The simulation shows that compared with the expected purchasing decision based on the stochastic cumulative distribution function, the decision based on the confidence structure distribution can reduce the purchasing decision bias, manifested in the lower mean cost loss and a higher mean value of service level. Sensitivity analyses of the number of rules, product shelf life, and critical values show that the purchasing confidence rule base is highly adaptable. 28 refs. (Received in July 2023, accepted in May 2024. This paper was with the authors 10 months for 2 revisions.)

Key Words: *Purchasing, Confidence Rule Base Modelling, Data-Driven Demand, Simulation*
