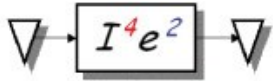


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International Institute for Innovation, Industrial Engineering and Entrepreneurship



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Industrial Engineering and Systems Management

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May 25-27, 2011 - Metz, France

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Lyes Benyoucef

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Program

May 25th

Registration (8h00 - 9h00)
Welcome speech and opening session (9h00 - 10h00)

10h00 – 11h00

Plenary talk: *Distributed Control of Manufacturing and Service Systems* Speaker: *Prabhu V.*

11h00 - 12h30						
T1S1	S1	T2S1	T3S1	T4S1	S2	S3
14h15 - 16h15						
T1S2	T1S3	T2S2	T3S2	T4S2	S4	
16h45 - 18h45						
S5	S6	T2S3	T3S3	T4S3	S7	

May 26th

8h30 - 10h30						
T1S4	T1S5	T2S4	T3S4	T4S4	S8	S9

11h00 - 12h00

Plenary talk: *Intelligent Optimisation* Speaker: *Pham D.T.*

13h45 - 16h15						
T1S6	S10	T2S5	S11	T5S1	S12	S13

May 27th

8h30 - 10h30						
T1S7	T1S8	T2S6	S14	T5S2	S15	

11h00 - 12h00

Plenary talk: *Metaheuristics: A unified view* Speaker: *Talbi E.*

13h45 - 16h15						
T1S9	S16	T2S7	S17	T5S3	S18	

Closing session (16h15 – 17h00)

Preface

Dear colleagues and friends,

It was a great pleasure and honor for us in organizing the 4th edition of IESM, being a vehicle in bringing together the international scientific community of industrial engineering and system management. Fifty sessions have been planned, with nearly half under the following five main tracks:

- * Supply chains,
- * Maintenance and reliability,
- * Advances in optimization for vehicle routing problems,
- * Intelligent Manufacturing & Services Systems,
- * Health Care Systems Management and Engineering.

The IESM 2011 has also comprised regular sessions on both the classical and innovative emerging topics. We were proud to have three *keynotes* – from the renowned researchers with profound knowledge and deep experience in their respective fields which concern Optimisation, Metaheuristics and Manufacturing problems. We chose the plenary of Duc Truong PHAM to be presented in this document. He talked about Intelligent Optimisation regarding different formulations of the Bees Algorithm. The comparison of the effectiveness of the Bees Algorithm to that of three state-of-the-art biologically inspired search methods.

In its continuing journey of improvement and success, IESM has initiated and implemented the following key processes in this 4th edition:

- Complementing to the regular calls for papers, *special sessions* are organized for the first time, with topics suggested by the international community;
- In order to guarantee the consistency of the conference topics and the impartiality of the review process we have organized the evaluation of papers without the help of the sessions chairs;
- For papers with major revision needed, we have asked for a response to reviewer, implying a final acceptance under the respect of the review;
- Every paper has been tested for possible plagiarism. Several papers have been submitted without any consideration paid for other scientists' works. This unforgivable behavior has systematically led to a clear reject with the proofs of the plagiarism.

You have in hand the official edited version of the proceedings. More than 220 papers were submitted and 160 are published for this edition of IESM.

We are grateful to the international scientific committee for the objective and constructive evaluation of the submissions. We would like to acknowledge the authors, reviewers, and organizing committee members for their sincere efforts and valuable time to make IESM 2011 a reality. Special thanks to Etienne, Maryline and Chantal for their meticulous work and seamless coordination.

Long live IESM!

<http://www.iesm11.org/>

Lyes Benyoucef, Damien Trentesaux
Abdelhakim Artiba, Nidhal Rezg

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Plenary talks

P1T1: Distributed Control of Manufacturing and Service Systems

P1T2: Intelligent Optimisation

P1T3: Metaheuristics: A unified view



V. PRABHU

Distributed Control of Manufacturing and Service Systems

In this talk we will review distributed control algorithms that have been developed for real-time decision-making in manufacturing and service systems. The talk will focus on a class of feedback control algorithms that use continuous variables for controlling discrete-event timing. These algorithms can potentially be used for unified decision making across multiple functions such as production scheduling, maintenance scheduling, inventory management, and transportation. Moreover, because of their non-combinatorial nature and inherent parallel/distributed nature they offer scalability. The talk will briefly review some the mathematical techniques for modeling and analysis of these control systems using discontinuous differential equations and control theory.

Professor Prabhu works in the area of distributed control systems with a focus on manufacturing and service enterprises. The goal of his research is to develop a unified mathematical and computational framework that enables engineering of distributed control systems consisting of discrete-events, physical processes, and service processes. The science-base of this work includes theories of discontinuous differential equations, Lyapunov stability, adaptive control, and nonlinear control for studying distributed algorithms.



D.T. PHAM

Intelligent Optimisation

This plenary is developed hereafter.

Many real-world engineering problems require the manipulation of a number of system variables in order to optimise a given quality parameter such as the reliability or accuracy of a process, or the cost or performance of a product. Optimizations will become even more important as resources diminish. The Bees Algorithm models the foraging behavior of a swarm of honeybees in order to solve complex optimisation problems. The algorithm performs a combination of exploitative neighborhood search and random explorative search. In this presentation, we will review different formulations of the Bees Algorithm together with other swarm-based optimization algorithms and compare the effectiveness of the Bees Algorithm to that of three state-of-the-art biologically inspired search methods. We will explain the search mechanisms of the Bees Algorithm and the three control methods, and highlight their differences, strengths, and weaknesses.



E. TALBI

Metaheuristics: A unified view

This talk provides a complete background on metaheuristics and presents in a unified view the main design questions for all families of metaheuristics and clearly illustrates how to implement the algorithms under a software framework to reuse both the design and code. The key search components of metaheuristics are considered as a toolbox for:

- Designing efficient metaheuristics (e.g. local search, tabu search, simulated annealing, evolutionary algorithms, particle swarm optimization, scatter search, ant colonies, bee colonies, artificial immune systems) for optimization problems
- Designing efficient metaheuristics for multi-objective optimization problems
- Designing hybrid, parallel and distributed metaheuristics

El-ghazali Talbi is a full Professor in Computer Science at the University of Lille (France) and head of the optimization group of the Computer Science Laboratory (L.I.F.L.). His current research interests are in the fields of metaheuristics, parallel algorithms, multi-objective combinatorial optimization, cluster and grid computing, hybrid and cooperative optimization, and application to bioinformatics, networking, transportation and logistics. He is the founder of the conference META (International conference on metaheuristics and nature inspired computing) and is head of the INRIA Dolphin project dealing with robust multi-objective optimization of complex systems.

Intelligent Optimisation ^{*}

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Abstract

Intelligent Optimisation is optimisation inspired by natural processes. Intelligent Optimisation approaches tend to be heuristic and stochastic. This paper reviews the main Intelligent Optimisation approaches, and discusses their similarities and differences. The paper concludes with a brief discussion of a way to enhance an intelligent algorithm by combining it with a deterministic local search tool.

Key words: Intelligent Optimisation, Swarm Intelligence, Bees Algorithm, Difference of Convex Functions

1 Introduction

The capability of biological systems to solve complex optimisation tasks is shown in many remarkable examples, such as the adaptation of species to the natural environment, the food gathering process of social insects, the ability of the human immune system to respond to different and constantly new kinds of bacterial infections, etc.

Conceived in the 1960s, Evolutionary Algorithms (EAs) [27], [8], [10], [26] were the first optimisation methods to mimic the collective search process of a population of biological agents. The problem domain is represented by a fitness function, which is used to provide feedback on the performance of the candidate solutions. Through the iteration of cycles of mutation, crossover, and selection, EAs evolve a population of artificial agents towards meeting some desired fitness measure(s). Initially slowed down by the limited processing power of early computers, EA research achieved dramatic progress and notoriety starting from the middle-1970s. EAs have become nowadays a main branch of Intelligent Optimisation, and represent a field of active and wide-ranging investigation [13].

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- S12: Simulation and metaheuristics applied to goods and services production systems
- S13: Integration of environmental aspects into product design and development
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- S15: Performance Measurement of Reverse Logistic processes
- S16: Extended Product Lifecycle Management approach
- S17: Physical Internet and Supply Webs
- S18: Advanced optimal control for manufacturing systems

Value/Risk based Performance Evaluation of Integrated Product and Process Design*

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Abstract

A value/risk based performance evaluation framework is proposed for manufacturing process planning at the industrialization phase of product development. Various risk factors are identified from a Failure Mode and Effect Analysis (FMEA) of the manufacturing process. A process modelling method (e.g. IDEF3) is used to model the process plans as well as the risk factors identified in the FMEA. Subsequently, a so-called Risk Embedded Manufacturing Process Plan (Risk-Embedded MPP) is obtained that provides an efficient environment for evaluating the performance of the manufacturing process plan and the impact of each risk on the overall performance. Performance is then evaluated in terms of risk and value, an aggregation of cost, quality and time by means of Arena. Alternative scenarios are developed, simulated and compared with reference scenario. The methodology is illustrated by means of a case study

Key words: Manufacturing process modelling, Process performance, Risk, Value, Simulation

1. Introduction

In a competitive environment, the development of new products and processes is a cornerstone for sustainability. Manufacturing may result in unnecessarily long design cycles that consequently waste time and money, leading to products less competitive in a global market. This led to the development of concurrent engineering, integrated product and process design and computer-aided simulation tools that could provide the customer with a high quality product at reasonable cost in a timely manner. To properly evaluate the performance of product development activities, particularly manufacturing process performance while using these techniques, there is a need for performance measurement systems (PMS) to facilitate the decision making process [1]. Many performance measurement systems have been developed so far to meet the growing demand of evaluating the performance in decision making processes. Among them is Activity-Based Costing (ABC) promoted by Kaplan and Cooper [12] and Brimson [3]. It focuses on the identification of activities and processes which create value in the company and the factors which induce this value creation process. It assigns resource costs to cost objects

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Ant Colony Optimization to solve a Robotic Assembly line Balancing Problem (rALB-II) ^{*}

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Abstract

A robotic assembly system which consists of seizing products and assembling them on deposit points is considered in this paper. This type of systems has been extensively applied recently in assembly systems and is known as robotic assembly lines. The problem studied in this paper is a robotic assembly line balancing (rALB-II) problem, in which the assembly tasks have to be assigned to robotic workstations and with the objective of minimizing the cycle time and to define the gripping strategies for each robot within a bounded time. For that purpose, we develop an efficient algorithm based on ant colony optimization which defines the best combination of assigned assembly tasks and products for each robotic workstation. To assess the quality of our method, we compare the results to the optimal solutions of the tested instances that are obtained by applying a full enumeration method based on a mathematical formulation of our problem. The computational experiments show the efficiency and the reliability of our method within a short computational time.

Key words: Robotic systems, Ant colony optimization, Assembly line balancing.

1 Introduction

In nowadays industries, robotic systems are an essential part in many automated manufacturing process. In practice, robots are usually guided by computer or automated controllers, and are thus able to do tasks on their own. There are different types of robots. In this work, we are interested in a robotic assembly system which realizes pick and place operations. Recently, robotic pick and place operations have been widely applied on automated equipments, electronics and press fabrication industries as they could satisfy some special performances requirements. Therefore, the evaluation and the optimization of pick and place robotic assembly systems by minimizing the cycle time are considered in this paper.

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Investigation of the Influence of Machine-Driven Capacity Constellations on the Performance of Job-Shop-Systems^{*}

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Abstract

Workshops within job-shop-systems are mostly composed of single machines with identical or similar function yet differing machining capabilities and characteristics. Against the background of changeable manufacturing and reconfigurable manufacturing systems, machine-driven diversity of capacity supply will increase. However, research lacks a detailed investigation about the impact of machine-related capacity constellations within workshops on the dynamics and on the performance of the production system. In this article we examine varying workshop configurations within discrete-event simulation and investigate their influence on inventory evolutions and logistic key figures. In addition to a quantitative analysis based on logistic objectives we derive recommendations to support the design of capacity constellations of workshops within job-shop-systems.

Keywords: Job-Shop-System, Capacity Constellation, Configuration, Performance

1 Introduction

Job-shop-systems are characterized by the concentration of machines of identical or similar function in organizational and spatial units [20]. These production units are called workshops. Although similar in function, each machine within a workshop features its own characteristics. Especially in production systems which evolved over time we often find a mixture of machines which differ in numerous properties like size and material of machinable parts, controlled axes, deployed control systems, maintenance requirements and mean downtimes [5]. Furthermore, we find qualities which are machine-specific as well as part-specific like set-up times, cutting speeds and feasible axial feeds. Especially the data on specific times and rates determines the overall processing time for a given order. This has further consequences for the available machine-oriented capacity and therefore for the aggregated capacity supply of the associated workshop. Even though all machines within a workshop are traditionally designed to perform equal machining tasks, this results in capacity constellations in terms of machine-specific processing times. In addition, we must consider the increasing trend

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An Efficient Branch and Bound Search Strategy for Permutation Flowshop Problems^{*}

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Abstract

The general m -machine permutation flowshop problem with the total flow-time objective is known to be NP-hard for $m \geq 2$. The only practical method has been branch-and-bound algorithms which use Depth-First and/or Best-First Search to find an optimal schedule. In this paper, we present an improved algorithm which is based on a strict alternation of Generation and Exploration execution modes as well as Depth-First/Best-First hybrid strategies. The experimental results show that the proposed method exhibits improved performance compared with the algorithm in [3]. Furthermore, our model can be easily extended and implemented with lightweight threads on multicore parallel systems to speed up the execution times.

Key words: Branch and Bound, Search Strategies, Parallel Processing, Multithreaded Programming, Permutation Flowshop

1 Introduction

In the permutation flowshop problem, each of n jobs has to be processed on machines $1 \dots m$ in that order. The processing times of each job on each machine are known. At any time, each machine can process at most one job and each job can be processed on at most one machine. Once the processing of a job on a machine has started, it must be completed without interruption. The usual objectives are the minimization of the make-span, flow time, tardiness, lateness, and the number of jobs late. For a review of the general flowshop problem, see [1], and more recently [6]. The application of the flowshop scheduling research can be found in the areas such as chemical process industry and manufacturing systems, especially flexible transfer or assembly lines in which a wide range of parts are manufactured [4].

Schedules where each job must be processed in the same order at every machine are called *permutation schedules*. When $m \leq 2$, the restriction to permutation schedules is harmless; however, when $m > 3$, there may exist a schedule whose total flow is strictly less than the total flow of any permutation schedule. Finding such a schedule

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Solving a Combined Routing and Scheduling Problem in Forestry*

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Abstract

We consider a weekly transportation problem in forestry which arises when transporting logs from forest sites to wood mills. We develop a decomposed approach in order to solve the weekly problem in three phases. In the first phase we use a constraint programming enumeration to generate a large set of feasible routes equivalent to one driver work shift..

In the second phase, we solve a set covering problem and then a mixed integer problem to select a set of routes, by truck and by home base, that satisfy the demands of all mills. Finally, we schedule all sets of routes using a constraint programming (CP) solver. These approaches are implemented using COMET2.0, which embeds a local solver, a mixed integer programming (MIP) solver and a CP solver. We test our method on an industrial case problem from an Eastern Canadian forest company.

Key words: transportation, forestry, industrial case, constraint programming enumeration, constraint programming (CP) solver

1 Introduction

Transportation planning in forestry involves many decisions which are commonly managed according to four time horizons: strategic (up to 5 years), tactical (1/2 to 5 years), operational (1 to 180 days) and real-time (< 1 day). We refer to [21], [11] and [8] for an exhaustive survey. In the studied industrial problem, three main decisions occurring at the operation planning level must be addressed: i) allocation, ii) routing and iii) scheduling. We describe each of them, as well as their respective explicit (i.e. required) and implicit (i.e. "desirable") objectives.

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A Mixed-Integer Programming Model for Parallel Machine Scheduling with Controllable Processing Time^{*}

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Abstract

This paper considers a parallel machine scheduling problem because of its extended applications in today's practicing firms. This problem is investigated under deterministic circumstances for identical machines, in which the processing times are completely controllable. Likewise, the developed mathematical model is enriched with different operational times so that the scheduling conditions can be more flexible. In order to enhance the scheduling plan, we consider that the jobs can be processed in the compressed time, if required. The objective function (OF) minimizes the total tardiness and the penalty associated with the total amount of compressed jobs. Finally, a heuristic solution algorithm is proposed for the problem and the formulation is tested by some different-sized problems, whose data are created randomly. The comparisons between the exact and heuristic solution methods indicate that the heuristic one can outperform efficiently.

Key words: Parallel machine scheduling, tardiness, compression, completion time

1 Introduction

Scheduling parallel machines has been concentrated within the last years as an important manufacturing method [15]. As a general rule, a set of independent jobs are to be scheduled and processed in parallel machine scheduling so that the objective functions (OF) associated with time completion are fulfilled. Minimizing the total tardiness is dealt with as one of the most critical issues in satisfying the customers' needs. It is concentrated on the papers much and less because of its broad usages in different industries. Referring to last researches, the parallel machine scheduling problem (PMSP) is divided by three distinctive categories including identical parallel machine, unrelated parallel machine, and uniform parallel machine [3]. An identical parallel machine issue is characterized by a set of machines that serve similar services with similar features [1]. The uniform parallel machine problem is associated with the practicing machines that are thoroughly the same with respect to operational qualities [16]. The scheduling problem of unrelated parallel machines is represented by machines that perform the similar functions in spite of having different capabilities or capacities [15]. In fact, it is a generalization of the other two categories.

The presented mathematical model is supposed to be run in deterministic conditions, in which the practitioners are to utilize identical machines. Regarding the available literature, there are many researches on deterministic parallel machines. However, we develop the model so that it is not bounded by inflexible issues caused by strict

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Policies for Positioning Empty Containers in an Inland Multi-depot System *

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Abstract

This research focuses on the problem of positioning empty containers in a port area with multiple depots. Three options are considered to prepare the required extent of positioning: positioning from other overseas ports, inland positioning between depots, and leasing. The policies for empty-container management are as follows: a coordinated (s, S) inventory policy for overseas positioning, (r_i, R_i) policy at each depot for inland positioning; and a simple leasing policy with zero lead-time. For inland positioning policy, four different methods are proposed to reposition empty containers between depots. Customer demands and returning containers in depots and lead-time for positioning from overseas are considered as uncertain factors. The objective is to obtain the optimal policy in order to minimize the expected total cost including inventory holding, overseas positioning, inland positioning and leasing costs. Different optimal policies are obtained corresponding to different methods of inland positioning and they are then compared with those of non-inland-positioning (NIP) policy so as to prove the effectiveness of the proposed approach. A simulation-based genetic algorithm is developed to find the optimal policies. Numerical examples are given to demonstrate the results.

Key words: Empty Containers, Inventory Policies, Simulation, Genetic Algorithm.

1 Introduction

Empty containers are important logistical resources in light of the changes in the international logistics environment and have been received much more attention for recent years. Since the beginning of containerization, the industry has seen a general increase in productivity, efficiency, safety, and reduction in cost and service time. A decision factor for shipping companies' competitiveness is the availability of containers at a particular place and time to meet customer orders, avoiding immobilization costs. Thus, shipping companies need to plan how containers can be repositioned in order to take advantage of future transportation opportunities.

In the line of empty container repositioning problem, Cheung and Chen [2] considered a two-stage stochastic network model for the dynamic empty containers allocation problem. Li *et al.* [8] and [9] developed a new (u, d)

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A capacitated lot-sizing problem with limited number of changes [★]

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Abstract

This work deals with single-level lot sizing decisions with capacity constraints. Lot sizing decisions give rise to the problem of identifying when and how much of an article to produce such that setup, production and holding costs are minimized. Setting up the machine for producing a product different from the previous one, would cause a changeover cost due, for example, to clean or install the appropriate tools for the machine. We focus on the Continuous Setup Lot Sizing Problem (CSLP) which allows partial capacity usage, in the multi-item case. Only a single item can be produced per period per resource. In the literature and to our knowledge, the problem of number of change limited is not addressed. Thus, we developed an extension of the typical model in the multi-item, multi-resource case and solved the problem with a genetic algorithm (GA) and an ant colony optimization (ACO).

Key words: lot-sizing, meta-heuristics, GA, ACO, multi-product, capacity constraints

1 Introduction

Production planning is an activity that considers the best use of production resources in order to satisfy production goals over a certain period named the planning horizon. Production planning typically encompasses three time ranges for decision making: long-term, medium-term and short-term. In our study, we focus on medium-term production planning and especially on single-level lot sizing decisions with capacity constraints. Lot sizing decisions give rise to the problem of identifying when and how much a product has to be produced such that setup, production and holding costs are minimized.

As Jans and Degraeve [9] explain, several models have been proposed for lot sizing problems. The classification of lot sizing problems is based on several criteria as number of machines, number of production stages (levels), capacity constraints and their nature (fixed or variable), nature of the demand, length of production periods.

The first developed model is the Economic Order Quantity (EOQ), developed by Harris in 1913 (as explain in [6], [13]), which is a continuous time model with an infinite time horizon. It considers a single item and imposes

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Simple Assembly Line Balancing under Uncertainty: A Robust Approach [★]

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Abstract

We address line balancing under uncertainty and propose a robust optimization model that assumes interval uncertainty for operation times. Our main objective is to design assembly lines that are protected against disruptions. Specifically, we deal with the simple model assembly line problem with cycle time minimization objective (SALBP-2). In order to solve the robust model to optimality, we propose a decomposition based algorithm and to solve large scale instances, we integrate some enhancement strategies. We also test the efficiency of the algorithm and present some experimental results. We believe that the modeling approach and solution algorithm of this research serves as a basis to develop decision support systems on this subject.

Key words: assembly line balancing, uncertainty, robust optimization.

1 Introduction

Assembly lines are flow-line production systems that have been commonly used in many industries to produce large amounts of standardized products efficiently. They contain serially located workstations that process operations of a product continuously. On the other hand, line balancing problems mainly deal with assigning the tasks among the stations considering some objectives and precedence relations. Mostly, capacity related objectives such as minimizing the number of workstations given a required cycle time (type 1 problem) or minimizing the cycle time given the number of workstations (type 2 problem) have been investigated in the literature.

Scholl [11] classifies the assembly line balancing problem into three with respect to number of product models : simple model, mixed model and multi model. Simple model assembly lines produce a homogeneous product, whereas in mixed model lines, several models of the same product are assembled. If the product families require dissimilar production processes, set-ups are usually required, and these lines are grouped into multi-model lines.

Among these line types, we will address the simple model assembly line problem with cycle time minimization objective (SALBP-2). The cycle time of the line is defined by the maximum of the station times (total execution

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Mathematical formulation of the supply chain with cash flow per production unit modelled as job-shop [★]

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Abstract

In this paper, we discuss supply chain optimization. The financial constraints are included to model the cash flow exchanges between suppliers, retailers and manufacturers. The supply chain is modelled as a job where each production unit is considered as a machine. The job-shop problem, which is called "job-shop with financial constraint", is defined as a job-shop problem with explicit consideration of machine specific resource requirements and constraints. In order to understand the physical and financial exchanges between the different production units, a linear program is done. A linear program is useful to obtain optimal solutions on small and medium industrial instances. Tackling financial considerations permits to consider the proper coordination of production units and financial constraints when optimizing the supply chain operational planning in order to obtain the smallest production duration. The modelling of the supply chain is novel in the sense that the model encompasses specific financial resource per machine i.e. per production unit. In fact each production unit has each own limited budget. An experiment is done on a set of modified instances coming from the Laurence's job-shop instances.

Key words: supply chain, job shop, financial constrain, linear program

1 Introduction

1.1 Supply chain management and financial operational problems

A global production system of a supply chain can be represented as a set of existing or potential, warehouses, suppliers, production units and distribution centres, with multiple supply configurations and customers with demands. All these facilities can be located in different regions of the world where different tax are applied and various currencies are used. Modelling a supply chain as a job-shop gives the opportunity to address the proper coordination between production units and financial considerations. Typically, scheduling decisions are made in the short term (several weeks or months) and financial decisions follow to satisfy the required base-stock levels and human resources. Operational planning in scheduling [14] has the same horizon term as cash management

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Mathematical Model and Lower Bound for Flowshop Problem With Mixed Blocking Constraints^{*}

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Abstract

In this paper, we consider a flowshop scheduling problem with mixed blocking constraints. This production system is prevalent in industrial environments where buffer space capacities between successive machines may be unlimited, limited or null. In flowshop scheduling literature, many studies and researches were realized about classical flowshop problem and also about some problems with only one blocking constraint between all machines. But only few works have dealt with different blocking constraints in a same flowshop scheduling problem. After a problem description and different blocking constraints definitions, a mathematical model and a lower bound for flowshop scheduling problems with mixed blocking constraints are proposed and numerical results are presented and discussed.

Key words: Scheduling, flowshop, mixed blocking constraints, I.L.P model, lower bound, makespan.

1 Introduction

In industrial environment, if there is not enough space for carrying stock after a job has finished its operation on a machine and following machine in process is not yet available, it is said to be a blocking situation. In literature, different blocking constraints are considered, therefore scheduling models differ on used technology and constraints applied in system. The most common scheduling problem is classical flowshop where buffer space capacity between machines is considered as unlimited. Other problems are characterized by only classical blocking constraint (*RSb*) where storage capacity is limited or null and others by a specific blocking constraint (*RCb* or *RCb**). In this paper, general case is presented and modeled as a flowshop problem subject to several types of blocking constraints, considering makespan as optimization criterion.

First article dealing with a flowshop problem was published fifty years ago [9]. Since, many authors focused on different aspects of this problem. We can cite articles [1] and [2] for flowshop classical problem with two machines and [12] and [4] for general case with multiple machines. For greater size problems, some heuristics and metaheuristics have been proposed [8], [16].

For problems with classical blocking constraint (*RSb*), an heuristic for multi-stage flowshop problem, with and without storage capacity respectively is proposed in [14] and [15]. A hybrid genetic algorithm for flowshop scheduling with limited buffers has also been developed [18]. Other articles dealing with flowshop problems with *RSb* constraint like [3] and [13] can also be cited.

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Scheduling of an engine assembly workshop ^{*}

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Abstract

Several studies have been made concerning the control and the flow optimisation in car assembly plants in order to satisfy the expectations and customer needs. But investigations of the same nature were not observed so far in component manufacturing plants. That is why we propose in this paper to study the production management problem in an engine plant, in particular the scheduling problem of an engine assembly workshop. Firstly, we present the characteristics of an engine plant. Secondly, we provide an integer linear model, which helps the manager to take the best decisions for the scheduling of the engines. This optimisation model tries to group and sequence the engines so that all the workshop constraints, required by the production manager and the customers, are satisfied. We apply this tool to real data, coming from an engine assembly workshop, and the obtained results are compared to the current manual schedules.

Key words: Scheduling, batching, linear programming, assembly engine plant

1. Introduction

In order to stay competitive, car industries have to adapt constantly to the changing market, thus giving answers to the changing expectations and customer needs. Several studies have been made, dealing with the control and the flow optimisation in car plants to follow the market evolution. But studies of the same nature were not observed so far in component manufacturing plants.

Regarding a car assembly plant, one of the most studied problems in the literature is the car sequencing problem (see [1], [7] and [12]). The basic question is: What is the optimal production ordering of the vehicles that takes into account all assembly constraints? Some years ago, several tools have been proposed to answer this question. But the same question arises in component manufacturing plants (engines, gearboxes, running gear, etc.), for which no tool has been developed so far. The French car manufacturer, PSA Peugeot Citroën, wanted to examine this question. Studies were realized, inside the group, to define the scheduling mode for all the assembly workshops of component manufacturing plants. The objective is to standardize information systems in all the mechanical plants of the group and not only in engine assembly workshops.

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Scheduling Jobs on a Flexible Machine to Minimize Overtime and Weighted Tardiness Costs^{*}

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Abstract

We treat a practical application of scheduling jobs on flexible machines. The company in analysis is a metal working industry where a single flexible machine is used to manufacture precision parts. The machine is assisted by computer aided manufacturing softwares and allows automatic changing between two different jobs. The machine has to be stopped and human intervention occurs when a job requires at least one tool which is not already in the tool magazine. Thus, the job scheduling and tool switching problem to minimize overtime and weighted tardiness costs consists of deciding the jobs to be processed in each day of the horizon, along with their processing order, given that the required tools to start a job must be on the limited capacity tool magazine. We propose an integer programming model for the problem. We present numerical results on real data instances, and significant gains were obtained with respect to the firm's practice. Results show the potential to the use of the optimization model in the real-life setting and encourage to the development of heuristic approaches.

Key words: Scheduling, Flexible Machine, Overtime, Tardiness

1 Introduction

A flexible machine is a computer-controlled machine equipped with automated material handling systems. The machine allows automatic changing between two different jobs, given that tools required to perform both jobs do not exceed its limited capacity tool magazine. This gives rise to the job scheduling and tool switching problem (SSP) where one seeks to sequence jobs and assign the required tools to the magazine in order to minimize the number of tool switches. The SSP is an NP-Hard problem (see [Crama *et al.*, 1994]), and it has been systematically studied since the works of Bard [Bard, 1988] and Tang and Denardo [Tang and Denardo, 1988].

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Incorporation of competitors' reactions in discrete competitive facility location and design [★]

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Abstract

When a retail firm locates a new facility in a network and begins attracting customers in an existing market, it will typically stimulate certain reactions of other firms offering the same goods. To maximize its market share by optimizing its location and design decisions, the entering firm must anticipate the reactions of the facilities already present in the market. Since the relocation of an existing facility is expensive, the competitors usually improve their qualities to compete with the new firm so as to minimize their market share lost.

In this paper, we develop a new method that takes into account the reactions of the facilities already present for a discrete competitive facility location and design problem. The method proposed uses a genetic algorithm to search for optimal or near-optimal locations of new facilities and uses Nash equilibrium to determine the best quality of each facility.

Key words: Discrete competitive facility location and design, Game theory, Nash equilibrium, Genetic Algorithm

1 Introduction

For a retail firm, one important strategy decision is the choice of the locations of its retail facilities from which goods are sold to customers. Although the location decision is critical for such firm, it is very complex because of the existence of other facilities of competitors. As the facilities offering the same goods are already present in a market, the new facilities will have to compete for the market with the existing facilities. Such decision problem is referred to as a competitive facility location and design problem, which deals with the decisions of locating new facilities to provide goods to customers in a given geographical area and designing their service qualities.

It is generally agreed that the first paper on competitive facility location is Hotelling's paper [13] on duopoly in a linear market. Hakimi [10], [11] and [12] formulated the problem in a network. Drezner [4] solved a single facility location in a continuous space. Their formulations are based on the assumption that each customer patronizes its closest facility. A more realistic approach was introduced by Huff [14] and [15], in which a more reasonable

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Optimal admission policy in make-to-stock/ make-to-order production systems*

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Abstract

This paper analyses the performances of a supplier who, besides his own products, has the possibility to accept or not the production of a personalized product for a customer who may be a new one. The contract with this customer specifies the demand arrival rate, the sale price and the backorder cost. Face to this proposition, the supplier has to decide whether to accept or not the contract and how to manage his production system: which products must be produced according to make-to-order policy? Which quantity of finished goods must be kept in the stock for those to produce under make-to-stock policy? We characterize analytically and through numerical examples the structure of the optimal decision with regard to the questions quoted above. We extend the analysis to the case where the supplier can choose between several new product proposals.

Key words: Subcontracting, Make-to-stock, Make-to-order, queuing models.

1 Introduction

New ways for dealing with production environments have been appearing, in order to reduce lead times, to improve reactivity and to fight constant change and complexity imposed by actual markets. In fact, competition is characterized by volatile demand, less production costs and emergence of more customized products. This new reality naturally leads companies to network with other companies and incites to cooperation through different axes, namely subcontracting.

On the other hand, companies that face several propositions of new items production, have to choose among them which proposals to accept according to the new item's parameters. The choice is generally based on the evaluation of the total profit ensured upon accepting each combination of proposals. The idea is that companies don't accept any series of products if there is no more benefits resulting, and look for proposals which add the highest benefit as well.

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Decomposition algorithms for planning the production of a real shampoo industry [★]

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Abstract

We present in this paper the problem of planning the production of various capillary products in a real shampoo industry. The overall production system consists of three services: the making, the temporary storage and the packing services. Everyday, the packing service of the company transmits to the making service plans of orders to be produced (also called *batches*). Each plan corresponds to the work that has to be performed by one packing line for the next production horizon. The making service gathers several making units and is in charge of producing the batches that will later on be packed in bottles by the packing service. The aim of this scheduling problem is to assign the batches to the making units and to schedule them on their resources. The objective is to minimize the number of cleanings of the making resources. We model the problem on one making unit as a three stage Hybrid Flowshop with a common server of setups. We also present experimental results of decomposition heuristics that we have developed to solve this problem.

Key words: Hybrid Flowshop, Family dependent setup times, Common server, Greedy algorithms.

1 Introduction

We address a scheduling problem occurring in a real-world industry of capillary products production. The overall production system consists of three services: the making, the temporary storage and the packing services. The production process is led by the packing service in which production targets are fixed on the planning horizon according to known deterministic market needs. The planning of the packing service is done under the assumption of enough making and storage capacities. The making service is in charge of producing the products that will later on be packed in bottles by the packing service. The storage service is the interface between the making and the packing services: whenever a product is produced by the making service, it is delivered to the storage service before being sent for packing.

Every day, the packing service plans the production for the next 24 hours for each packing line. After that, it transmits the planning of orders to be produced (also called *batches*), one for each packing line, to the making service. Several *making units* compose the making service and have to produce and transfer the batches to the storage facility. A batch within a storage tank is supplied to the intended packing line according to its planning.

A batch is a fixed and indivisible amount (12 tons) of a kind of shampoo product (also called a *family*). Here, "indivisible" means that each batch has to be entirely produced by one making unit, stored in one tank and

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Capacity planning of a semi-conductor manufacturing information system: building a n-parameters tree-structured regression model through data analysis *

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Abstract

This paper presents the first results of a PhD thesis developed in collaboration with the company ST-Microelectronics. The overall objective is to anticipate the impact of business activity changes on the capacity of the physical resources of a complex semi-conductor manufacturing information system (IS). Our intention is to build a systemic model, allowing the integration of complex business workloads, in order to test and anticipate business scenario changes. In that perspective, an iterative method is proposed: through two interrelated exploratory and explanatory phases, both mixing qualitative and quantitative analyses, we suggest a way to create a n-parameters tree-structured regression model of the IS considered.

Key words: information system change scenario, complex system modeling, information system capacity planning, data analysis, regression models, semi-conductor industry

1 Introduction

This paper discusses the first results of a research work developed by a PhD thesis in collaboration with the company ST-Microelectronics. The general research objective is to anticipate the impact of business activity and manufacturing system changes on the capacity of the resources (servers, databases ...) of a complex information system (IS). This work is carried out within a semi-conductor factory and considers its manufacturing IS. It is commonly accepted that IS is crucial to the performance of semi-conductor production systems [15] and its capacity needs to be carefully sized, to provide optimal performance while limiting costs. However, managing such an IS is a challenging task, due an extremely changing production activity (production ramp-ups, deployment of automated processes, technology evolutions...). ST-Microelectronics IS managers look for a method aimed at evaluating predicatively “what if” scenarios, so as to better anticipate how business activity changes could impact IS performance. The current paper only focuses on a first step on this research, which consists in building an IS model, with good capabilities of prediction.

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ProdLineSim: a simulation engine for multistate production lines*

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Abstract

In this paper we introduce “*ProdLineSim*”: an object-oriented simulation engine used to simulate the behaviour of multistate production lines (i.e. subject to multiple failure modes or with the ability to work in a degraded operating mode). *ProdLineSim* is a discrete event simulation engine written in .NET and built based on the three-phase approach. It is used to validate our analytical models for the performance evaluation of multistate production lines. Since it is designed in object-oriented programming style, it can be extended and adapted to the simulation of other production lines structures and/or the evaluation of other configurations.

Key words: Performance evaluation, Simulation, Production lines, Multistate systems

1 Introduction

Due to constant technological change and fierce competition, companies shall ensure to quickly adjust to changes and transformations imposed by markets smaller and more difficult to penetrate. Thus, to remain competitive, the main concern of each entrepreneur is profitable operations aiming at the highest yield on its production system which typically represents a significant investment in an industrial project. Thus, it is necessary to meet production forecasts and profitability, as any deviation from these forecast results in an increase in the production costs. Hence, it is important to use effective methods for the analysis of the performance of production systems.

In multistate production lines, machines can be subject to different kinds of failures which occur at different frequencies and require different amounts of time to be repaired [1][5][10]. In another type of multistate production lines, also called reconfigurable systems [7], service continuity under failure may be allowed, on the basis of a reduced level of functionality. Such a system is considered as a set of equipments partitioned into a subset of essential equipments and a subset of non-essential equipments. An essential equipment is one whose failure causes the entire system shut-down. In contrast, at the failure of a non-essential equipment, the service is allowed to continue but implies the degradation of production. This continuity of service may be accomplished elegantly, rather than just by throwing money at the problem with brute-force redundancy.

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Simulation-based-optimization to solve a multiobjective hybrid flowshop scheduling problem [★]

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Abstract

This paper deals with a multiobjective hybrid flowshop scheduling optimization problem. Due to the difficulty to develop a mathematical model of the studied problem in order to solve it with an analytical approach, an efficient simulation with ARENA is applied to model the considered flowshop. We have proposed a special pre-emption structure to ensure that the job sequence in each machine corresponds to the solution encoding of the resolution method. The latter is a well known multiobjective genetic algorithm NSGA-II which is applied to optimize the makespan and the total tardiness of the production. The results of the NSGA-II algorithm are compared with industrial solutions and an exact method for small size problems to prove the efficiency and the feasibility of the proposed algorithm.

Key words: Hybrid Flowshop, Multiobjective optimization, NSGA-II, Simulation, ARENA, Assembly line

1 Introduction

A hybrid flowshop consists of several stages of machines, and at least one stage must have more than one machine in parallel. This type of workshop is a typical problem for several production and service industries such as electronics manufacturing, petrochemical production and textile production. The real world scheduling problems are always considered in a multiobjective way where several different criteria are optimized simultaneously. Multiobjective optimization consists of finding a set of non-dominated feasible solutions (Pareto optimal solutions) that optimize the considered objectives instead of one optimal solution. This is due to the fact that no single solution can be better than any other one with respect to all objective functions.

There are many approximated methods to solve the multiobjective optimization problems (MOPs). Recently, the researchers have focused on the use of multiobjective genetic algorithms based on Pareto dominance relationship. The Pareto based approaches are widely applied for solving MOPs, such as Multiple Objective Genetic Algorithm (MOGA) [7], Niche Pareto Genetic Algorithm (NPGA) [8], Non-dominated Sorting Genetic Algorithm (NSGA-II) [5], Strength Pareto Evolutionary Algorithm (SPEA-II) [16], Pareto Archived Evolution Strategy (PAES) [12], Pareto Envelope based Selection Algorithm (PESA) [4].

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Degradation of the Available Information over Time in Layout Design: A Fuzzy Evolutionary Approach *

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Abstract

One of the problems encountered in industry is how to arrange the machines on the surface of the workshop, which is commonly called a layout problem. At this design stage, the workshop is not in phase of production yet and production data used to optimize the placement of machines (e. g. part mix, operating time) are often rough estimates, which can be more or less accurate. Unfortunately, most approaches that try to solve this type of problems, consider that the required data are available with enough certainty. If good forecasts about what is to be produced in the next weeks can be relevant, they will obviously become more and more unreliable as the considered period of time will increase, so that layout found using classical approaches can turn out not to be relevant on the medium or long term. We propose an approach to design a layout in a context where information degrades over time, which is usually the case for real applications. We propose a resolution approach based on a fuzzy evolutionary algorithm, which includes vague considerations. Our experimental results show the importance of the consideration of the degradation of the information.

Key words: Layout problem, Fuzzy data, Degradation of information, Evolutionary algorithm.

1 Introduction

Layout problems are generally addressed using optimization approaches [7]. Unfortunately, at the time when a system is designed, the information required for this optimization about the production to be carried out by the future system is not known with certainty. This is typically the case for the production demand of each part. Forecasts can be used but, if they can be accurate on the short term, they turn out to be much more difficult to obtain on the medium terms and can even become inaccurate on the long term. Indeed, it is known that the markets are subjected to strong fluctuations and the customers' demand can change over time. As noted in [10] and [16], 1/3 of USA companies undergo major reorganization of the production facilities every 2 years and on

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An improved Particle Swarm Optimization for solving constrained engineering design problems^{*}

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Abstract

This paper addresses engineering problems modelled as analytic equations. The analytic model based method aims to describe both multi-physic behaviour and economic characteristics of the product. This model is processed as a global constrained optimization program. We propose to adapt a particle swarm optimization algorithm to solve this constrained model. Indeed, we introduce a mechanism to handle constraints in PSO algorithm based on a model reformulation and on a feasibility-based rule. In order to show the performance of the constrained PSO proposed, several experiments are performed on well-known used benchmark and on the optimal design of electrical actuators.

Key words: preliminary design, analytical model, global optimization, particular swarm optimization, constraint-handling

1 Introduction

The objective of this paper is to develop powerful optimization algorithms enough to handle complex engineering problems. An engineering optimization problem consists of a set of analytic equations describing the physical behaviour of the product and dealing with several engineering fields (mechanics, heat, electrical...). These equations must be strongly fulfilled and has several complexity levels. They can either be explicit, implicit or including functional equations (ODE, integrals). They are mostly continuous, non-linear and non-convex. Global optimization is an important issue in the field of product engineering allowing to reduce costs, to improve product performance, reliability and shorten design time. The analytic models related to the engineering design applications are assumed available. Thus, this paper deals only with the optimization step.

The selection of the solving algorithm is extremely important. This will be guided by the problem formulation and the expected results. Nowadays, there are two kinds of methods to solve global optimization problems: deterministic methods and stochastic methods. Many deterministic algorithms exist to solve problems with particular structures: convex optimization for convex functions, simplex algorithm for linear programs, quadratic programming for quadratic functions. The engineering problems we solve belong to a large and complex class of optimization problems with non-linear and non-convex functions. Therefore, it is difficult to find exact global optima in a reasonable runtime. The above shortcoming may be avoided through the use of evolutionary algorithms which may not be able to guarantee that the global optima have been found. The objective function and the constraints are not required to be differentiable, continuous, or even explicit. Moreover, evolutionary algorithms have a good global search ability.

In this paper we are interested in attempting the capabilities of the particle swarm optimization (PSO) to solve real engineering problems. PSO is an evolutionary global optimization method mainly dedicated to continuous problems. It was introduced by Kennedy and Eberhart in 1995 [18] and based on the observation of the social behaviour of a population of animals (birds, fishes). This algorithm is useful to optimize engineering problems.

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Solving Power Control Problems in Wireless Networks via DCA [★]

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Abstract

Nowadays the wireless networks are becoming an innovative business environment in which new values can be created by competing as well as collaborating enterprises through innovation. Power control is typically used in wireless cellular networks in order to optimize the transmission subject to quality of service (QoS) constraints. It has been shown earlier that the power control problem in the wireless cellular network framework can be efficiently solved using the so-called *geometric programming*. However, in order to enable the application of geometric programming to solve the throughput maximization or weighted sum of data rates maximization problems, $\text{SINR} + 1$ has to be approximated as SINR where SINR is the signal to interference-and-noise ratio. Such change of the original problem formulation is obviously imprecise and might be very loose, especially at low SINR regime which is an usual scenario for systems with CDMA applications. In this paper, based on *difference of convex functions* (DC) programming and *DC Algorithm* (DCA), we investigate a new solution method for solving the aforementioned problems. Albeit sub-optimal, the numerical simulations are compared with *geometric programming* show that the proposed algorithm is an efficient approach.

Key words: wireless communications, quality of service (QoS), DC programming, DC Algorithm.

1 Introduction

The technology and business of wireless communication system have been developed dramatically since 1990s. With new mobile satellites coming on line, business arrangements, technology and spectrum allocations make it possible for people to make and receive telephone calls anytime anywhere. Today, the mobile telephone success story calls the wireless communications community to turn its attention to other information services, most of them in the category of "wireless data" communications. Wireless technology is a truly revolutionary paradigm shift, enabling multimedia communications between people and devices from any location. It also underpins exciting applications such as sensor networks, smart homes, telemedicine, and automated highways. Wireless networks continue to develop, usage has grown in 2010. Cellular phones are part of everyday wireless networks, allowing easy personal communications. Inter-continental network systems use radio satellites to communicate across the world. Emergency services such as the police utilize wireless networks to communicate effectively. Individuals and businesses use wireless networks to send and share data rapidly, whether it be in a small office

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A DC programming approach for the constrained two-dimensional non-guillotine cutting problem^{*}

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Abstract

We investigate a new application of DC (Difference of Convex functions) programming and DCA (DC Algorithm) in solving the constrained two-dimensional non-guillotine cutting problem. This problem consists of cutting a number of rectangular pieces from a large rectangular object. The cuts are done under some constraints and the objective is to maximize the total value of the pieces cut. We reformulate this problem as a DC program and solve it by DCA. The performance of the approach is compared with the standard solver CPLEX.

Key words: DC Programming, DCA, Constrained two-dimensional non-guillotine cutting.

1 Introduction

The field of combinatorial optimization involves many challenging problems. Different practical applications of these problems, motivates the researchers to develop new methods in order to solve them as efficiently as possible. One of the important classes of combinatorial optimization problems is the class of the cutting and packing problems. The constrained two-dimensional non-guillotine cutting problem (NGC) is one of the cutting and packing problems that have been studied by several researchers ([1,2,12,18]). The constrained two-dimensional non-guillotine cutting problem consists of cutting a number of rectangular pieces from a large rectangular object. The cuts are done under some constraints and the objective is to maximize the total value of the pieces cut.

This problem arises in several practical applications, such as cutting the steel or glass plates into required sizes, cutting the wood sheets to make furniture etc. [1]. The optimal solution of this problem minimizes the amount of wastes produced (see Fig. 1).

In this study, we consider the constrained two-dimensional non-guillotine cutting problem and we investigate a deterministic approach based on DC programming techniques to solve it. The particular interest of the work is in the design of the algorithms called DCA (DC Algorithm). This approach is a local deterministic method based on DC (Difference of Convex functions) programming. The DC Algorithm (DCA) was first introduced,

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A DC programming approach for mixed integer convex quadratic programs [★]

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Abstract

In this paper, we proposed local and global DC (difference of convex functions) programming approaches for solving the mixed integer convex quadratic programs (MICQP). We develop a DC programming formulation of the mixed integer program via the continuous reformulation techniques for integer set, this DC program can be solved by an efficient local optimization algorithm - DCA (DC Algorithm). Combining DCA with a Branch-and-Bound scheme, we proposed a global optimization method (GOA-DCA). Some preliminary numerical simulations comparing DCA, GOA-DCA and CPLEX will be reported which show the good performance of our approaches.

Key words: Mixed integer convex quadratic programs (MICQP), DC Programming, DCA, Branch-and-Bound, GOA-DCA

1 Introduction

Considering the optimization problem:

$$(MIQCP) \quad \min\{f(x, y) := x^T Q_0 x + y^T P_0 y + c_0^T x + d_0^T y : (x, y) \in C, x \in \mathbb{R}^n, y \in \mathbb{Z}^m\}$$

$C = P \cap Q$ is assumed to be a nonempty compact convex set, where $P := \{(x, y) \in \mathbb{R}^n \times \mathbb{R}^m : Ax + By \leq b, A_{eq}x + B_{eq}y = b_{eq}, x \in [\underline{x}, \bar{x}], y \in [\underline{y}, \bar{y}]\}$ is a set of linear constraints (including linear equalities, linear inequalities and box constraints); $Q := \{(x, y) \in \mathbb{R}^n \times \mathbb{R}^m : x^T Q_i x + y^T P_i y + c_i^T x + d_i^T y \leq s_i, i = 1, \dots, L\}$ is a set of convex quadratic constraints (i.e., all matrices Q_i and P_i are positive semidefinites). This problem is called *Mixed Integer Quadratic Convex Program* (MIQCP) which is a nonconvex program since the integer variables destroy the convexity of the constraints.

Many classical combinatorial optimization problems are in fact one special case of this formulation, such as the mixed 0-1 linear program (M0ILP), the mixed integer linear program (MILP), the mixed integer quadratic convex program (MIQCP) etc. Many application problems in Financial Optimization, Telecommunication, Data Mining, Bioinformation, Cryptography... are MIQCPs (see [1],[2],[7],[11] and [16–18]). Therefore, solving MIQCP is very important both on theoretical and practical aspects. However, it is well-known that MIQCP is a NP-Hard problem and difficult to find its global optimal solution especially for large-scale problem. The existing methods such as Branch-and-Bound method can only solve small-scale problems. In this paper we propose to reformulate the MIQCP as a DC program and then solving it via continuous optimization approach in DC programming.

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A performance aggregation model for choosing a set of actions in a PETRA industrial improvement approach*

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Abstract

Industrial companies have to continuously improve their performance, which is defined in terms of numerous and multi-level criteria. According to the Deming wheel principle, decision-makers need to be provided with sound and pragmatic improvement methodologies, supplying operational tools for the objectives' definition, the action choice and the performance expression. Based on the generic PETRA methodology and using an established performance model that expresses overall performance by aggregating elementary ones, this article is a contribution to the decision-makers' information needs. By considering performance as a satisfaction degree of a given objective, we particularly focus, here, on the improvement of an overall performance, and thus on the choice of the right opportunity viewed as the best subset of relevant actions among the set of potential actions. Therefore the notion of action impact on the elementary performances is defined. Then the problem of the impact of a subset of actions on the elementary performances is posed and several ways are proposed to deal with it. Lastly the subset of actions impact on the overall performance is defined by a performance aggregation model. The proposed approach is applied to a case study submitted by an automation component manufacturer.

Key words: Industrial Performance, Actions impact, Set of actions impact, Aggregation, Improvement approach

1 Introduction

In the current context of financial crisis and economic globalisation, the performance continuous improvement needs a strong synergy between the company strategy, the defined objectives and the launched actions. This is the purpose of improvement philosophies such as Kaizen [17], the Total Quality Management [22], the Lean Manufacturing [26], 6 Sigma [23]... All these improvement approaches are based on the Plan – Do – Check – Act (PDCA) cycle. Namely, improvement actions are first planned knowing the associated expected performance measures, before they are implemented, then checked according to both the fixed targets and the considered performances, and corrected if necessary, and so on as long as some improvements are still achievable [9].

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Optimizing layout of a very high density storage system^{*}

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Abstract

This paper studies random storage in a very high density storage system where products are stored multi-deep. Although such storage systems are still rare, they are increasingly used, for example in automated car parking systems. Each load is accessible individually and can be moved to a lift on every level of the system in x- and y-directions by a shuttle as long as an open slot is available next to it, comparable to Sam Loyd's sliding puzzles. A lift moves the loads across different levels in z-direction. We derive the expected travel time of a random load from its storage location to the input/output point. We optimize system dimensions by minimizing the retrieval time.

Key words: Logistics, warehousing, very high density storage system, random storage

1 Introduction

Storage facilities, including warehouses, distribution centers and container terminals, can be found everywhere in supply chain networks. They form the key nodes in supply chain networks decoupling demand from supply in time and quantity. Over the past decades, these facilities have evolved towards higher storage density, more automation, and more intelligent control. This development is particularly attractive as (1) land becomes more scarce and expensive in many densely populated areas, like the Netherlands, or when space is scarce, like within ships or aircrafts; (2) costs of technology-based systems are decreasing, and (3) system response times have to be shortened to earn customers. As a result, a new generation of storage systems is emerging: dense, autonomous and intelligent (DAI) storage systems, also called puzzle-based compact storage systems or very high density storage systems. In a puzzle-based compact storage system, every load is accessible and can be moved between storage locations and input/output (I/O) point. Each unit load can move in x- and y-directions as long as an empty slot is available next to it. In such a system, unit loads are stored in a grid in which at least one location is open, and so the location utilization can reach $(n-1)/n$, where n is the number of storage cells in the grid [5]. Compared to traditional storage facilities where unit loads are stored single deep with many transport aisles, very high density storage systems need less space.

The random storage policy is studied broadly in the literature ([1,2,6,7]). Random storage requires the least data since no product information is used in determining storage assignment [3]. In many studies, e.g., Hausman et al. [6], and Lee and Elsayed [7], it is used as a benchmark to measure the improvements of other storage policies.

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Optimization of two dimensions of a multi- aisle AS/RS with fixed third dimension*

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Abstract

In the present paper we focus on multi-aisle Storage/Retrieval systems. In this kind of systems, we often face dimension constraints of the premises used to house the AS/RS. We end up with one or two dimensions of the fixed system, and we have to find the optimal values of the others. We consider the case where only one dimension is fixed, and we determine the optimal values of the other two, for a minimal cycle time. In order to start this work, we used analytical expressions of a multi-aisle AS/RS cycle time, established by Ghomri et al [2], [3]. These expressions have got three real variables that correspond to displacement times in the horizontal direction (t_h), the vertical direction (t_v) and between aisles (t_p). Each time, we suppose that one of the displacement times is constant, and we calculate the optimal values of the other two.

Key words: Optimization, Multi-aisle AS/RS, AS/RS storage/retrieval.

1 Introduction

One of the most important objectives of Flexible Manufacturing Systems (FMS) is to minimize all the factors that may lead to additional costs without providing any additional values to the products. Storage is one of these factors. During this operation, the product undergoes no transformation and, consequently, acquires no increase in value.

Furthermore, it becomes costly in time and money. For this reason, the best storage policy in Flexible Manufacturing Systems would be «no storage at all». It is nevertheless obvious that this statement – though sensible – is not controllable for as much. Storage still remains necessary for a good functioning of manufacturing systems. In an assembly line, for instance, if a part – however small and cheap it is – would be missing, it could paralyze the whole line.

Therefore, the storage system must be reduced to its minimum without being totally annihilated (this would consist in minimizing the initial investment, the number of stored products, storage times...).

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A fast and scalable algorithm for a multi-stage manufacturing problem[★]

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Abstract

This paper deals with minimizing the cost of setup, transportation and inventory of a multi-stage manufacturing system with the presence of a bottleneck. The considered optimization model is a mixed integer nonlinear program. We propose an approach based on DC (Difference of Convex) programming and DCA (DC algorithm) to solve the problem. The mixed integer nonlinear problem is first reformulated as a DC program. Afterward, DCA is developed to solve the resulting problem. For evaluating the goodness of the solution furnished by DCA, we find a lower bound of the optimal value by solving a convex relaxation problem. The numerical results show that DCA is a fast and scalable algorithm for finding a good approximation solution: it realizes well the tradeoff between the efficiency and accuracy.

Key words: DC Programming, DCA, Multistage manufacturing problem, Lot size, Unequal batches, Bottleneck.

1 Introduction

Multistage manufacturing system is a system in which a product is produced in a sequence of separated manufacturing operations. An important goal is lot sizing while minimizing the cost of setup, transportation and inventory. In the literature, a huge number of different models have been developed. In [14], the author proposed a model where a lot Q is divided in b batches of equal size ($1 \leq b \leq Q$). The effect of dividing the production of Q units in b batches is to reduce the manufacturing cycle time and the process inventory. In [2], the author gave a model for the problem of two stages where an uniform lot size and the unequal batch sizes that follow geometric series have been used. His approach leads to lower costs than those obtained by equal size batches (ref. [2],[3],[15]). In 2001, Bagaschewsky et al. extended this model for the problem of multistage production [1]. They adopted an uniform lot size through all stages with a single setup cost and without interruption at each stage. The batches can be transported to the next stage upon completion and the number of the batches can be different across stages. Here the authors assumed that the production rates of all stages are greater than the demand rate.

In [6], Hsiao et al. proposed an extension of the model given in [1] by considering the presence of a bottleneck (bottleneck appears in a serial supply chain if the minimum production rate at all stages is smaller than the demand rate). Two different uniform lot sizes are produced: one is pulled through the upstream stages from the bottleneck, and another is pushed through the downstream stages from the bottleneck. The proposed model is a mixed integer nonlinear programming problem (MINLP). It is divided into pull and push sub-models. The

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Solving Job Shop Scheduling Problems with a Generic Bee Colony Optimization Framework^{*}

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Abstract

Job Shop Scheduling Problem (JSSP) is a Combinatorial Optimization Problem (COP) with NP-hard nature [14]. Hence, finding an optimum solution for a JSSP with large scale of data and constraints is complicated. This paper presents a generic Bee Colony Optimization (BCO) framework for solving JSSP. The proposed BCO framework realizes computationally the foraging behaviour and waggle dance performed by bees. It is also integrated with mechanisms such as elitism, local optimization and adaptive pruning. The framework is designed using the object-oriented approach where it contains a set of domain independent classes and abstract classes. The framework can be extended to solve other COPs and any enhancement added to the proposed framework will be applicable across all other COPs. A set of 82 JSSP benchmark instances were employed as the testbed and the results show that the proposed BCO framework is able to solve 54% of them to an average deviation percentage of $\leq 1\%$ from known optimal or known upper bound.

Key words: Bee Colony Optimization, Job Shop Scheduling Problem, bio-inspired computation, metaheuristic, soft computing.

1 Introduction

Bees are highly organized social insects. The survival of the entire colony depends on every individual bee carrying out its tasks in a cooperative manner. Bees practise a systematic task segregation among themselves to ensure a continued existence of its colony. They perform various tasks such as foraging, reproduction, taking care of young and constructing hive. Of these, foraging is one of the most important activity as bees have to ensure an uninterrupted supply of food to the colony. When a bee found a new food source, upon flying back to its hive, the bee would perform an informative waggle dance to its hive mates [32]. Its intention is to attract more bees towards the newly discovered food source. Via the waggle dance, important information about the newly discovered food source (e.g. direction and distance) is conveyed to other bees. The waggle dance serves as an important communication medium among bees.

Various bees-inspired algorithms that apply the bee foraging behaviour and waggle dance model have been attempted in different domains [12,31]. Among them are the Bees Algorithm proposed by Pham et al [21], the

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Optimisation of Deep Drawing Process Time and Cost Using the Bees Algorithm

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Abstract

The multi-stage deep drawing is a widely used process in the manufacturing industry for parts that require several stages, in particular different combinations of drawing, redrawing and ironing in order to achieve the required shape and dimensions. The key problem here is optimising the main process variables in order to determine the resolution of the multi-stage deep drawing process. This paper presents the use of the “Bees Algorithm” applied to the deep drawing process to find the near optimal solution for the process which minimises the process time and cost. The bees algorithm is a swarm based optimisation method that mimics the food foraging behaviour of honey bees. The results obtained in this study show that the “Bees Algorithm” is able to optimise the deep drawing process, and perform better than the “Deep Drawing Tool” which uses a numerical method to optimise the process time and cost.

Key words: Bees Algorithm, Optimisation, Deep drawing, Deep Drawing Tool, Redrawing, Ironing

1 Introduction

The manufacturing industry is under constant pressure to improve its processes and reduce costs. The multi-stage deep drawing is a widely used process in the manufacturing industry for parts that require several stages of different combinations of drawing, redrawing and ironing in order to achieve the required shape and dimensions. The key problem here is optimising the main process variables in order to determine the resolution of the multi-stage deep drawing process.

In the literature one can find ways of optimising this process, such as the work done by Choi et al. [2] where an intelligent design support system is used for this purpose. In the case of Colgan and Mohaghan [4] they used the finite element method but focused on drawing and redrawing process without considering the ironing process. Padmanabhan et al. [9] looked to optimise the costs through the finite element and Taguchi methods. In general, the contributions made by specific studies in the literature relate to some key parameters or aspects of the process such as the limiting drawing ratio (LDR) [3], [7], [15], [16], and [1], the redrawing operation [3] or the initial blank design [6]. Hence, the literature lacks a broader model with capacity to design the three processes of drawing, redrawing and ironing are of industrial interest and necessary for optimising the deep drawing process.

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Robust genetic algorithm for RCPSP with uncertain activities processing time^{*}

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Abstract

The objective of the present work is to establish a robust approach for the resource-constrained project scheduling problem (RCPSP) under uncertainties with the special case of activities durations variability. The proposed approach is based on a Genetic Algorithm (GA) which incorporates both performance and robustness measures. Several robustness metrics were proposed and discussed in the literature. We adopt minmax and minmax-regret objectives to study the compromise between the makespan and the robustness criteria. The goal is to analyse and compare robustness values and their impact on the solution quality.

Key words: RCPSP under uncertainty, disturbed modes generation, evolutionary algorithm, robustness criteria

1 Introduction

Project scheduling under uncertainty consists of the allocation of activities overtime to scarce resources in an uncertain environment. Uncertainty can be the result of uncertain problem data or unexpected events occurring during the execution time which lead to schedule disruptions. In most of the real cases, deterministic schedules do not support disturbances, during execution and become then invalid.

Recently, many researchers reflects are concentrated on dealing with uncertainties during scheduling process by establishing new scheduling approaches. We distinguish two basic classes of approaches. The first class concerns reactive approach that aims to find the best strategies and scheduling policies to accommodate current solutions to dynamic disruptions. Thus, schedules may be modified during their execution. Proactive approaches work offline and no change of schedule is permitted during execution. The goal of the last approaches is to generate robust schedules with the guarantee of performance solution. The schedule robustness [3] can be defined as the capability to absorb unexpected system variability with the minimum cost.

In project scheduling area, RCPSP represents a general model of large real world applications which is classified as an NP-hard problem [5]. In fact, the search space exploring to find the optimal solution having the minimal project duration (makespan) leads to combinatorial explosion. The robustness problem tackled in a disturbed

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Optimal resource-constraint project scheduling with overlapping modes ^{*}

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Abstract

Overlapping activities is widely used to accelerate project execution. Overlapping consist in executing in parallel two sequential activities by allowing a downstream activity to start before the end of an upstream activity based on preliminary information. In companies, overlapping is examined in resource constraints scheduling without considering interaction between activities and rework caused by alteration of information exchanged until finalized information is available at the completion of the upstream activity. By contrast, most papers deal with overlapping of couple of activities without considering a whole project with resource constraints. We here investigate the resource-constrained project scheduling problem with different feasible modes of overlapping including associated rework. We formulate the optimization problem as an integer linear programming problem. An example of a 30 activity project is provided to illustrate the utility and efficiency of this model. An optimal solution is reached within reasonable computation time. Our results also highlight the closed interaction between resource constraints and overlapping modes and confirms the relevance of jointly consider them.

Key words: Activity overlapping, Concurrent engineering, Project management, Project scheduling

1 Introduction

The RCPSP (Resource-Constrained Project Scheduling Problem) has been addressed in numerous papers. Various models attempt to minimize project time completion while considering limited resources [6]. Among extensions addressed in the literature, overlapping activities is one of the most applied strategies to accelerate a project either in its early stage when the schedule baseline is set up or following project delay during its execution. Overlapping is inherently risky as it entails that downstream activities start before the information they require is available in a finalized form. However, additional workload required to accommodate the

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The state space in stochastic activity networks: worst case performance bound of the T-1 heuristic^{*}

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Abstract

The state space of stochastic activity networks becomes quickly unmanageable with increase of the number of activities. A ‘tunneling’ heuristic, labeled T- k , is proposed that is akin to the ‘filtered beam’ approach in branch-and-bound search trees, in which k out of the $m \geq k$ ‘active’ activities are selected for completion. When $k = 1$ the heuristic reduces to branching from the activity with the least expected duration. We demonstrate that the worst case performance bound of this heuristic is unbounded, meaning that it can be arbitrarily bad.

Key words: Activity Networks, State Space, Tunneling

1 Background

The CPM/PERT analysis (Critical Path Method/Program Evaluation and Review Technique), introduced in 1959 [4],[6], modeled the activities in projects as directed acyclic networks with deterministic (in the case of CPM) or stochastic (in the case of PERT) activity durations. This inaugurated the field of *Activity Networks* (AN's) in project planning and management (PP&M). Under stochastic conditions it has been known for some time that progress in the project execution can be represented by tracing over a ‘state space’ that is generated from the original AN based on which activity among the ‘active’ (i.e., on-going) ones finishes first. Kulkarni & Adlakha [5] capitalized on this idea, and assuming that the duration of all the activities are exponentially distributed, succeeded in modeling the problem as a *continuous time Markov chain* (CTMC) and in securing a recursive formula for the non-central moments of the completion time of the project – or, for that matter, any subset of the activities. Sobel, Szmerekovsky and Tilson [8] used the same idea to determine the start time of the activities so as to optimize a given criterion function. Elmaghraby & Ramachandra [1] and Elmaghraby & Rudolph [2] used the CTMC model in the allocation of a resource to the activities so as to optimize an economic objective function composed of the cost of resource usage and a penalty for tardiness beyond a target completion time. More recently, Elmaghraby et al [3] proposed the extension of all suggested procedures to non-exponential distributions via the device of ‘Phase-Type distributions’.

The Achilles’ heel of all these studies is the vast expansion of the state space with the number of activities, especially when their majority are in parallel: A project with n activities in parallel would give rise to $n!$ states, which renders exact analysis un-achievable.

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Project scheduling in an industrial context[★]

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Abstract

This paper presents a generic model for an industrial project scheduling problem. This problem is an extension of the RCPSP and the MultiSkill RCPSP. The main differences with RCPSP are that both preemptive activities and non-preemptive activities are considered and resources requirements of activities are given in term of skills. This model and its resolution methods aim to be used into *OFBiz* open source ERP, and then have to satisfy some industrial constraints. One of these constraints is the use of a rule based engine to build solutions. Thus this paper has two objectives (1) propose a general model for this problem and (2) evaluate the impact of the use of a rule based engine to get solutions. We first propose an ILP formulation. Then to evaluate the benefit or the drawback to use a rule based engine for solving this industrial problem. Hence, preliminary results are presented comparing a method using a rule based engine and a method based standard programming. In the best of our knowledge, there is no implementation of the RCPSP multi-skill algorithms inside ERPs, in general the ERPs refer to another scheduling software to retrieve the result of scheduling algorithms. In *OFBiz*, time execution limit for web services is user-defined so we can say that there is no time constraints related to environment.

Key words: Project scheduling, multi-skill, preemption.

1 Introduction

Project scheduling problems are among the most studied scheduling problems in the literature. Resource Constrained Project Scheduling Problem is the most classical version of these problems. In the RCPSP, a set of non-preemptable activities have to be processed. Activities require a given amount of each resource to be processed. Resources are available in limited amount. Activities are submitted to classical end-to-start precedence relationship. This problem is known to be NP-Hard [5] and several states of the art can be found dealing with RCPSP [7]. Resource modeling has been one fruitful research direction for new project scheduling models. Resources can be renewable, non renewable or doubly constrained. Moreover resource requirements of activities may differ from one mode to another. These types of resources are modelled in the Multi-Mode Resource Constrained Project Scheduling problem [12,8]. Several methods for solving MM-RCPSP have been proposed including exact methods such as branch-and-bound and heuristics. Recently, authors have proposed to enlarge RCPSP model to take into account the notion of skills, i.e, staff members involved in the project realization can contribute only to a given subset of activities. This is known as the Multi-Skill Project Scheduling Problem [4,2]. Resources considered are human resources, i.e. staff members, each of them are able to perform more than one kind of activities. This model is useful in several industrial contexts, and for instance in the context of IT companies where human resources are the most constrained resources. Moreover availability periods are

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Solving for a Quay Crane Scheduling and Assignment Problem by Simulated Annealing^{*}

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Abstract

This paper proposes a simulated annealing (SA) algorithm for the quay crane (QC) scheduling and assignment problem, namely QCSAP, whose objective is to minimize the sum of completion time of loading and unloading containers on vessels. The efficiency of the proposed SA is compared with the genetic algorithm (GA) proposed by Tavakkoli-Moghaddam et al. [14] considering the statistical analysis. The solution results show that our proposed SA has better efficiency than the GA in terms of the computational time; however, in overall the GA outperforms the SA in terms of the objective function value.

Key words: Quay crane scheduling; Assignment; Container terminal; Simulated Annealing; Genetic algorithm.

1 Introduction

The container terminals play an important role in cargo transportation chain during last decades, and utilizing of container rapidly increases, in which the terminal container's productivity is the main objective of port operations. In container terminals, productivity is measured with two factors: 1) ship operations where containers are unload/load from and onto a vessel and 2) receiving and delivery operations where containers are transferred to and from outside trucks [5]. There are several decision points in each container terminal that are influenced together as berth planning, quay crane (QC) or work scheduling and unload/load sequencing. The berthing time and the berthing position of a container ship on a dock should be determined during the process of berth planning. The bays sequencing in a vessel by each QC and the time schedule for the services are determined by QC scheduling. The necessary data for QC scheduling are stowage plan of a ship, the ready time of each QC, and a yard map showing the storage locations of containers bound for the ship. Ultimately, during unload/load sequencing, the unload/load sequence of each containers are determined based on a QC schedule. This paper focuses on the QCSAP that is related to the second stage of ship operation planning.

Minimizing the makespan of vessels is the main objective of a QC scheduling problem. Kim and Park presented a mathematical model for a QC scheduling problem [5]. In this paper, we extend their model incorporating with

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Approximate solution methods for the parallel machine scheduling problem with total tardiness minimization*

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Abstract

The present article deals with the parallel machine scheduling problem to minimize the total tardiness when jobs have different release dates. In this case, each job has its own release date, processing time and due date. The machines are identical (all the machines have the same speed) and they are available during the entire scheduling period. The schedule can not include preemption or splitting. This problem is considered NP-hard. To our knowledge there are no publications about this particular problem. In this article three approximate solution methods are proposed to solve the problem: a heuristic method adapted from the BHG (Biskup, Heremann and Gupta) heuristic; an Ant colony algorithm; and a Genetic algorithm. The mathematical formulation of the problem is also included. At the end, these different methods are tested on 1125 instances and the obtained results are compared.

Key words: Parallel machine, scheduling problem, total tardiness, meta-heuristics

1 Introduction

This article presents the scheduling problem of n jobs on m identical machines with the objective to minimize the total tardiness of jobs. The scheduling is built without preemption or splitting and each job has its own processing time, due date and release date. Here the machines are supposed to be identical and available during all the scheduling period; this leads the processing time of a job to be the same in any of the m machines. As the problem dealt here includes release dates, a job i can only be scheduled in a machine j at a time t if $t \geq r_i$ where r_i is the release date of the job i . Only one job can be processed at once in the machine j . A job is late when its completion time is greater than its due date. The tardiness is the positive difference between the due date and the completion time of a tardy job. The problem can be represented following the Lawler's [7] representation as problem $P : Pm / r_i / \sum T_i$.

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Production scheduling problems with stage-dependent inventory and delivery considerations^{*}

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Abstract

We consider a general two-stage scheduling problem in which n identical jobs with given due dates are batch processed by one first-stage processor and then, in the second stage, the completed jobs need to be batch delivered to a pre-specified customer by a capacitated transporter. Delay is not allowed. Moreover, it is supposed that a job which is finished before its delivery date or arrive at the customer before its due date will incur an earliness penalty which is equivalent to the corresponding inventory cost. The objective is to find a coordinated schedule of production and transportation such that the sum of setup, production, inventory and delivery cost is minimized. We firstly proposed a branch and bound (BBP) algorithm based on some properties for solving this problem. Then in order to improve the time efficiency, we proposed a heuristic-greedy algorithm (G). Computational results indicate the efficiency of the proposed algorithm.

Key words: Production scheduling, Greedy, Branch and Bound, Batch Scheduling

1 Introduction

In recent years batch scheduling problems with delivery consideration have gained new importance with the development of supply chain management. The relevant models can be divided into two variants depending on two different assumptions. The first is batch availability, under which a job only becomes available when the complete batch to which it belongs has been processed. The second is job availability under which a job becomes available once it has been processed. This paper adopts the assumption of batch availability.

Most of research on batch scheduling with delivery considerations implicitly assume that the production batch size is limited by the transporter capacity (See, for example, paper [2] and [4]). However, in real life applications, when high setup cost exist, large production batches will have the advantage of lower operation cost. But a large production batch may exceed the capacity of the transporter when the transportation resources is scare, (for example, single transporter). Motivated by the above instance, this paper explicitly relax the constraint that the production batch size is limited by the transporter capacity.

The integrated scheduling problems is very important within the framework of supply chain management and has been studied by many of researchers. Several survey papers on scheduling and batching problems are

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Analysis of Hybrid Genetic Algorithms for SDST Flow Shop Scheduling with Multiple Objectives^{*}

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Abstract

Production scheduling is generally considered to be the one of the most significant issues in the planning and operations of a manufacturing system. There are different systems of production scheduling including flow shop in which jobs are to be processed through series of machines for optimizing number of required performance measures. Classical flow shop scheduling problems are mainly concerned with completion time related objectives, however, in modern manufacturing and operations management, on time delivery is a significant factor as for the reason of upward stress of competition on the markets. Hence, there is a requirement of multi-objective scheduling system through which all the objectives can be achieved simultaneously. This paper considers the multi-objective flow shop scheduling problems by considering the weighted sum of total weighted squared tardiness, total weighted squared earliness, makespan and the number of tardy jobs. Different Hybrid Genetic Algorithms (HGAs) have been proposed and their analysis have been made upto 200 jobs and 20 machines sequence dependent set-up time (SDST) flow shop scheduling problems. Initial seed sequence of genetic algorithm has been obtained by four despatching rules and six modified NEH heuristics to form ten HGAs for approximate solutions in a reasonable time. Computational experiments carried out with the benchmark problems of Taillard shows that the proposed modified NEH heuristic based HGAs provide solutions superior to those obtained by others.

Key words: Hybrid Genetic Algorithm (HGA), total weighted squared tardiness, makespan, number of tardy jobs, sequence dependent setup time (SDST).

1 Introduction

Production scheduling is generally considered to be the one of the most significant concern in the planning and operation of manufacturing system. Several production related problems including low machines utilization can be assigned to inadequate scheduling. Better scheduling system has significant impact on cost reduction, increased productivity, customer satisfaction and overall competitive advantage. In addition, recent customer demand for high variety products has contributed to an increase in product complexity that further emphasizes the need for improved planning and scheduling. Scheduling in manufacturing systems is classically associated with scheduling a set of jobs on a set of machines in order minimize several regular and non-regular performance measures. A common flow shop problem consists of n jobs $\{j_1, j_2, j_3, \dots, j_n\}$ to be processed through m machine $\{m_1, m_2, m_3, \dots, m_m\}$ such that each job visit each machine once in a particular order. For a

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Due date setting in permutation flowshop with arrival of new jobs[★]

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Abstract

In this paper we describe a generic scenario in which a manufacturing company must provide due dates for a set of jobs representing (potential) incoming orders. We analyse two different cases: 1) a set of incoming jobs belonging to the same order and the objective is to set a common due date for these new jobs ; and 2) the incoming jobs belong to different orders, and the objective is to set different due dates. Jobs previously scheduled in the system are called old jobs. We also consider two cases: they have committed a common due date and each old job has a different due date. In both cases the due dates must not be violated. Different problems can be identified. The aim of this paper is to analyse these problems in order to identify a number of insights from the viewpoint of order management. The analysis of the problems shows that applying rescheduling is the best option, since better due dates for the new order can be committed. However, the results also prove that the resulting rescheduling problems are (statistically) much more difficult than considering other options.

Key words: permutation flowshop, due date setting, arrival of new jobs

1 Introduction

In this paper we focus our attention in a critical scheduling area: i.e. the due date setting problem. This problem is closely related to order management in production companies, and to the quality of the service offered to the customer, since determining a suitable due date for customer's orders is a key issue to maintain the credibility of a production company. Among the different shop floor layouts, we focus onto the permutation flowshop. We analyse a scenario where we can distinguish two sets of jobs: the old jobs belong to previously scheduled orders, denoted as the set J_O with n_O jobs, and a set of new jobs, J_N , with n_N jobs. We consider two different cases:

- Common due date case. The due date is the same for all jobs in each set. This case represents a situation in which the jobs belong to a single customer, or are produced in a single batch. As jobs in J_O have been scheduled, their common due date, denoted by d , has been already set. The objective is to set a common due date for jobs in J_N without violating the common due date for jobs in J_O .
- Different due date case. Each job belongs to a different customer, or are produced in different batches. Jobs in J_O have different due dates, denoted as d_j , which have been already set. The objective is to set a due date for each job in J_N (a different one for each job) without violating the due dates for jobs in J_O .

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A Memetic Algorithm for the Two-Dimensional Bin-Packing Problem with Partial Conflicts*

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Abstract

The Two-dimensional Bin-Packing Problem (2BP) is a classical problem for which several exact and approximation methods were proposed. In real life applications, such as in Hazardous Material transportation, transported items may be partially incompatible, and have to be separated by a safe distance. This complication has not yet been considered in the literature. This paper introduces this extension called the Two-dimensional Bin-Packing Problem with Partial Conflicts (2BPPC) which is The a 2BP with distance constraints between given items to respect, if they are packed within the same bin. The problem is NP-hard since it generalizes the BP, already NP-hard. This study presents a mathematical model and a genetic algorithm for this new problem. The initial solutions are obtained with an adaptation of the Bottom-left-fill heuristic classically used for the BP. A local search is called to improve the quality of the generated solutions.

Key words: bin-packing, distance constraint, conflicts, genetic algorithm.

1 Introduction

Packing problems form an important class of combinatorial optimization problems that have been studied under different variants (see [2] for a survey). Generally, they consist in placing objects in bins with one, two or three dimensions. This paper deals with the two dimensional problems. Many packing problems involve the insertion of rectangular items in rectangular bins. They mostly differ on the objective function to minimize. Among these problems, we find the Two-Dimensional Bin Packing Problem (2BP) that consists in packing a set of rectangular items into a minimum number of identical rectangular bins.

Several extensions have been studied in scientific publications, including but not limited to rotation of items, limitations on the total weight and/or item costs, incompatibility between items. The Two-Dimensional Bin Packing Problem with Partial Conflicts (2BPPC) is a 2BP with distance constraints between given items to respect, if they are packed within the same bin.

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Optimization of Manufacturing Cell Formation with Extended Great Deluge Approach*

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Abstract

The concept of cellular manufacturing system and cell scheduling have been widely used to meet various production needs. The CMS is a particular case of group technology applied to improve the production efficiency and reduce operational costs. This work addresses the machine/part grouping. The cell formation problem has long been recognized as the most challenging problem in realizing the concept of cellular manufacturing. It belongs to the class of NP-hard problems. To solve this problem an Extended Great Deluge approach algorithm is employed. The results of the proposed approach show a major improvement when compared with the results of one of the so far best algorithms presented by other researchers.

Key words: Extended Great Deluge, Meta-heuristic, Cellular manufacturing system, cell formation, Simulation, Optimization.

1 Introduction

Group Technology (GT) is an industrial philosophy who profit the components similarities to improve the productivity of industrial systems. An industrial system based on the group technology (GT) is known under the name “cellular manufacturing system” (CMS). The cellular manufacturing system is a compromise between the flow shop and job shop; it is greater flexibility and efficiency for small and medium series [12]. The CMS can treat a limited number of different job types and provide an opportunity to reduce setup time, trim work-in-process (WIP) and shorten manufacturing lead and through put times [5]. In a cellular manufacturing system, the parts are classified into families based on similarity of process requirements, and machines are grouped into machine cells based on the requirements for operation of part families. The design and planning of the CMS require cell formation, layout of CMS, production planning and scheduling in CMS [10].

The formation of manufacturing cells has long been recognized as the most difficult problem to realize the concepts of cell formation. It belongs to the class of problems NP-hard, which means that increasing the size of the problem will increase exponentially the computational time for all the optimization techniques answered.

Current literature includes several approaches to cell formation problems which can be classified according to different perspectives. These perspectives go from exact methods (mathematical approaches) to heuristics and/or metaheuristics techniques. However, faced to several weaknesses such as time or duration of convergence and/or the quality of the solutions, other metaheuristics approaches based on the neural networks and genetic algorithms have been investigated. Miltenburg and al. [8] paint a picture of many approaches used for cell formation problem. In spite of high performance of solution, a major fact with these approaches remains: for big size industrial problems, these approaches are not satisfactory because the solution is not always possible and/or

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Cutting tool image data processing for automatic tool wear recognition through artificial neural networks^{*}

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Abstract

In a manufacturing system, machining efficiency is easily influenced by the kind of tool selected at each cutting process. One of the most complex problems for tool selection is that of estimating the life of the tool under a given cutting condition as accurately as possible. As the quality of the cutting tool is directly related to the quality of the product, the level of tool wear should be kept under control during machining operations. Automatic cutting tool wear monitoring is an important aspect in the improvement of production systems.

In this paper, a procedure for the processing of cutting tool images detected during turning tests is presented. Images with standard size and pixel density were produced by elaborating tool image files obtained during machining tests.

A methodology to design artificial neural networks for automatic tool wear recognition using standard images of cutting tool is proposed.

Key words: Cutting tool wear, Image processing, Neural network

1 Introduction

The technology of metal cutting is in permanent evolution and is a field of much interest in terms of computer applications. Cutting tool wear detection and monitoring is a fundamental aspect in the evolution of production techniques. As the quality of the cutting tool is directly related to the quality of the product, the level of tool wear should be kept under control during machining operations.

The recognition of the general conditions of a cutting tool has a major role in the optimisation of machining processes, since the accurate prediction of the exact moment for tool change results in many cases in an effective economy: a longer cutting tool life can be achieved, tolerances can be under control and rejection of pieces by deterioration of the tool conditions can be prevented [1].

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A combination metaheuristic-simulation for solving a transportation problem in a hospital environment*

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Abstract

This paper deals with the scheduling of logistic flows in a hospital environment. This work is based on a study proposed by the CHRU of Clermont-Ferrand, which wants to organize the transport of meals, linen and medicines for internal and external hospitals. The objective is to schedule the activities under precedence constraints, release dates and due dates. Moreover, the realization of each activity requires containers. The number of available containers is limited and known. Some steps require in addition to the containers, production line, loading bay, unloading bay and cleaning area. We have modeled our problem as a PDP-TW with resource constraints. We propose to solve it with a combination metaheuristic - simulation. The simulation model allows to carry the complexity due to the use of multiple resources and the metaheuristic allows to solve the scheduling problem. The results are given for the instances corresponding to the study proposed by the CHRU.

Key words: combination, metaheuristic, simulation model, pickup, delivery

1 Introduction

The CHRU of Clermont-Ferrand sees lot of modifications: the building of new hospital, the reorganization of the care units, the closing down of a hospital, the centralization of the meal production and services to the external hospital. In this study, we work on the transport of meals, linen and medicines. Before the reorganization, 5 drivers and 3 vehicles were used for the 41 activities per day. In the future, the number of drivers and vehicles must allow to realize 86 activities per day. The drivers work according to a planning. This planning is called a shift defined by a beginning date, an end date and a mealtime, so a shift is composed of two slots. Some other resources such as the production lines, loading bays, unloading bays and cleaning areas are available in limited number. These resources must be taken into account for the preparation and the loading, before the delivery, and for the unloading and the cleaning, after the pickup. In a week, the number of activities per day fluctuates but the weeks are similar.

The objective is to propose a decision making aid tool which allows to share the activities for a day between the drivers and to schedule these activities under precedence constraints, release dates and due date, for a given number of resources and given slots for each drivers.

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Application of RSM, Fuzzy Regression and Simulated Annealing for Evaluating of Effective Factors in Vehicle Brake Drum Assembling Process *

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Abstract

This paper aims at optimizing the vehicle brake drum assembling process. Considering the crucial role of the Axle unit, especially its vehicle brake drum which is related to the safety of the passengers, the study of the producing and assembling processes and conducting the quality control experiments during these stages is of great importance. With regard to the great significance of three main factors, namely, seal-oil spindle diameter, seal-oil internal diameter, and nut lock torque as independent variables, the present research attempts to optimize the rotatory torque of the automobile brake drum getting help from the discussions in the response surface methodology (RSM) and the unsteady of the automobile brake drum getting help from fuzzy regression using least absolute deviation estimators. Finally, the optimal solution is perused by a nonlinear programming model and a simulated annealing (SA) algorithm using one of multi-objective existing methods (LP-metric). Comparing the two optimization methods is shown that our proposed SA has better performance rather than nonlinear programming model.

Key words: Design Of Experiment, Response Surface Methodology, Fuzzy Regression, Simulated Annealing.

1 Introduction

The design of experiment is one of the powerful means for refining and improving the producing processes operations. The design starts with determining the goals of the experiment and selecting the process factors. In mathematical words, the goal is to find k operational conditions or factor levels (X_1, X_2, \dots, X_k) so that r response variables (Y_1, Y_2, \dots, Y_r), depending on the type of the problem, become minimized or maximized. In other words, the goals in the design of experiments and response surface methodology which are often conducted sequentially consist of extracting the elements or variables which are effective on response and adjusting their

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Improving Product Performance With Integration Of Using Tasks During The Design Phase: A Behavioural Design Approach*

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Abstract

The design of a product is usually simply based on the consideration of product functions and structures, while product's behaviour in use and user's behaviour are not completely considered during the design phase. Based on the analysis of the existing approaches, a global view of behavioural design approach is proposed as a feasible solution to improve product performance from the design. In order to improve the product performance, our research aims to achieve a better integration between product's behaviour and user's behaviour during the design phase. This paper is mainly focus on the using tasks and user's behaviours. The concept of "Use Plans" is proposed to realize the mapping between the manual functions and user's behaviour.

Key words: behavioural design, using tasks, user's behaviour, Use Plans

1 Introduction

In order to improve the product performance, our research aims to achieve a better integration of product's and user's behaviour during the design phase. In our case, a product could be a production system, a machine or any tools handled or used by a user (correlative working team). The using tasks are directly proposed by design results, which are also the major factor for improving the product performance. We define using tasks as all action, or movement that the product and its user well do to fulfill the product function. The combinations of using tasks elicit the using behavior. To illustrate our problem, we quote here two examples observed in the real companies.

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Eco-Design of Complex Products using System Engineering^{*}

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Abstract

Eco-design is a key element of sustainable development. The particular complexity of this type of design project requires developing a specific approach. This approach must be able to cover needs definition, product design and realization, while integrating the viewpoints of all stakeholders.

We propose an eco-design approach for creating innovative products. This approach takes into account requirements related to the product itself, to the design process and to company organization. To these requirements we will add those that arise from interactions with the external environment. We propose a requirements management model based on a System Engineering approach and the UML formalism. This model will allow us to show the co-evolution of the design problem and its solution. We will emphasize the importance of going beyond different types of contradictions to develop innovative products that are environmentally friendly. This implies being able to clarify and/or to modify the initial project requirements and allowing new requirements to emerge.

Key words: Eco-Design, innovation, system engineering, requirements, complexity.

1 Introduction

Due to the pressure of customer demands, companies are increasingly obliged to offer products that meet the requirements of sustainable development. Mastery of the product design process and the product's innovative potential is thus a major factor in company strategy.

The concept of sustainable development, or "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [33] (as defined in 1987 by the World Commission on Environment and Development, also known as the Brundtland Commission), originated at the Stockholm conference in 1972 but has taken on worldwide significance only since the Rio de Janeiro conference in 1992. According to Jansen [21], although the optimization and improvement of existing products and processes can be envisaged for the short term, the design of new products and processes will be the key strategy in the coming decades. Sustainable development is thus directly tied to innovation based on needs.

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Introduction of an eco-design process within an SME to design product ranges ^{*}

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Abstract

Nowadays, in order to face increasing competition, businesses must differentiate through innovation, but also crucially by positioning themselves with respect to environmental concerns, in order to improve brand image. SMEs are particularly plagued with a lack in human, financial, and time resources to integrate such aspects to design. In this paper, we propose a dynamic approach (short- medium- and long-term) to initiating an eco-design process to design ranges of products in SMEs. This process, based on a state of the art, comprises four stages: analysis, sensitization, eco-design strategy and sustained improvement. An early experimentation, carried out within an SME (mulTiroir-Controlec) has allowed us to perform early environmental evaluations (checklist) regarding the design of a product range (hospital carts). This first analysis will allow us, in the medium- to long-term, to develop a strategy for integration of eco-design within SMEs.

Keywords: eco-design, product design, environmental aspects, company strategy, SMEs

1 Introduction

As the regulatory frameworks become more stringent, all companies are gradually expressing more and more concern with respect to eco-design. Taking into account environmental constraints within the scope of product design is an industrial truism, but one which is mastered to varying degrees [10,11].

However, the stakes for companies are numerous. There are strong impacts of these environmental aspects, for example, on economic gain, brand image and market differentiation [13]. From a more pragmatic point of view, the issue is clearly to better understand the risks and the costs related to product life cycles, to identify nascent expectations in stakeholders and consumers who are increasingly sensitive to environmental concerns, as well as to turn the environment into a new factor of competitiveness and innovation in processes of creative product design, by stimulating designer creativity, better mastering project costs, and opening up new commercial opportunities.

Many methods, however, have proven to be too lengthy and expensive in the field. Therefore, few SMEs have really committed to using them [3].

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Combining organisational performance with sustainable development issues: empirical evidence from Lean and Green Project*

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Abstract

To become and to remain competitive, companies must adopt evolution strategies. Lean Manufacturing thinking is one of the strategies used in several industrial companies. Lean Manufacturing thinking is based on the identification and elimination of waste in various production processes such as reducing energy, waste generation, etc. To this, we added environmental aspects of resource management by a Green approach. Thus, the Lean and Green approach that we want to introduce place is intended to eliminate unnecessary in terms of environment. This is an additional approach in terms of eliminating waste, and thus gains for the company. This paper shows the results of the Lean and Green approach applied within 21 Alsatian industrial companies.

Key words: Lean Manufacturing thinking; Green approach; sustainability, Environment.

1 Introduction

1.1 *Lean today – The wave of sustainable development*

A lot of companies have actually implemented Lean Manufacturing thinking in their programs. The Lean manufacturing thinking or "Lean" is a practice that helps companies to identify and eliminate waste through continuous improvement. That continuous improvement involves controlling the Lean tools. Lean identifies seven wastes: Overproduction, Waiting, Transportation, Defect, and Inappropriate processing, Unnecessary Inventory and Unnecessary Motion. Eliminating those wastes aims to increase efficiency, to reduce costs, to improve customer response time, and contribute to improve quality, greater profitability, and enhanced public image [1].

Nevertheless, actually, the efficiency of companies should be reached not only by implementing practices such as Lean, but also by improving the environmental impact of the company. Then, Green approach, or "Green",

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Research orientations in design for recovery applied to composite parts *

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Abstract

The composite use in industry increases. Despite, composite end of life solutions are still under development. We proposed to address a combined definition of both composite design and composite recycling process. This paper will discuss the needs of multi-disciplinary skills in order to take into account recycling possibilities in the design, and to assess recycling product capabilities by the design requirements. This paper highlights the relation between functional approach by designer, characterization for material and mechanics behavior and recycling process limits, constraints and opportunities.

Key words: Design for recycling, Eco-design, Composite recycling, Design for environment

1 Introduction

Today, the key focus for the transport industry is to make lighter vehicles. Reduction in weight leads to a decrease in energy consumption and CO₂ emissions. Reducing greenhouse gases and pollution is one of our society's main challenges as it strives for sustainable development. Composites provide good opportunities for combining high modulus materials with free definitions of geometry. As a result, their use in industry is increasing. The aerospace and aeronautics sectors have integrated composites at different levels for their products (organic matrix based for cold applications and metallic or ceramic-based composites for hot applications). Today, in the automotive industry, the limits of the use for the composites are their potential recyclability. Indeed, a global and eco-friendly approach analyzes and takes end of life solutions for systems into account at an early stage of their development process. Moreover, in the case of automotive, regulations impose a 95% ratio of recycling of an out of use vehicle. The term “de-manufacture” has become more and more common, especially in the electronics industry. It characterizes the process of recycling materials and products, including end of life strategies and logistics in product development [3][11]. Design engineers have to balance safety, energy efficiency and cost. Unfortunately, they rarely get to the point of thinking about what will happen to the product at the end of its useful life [12][25].

However, as time goes by and new materials and technologies are developed, the challenge that recyclers face in safely and economically recycling those products grows ever more difficult [6]. Recycling a product means: (i) have a recycling technology available, (ii) get dismantle solution and access for the product, and (iii),

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SysPEM: A SysML and SPEM Based Process Modeling Language for Systems Engineering*

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Abstract

The evolution of industry through a competitive environment resulted in a need for optimizing the manufacturing processes. Many studies focalized on this topic, especially in the case of software engineering processes, which led to the definition of a standard for development processes (SPEM) by the OMG (Object Management Group), and a race to implement it through different languages and meta-models. Even if there is a huge similarity between software engineering and systems engineering, the standard and its different implementations are still insufficient to fulfill the requirements expressed through systems engineering standards such as EIA 632.

In this paper a meta-model keeps the fruitful approach of the Software Process Engineering Meta-model (SPEM) combined with some useful concepts from the System Modeling Language (SysML). This model was validated through some predefined criteria and the specification of the EIA 632 standard.

Key words: Systems Engineering, Process, Meta-model, SPEM, SysML

1 Introduction

In a highly competitive environment, it is capital to master up and optimize the different processes participating to product manufacturing [13]. In fact systems engineering is a hybrid field, and each discipline participating to this field has achieved its own maturity. Thus, it is inevitable to discuss the coherence and collaboration of such disciplines and processes.

On the other hand the consolidation of the best approaches and practices concerning software development has led to the elaboration of a standard for software process modeling known as SPEM (Software Process

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Standards for Information and knowledge sharing in the collaborative design of planning systems within the forest products industry: A survey and roadmap^{*}

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Abstract

Forest products value chains (FPVC) are complex networks of units with different goals and beliefs. These units need to work together to generate the different values. In order to study these value chains, a common representation and understanding of the different components of a value chain must be gained. This will permit evaluating forest and industry strategies, supply chain configurations and planning approaches using simulations. Agent-based modelling (ABM) is favored to facilitate the assessment of different scenarios, however, the information and knowledge sharing (IKS) in a collaborative modeling context remains an issue. This paper discusses the need for collaborative modelling and simulation of the FPVC, and surveys the literature about the most significant standardization initiatives for IKS and ABM platforms with focus on the FPVC. Then the key findings are explained, and a roadmap toward defining a standard for value chain modeling is proposed.

Key words: Information and knowledge sharing, standardization, value chain, agent-based modelling, forestry

1 Introduction

Canadian academic researchers, in collaboration with FPInnovations, a national forest research institute, are proposing to build a strategic research network on value chain optimization (VCON) that aims to provide the industry and policy makers with new advanced planning and decision support systems to design and deploy optimized forest bioeconomy networks. The network should develop and maintain virtual business test-benches providing data sets and rich business contexts to aid demonstration of the potential benefits of the different integration and synchronization methods. It has favored an agent-based approach to facilitate the assessment of different scenarios, however, the sharing of information and knowledge in a collaborative modeling context remain a key theme. This paper is focused on this issue. It surveys the literature about the most significant standardization initiatives for IKS and ABM platforms with focus on the FPVC, and it proposes a roadmap towards defining a collaborative knowledge-based platform (CKBP) to support researchers within the VCON. The paper is organized as follows. Section 2 discusses the collaborative design of planning systems within the forest products industry. Section 3 presents the literature review. It begins with an overview of the components of a typical architecture for information and knowledge exchange in value chain followed by a review of the most significant standardization initiatives and ABM platforms in value chain. Then, the focus is on the standardization initiatives and ABM platforms that were specifically developed for the forestry. This section terminates with a summary of the key findings. Finally, section 4 presents the proposed roadmap.

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A model-driven approach for the management of workflow patterns[★]

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Abstract

Modeling and performance analysis in one of the most important issue in business processes. Built on top of Web protocols, Web services are emerging as a framework to provide application-to-application interaction and interoperability. An important challenge is their integration in order to provide new composite services, allowing consequently Business-to-Business relationships. In the context of web services modeling, the existing formalisms and standards have failed to define formal semantics required to apply mathematical techniques and resulting evaluation method on the proposed models. To address this issue, this paper provides a mapping from workflow patterns to Petri net models. More precisely, we propose a Petri nets formalization of control-flow patterns for service composition. In doing so, a high-level class of Petri nets with the capability to describe, within an alone model, the behavior of a given scenario while taking into account all possible operating modes and interaction between involved services is proposed. Translation rules from workflow patterns into Petri net models are provided.

Key words: Business processes, Workflow patterns, Web services composition, Petri net, Modeling, Verification and validation.

1 Introduction

Business-to-Business (B2B) relationships allow organizations to share costs, resources and skills by sharing their knowledge and combining their applications. As Web services have imposed themselves as a technology for organizations to provide their know-how on the Internet, many researches focus on Web services composition [9,4]. In such composition, already defined services are joined together to achieve a common goal, resulting in a new composite and value-added Web service. A such composition may be seen as the composition of the workflow patterns. A common Web service composition approach relies on the elaboration of a scenario of workflow patterns which coordinates Web services interactions.

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Proposition of a framework for consistency management between Digital Factory simulations^{*}

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Abstract

The Digital Factory aims to design, simulate and optimize production systems as early as possible in the product development process, by taking advantage of available software tools and 3D digital representations. Nevertheless, the multiplicity of simulation models and representations induce heterogeneity of available data and information, which complicates the management of information consistency. This article proposes a framework based on a semantic model representing a production system at the various necessary scales, to ensure consistency between simulation models. This framework is partially validated with a first use case addressed by an industrial partner.

Key words: Digital Factory, information consistency, ontology, interoperability

1 Introduction

In a context of increasing competition and pressure to reduce time-to-market, the Digital Factory was born to design and simulate production systems throughout the product design process. It can be defined as a set of software tools and methodologies allowing the design, simulation, initiation and optimization of production systems [4], [6] and [17]. This approach, originating from concurrent engineering and from Computer Integrated Manufacturing (CIM), aims to reduce validation loops by ensuring, as early as possible in the product lifecycle, integration of the product manufacturability and productibility with business constraints. This approach takes part of a Product Lifecycle Management (PLM) approach that aims to share information relative to a product in each stage of its lifecycle [8].

One purpose of the Digital Factory is to support the planning process, when alterations are made to production processes (introduction of a new product or a new workcenter, alteration of the production rate, etc.) with a series of tools, such as, e.g. 3D modeling programs or simulation programs. Using these tools the planner or planning team can create a digital image of individual workplaces or even a complete factory, along with the respective production processes. Using simulations, investigations of possible weaknesses in the planned system can be carried out. Thus, dynamic factory occurrences can be played, analyzed and improved. Necessary structural changes can also be carried out and changed directly in the computer model.

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Forecasting returns in reverse logistics: application to catalog and mail-order retailing^{*}

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Abstract

An efficient management of returned items is the last way to keep an unsatisfied customer. For Catalog and Mail-Order Retailers, as more than ninety percent of the returned items go back to stock, returns can be concerned as the first supplier. Quality managers study the returns as they reflect the opinion of customers against the product's quality. Thus, a precise forecast of the returns and indicators of returns is compulsory in order to optimize the supply chain and improve the service quality.

The returns rate, ratio between returned and sent items, is a strategic indicator often used by several departments in catalog and mail-Order retailers. It's used to improve the Supply chain control by well forecasting the quantity of work and reducing the outstanding goods. It's also used to estimate the budget and define which items from the current season can be carried forward for the next season, and which items will need improvements.

This paper presents a study of a real returns phenomenon. A new way to estimate the returns rate is provided and a study of forecasting models is explained. A phased approach to forecast returns rate is provided for distance selling sector.

Key words: Reverse Distribution, Forecasting, Returns, Phasing, Returns indicators, Mail-order retailing.

1 Introduction

Distance selling sector has been generally stagnant or even declining for many years ago. Because of the increased supply, the market has become more volatile and the competition extends now beyond the selling distance.

The logistical chain, as the customer relationship, is a priority where mail-order companies are relying on in their strategies in order to be able to stay competitive in the market and to increase their market share as well. Recently viewed as one of the logistical chain issues, the subject of returns management becomes increasingly important and regarded as a strategic business element.

In order to satisfy their clients, Distance Selling actors afford the opportunity of returning the product at almost any time even if it is specified on each sale support a return date limit for each item category. This strategy generates a very important stream of returns of around 25% in average sale in terms of quantity [8] which explains the consideration of returns as the leading supplier. Consequently, returns prediction has become the paramount importance.

Through this article we present a phased approach in order to predict the return rate early in the current season. This work was developed mainly for quality managers to provide them with a better visibility of customers'

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A new multicriteria approach for EOL product strategy*

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Abstract

The End-of-Life (EOL) is one stage of the life cycle having gained the attention of the market. Due to several factors including stricter regulations, technological growth and environmental impacts, the choice of the best strategy for EOL product have become a major concern. This study proposes an integrated methodology that relies on multi-criteria analysis, takes into consideration both quantitative and qualitative criteria while respecting mutual interactions between them. This has been performed by introducing the 2-tuple linguistic representation model dealing with non-homogeneous information data and the Choquet Integral modelling interaction between criteria into the PROMETHEE method. Although it has been developed for EOL selection problems, this proposed method applies to all kinds of decision-making problems with heterogeneous information. As this work demonstrates, multi-criteria analysis can offer a technical-scientific decision making support tool to validate their own choices so clearly and reliably in the EOL product sector.

Key words: Environment, PROMETHEE method, 2-tuple model, Choquet integral, End-Of-Life product.

1 Introduction

Due to stricter product recycling regulations, such as electronic and electrical equipment (WEEE) and the rapid technological growth that has dramatically increased environmental pollution, EOL product strategy determination has become important [24]. The governments put more efforts in policy making of product recycling. For example, in Tunisia, the laws have been passed by some states to mandate the use of recycled materials in electronic products. It has issued the directives such as waste of WEEE, and the restrictions on hazardous substance guidelines in electronic and electrical equipment (EEE). Waste-disposal alternatives such as incineration and ocean dumping will no longer be acceptable with government regulations calling on product manufacturers to ensure the minimal environmental impact of their manufactured durable goods [25]. The objectives and criteria in the best EOL product strategy selection are often in conflicts and it involves trade-offs amongst decisive factors such as the energy performance, the cost, operating environment, health-related impacts, resources depletion, greenhouse effect, human toxicity, etc. This paper presents an integrated approach for the multi-criteria optimization of the EOL product strategies. It tries to provide a simple and quick solution for the questions of how to determine recycling strategy for a product by taking into account interactions between criteria. For this, it develops a new methodology based on PROMETHEE II method that integrates the 2-tuple fuzzy linguistic representation model [12] like an easier way to replace the six preference functions and

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Reverse Logistics Optimization : Application to Reusable Containers *

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Abstract

Reverse Logistics is now considered as an interesting source of economies in supply chain management. Through different activities, this logistics has received increasing attention from researchers and practitioners. In this paper, we are interested in a tactical problem by focusing on the optimization of return flows of reusable containers, while considering an existing network. This situation is very encountered by third part logistics companies. The optimization model we propose is a MILP which minimizes the total cost of these return flows. In order to be realistic, we want to use this model on large size networks. The key point is the computation time which exponentially increases with the size of the problem. A simple heuristic is also proposed in order to reduce this computational time. Finally, a numerical experiment is presented to demonstrate the performance of the developed model as well as the efficiency of the proposed heuristic.

Key words: Reverse Logistics, Optimization Model, Heuristic, Reusable containers

1 Introduction

Since a few decades, supply chain management has received more and more attention from researchers and practitioners. Most of the time, this term was mainly related to “traditional” logistics management, which deals with material flows from producers to consumers. In recent years, more and more researchers and practitioners are interested in the management of reverse flows (from customers to producers) called “Reverse Logistics” (RL). This new logistics has been paid increasing attention because it is now considered as a source of economies and a way to reduce the environmental impact of the supply chain activities. Moreover, new legislations oblige companies to better manage their returns such as electronic waste for instance. Reverse logistics network is necessary because of several factors. Some economies, like the revalorisation or remanufacturing of used products, the reuse of returnable items, the recycling of some products or raw materials and some environmental bounded to the management of waste. This RL can also be very interesting for consumers who know that the return of their products is well managed (in the sector of after sale service for example). In this paper, we first present a comprehensive review of the literature on reverse logistics and particularly on the reuse activity which is the problem we consider in this paper. After that, we present our model of a large scale reverse logistics network for reusable container and some computational results. The last section concludes this paper with relevant future directions.

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A two-stage production/inventory system with admission control of product returns [★]

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Abstract

We consider a two-stage production-inventory system. Each stage is made of an exponential production server and an output inventory. The downstream inventory faces a Poisson demand and each inventory receives product returns that can be either accepted or rejected. The objective is to find a production/admission policy minimizing the expected discounted costs over an infinite horizon. We consider linear holding, backorder, production, admission and rejecting costs. We show that the optimal policy is characterized by state-dependent base-stock levels and state-dependent disposal thresholds. We also obtain monotonicity results for these switching curves. Interestingly, our results can be transposed to an hybrid single-echelon system with a production facility and a remanufacturing facility, both with exponential leadtimes. Finally, we design heuristics to control production and disposal and we carry out a numerical study to investigate their performances.

Key words: Multi-echelon, Reverse logistics, Production/Inventory system, Optimal Control, Remanufacturing

1 Introduction

Products are more and more returned in supply chains. Customers can return products a short time after purchase due to take-back commitments of the supplier. The proportion of returns is particularly important in electronic business where customers can not touch a product before purchasing it. Customers might also return used products a long time after purchase. This type of return has increased in recent years due to new regulations encouraging waste reduction, especially in Europe. Some industries also encourage it for economical and marketing reasons.

Returns constitute a reverse flow, from the customer to the supplier, which complicates inventory control. A recent review of literature on reverse logistics is provided by Ilgin and Gupta [8]. Inventory management constitutes a part of this review, and we can see that an abundant literature is devoted to the inventory control of single echelon systems. In several situations, the structure of the optimal policy is similar to the case without returns. For instance, Fleischmann and Kuik [6] consider a single inventory with stochastic demand and stochastic independent returns. To model the returns, they consider a demand that can be both positive or negative. They show average cost optimality of an (s, S) policy.

In this paper, we consider a two-stage production /inventory system with returns of products at each stage and a disposal option upon arrival of returns. Before presenting in detail our model, we briefly review the related

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Support of business processes flexibility in PLM systems using services based approach *

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Abstract

Industrial companies collaborating to develop new products need to implement an effective management of their design processes and product information. Unfortunately, PLM (Product Lifecycle Management) systems which are dedicated to support design activities are not efficient as it might be expected. Indeed, design processes are changing, emergent and non deterministic whereas PLM systems, based on workflow technology, don't support process flexibility. So, needs in terms of process support flexibility are necessary to facilitate the coupling with the business reality. Furthermore, Service Oriented Architectures (SOA) enhances flexibility and adaptability of composed solutions. Systems based on SOA have the ability to inherently being evolvable. This paper proposes an approach to deal with business process flexibility in PLM systems by making profiles from SOA. The objective is to specify, design and implement business processes in a very flexible way so that business changes are rapidly considered in PLM solutions.

Key words: PLM system; Business processes; flexibility; SOA

1 Introduction

Current manufacturing industry is facing an increasing challenge to satisfy customers and compete in market. To stay competitive, they are adopting Product Lifecycle Management (PLM) systems which have the goal to foster collaboration among different actors involved in product design processes [20]. Furthermore, design processes have become increasingly important in many industries since they determine the procedure for developing and distributing added value for the enterprise. PLM systems play an essential role by managing product information in all phases of its lifecycle (design, industrialization, manufacturing, delivery, recycling, etc) and facilitating collaborations. Thus, each PLM system (1) provides a database to store product definition information and the whole functions necessary to the management of this stored information and (2) integrates a tool to model, execute and control business processes associated to product design. A business process organizes the creation, circulation, use and development of products information in order to control their creation and evolution (like document validation process, change management process, etc.). Most PLM systems are adopting workflow technology to cope with business processes. This technology usually does not handle dynamic behaviours, such as dynamic changes on running workflows instances [3]. Nevertheless, brakes analysis of design processes

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Lean Product Development: Fact Finding Research in Italy*

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Abstract

Companies have to constantly innovate and introduce new products to the market to win the current pressure they are facing in the globalization era. New Product Development (NPD) Process is becoming crucial, and its performances determine the success of the whole enterprise. Most efforts have been dedicated to improve the phase using different tools and methodologies. Particularly some are trying to apply lean product development to foster the efficiency and effectiveness of their NPD. Though literatures show its success, its implementation is complex and asks for relevant efforts to get benefits out of it. The contribution of this work is to understand if the application of Lean in NPD is currently diffused in Italy. In order to do this we analyzed the development phases of eleven SME and large Italian companies working in mechanical and electronics sector. As a methodology a direct interview has been conducted using semi-structured questioner consists of 39 questions divided into 5 sections. The first section was about lean product development process, the second section was about lean product design, the third section was about knowledge based engineering, and fourth was about cost estimation and the last part consists of additional question about the challenges to implement lean in product development. The interview personnel were project managers, product designers and technical directors. From the study it is found out that most of the companies seldom integrate lean thinking in their product development. Moreover, the early involvement of suppliers in NPD is low, rather the traditional concurrent engineering practice is seen to be adopted by many of the companies interviewed by integrating for example manufacturing starting from concept phase to launch phase. However, the study is a fact finding research, and it is neither intended to be exhaustive nor to be accurate to draw complete conclusions about lean adoption in Italian manufacturing industries.

Key words: Lean NPD process, lean product design, set-based concurrent engineering, knowledge based engineering, value stream mapping.

1 Introduction to Lean Product Development

In *The machine that changed the world*, Womack, Jones and Ross (1990) introduced Lean Thinking [14]. Even if they discuss the application of Lean to NPD, they focalize on Lean in manufacturing. For years the core of Lean thinking has been on production. So, most of the effort in standardization and modelling was on this field.

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PLM and Lean: two complementary pillars for the company^{*}

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Abstract

Faced to a constant evolving environment, enterprises install tools derived from methods which aim at increasing operational agility. These methods have shown their relevance by promoting axes of improvement in specific sectors without however measuring the global impact of the modifications on the rest of the enterprise. In this article, we focus on two approaches, Product Lifecycle Management (PLM) and Lean, in order to analyze their complementarities regarding this search of agility. If the contribution of Lean to the agility is obvious, that of PLM is less. First, because PLM evolves in a world different from that of Lean (Production world for Lean / Engineering world for PLM). Second, because of current vision and industrial practice of PLM, restricted to PLM tools which are heavy to deploy, deeply structuring even fossilizing information assets. The aim of this paper is to show how the PLM contributes to the enterprise agility. To approach the question, and since that Lean is obviously contributing to enterprise agility, we analyze the complementarities between Lean and PLM.

Key words: Product Lifecycle Management, Lean, ambivalence paradigm, enterprise agility

1 Introduction

Nowadays, a company has to face with faster and faster evolutions of its environment (globalization of the market, fast change of the demand, transformation of the social environment, etc.). This environment favors permanent reorganizations, partnerships and fusions. Confronted to these pressures, any company must gain operational agility to face with customer demands that are more and more immediate as well as changes in its environment and its own functioning. Operational agility assesses improvements made on the production tool by the effects on cost, quality and time after implementation. This triplet "Cost, Quality, Time" (CQT) represents key indicators as companies use them as targets in order to get new market shares or simply to keep those that are already acquired.

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An Investigation into the Physical Internet: Establishing the Logistics System Gain Potential^{*}

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Abstract

As a new paradigm for logistics, the Physical Internet is an open global logistics system leveraging interconnected supply networks through a standard set of collaborative protocols, modular containers and smart interfaces for increased efficiency and sustainability. If realized, adoption of the PI will result in much greater logistics system efficiency through increasing the utilization of trailers on the road and decreasing the number of miles driven. In the U.S. alone, even modest reductions in fuel consumption, pollution, greenhouse emissions, and packaging waste would save billions of dollars annually. Before being realized, fundamental research is needed to establish the logistics system gain potential. As part of establishing this potential gain, the objective of our research is to address the following questions: (1) what are the preferred sizes of PI containers and (2) how will the PI change how loads are distributed across the freight distribution network. In this paper we define a research program to achieve this objective.

Key words: Logistics, Distribution, Sustainable, Package Sizing, Network Flow Models

1 Introduction

Our current logistics system is unsustainable from economic, environmental, and social perspectives [14]. In response, Montreuil [15] has issued the Global Logistics Sustainability Challenge and described his vision where the challenge is addressed with the Physical Internet (PI). For the purposes of this paper, the PI is an open global logistics system leveraging interconnected supply networks through a standard set of collaborative protocols, modular containers and smart interfaces for increased efficiency and sustainability. In this context, logistics is viewed broadly and encompasses transportation logistics (between facilities) and facility logistics (at and within facilities).

The impact of such a system is far reaching. In the U.S. alone, the freight transportation industry accounts for 10% of GDP [12] and reductions in fuel consumption, pollution, greenhouse gas emissions, and packaging waste would save billions of dollars annually.

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Topology of Logistic Networks and the Potential of a Physical Internet*

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Abstract

The topology of the logistic networks that constitute contemporary logistics is minimally examined or challenged in the assessment and improvement of the performance of supply chains, logistic networks and freight transportation. We show in this paper that the topology of logistic networks has a major performance impact and that it can be significantly improved if the actual organization of flows is substituted by an organization founded on the universal interconnectivity of logistic networks: the Physical Internet. Given the exploratory nature of this work, the demonstration is achieved analytically by exploiting the continuous approximation method. The performance of contemporary vs. Physical Internet enabled network topologies is measured and contrasted through transportation throughput requirements, flow travel, and total costs.

Key words: Physical Internet, Logistics, Transportation, Supply Chain, Network Topology, Efficiency.

1 Introduction

Logistic and transportation performance improvement is an old topic that has gone through numerous developments: location of warehouses and distribution centers, consolidation, and so on. There is currently a surge of renewed interest in the topic as there is a growing awareness of its environmental consequences: logistics and transportation combine to be among the most important greenhouse gas emission sources in industrialized countries. The search for more sustainable logistic systems involves numerous technical aspects, yet there is a void of visibility on systems capable of meeting the forthcoming energy and climatic requirements. The organization of logistics and transportation is another way for opening improvement perspectives, as shown in recent works on logistic pooling [2, 14] and multimodal transportation [4, 9, 11]. Yet these research works also highlight the implementation difficulties associated with such solutions. The improvements needed are not minor in any way. They require breakthrough approaches as the logistic and transportation flows keep growing while the targeted worldwide CO₂ emission reductions are on the order of 20% by 2020 and 75% by 2050 [15].

In this paper we present an alternative organization of logistics and transportation, the Physical Internet [7], and we emphasize the implied differences in terms of logistic network topology. Then we progressively study these

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A Conceptual Framework for Designing Non-Programmed Decision Support Systems in the Context of Supply Webs^{*}

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Abstract

With the desire to offer decision support systems for a field of study as large as supply chain management when taking in consideration the supply web dimensions, it is necessary to combine concepts, methods, and approaches, capable of handling extreme complexity, into a multidisciplinary approach. The paper introduces a conceptual framework that blends a variety of concepts into one consistent body of knowledge around the design of decision support systems for supply chain management. The framework is based upon a holistic approach to create, model, and build tools that takes in consideration the complexity inherited in supply webs to provide, at the end, an efficient non-programmed multi-dimensional decision support.

Key words: Supply Web, Non-Programmed Decision Support Systems, Business Intelligence

1 Introduction

A Supply Web (SW) is defined as “... a network of interrelated supply networks, each embedding interlaced supply chains, involving multiple organizations with collaborative or competitive supply relationships” [8]. This concept goes beyond the notion of supply network by highlighting the importance of taking in consideration the interactions of multiple distinct supply networks and the mutual influence occurring between them. The supply web concept suggests that managers should be able to handle the supply web complexity and that the design of decision support systems for supply chain management should integrate the supply web dimensions by considering granulated levels of detail, and multi-dimensional decision perspectives in order to maximize the potential benefits generated by inter-organisational collaboration.

In a series of papers [21; 8; 9], we introduced the concept of supply webs and discussed various software solutions that support a holistic approach to address supply operations issues within supply web contexts. These software tools help managers to be aware of dynamics in their supply environment, to gain an enhanced understanding of interactions influencing their operations and to make decisions based on comprehensive analysis of complex and large volume of data. Building on learning from our works on formalising the supply web concept as well as our works on conceptualizing and prototyping software solutions for supporting

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Petri net control of a kanban loop ^{*}

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Abstract

Just in Time (JIT) is a management philosophy that favors improvement through inventory reduction by producing only the right quantity at the right time. A kanban system is an important element of JIT philosophy. However, whereas kanban system is suitable when demand is stable, it should to be adjusted when demand is a significantly variable to be efficient. In addition, some works have proved that Petri nets are useful to model a kanban loop. Then, the objective of the present work is to exploit the analytical relation of Petri net models in order to improve the control of kanban system by using the real data provided by the system or by the product. This approach is based on the use of a continuous approximation of a discrete Petri net model in order to exploit a strategy of command based on gradient descent. In the present paper, two continuous approximations are proposed and compared.

Key words: Kanban, Petri net, gradient, just in time

1 Introduction

The Just in Time (JIT) philosophy has appeared during the seventies in Japan [9], [18], [27]. In a JIT system, a good is produced with the right quantity at the right time [2]. In order to drive a JIT system, a kanban system is needed. Kanban means card in Japanese. In a kanban system, cards are used systematically to control the production within stations and the movement of parts between stations. A kanban card is attached to each product (or to each batch). Then, consumption of one product (or batch) frees the kanban card which can be attached to a new product (or batch) to product. This release of kanban card leads to a new manufacturing order. The kanban system is a pull control system, which can be represented by using stage notion [9]. Pull systems are most successful in production environments with stable demand and lead time [28]. In this case, a kanban system uses a constant number of cards which can be allocated to a product (or batch) or free. In an instable environment (high variation of demand), such a system is inefficient in such context leading to modifying and adjusting its parameters to avoid starving or high stock level. Usually, two approaches can be used. First, the number of kanban cards present in the system may be adjusted. Second, the number of products associated to a kanban card may be modified. This is an adaptive kanban system [25], [28].

Petri nets (PN) are useful for the discrete event systems (DES) and hybrid systems (HS) modelling [6], [17], [30] because they combine, in a comprehensive way, intuitive graphical representations and powerful analytic

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A Mathematical Programming Approach for Determining Control Plans in Semiconductor Manufacturing*

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Abstract

Worldwide competition, the move to ever smaller geometries in manufacturing processes, and the increasing of complexity in High-Mix semiconductor plants led to the introduction of numerous controls at different manufacturing stages. However, with the costs associated to metrology, i.e. non added value operations, it becomes increasingly important and challenging to reduce the number of controls for delivering products at high yield and at minimal costs. This has aroused a huge interest for dynamic sampling techniques.

In this paper, an Integer Linear Programming model is proposed in order to determine key parameters for an optimal dynamic sampling plan. These key parameters correspond to the maximum risk that can be tolerated for each production tool while taking into account the metrology capacity and the current control plan. The key parameters are chosen to optimize the number of controls, reduce risks on production tools, and use metrology tools efficiently. The Integer Linear Programming model has been tested on real instances and validated through a smart sampling simulator prototype.

Key words: Integer Linear Programming, Risk, Control plan, Dynamic sampling

1 Introduction

Because of the increase of international competition in modern semiconductor manufacturing, the constant quest for cost reduction and yield increase forces companies to constantly search for new ways to remain competitive by ensuring the best possible quality to customers. Because they are considered as “non added value” (see e.g. [9] and [13]), metrology operations are seen as a good opportunity to reduce costs since they are not completely integrated in the estimation of the return on investment [5] [8].

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A Method for Air Traffic rescheduling Based on Ground Delay, Rerouting and Flight Canceling *

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Abstract

Motivated by the importance of congestion in air traffic problem and its bad effects on airlines companies and passenger's security, we have implemented a decision support framework for flight rescheduling in air traffic management based on ground delay, rerouting and flight canceling. This approach is based on using *Time Petri Nets* (TPN) to model air traffic networks. We introduce a Binary Decision Diagram based tool to represent the state space of Time Petri Nets. This tool, called *Time Ordered Binary Decision Diagrams* (TOBDDs) is able to represent a large state space of a TPN with a small data structure and enable the efficient manipulation of this set. In what follows, we developed a technique, based on a Boolean function, to build the TOBDDs associated to a TPN. TOBDDs allow an efficient manipulation of the state space, in order to explore all flight plans. We defined a simple and efficient cost structure. An exact algorithm based on branch and bound technique is used to minimize the cost function and determine the optimal flight plan according to time, routing and capacity constraints.

Key words: Air traffic management, discrete event systems, time Petri nets, time ordered binary decision diagrams, optimization.

1 Introduction

During the last years, the growth in commercial air services continues to outstrip the available capacity of Network Air traffic System (NAS). However, the market recovered between 2012 and 2017 the number of passengers travelling will be increased of 3,5 per cent in Europe and in 2,8 per cent United States. Meanwhile the capacity of NAS has practically remained unchanged. Besides, its capacity is usually affected by adverse weather conditions (wind, fog, stormy weather,...).

Air traffic increase and adverse weather conditions are among the main factors of congestion in the air traffic network. The congestion problem is considered differently in Europe and in United States. On one hand, in

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The Collision Elimination Algorithm in the Hoist Scheduling Problem *

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Abstract

The Hoist Scheduling Problem occurs in many production systems, e.g. electroplating production lines. The problem is to create schedule for automated hoists, which transport products between workstations. We are interested in hoists, because the hoists schedule is sufficient to create schedule for workstations. Besides sequencing of transport operations, allocation of the resources, solution must also decide about routing of the hoist. Hoists can be controlled almost freely with respect to their physical constraints, so routing algorithm has a lot of possibilities to manage hoist route. Hoist route consists of picking item from workstation up, putting item down and moving along single constant axis. The feasible hoist route does not allow collisions of hoists. This paper describes universal hoist routing algorithm, which is applicable both to cyclic and dynamic instances of the problem.

Key words: hoist scheduling problem, electroplating, flexible manufacturing systems.

1 Introduction

An electroplating production line is a production system, which is used for production of variety types of items, by processing them by a number of chemical treatments. The items are usually covered in some noble metal coating by process of galvanization. An electroplating production line, consists of a number of workstations, mainly tanks filled with appropriate chemicals or other material processing devices. Workstations are arranged in a line and create axis for hoist movement. A hoist is an automaton, capable of moving above workstations and transporting products by picking items and putting them down. Due to the chemical processing it is assumed that the processing in the workstation begins when item is plunged into the tank and finished when it is removed from tank. Other result of chemical processing is that a technological process is defined as a series of product exposures to baths in workstations. The technological process defines a sequence of workstations, which item must be exposed to in order to be successfully finished. Each stage has quality constraints defined. Quality constraints are in fact minimum and maximum times of item processing time (time of lying in tank exposed to chemicals) – an interval of acceptable exposure time. In case an item is exposed too much it is treated as failed, e.g. too long exposure to acid caused not only grease removal, but also damage to the item itself. Similarly in case an item is exposed too little, the item does not achieve proper qualities. A production line usually produces more than one item type. A type of item defines a type of technological process to be performed on the item. Each item can have its own number of stages, sequence of workstations and exposition times. Items may share the workstations they use during the processing, but each workstation can process only one item at time.

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Track 1 – Supply chains – S1 to S9

T1S1: Modelling Uncertainty in Supply Chain Design I

T1S2: Green Supply Chain

T1S3: Modelling Uncertainty in Supply Chain Design II

T1S4: Supplier selection/evaluation process: decision support system I

T1S5: Complex optimization problems in Supply Chain Management I

T1S6: Supplier selection/evaluation process: decision support system II

T1S7: Information sharing and trust impact on coordination and performances of supply chains

T1S8: Complex optimization problems in Supply Chain Management II

T1S9: Decision Support in supply chains

Forecasting and Inventory Performance in a Two-Stage Supply Chain with ARIMA(0,1,1) Demand^{*}

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Abstract

The ARIMA(0,1,1) demand model has been analysed extensively by researchers and used widely by forecasting practitioners due to its attractive theoretical properties and empirical evidence in its support. However, no empirical investigations have been conducted in the academic literature to analyse demand forecasting and inventory performance under such a demand model. In this paper, we consider a supply chain formed by a manufacturer and a retailer facing an ARIMA(0,1,1) demand process. The relationship between the forecasting accuracy and inventory performance is analysed along with an investigation on the potential benefits of forecast information sharing between the retailer and the manufacturer. Results are obtained analytically but also empirically by means of experimentation with the sales data related to 406 Stock Keeping Units (SKUs) from a major European superstore. Our analysis contributes towards the development of the current state of knowledge in the areas of inventory forecasting and forecast information sharing and offers insights that should be valuable from the practitioner perspective.

Key words: Inventory, Forecasting, ARIMA Demand, Supply Chain, Information Sharing

1 Introduction

The classical approach of inventory forecasting considered by researchers and practitioners alike consists of selecting an accurate forecasting method that is subsequently used for stock control purposes. However, it should be noted that this approach tends to look at demand forecasting and inventory management as two independent stages without interactions, which may lead to a sub-optimal performance of the whole system [17]. In fact, previous research has shown that forecast accuracy is to be distinguished from the performance of the forecasts when utility measures are employed, especially in an inventory management context where the interactions between forecasting and stock control are not yet fully understood [2]. So, an accurate forecasting method does not necessarily imply inventory cost savings and/or a service level increase.

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Distribution Supply Chain Design under Demand uncertainty^{*}

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Abstract

In this paper, we develop a two-stage stochastic programming approach for distribution supply chain design under demand uncertainty. We describe a realistic distribution supply chain, and a model for uncertain demand. Then, we construct a two-stage stochastic model, where the objective is to minimize the sum of investment costs and expected costs of operating the supply chain. The first-stage decisions are strategic location decisions, whereas the second stage consists of production and distribution decisions. This stochastic programming model, is applied to a representative real distribution supply chain network problem from the European textile industry. The models are solved by commercial software Cplex 12.1.0 and the computational results are compared .

Key words: Distribution Supply Chain Design, Two-stage stochastic programming, Demand uncertainty.

1 Introduction

A supply chain is a network of suppliers, manufacturing plants, warehouses, and distribution channels organized to acquire raw materials, convert these raw materials to finished products, and distribute these products to customers. (Santoso et al.[17]). Strategic level supply chain design involves deciding the configuration of the network: How many manufacturing plants should be implemented? How many distribution centres should be implemented? Where should they be implemented? How much capacity should we have? Which customer zones to target? Which production plant should be supplied by each supplier? Which customer should be supplied by each distribution center? How much goods should be transported throughout the supply chain network? Which transportation mode should be used? The interested reader can find these strategic questions in some important reviews on supply chain network design ReVelle and Eiselt[16], Daskin et al.[10], Bouzembrak et al.[6], Bouzembrak et al.[7], Vila et al.[20], Martel [13], Klose and Drexler.[12], Arntzen et al.[4], Cordeau et al.[9], Amiri [2], Amrani et al.[3].

Managing uncertainty is a main challenge within supply chain management. The future business environment

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Supply chain design under uncertainty on product life cycle*

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Abstract

Supply chain design has emerged as one of the major areas for companies to gain a competitive edge. Designing a supply chain effectively is a complex and challenging task, due to the increasing outsourcing, globalization of businesses, continuous advances in information technology, and product life cycle uncertainty. Indeed, uncertainty is one of the characteristics of the product life cycle. In particular the strategic design of the supply chain has to take uncertain information into account. This paper attempts to present a strategic analysis model of a supply chain design with product life cycle uncertainty considerations

Keywords: supply chain design, product life cycle, uncertainty, stochastic programming

1 Introduction

The Product life cycle describes the stages a product goes through from beginning to end. The competitive criteria generally differ during the different phases of product life cycle; for instance, availability and technology are needed at the “introduction” phase, and cost, quality and speed are needed at the “maturity” phase [3]. Consequently, a firm should select the effective supply chain partners and dynamically match the supply chain strategies so as to satisfy product requirements across multiple criteria and to maximize competitiveness over time.

When the product is introduced, sales will be low until customers become aware of the product and its benefits. The distribution is selective and scattered as the firm commences implementation of distribution plan. During the introductory stage the firm is likely to incur additional costs associated with the initial distribution of the product. These higher costs coupled with a low sales volume usually make the introduction stage a period of negative profits.

After, sales volume grows as more the customers become aware of the product and its benefits and additional market segments are targeted. An improvement of the product quality may be considered. The distribution becomes more intensive and trade discounts are minimal if wholesalers show a strong interest in the product. The growth stage is a period of rapid revenue growth.

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How to Incorporate Sustainability Criteria into Operations Management Models? The Sustainable Order Quantity Example^{*}

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Abstract

Even if sustainable development (SD) is nowadays a must-have for operations management (OM) literature, model-based research that includes SD criteria is scarce. This paper thus presents a novel approach for integrating sustainability criteria into operations management models based on two main observations. First of all, the definition of SD requires formulating the problem as a multiobjective optimization one. Moreover, decisions may be taken several times a day in the OM context. In this setting, the procedure should quickly end up with a unique solution. To do so, the firm may provide preference information that can be added to the model based on multi-criteria decision analysis methods. Our contribution is thus twofold. First, the proposed interactive procedure provides a strong support to include SD criteria into OM models. Moreover, the procedure is a new combination of multi-criteria decision analysis techniques.

Key words: Sustainable operations management, Green logistics, Sustainable order quantity, Interactive multiobjective optimization.

1 Introduction

Sustainable development (SD) is becoming a key issue for companies worldwide. Facing government, customers and other stakeholders' pressure, the firms are undertaking initiatives to reduce their environmental and social impacts while continuing to be profitable. Following this trend, the literature dealing with SD and operations is significant; see [23, 9, 22, 30] for reviews. However, the papers dealing with quantitative models have up till now mainly focused on reverse and closed-loop logistics or on waste management; see [29] for a review.

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Measuring Carbon Footprint in an Agro-industrial Supply Network*

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Abstract

Over the last few years, the fight against climate change has become one of the main topics of international debate. Hence, consumer behaviour has begun to change as they have started to assess the environmental impacts of the products and services they buy. The aim of this work is to measure and to analyze the carbon footprint of the global supply chain of a Company belonging to the agro-industrial sector. The basics of the Greenhouse Gas (GHG) protocol were used to measure carbon footprint, together with adopted subjective weights depending on the reliability of data sources. Results were analyzed to provide the Company with more insights about the efficiency that can be achieved by reducing CO₂ emission over its global supply chain. Benchmarks were also considered, despite the difficulties for this comparison due to limited amount of information available and differences in calculation methodologies for several other beverage, food or agricultural companies.

Key words: Carbon footprint, Supply Chain, Greenhouse Gas Protocol, Case Study, Agro-industry

1 Introduction

Over the last few years, the fight against climate change has become one of the main topics of international debate, and is now identified as one of the greatest challenges humanity has ever faced [12]. The main cause of climate change has been identified as the emission of Greenhouse Gases (GHG) connected to human activities [14]. The international community has started several initiatives leading to the drafting of the Kyoto Protocol [12], that involves both industrialized and developing countries with market economies, and aims to reduce GHG emissions on a global scale. Together with the international community's increased attention on this matter, consumer behavior has begun to change: consumers have started to assess the environmental impacts of the products and services they buy [9,11,12]. As a matter of fact, enterprises now play a key role in the achievement of GHG reduction goals. Hence, an important way of progress for industrial organization is to adopt green supply networks.

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A Strategic Mathematical Model with Sustainable Development Thinking for Global Relocation Decision^{*}

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Abstract

Relocation is chosen by companies which want to use foreign or/and external resources to meet their requirements such as low cost, new markets and skills. Nowadays, some companies which have already relocated their production activities are forced to make successive relocations. In the context of globalization, all the relocation decisions could have a long-term and great influence on the environment and society. How to make these decisions which should achieve social, environmental, and economic goals at the same time is the research question of this paper. Based on a literature review, we clarify global relocation strategies from two dimensions and summarize the progress made in the business and academic fields. We propose a MILP (mixed integer linear programming) model with sustainable development thinking integrated to support decisions on location selection. Simulated experiments are carried out with Lingo software.

Key words: strategic planning, relocation, sustainable development, optimization and decision support

1 Introduction

Under the background of international production sharing and globalization, global relocation which means moving activities out of their current locations is a concern of many companies. Global relocation asks for the reallocation of the resources worldwide, which can have a long-term impact on the environment and society. With more and more public awareness on sustainable development, how to make relocation decisions without causing unwanted environmental and social consequences is our research question in this paper.

Our paper consists of seven sections. After the introduction of the two terms: sustainable development and relocation in Section 2, related works and research questions are discussed in Sections 3 and 4. Section 5 is our main contribution with a MILP model proposed which is based on classical models but with sustainable development issues integrated. Experiments are carried out with Lingo software in Section 6 to illustrate the model. Finally, a conclusion and perspectives are presented in Section 7.

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Agile supply chain in the fashion industry: a literature review^{*}

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Abstract

For the past twenty years, there has been an increasing interest in the literature for studying the complexity and uniqueness of the fashion industry. Fashion consumers are demanding more variety, better quality and service, including both reliability and faster delivery. These pressures have brought academics and industrials to investigate new methods in order to achieve effectiveness across the fashion supply chain. As such, the concepts of agile supply chain, flexible systems, and quick response have emerged and been adopted in several ways in the fashion industry. Despite their recognitions, these concepts are often confused in the literature. To avoid those issues, this paper aims at proposing a formal framework for conducting a literature review of the agility initiatives and models developed for the fashion industry. The proposed framework identifies key dimensions related to supply chain agility.

Key words: Fashion industry, agility, supply chain, network, integration, market sensitivity

1 Introduction

For the past twenty years, there has been an increasing interest in the literature for studying the complexity and uniqueness of the fashion industry. The fashion market is characterized by a short life cycle, high volatility, low predictability, high impulse purchase customer behavior, and a long and heterogeneous supply process [8] [9] [16] [42]. In addition, the industry is now increasingly facing global competition and rapid technology advances, which bring new challenges and opportunities. Customers are also demanding for more variety, better quality and service, including both reliability and faster delivery [18].

These pressures have brought academics and industrials to investigate new methods to improve the effectiveness of the entire fashion supply chain. O'Marah [37] pointed that today's market competition is no longer based on

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Scenario-Based Supply Network Design under Disruptions^{*}

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Abstract

This paper proposes a risk modeling approach and a design model formulation for the Supply Network (SN) problem under uncertainty. It recognizes that the future SN environment is characterised by random factors and network disruptions. The three phases risk modeling process is based on the modeling of multihazard exposure levels, the estimation of an arrival process, and the assessment of multihazard consequences. A Monte-Carlo approach is also proposed to generate samples of plausible future scenarios. A stochastic programming formulation to the SN design problem is provided, and solved using the sample average approximation method. A realistic case is developed to illustrate the approach and to underline major issues to consider in the design of SNs under uncertainty.

Key words: Supply Networks, Scenarios Planning, Risk modeling

1 Introduction

Supply network (SN) design problems involve strategic decisions on the location of a set of facilities (sales points, distribution centers, plants...) and on their mission, in order to serve a set of customers on a daily basis. Since these decisions shape the structure of the SN, their impact is felt during several years. However, when these decisions are made, customers' future demands as well as potential network disruptions are not known with certainty. At that point in time, the best that can be done is to anticipate future network operations in order to design effective SNs, and to characterize adequately the future business environment in order to design resilient SNs. Recently, several events such as the 9/11 terrorist attacks on WTC, the US blackout in 2004, hurricane Katrina in 2005 and Chile's earthquake in 2010, showed how risky the future business environment can be. Several deterministic models ([12],[3]) and a few stochastic models ([15],[17]) were proposed in the literature to deal with supply chain design problems under random business-as-usual factors. A few robust optimization [20] and stochastic programming ([20],[21],[13],[11]) models were also proposed to deal with location problems under the risk of failure for some network nodes and/or links. In these papers, the emphasis is on showing the effect of supplier and/or retailer failures on location decisions, and on building more reliable networks by introducing flexibility constructs into the design model. However, the risk modeling aspects are

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Decision support system for production and supplier selection in unreliable supply chains^{*}

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Abstract

As supply chains are complex, dynamic and consequently unstable, it is inevitable that the involved actors have to react to unforeseen events. Adaptive manufacturing strategies, also known as responsive manufacturing, address this issue by aiming at profitably replenishing the supply chain while dynamically adapting to change. This paper intends to present an aggregated adaptive strategy integrating production, replenishment and supplier selection activities. Based on previous findings and two case studies, involving up to three suppliers, the obtained results show clearly that it is always profitable to consider multiple suppliers to make replenishment and production decisions. We also discuss the generalization of the proposed strategy for more than three suppliers.

Key words: Stochastic optimal control, supplier selection strategy, production control, simulation.

1 Introduction

Outsourcing of logistics operations to third parties is one of the common practices adopted nowadays by companies to cope with the complexity of supply chain management. This outsourcing allows companies to focus on their niches, reduce operational costs and increase sales. In return, companies become dependent of their product/service suppliers and the performance of the whole supply chain may be considerably affected if poor decisions are made. These decisions are of three levels: long-term, mid-term and short-term and may concern, for example, supplier selection, supplier management, replenishment strategies, etc. [2]. Cooperation and integration of information exchange systems are also fundamental to reach company objectives ([9], [1]).

This paper addresses the problem of supplier management in a manufacturing context within a mid-term or a short-term perspective. It considers a joint replenishment and production control problem for an unreliable manufacturing system supplied by multiple unreliable suppliers. More specifically, we assume that, for a given class of a product, a set of potential suppliers have been pre-selected. When receiving a new order, the manufacturer should respond to a series of questions: (1) from the pre-selected set of suppliers, who can respond efficiently to the current order? (2) What is the order quantity to place? (3) At what time should the order be

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A fuzzy MCDM approach for supplier selection and evaluation: A case study in an automobile manufacturing company *

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Abstract

Competitive international business environment has forced many firms to focus on supply chain management to gain competitive advantages. During recent years, supplier selection process in the supply chain has become a key strategic consideration because most of the firms have been spending considerable amount of their revenues on purchasing. However, In general, many quantitative and qualitative factors such as quality, Price, flexibility and delivery performance must be considered to determine suitable suppliers. This means that the nature of supplier selection decisions usually is complex and unstructured.

This paper is aimed to present a fuzzy decision-making approach to deal with the supplier selection problem. We generalize TOPSIS to fuzzy multiple-criteria decision-making. TOPSIS is one of the well-known and widely accepted methods for multiple criteria decision making (MCDM). We use triangular fuzzy numbers to express linguistic values of experts' subjective preferences. The application process has been demonstrated with a real case study in an automobile manufacturing company. The study was followed by the sensitivity analyses of the results.

Key words: Supplier selection, TOPSIS, Multiple criteria decision making (MCDM), Fuzzy set theory

1 Introduction

In today's highly competitive environment, it is impossible for a company to successfully produce low cost, high quality products without satisfactory suppliers [31]. Among the issues of supply chain management concerning purchasing decision, supplier selection is the most important activity of a firm's purchasing department because the purchasing decisions have a direct effect on cost reduction, profitability and the flexibility of the company. Practically supplier selection decision consists of several criteria such as price, quality, on-time delivery, after-sales services, supplier location, and supplier's financial status. Supplier selection is a multi criteria decision problem, which includes both quantitative and qualitative criteria. It is necessary to make trade-offs between these tangible and intangible criteria which may conflict with one another to select the best suppliers [22].

MCDM methods are formal approaches to structure information and decision evaluation in problems with multiple, conflicting goals. MCDM can help users understand the results of integrated assessments, including

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Multi-stage, multi-criteria framework supporting supplier selection and outsourcing decisions of core product to collaborative supplier*

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Abstract

Decision about outsourcing core products is one of the subtlest and most important decisions made by a purchaser. It is a two-edged sword decision that can be the source of huge competitive advantage, such as cutting fixed costs while improving quality and giving access to innovation, but can also be the beginning of company disaster. Indeed, outsourcing a strategic product to an inappropriate contract manufacturer might provoke not only huge financial losses, and corporate image humiliation but can also lead to company bankruptcy. Therefore these decisions must be made with a high level of vigilance. Suppliers must be selected in a way to minimise the risks such as loss of intellectual property, and ethical issues and to maximize potential rewards. The evaluation of suppliers against qualitative and intangible as well as quantifiable criteria is therefore essential and the use of model that facilitates this is highly desirable, leading to better informed decisions. This paper demonstrates the practical application of such a framework in Staedtlich, a company faced with the decision regarding the outsourcing of a core product to collaborative supplier.

Key words: Supplier selection, outsourcing, core product, collaborative relationship, purchasing framework, framing, decision on stages, MCDA, practitioners

1 Introduction

Outsourcing, that refers to the practice of a firm entrusting to an external entity the performance of an activity (manufacturing of a good or performing of a service) [14], is a phenomenon that expanded from a simple externalization of non-strategic activities, such as canteen or cleaning, to core activities, such as production and research and development. Outsourcing has been widely discussed by academics, practitioners and consulting companies. Wide range of *outsourcing* synonyms can be found in literature such as *externalizing*, *contract manufacturing* or *subcontracting*. To express the choice between outsourcing and in-house production (performing activity inside boundaries of the firm) terms such as '*make or buy*' are frequently used. Multiple companies are tempted by huge opportunities of outsourcing, such as quick reduction of operations costs that reflects directly in financial sheet; access to new human capital; and increase of flexibility. Numerous are examples of so called '*virtual corporations*' [10] i.e. vertically disintegrated manufacturers that focus on

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Towards an analysis methodology for identifying root causes of poor delivery performance*

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Abstract

This paper presents an analysis methodology for establishing the stability of the planning environment faced by a company and the impact on the stability from changes to sales order lines. The methodology focuses on three critical planning parameters derived from customer orders: product mix, volume and order sizes. Furthermore, the methodology links the delivery performance of a company to the changes made to sales orders. Based on a test case application of the methodology, it is concluded that by accepting changes, the demand faced by the case company has become more unstable on product mix, volume and the number of order lines per period. Furthermore, it is found that the stability of the order sizes is not improved significantly. Ultimately, by applying the methodology to the case company it is found that by changing the sales orders the company does not improve the delivery performance.

Key words: Business Intelligence, Diagnostics, Decision Support Systems, Performance Improvement Systems

1 Introduction

The main challenge in today's businesses is not getting enough information to make qualified decisions, but rather structuring the information already available, in a manner that facilitates pro- and reactive actions to improve the performance of the business. The motivation for this research is the long-term development of a complete diagnostic methodology that considers and enables diagnosis of the manufacturing planning and control system, by examining the inputs and changes to the system. In this context, the paper presents a step towards developing a comprehensive analysis methodology for identifying root causes for poor delivery performance. The paper focuses on three critical planning parameters; product mix, volume and order sizes and presents a number of methods to analyze these areas. Specifically, the analysis methodology focuses on establishing the stability of the planning environment faced by the company in the form of demand and the impact of changes to sales order lines on the stability. A stable planning environment is in this context considered to have the following attributes:

- The product mix is stable i.e. the product mix does not vary from planning period to period.
- The demand is stable, i.e. the demand is constant in volume from planning period to period.
- The order sizes are constant or follow a symmetric distribution.

The paper likewise introduces three different On-Time-in-Full delivery performance measures that give a ratio of order lines, volume and revenue respectively satisfactorily delivered On-Time-In-Full. These measures are cho-

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An Iterated Local Search Algorithm for the Single-Vehicle Cyclic Inventory Routing Problem [★]

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Abstract

The single-vehicle cyclic inventory routing problem (SV-CIRP) is concerned with a repeated distribution of a product from a single depot to a selected subset of retailers having stable demands. If a retailer is selected for replenishment, the supplier collects a retailer-related fixed reward. The objective is to determine the subset of retailers to cyclically replenish, the quantities to be delivered to each, and to design the vehicle delivery routes so that the expected total distribution and inventory cost is minimized while the total collected rewards from the selected retailers is maximized. The resulting distribution plan must prevent stockouts from occurring at each retailer. The underlying optimization problem for this SV-CIRP is formulated as a mixed-integer program with linear constraints and a nonlinear objective function. In this paper, an iterated local search algorithm (ILS) is developed to solve the SV-CIRP. The proposed approach is tested on some randomly generated problems and the obtained results are compared with the results from an efficient insertion heuristic approach. Computational results show that the proposed iterated local search algorithm is more competitive and superior to the known heuristic approaches for the single-vehicle cyclic inventory routing problem.

Key words: Inventory-Routing, Nonlinear Mixed-Integer Programming, Heuristics, Iterated Local Search

1 Introduction

The cyclic inventory routing problem (CIRP) is one of the important and practical problems in logistics. The problem involves the integration of inventory management and vehicle scheduling and routing policies. In practice, policies such as ‘Vendor Managed Inventory’ (VMI) have proven that this kind of inventory and distribution integration improves considerably the overall performance of the supply network. VMI is an agreement between a vendor and his customers according to which customers agree to the fact that the vendor decides the timing and size of the deliveries. In other words, the vendor is granted full authority to manage inventories at his customers’. The CIRP is an underlying optimization model for the VMI policy when customer demand rates are stable.

The single-vehicle cyclic inventory routing problem (SV-CIRP) arises naturally as a sub-problem, when branch-and-price or a column generation based approach is used to solve the CIRP (see e.g. [2] and [20]). The purpose of the SV-CIRP is to design an optimal distribution plan in which the inventory at each one of the selected retailers is replenished on a cyclical basis. The quantity of the product to be delivered to each retailer and the vehicle routes must be determined so that the resulting total distribution and inventory cost is minimized and the total

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Solving a Capacitated Single-Allocation Hub Covering Location Problem by a Genetic Algorithm*

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Abstract

Hub location problems (HLP) are synthetic optimization problems that appear in telecommunication and transportation networks where nodes send and receive commodities (i.e., data transmissions, passenger transportation, postal deliveries, etc.) through special facilities or transshipment points called hubs. Hub location problems are related to finding the location of hub facilities and the allocation of non-hub nodes to those located hub. In this paper, the capacitated single allocation hub covering location problem-CSAHCLP over complete hub network is studied. In order to minimizing the transportation cost through the hub network, a mixed-integer programming (MIP) model will be presented so that each hub has limited capacity of serving received flows. Due to the computational complexity of the resulted model, a meta-heuristic algorithm based on Genetic Algorithm to find near optimal solution of the problem is proposed.

Key words: Hub covering problem, Network design, Capacity constraints, Genetic algorithm

1 Introduction

A basic task of any traffic network is establishing the flow from a set of sources to a set of destinations by providing cost effective means. Hub-and-spoke networks have a lot of application in transportation and telecommunication system including passenger travel through an airline's network of airports, to postal delivery, communication, cargo and public transportation networks where several origin/destination points send and receive some products. The key feature of these networks is to route products via a specific subset of links, rather than routing each product with a direct link from its origin to its destination point. So, the main duties of hubs are to consolidate and to reroute the flows received from located nodes through hub network.

In the hub covering location problem (HCLP), the number of hubs is not given and the objective is to find the best location of hubs in the network and allocation of nodes to hubs such that the total cost of locating the hubs is minimized. The HCLP contains cover constraints, which limit the number of non-hub nodes that can allocate to each hub. Three coverage criteria for hubs have been defined as follows [5]. The origin destination pair (i, j) is covered by hubs k and m if:

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Branch and Bound for Scheduling Jobs on Parallel Machines under Maintenance Constraints^{*}

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Abstract

In this paper, we propose a branch and bound algorithm (B&B) for the problem of scheduling N production jobs on M parallel machines. Each machine should be maintained once during the planning horizon. The maintenance resources ensuring the preventive maintenance activities are not sufficient. For this reason, the maintenance tasks should be continuously run during the planning horizon. We aim in this study to find a schedule composed of the production jobs for which the total sum of the job's weighted completion times is minimized such that the preventive maintenance periods are not known in advance.

Key words: Branch and Bound, Lower Bound, Upper Bound.

1 Introduction

Preventive maintenance operations are usually required in manufacturing shops to keep processing equipments in well working conditions. Sometimes, the maintenance resources ensuring the preventive maintenance activities are very expensive which implies their limited number in the shops. In such a situation, most preventive maintenance policies try to continuously execute the preventive maintenance tasks during the planning horizon. This fact obliges the execution of some preventive maintenance tasks to be early or tardy. Since delaying or early execute a preventive maintenance task increases the preventive maintenance cost, it is suggested to check the preventive maintenance tasks' executions during the planning horizon in order to get a minimal preventive

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Solving the Reliable Fixed-Charge Location Model by NSGA-II *

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Abstract

Supply chain designers encounter facility disruptions and in most cases, facility location decisions are expensive to change. Therefore, managers prefer to prevent failures or at least reduce the number of disruptions. A narrow research area is dedicated to reliable facility location models during the last decade. We consider a known reliable fixed-charge location problem (RFLP) proposed by Snyder and Daskin [17] to solve. The model is a bi-objective one, in which decreasing in one objective (i.e., transportation cost) results in increasing the other objective (i.e., fixed cost). Despite of the fact that the problem is a multi-objective NP-hard problem, no researcher has applied meta-heuristic approaches for this model. We apply a non-dominated sorting genetic algorithm (NSGA-II) in order to obtain Pareto front non-dominated solutions for the first time. Finally, experimental results clarified that the NSGA-II is an efficient algorithm for achieving non-dominated solutions in this problem.

Key words: Reliable facility location, Disruption, Non-dominated sorting genetic algorithm (NSGA-II)

1 Introduction

Facility location models have been widely used in real-world cases, such as warehouses, emergency services, communication networks, airports and distribution centers in supply chain. In these models, the goal is to locate the facilities among candidate sites and to assign customers to facilities in a way that minimizes the total cost [5], [10] and [14]. Primary models considered that facilities never would fail or they were completely reliable, but in recent papers, researchers have focused on revising the previous models into improved version, in a way that they provide the possibility of considering failure probabilities for facilities. In real cases, facilities may face up with disruptions with different failure probabilities.

In general, reliability of the system increases by applying the following approaches: 1) using facilities that are more reliable, 2) using non-failable facilities and 3) is a combination of both methods. The purpose of applying reliable facility location models is to imply that the system operates properly even if failure happens. Supply

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AHPSort for supplier base reduction*

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Abstract:

The Analytic Hierarchy Process (AHP) is a useful method but it is not often applied for supplier selection, especially when the number of candidates is high. Therefore, AHP would not be able to solve supplier base reduction problems. This paper presents AHPSort, a new variant of the AHP, used for sorting alternatives. A real case study confirming or dismissing suppliers is used to evaluate our approach. However useful, two conditions are missing for a full adoption by the studied company: the explanation of the mathematics behind the method and the implementation in an integrated procurement system.

Keywords: AHP, AHPSort, MCDA; supplier base reduction, outsourcing

1. Introduction

The Analytic Hierarchy Process (AHP) is a multi-criteria decision method with an impressive record of success stories compiled in several papers [19], [21], [26], [33], [37], [50], [61], [67], [68], [72], [84]. The core ingredient of the AHP is the pair-wise evaluation of alternatives and criteria, which offers a more precise result than a direct evaluation as in a traditional weighted sum [43], [57], [58], [60], [76]. Supplier selection is seen as extremely important for companies (e.g. see recent surveys [38-40]), however the AHP is not the main method adopted for such exercise. Most companies still prefer to use a simple weighted sum. The aim of this study is to understand the barriers for adopting the AHP. In the first part of our study, a literature review highlights that the AHP has been used only when the number of potential suppliers is small. Therefore, AHP is not adapted for supplier base reduction. In order to tackle this problem, the AHPSort has been developed as a sorting method. A case study is then used to illustrate AHPSort. We have observed that our approach is appreciated and reliable, but it cannot be adopted straightaway as it is not integrated with the current IT system in place and the company requires explanation on the mathematical background of the method.

2. Literature review

Supplier selection is a complicate exercise as several, often conflicting criteria have to be considered in the decision making process.

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Description logic based decision support for integrating supplier with product in networked supply chain^{*}

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Abstract

Flexibility and speed are the hall marks of success in the modern supply chains; traditional supply chains with long lead times and inferior product variety are no longer feasible. Supply chains are becoming more integrated through improved integration and through improved standardization among the enterprise control systems, e.g. Manufacturing Execution Systems, Enterprise Resource Planning Systems etc; and through improved information sharing among the supply chain partners, like in the case of Vendor Managed Inventories. These technologies provide never before seen flexibility and speed to modern supply chains, but their implementation is not cheap. We provide a substitute for small and medium enterprise to benefit from the standardized reference models created for the aforementioned technologies. We provide implementation for the proof of concept of utilizing ontologies as a decisional support tool for improved awareness of the decision makers at the interactions locus of the networked supply chain. The modelled ontology, in its scope integrates the product with its material requirements, and the quality assurance requirements, but the business rules defined by the authors have the limiting scope of material and its corresponding integration to the product. As the ontology is modelled on standardized reference integration models its can be further be extended to integrate product life cycle management models but this is beyond the scope of this paper.

Key words: Decision support system, enterprise ontology, IEC 62264, STEP-PDM (product data model), DL (Description logic), SWRL (Semantic Web Rule Language), Protégé, JESS (Java Expert System Shell), model driven architecture, inference rules.

1 Introduction

Recently the dramatic increase in the product variety and mass customization have presented with new challenges in enterprise integration, these challenges range from product design strategies, production planning and the corresponding supply chain management strategies [6]. These challenges have also resulted in the competition among the supply chains and impacted the supply chain structure from central tight knitted organizations with defined hierarchies, towards more collaboration oriented structures. The competitive advantage, in the above circumstances is in improving the integration and coordination among the associated partners and in modelling decision support systems that can provide increased supply chain awareness to the decision makers and their associated partners at key interaction locus in supply chain.

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A Hybrid Fuzzy Decision Making Approach for Provider Selection in Third-party Logistics*

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Abstract

Outsourcing some of logistics activities is a useful strategy for companies in recent years. This makes possible firms to concentrate their main issues and processes, presents facility to improve logistics performance, to reduce costs and to improve quality. Therefore provider selection and evaluation in third-party logistics becomes an important activity for companies. Making a strategic decision like this is significantly hard and crucial. In this study we proposed a Fuzzy MCDM (Multi Criteria Decision Making) approach to effectively select the most appropriate provider. First we identify the provider selection criteria and build the hierarchical structure of decision model. After building the hierarchical structure we determined the selection criteria weights by using Fuzzy AHP (Analytical Hierarchy Process) technique. Then we applied Fuzzy VIKOR (Vise Kriterijumska Optimizacija I Kompromisno Resenje) to obtain final rankings for providers. And finally an illustrative example is also given to demonstrate the effectiveness of the proposed model.

Key words: Fuzzy MCDM, Fuzzy AHP, Fuzzy VIKOR, Third-party Logistics

1 Introduction

Supply chain management involves the design and management of seamless, value-added processes across organizational boundaries to meet the real needs of the end customer [9], [11], [12]. Logistics plays a significant role in integrating the supply chain of industries. However, as the market becomes more global, logistics is now seen as an important area where industries can cut costs and improve their customer service quality [23]. Logistics outsourcing and third-party logistics originated in the 1980s as important means of improving supply chain effectiveness [19].

Estimates indicate that the proportion of companies in the US implementing this approach has increased by 5–8% annually between 1996 and 2004 [1]. Moreover, in 2005 no less than 80% of the Fortune 500 Companies stated that they relied on TPL [16]. Current predictions indicate growth rates in the range of 15–20% between 2009 and 2011 in both Western Europe and the US [10], [13].

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Supplier selection using multivariate data analysis and multicriteria analysis methods *

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Abstract

Supplier selection is a common problem for acquiring the necessary materials for firms or organizations. On the other hand, it is a hard problem in which multiple criteria need to be carefully examined. The paper introduces the Correspondence Analysis method to a stochastic multicriteria group decision problem in order to provide solutions for the suppliers' selection process. The method is applied to an initial set of categorical data and interprets the ranking of suppliers by means of a new family of weighted hyper-criteria. In case where an aggregation procedure is requested, a synthetic approach based upon the general concept of outranking relations is introduced.

Key words: supplier selection, correspondence analysis, categorical data, stochastic multicriteria group decision-making

1 Introduction

The term "Supply Chain Management (SCM)" arose in the late 1980s and came into widespread use in the 1990s. According to Caneshan & Harisson [12] "a Supply Chain (SC) is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers". SCM can be defined as a coordination process concerning decision making in five areas: production, inventory, location, transportation and information. Its main goal, which can be described as the "increase throuput while simultaneously reducing both inventory and operating porocess" [8], is purely analyzed in terms of actions such as: reduction of SC risk, reduction of production costs, maximazation of revenue, optimazation of inventory levels, business processes and cycle times, improvement of customers service and increasment of competitiveness, satisfaction and profitability [15].

Nowadays, the global competition has imposed tremendous pressure on product and service practices. Quality and time delivery factors add a new level of complexity, especially for the part of the purchasing process. Under this point of view, the purchasing function is increasingly seen as a strategic issue in companies or organizations. One major aspect of this function refers to the selection of a competent group of suppliers for aquiring the necessary materials to support all types of business enterpises. Supplier selection (choice) can be defined as the process by which suppliers are reviewed,

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Real-time information management in supply chain modeling tools.*

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Abstract

To face turbulent environment, enterprises need to adapt their procedures to uncertainty and respond accurately and rapidly to various hazards. Therefore, they need to orient their control system on the use of information in real time, allowing visibility and tracing throughout the supply chain. Modeling the supply chain allows us to understand its mechanism, to analyze performance and behaviour in order to enhance performance or to validate the decision to implement a new organization. This paper aims to analyze existing modeling tools in order to highlight those which are liable to model a supply chain's dynamic performance. Our analysis will be based on real-time information use allowing flexibility and reactivity in managing volatile environments.

Key words: Real-time information, supply chain, model, and dynamic.

1 Introduction

A supply chain is a network of partners based upon mutual interference and collaboration, whose overall goal is to satisfy customers with low cost [28]. This objective remains a competitive asset for any business wishing to secure its durability in a particularly volatile context characterized by strong competition, versatile consumers, emerging technologies, and a shorter product lifecycle. Supply chain management has become more and more complex. A supply chain cannot longer be seen as a succession of stable and sequenced operations, but is more similar to a dynamic network which is able to adapt itself to change and uncertainty.

In this context, supply chain management relies on its capability to adjust its functions and respond quickly and accurately to a volatile environment. Therefore, businesses need to ensure the reactive monitoring of the physical and informational flows in a system, based on the use information in real-time. The instant recognition of disruptive events allows the perception of alterations in resources or products, of machine breakdowns, of demand variations [3] while improving planning, control, process management, and cost reduction.

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Fuzzy TOPSIS based Methodology For Supply Chain Coordination Problems*

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Abstract

This article presents a fuzzy TOPSIS and soft consensus based group decision making methodology to solve the multi-criteria decision making (MCDM) problems in supply chain coordination *i.e.*, selection problems. This methodology is proposed to improve the coordination in decentralized supply chains, *i.e.*, supply chains that comprise several independent, legally separated entities with their own decision authorities. In order to address the imprecision of supply chain partners in formulating the preference value of various criteria, a fuzzy TOPSIS based methodology is proposed. Moreover, a soft consensus based group decision making approach is used for consensus forming among the supply chain partners, regarding the preference values of various criteria for different alternatives. Correlation coefficient and standard deviation (CCSD) based objective weight determination method is also used for enumeration of the weights of the criterion for fuzzy TOPSIS. To demonstrate the applicability of proposed methodology, an illustrative example has been presented.

Key words: Supply chain coordination, neat OWA operator, group decision making, fuzzy logic, fuzzy TOPSIS

1 Introduction

Supply Chain Management (SCM) is nowadays one of the active research topics in global logistics. Companies face competition not only within their industry, but also across supply chains. Larsen [16] defined supply chain coordination (SCC) as “collaborative working for joint planning, joint product development, mutual exchange of information and integrated information systems, cross coordination on several levels in the companies on the network, long-term cooperation and fair sharing of risks and benefits”. According to Simatupang and Sridharan [18], “a collaborative SC simply means that two or more independent companies work jointly to plan to execute SC operations with greater success than when acting in isolation”. However, the most accepted definition of coordination is “the act of managing the dependencies between entities and joint effort of the entities working together toward mutually defined goals [17]”.

According to Arshinder *et al.* [1], different issues of SCC addressed in literature are: i) Role of coordination in supply chain and various models, ii) Coordination across functions of supply chain *i.e.*, logistic, inventory, forecasting, product design, etc., iii) Coordination at SC interfaces *i.e.*, procurement-production, production-inventory, production-distribution, and distribution-inventory, etc., and iv) Coordination mechanism like contracts, information technology, information sharing, joint decision making, etc., in context of resource sharing, risk and reward sharing, joint promotional activities, forecasting, joint decision making, etc. In this article, the supply chain coordination problem is considered as group multi-criteria decision making (GMCDM)

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Identify Information Sharing Antecedents in Supply Chain Relational Dynamics *

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Abstract

The environment complexity in which supply chain members are evolving leads them to adopt opposite strategies in a constructive way. In this sense companies tend to create value by cooperation and, at the same time, capture value by competition. This ago-antagonistic behavior generates a relational dynamics in which companies perform on a set of factors to improve their position within the chain. This enables them to progress towards common interests while ensuring on their own ones. In the present paper, this dynamics is analyzed by using ago-antagonistic system theory, which integrates an economic exchange orientation with a social exchange perspective in order to come up with a framework permitting to better understand and justify information sharing antecedents according to supply chain members' behavior.

Key words: Supply chain, information sharing, relational dynamics, Transaction cost theory, Social exchange theory, Ago-antagonistic system.

1 Introduction

The exceptional growth experienced by the global economic environment in recent years has greatly contributed to increased consumption, which in turn resulted in bigger sales. This meteoric rise, coupled with the opening of markets, the shrinking of product life cycles, the acceleration of trade, the unprecedented development of information and communication technologies, the increased demanding customers and also the expansion of transportation networks, represent major consequences of amplification of flows complexity between different actors of the economic system. This meant that these flows have become difficult to rationalize prompted companies to focus on their core competencies, by outsourcing non-generating value activities to face a number of constraints when managing their processes that deal with the product (or service) from its design to its commercialization, incorporating returns and recycling. To handle such constraints, firms implement new business models and organizational configurations integrating the notion of networks. These were achieved by the advent of 'supply chains' which represent central organizing units in nowadays' industries [38].

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A Profit Allocation Mechanism for Carriers' Collaboration in Less Than Truckload Transportation *

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Abstract

A carriers' collaboration problem in less than truckload transportation with pickup and delivery requests (CCPLTL) is studied, where multiple carriers form an alliance to share their vehicle capacities and delivery requests. CCPLTL has two important issues which are the optimal reallocation of transportation requests among carriers to maximize the total profit of the alliance and the fair allocation of the profit among carriers to maintain the stability of the alliance. In this study, the second issue is addressed under the assumption that the optimal reallocation of transportation requests is realized by using a centralised approach. We propose a fair or nearly fair profit allocation mechanism which takes account of the contribution of each carrier both in offering requests and in serving requests. The mechanism ensures that the allocation is in core or γ -budget balanced. Numerical experiments on randomly generated instances demonstrate the effectiveness of the mechanism.

Key words: Collaborative logistics, Carriers' collaboration, Less than truckload, Profit allocation mechanism

1 Introduction

In collaborative logistics, multiple carriers may form an alliance to share their vehicle capacities and delivery requests in order to optimize their transportation operations. The objective of the collaboration is to eliminate empty back hauls, to raise vehicle utilization rates, and thus to increase the profit of each carrier involved. Driven by cost reduction requirement due to fierce competition in the transportation market and increased environmental concerns, improving operational efficiency through resources sharing and collaborative transportation planning is becoming a new business model for transportation industry [6].

In practice, two types (modes) of transportation are often performed: truckload (TL) transportation and less than truckload (LTL) transportation. Until now, more studies in collaborative logistics were focused on TL transportation [7], [8], [14] and [15]. For carrier collaboration with TL mode, Kwon et al. [14] proposed an integrated multi-round combinatorial auction framework for TL transportation procurement, where shippers receive bids on packages of lanes and solve a winner determination problem (WDP) to assign lanes to carriers, and carriers solve a bid generation problem [15] for maximizing their profits and discovering profitable lanes to bid at each round. Price information derived from the solution of WDP in the current round is used by bidders in identifying profitable lanes in the next round. The results showed that by using their framework, shippers can reduce costs of procurement of services and carriers are able to identify alternative valuable packages of lanes.

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Quasi-optimal single-vendor single-buyer strategies with imperfect production process^{*}

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Abstract

This paper deals with the integrated supply chain management problem in the context of a single vendor-single buyer system for which the production unit is assumed to randomly shift from an in-control to an out-of-control state. Two different strategies, integrating production, shipment and maintenance policies, are proposed and compared to satisfy the buyers order at a minimum total cost rate. The first strategy is based on a classical production policy for which the buyer's order of size nQ is manufactured continuously and shipped by lots of size Q . The second strategy suggests that the same buyer's order should be produced and shipped separately by equal sized lots Q . For both strategies, a corrective or preventive maintenance action is performed at the end of each production cycle, depending on the state of the production unit, and a new setup is carried out. The total integrated average cost per time unit is considered as the performance criterion allowing choosing the best policy for any given situation.

Key words: supply chain management, production, inventory, maintenance, quality, single-vendor single-buyer

1 Introduction

The Economic Lot Sizing problem has been widely and differently treated in single context (EOQ: Economic Order Quantity from the buyer side, EPQ: Economic Production Quantity for the vendor side) as well as in joint context (JELS: Joint Economic Lot Sizing for both the buyer and the vendor). Since Harris's classical EOQ, researchers have relaxed assumptions, such as the perfect production process, making models more and more realistic.

A multitude of individual models related to the case of imperfect production process have been developed. For example, Rosenblatt and Lee [19], Cheng [6], Lin [14] and Khouja and Mehrez [11] developed models assuming that at the beginning of each production run, the production facility is in an in-control state. After a period of time during the production run, the facility shifts to an out-of-control state. They tried to optimize the total cost but didn't suggest any solution to counter the unreliability problem. On the other hand, many authors have integrated differently inspection and/or maintenance policies in order to stop or minimize the production of non-conforming items, such as Lee and Srinivason [13], Lee and Park [12], Ben-Daya and Khurshed [4], Ben-Daya [3] and Aghezzaf et al. [2]. Recently, Yang et al. [21] proposed a new method for the scheduling of maintenance

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A MILP model for joint product family and supply chain design [★]

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Abstract

This paper tackles the difficult problem of joint family product and supply chain design. This issue attracted more and more attention in the recent years. In this paper, we propose a Mixed Integer Linear Program (MILP) model which integrates product, sub-assembly and component substitution possibilities to a supply chain design model. First, the problem is described, notions of supply chain and product substitution are explained. The concept of substitution is discussed and illustrated. Then we present the MILP which includes joint product and supply chain optimization. Finally, experiments characterize the complexity of the problem through the comparison of the resolution length and efficiency with and without substitution.

Key words: Supply chain design, Product family, Mixed Integer Linear Programming

1 Introduction

In a highly competitive business environment, companies must diversify their offers to meet customer's demands. This diversity affects conception, production and distribution processes in decreasing economies of scale. In this conditions, the question is how to offer a wide variety of products that meets customer's needs, while controlling production and logistical costs? Leverage actions that are considered in this paper are the supply chain design and the product family design through sub-assembly substitution.

Works on product family design usually take into account production and logistical constraints. Mass customization [10] is now a well spread conception technique to achieve large variety of product designs at minimum cost. This allows focusing on the optimization of the product family, considering that assembly constraint are more flexible. Many problematics arise as determining the product family variety [3] or the module optimization [1] to minimize production costs.

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Hybrid Flow Shop Scheduling with Several Users [★]

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Abstract

Schedules have implications that are experienced collectively by a number of different persons with different responsibilities. It is, therefore, reasonable to make scheduling decisions in such a way that satisfies the considerations of all the involved partners. Unfortunately, even though there is a vast body of literature on production scheduling, the existing research generally concentrates on generating schedules that optimize one or more performance measures and does not address the problem of how to find a schedule that can be found acceptable by several *users*. Moreover, the considerations of the users may not be fully known in advance, can be implicit or qualitative, and therefore may not be included in the initial problem definition. In this study, we tackle with this problem and propose an approach that aims at determining a schedule that is the result of an agreement between different partners rather than at imposing an optimal solution to everyone. To alleviate difficulties, we suggest that it is first necessary to find a set of different schedules that can be considered efficient by everyone. The solutions can afterwards be passed on to the users to decide on the most appropriate schedule according to their priorities. The proposed two-step approach is illustrated on a hybrid flow shop environment. We propose a multimodal genetic algorithm to solve the first sub-problem. Our computational experiments on a set of benchmark problems from the literature indicate not only that the proposed algorithm is very competitive when compared to the existing exact or heuristic state-of-the-art methods, but that it is also quite promising in obtaining a diverse set of efficient (mostly optimal) alternative schedules. We address the second sub-problem using a multiplicative variant of the popular analytic hierarchy processing(AHP) technique, which does not suffer from dependence on irrelevant alternatives as the original version.

Key words: multimodal optimization, hybrid flow shop, genetic algorithm, production scheduling, group decision making, AHP, preference aggregation

1 Introduction

Scheduling is a decision making process that is far from being isolated. It is in interaction with other decision making processes such as production planning, order review/release, due date quotation, lot sizing, multi-plant coordination, etc. Schedules are not just time/machine/operation assignments, but they are also programs that guide purchasing of raw material, negotiation of due-dates with the customers, tool, fixture and operator assignments, determination of work-force and overtime levels, transportation of raw material and finished goods, etc. Note that the implications of a schedule are not even confined within the borders of the company. It is increasingly becoming common for the companies to share their production schedules with their suppliers with

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Supplier Selection With Order Allocation Using a Simulation-based Fuzzy Approach *

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Abstract

This paper presents a new decision making approach for automatic fuzzy based knowledge acquisition, which clubs supplier selection process with order allocation for dynamic supply chains to cope market variations. More specifically, the developed approach imitates the knowledge acquisition and manipulation in a manner similar to the decision makers who have gathered considerable knowledge and expertise in procurement domain. As per this concept, those decision criteria for supplier selection are considered first through four classes (CLASS I: Performance strategy, CLASS II: Quality of service, CLASS III: Innovation and CLASS IV: Risk), which are qualitatively meaningful. Thereafter, using fuzzy logic, the criteria application is quantitatively evaluated. As a result, the approach generates decision-making knowledge, and thereafter, the developed combination of rules for supplier selection with order allocation can easily be interpreted, adopted and at the same time if necessary, modified by decision makers/managers.

Key words: Supplier selection, fuzzy AHP, fuzzy TOPSIS, knowledge, multi-criteria

1 Introduction

In many settings, supplier selection is a crucial strategic sourcing decision that has long-term impacts on a company's profitability and efficiency. Recently, Van der Rhee *et al.* [10] explored how executives' trade-off amongst various dimensions when selecting a supplier. An empirical study is presented to assess the marginal trade-off for cost, delivery performance, flexibility, and value-added service/support in a supplier selection process using a market utility-based approach (DCA). Specifically, the three objectives are: (i) how do managers trade-off between price and other competitive criteria in supplier selection process, given acceptable quality?, (ii) what is the relative importance of value-added service and support when selecting suppliers, given acceptable quality?, and How do trade-offs in the supplier selection process differ across cultural/national regions?.

Sanayei *et al.* [9] proposed an integrated approach using multi-attribute utility theory (MAUT) and linear programming for rating and selecting the best suppliers, and defining the optimum order quantities among selected ones in order to maximize the quantity of purchase from the desired suppliers. Moreover, Wu *et al.* [13] proposed a two-stage integrated multi-objective decision-making approach using analytic network process (ANP) and mixed integer programming (MIP) to select suppliers when the bundling strategy existed.

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Positioning Product Architecture As the Driver for Carbon Footprint & Efficiency Trade-offs in A Global Supply Chain*

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Abstract

We propose to position the product architecture as the driver for carbon footprint, cost and lead time minimization in a global supply chain. With data from an industrial case, we show the implications of the product architecture decisions on the supply chain performance measures, including carbon footprint levels. Our results point to the importance of the product architecture as a customization platform to supply globally while optimizing different performance measures for different contexts.

Key words: Carbon Footprint, Supply Chain Optimization

1 Introduction

Sustainability and carbon footprint (CF) concepts are becoming increasingly important for companies to incorporate into their business practices [14]. Consumers are more aware of their impact on the environment and are pressuring companies to produce sustainable products [13]. It is anticipated that the government will legislate cap and trade policies for greenhouse gas (GHG) emissions [14]. In fact, trial programs have already been enacted globally for assessing and reporting the life cycle GHG emissions of products and services [5]. Denmark has CO₂ taxes in place, which motivates industry to move away from fossil fuels [6]. The International Organization for Standardization (ISO) also is developing a standard on the carbon footprint of products [5].

Some companies are tracking and reducing GHG emissions before laws are enacted, so they are less likely to incur anticipated fines, and more likely to keep and expand their customer base through a *green* image. Given that the international CF of manufacturing products in 2001 was 13% of the entire carbon footprint, and that wealthier nations' consumers purchase more manufactured goods, efforts toward producing more sustainable products are critical [7,8].

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Exploring the potential of retail customer demand analytics for supply decision support *

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Abstract

In this article, a demand analytics decision support system is presented, which is an integration, visualization, mapping and assessment system using direct-from-customer product trial demand data. It allows analysts and decision-makers to explore efficiently large quantities of data from different information systems about the products and their trial demand within a supply network based on forward relationships. The system allows a visual mining and representation of relations existing between multiple products (present and past) as well as forecasts according to a customizable time window. These representations are done through multi-dimensional summarizing diagrams. These diagrams take the form of relationships graphs, chronological graphs, dashboards, Pareto and forecasts interfaces. The data that feeds these diagrams come from product trial demand and sales recorded directly in the information systems of the various sales points. The article presents a prototype developed in our laboratories and tested on a large scale case in the retailing of fashion shoes and articles.

Key words: Demand Analytics, Customer Data Integration, Business Intelligence, Mining Tools, Multidimensional Mapping, Interactive Viewers, Visual Analytics, Trial Demand

1 Introduction

During the past decades, the retail industry has undergone major changes with the introduction of demand and supply chain management information systems [10] where relevant data about customers represent a competitive advantage. New technologies of information and communication supporting such systems allow the exploration of new perspectives for analyzing in real time market evolution, supply activities, financial performances, inventory levels, store traffic and customer behaviors/preferences/requirements. The retail industry business is particularly affected by an increasing consumer demand for product variety. To remain competitive it appears essential for retail industry to possess and exploit advanced technologies in order to fully apprehend customer demand. The retail companies develop technology defined as strategic to manage information and make decisions. In such a context decision-makers need accurate and well adapted demand analytics systems to support their day-to-day activities, but a question arises: How can the information about the demand be collected and used? Indeed, managers are confronted with more raw data than they can handle and there is a need for developing systems to represent and synthesize the information to support decisions in multiple dimensions and perspectives.

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Track 2 – Maintenance and reliability – S1 to S7

T2S1: Condition Based Maintenance

T2S2: Recent Advances in Joint Production and Maintenance Planning

T2S3: Reliability and Maintenance of Integrated Systems I

T2S4: Reliability and Maintenance of Integrated Systems II

T2S5: Management of aircraft production, maintenance and dismantling

T2S6: Reliability and Maintenance of Integrated Systems III

T2S7: Design and monitoring of safe, maintainable, resilient, complex and distributed critical infomechatronic systems

The use of Logical Analysis of Data in Conjunction with Expert Elicitation in Condition Based Maintenance *

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Abstract

Logical Analysis of Data (LAD) is a supervised learning data mining technique that possesses distinctive advantages which can be of use in Condition Based Maintenance (CBM). The ability of LAD to generate interpretable patterns serves to reinforce the theoretical knowledge or to uncover new knowledge about a certain diagnostic problem in CBM. This paper discusses three scenarios where LAD has been used as a classification tool for fault diagnosis in CBM. In each of these scenarios expert knowledge is elicited in different forms and used in the diagnostic decision. The paper describes the advantages of using LAD for fault diagnosis in each of these three scenarios and concludes that the combination of LAD with expert elicitation permits the use of the former in an unsupervised environment.

Key words: Logical Analysis of Data, Condition Based Maintenance, Expert Elicitation, Pattern Generation

1 Introduction

Condition based maintenance (CBM) is defined as the use of engineering and technical skills in order to continuously monitor the health of an asset (or equipment), using certain indicators, and issue the necessary maintenance actions should the state of the asset require so. A CBM strategy is composed of three steps: data acquisition, data processing, and decision making. Data acquisition entails the collection of data that could be useful to detecting the health of the equipment. This data may consist of anything from visual inspection reports, to performance parameters and historical failure records, to signals collected from sensors such as accelerometers and gas sensors. The following step entails processing the collected data in order to extract meaningful information in the form of data features. Different processing techniques can be used depending on the nature of the data collected in the previous step. The final part of a CBM strategy is the decision making step, where a decision model is used to analyse the processed data and decide on which maintenance action to take if necessary.

Different fault classification approaches have been discussed in the literature for the design of decision models in CBM. Jardine et al. [6] describes different statistical, Artificial intelligence (AI), and model-based

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A Condition Base Maintenance System for Energy Efficiency in Manufacturing^{*}

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Abstract

The primary objective of the maintenance strategies, i.e. reactive, preventive and Condition-based maintenance, is to keep the machines and tools in good health for smooth production and to minimize machine downtime due to catastrophic breakdown of machine. The consequences of catastrophic breakdown of machine are significant in terms of loss of production, delay in delivery of finished products and finally the cost of production. Condition based maintenance is primarily intended as a maintenance strategy for continuously monitoring the health of machines and perform the need based maintenance. This strategy can be applied for monitoring the energy consumption during the production and perform the maintenance when the consumption of energy exceed the expected consumption. As the production processes are expected to consume the specified amount of energy during a production cycle. Increase in the consumption of energy indicates the trend of degrading performance of the machine or components attached to it. There are various reasons of increase in energy consumption i.e. increased friction among moving parts, air leakage through the very small holes in the rubber fittings of the machine. The air leakages in the pneumatic components of the machines are difficult to diagnose because of very small size of the holes (diameter in mm) and effect of the leakage is not reflected as other indicator e.g. increase in vibration due to increased friction. The cumulative effect of these small holes is significant. If not ratified proactively, it may lead to the breakdown of the machine and complete production halt or increased energy consumption during production and finally the increased cost of production and large carbon foot print. In this paper a case study about the application of condition based monitoring and maintenance for achieving energy efficiency of machine using pneumatic components is described. Depending on the level of leakage, condition based maintenance can be performed. On time notification of leakage and subsequent maintenance thus helps in controlling the energy consumption consequently improves the energy efficiency.

Key words: Condition based maintenance, Energy efficiency, Sensors, ERP Systems

1 Introduction

Maintenance is an integral part of daily life of each and every organization in this world irrespective of their size and geographical location for example maintenance is required in homes, in big industrial plants, even at research centers in Antarctica. Depending on the frequency of breakdowns, impact of catastrophic break down on the production processes and cost of production etc. most suitable maintenance strategy is followed. The maintenance strategies can be broadly categories as reactive maintenance, preventive maintenance and condition based (or predictive) maintenance. The reactive maintenance [10] is to perform maintenance after the breakdown occurs or there are visible sign of deterioration of machines. For example in case of home appliances (self) maintenance operation is performed or maintenance service is sought after the breakdown of appliances e.g. refrigerator, television. If the appliance is not repairable then replacement takes place. Thus there is significant lapse of time and monetary expenses in getting appliances back to working condition but it saves maintenance planning and scheduling time.

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A nearly optimal inspection policy for a two-component series system *

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Abstract

This paper deals with a condition based maintenance policy for a series system made of two components subject to gradual deterioration and whose failures are not self-announcing and can be detected only through inspection. An inspection consists in measuring one control parameter for each component and comparing the obtained value with a predefined corresponding alarm threshold level. At this point, a decision should be made based on the inspections results, doing preventive or corrective replacements respectively when one component threshold level is exceeded or when it is found in a failure state, or do nothing in case neither of the two alarm thresholds is found above the corresponding alarm threshold level. A preventive replacement of a component is performed in case the other one has to be replaced. A mathematical model and a numerical procedure are developed in order to generate a nearly optimal inspection sequence (inspection instants) which minimizes the average total cost per time unit induced by both inspection and maintenance actions over an infinite horizon. Numerical results are presented and discussed.

Key words: Inspection strategies, condition based maintenance, multi-components systems.

1. Introduction

A variety of equipment such as stand-by productive systems and alarm and detection systems often do not display any apparent symptoms indicating a failed state or the imminence of failure. They are called non-self-announcing-failure systems. Such equipment need to be inspected in order to determine their state or to assess the level of degradation in order to take the appropriate decision in terms of maintenance actions to be performed. Generally, inspections consist either in assessing if the equipment is working or in a failed state (direct inspection) or in measuring predetermined control parameters and comparing the measured values to predefined threshold levels (indirect inspection) in order to assess the equipment condition and eventually take

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Developments of Integrated Maintenance policy based on the functional age with withdrawal right^{*}

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Abstract

In this paper, we deal with the problem of integrated maintenance with take into account the return of product by customer (withdrawal right). The manufacturing system consists of a machine M that produces a single product in order to satisfy a random demand d under given service level constraint.

First, we establish an economical production plan which minimizes the total inventory and production cost taking into consideration the withdrawal right. Secondly, using this optimal production plan and based on the functional age concept, we derive an optimal maintenance plan which minimizes the total maintenance cost. Finally, a numerical example is studied in order to apply the developed approach.

Keywords: random demand, service level, stochastic model, withdrawal right, functional age, maintenance strategy.

1 Introduction

An integrated approach of maintenance and production policies has recently become an important research area. In deed the development of an optimal production/maintenance plan which minimizes the total cost including production, inventory and maintenance is among the important actions of a hierarchical decision manufacture process. Surely, this is complex to solve since the various uncertainties; the knowing of the random demand evolution by period, the material availability and Failures rate variation. On the other hand, maintenance becomes even more significant with the production control policies implementation like Just-in-Time, which require the availability of machines at the right time. In this context, Abdelnour et al. [1], and Chan et al. [3] proposed a simulation model to evaluate the performance of a production line operating in push system. Rezg and Al. [7] presented a common optimization of the preventive maintenance and stock control in a production line made up of N machines. In the same context of integrating maintenance and production Rezg and al.[8] presented a mathematical model and a numerical procedure which allows determining a joint optimal inventory control and age based preventive maintenance policy for a randomly failing production system. New maintenance/production strategies by taking into account the context of subcontractor are studied by Dellagi, S. et al. [4].

They developed and optimize a new maintenance policy with taking into account a machine subcontractor constraint and they studied the case of several subcontractor machines and developed an optimal switching strategy between the subcontractor machines.

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Dantzig-Wolfe decomposition based Heuristic for an Integrated Production and Maintenance planning Problem*

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Abstract

In this paper, an approach is developed to solve the integrated production planning and maintenance problem. It is a heuristic based on Dantzig-Wolfe decomposition [5]. The Dantzig-Wolfe Decomposition principle reformulates the original model and Column generation is then used to deal with the huge number of variables of the reformulated model. A simple rounding heuristic and a smoothing procedure are finally carried out in order to obtain an integer solution. Computational experiments are carried out to show the results obtained by the approaches and by a commercial solver, afterwards, results are analyzed in detail.

Key words: Production planning, Maintenance, Heuristic, Dantzig-Wolfe decomposition, Columns generation.

1 Introduction

Maintenance is a task closely related to production scheduling in industrial settings. It is the function that allows maintaining or restoring equipment to a specific state and guaranteeing a given service. Both activities conflict since, as it is known, maintenance is generally a secondary process in companies that have production as their core business. Indeed, preventive maintenance activities are often carried out in hours or days out of service. Therefore, the number of unplanned breakdowns increases and the availability of the production equipment are reduced. We notice then that production planning and maintenance are addressed separately in the literature and also in the industry. As a remedy to this problem, maintenance planning should be an integral part of the overall business strategy and should be coordinated and scheduled with manufacturing activities. So, we should consider maintenance as an integral part of the production plan rather than as interruptions to that plan. Any violation of the maintenance schedule is treated as a violation of the production plan integrity.

In this paper, a new integrated production and maintenance planning problem is studied considering a single production line at the tactical level. In the core of production planning, the single stage multi item capacitated lot

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Integrated maintenance optimization with random demand and subcontracting constraint*

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Abstract

This paper deals with an industrial problematic of a manufacturing system called to satisfy a random demand during a finite horizon with a given service level. The manufacturing system production rate is limited. To respond to this demand, the manufacturing calls upon subcontracting. The problem is to determine first an optimal production plan minimizing production and inventory costs. We then derive an optimal integrated maintenance production plan minimizing simultaneously, production, inventory and maintenance cost, taking into account the influence of the production rate on the manufacturing system failure rate.

Key words: Optimization, integrated maintenance/production, failure rate, variable production rate, production plan, service level.

1 Introduction

The integrated maintenance has been the subject of several studies in recent years. It has been proven that the maintenance management is closely linked to both, production structure and demand nature. Buzacott. [6] among the first authors who treated the problem of maintenance and production, he studied the role of buffer stock on increasing the system productivity. In the JIT context, Abdelnour et al. [1], and Chan et al. [7] proposed a simulation model to evaluate the performance of a production line operating in push system. Van Brachte [16] proposed a preventive maintenance policy considering the machine age and the stock capacity between two machines.

Concerning subcontracting, it has grown in the industrial world in virtually all domains as noted by Amesse et al. [2]. This practice is not always justified by production costs. It is part of cooperation logic and coordination based on technological incentives, to satisfy customers in terms of quantity and delay. The above was treated by Andersen. [3] and Bertrand et al. [5]. Recently, in the context of integrated maintenance, Dellagi. et al. [9] developed a maintenance strategy integrating a subcontracting constraint. They treated a production system represented by a machine producing a single product type to satisfy a constant demand during time. The machine calls upon the sub-contracting represented by a second machine to complete the entire demand exceeding the maximum machine capacity. Following the results obtained by Dellagi et al. [9], the authors Dellagi et al. [10] continued in the same context to address the problem but with two subcontractors. They defined a policy of switching between sub-contractors. The optimization of this strategy is sequential. It consists in determining first,

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A Preliminary Integrated Model for Optimizing Tactical Production Planning and Condition-Based Maintenance^{*}

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Abstract

The inclusion of production and maintenance objectives in an overall decision-making approach remains as well an academic challenge as a response to a real industrial need. Based on the observation of mutual dependence between production planning and the stochastic variability of the system production performance due to degradation, we propose in this paper a strategy for optimizing both tactical production planning and maintenance under feasibility constraint. The strategy is driven by an iterative two-unit algorithm. The first unit performs the Master Production Schedule optimization whereas the second unit provides an estimation of the feasibility indicators via a stochastic simulation-based approach. Mathematical framework and the proposed iterative algorithm are directly integrated in friendly-user interface software for optimizing the methodology usability in an industrial context.

Key words: Tactical planning, Maintenance, Performance Threshold, Stochastic Simulation base approach, Software tool

1 Introduction

Production management deals with a set of decisions in order to ensure company continuity. These decisions have to allow the production of customers demand, at the right due date and with the lowest costs. Thus, production management must find a compromise between the satisfaction of customers demand and production criteria such as logistic costs, production times and products quality. Usually, this set is divided into three decisional levels [8]: the strategic level (long-term: more than 18 months), the tactical level (midterm: from 6 to 18 months) and finally the operational level (short-term: from daily to weekly). Each level can be characterized on the one hand by the horizon on which decisions are taken and, on the other hand, by the costs that these decisions can bring about. It defines a framework for the next lower level.

Transversely to these decisional degrees, a major problem can be underlined in production management: the industrial planning. Thus, this problem can be also divided into three hierarchical levels: the strategical, tactical and operational plannings.

1. Strategical planning (long-term) deals with, for instance, the elaboration of the Supply Chain Network (facilities or warehouses locations etc.) and provides a framework for the tactical planning.

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Estimation of non-linear tolerance chains with the monte-carlo-method illustrated by an example from circuit boards *

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Abstract

The classical analysis of tolerance chains, which is an essential part of tolerance calculation, computes the tolerance of the fitment of two or more components by means of convolution. Using convolution has the advantage of being unambiguous for linear cases. The disadvantage is the limited applicability when analyzing non-linear coherences of functions such as slackness and furthermore, when analysing a huge amount of components. These coherences can not be represented analytically for non-linear cases or only with a lot of effort when analyzing many components. For these cases the statistical analysis using Monte-Carlo-Simulation is an established method to describe, link and analyse such tolerances

Key words: Monte-Carlo-Simulation, Tolerance Chains, Reliability analysis, Circuit board, Manufacturing

1 Introduction

New technical and mechanical assemblies are featured by an increasing amount of components in connection with decreasing dimensions. Therefore, complying with given tolerances is necessary for producing new assemblies. When regarding the mechanical case mostly dimensions such as the length or width of components are focused. For other technical assemblies, e.g. containing electronic parts attributes like the capacity of a capacitor or the resistance of a resistor have to be regarded. Thus, there is a need to conform to given attributes for producing reliable assemblies and to avoid high costs due to scrap or field returns. Therefore, a tolerance calculation using tolerance chains has to be made in an early stage of development. The classical methods like linear tolerance calculations or the worst case method are well known and used in industry, compare [5].

Linear tolerance calculations can lead to satisfying results when having mechanical assemblies with attributes which can be summed up easily. By using validated distributions of the attributes an exact analytical result for occurring deviations of tolerances can be achieved. Unfortunately, the linear approach is only applicable for simple cases with few components. Thus this method is not reasonable for complex assemblies as they are used nowadays.

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The Policy of Maintenance of Drinking Water Networks Subjected to Water Hammer*

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Abstract

The aim of this paper is to develop a new policy of maintenance of drinking water networks. For this, one determines the probabilistic safety factors for cast iron water pipes exhibiting surface defects such as gouges. The pipes are located in a water network which consists of a pump, a reservoir and five pipe sections. The water pipes are subjected to a water hammer phenomenon which is considered as the loading condition. The overpressure due to water hammer is calculated for each pipe connection with a software programme. The circumferential stress induced by the overpressure is then evaluated. Probabilistic safety factors associated with low failure probability are determined using a Notch Failure Assessment Diagram (NFAD). Fracture toughness, yield stress and gouge depth are assumed to be randomly distributed to allow the determination of safety factors by Monte-Carlo and FORM methods. For the studied water network, we show that the probabilistic safety factor is acceptable because its value is lower than 2.

Key words: Probabilistic Safety Factor, NFAD, Pipe, Water Hammer, Cast Iron, Monte-Carlo, FORM method.

1 Introduction

The early design methods against the risk of failure were based on the concept of permissible stress design (in the US design more commonly called allowable strength design) which is a design policy used by civil engineers. The designer ensures that the stresses developed in a structure due to service loads do not exceed the strength limit. But the knowledge of the service loads is not sufficient: it is necessary to think of an inappropriate use such as: carelessness of the user, accidental overload, failure of a component, unforeseen external events, etc. For that one uses a safety factor usually noted. The method is usually determined by ensuring that permissible stresses remain within limits through the use of the safety factor and the strength limit. The strength limit is generally the yield stress for conservative reasons:

$$\sigma_{ad} = \frac{\sigma_y}{f_s} \quad (1)$$

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Evaluating Dysfunction of Level Crossing by Bayesian Approach *

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Abstract

Dependability has a determining role in making and design systems. The normal or degrade operating modes will condition the performance of these systems and the effective management of these modes will evaluate the performance in order to achieve the required objectives.

In Morocco, the railway network of the "Office National des Chemins de Fer" (ONCF) has more than 580 level crossings(LC) which 82% are not guarded, and records an average of ten serious incidents per year.

The elimination of level crossings and their replacement with elevation bridges is a project to achieve in long-term by the Directorate of ONCF because it generates considerable costs and time relatively long for study and accomplishments. In this context, this work aims to develop within this establishment, a tool for evaluating the performance of level crossings based on the Bayesian approach, which is a dynamic analysis, thus taking into account behavioral and temporal aspects of the system (events related to material or human factor, random events of accidents, uncontrolled consequences of accidents etc..). It also allows for a forecast based on data collected from the past (feedback).

Keywords: Level Crossing, Performance, Bayesian Networks, Railway Safety.

1 Introduction

The Bayesian approach in the evaluation of dysfunction and quantification of the risks of Level Crossings of Railways is a dynamic analysis, thus taking into account the behavioral and temporal aspects of the system (events related to human or material factor, random events of accidents, uncontrolled consequences of accidents etc.).

The Bayesian approach based on conditional probabilities and derived from Bayes theorem allows a prediction based on data gathered from the past (feedback). To this end, this model requires as input a perfect knowledge of

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An integrated production/quality/maintenance strategy for an unreliable production system: case of perishable products ^{*}

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Abstract

This study suggests a joint production-maintenance strategy for unreliable production systems producing conforming and non-conforming items which are perishable with time. The production system may randomly shift to an "out-of-control" state. It is submitted to an age-based preventive maintenance policy. A mathematical model and a numerical procedure are developed to determine simultaneously the optimal values of the lot size Q and the age T for performing preventive maintenance, minimizing the expected total cost per time unit over an infinite horizon. We show, through a numerical example, the effects of scheduling a preventive maintenance on quality and inventory related costs.

Key words: Inventory, Lot size, Preventive maintenance, Quality, Perishable products

1 Introduction

Industrial systems are submitted to various disruptions which steadily reduce their performance. Major complexities reside in sudden stop of the production system due to unforeseen factors such as random breakdowns and the production of non-conforming products. Several researches have dealt with the issue of performance assessment of production systems submitted to random failures. Such failures may lessen the system's effective capacity and may induce high operating costs. In this context, preventive maintenance (PM) strategies have been widely exhibited in the literature. Implementing PM can be effective in a way to extend failing units lives, hence improving the equipment reliability and reducing operating costs. Gupta et al. [10] linked PM implementation to the performance of production systems. Chelbi et al. [5] proposed a joint strategy

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Statistical Prediction for Maintenance and Reliability Based on Life Data from Extreme Value Distributions *

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Abstract

This paper describes technique for using censored life data from extreme value distributions to construct prediction bounds or intervals for future outcomes. In particular, new-sample prediction based on a previous sample (i.e., when for predicting the future failure time of an unit in a new sample there are available the failure data only from a previous sample), within-sample prediction based on the early-failure data from a current experiment (i.e., when for predicting the future failure time of an unit in a sample there are available the early-failure data only from that sample), and new-within-sample prediction based on both the early-failure data from that sample and the data from a previous sample (i.e., when for predicting the future failure time of an unit in a new sample there are available both the early-failure data from that sample and the data from a previous sample) are considered. In order to construct prediction bounds or intervals for future outcomes, the invariant embedding technique representing the exact pivotal-based method is used.

Key words: Extreme value distribution, Type II censored data, Pivotal quantities, Predictive inferences

1 Introduction

The problem of modeling extreme or rare events arises in many areas where such events can have very negative consequences. Some examples of rare events include extreme floods and snowfalls, high wind speeds, extreme temperatures, large fluctuations in exchange rates, and market crashes. To develop appropriate probabilistic models and assess the risks caused by these events, business analysts and engineers frequently use the extreme value distributions (EVD). Extreme value distributions are usually considered to comprise the following three families:

Type 1, (Gumbel distribution):

$$\Pr\{X > x\} = \exp\left[-\exp\left(\frac{x-\mu}{\sigma}\right)\right], \quad -\infty < x < \infty, \quad (1)$$

where μ is the location parameter, and σ is the scale parameter ($\sigma > 0$). The shape of the Gumbel model does not

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A maintenance policy for a production system under environment constraints^{*}

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Abstract

This paper presents a maintenance policy for a production system to reduce both the environment degradation and the production losses due to failures. To maintain the system, a preventive maintenance action is performed according to statistical knowledge of environment degradation level; while a corrective maintenance action is executed at system failures. Each preventive maintenance action is planned after inspection, which reveals that the value of environment degradation exceeds a specified threshold level. The purpose of this work is to find an optimal vector of inspection times in order to minimize the expected total maintenance and inspection costs per time unit. A mathematical model of the problem is proposed and conditions under which inspection and maintenance dates exist are derived. Numerical examples are given for illustration.

Key words: Average cycle cost, Environment degradation, Inspection, Maintenance policy

1 Introduction

Currently, companies must meet the requirements standards for the protection of the environment. To respect and to respond to such standards, companies must adopt new maintenance strategies developed in order to maximize profit while considering their impact on the environment. The system degradations can have multiple impacts on the environment, for example, air pollution, water pollution, noise and microwave pollutions. Indeed, such impacts are more important especially in cases of transportation as well as petrochemical systems.

In the existing literature, there are several research papers which deal with system inspection and maintenance problems. Early works are those initiated by Barlow and his co-authors [2]. The authors in [2] proposed two preventive maintenance policies for a system subject to random failures and whose state is assumed to be known at any moment. In [2], an optimization model is developed where the objective is either to minimize the total cost generated by maintenance activities, or to maximize availability. Barlow and his co-authors [3] introduced an inspection policy where the objective is to minimize the average total cost of inspection activities. An algorithm based on a recurrence relation is proposed to calculate the optimal dates of inspection. Several

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Hybridization of Bayesian networks and belief functions to assess risk. Application to aircraft deconstruction. *

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Abstract

This paper aims to present a study on knowledge management for the disassembly of end-of-life aircraft. We propose a model using Bayesian networks to assess risk and present three approaches to integrate the belief functions standing for the representation of fuzzy and uncertain knowledge.

Key words: Bayesian networks, belief functions, risk assessment, knowledge management, aeronautical deconstruction.

1 Introduction

1.1 General overview

The disassembly of end-of-life aircraft shows nowadays a rapid growth for several reasons. Firstly, the aircraft fleet ageing raises substantially the number of aircraft arriving at their end-of-life period. In addition, the recent changes in regulations significantly increase the manufacturer liability regarding the management of the end of life of their aircraft. Finally current environmental concerns encourage aircraft manufacturers to integrate the environmental dimension in their industrial strategies.

This paper aims to present a study on knowledge management for the disassembly of end-of-life aircraft. Our work is part of a project called “DIAGNOSTAT”. This project, supported by the Aerospace Valley cluster, is funded by the “Fond Unique Interministériel” (FUI). In this context we wish to develop decision-support mechanisms using the experience feedback to perform risk assessments on critical areas of an aircraft.

1.2 Problematic

The DIAGNOSTAT project focuses on two specific aspects of aircraft deconstruction which are, first, the recovery and the certification of parts for reuse as spares, and, secondly, the knowledge capitalization on airplane status (in particular its critical areas) to improve aircraft design and maintenance.

In this context, we focus specifically on the capitalization of the knowledge generated during aircraft deconstruction. We aim the establishment of an information system to facilitate knowledge management used in the aircraft deconstruction and particularly during the inspection phase of the plane. We first planned to build an

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Decision support in the management of end-of-life aircraft*

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Abstract

The study of five aircraft disassembly and dismantling companies (DDCs) showed that there is no unique dismantling method established in the end-of-life aircraft industry. Depending on capabilities, know-how and experience, DDCs perform various depths of dismantling before scrapping. However, a DDC usually uses the same strategy for every aircraft. This paper proposes a model aiming at allowing them to adapt that strategy to each aircraft, according to various factors such as the added value brought by a further depth of dismantling (from an economical and environmental perspective), time available and economies of scale due to scrapping several aircraft at a time.

Key words: end-of-life aircraft, disassembly, dismantling, scrap metal, spare parts

1 Introduction

Until recently, most product manufacturers focused their efforts on design, production, marketing and sales: once a product left the factory, the only further contact between the manufacturer and its customer were related to after sales service. At the present time, environmental concerns, new regulations, corporate imaging, production cost reduction, among others, are more and more forcing companies to take care of their products when the customer is ready to dispose of them according to the “polluter pays principle”. Those issues affect a lot of industry sectors, including automotive, consumer appliances, electronic, etc. Aircrafts are a little particular, in the sense that the volume of EOL aircrafts remains small compared to the volume of obsolete products relevant to the above mentioned domains. Further, unlike the automotive sector, the asset value of components and materials contained in retired airframes can be very considerable depending on the technologies employed. They are made of high quality alloys and very valuable spare parts can be removed such as engines and landing gear.

Between 6,400 and 8,500 aircraft will reach the end of their life cycle over the next 20 years. Multiple reasons may explain an airplane retiring from service, including: increased maintenance cost as the aircraft gets older, high fuel cost due to a high consumption combined with the increasing price of oil, various legislation motives like expensive technology upgrade requirements, and the difficulty of acquiring older spare parts. Storing these aircrafts to wait for an alternative use is not a viable long term option. Although this practice is still done to a large extent, new options must be found. Legislation all over the world, and especially in Europe, is becoming tougher regarding the environment. Therefore, for these new solutions to last, they self-evidently have to be economically profitable in order to allow companies to run their business properly, but soon they will also have to be environmental-friendly to meet legislation requirements.

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Simulation of aircraft maintenance improvement using RFID systems*

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Abstract

The paper describes the maintenance process applied to an aircraft part along periodic maintenance operations and/or failure repairs. This paper deals with the assessment of RFID (Radio Frequency Identification) technology contribution to the follow-up of aircraft parts. The construction of a simulation model and validation of the study are based on both experts' knowledge and data on flight and maintenance operations. Each stage of the maintenance process is modelled in terms of time (average times and boundaries) and the transition probability between stages. The impact of RFID technologies in the overall maintenance process is assessed. The main use of the analysis is the evaluation of different maintenance strategies and a first quantification of the impacts related to introducing RFID in maintenance processes. It should be helpful to support the decisions on RFID integration. The model could be used to design a decision support tool for maintenance designers and managers.

Keywords: Maintenance, RFID, Helicopter, Part tracking, Process modelling

1 Introduction

For a global maintenance process analysis, various parameters, i.e. the use of human resources, spares and equipment have to be combined to ensure that the entire system is properly modelled. The aim of this paper is not to model the complete detailed maintenance process, but rather to have a first relevant overview. Details concerning maintenance are studied and mapped when necessary, i.e. when RFID (Radio Frequency Identification) technologies may play a significant role.

The benefits of RFID integration are assessed and quantified on the maintenance process through the model. This will lead to a global estimation of the process impacts. The purpose of the study in this paper is to emphasize the benefits in terms of availability improvement and cycle time reduction. The resulting model could help the flight and maintenance policy planners for the identification of maintenance performance improvements more thoroughly. The model is aimed at providing an experienced user, such as a maintenance

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Fuzzy capacity planning for an helicopter maintenance center^{*}

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Abstract

Aircraft maintenance costs are becoming an important issue in the aeronautical industry. In this paper we present a tactical planning model for an helicopter maintenance center. The objective is to guarantee a good service level, i.e. to limit aircraft visit duration. Difficulties come from the numerous uncertainties on maintenance activities: additional activities, procurement delays... To cope with these uncertainties, a fuzzy multiproject planning model is proposed. From the task fuzzy dates and durations, a periodic load chart can be established. Then a parallel algorithm is adapted to this model in order to solve capacity problems.

Key words: Maintenance, Multiproject, Fuzzy, Capacity planning

1 Introduction

Aircraft maintenance is a highly regulated activity, due to the potential criticality of the failures. Aircrafts must follow a maintenance program in which several levels of inspection appear, from light maintenance that can be performed daily at the aircraft's basis, to heavy maintenance that can last several months and requires specific equipment. Our work focuses on the organization of a helicopter maintenance center where heavy maintenance visits (HMV) are performed.

An HMV contains planned maintenance tasks and also corrective maintenance tasks because problems are discovered during the inspection of the helicopter at the beginning of the visit. Even planned tasks may differ from one helicopter to another, according to equipment, conditions of use, etc. Precedence constraints exist, due to technical or accessibility considerations. Hence a HMV may be seen as a project involving various resources as operators, equipment and spare parts. Minimizing the overall visit duration give a competitive advantage to the company. Consequently, the management of a maintenance center is viewed as multiproject management, where every project duration should be minimized while respecting capacity constraints. A particularity of these project is the level of uncertainty, mainly due to unexpected failures that induce additional work and procurement delays. In case of important homogeneous fleets, a global optimization of maintenance visits can be done, guaranteeing a general helicopter availability level [8]. This is not the case in our project dedicated to civil customers whose mean number of helicopter is between two and three, with a great heterogeneity in the equipments and conditions of use.

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Management of airframe disassembly and dismantling for reusing, remanufacturing and recycling *

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Abstract

A possible legislation for aircrafts' end-of-life treatment is anticipated by the aircrafts manufacturers because of the emergence of environmental legislations. It is important to make sure that the aircraft dismantling process is profitable. In this research project an algorithm is proposed in order to minimise the time needed to determine the best dismantling operations sequence according to the knowledge of the employee assigned to this task while maximizing the aluminum valorization and minimizing operational costs. A linear and binary program model is developed to enable the optimisation of the dismantling sequence which is in one of the main steps of the algorithm. The mathematical model presented optimizes the profitability of aircraft dismantling process by determining which airframe entities must be sheared and sorted prior to shred its components or which entities must be directly shredded. The model also identifies which shredded components should be sorted in order to upgrade recovered materials composition. The model proposed here is aircraft-oriented and is not only based on assembly connection types and fasteners classification which are considered as being too restrictive. Analysing the program utilization with the software AmplStudio and its behaviour, it is justified to conclude that the mathematical model and the implemented program reach to the objectives mentioned.

Key words: Aircraft disassembly and dismantling, product value recovery, material recovery, end-of-life aircrafts, mathematical optimization.

1 Introduction

According to the Engineering and Physical Sciences Research Council (EPSRC) report 2007, "Over the next 20 years, approximately 5000 commercial airliners are expected to be withdrawn from service at a rate of approximately 250 per year". In another side Boeing has determined that about 7,200 civil airplanes will be retired in the next 20 years without considering military equipment. More than half of these aircrafts end up their life abandoned in desert or in warehouse because of the **lack of dedicated infrastructure** and **profitable recycling process**. For the aerospace sector, this becomes image and economical issues. Actually, about 300

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Raising the reliability of manual assembly through predicting human reliability^{*}

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Abstract

Due to increasing customer requirements, the price and quality of products are becoming more and more important sales criteria. As a result of the severe competition in the automotive industry, companies are therefore interested in providing a maximum level of quality while keeping their costs as low as possible.

Quality and price are significantly influenced by the production of the vehicle itself as the quality, later to be experienced by customers, is generated here. Furthermore, a large proportion of the production costs are caused in vehicle assembly.

As a result of the fast-changing automotive market driven by continually changing versions of models, the assembly is carried out manually to a large extent in automotive production. The individual person who performs the assembly is very important since he or she directly affects the quality of the products. To ensure high quality the production system must be extremely reliable, which is determined by human reliability. Therefore it is very helpful to know which human actions or tendencies may reduce the quality of, or create a defect in, the finished product.

The aim of this study is to create an approach, which shall provide a quantitative prediction of human reliability in manual assembly. At present the known methods for predicting human reliability, which use for their assessment task-, time- or PSF- (Performance Shaping Factors) related quantification principles, are not practicable for vehicle production.

The assessment tool developed by this study is an operation-based model which uses available standardised documents from manual assembly, which allows an early application of the relevant calculations in the product development process. Thereby, a continuous and early adaptability of the created tool in the development process is guaranteed, so that preventive measures can be introduced to raise human reliability and therefore product quality by an optimised product and process design.

Key words: Human reliability, manual assembly, prediction, quality control

1 Introduction

The enduring stability and success of a company in a given market is primarily influenced by the price and quality of the products it delivers. That is why most companies strive to increase their quality level while

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Comparison of diagnosis approaches for Discrete Event Systems^{*}

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Abstract

This paper compares a centralized approach of diagnosis with a decentralized approach for Discrete Event Systems. It introduces a notion of independent codiagnosability for the discrete manufacturing systems by using an approach based on components. The system is represented by models of its elements called « Plant Elements » (PEs). Temporal constraints are added for every PE to construct local diagnosers. To check independence between components, a notion of independent codiagnosability is defined. An example of two tanks is used to illustrate the approach.

Key words: Diagnosis, Discrete Event Systems, Manufacturing Systems, Modelling

1 Introduction

Manufacturing systems became more and more complex owed to technological evolution. This complexity and the new requested such as availability, reliability and safety demanded the development of systematic approaches of diagnosis. Detection and isolation of faults in these systems are not an easy task. For it, a study of the problems of diagnosis and diagnosticability became necessary [13]. Discrete event system (DES) is a dynamic system with discrete state which changes only by discrete events [2].

Diagnosis of DES consists to determine if the behaviour of the system is normal or not by using observations. However, in DES, Boolean information is only available and its observation alone does not often allow to detect the fault occurrences and to isolate the responsible elements. Several approaches have been developed to solve the Fault Detection and Isolation (FDI) problem with different notion of diagnosability for centralized approaches [5, 12, 15] or codiagnosability for decentralized approaches [4, 7, 11, 14].

In the centralized structure, a global diagnoser performs one decision based on a global model, about the normal and/or abnormal functioning of a system. A diagnoser is a special case of an observer that carries fault information by means of labels. Consequently, the major drawback of centralized structure is the combinatory

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A decision model for adopting an extended two-dimensional warranty region under different maintenance policies*

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Abstract

In this paper we study the opportunity provided by adopting a two-dimensional extended warranty for the manufacturer as well as for the consumer of randomly failing products. The buyer has to decide to pay or not for the extended warranty when purchasing the product. The total expected cost incurred by each side during the product's life cycle is expressed in order to determine the maximum extra cost the consumer should pay and the minimum price at which the manufacturer should sell the extended warranty. This is done under different options in terms of maintenance strategies adopted during the product's lifecycle.

Key words: two-dimensional warranty, extended warranty, preventive maintenance

1 Introduction

Several works in the literature tackled the issue of warranty contracts and warranty policies for randomly failing products. Most of the studies on this subject consider the well known one-dimensional warranty which considers only the age of the products. Different review papers are available on this topic of warranty policies, they deal with various aspects related to product warranty (warranty vs maintenance, warranty vs cost analysis over the product lifecycle, etc). We mention the following: Murthy D.N.P [13], Murthy and Bilshke [14], Murthy and Djameludin [16].

In many practical situations such as in the automotive and aeronautic industry, warranty contracts are based a two-dimensional warranty; such a warranty is generally characterized by a two-dimensional region with one axis representing product's age and the other representing its usage. This region is usually a rectangle $[0, Kw] \times [0, Lw]$, the warranty ceases when the sold item reaches the age Kw , or earlier if the usage exceeds Lw .

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Optimal mixture strategy of two identical subpopulations with different ages [★]

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Abstract

In this paper, we introduce and study the shape and the behaviour of the failure rate of a mixture of two subpopulations with the same distribution but different ages. This type of mixture is encountered in industrial settings when new and reconditioned systems are mixed together in remanufacturing or maintenance operations. It is shown that a proper mixture of components can result in the delaying of maintenance actions and that cost-optimal mixture strategies can be derived.

Key words: Mixture, New and used components, Increasing failure rate, Bathtub failure rate, Maintenance.

1 Introduction

With the introduction of legislation to force the collection and recovery of end-of-life products, and electronics in particular, original equipment manufacturers are finding themselves with a non-negligible source for components that can be reconditioned to be reused on assembly lines or in maintenance activities. This new source for components raises many interesting research problems which have been studied by several researchers. Fleischmann *et al.* [5], Teunter [10] and many more have addressed the determination of the optimal inventory control models. Others like Richter *et al.* [8], and Vlachos *et al.* [11] have focused on the remanufacturing production planning aspect. Very few papers have however directly dealt with the reliability and maintenance aspects of the reconditioned spare parts (see [1], [4]). The heterogeneous population resulting from this mixture of new and aged components can be described with the statistical concept of mixture of distributions as studied by [3], [7] and [12].

Many authors have used the general concept of mixture distribution to study reliability and maintenance issues and they always mix two or several distributions with known parameters. Jiang and Jardine [6] use the mixture of two Weibull distributions to find the optimal burn-in preventive replacement model. Scarf *et al.* [9] also use a mixture of two Weibulls to determine the aged-based inspection and replacement policy for heterogeneous components.

In this study, we consider that only similar components are mixed together. Hence, it is reasonable to assume

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Safety-Based Availability Assessment In Mechanical Design *

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Abstract

Many lost of performance and sometime accidents happened because of different unforeseeable situations. These unforeseeable situations engender some stops of system to guaranty user-safety required by standards. We noted that the real system operational availability is different from that estimated at design stage. The aim of this work is to provide an approach for safety-based availability assessment. In this purpose, we consider all stop events that could happen during the utilization of production system and may influence its availability like Accidents, Preventive maintenance activities or Failures. We use Markov chains to illustrate our model. This paper proposes a generic approach, to improve the system's performance by analyzing the influence of accidents and preventive maintenance tasks, in routine design. Such an approach will provide the systems' stops traceability and their causes. to know how we could reduce it by understanding: What is the principal cause of stop? On what designer must work? And what designer requirement in data, in information and or perhaps in expertise?

The comparison of our simulation with an industrial case study shows a good agreement of the influence of safety on the availability of system.

Key words: Product performance, Safety-based Availability, Safety, Maintainability, Use conditions, routine design.

1. Problematic

Availability represents the probability that a system is in an operational state at an instant t . It is one of the crucial characteristics that strongly influence customers' final choice decision between concurrent products. Evaluating availability at early design stage is of great importance to determine ways to improve a system's performance for its future version. Actually, availability is determined using statistical failure data for existing products. Form these data the type of stop could be identified (accident stop, failure stop, maintenance stop) and its influence on system performance could be evaluate. In function of major stop type designer could know where and on what he could react. Most of literature works do not consider safety constraints when human intervention is required for setting-up, operating and maintaining the system. However, if an accident happens

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Failure predicting for the failure process modelling of an equipment in operation*

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Abstract

The estimation of the failure density of equipments in operation is difficult in practice due to events coincidences that disrupt the data collection. In this paper we propose to couple nonparametric statistical methods for better estimating the probability density failure of equipments subjected to systematic preventive maintenance actions based on operating hours. Through this study, we complete training data with the predicted failure beyond of the preventive maintenance. The estimated samples have allowed us to build the behaviour law models without any a priori on the probability law of failures. On simulations, we showed that when the variation of standard deviation of samples is negative, the constructed samples provide the best estimations of the probability density failure.

Keywords: density function, estimation, kernel, prediction

1. Introduction

Production facilities are often subject to corrective maintenance actions after failures. Also, preventive maintenance actions can improve the life of machineries by avoiding the machines failures or by slowing down their degradation speed. In practice, the extraction of the failure process model of an in operation machine, especially of complex and multi-component systems, (e.g. generator), is difficult because of the preventive maintenance actions, which enact effects of censoring on the failures events data .

During operation, two important factors should be considered for improving the quality of the behaviour models: the reliability function extracted from failure data and the corresponding times to failures data censored by the scheduled systematic preventive maintenance actions.

The random aspect of the events complicates their management, and it becomes difficult to integrate them for modelling machines failures by using a parametric model. This problem was introduced in Brown Fontenot & Proschan , Wang & Pham . These authors proposed probabilistic approaches for integrating the quality of maintenance actions. Pham and Wang carried out a detailed bibliography study on imperfect maintenance concept with various solutions. As for the effect of preventive maintenance plans, there are many approaches in the literature devoted to the processing of failures data, and there are many assumptions addressing the issue of maintenance quality. Data may be incomplete, omitted or censored. One will often encounter three kinds of

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Facility protection strategies against intentional attacks^{*}

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Abstract

The article presents an optimization modeling approach for allocating protection resources among a system of facilities so that the disruptive effects of possible intentional attacks to the system. This article considers the uncapacitated fixed charge location problem (UFLP) to deal with defence resource allocation. The vulnerability of each facility is determined by an attacker-defender contest success function. The article considers a two-period min-max game where the defender invests in the first period, and the attacker moves in the second period. This means that the defender selects a strategy in the first period that minimizes the maximum loss that the attacker may cause in the second period. The loss incurred by the defender is evaluated of the increasing in transportation cost, and the cost necessary to restore the disabled facility.

Key words: facility location, attack, protection, loss, games theory, optimization

1 Introduction

Due to the complex interaction amongst its components, supply chains are subject to a variety of risks. Also, there are the risks of, financial instability, cargo loss due to theft, natural disasters, terrorism, and so on. In October 2001, anthrax spores were discovered at the United States Postal Service (USPS) processing facility in Brentwood (Washington, D.C) [16]. Terrorist acts were believed to be responsible for this incident. This led to the closure of the facility that was 633,000 square feet. Due to this shut down, USPS lost the capacity of a huge facility. This case shows how supply chains can be vulnerable to disruptive events such as terrorist attacks. There are also many instances where intentional disruptions, have caused disruption in the supply chain.

The facilities of the supply chain network constitute critical infrastructures which are potentially vulnerable to the disruption caused by the intentional attacks. These disruptions have negative impacts on the performance of a supply chain network. Failure of a facility means that the facility is no longer available to serve its customers. When these facilities fail, the concerned organization has to find alternate sources of supply chain to provide service to the customers and/or reroute shipments that were initially intended to go to a particular facility or incur large penalties. It is therefore important to protect against this type of attacks at the design stage. This article considers the uncapacitated fixed charge location problem (UFLP) to deal with defence resource allocation. The UFLP is a classical location problem and forms the basis of several location models. In this model used for the optimization of the location of the facilities, we have not considered limits on the ability of facilities. Snyder and Daskin [4] and [18] present deterministic formulations for locating facilities for the UFLP.

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Track 3 – Advances in optimization for vehicule routing problems – S1 to S4

T3S1: Cooperative approaches for vehicle routing problems

T3S2: Metaheuristics for vehicle routing problems

T3S3: Exact methods for vehicle routing problems

T3S4: vehicle routing problems and logistics

A hybrid metaheuristic for the Two-Echelon Location Routing Problem^{*}

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Abstract

The two-echelon location-routing problem (LRP-2E) is a problem arising from the actual design of transportation networks and particularly in city logistics. It involves two sets of vehicle trips: first-level trips serve from a main depot a set of satellite depots, which must be located, while second-level trips visit customers from these satellites. Two algorithms to solve this problem are proposed: a memetic algorithm (MA) and a memetic algorithm hybridized with simulated annealing (SAMA). The good results are obtained not only on LRP-2E, but also on the LRP single echelon special case.

Key words: memetic algorithm, simulated annealing, two-echelon location-routing problem, vehicle routing, facility location.

1 Introduction

The two-echelon location-routing problem (LRP-2E) combines two NP-hard problems: the two-echelon facility location problem (FLP-2E) and the two-echelon vehicle routing problem (VRP-2E). Generalizing from distribution or collection networks, the LRP-2E involves two sets of vehicle trips: first-level trips serve from a main depot a set of satellite depots, which must be located, while second-level trips visit customers from these satellites. In this paper, the LRP-2E can be defined as follows. One main depot stores the goods and a fleet of first-level vehicles, while smaller depots called satellites share a fleet of second-level vehicles. Each customer is served by one route coming from one of the satellites. The vehicles at the first level perform tours to supply satellites. However, customers may be delivered directly from the main depot, using a virtual satellite located at the depot. There to, satellites may also act as customers, by adding a virtual customer on the satellite. The LRP-2E can also model collection problems, by reversing the direction of flow. Figure 1 depicts one example of feasible solutions of the LRP-2E.

The objective is to determine the set of satellites to be opened and the routes for the two levels, to minimize the total cost which includes the total distance travelled, one fixed cost for each vehicle used, and one opening cost for each satellite used.

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Heuristic column generation for the truck and trailer routing problem [★]

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Abstract

We present a heuristic column generation for the truck and trailer routing problem (TTRP) in which the routes of the local optima of a GRASP/VNS are used as columns of a set-partitioning formulation of the TTRP. This approach outperforms the previous state-of-the-art methods and improves the best-known solutions for several test instances from the literature.

Key words: Truck and trailer routing problem (TTRP), matheuristics, set-partitioning problem, greedy randomized adaptive search procedures (GRASP), variable neighborhood search (VNS).

1 Introduction

In the last years a new generation of hybrid optimization methods known as matheuristics has emerged. Matheuristics combine elements of exact mathematical programming algorithms and metaheuristics in a cooperative way [3,10,12]. Recently, Villegas et al. [17,18] presented a very effective GRASP/VNS with path relinking for the solution of the truck and trailer routing problem (TTRP). In their experiments a GRASP/VNS that uses path relinking as post-optimizer offered a good trade-off between solution quality and running time. This shows that GRASP/VNS is able to generate diverse high-quality solutions for the TTRP that can be used as input of a post-optimization phase. Therefore, in this paper we solve the TTRP using a hybrid method that combines a GRASP/VNS metaheuristic and a set-partitioning formulation of the problem.

The remainder of this paper is organized as follows. Section 2 describes the TTRP and gives a brief literature review of the methods to solve it. Section 3 presents a set-partitioning formulation of the TTRP. Section 4 describes the elements of the proposed matheuristic. Computational results are presented in Section 5 followed by the conclusions in Section 6.

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A Hybrid Algorithm for the Fleet Size and Mix Vehicle Routing Problem [★]

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Abstract

This paper deals with the Fleet Size and Mix (FSM) Vehicle Routing Problem. The FSM generalizes the classical Vehicle Routing Problem (VRP) by allowing the existence of an unlimited heterogeneous fleet of vehicles. Each type of vehicle is associated with a distance-dependent and/or fixed cost. The objective is to determine the best fleet composition as well as the set of routes that minimize the travel costs. The proposed hybrid algorithm is composed by an Iterated Local Search (ILS) based heuristic and a Set Partitioning (SP) formulation. The SP model is solved by means of a Mixed Integer Programming (MIP) solver that interactively calls the ILS heuristic during its execution. The developed algorithm was tested on benchmark instances involving up to 100 customers. The results obtained are highly competitive since the hybrid approach was always capable to find or improve the best known solutions reported in the literature.

Key words: Fleet Size and Mix, Vehicle Routing Problem, Matheuristics, Iterated Local Search, Set Partitioning

1 Introduction

The Vehicle Routing Problem (VRP) is one of the most studied problems in the fields of Operations Research and Combinatorial Optimization. The importance of this problem can be verified by observing the huge number of works that had been proposed over the last 50 years. Motivated by applications that arise in real-life, a

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A Route Feasibility Algorithm for the Dial a Ride Problem with Transfers[★]

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Abstract

The Dial-A-Ride Problem (DARP) consists in determining and scheduling routes serviced by a set of vehicles in order to satisfy transportation requests from pickup points to delivery points. This paper introduces a variant of the DARP where the client can be transferred from one vehicle to another on specific points called “transfer points”. Solving this variant of the DARP yields new algorithmic difficulties. In this paper, we investigate checking efficiently whether a modification of the current solution through a local search is feasible or not. The method has been embedded into a tabu search algorithm and evaluated over generated and real instances.

Key words: DARPT, feasibility, STP

1 Introduction

This study is motivated by a practical case of school bus routing for handicapped children in France. Contrary to the classic school bus routing problem, the objective is to perform door-to-door transportations. Each request is a trip from home to school. As each school may receive only a few handicapped children, this problem can be considered as a Dial A Ride Problem (DARP) rather than several separated Vehicle Routing Problems. Furthermore, as often for the DARP, the legislation limits the maximum ride time of the users.

In practice the transportation plan are often performed by school directors or their assistant. One usual technique is to gather some geographically spread children to a predetermined location, from where they can be transported to their school by an unique vehicle. Technically, this problem can be modeled as a DARP where requests can be transferred from one vehicle to another at some specific predetermined locations, called transfer points. This problem is called the Dial A Ride Problem with Transfers (DARPT).

In the DARP, the aim is to determine a set of minimum cost routes that services a set of transportation requests [1]. These requests emanate from users who ask for a ride between an origin location and a destination. Several users can share a vehicle as far as its capacity is respected. The transportation of handicapped people [1] is a common application of the DARP. As the DARP deals with the transportation of persons, the quality of

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Solution of a Multicriteria Dial-a-Ride Problem with an Ecological Measure and Heterogeneous Vehicles. ^{*}

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Abstract

The Dial-a-Ride Problem (DARP) is a complex combinatorial optimization problem with many real-world applications in transportation of persons. It consists in routing a heterogeneous fleet of vehicles based at a common depot in order to satisfy users' transportation requests. Each request consists in a number of persons, a specified pickup location, a destination location and desired departure and arrival time windows. In this paper we investigate a new and general model for the transportation of persons. It involves three objective functions that have to be optimized in order to measure the potential efficiency of the DARP solution on different aspects: the cost for the transportation operator, the quality of service for users and the impact on the environment.

Key words: Dial-a-Ride Problem, multiobjective optimization, evolutionary algorithms.

1 Introduction

The Dial-a-Ride Problem (DARP) belongs to the general class of Vehicle Routing Problems with Pickup and Delivery (VRPPD). It consists in scheduling a set of transportation request on a fleet of vehicles, *i.e* determining a routing for each vehicle. Each request in picking up and delivering users within user specified time windows between origin and destination locations. In practice, the transportation requests of the DARP are usually booked in advance, so in this paper we consider the static version of the problem [6]. More precisely we consider a novel model aimed to be closer to real-life situations since we consider not only the reduction of the transportation costs, which only reflects the transportation operator desires, but also criteria related to the users and the ecological impact of vehicle routings. The later is of high importance, mainly for societal and environmental reasons. The three criteria we consider are the following:

- Minimizing the transportation cost,
- Maximizing the quality of service provided to the users (or equivalently, minimizing the user's dissatisfaction),
- Minimizing the CO₂ quantity emitted by the vehicles.

The DARP, when only the aim is to minimize the transportation cost, turns out to be NP-hard. Consequently, the tricriteria problem tackled here is so.

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A hybrid algorithm for the Vehicle Routing Problem with Time Windows^{*}

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Abstract

The Vehicle Routing Problem with Time Windows is a particular case of the classical Vehicle Routing Problem in which the demands of each customer should be met within an established time window. Due to the combinatorial complexity of the problem its resolution by pure exact methods is, in many cases, computationally impractical. This fact motivates the development of heuristic algorithms, which are usually faster but do not guarantee the best solution for the problem. This work proposes a hybrid algorithm that combines the metaheuristic Iterated Local Search, the Variable Neighborhood Descent procedure and an exact Set Partitioning model. The latter mathematical procedure is periodically activated in order to find the best combination of the routes generated along the execution of the algorithm. The computational results demonstrate that the proposed hybrid approach is quite competitive, since out of the 56 test problems considered, the algorithm was found capable to improve the best known heuristic/hybrid solution in 12 cases and to equal the result of another 27.

Key words: Vehicle Routing Problem, Hybrid Algorithms, Iterated Local Search

1 Introduction

The Vehicle Routing Problem with Time Windows (VRPTW) is a well known optimization problem and it has received a lot of attention in operational research literature. In this problem, a fleet of vehicles must leave the depot, serve customer demands, and return to the depot, at minimum cost, without violating the capacity of the vehicles as well as the time window specified by each customer.

There are two main reasons (operational and theoretical) for investing in research to develop new algorithms for the efficient resolution of this problem. From the practical/operational point of view, the costs related to transporting people or merchandise are generally high, with a tendency to increase, motivated by the actual expansion of commerce of all types [3]. Researchers calculate that 10% to 15% of the final cost of the merchandise commercialized in the world is due to its transport [10]. From the theoretical aspect, since the VRP and most of its variants, including the VRPTW, are NP-hard problems [13], the efficient resolution of these problems represents a challenge for researchers, who, in general, opt for heuristic approaches. The size of this challenge is demonstrated by the great number of articles dealing with this type of problem.

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An evolutionary algorithm for the bi-objective multiple traveling salesman problem [★]

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Abstract

This paper deals with the bi-objective variant of the multiple Traveling Salesman Problem (m-TSP). This problem generalizes the classical TSP with profits (TSPP). Depending of the nature of the objective function, three well known kinds of problems constitute the TSPP family: the Orienteering Problems (OP), the Profitable Tour Problems (PTP) and the Prize Collecting TSP (PCTSP). In the bi-objective m-TSP considered here, the aim is to build m cycles covering a subset of potential customers so that the total collected profit is maximized and the overall traveling distance is minimized. This paper presents an effective evolutionary algorithm to solve this problem.

Key words: multiple TSP, multi-objective optimization, evolutionary algorithm

1 Introduction

Multi-objective combinatorial optimization (MOCO) is an important research field prospering mainly since the last two decades. In many practical applications of the combinatorial optimization problems, the decision makers must deal with multiple – often opposite – criteria. The purpose of MOCO is thus to provide a set of non-dominated solutions rather than a single solution with only one objective or a weighted sum of multiple objectives optimized.

This paper presents the first study for the bi-objective multiple Traveling Salesman Problem (m-TSP). The problem is an extended variant of the Traveling Salesman with Profits (TSPP), where a fixed number m of tours must be used in the solution. In the TSPP, each customer is associated with a nonnegative profit, which is collected at the first customers' visit. It is thus by nature a bi-objective combinatorial optimization problem with two opposite optimization objectives, the first objective forces to extend the tour and collect as much profit as possible while the other instigates the traveler to reduce the length of the tour. In that case the decision maker must give the priority to a subset of customers. Among practical applications can be mentioned for example scheduling of traveling salesman visits to the most profitable customers [15] or an intelligent tourist travel guide system proposing to the user a subset of the most interesting tourist sites that can be visited within a given time horizon [13,16,18].

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Fleet optimization for cyclic inventory routing[★]

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Abstract

This paper considers the optimization of a vehicle fleet to cyclically repeat a given set of routes, whose cycle times can be adjusted if necessary. The objective is to minimize the overall cost rate, consisting of fixed vehicle costs, route-specific costs and holding costs at the customers being cyclically replenished, where these latter two cost components obviously depend on the selected cycle times of the routes. First, this fleet design problem is formally described in a mathematical model. Then, several heuristic solution methods are proposed: two variants of a constructive insertion heuristic, a remove-and-reinsert local search procedure, and an ejection chain local search procedure. The performance of these heuristics is evaluated in a design of experiments.

Key words: Fleet sizing, Cyclic planning, Inventory routing.

1 Introduction

‘Vendor Managed Inventory’ (VMI) or ‘Supplier Managed Inventory’ (SMI) [8] aims at seamlessly integrating distribution and inventory management. Through information sharing, the supplier is able to integrate decisions about whom to replenish with decisions about vehicle routes. If customer demand rates are constant over time, a cyclic planning approach is highly appropriate, and the resulting integrated optimization problem is the so-called “Cyclic Inventory Routing Problem” (CIRP) [5,6].

With constant demand rates and a cyclic planning approach, the same solution will be reiterated over the long term. In that long term, the available fleet size for making the replenishment routes is no longer a given parameter as in most short-term routing problems studied in the literature, but becomes a decision variable instead. Thus, solving the cyclic inventory routing problem comprises two major subproblems, namely designing a set of efficient routes, and then deciding on the required vehicle fleet that is needed to repeatedly perform these routes. In this paper, we will focus on this second subproblem.

Once customers are assigned to routes, a schedule has to be constructed that assigns the routes to vehicles. At this moment, better solutions can be obtained if the individual cycle times of the routes can be modified. A short example illustrates this issue. Consider two routes, both taking a full day to complete, with individual optimal cycle times of 2, respectively 3 days. When these cycle times are fixed, both routes have to be made on

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A Multi-Commodity Flow Model for Integrated Design and Routing in Intelligent Networks^{*}

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Abstract

We study the problem of designing and demand routing, at minimum cost, in Intelligent Networks (IN). The problem consists of, simultaneously, locating Service Switching Points (SSP), assigning calls to SSP, determining transmission capacities on the links and routing the calls through the network. The present work is an extension to our previous paper on the same topic where we modeled the problem as a Hub Location for a particular telecommunication operator. However, the model is not suitable for large networks, due to the compact structure of the arc-node formulation. To cope with this weakness on the previous model, we develop another graph based model in order to transform the initial problem into a Multi-commodity Flow problem. Then, we derive a linear mathematical program that integrates all the sub-problems mentioned above into a simpler formulation that is more convenient for large networks.

Key words: Intelligent Networks, Telecommunication, Multi-commodity flow

1 Introduction

The intelligent network (IN) is intended to process, in a central way, the services that a telecommunication operator offers to its customers such as Freephone, Virtual Private Networks (VPN), Calling Card Services, Reverse Charging, etc.. All these services are hosted in a set of collocated servers called Service Control Point (SCP). These servers run software and data for processing the requests of any customer for a given service.

In order to access any service managed by the SCP, any call must be transferred, first, to a Service Switching Point (SSP), which is a software entity installed on an exchange to which the customers are connected. When a customer requests for a given IN service, the SSP sends queries, through signaling protocol, to the SCP on how to process the call in accordance to the service logic in the SCP. Upon reception of the response, the call is transferred to its destination through the transmission links of the telecommunication networks. (see [2], [4], [6] and [7] for technical details)

A typical telecommunication network is composed of two layers, namely, access layer and transit layer, as illustrated in figure (1). The access layer connects the terminals of the customers, via radio or copper links, to the local exchanges. Each demand consists of a source exchange, a destination exchange and the calls that must be established between these exchanges. The transit layer is made up of transit exchanges that are in charge of

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Column Generation Algorithm for Mobile Sensor Routing in Event Capture *

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Abstract

Mobile sensors are now used to capture stochastic events and collect data in complex environments. To ensure a given high probability of event capture, the time between two consecutive visits to each point by a mobile sensor must be less than or equal to a critical time depending on event occurrence frequency (probability) of the point. In this paper, we study the routing of mobile sensors in this context of event capture to minimize the total energy consumption of all sensors concerned. This problem can be formulated as a cyclic vehicle (sensor) routing problem with non uniform visiting frequencies and inter-visit time constraints of nodes. We present an optimization approach based on column generation to solve the problem. In the approach, the LP relaxation of the set partitioning formulation of the problem is solved by column generation, where the pricing problem, which is an elementary shortest path problem with resource constraints, is solved by a dynamic programming labeling algorithm. A partial branch-and-bound algorithm with the branching strategy suggested by Ryan and Foster is used to obtain a high quality near-optimal feasible (integer) solution of the problem. The performance of this approach is evaluated by numerical experiments on randomly generated instances.

Key words: mobile sensor networks, event capture, vehicle routing and scheduling, column generation

1 Introduction

Wireless sensor networks (WSNs) have been applied in environment monitoring, safety surveillance, battlefield target tracking, and chemical attack detection [12]. In traditional sense, sensors in a network are static; they are randomly distributed over a sensor field with high density to communicate with others. However this kind of sensor deployment approach has some disadvantages, one disadvantage is that it will greatly increase the deployment and operating cost of the network.

To alleviate this disadvantage of static sensor networks, various applications begin to adopt mobile sensors. Mobile sensors are becoming a viable choice for sensing applications mentioned above. Many researchers have made great efforts to find effective methods for motion planning of mobile sensors in order to cover more area than stationary sensors[3],[7]. Our work is motivated by these works.

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Two objective functions for a real life Split Delivery Vehicle Routing Problem[★]

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Abstract

Different products have to be delivered by trucks. Due to the trucks capacity, each order is split into one or more deliveries supplied from a main depot or from local depots. Simple and complex constraints have to be satisfied as drivers and trucks availability or the fact that only specific trucks can be loaded in local depots. The problem is formulated as a MIP and considers two different objective functions. The first one defines a vehicle routing problem where the total travel time is minimized while the second one defines a VRP where the number of different trucks supplying each individual customer is minimized.

Key words: Vehicle Routing Problem, Split Deliveries, Mixed Integer Programming

1 Introduction

In the classical Vehicle Routing Problem (VRP), a fleet of vehicles has to supply a set of customers from a depot with the objective of minimizing the total traveled distance. Each customer has to be visited exactly once and the total demand of customers visited by a vehicle must not exceed its capacity. An overview of resolution methods can be found in [12] and [5]. Extensions of this problem, named Split Delivery Vehicle Routing Problems (SDVRP), are studied for over 20 years and were first introduced in [8]. In this seminal paper, Dror and Trudeau split deliveries such that each customer can be visited by more than one vehicle. Due to the complexity of the problem (it is NP-hard), a two-stage algorithm including five interconnected subroutines is developed, but it does not guarantee an optimal solution. The relaxation results in savings in the total traveled distance and in the number of vehicles used in the solution. An empirical study is presented in [1]. A similar heuristic is implemented in [13] to solve a feed distribution problem formulated as a collection of split delivery capacitated rural postman problem with time windows on arcs. In [7], the Split Delivery Vehicle Routing Problem is formulated as an integer linear program including constraints on subtours elimination and is decomposed in subproblems solved by simplex and branch and bound methods. A mathematical formulation and a heuristic are presented in [10] which include grid network distances and time window constraints. A lower bound based on a polyhedral study of the problem is proposed in [3] and a branch and price approach is presented in [9]. In [11] and [2], Tabu Search metaheuristics using a memory-based search strategy which give quickly good results are implemented.

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Rich Vehicle Routing Problem: model and experimental design analysis*

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Abstract

Over the last years the Vehicle Routing Problem (VRP) has been enriched by different complicated constraints encountered in the real-life. In this paper, we tackle a rich VRP namely the Multi Compartment Multi Commodity Heterogeneous Fixed Fleet Vehicle Routing Problem with hard Time Windows (MCMCHFFVRPTW). The objective of the problem is to determine an assignment of the non-intermixable products into vehicle compartments of different sizes and a set of vehicle routes of total minimum distance and minimum waiting time such that the customer demands are satisfied. The main contribution of this paper is to identify the most relevant instance factor for this problem. Thus, we develop a generic parameterized mathematical model and a data set generator able to produce a great variety of instances based on various service policies and fleet characteristics. New sets of instances were generated by systematically varying design parameters. First, an exact resolution for four models using CPLEX 10.0 is provided. Second, we carry out a D-optimal factorial design using the Design Expert 7.0 software to select from five factors, the factors which lead to significant variations of the objective value (OV). The statistical study shows that the fitted model is adequate to analyze the effect of the retained parameters on the OV.

Key words: VRP with compartments, Experimental design, New sets generator, Flow meters, Depots location.

1 Introduction

The Multi Compartment Vehicle Routing Problem (MCVRP) consists of designing a set of minimum cost routes to serve the demands for multiple products of a set of geographically scattered customers. A distinct feature of the problem is that products are incompatible and must be transported on independent vehicle compartments. The use of multiple compartments is relevant, when the vehicles transport several commodities which must remain separated during transportation. The MCVRP naturally arises in several practical situations. For instance, dairies often use vehicles with multiple compartments to collect milk of different types (e.g., from cows and goats) and qualities (e.g., different suckling dates) [14]; public utilities use trucks with compartments to perform selective waste collection; and food companies distribute in compartmentalized vehicles groceries that require different levels of refrigeration. Furthermore, [1] mention the distribution of cattle food to farms during which sanitary rules recommend to always use the same compartment for some species. Similar examples of product

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Vehicle Routing Problem with Overlap constraints ^{*}

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Abstract

In this paper we studied an adaptive version of the vehicle routing problem for logistic of valuable goods. This problem is motivated by the need to reduce the predictability of the service. The objective is to minimize the total cost of a set of solutions but with not exceed a similarity degree in the set. The temporal similarity aspect is a very important factor of predictability but has never been take into account at the best of our knowledge. A new mathematic formulation is then proposed by introduced specifics constraints which avoid to create similar routes. The model was tested in modified Solomon's instances for the vehicle routing problem with time windows and results are discussed. Finally, two heuristics are proposed and compared both with an exact method and together.

Key words: vehicle routing, security, model

1 Introduction

The vehicle routing problem originally proposed by Dantzig and Ramser [1] is one of the most studied combinatorial problems today. This problem consists in finding a set of trips with the minimum total cost, to deliver fixed amounts of goods to customers with a fleet of identical capacity vehicles. Each trip must depart and end at the depot, each client must be visited exactly once and the capacity of a vehicle must not be violated along the trip. This problem is known as NP hard and has many variants that can handle for example time windows availability at customers in VRPTW (Vehicle Routing Problem with Time Windows) or reverse logistics constraints (where the clients can also have a quantity of goods to return to the depot). For more details on these variants, interested reader is referred to the book of Toth and Vigo [9] or more recently Golden and al. [2]. We have chosen to focus here more specifically on security constraints. Security considerations in vehicle routing have been receiving a very little attention in the literature. Two major trends can be defined:

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Robust optimization of inventory routing for bulk gas distribution*

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Abstract: Robust optimization of inventory routing for bulk gas distribution

We address the ‘rich’ (i.e., with real-world features and constraints) inventory routing problem for bulk gas distribution under uncertainty. We consider that the uncertainty occurs on the supply side and consists of outages at the production plant. We propose a general methodology for generating, classifying and selecting ‘robust’ solutions: solutions that are less impacted when uncertain events occur such as plant outages. This methodology is applied to real data provided by the Air Liquide company in the context of bulk gas distribution, and we show that for a relatively small increase in cost, the robustness of routes and schedules for the bulk gas distribution with regard to possible plant outages is improved. Results show that we can reduce the extra cost induced by plant outage, while only slightly increasing the cost in the cases where no outages occur.

Key words: Inventory Routing Problem, Uncertainty, Robustness, Supply Disruption

1 Introduction

Optimization models for transportation, distribution and supply chain problems are generally treated under deterministic assumption where all the data about the problem is assumed known with certitude prior to its solving. As a consequence, when uncertain events happen the ‘optimized solutions’ may become less efficient or even infeasible, which may induce extra costs or a poor quality of service. Moreover, large parts of real world optimization problems are subject to uncertainties occurring in the problem data and parameters. In order to cope with such uncertainty, the notion of “robustness” has been proposed by authors such as Kouvelis and Yu [12]. Robust solutions ensure feasibility, and to a further extend good result, regardless of the realization of the uncertainty.

The key objective of this research work is to propose a generic methodology for generating robust solutions for the inventory routing problem (IRP) in an uncertain environment. The proposed methodology is applied to the specific

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Track 4 – Intelligent Manufacturing & Services Systems – S1 to S4

T4S1: Closed-loop PLM & Intelligent products

T4S2: Service-Oriented Control in Holonic Manufacturing

T4S3: Product-driven and distributed control I

T4S4: Product-driven and distributed control II

Prototyping of a communicating textile^{*}

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Abstract

A new era is coming with intelligent materials, which are able to provide diverse functionalities to users all along the product lifecycle, during the design, manufacturing, use and dismantling phases. These materials can track their own evolution all along the Supply Chain, which lead to gather helpful information and allow information continuum at all time and everywhere (synchronization of informational and physical flows). Usually, these functionalities are fulfilled via the integration of specific electronic components into the material (wireless sensors, RFID). The present paper forms part of this framework. To go further in the interpretation of this paradigm, it proposes an approach to design this kind of communicating material and its necessary communication architecture useful to enable communication between textile and environment. Feasibility studies related to industrial processes, to usage and technology constraints are handled within the paper too. A prototype is realized in which a huge number of tags are scattered. Afterwards, the physical limits of the textile are evaluated and compared to a classic one. A digitizing tool is also introduced which allows getting dynamically the location map of tags constituting the material.

Key words: Communicating material, Prototyping, Smart clothing, Supply chain management, Ubiquitous computing.

1 Introduction

A new era is coming with intelligent materials, which are able to provide diverse functionalities to users all along the product lifecycle, during the use phase (medical sector [6, 3], clothing [26], military [22], home automation [12, 2], ...) or during the design, manufacturing and dismantling phases. These materials can track their own evolution all along the Supply Chain, which lead to gather helpful information and allow information continuum at all time and everywhere. As a matter of fact, [5] showed the product needs technologies not only to carry data but both data and knowledge (e.g via wireless sensors, RFID, ...). Both physical and informational flows being merged into the product, that kind of material ensure a synchronization between them [23]. Works about *intelligent products* [30, 20] in the logistic field often consider discrete products. In this context, each product disposes of a distinct informational part, located on an electronic tag. Nonetheless, this concept already shows a certain number of limits : discrete reading, risk of tag damage, problem of information loss when cutting the product in several parts. [27] emphasizes the significant proportion of defective tags and false reads (which has been as high as 20 – 50% in some pilot projects). The problems pointed out previously could be resolved, if one imagines that all the material composing the product has the property to be communicating. The technology is inserted into the material during its initial production so as to be inseparable. Then, it is not a punctual part of the product which acquires and broadcasts information but the material in its wholeness. The product becomes ipso

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Intelligent Products in Real-Life Applications ^{*}

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Abstract

Intelligent Products are capable of collecting information and reacting on it proactively, e.g. estimating needs for maintenance or repair. With increased computing power and communication capabilities, products may also become proactive. We claim that when such products will have the means to communicate between themselves and with other systems, only then will the true potential of the Internet of Things concept have been accomplished. In this paper we describe a number of real-life applications that have been implemented using the Intelligent Product and Internet of Things concepts. These applications reveal some of the potential for the future of these technologies.

Key words: Intelligent Products, Internet of Things, Closed-loop PLM, Product Instance, Middleware

1 Introduction

For Product Lifecycle Management using Smart Embedded Systems [13], the number and variety of information systems that need to communicate is greater than in most other application domains. Indeed, it is not one application domain; it is, rather, a collection of application domains that need to use and share partially identical information. The Internet of Things has been proposed as a concept that encompasses at least some parts of the application domains considered. The Internet of Things will be an extension of the Internet that makes it possible to access information about any tangible “thing” over the Internet. The Internet of Things concept was probably first coined by Ashton (2000) but other early and publicly accessible sources are e.g. [9] and [8]. Still, earlier concepts such as “Ubiquitous Computing” proposed in 1991 [21] and “Mirror Worlds” proposed in 1993 [7] contain many common elements with the Internet of Things concept.

The notion of Intelligent Product is still rather undecided and we don't currently have a single established definition [4]. However, there is an increasing need to treat products as instances due to mass customization and the efforts to invest in after-sales services. In each case, a specialization of the product occurs – whether it be in terms of different functionalities, different delivery paths, different usage modes – making it increasingly important to maintain information unique to each item in some way. Even two initially identical product items will have different owners or be used in different conditions. The product usage phase may even begin before it is sold because many products nowadays go through an individual initialization procedure where “normal” operation profiles are recorded and stored. The product's control system can also be fine-tuned so that individual

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Myopic Behavior in Heterarchical Control of FMS^{*}

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Abstract

Heterarchical Control Architectures (HeCA) have shown various benefits such as agility and reactivity, but have to face some drawbacks in order to be implemented in the industrial world. Precisely, one of the problems encountered in heterarchical systems is referred to as the lack of a global view and reference of the whole system, to actually guarantee optimal decision-making. This behavior has been labeled by some researchers as "Myopia". This paper is intended to look for this kind of behavior in other domains, and then try to identify and set-up a classification scheme, appropriate to a production systems' scenario. Then, different methodologies attempting to solve this issue are shown and also classified according to the type of myopia they try to diminish, and their robustness. In order to demonstrate specifically this matter, a case study is reported to exhibit the phenomenon and then a basic solution is implemented over the AIP-PRIMECA manufacturing cell located at the University of Valenciennes, France. Finally, some conclusions and challenges will serve as a mark for an interesting research path, aiming at the adoption and industrial deployment of HeCA.

Key words: Manufacturing systems, FMS control, myopia, heterarchical systems, global performance

1 Introduction

In the second part of the last century, due to a relative stability of markets, products life cycles and complexity, hierarchical control architectures (HiCA) were widely accepted and deployed by industrials in manufacturing, since long term optimality was reachable. Besides, these static architectures allow information and power to be distributed in various levels, forming a pyramid in which leadership is taken by superior levels that make decisions based on their global view of the system, and operational levels remaining attentive to directions. In this way, global performance of processes is assured. Nevertheless, these types of organizations imply a high number of decision loops with non negligible associated lags with major issues concerning aggregation and de-

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Integrated Diagnosis for Adaptive Service-oriented Manufacturing Control with Autonomous Products^{*}

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Abstract

This paper presents a novel approach towards proactive manufacturing control. The proposed solution combines an innovative conceptualization of product-driven manufacturing based on a generic service description with recent results on tractable predictive model-based diagnosis. We demonstrate the versatility of our approach on a flexible production scenario for a user-configured product: While the product-driven approach naturally allows for small lot sizes and efficient product change-over, predictive diagnosis of the production machinery facilitates autonomous compensation of partial and complete machine failure by automatically restricting the set of services provided. The diagnosis module itself is implemented as a software service, therefore integrating seamlessly into the proposed framework.

Key words: fault-tolerance, product-driven manufacturing, service-oriented architecture, semantics, model-based diagnosis

1 Introduction

To address both, the growing demand for improved reactivity to market trends experienced by manufacturers and the customer request for high individualization of products, an ongoing trend from supplier-driven to customer-driven manufacturing can be observed. This results in higher flexibility requirements for manufacturing systems, namely (i) provision of flexible but robust processes to enable small lot sizes and (ii) efficient change-over between product variants. This customization of products particularly challenges traditional engineering approaches. Examples for such products are manifold, ranging from traditional products such as cars and computers to newcomers like personalized teas or mueslis.

State of the art large-scale production of goods is typically based on static production plans developed for specific facilities, integrated into long-term scheduling plans to reduce the effort for (mostly manual) reconfiguration of production facilities. Manufacturing of dynamically requested customized products can not be handled efficiently by traditional systems due to their hierarchical control structure. Therefore, new concepts for eased adaption of production systems have been developed in the last years. A number of projects explored new ways to improve supply chains with adaptable processes [22] or reorganize automation systems e. g. with automatically composable, modular assembly systems [21]. The ongoing trend towards intelligent mechatronic components with enhanced capabilities additionally results in the development of approaches to ease their integration.

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Enhancing Service-oriented Holonic Multi-agent Systems with Self-organization *

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Abstract

Multi-agents systems and holonic manufacturing systems are suitable approaches to design a new and alternative class of production control systems, based on the decentralization of control functions over distributed autonomous and cooperative entities. However, in spite of their enormous potential they lack some aspects related to interoperability, migration, optimisation in decentralised structures and truly self-adaptation. This paper discusses the advantages of combining these paradigms with complementary paradigms, such as service-oriented architectures, and enhancing them with biologically inspired algorithms and techniques, such as emergent behaviour and self-organization, to reach a truly robust, agile and adaptive control system. An example of applying a stigmergy-based algorithm to dynamically route pallets in a production system is also provided.

Key words: Multi-agent Systems, Holonic systems, Service-oriented systems, Self-organization

1 Introduction

Nowadays, manufacturing should adapt to strong changing conditions imposed by the markets. The greater variety of products, the possible large fluctuations in the demand, the shorter lifecycle of products expressed by a higher dynamics of new products are some challenges that manufacturing companies have to deal with to remain competitive. The traditional approach (i.e. centralised or hierarchical) to control complex systems (such as manufacturing systems or administrative systems) splits the overall problem into hierarchically dependent functions that operate within decreasing time-ranges, such as planning, scheduling and/or monitoring. This approach has produced interesting results and near optimal solutions, but only when hard assumptions are satisfied, for example, without the occurrence of external perturbations (e.g., urgent orders) or internal perturbations (e.g., machine breakdowns). However, a real (industrial) system is often complex with the

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Service Oriented Architecture in PROSIS holonic control[★]

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Abstract

Ambient intelligence applied to manufacturing systems will deeply transform approaches to production organization and control. Infotronics technologies will enlarge the capabilities to interact, to react and to customize control systems with innovative possibilities that should already be envisaged and thoroughly studied. Indeed, beyond identification, traceability and security applications that are generally considered, these technologies offer the possibility to associate to each entity, constituting a production system, a decisional intelligence. Autonomy properties are thus associated to the entity. Under these new advances, a control system based on the holonic paradigm and an isoarchic architecture, named PROSIS (Product, Resource, Order, Simulation Isoarchical System), was proposed. This approach provides a range of ambient services to the holonic entities. The aim of this paper is to present the service oriented architecture in the PROSIS control system. After presenting the holonic control system (PROSIS) model, the ambient services that can be provided are described and the way these services could be delivered are presented.

Key words: Holonic control, Isoarchic architecture, PROSIS model, Ambient services, SOA

1 Introduction

Future production needs are already expressed through emerging paradigms, such as mass customisation, lean approach, Six sigma approaches and product traceability. Mass customisation requires individualized and flexible product tracking. Lean approach leads to drastic stock reduction and enhanced flow control. Six sigma approaches brings more rigor and requirements in the results to be achieved. In order to address these objectives, new control approaches should be proposed, based on the use of emerging technologies that would allow their operability in manufacturing sites. Traditional management and control methods show their limits against the increase of production constraints, and it becomes essential to study new control approaches. An architecture for the control of production systems, without any hierarchical decision-making dimension, was proposed. The approach uses holonic paradigm and isoarchic architecture providing a range of ambient services to the holonic entities. In the sequel, section two will introduce the new information technologies in manufacturing. Section three describes the PROSIS control system. Section four describes, on one hand, the ambient services provided to the holonic entities and on the other hand builds up the service oriented architecture (SOA) in PROSIS. Finally section five provides our conclusions and future work.

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Product-driven automation in a service oriented manufacturing cell*

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Abstract

The paper describes a solution for the automation of a flexible manufacturing system using the concept of product-driven automation. A semi-heterarchical control model based on the concept of holonic manufacturing is proposed which switches its operation mode from hierarchical to heterarchical in the presence of perturbations to ensure as long as possible global optimization and agility to changes in the production environment. In order to ensure this functionality a service oriented manufacturing environment is proposed and implemented, whose structure is described by and accessed through a decentralized fault-tolerant Resource Service Access Model. This mode is used to reduce the myopia of the scheduling system at the level of products in execution. Besides the design of a generic structural and dynamic model, a real implementation solution is proposed using a multi-agent framework.

Key words: product-driven automation, holonic manufacturing, embedded devices, service orientation

1 Introduction

The present economy trends demand that production cells equipped with robotized workstations operate in an optimized manner and behave predictable over time. The only way that can guarantee this optimization is a hierarchical driving strategy, which executes an off-line generated schedule controlled by a central entity. Unfortunately, perturbations occur when driving such cells, such as resource failure or stock depletion of a workstation. This means that the entire cell needs to stop, at least until the planning is recalculated, with bad consequences on the production schedule. In order to avoid cell downtime, efforts have been made to decentralize production's schedule and distribute the control scheme so that a perturbation will be properly handled for job continuity. So, to summarize, the control of production cells has two main implementation directions, the two having complementary advantages (A) and disadvantages (D):

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An Immune Inspired Multi Agent System to Handle Disruptions in Manufacturing Production Systems *

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Abstract

Disruption management is a major issue in production systems monitoring and control. Existing architectures offer few concepts both specifically dedicated and sufficiently generic to allow handling a broad variety of disruptions such as resource failures, supply delays, rush orders, etc. Although biological immunity is naturally able to deal with threats endangering the host organism, to the best of our knowledge, it has not yet been applied to handle production system disruptions. Taking this system as a source of inspiration, we suggest an agent based approach, which involves functions specifically dedicated to deal with a variety of disruptions, such as detection, identification of consequences and reaction to disruptions. This architecture is intended to be embedded within industrial information and decision support systems, such as ERP (« Enterprise Resource Planning ») and MES (« Manufacturing Execution System »). A prototype implementation using the JADE platform and the JAVA language shows the relevance of the suggested agent-oriented approach. A simplified example illustrates the kind of support that can be provided to decision makers when dealing with an unexpected supplier unavailability.

Key words: monitoring, control, disruption, biological immune system, artificial immune system, multi agent system.

1 Introduction

Today's manufacturing companies are vulnerable to unpredictable events that may disrupt pre established plans and expected performances. Such disruptions include for example machine failures, tool breakage, workforce absenteeism or strikes, quality problems, rush orders, supply delays and several other possibilities. Unless some strategy to deal with a disruption is implemented, the production system is forced to stop or at least to deviate from its expected operation and performance. Disruption impacts refer to direct and indirect disruption consequences, which are related to questions such as: does the disruption affect the promised due dates or the starting and finish times for setup? Does the disruption impact one or multiple resources, parts or products? Does the disruption impact material availability or direct product cost? etc. [2]. In this respect, disruption management has become a major monitoring and control issue. To take into account such disruptions and assist in reducing their impact, industrial tools – such as manufacturing execution systems (MES) – and academic approaches – such as distributed scheduling and distributed monitoring and control – were designed.

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A PLC-based Control Solution for a Holonic Planned Manufacturing System *

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Abstract

The paper describes a modern solution for controlling a complex manufacturing cell, consisting of conveyors, robots, stoppers and other devices, using a single programmable logical controller (PLC). The objective was to design a control system for a Holonic Planned Manufacturing System running into an Intelligent Production Cell. In order to achieve this goal, each product processed in the manufacturing cell has to be identified and its own routing / workstation jobs schedule needs to be implemented without interfering with other products. The chosen solution was a special array of data structures that is used to easily access and manages the pallets processed at the four robotized stations of the cell. In addition, high performance communication protocols are implemented in order to allow PLC – Robot interaction, protocols that use both I/O lines and TCP/IP.

Key words: Intelligent manufacturing system, holonic manufacturing system, flexible and reconfigurable manufacturing system, production activity control, supervisory control, PLC.

1 Introduction

Traditional networked assembly structures have either a hybrid or a heterarchical architecture. The first type allows data exchange and co-operation between lower-level (robot) controllers. In this architecture, a master initiates all the activities and then the subordinates cooperate to perform them. The second type of architecture is formed by a group of independent entities, usually called agents, which bid for orders based on their status and future workload [5]. The master-slave relationship is dismissed and due to this decentralized control architecture, the agents have a complete local autonomy and the system is able to react promptly to any event such as: resource failure, new customer's order etc [7]. Global batch optimization it is however improbable, because the execution of one order depends on the features of other orders. The system's performance is also unpredictable.

In order to face resource break-downs, job shop assembly structures use networked robot controllers with multiple-LAN communication facilities allowing production data saving and automatic re-planning of batch production using failure and recovery management [1].

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RFID as a Supply Chain System Regulator *

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Abstract

Information transfer in the supply chain is complex and causes instability and unpredictable behavior, when information transferred is incomplete or incorrect. This instability is characterized by the Bullwhip Effect that represents concretization of entropy, namely the degree of disorder within a system. In this paper we assume that “complete” and “accurate” real-time information sharing concerning product and inventory levels through RFID reduces entropy and limits its effects on the supply chain. RFID can reduce information loss and increase accuracy. From the literature we show that RFID can improve visibility, reduce uncertainty and complexity of the supply chain permitting us to conclude that it represents a regulatory mechanism of informational entropy in the supply chain.

Key words: Supply chain system, entropy, Bullwhip Effect, RFID

1 Introduction

In this last century, firms evolve in an extremely complex environment, constituted by open markets, globalization of sourcing, advancements in and intensive use of information technologies, decreasing product lifecycles, and increased demand. This complexity is intensified by consumers who are becoming increasingly demanding in terms of product quality and service. These pressures have led companies to focus on their core business, resulting in outsourcing of less profitable activities. Most of these companies have opted for specialization and differentiation strategies, resulting in rapid new market growth and intensified flow between all actors. The intensity and ever increasing complexity of these flows has further destabilized the environment in which companies evolve. Globally the system has become extremely volatile, making planning and predicting quite difficult for all actors concerned. Streamlining processes and flows through the value creation system has also become rather problematic as a result. To cope with this complexity, firms have adopted new business models around the concept of networks.

According to systems theory, supply chains can be considered as dynamic and complex systems composed of autonomous firms that interact with one another contributing to fulfilling a common goal. These firms' behaviors are actually non-linear, varying between cooperation and conflict. Firms create value by cooperation

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Exploring the benefits of using the RFID technology in road-based goods transportation processes*

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Abstract

RFID (Radio Frequency Identification) technology is a rapidly emerging technology that can be used to enhance the performance of the supply chain. Previous researchers have studied the benefits of the RFID technology in supply chain management. Most of the relevant studies focused on: i) manufacturing processes aiming at ensuring that the right components are putted into the right products, ii) warehousing processes aiming at reducing inventory errors and iii) reverse logistics processes aiming at increasing accuracy on the quantity of returned products. However, little research has been done on the benefits of the RFID technology in goods transportation processes. Most of the published work is dealing with the benefits of using this technology for the transportation of perishable goods within cold chains. The focus of this work is to provide a better understanding of potential benefits stemming from using the real-time information provided by the RFID technology in road-based goods transportation processes. Finally, we conclude with a discussion of some challenges of RFID implementation for road freight carriers.

Key words Goods transportation, Process modelling, RFID technology

1 Introduction and research background

A supply chain consists of all parties involved, directly or indirectly such as suppliers, manufactures, distributors, and retailers, in order to fill a customer request [7]. Supply chain management is considered as a lever to achieve the customer's requirements with a more cost effective way through integration of all supply chain processes: replenishment processes, production processes and distribution processes. There are several activities in the distribution process. The transportation activity is among the most important ones since it directly impacts both supply chain costs and customer service levels. Indeed, it is the interface between the supply chain and the customer.

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Augmentation concept for the embedded diagnosis of complex systems^{*}

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Abstract

The recent developments in infotronics and in communication make it possible to develop intelligent Condition-Based Maintenance (CBM) systems. In this context, this paper proposes the concept of "activeness" and a modeling approach designed to increase the informational, communicational and decisional capacities of a system with a distributed architecture. This "activeness" concept is then applied to the advanced diagnosis of train doors in a railway application (i.e., the SURFER project led by BOMBARDIER).

Key words: Augmentation concept, distributed systems, monitoring, diagnosis, conditional maintenance, railway transportation system

1 Introduction

As equipment becomes more complex and computerized, intelligent maintenance schemes must replace the old prescheduled, labor-intensive planned maintenance systems to ensure that the equipment continues to function correctly [18]. In this context, proactive maintenance or Condition-Based Maintenance (CBM) is vital for today's complex systems in industry and transportation (e.g., the aviation, automotive, railway & shipping industries) [18, 15, 4]. The goals are to maximize equipment up-time, minimize maintenance and operating costs, reduce life-cycle total ownership costs (TOC) and improve the safety of equipment [18]. CBM identifies incipient faults before they become critical and identifies their causes in order to avoid additional imminent failures.

CBM has evolved towards intelligent CBM [15, 5, 19], which was made possible with the advent of new information technologies and infotronic progress [10, 2]. Approaches based on remote maintenance [1], e-

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A Viable System Model for Product-Driven Systems[★]

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Abstract

This paper describes a modeling approach for product-driven systems based on the Viable System Model (VSM). A general VSM description is presented, highlighting the pertinence of this approach for modeling intelligent product systems, specifically when a compromise between control and autonomy is aimed. An application is also provided for modeling a hybrid centralized/distributed production planning and control system. System modeling using the conceptual framework provided by VSM, allows to handle the complexity of the planning and control functions, considering aspects such as efficiency, flexibility, adaptability, scalability and reusability.

Key words: Product-Driven Systems, Viable System Model, Manufacturing Planning and Control Systems, Flexibility, Adaptability.

1 Introduction

The reduction of the Product Life Cycle caused by the ever growing demand for customization and global competitiveness, has imposed new challenges for many industrial sectors. These challenges force companies to organize and structure themselves, adapting their internal processes towards a high changeable environment and facing their own internal failures. In this context, centralized and hierarchical approaches applied to the decision making process, can be inadequate, especially under conditions of disruption and long-term changes [18,17]. An alternative approach to this conventional hierarchical organization is the concept of Product-Driven System (PDS).

A PDS, changes the vision to a more interoperable and intelligent system, postulating the customized product as the controller of manufacturing enterprise resources [23]. This leads to the design of an *intelligent product* [21], which has been defined as an entity with a physical and information-based representation, able to influence decisions which concern itself [19]. From a practical perspective, Radio-Frequency Identification (RFID) has been widely accepted as a suitable technology linking information systems with the physical world [33,29].

Despite the increasing development of PDS [24,8,9], currently, there is no specific modeling framework for this kind of systems. According to [22], an important condition for these new approaches is to contribute to the

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Real-time Feedback Control for Production, Maintenance, and Capacity *

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Abstract

In this paper, we develop dynamic models for production scheduling, machine maintenance planning, and machine capacity control. Specifically, differential equation based models are used to characterize real-time dynamics that span from controlling machinery capacity to production and maintenance planning. Based on these dynamic models, distributed feedback control algorithm which is performed upon discrete-event simulation using each part's and machine's local information is developed to determine the production and the machine maintenance event scheduling while controlling the machine capacity in a unified manner.

Key words: Distributed feedback control, Manufacturing, Capacity, Maintenance

1 Introduction

A need for seamless process-flows while satisfying just-in-time requests for each production stage make the production processes more intelligent in terms of responding to various uncertain events such as urgent orders, changing due-date, and unexpected machine failures. Both traditional and new methodologies for intelligent production have continuously sought more economic and efficient way to handle these uncertainties, but most of efforts have treated each function in isolation. The typical problems in a production area are production scheduling and preventive maintenance planning which are usually made independently even though they closely affect each other. Although integrated approaches for those two objectives had been continuously developed [1, 2, 3, 7], maintenance plans were mostly considered as a given constraint for solving production scheduling. The problem here is that this 'partially integrated' approach can make one of their objectives deteriorated even though the other can be improved.

Recently, optimization and heuristic approaches have been developed for both production and machine maintenance problems in an integrated manner. Such integrated models that simultaneously determine production scheduling and preventive maintenance planning decisions have been proposed to satisfy various objective functions such that minimizing job tardiness [2], minimizing production and maintenance cost [1], and minimizing total costs of inventory, repair, and preventive maintenance [3]. These approaches try to improve solutions for various objectives, but most of them assume that dynamic changes by uncertain disturbances do not occur while the system operates. In real manufacturing environment, however, various disturbances cause

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Track 5 – Health Care Systems Management and Engineering – S1 to S3

T5S1: Health care systems planning and scheduling

T5S2: Simulation and metaheuristics applied to Healthcare Decision Making

T5S3: Design and organization of health care systems

New heuristics for the Operating Room Planning Problem^{*}

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Abstract

We address the Operating Room Planning Problem (ORPP) for a surgery unit. This problem involves determining the number of surgeries to be carried out in a surgery unit for a given planning horizon together with the date of the surgery and the specific operating room in which each surgery will be performed. The objective is to maximize the service level of planned patients expressed as a function of the medical priority, number of days in the waiting list, and the resulting surgery date. To solve this problem, we present new constructive heuristics and several new local search algorithms. The performance of these methods is evaluated by generating a large set of instances based on an analysis of the literature.

Key words: planning, operating room, heuristics, surgery, optimization

1 Introduction

The Operating Room Planning Problem (ORPP) deals about determining a surgery schedule for a given surgery unit, i.e. to establish which patients in the waiting list of this unit (each one with a different priority) are to be intervened in a given planning horizon, also specifying when (date of surgery) and where (OR) each surgery will be performed. We assume that each patient has been already assigned to a specific surgeon who will perform the surgery. This is a common policy that guarantees the continuity of care, i.e. each patient is operated by the surgeon who treated him/her since his/her arrival to the hospital. This problem can be formulated as an optimization problem where the objective function is to maximize the service level (i.e. the quotient between the priority and the planned date) of the planned surgeries.

The problem under consideration can be fitted within the framework of OR planning and scheduling proposed by Cardoen et al. [1]. According to that reference, there are three levels of decisions problems (all of them general assignment problems, which are strongly NP-hard): speciality, surgeon or patient. In ORPP we consider two decision levels simultaneously, i.e.: surgeon and patient decision level. The surgeon decision level is considered since a surgery schedule specifies the block of OR time assigned in each OR-shift during a day to each surgeon.

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Multi-objective Constraint programming for Scheduling Operating Theatres^{*}

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Abstract

The aim of this paper is to help in the management of the operating theatre in order to improve its functionality. Our research focuses on the daily scheduling of the surgical acts in an operating theatre. We also take into account specific human and material constraints that indeed exist like, for example, the surgeon's preference for a specific operating room, a specific material or a specific team. However, it is obvious that the more the constraints, the more our problem will be complex to model and to solve. To solve this highly constrained scheduling problem, we take advantage of the constraint programming paradigm. Our constraint programming model optimizes the use of the operating theatre by minimizing the makespan, minimizing the overtime hours and maximizing the affinities between members of the surgical team. This model is instantiated on a real-life problem to present some results in this paper.

Key words: Operating rooms, multi-objective scheduling, constraint programming

1 Introduction

According to the researchers who focus their study on dealing with operating theatre problems, the operating theatre is also known to be one of the most expensive items among all sectors of a hospital (Macario, 2006). Considering the importance of improving the efficiency of the operating theatre, increasingly more researchers have tried to optimize its functioning. In general, operating planning and scheduling methodology is fairly helpful to hospital managers (Macario, 2006), enabling them to use operating theatre as efficiently as possible by minimizing operating cost, satisfying the needs of patients and the preference of surgeons while taking into account some constraints on human and material resources.

While some constraints on resources are linked to the limited number or the capacity of the resources (opening hours of the operating rooms, the availability of surgeons, nurses and anaesthetists but also of surgical equipment, free beds in the recovery room), some others depend on the competences of the resources like the versatility of the operating rooms, and the staff's qualifications. Just like operating rooms can be destined to certain types of

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A stochastic approach for operating room planning with uncertain surgical case durations^{*}

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Abstract

This work focuses on operating room planning for elective cases by taking into account the uncertainties related to surgery durations. The objective is to fix the elective cases to be achieved in each operating room during each day of the week in such a way that the overall cost incurred by this decision is minimized. A stochastic mixed integer programming model is first proposed. The latter is then approximated by a deterministic mixed integer linear program. Operating room plans generated by the stochastic vs. the deterministic approach are evaluated and compared using simulation. The obtained results show the necessity of developing stochastic approaches for operating room planning. We particularly focus on the impact of stochastic surgery durations on the operating room performance and practice.

Key words: Operating room planning, Integer stochastic programming, Sample average approximation, Performance evaluation.

1 Introduction

Operating rooms are considered among the most costly hospital facilities. They can consume more than 9% of a hospital's annual budget [6]. Effective planning and scheduling of operating rooms, for the purpose of reducing costs while maintaining good quality of care, have become one of the major priorities for healthcare institutions.

In this paper, we focus on operating room planning. The problem consists in determining the set of elective surgical cases to be achieved each day over a planning horizon of one or two weeks. This assignment problem has been extensively addressed in the literature over the past two decades. Much research has been conducted on the use of deterministic approaches [7][15][10][5][7][19]. In most of this literature, a two-step approach has been proposed for the operating room planning and scheduling [7][10][5]. First, elective patients are assigned to operating rooms (referred to as "operating room planning"); then scheduled on a daily basis (referred to as "operating room scheduling"). Mixed-integer programming models have been proposed for operating room planning and scheduling. However, this problem is known to be NP-hard. That's why some recent papers have concentrated on finding good operating room plans and schedules in reasonable computing time rather than optimal ones obtained after a long time. The objective is to generate good solutions quickly for real life

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An optimization method applied to the production planning of chemotherapy drugs in a hospital pharmacy*

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Abstract

In this study, we developed a simple approach to optimize the production scheduling of planned chemotherapy drugs. This work has been conducted in collaboration with an advanced chemotherapy pharmacy from a hospital for application to its real operation. One of the main problems faced by the managers of these pharmacies is the unbalancing of workloads among the workdays: there are days with low utilization, whereas other days with congestion. Usually, it occurs due to problems in planning the date of fabrication for planned (make to stock) and non-planned drugs along a period of time, which results in non-uniformity of workloads among the different days (or periods of the day). By solving the optimization problem and comparing the results with the data from the current organization of this system, we show that our method is promising in improving the utilization balancing among the workdays.

Key words: production planning; scheduling; chemotherapy pharmacy; chemotherapy planned drugs

1 Introduction

The preparation of chemotherapy drugs corresponds to a specific and delicate process, involving expensive materials and substances. Moreover, the main constraint to the production in advance of these products is their durability (they are essentially perishable products), which is determined by the measure of stability of each substance component. In France, usually, the fabrication of these medications takes place at a chemotherapy pharmacy inside a hospital specialized in cancer treatments. In general, the service and operation in these pharmacies can be evaluated by the treatments and procedures with the prescriptions, reduction of losses of drugs, care with the patient administration, logistics and well utilization of the costly resources and material.

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Analysis of an urban emergency medical system by using discrete simulation*

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Abstract

The emergency medical service in France (called SAMU - *Service d'Aide Médicale Urgente*) is a public service responsible for provision of basic life support to all emergency requests, essentially external from health units. This paper applies discrete simulation techniques to study the configuration and operation of a SAMU in France, analyzing the performance of the system and investigating alternative configurations and dispatching policies for its operations. In particular, we evaluate the fraction of calls are responded within a threshold time T (varying from 10 to 25 minutes), with special concern to cardiac arrest emergencies, and the utilization rates of medical equipments. It is show that, modifications on the configuration such as decentralization of medical equipments, and modifications on the dispatching can result in significant improvements for the performance measures under analysis.

Key words: Emergency medical services, Ambulance deployment, Discrete simulation, Health Care

1 Introduction

The emergency medical services (EMS) are considered efficient if they arrive in the emergency requests location as rapid as possible transporting specialized personal and equipment (e.g.; doctor, rescuers, medicines, oxygen...). In additional, an ambulance must be able to transport the patient to a suitable hospital or clinic. Conversely, EMS managers must often to balance the benefits of providing a suitable care as quickly as possible and their costs related to medical resources and capacity (more ambulances and specialists, stations, better training of personnel, improved equipments) in the system. In France, the main pre-hospital care operations external of health care units (hospitals, clinics) are under the management of the SAMU. One of the major concerns of these systems is related to response time (interval between the arrival of the request and the arrival of medical equip at the site where the emergency occurs). As mentioned in [8], other performance measures to an EMS are: the balance of ambulance workloads, the fraction of calls not serviced by the system (loss probability), and the fraction of calls serviced within a predetermined threshold (i.e., fraction of calls with response times not exceeding T minutes). In particular, one of the critical urgencies for the SAMU is the cardiac arrest. In this case the response time, and consequently the reasonable delay to restore the blood circulation is in order of few minutes, otherwise it can result in permanent cerebral sequels or death to the patient. One

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A simulation model for evaluation of the impacts of chemotherapy at home on hospitals[★]

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Abstract

The outgoing service in hospitals is in charge of ambulatory care. With the introduction of home-based structures some of these services, like chemotherapy, can be provided at home. This implies the creation of new roles, changes in actors' behavior and new ways of organization. The rise of such structures has a strong impact on the global organization of traditional ambulatory services in hospitals and on the health-care network organization. Two main questions arise: (i) Are the home-based structures pertinent from the insurance's economic standpoint, and (ii) What will be the changes inside the hospitals due to the new offer? This article presents a new simulation model to evaluate the impact of home chemotherapy on the organization and resource utilization of hospitals, and cost for the insurance system. The simulation model takes into account the health condition and geographic location of patients. Numerical experiments based on field data are performed to assess the overall costs and performance measures of different strategies of integrating the home-based structure.

Key words: Discrete-Event Simulation, Chemotherapy, Home Care, Territorial Networks of Healthcare.

1 Introduction

This article will focus on chemotherapy ambulatory services. Such care can be delivered in the outgoing service of a hospital or in a network-based organization. These network-based structures (we will refer to them as RTS) are composed of two main components: (i) *a network of freelance actors* including, nurses, laboratories, drugstores, doctors, and (ii) *a coordination cell* that will follow the patient's treatment, contact the freelance professionals and ensure the quality of service. In general, the medical procedure itself is delivered by staff being outside of the structure. Thus the insurance will provide a budget for the coordination cell and every professional will report his/her activity to the insurance to receive a payment according to established pricing lists. The main advantage of this structure is that activities like planning routes or workload scheduling are done by every actor. The main disadvantage is the coordination difficulty to ensure quality medical treatment and training of human resources.

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Comparison of chemotherapy at home systems using discrete-event simulation^{*}

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Abstract

In recent years, following a rapid development of Home Care Services (HCS) in France, chemotherapy at home (one of 24 subsistent HCS schemes) is beginning to attract the interest of institutions dealing with cancer, and researchers in healthcare engineering. We study, through a comparative analysis, chemotherapy at home systems based on real world cases studies. The objective is to identify good practices which could be extended to other chemotherapy at home systems. The comparative analysis is composed of a qualitative analysis and a quantitative one in which experimentations are realized using discrete-event simulation.

Key words: Home care services; Chemotherapy at home; comparative analysis; Performance evaluation; Discrete-event simulation

1 Introduction

The increased aging population is an important pressure to hospitals, which are heavily constrained by their resources to meet growing patient demands. Home care services has thus met a rapid development in France., It is considered by health professionals as an alternative to traditional inpatient stay, for reducing costs, smoothing the production of care and improving patient comfort.

Technical care for cancer accounts for 19% of stays in HCS, and ranks second in terms of patient admissions. The most important technical care comes to cancer chemotherapy, which represents itself, 15.6% of stays in HCS [1]. Chemotherapy at home is starting to attract the interest of institutions dealing with cancer and researchers in healthcare engineering.

We deal with this problematic of chemotherapy at home. An analysis, based on real world cases studies, is done in order to compare two types of organization for chemotherapy at home. Two HCS structures are concerned.

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Application of software engineering methods for modeling the patient empowerment process with cancer*

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Abstract.

In an international increasingly competitive context, hospital systems, like any other system, constantly need to adapt and optimize their management and methods tools to improve service levels and reduce their cost. Particularly, the decision regarding the medical condition of a patient is evaluated based on the satisfaction level of the latter and the cost optimization in terms of consumption of pharmaceuticals. In this paper, we first define the patient empowerment process, which enables the medical decision sharing between the different actors involved, including the patient, then we present a comparative study of different software engineering methods in a multidimensional benchmarks framework, and finally, we conclude with the establishment of a methodology for modeling this process in the case of a patient with cancer and treated with chemotherapy.

Keywords: Empowerment patient, Holon, multiagent system, medical decision making.

1 Introduction

Health remains the issue that concerns almost all citizens of a country. Its expenses often increase faster than the creation of wealth of a country. In Morocco, these expenses increased from 4.5% of GDP (Gross Domestic Product) in 1997/98 to 5% in 2001. To control these expenditures, the health system undergoes a reform process that takes into account the criteria of patient satisfaction (effectiveness) and cost optimization (efficiency). This new operation mode requires empowerment of the user behavior in his care health, and suited information to the patient and his entourage appears as a pre-requisite to a relay support to patient's home.

This empowerment gives the patient the right to share with healthcare professionals the information that will lead him to participate in decision making about his health and also requires a therapeutic education to support his illness at home. Such education should be integrated into the care process and considered as an added value to the relationship care-receiver/care-giver.

To address this empowerment problem, we adopted an organizational concept based on holonic systems. The concept of Holon is defined by Koester (see [6]) as the concatenation of two words "holos" meaning the whole and the suffix "On" suggesting a party as the proton.

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A Unified approach for Home Care and Health Care system*

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Abstract

This paper provides a state-of-the-art on the application of Location-Allocation (LA) problem in health care and Home Care (HC) systems. We propose a unified approach for the optimization of health care system and introduce a simplified version of LA problem called patient allocation problem. We discuss the criteria for applying this new approach and conclude its effects on the health care system.

Key words: Location-Allocation, Home Care, unified approach.

1 Introduction

The Location-Allocation (LA) problem determines the optimal facility locations and the assignment of customers to the selected facilities. The objective is to maximize the population accessibility and to minimize the costs. Home Care (HC) problem is the way of treatment in which a patient receives all his care at his home by health professionals. HC replaces the traditional hospitalization or helps in the early discharge of a patient. The objective of HC is to assign health professionals to patients at minimum cost, while satisfying various constraints.

Our problem is to find a system which can deal these two problems simultaneously. We have presented a modified form of LA problem. This modified form is then used to define a unified approach for optimization of the health care system.

This paper is organized as follows. Section 2 provides the detailed literature review relevant to Home Care Problem, their application and a comparison study of traditional hospitalization and home care. Section 3 proposes a unified approach for health care system and discusses the criteria, benefits of the proposed approach in real-world setting. In section 4 we find some combinatorial problems relevant to the new development of the

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Strategic decision-maker requirements for hospital bed managers^{*}

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Abstract

According to the MEAH (2008), hospital bed management consists of managing as best as possible the welcoming capacity in order to take into account a volume activity, while respecting quality criterion (quality of cares, delays, duration, ...) under resources constraints. This research aims to help hospital bed manager, at a strategic level, and tries to give them tools that optimize bed management while integrating the whole patient's trajectory. This paper will put the emphasis on the originalities of this research which can be categorized into three axis. Firstly, the project wants to work on strategic level within the framework of hospitals working in networks in order to better distribute and anticipate patients' exits. Secondly, availabilities of diagnosis resource (e.g. scan) are also going to be taken into account. Thirdly, the decision-making tool that will be developed will integrate the whole patient's trajectory i.e. the downwards as well as the upwards.

Key words: Decision-making tool, strategic hospital bed management, network of hospitals

1 Introduction

Nowadays, the hospital bed management evolves in an environment distinguished by the different mechanisms of hospital funding, linked to running costs, and by the need of delivering high quality cares to its patients. Healthcare establishments have generally decided to integrate inside their structure a department responsible for the hospital bed management while stimulating changes and systems improvements. Lots of hospitals have therefore decided to centre their organization on a best resources affectation and more precisely on one specific resource: the hospital bed. It is important to define the hospital bed management. Hospital bed management consists of managing as best as possible the welcoming capacity in order to take into account a volume activity, while respecting quality criterion (quality of cares, delays, duration, ...) under resources constraints.

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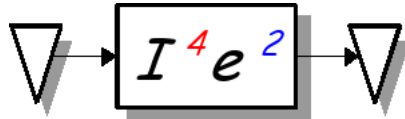
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