

# Paper Abstracts of 2013 IFAC Conference on Manufacturing Modelling, Management, and Control

## Technical Program for Wednesday June 19, 2013

<b>WeK1</b>	Grand Hall (St. Petersburg State University)
<b>Keynote Addresses - 1 (Plenary Session)</b>	

Chair: Gershwin, Stanley  
Co-Chair: Meerkov, Semyon M.

Massachusetts Inst. of Tech.  
Univ. of Michigan

11:30-12:20 WeK1.1

*Managing with Incomplete Inventory Information (I3)*, pp. 1-6

Sethi, Suresh P.  
Shi, Ruixia

Univ. of Texas at Dallas  
Univ. of Richmond

A critical assumption in the vast literature on inventory management has been that the current level of inventory is known to the decision maker. Some of the most celebrated results such as the optimality of base-stock policies have been obtained under this assumption. Yet it is often the case in practice that the decision makers have incomplete or partial information about their inventory levels. The reasons for this are many: Inventory records or cash register information differ from actual inventory because of a variety of factors including transaction errors, theft, spoilage, misplacement, unobserved lost demands, and information delays. As a result, what are usually observed are some events or surrogate measures, called signals, related to the inventory level. These relationships can provide the distribution of current inventory levels. Therefore, the system state in the inventory control problems is not the current inventory level, but rather its distribution given the observed signals. Thus, the analysis for finding optimal production or ordering policies takes place generally in the space of probability distributions. The purpose of this paper is to review some recent developments in the analysis of inventory management problems with incomplete information.

12:20-13:10 WeK1.2

*The Control under Uncertainty Conditions: History and Perspective*, pp. 7-14

Emelyanov, Stanislav  
Fomichev, Vasily  
Fursov, Andrew

ISA RAS  
Moscow State Univ.  
Moscow State Univ.

Within a problem of control of dynamic plants under uncertainty are considered both classical methods of the theory of systems with variable structure, and their modern development in the form of the theory of new types of feedback. The exact structure of feedback in control variable structure systems is clarified. Existence of two types of feedback is revealed: one classical feedback by the general regulation error, and another, new type, the coordinate-to-operational feedback.

Thus feedback is responsible for a set of positive dynamical properties for control variable structure systems. Also the perspective directions of further development of the theory of new types of feedback are considered. In particular, methods of simultaneous control by families of dynamic plants are considered.

<b>WeK2</b>	Grand Hall (St. Petersburg State University)
<b>Keynote Addresses - 2 (Plenary Session)</b>	

Chair: Tiwari, Manoj K  
Co-Chair: Kovalyov, Mikhail Y.

Indian Inst. of Tech. Kharagpur  
United Inst. of Informatics Problems

14:30-15:20 WeK2.3

*Virtual and Augmented Reality Applications in Manufacturing*, pp. 15-26

Nee, A Y C  
ONG, S K

National Univ. of Singapore  
National Univ. of Singapore

Augmented Reality (AR) is a fast rising technology and it has been applied in many fields such as gaming, learning, entertainment, medical, military, sports, etc. This paper reviews some of the academic studies of AR applications in manufacturing operations. Comparatively, it is lesser addressed due to stringent requirements of high accuracy, fast response and the desirable alignment with industrial standards and practices such that the users will not find drastic transition when adopting this new technology. This paper looks into common manufacturing activities such as product design, robotics, facilities layout planning, maintenance, CNC machining simulation and assembly planning. Some of the issues and future trends of AR technology are also addressed.

15:20-16:10 WeK2.4

*Planning and Scheduling in Intermodal Transport*, pp. 27-32

Pesch, Erwin  
Nossack, Jenny

Univ. of Siegen  
Univ. of Siegen

Attracting a higher share of freight traffic on rail requires freight handling in railway yards that is more efficient, and which includes technical innovations as well as the development of suitable optimization approaches and decision-support systems. In this talk we will review planning and scheduling problems of container processing in railway yards, and analyzes basic decision problems and solution approaches for the two most important yard types: conventional railroad and modern railrail transshipment yards. Furthermore, we review some of the relevant literature and identify open research challenges. Additionally we address a scheduling problem that arises in intermodal container transportation, where containers need to be transported between customers (shippers or receivers) and container terminals (rail or maritime) and vice versa. The solution method can be applied to other problems as well.

Keynote Addresses - 3 (Plenary Session)

Chair: Vassilyev, Stanislav N. Trapeznikov Inst. of Control Sciences RAS  
Co-Chair: Leonov, Gennady Saint-Peterburg State Univ.

16:50-17:40 WeK3.5

*Nonlinear Problems in Control of Manufacturing Systems*, pp. 33-42

Leonov, Gennady Saint-Peterburg State Univ.  
Pogromsky, A. Yu. Eindhoven Univ. of Tech.  
Starkov, Konstantin K. Eindhoven Univ. of Tech.  
Andrievsky, Boris Inst. for Problems of Mechanical Engineering RAS  
Kuznetsov, Nikolay Saint-Petersburg State Univ.  
Adan, I.J.B.F. Eindhoven Univ. of Tech.

Nowadays, production control problems has been widely studied and a lot of valuable approaches have been implemented. This paper addresses the problem of tracking the uncertain demand in case of uncertain production speeds. The uncertainties are described by deterministic inequalities and the performance is analyzed in from of the worst-case scenario. First, simple mathematical models are introduced and the control problem is formulated. In continuous-time, the cumulative output of a manufacturing machine is the integral of the production speed over time. At the same time, the production speed is bounded from below and above, and hence the manufacturing process can be modeled as an integrator with saturated input. Since the cumulative demand (which is the reference signal to track) is a growing function of time, it is natural to consider control policies that involve integration of the mismatch between the current output and current demand. In the simplest consideration it results in models similar to a double integrator closed by saturated linear feedback with an extra input that models disturbances of a different nature. This model is analyzed and particular attention is devoted to the integrator windup phenomenon: lack of global stability of the system solutions that correspond to the same input signal. As a systematic design procedure to prevent the windup phenomenon we present observer based techniques with full and reduced-order observers. The next part of the paper deals with a similar control problem in discrete-time under the surplus-based policy: each machine in the production network tracks the demand trying to keep the downstream buffer at some specified safe level. The performance of manufacturing networks with different topologies is analyzed via the second Lyapunov method, while the disturbances are modeled by deterministic inequalities. The nature of the approach leads to performance analysis in the form of a worst case scenario and allows to find a tradeoff between the inventory for each machine in the system and the demand tracking accuracy. The final part of the paper illustrates how to make the theoretical findings operational with the experimental setup called Liquitrol.

17:40-18:30 WeK3.6

*Assembly Line Balancing: Conventional Methods and Extensions*, pp. 43-48

Dolgui, Alexandre Ec. Nationale Supérieure des Mines de Saint-Etienne  
Proth, Jean-Marie INRIA

In this presentation the standard line balancing models from the Operations Research literature are mentioned, as well as some simple available algorithms that provide a solution close to optimum. Then some extensions of previous algorithms are introduced. A particular attention is paid to line balancing problems in machining environments. Real life examples are presented. This shows how advanced line balancing techniques can be efficiently used for automated manufacturing system design and management.

18:30-19:20 WeK3.7

*Intelligent Control of Industrial Processes*, pp. 49-57

Vassilyev, Stanislav N. Trapeznikov Inst. of Control Sciences RAS  
Novikov, Dmitry Inst. of Control Sciences of Russian Acad. ofSciences  
Bakhtadze, Natalia V.A. Trapeznikov Inst. of Control Sciences, Russian Acad.

The paper analyzes the problems of intelligent production control subject to world economy trends. It discusses the evolution of the problem of integrated plant floor and plant logistics control and overviews the state-of-the-art control theory methods and the ways to apply them in production control.

Technical Program for Thursday June 20, 2013

<b>ThA1</b>	Aud.11 (ITMO)
<b>Automotive Manufacturing &amp; Supply Chain Management - 1 (Invited Session)</b>	

Chair: Dolgui, Alexandre Ec. Nationale Supérieure des Mines de Saint-Etienne  
 Co-Chair: Gusikhin, Oleg Ford Motor Company

10:00-10:20 ThA1.1

*Optimal Stockout Risk for a Component Mounted on Several Assembly Lines in Case of Emergency Supplies (I)*, pp. 58-63

GIARD, Vincent Univ. Paris-Dauphine (PSL)  
 SALI, Mustapha Renault

This article focuses on the determination of the optimal stockout risk of a component used by some alternative modules that are mounted in several assembly lines. The studied context is that of a supply chain dedicated to the mass production of strongly diversified products, as found in the automotive industry. The MRP approach is adapted for the monitoring of this chain but the distance between the production units leads to a mix between production to stock and production to order for the component we are interested with. To prevent any stock-out propagation along the downstream part of the supply chain, emergency supply is triggered when it is about to occur. The optimal definition of the safety stock optimal, and thus of the optimal stockout risk, lays on a mono-period model that takes into account the cost of a safety stock and the costs involved by the emergency supply (transportation and production). The analytical solutions that depend on the involved cost are illustrated

10:20-10:40 ThA1.2

*Coordinating Sales and Operations Management in Automobile Industry under Long Procurement Lead Times (I)*, pp. 64-69

Lim, Lâm Laurent Grenoble-INP / UJF-Grenoble 1 / CNRS, G-SCOP UMR5272 Grenoble  
 Alpan, Gulgun ENSGI - INPG  
 Penz, Bernard Grenoble-INP / UJF-Grenoble 1 / CNRS, G-SCOP UMR5272 Grenoble

The automobile industry is characterized by a very volatile demand and impatient customers. Furthermore, globalization has grown longer procurement lead times of vehicle assembly plants. Therefore a challenge for automotive manufacturers is to cleverly adjust production capacities with customer demands. To satisfy car buyers in a competitive market, sales dealers require short delivery lead time and the possibility to order customized vehicles as late as possible. However, plants need to order parts several weeks beforehand for distant suppliers, when the demand is not known yet. The issue is to find the best trade-off between these sales requirements and industrial constraints while limiting stock levels and emergency supplies due to parts shortages. This study is based on the actual situation of a global automotive manufacturer where a continuous negotiation process is done between sales and supply chain departments to manage this trade-off. During the sales and operations planning, flexibility levels are defined and represent the maximum number of a given vehicle type that sales dealers can order during a week. Since this process is new, supply chain managers lack insights about how this flexibility may impact inventories and delivery lead time. Our objective is to model the dynamics of this sales and operations planning and to study how to improve logistics performance without deteriorating customer satisfaction. We show how flexibility levels impact delivery time and logistics costs by using a simulation approach based on actual industrial data.

10:40-11:00 ThA1.3

*A New Parallel Genetic Algorithm for Reducing the Bullwhip Effect in an Automotive Supply Chain (I)*, pp. 70-74

Tosun, Umut Middle East Tech. Univ.  
 Dokeroglu, Tansel Middle East Tech. Univ.  
 Cosar, Ahmet Middle East Tech. Univ.

With the developments in the automotive industry, most of the car manufacturing companies aim to move from stock oriented production of cars through a built order production. There have been many improvements in recent years in terms of delivery times, reliability and responsiveness. Shortening the delivery times, increasing the reliability and the responsiveness perform the most of the efforts in car manufacturing optimization. Foreseen vulnerability of bullwhip effect for short-term and mid-term car manufacturing and supply chain planning are considered. The bullwhip effect occurring with respect to demand order fluctuations is transferred while moving up the supply chain. Information deterioration end to end in a supply chain causes drastic ineffectiveness and inefficiencies. Companies should understand the causes to overcome extra costs over the supply chain. In this paper, a supply chain model based on the MIT Beer Game for automotive industry is discussed. Finally, a parallel genetic algorithm to reduce the bullwhip effect and cost in an automotive supply chain is proposed.

11:00-11:20 ThA1.4

*Order Crossovers in an Automotive Supply Chain (I)*, pp. 75-80

Riezebos, Jan Univ. of Groningen

Order crossovers occur when the delivery of orders is not in sequence with the issuing of orders. In automotive supply chains this may occur due to transportation mode choices, multiple suppliers, asynchronous capacity management at the suppliers, supply chain design choices, and speed differences in long supply chains.

This study examines the problem that a Dutch first tier supplier to the automotive industry in Europe faces when ordering items in Asia. Their information system and procurement procedures do not take the possibility of order crossovers into account. We have examined the consequences of neglecting these order crossovers with a situation where the occurrence of such order crossovers is used to advance the supply chain management and reduce the overall costs for the first tier supplier.

The proposed model is an extension of MRP ordering procedures and is demonstrated in an Excel spreadsheet.

---

11:20-11:40 ThA1.5

*Evaluation of a Configuration Model for the Design of Adaptable Logistics Chains in the Railway Vehicle Manufacturing Industry (I)*, pp. 81-86

Sihn, Wilfried Vienna Univ. of Tech. Fraunhofer Austria Res. Gmb  
Gommel, Henrik Fraunhofer Austria Res. GmbH  
Florian, Markus Fraunhofer Austria Res. GmbH

This paper presents an approach on how to identify and design adaptable logistics chains configurations. Logistics chains are mostly influenced by changes in their business environment. A system's adaptability is seen as one potential to effectively counteract these environmental changes. To consider the effects of adaptability on the whole supply chain, a framework for configuring adaptable logistic chains was developed within the research project "KoWaLo". The approach and a case study in the railway vehicle manufacturing industry, developed and performed within this research project, is shown in this paper.

---

11:40-12:00 ThA1.6

*Diagnosis of Automobiles Field Failures Based on Event Logs (I)*, pp. 87-92

Tiwari, Manoj K Indian Inst. of Tech. Kharagpur  
Nayak, Ashutosh Indian Inst. of Tech. Kharagpur  
Raj, Ratan Indian Inst. of Tech. Kharagpur

Event logs contain rich information on the operating status and working conditions of the system. This paper proposes to build event log model for service history of automobiles and establish job patterns. To establish the best pattern a growing algorithm has been proposed with association and dependency measures. Using a real world example, the effectiveness of the proposed method is highlighted.

---

**ThA2** Oak Hall (ITMO)

**Reverse Supply Chains - 1** (Invited Session)

Chair: Gupta, Surendra M. Northeastern Univ.  
Co-Chair: NAKASHIMA, Kenichi Kanagawa Univ.

---

10:00-10:20 ThA2.1

*Simulated Annealing Algorithm for Solving Sequence-Dependent Disassembly Line Balancing Problem (I)*, pp. 93-98

Kalayci, Can Berk Pamukkale Univ.  
Gupta, Surendra M. Northeastern Univ.

In this paper, we consider a sequence-dependent disassembly line balancing problem (SDDLBP) with multiple objectives that concerns with the assignment of disassembly tasks to a set of ordered disassembly workstations while satisfying the disassembly precedence constraints and optimizing the effectiveness of several measures considering sequence-dependent time increments among disassembly tasks. Due to the high complexity of the SDDLBP, there is currently no known way to optimally solve even moderately sized instances of the problem; therefore an efficient methodology based on the simulated annealing is proposed to solve the SDDLBP.

---

10:20-10:40 ThA2.2

*Optimization of a Reverse Manufacturing System with Multiple Virtual Inventories (I)*, pp. 99-104

NAKASHIMA, Kenichi Kanagawa Univ.  
Gupta, Surendra M. Northeastern Univ.

This paper deals with a cost management problem of a remanufacturing system with stochastic variability such as demand. We model the system with consideration for two types of inventories. One is the actual product inventory in a factory. The other is the virtual inventory that is used by customer. For this virtual inventory, it should be required to consider an operational cost that we need in order to observe and check the quantity of the inventory. We call it the virtual inventory cost and model the system including it. We define the state of the remanufacturing system by the both of the inventory levels. It is assumed that the cost function is composed of various cost factors such as holding, backlog and some kinds of manufacturing costs etc. We obtain the optimal policy that minimizes the expected average cost per period. Numerical results show the effects of the factors on the optimal policy.

---

10:40-11:00 ThA2.3

*Evaluation Process in End-Of-Life Systems Management Using BOCR Analysis (I)*, pp. 105-110

Bouzarour, Yasmina Univ. Paul Sabatier, Ec. Nationale d'Ingénieurs de Tarbes  
Tchangani, Ayeley, Philippe Lab. Génie de Production  
Peres, Francois ENIT

Nowadays, sustainability is an indicator or even a concept that guides many public as well as private decisions or actions. In manufacturing sectors, firms are paying an increasing attention to this concept with regards to their products once they are the end of their life; this attention is not only due to the respect of norms and laws policy makers are continuously editing to protect the environment or the sensitivity of consumers to ecological issues but also because of possibilities of new business this concept offers. Indeed, firms noticed that they can create value with the end-of-life products by dismantling them and recovering parts and/or materials that can be re-introduced into manufacturing process, into maintenance process, etc.; or just by the improvement of their image with regards to public opinion. The process of recuperating end-of-life products, known as reverse logistics, is therefore a sustainable development process which will be triggered by the consumer and consists in a series of activities; one such activity concerns withdrawal problem that consists in responding some questions such as: where the end-of-life product must be dismantled?, how to bring the product from its actual position to the dismantling place?, who is in charge of this activity?, etc. This paper considers the issue of evaluating and optimizing the withdrawal process in the field of aircraft dismantling. The withdrawal plan evaluation is formulated here as multi-criteria / multi-objectives decision making problem and solved using BOCR analysis as the structuring

framework for the elicitation process and satisficing game theory as the most suitable mathematical tool for recommendation process.

11:00-11:20

ThA2.4

*A Fuzzy Approach to the Location of Depots for Returned Maritime Containers (I)*, pp. 111-116

Palacio, Antonio

Univ. de Oviedo

Adenso-Diaz, Belarmino

Univ. of Oviedo

Lozano, Sebastián

Univ. of Seville

The container depot location problem is usually treated as a cost minimization problem due to the impact of container depots on logistic costs. But these depots, that store the returned empty maritime containers until they are needed, have also an environmental impact in the areas where they are located. In this paper a biobjective model is considered for designing a depots network in a hinterland. The two objectives used are the total cost of the network and the environmental impact generated by the commissioning and maintenance of the container depots and by the transport operations in and out of the depots. As the capacity of a depot is not an exact value, they have been modeled as a fuzzy restriction. An additive fuzzy multiobjective optimization approach has been used to solve the problem. Results were applied to the case of the Port of Valencia, Spain.

11:20-11:40

ThA2.5

*Combining Lean and Green in Manufacturing: A Model of Waste Management (I)*, pp. 117-122

FERCOQ, Alain

Arts et Métiers ParisTech

LAMOURI, Samir

Arts et Métiers ParisTech

CARBONE, Valentina

ESCP Europe

Lelièvre, Adrien

Exxelia

LEMIEUX, Andrée-Anne

Ec. Pol. de Montréal

In this paper, we focus our attention on the modelling of waste management as an application of environmental concern (green) integrated with lean manufacturing. The literature confirms the convergence between the two concepts, for waste reduction. Nevertheless, there are interesting avenues of research in the development of an integrated model, at the crossroads of lean and green principles. So, we propose a framework in three levels for optimizing a waste minimization program: an integrated improvement process (level 1), a strategic matrix and an integrated toolkit (level 2), and finally an "advanced 3R (Reduction / Reuse / Recovery)" method (level 3).

11:40-12:00

ThA2.6

*Optimal Collection Period for Returned Products in the Reverse Supply Chain (I)*, pp. 123-127

Zaarour, Nizar

Northeastern Univ.

Melachrinoudis, Emanuel

Northeastern Univ.

Solomon, Marius

Northeastern Univ.

Min, Hokey

Bowling Green State Univ.

This paper deals with return flows of products from the consumers to the manufacturer in the closed loop supply chain. A mathematical model is developed to determine the optimal collection period at an initial collection point before transshipping the returned products to a centralized return center. Inventory cost at an initial collection point is traded off with transportation cost to the centralized return center in the presence of freight quantity discounts. To reflect a realistic product return process, we analyzed the case of discrete collection time period.

**ThA3**

Aud.41 (ITMO)

**Scheduling and Lotsizing** (Regular Session)

Chair: Pesch, Erwin

Univ. of Siegen

Co-Chair: Nicod, Jean-Marc

FEMTO-ST Inst. / ENSMM

10:00-10:20

ThA3.1

*Improved Intelligent Water Drops Optimization for Single and Multiple Objective Job Shop Scheduling*, pp. 128-133

ONG, S K

National Univ. of Singapore

Niu, S H

National Univ. of Singapore

Nee, A Y C

National Univ. of Singapore

Single objective Job Shop Scheduling Problem (SOJSSP) and Multiple Objective Job Shop Scheduling Problem (MOJSSP) are typical NP-hard optimization problems which have significant values in manufacturing and remanufacturing environments. Intelligent Water Drops (IWD) is a new type of meta-heuristics which shows excellent ability of solving optimization problems. In this research, IWD is improved and customized to solve SOJSSP and MOJSSP problems. Experiments have been conducted, and the results show that the enhanced algorithms have comparable if not better performance compared to current literature in solving these two types of problems. To the best of the authors' knowledge, this is among the first research employing IWD for solving SOJSSP and MOJSSP.

10:20-10:40

ThA3.2

*Task Scheduling to Extend Platform Useful Life under Service Constraint Using Prognostic*, pp. 134-139

Nicod, Jean-Marc

FEMTO-ST Inst. / ENSMM

Obrecht, Léo

ENSMM

VARNIER, Christophe

Femto-ST Inst.

In this paper, we aim at maximizing the useful life of a heterogeneous distributed platform which has to deliver a given production. The machines perform independent tasks and may be configured with different profiles (one nominal mode and several degraded ones). Depending on the profile, a machine reaches a given throughput. At each time the sum of the machine throughputs that are currently

running determines the global throughput. Moreover, each machine is supposed to be monitored and a prognostic module gives its remaining useful life depending on both its past and future usage (profile). The objective is to configure the platform so as to reach the demand as long as possible.

We propose to discretize the time into periods and to choose a configuration for each period. We propose an Integer Linear Programming (ILP) model to find such configurations for a fixed time horizon. Due to the number of variables and constraints in the ILP, the largest horizon can be computed for small instances of the problem. For larger ones, we propose polynomial time heuristics to maximize the useful life. Exhaustive simulations show that the heuristic solutions are close to the optimal (5% in average) in the case where the optimal horizon can be computed. For other platforms with a very large number of machines, simulations assess the efficiency of our heuristics. The distance to the theoretical maximal value is about 8% in average.

---

10:40-11:00 ThA3.3

*Hierarchical Scheduling and Utility Disturbance Management in the Process Industry*, pp. 140-145

Lindholm, Anna	Lund Univ.
Johnsson, Charlotta	Lund Univ.
Quttineh, Nils-Hassan	Department of Mathematics, Linköping Univ.
Lidestam, Helene	Department of Management and Engineering, Linköping Univ.
Henningsson, Mathias	Department of Management and Engineering, Linköping Univ.
Wikner, Joakim	Linköping Univ.
Tang, Ou	Department of Management and Engineering, Linköping Univ.
Nytzén, Nils-Petter	Perstorp AB, Perstorp
Forsman, Krister	Perstorp AB

The integration of scheduling and control in the process industry is a topic that has been frequently discussed during the recent years, but many challenges remain in order to achieve integrated solutions that can be implemented for large-scale industrial sites. In this paper we consider production control under disturbances in the supply of utilities at integrated sites together with the integration towards production scheduling. Utilities, such as steam and cooling water, are often shared between the production areas of a site, which enables formulation of an optimization problem for determining the optimal supply of utilities to each area at the occurrence of a disturbance. Optimization in two timescales is suggested to handle the scheduling and disturbance management problems in a hierarchical fashion. The suggested structure has been discussed with companies within the chemical process industry. A simple example is provided to show how the structure may be used.

---

11:00-11:20 ThA3.4

*Cyclic Scheduling of Sequentially Connected Cluster Tools with a Single I/O Module*, pp. 146-151

Kim, Dae-Kyu	Korea Advanced Inst. of Science and Tech.
Lee, Tae-Eog	Korea Advanced Inst. of Science and Tech.

A cluster tool has been widely used for most wafer or flat panel fabrication processes. We examine cyclic scheduling problems of sequentially connected cluster tools with a single input and output module, which includes multi-cluster tools as well as linear cluster tools. We first compute workloads for each process step and each robot, of which the maximum provide a lower bound of the tool cycle time. We then identify an assignment rule of assigning the chambers to the process steps that makes the tool cycle time independent of the order of using the parallel chambers. We also propose a robot task sequence for each component cluster tool, which is modified from the well-known swap sequence. We prove that the modified swap sequence is optimal when one of the process steps, not a robot, is the bottleneck. Finally, we present a scheduling strategy which controls robot task timings to deal with interference of wafer flows between each pair of adjacent component cluster tools, which is complicated by blocking due to limited buffer capacity between them and backward wafer flows.

---

11:20-11:40 ThA3.5

*A Capacitated Multi-Product Dynamic Lot-Sizing Problem by Considering Expiration Dates; a New Approach*, pp. 152-157

Mirzapour Al-e-hashem, Seyed Mohammad Javad	Emlyon business school
Sazvar, Zeinab	Department of Industrial Engineering, SharifUniversityofTechnolo
BABOLI, Armand	INSA-Lyon, DISP Lab. F-69621,France
Rekik, Yacine	EMLYON Business School
Akbari Jokar, Mohammad Reza	Department of Industrial Engineering, Sharif Univ. of Tech.

Although managing and controlling the inventories of perishable products is progressively becoming more important, they are often neglected in lot-sizing research and modeling. This paper studies a new multi-product multi-period dynamic lot sizing problem, where the inventories of products are assumed to be expired at a pre-specified date. For this purpose we assume a retailer that purchases products in large quantities (lot size) from manufacturers, and then sells smaller quantities (or single units) to the consumer. So, the order quantities can be merely an integer multiplier of that product batch size. The retailer also owns a capacitated warehouse. In order to make decisions on "how much to order" and "when to order", a novel mixed integer programming model is developed that minimizes total costs including the procurement cost, inventory holding cost, ordering, backordering and expiration costs subject to warehouse capacity. Furthermore, a numerical example is presented to demonstrate the applicability of the proposed model.

---

11:40-12:00 ThA3.6

*Energy Management Based on a Hybrid Modeling Approach*, pp. 158-161

Meyer, Heiko	Gefasoft AG
Plössnig, Josef	Gefasoft AG
Weißberger, Benedikt	Tech. Univ. of Munich
Vogel-Heuser, Birgit	Tech. Univ. of Munich

This document provides information about the current development status for energy management and introduces a new approach for

automated energy management by means of an MES based on a hybrid modeling approach. The objective of this new approach is to not only monitor but also forecast and control the energy consumption in production plants in real time. This helps companies to save energy and money.

---

<b>ThA4</b>	Aud.51 (ITMO)
<b>Pricing and Outsourcing (Regular Session)</b>	

---

Chair: Li, Jianxiang	Beijing Inst. of Tech.
Co-Chair: Mukhopadhyay, Samar K.	SKK Univ. GSB

---

10:00-10:20	ThA4.1
-------------	--------

---

*A Pricing Equilibrium Model for Digital Music Market*, pp. 162-167

Ko, Hing Tobey	The Univ. of Hong Kong
Lau, Henry	The Univ. of Hong Kong

Given the degrees of freedom on the internet and the ease of obtaining perfect replicates of digital music files, internet piracy of digital music is a serious free-riding problem that has become a social phenomenon. We argue that using the pirated digital music as a promotional tool could be beneficial to the record labels by increasing consumers' brand premium value. In this paper, we present the preliminary design of a self-selection model on optimal pricing of digital music. The model provides strategies to the recording industry to effectively price its products with the co-existence of piracy.

---

10:20-10:40	ThA4.2
-------------	--------

---

*An Agent-Based Framework for Partner Selection with Sustainability Considerations*, pp. 168-173

Lee, Lik Hang	The Univ. of Hong Kong
Wong, T. N.	The Univ. of Hong Kong
Sun, Zhe	The Univ. of Hong Kong

This paper presents a multi-agent system (MAS) to support partner selection in a sustainable supply chain network. With the growing awareness of environmental and social issues globally, governments and industry have recognized that they have vital roles in supporting and assuring sustainable development. In consideration of these concerns, companies worldwide have begun to adopt sustainability practices in the supply chain. An important issue of sustainability practices is to involve the sustainability considerations into organizational purchasing decision and long term relationships with suppliers. That is, in the selection of suppliers and outsourcing partners, enterprises should not only consider the general criteria, but also should consider the environmental and social impacts of their partners. Evaluation and selection of partners is a typical multi-criteria decision making (MCDM) problem involving both qualitative and quantitative issues. For the implementation of supply chain sustainability, issues regarding environmental and social responsibility are to be included in partner evaluation, in addition to the conventional criteria such as price, quality, delivery, and service. In this paper, the MAS is established to integrate sustainability concerns into the supply chain partner evaluation and selection process. Autonomous agents are established to represent various parties and functions of the supply chain, for instance, a buyer agent represents the buyer and the potential suppliers are represented by seller agents. The buyer agent has to exchange bids with the seller agents on the multiple criteria repeatedly. The MAS is equipped with suitable negotiation strategies and negotiation protocol to all agents. It supports multilateral negotiation, that is, the buyer agent is able to interact with many seller agents concurrently in the bidding process.

---

10:40-11:00	ThA4.3
-------------	--------

---

*Managing Multiple Outsourcing: Service Quality and Volume Issues*, pp. 174-179

Mukhopadhyay, Samar K.	SKK Univ. GSB
------------------------	---------------

Service operations like call center operations and business processes are being outsourced to offshore locations because of many operational reasons including cost savings. The main trade-off is the lack of control on service quality. When multiple suppliers are operating and service requirements are allocated to one or another, differential quality level is especially being an irritant to the firm's customers. In our model, the firm uses the allocation of quantity to motivate the multiple suppliers so that the equilibrium service quality in the market equalizes over all suppliers. The buyer's customers are assured of the same consistent quality level regardless of which of the multiple suppliers their calls are routed to. We obtain optimal policies of both the buyer and the suppliers in a two-supplier market and also study an asymmetric information case.

---

11:00-11:20	ThA4.4
-------------	--------

---

*Prices of Robustness and Reblending in Oil Industry*, pp. 180-185

Janaqi, Stefan	Ec. des Mines d'Alès
Aguilera, Jorgé	Ec. des Mines d'Ales
Chèbre, Mériam	TOTAL Refining and Marketing

In this paper we present a method to calculate the prices of robustness and reblending through a robust real-time optimization method for the on-line linear oil blending process. Our approach places this problem in a wider frame where different sources of uncertainty inherent to the blending process appear. The polytopal structure of our problem permits a robust approach that is simpler than the classical theory of Ben-Tal and Nemirovskii which needs convex programming tools. Our method is intended to avoid reblending and we measure its performance in terms of the blend quality giveaway and feedstocks prices. The difference between the nominal and the robust optimal values (the price of robustness) provides a benchmark for the cost of reblending which is difficult to estimate in practice. This new information can be used to adjust the level of conservatism in the model. Additional critical information for the control system is produced. For instance, knowing the minimal volume to pour before getting a robust feasible blend reduces the unnecessary control system interventions.

---

11:20-11:40	ThA4.5
-------------	--------

---

*An Integrated Approach for the Optimization of the Sustainable Performance: A Wood Supply Chain*, pp. 186-191

Boukherroub, Tassedat	Lab. Décision et Information pour les Systèmes de Product
-----------------------	---

Ruiz, Angel  
Alain, Guinet, Alain  
Julien, Fondrevelle, Julien

Faculté des sciences de l'Administration, Univ. Laval  
Lab. Décision et Information pour les Systèmes de Product  
Lab. Décision et Information pour les Systèmes de Product

This paper proposes an integrated approach that embeds the economic, environmental and social performances in the planning activities of the supply chain (SC). The approach is applied on a realistic case study inspired by the lumber industry where divergent manufacturing processes and various cutting patterns are involved. We first identify the sustainability objectives to be measured. Then, we link these objectives to the SC decision planning. Next, we define performance measures to assess the achievement of each objective. This triptych-based approach is transposed to a multi-objective mathematical programming (MOP) that serves as a performance optimizing and assessing tool. The MOP models a tactical planning problem where the SC is represented as a network of activities. The problem is resolved using the weighted sum method.

11:40-12:00

ThA4.6

[A Decentralized Allocation Algorithm for Distributed Supply Chains with Critical Tasks](#), pp. 192-197

Binetti, Giulio  
Naso, David  
Turchiano, Biagio

Pol. di Bari  
Pol. di Bari  
Pol. di bari

This paper considers the problem of allocating tasks to a network of interconnected nodes in a supply chain, considering functional heterogeneity, resource constraints, and critical tasks whose assignment has to be considered mandatory. The proposed approach is an auction-based algorithm which uses a consensus algorithm to obtain a conflict-free solution fulfilling all the constraints. Numerical simulations and a comparison with a centralized optimization algorithm are performed to evaluate the effectiveness of the proposed approach.

**ThA5**

Aud.52 (ITMO)

**Intelligent Manufacturing Systems** (Regular Session)

Chair: Garetti, Marco  
Co-Chair: Backhouse, Chris J.

Pol. di Milano  
Loughborough Univ.

10:00-10:20

ThA5.1

[Open Automation of Manufacturing Systems through Integration of Ontology and Web Services](#), pp. 198-203

Garetti, Marco  
Fumagalli, Luca  
Lobov, Andrei  
Martinez Lastra, Jose Luis

Pol. di Milano  
Pol. di Milano  
Tampere Univ. of Tech.  
Tampere Univ. of Tech.

The paper illustrates an innovative solution for the control architecture of automated manufacturing systems, based on the integration of the ontology and web-services technologies, which allows an easy configuration, update and expansion of the control system. The result is a fully open environment for the operational control of manufacturing equipment allowing the easy and fast commissioning of new plants, the achievement of a "plug & produce" inclusion of new equipment and the substitution of the traditional control model, based on the hierarchical hardware architecture, with a new one based on a free series of pure software control levels which manage, via a web services communication network, a single-level population of controllers of the various equipment on the shop floor.

10:20-10:40

ThA5.2

[Concept for Context-Aware Manufacturing Dashboard Applications](#), pp. 204-209

Nadoveza, Drazen  
Kiritsis, Dimitris

Ec. Pol. Federale de Lausanne  
EPFL

In today's integrated manufacturing systems where production and logistics dashboards collect and aggregate large amounts of data, finding the right information on time for a given purpose is often a challenge. Since these dashboard systems collect large amounts of information and not all of it is always relevant, the systems have to be able to anticipate which information is important for the appropriate user at a certain time. In order to deliver only relevant information at the right time to its users, systems must be aware of the user and business context. The idea presented in this paper is based on identifying the information relevancy by capturing the manufacturing context of the users which are using the system. This paper discusses the challenges and concepts for context modeling and context interpreting and suggests an infrastructure for the context-aware manufacturing applications.

10:40-11:00

ThA5.3

[A Versatile Agile Agent-Based Infrastructure for Hybrid Production Environments](#), pp. 210-215

Moergestel, Leo van  
Telgen, Daniël  
Puijk, Erik  
Meyer, John-Jules

HU Utrecht Univ. of Applied Sciences  
HU Utrecht Univ. of Applied Sciences  
HU Utrecht Univ. of Applied Sciences  
Utrecht Univ.

To meet the requirements of modern production, where short time to market, production driven by customer requirements and low cost small quantity production are important issues, we have developed an agent-based software infrastructure for agile industrial production. This production is done on special devices called equiplets. A grid of these equiplets connected by a fast network is capable of producing a variety of different products in parallel. The multi-agent-based software infrastructure is responsible for the agile manufacturing. This agent-based model also fits well in a production environment where the production is done by humans instead of equiplets. This is what we call a hybrid production environment.

11:00-11:20

ThA5.4

[A Process-Oriented Risk Assessment Methodology for Manufacturing Processes \(I\)](#), pp. 216-221



SHAH, Liaqat-Ali  
ETIENNE, Alain  
SIADAT, Ali  
Vernadat, François

Arts et Métiers ParisTech Centre Metz  
Arts et Métiers ParisTech Centre Metz  
Arts et Métiers ParisTech  
European Court of Auditors

A process-oriented risk assessment methodology is proposed. Risks involved in a process and the corresponding risk factors are identified through an objectives-oriented risk identification approach and evaluated qualitatively in the Process FMEA. The critical risks of the PFMEA are then incorporated in the process model for further quantitative analysis employing simulation technique. Using the proposed methodology as a decision-making tool, alternative scenarios are developed and evaluated against the developed risk measures. The risk measures values issues out of simulation are normalized and aggregated to form a global risk indicator to rank the alternative processes on the basis of desirability. The methodology is illustrated with a case study issued from parts manufacturing but is applicable to a wide range of other processes.

11:20-11:40

ThA5.5

*Intelligent and Flexible Manufacturing Product Line Supported by Agents and Wireless Sensor and Actuator Network*, pp. 222-227

Freitas, Edison Pignaton

UnB

Müller, Ivan

Federal Univ. of Rio Grande do Sul

Allgayer, Rodrigo

Federal Univ. of Rio Grande do Sul

Pereira, Carlos Eduardo

Federal Univ. of Rio Grande do Sul - UFRGS

Cavalcante, André

Federal Univ. of Manaus

Costa, João Paulo C. Lustosa da

Univ. of Brasilia

Sousa, Rafael Timóteo de

Univ. of Brasilia

Marinho, Marco

Univ. of Brasilia

The demand for highly decentralized control in factory automation is based on the current needs for flexibility and scalability in the production and assembly in product lines. On one hand, intelligent manufacturing systems, presenting holonic and multi-agent based approaches address these needs, providing the necessary decentralization in the manufacturing control. On the other hand, flexibility and scalability are also related to the disposition of the sensors and actuators devices in the factories, and how easily they can be displaced, introduced and reorganized. This second aspect is addressed by diminishing the needs for cabling to connect these devices, which is possible by using wireless connections instead. This paper explores these two aspects, by studying a flexible product line able to assemble different types of products in a production line by means of a multi-agent approach that drives the products through production units composed of a wireless sensor and actuator network, according to the specification of the products to be assembled. The feasibility of this approach is studied in the performed experiments by assessing timing properties of the proposed technique. This implies in how efficient is the combination of the multi-agent based factory control system with a wireless communication infrastructure in terms of timing.

11:40-12:00

ThA5.6

*Systems Thinking for Service Delivery Design: A Real Time Mass Customisation Model*, pp. 228-233

Jaaron, Ayham

Industrial Engineering Department, An-Najah National Univ.

Backhouse, Chris J.

Loughborough Univ.

Recent attempts have been witnessed in service science research to extend principles from mass customisation into the design of service delivery systems. This paper investigates a new form of service operations design, known as systems thinking, by studying its impact on the capability of the service delivery system to provide mass customized services on a real-time basis. Four case studies were conducted in UK private sector service organizations using semi-structured interviews with service directors, team leaders, and operational employees. Data were also supplemented through the means of observations and documents collection. The results indicate that systems thinking approach is an enabler for the delivery of a real-time mass customized services. Seven different factors have been found to affect the real-time mass customization capability of the service system. The value of this paper is the identification of an innovative design for service delivery system that can help companies to provide real-time mass customized services.

**ThA6**

Aud.31 (ITMO)

**Operational Research** (Regular Session)

Chair: Quilliot, Alain

CNRS and Blaise Pascal Univ.

Co-Chair: Yadykin, Igor

V.A. Trapeznikov Inst. of Control Sciences, Russian Acad. of Sciences

10:00-10:20

ThA6.1

*Motion Control of the Six-Legged Walking Robot with Unknown Inertia Matrix*, pp. 234-238

Surov, Maksim

Saint-Petersburg State Univ. of Information Technologies Mec

Pyrkin, Anton

Saint Petersburg National Res. Univ. of Information Tec

Bobtsov, Alexey

Sainr Petersburg National Res. Univ. of ITMO

We propose a new control approach to solve the problem of motion control of six-legged walking robot. Obtained control law does not require knowledge of inertia matrix of the robot. A proof of the asymptotic stability of the robot motion has been provided. To illustrate the effectiveness of the controller a numerical example is shown.

10:20-10:40

ThA6.2

*Packing Unequal Circles*, pp. 239-244

Beasley, J.E.

Brunel Univ. Uxbridge UB8 3PH, UK & JB Consultants, UK

In this paper we present a heuristic algorithm for the problem of packing unequal circles in a fixed size container, the unit circle. We view the problem as being one of scaling the radii of the unequal circles so that they can all be packed into the container. Our algorithm is composed of an optimisation phase and an improvement phase. The optimisation phase is based on the formulation space search method whilst the improvement phase creates a perturbation of the current solution by swapping two circles of similar size. Computational results show improvements over previous work in the literature.

10:40-11:00

ThA6.3

*Dial-A-Ride Problem with Time Windows, Transshipments, and Dynamic Transfer Points*, pp. 245-250

Deleplanque, Samuel  
Quilliot, Alain

LIMOS, UMR CNRS 6158, Bat. ISIMA, Blaise Pascal Univ. - Cle  
CNRS and Blaise Pascal Univ.

Dial-a-ride problems deal with on demand transportation. Today, this type of shared transport is used for elderly and disabled people for short distances. People provide a request for transport from an origin to a destination, both specific for a particular demand. Time constraints deal with maximum user ride time, time windows, maximum route duration limits and precedence. In this paper we try to solve these dial-a-ride problems, including the possibility of one transshipment from a dynamic transfer point by request. We propose an algorithm based on insertion techniques and constraints propagation.

11:00-11:20

ThA6.4

*Scheduling Ship Hull Assembly Using Lagrangian Relaxation Method*, pp. 251-256

Bao, Jinsong  
Xu, Aimin  
Wu, Dianliang

School of Mechanical Engineering, Shanghai Jiao Tong Univ.  
Shanghai Shipbuilding Tech. Res. Inst.  
School of Mechanical Engineering Shanghai JiaoTong Univ.

A new Lagrangian Relaxation approach is developed for the scheduling problem of ship hull assembly in a shipyard. It appears to be the first attempt to schedule parallel machines with arbitrary precedence constraints of tasks, capacity constraints of machines (defined in assembly fat-model) and the situation that some tasks must occupy multiple machines simultaneously. The objective is to minimize the weighted total completion time. A mathematical formulation of the problem is presented firstly. Then the task precedence constraints rather than crane machine capacity constraints are relaxed by Lagrangian relaxation method and the subgradient method is used to solve the Lagrangian dual problem. Finally the results are modified by some heuristic operation. This approach can get a lower bound and a feasible solution. A practical example of container vessel that includes 65 blocks is solved by the proposed approach, and the results show that the Lagrangian relaxation method is able to solve industrial-dimensioned problems within reasonable time and accuracy.

11:20-11:40

ThA6.5

*Innovative Technologies for Operation and Emergency Control in Electric Power Systems of Russia*, pp. 257-262

Yadykin, Igor  
Voropai, Nikolai I  
Efimov, Dmitry

V.A. Trapeznikov Inst. of Control Sciences, Russian Acad.  
Energy Systems Inst.  
Energy Systems Inst.

Operation and emergency control including dispatching and automatic control procedures and devices that provide reliability and survivability of electric power system plays an important role in the control of operating conditions in the Unified Energy System (UES) of Russia. This control system is rather developed and even now has elements of the Smart Grid ideology due to its current adaptability, optimality and intelligence. The authors present current operation and emergency control system in the UES of Russia and suggest a modern approach to monitoring, forecasting and control. Some advanced methods and tools for development of dispatching and automatic control in electric power system are discussed. This work was supported by the grant of Leading Scientific School of the Russian Federation #1507.2012.8.

11:40-12:00

ThA6.6

*Lyapunov-Based Small Signal Analysis for Power Systems of Russia*, pp. 263-268

Yadykin, Igor  
Voropai, Nikolai I  
Efimov, Dmitry

V.A. Trapeznikov Inst. of Control Sciences, Russian Acad.  
Energy Systems Inst.  
Energy Systems Inst.

A new mathematical general approach has been suggested to get a power systems small signals analysis by computing gramians spectral expansion in time and frequency domains. The gramians expansions are bilinear and quadratic forms for sequences of Faddeev matrices, generated by resolvents of the original matrices in the Lyapunov equation. New tool for assessment of order power system stability in small signals have been suggested. It is shown, that Frobenius norm of the system gramian may be considered as an index of vicinity of the power system to stability boundary in small signals.

**ThA7**

Aud.61 (ITMO)

**Discrete Event Systems in Manufacturing (Regular Session)**

Chair: Bright, Glen  
Co-Chair: Lefebvre, Dimitri

Univ. of KwaZulu Natal  
Univ. Le Havre

10:00-10:20

ThA7.1

*Manufacturing Flow Control Using Biased Minimum Feedback*, pp. 269-274

Walker, Anthony John  
Bright, Glen

Univ. of KwaZulu-Natal  
Univ. of KwaZulu Natal

Manufacturing flow control aims to adjust execution sequencing of a finite number of job types entering a manufacturing system, so as to stabilise work-in-process (WIP) and increase performance, under consideration of periodic non-negligible setup changes. This paper presents an event driven flow control formalism in which the setup scheduling problem is collapsed onto a finite automata termed

Biased Minimum Feedback (BMF). BMF is shown to have distinct operating modes under various job arrival sequence correlations. A simulation study on the control of a flexible manufacturing cell uncovers work-in-process levels which optimise setup frequency and downstream assembly performance under high-variety production operations.

10:20-10:40 ThA7.2

*Local Modular Control with Distinguishers Applied to a Manufacturing System*, pp. 275-280

Teixeira, Marcelo	Univ. Federal de Santa Catarina
Cury, Jose E. R.	Univ. Fed. S. Catarina
de Queiroz, Max H.	Univ. Federal de Santa Catarina

Local Modular Control (LMC) is a decentralized method to synthesize supervisors for Discrete Event Systems (DES) and distinguishers define a design-oriented concept that allows to simplify specifications modeling. When associated with approximations, distinguishers can also reduce synthesis effort. In this paper, we show how to combine advantages from LMC, distinguishers and approximations, to solve DES control problems. The approach preserves controllability, nonblocking and least restrictiveness of supervisors, while providing important computational gains. Our contributions are applied to the control of a manufacturing system with material feedback.

10:40-11:00 ThA7.3

*About Regulation and Disturbance Rejection for Partially Controlled ContPNs*, pp. 281-286

leclercq, edouard	Univ. du Havre
Lefebvre, Dimitri	Univ. Le Havre

This article concerns control design for partially controlled timed continuous Petri nets under infinite server semantics and constant bounded input control actions. Domains of stationary markings and of their corresponding control actions are computed. Linear matrix inequalities and linear programming problems are used for that purpose. Then, disturbance rejection in the neighborhood of the stationary markings is also investigated

11:00-11:20 ThA7.4

*An Algorithm of Linear Complexity for the Diagnosis of Discrete Event Systems*, pp. 287-292

Lefebvre, Dimitri	Univ. Le Havre
-------------------	----------------

This paper concerns fault detection and diagnosis for discrete event systems modeled with partially observed Petri nets. The proposed method provides a decision via the analysis of observation sequences that include some observable events and the partial measurement of the successive states visited by the system. To this end, the observation sequences are decomposed into elementary observation sequences, linear matrix inequalities are used to compute the firing sequences consistent with each elementary observation sequence and an algorithm of linear complexity with respect to the length of the observation sequences is proposed to return on-line diagnosis decisions.

11:20-11:40 ThA7.5

*Flight Rescheduling Problem Induced by Air Traffic Network Capacity Constraints Based on the Binary Decision Diagram Approach*, pp. 293-300

KAMMOUN, MOHAMED ALI	PAUL VERLAINE
----------------------	---------------

The exponential growth in air traffic and unplanned events on the day of flight schedules such as adverse weather conditions led to initial flight disruptions. In this paper, we propose a decision support framework for flight rescheduling in air traffic management based on ground delay, changing the initial flight 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 a class of Time Petri Nets. This tool, called Time Reduced Ordered Binary Decision Diagram (T-ROBDD) 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 to generate all the rescheduling flights plans taking into account the temporal and spatial constraints.

11:40-12:00 ThA7.6

*Design of RFID-Enabled Aircraft Reverse Logistics Network Simulation*, pp. 301-306

Awasthi, Anjali	Concordia Univ.
Adetiloye, Kehinde	Concordia Univ.
Hammad, Amin	Concordia Univ.

The reverse logistics (RL) of aircrafts poses a big challenge to its owners due to the complexity of its RL network, and the inherit problems of realizing a reliable system for efficiently monitoring and tracking the numerous parts of end-of-life (EOL) aircrafts in the RL network. Radio frequency identification (RFID) technology, through its automatic and wireless data capture capability, offers great potential for counteracting this problem. Widespread and cost-effective, traditional barcode systems, unlike RFID technology, requires manual scanning and line-of-sight for its use. In this research, we perform simulated studies of barcode tags, used at case-level, and passive tags used at item-level, case-level and pallet-level in the EOL aircraft RL network in order to comparatively analyze the Return-On-Investment (ROI) of RFID technology relative to bar-coding.

**ThA8** Aud.42 (ITMO)

**Modeling, Simulation, Control and Monitoring of Manufacturing Processes - 1 (Regular Session)**

Chair: Lototsky, Vladimir	V.A. Trapeznikov Inst. of Control Sciences
Co-Chair: Zacharewicz, Gregory	Lab. IMS-LAPS UMR CNRS 5218

10:00-10:20 ThA8.1

*Transforming Hierarchical Concepts of GRAFCET into a Suitable Petri Net Formalism*, pp. 307-312

Schumacher, Frank	Helmut-Schmidt-Univ. Hamburg
-------------------	------------------------------

GRAPhe Fonctionnel de Commande Etape Transition (GRAF CET) is a powerful graphical means for the specification of controllers in discrete event systems and an international standard since 1988. GRAFCET contributes to a more structural and model driven approach in the design of logic controllers but still lacks an exhaustive formal definition. As a step towards an exhaustive formal model of GRAFCET, some ambiguities of the standard's definitions have to be discussed with regard to means of hierarchical structuring, namely enclosing and forcing. Based on this discussion, the authors propose an extension of a formal model for GRAFCET as a control interpreted Petri net (CIPN).

---

10:20-10:40

ThA8.2

*Structure Based Derived Uniform Formula for Siphon, Its Complementary Set and T-Characteristic Vectors*, pp. 313-318

Chao, D. Y.

National Cheng Chi Univ.

Pan, Yen-Liang

Air Force Acad.

Liao, Wei-Hsiang

CAFA

Unmarked siphons in a Petri net modeling concurrent systems such as those in cloud computing induce deadlocks. The number of siphons grows exponentially with the size of a net. This problem can be relieved by computing compound (or strongly dependent) siphons based on basic siphons. A basic (resp. compound) siphon can be synthesized from an elementary (resp. compound called alternating) resource circuit. It however cannot be extended to cases where two elementary circuits intersect at a directed path rather than a single place (i.e., corresponding to a weakly dependent siphon). This paper develops a uniform formula not only for both cases but also valid for the complementary set of siphon and characteristic vectors. We further propose to generalize it to a compound siphon consisting of  $n$  basic siphons. This helps simplify the computation and the computer implementation to shorten the program size. Also, the formula is easier to be memorized without consulting the references due to the same underlying physics.

---

10:40-11:00

ThA8.3

*G-DEVS Model of Bottling Involved in a Interoperable Simulation (I)*, pp. 319-324

Zacharewicz, Gregory

Lab. IMS-LAPS UMR CNRS 5218

Giambiasi, Norbert

Univ. PaulC'ezanne, Aix-Marseille III.

This paper is introducing an example of G-DEVS model that represents a conveyor belt tank and valve to fill bottles. The idea is to introduce the G-DEVS concepts and to show the accuracy gain obtained by using G-DEVS instead of other classical discrete event modelling techniques. Then the paper opens these models to interoperability with other components in the supply chain with the possibility to compose different model format at simulation time. The distributed simulation and the HLA standard are used to support interoperability of the models and simulators.

---

11:00-11:20

ThA8.4

*A Knowledge Engineering Methodology for Resource Monitoring in the Industrial Domain*, pp. 325-330

Abele, Lisa

Tech. Univ. München

Hansen, Thorbjørn

Siemens AG

Kleinsteuber, Martin

Tech. Univ. München

In industrial production, the efficient use of resources is becoming increasingly important due to the rising prices of resources and ecological awareness. A resource monitoring system can observe the individual resource consumption of the devices in an industrial plant to detect excessive resource consumption while considering context information such as the process steps or varying energy costs. A systematic approach for the semantic integration of relevant information is a key requirement to infer reliable monitoring states of the devices. Recent research explores how future industrial plants may use decentralized autonomous devices. To integrate such autonomous devices in a monitoring system, semantic models are required that describe the devices and their data, thus we need knowledge-based approaches. To date, the research on knowledge-based systems in the industrial domain has tended to focus on application-specific solutions rather than on generic solutions that integrate knowledge of multiple sources. In this paper, we introduce a knowledge-engineering methodology to build a generic, reusable resource monitoring system for industrial plants which includes multiple knowledge sources. This approach can also be used to develop knowledge-based systems for other applications such as diagnostic or prognostic systems.

---

11:20-11:40

ThA8.5

*Fundamentals of Design and Operation of Manufacturing Executive Systems (MES) in Large Plants*, pp. 331-336

Itskovich, Emmanuil

V.A. Trapeznikov Inst. of Control Sciences

This paper addresses fundamentals of designing, building and operating manufacturing executive systems for large-scale plants, or enterprises. It formulates requirements to MES design, properties and support by the enterprise's services.

---

11:40-12:00

ThA8.6

*Hybrid Predictive Control for Building Climate Control and Energy Optimization*, pp. 337-342

Tejeda, Gabriel

Pontificia Univ. Católica de Chile

Estrada Samayoa, Fernando José

Pontificia Univ. Católica de Chile

Cipriano, Aldo

Pontificia Univ. Católica de Chile

The growing world's energy use and energy prices have raised a concern about the efficiency of energy management systems, energy resources and environmental impacts. In developed countries, buildings are accredited for 40% of the global energy consumption, being the heating and cooling system one of the main causes of it; as the growth of population, comfort levels and services are directly related to thermal systems. For this reason we present a Hybrid Model Predictive Control (HMPC) strategy to control all rooms of a building apartment in a centralized manner. This approach decreases energy consumption, maintaining comfort levels in an acceptable range, and showing that MPC control solutions can be substituted by more complex controls (as HMPC) to manage building thermal systems

ThA9	Aud.32 (ITMO)
<b>Enterprise-Related Methods, Models and Services</b> (Invited Session)	
Chair: Taratoukhine, Victor	Univ. of Münster
Co-Chair: Wagner, Ulf	Chemnitz Univ. of Tech.
10:00-10:20	ThA9.1
<i>A Model of Critical Success Factors for Software-As-A-Service Adoption (I)</i> , pp. 343-348	
Chowanetz, Maximilian	Univ. of Würzburg
Pfarr, Florian	Univ. of Wuerzburg
Winkelmann, Axel	Univ. of Wuerzburg
<p>Cloud Computing and Software as a Service (SaaS) are gaining increased attention by researchers and practitioners alike. In spite of its obvious relevance and potentials for increasing IT flexibility and reducing costs, significant concerns still exist on the side of potential users. Against this background, the paper at hand aims to collect empirical evidence about the specific reasons why decision makers may still be reluctant towards Cloud-based SaaS solutions. Drawing from these results, a model is developed that synthesizes the main success factors (security, privacy, compliance, flexibility and SLAs) along five dimensions. The paper closes with an assessment of practical implications and challenges for future research.</p>	
10:20-10:40	ThA9.2
<i>Investigation of Optimal Resource Allocation by Heuristic Combination Rules (I)</i> , pp. 349-352	
Stogniy, Igor	TU-Dresden
Taratoukhine, Victor	Univ. of Münster
Kabitzsch, Klaus	Dresden Univ. of Tech.
Fedotova, Alena	Bauman Moscow State Tech. Univ.
<p>The development of computer-aided systems (such as CAD/CAM/CAE, ERP, MES, SCADA) and mathematical methods (methods of operational research, genetic algorithms, and heuristics methods) allow to solve complex planning problems. In particular to solve problems of enterprise resource planning. The article focuses on the one of the actual tasks in enterprise resource planning – the optimal resource allocation. Heuristics methods is considered as a basis method for solving task. The article describes the approach and experimental results.</p>	
10:40-11:00	ThA9.3
<i>Cloud-Based Engineering Design and Manufacturing: State of the Art (I)</i> , pp. 353-358	
Tarchinskaya, Ekaterina	Univ. of Munster
Taratoukhine, Victor	Univ. of Münster
Matzner, Martin	Univ. of Munster
<p>Cloud-based technologies proliferated in the past few years, while the manufacturing industry moved towards digitization and network. Therefore, cloud-based technologies have been adopted in the development of new generation manufacturing systems which orchestrate different activities, including product design, process and task planning, production, customer service, etc. These new cloud-ingrained technologies have the potential to change the collaboration of product development partners, the processing and sharing of information as well as utilization rates of critical equipment. Cloud-based technologies affect many aspects of manufacturing activities, and they therefore have the power to enable new or change existing business models of the manufacturing industry. Based on the literature review, this paper analyzes the latest requirements, challenges, and trends of the manufacturing industry. It structures the findings in the coherent manner and further hypothesizes how cloud computing may address identified requirements and challenges as well as realize or support new concepts in manufacturing.</p>	
11:00-11:20	ThA9.4
<i>Implementation of Constraints Satisfaction Problems Methods for Solving the Periodic Maintenance Processes Scheduling (I)</i> , pp. 359-364	
Fedotova, Alena	Bauman Moscow State Tech. Univ.
Ovsyannikov, Michail	BMSTU
Taratoukhine, Victor	Univ. of Münster
<p>This paper reviews existing methods and techniques addressing the problem of maintenance support throughout the life cycle for high value manufacturing products. As part of this doctorate research the analysis of current methods of maintenance planning was conducted. In order to contribute to a more comprehensive solution, an advanced approach (algorithm) of periodic maintenance is presented. The authors believe that this approach will reduce the cost of maintenance of high value manufacturing products. The algorithm based on constraint programming methods is briefly presented and the future research directions are discussed.</p>	
11:20-11:40	ThA9.5
<i>Goal-Resource Networks and Their Application to Agents Communication and Co-Ordination in Virtual Enterprises (I)</i> , pp. 365-370	
Dyundyukov, Vladislav	Bauman Moscow State Tech. Univ.
Tarassov, Valery	Bauman Moscow State Tech. Univ.
<p>The concept of 3rd generation ERP system is discussed. In this context a goal-resource network is introduced to take into account agents types while exchanging resources. Primarily, main reasons and properties of agent communications, as well as basic prerequisites of multi-agent systems formation are stated. Key resource definitions, classifications and properties are discussed. A new classification of agent types based on theirs capacities to generate individual and joint goals is suggested. It underlies the introduced definition of Goal-Resource Network (GRN) that extends Kuznetsov's Resource Network (RN). Some basic versions of goal-resource links between agents are studied. Two theorems about GRN limit states are demonstrated. An example of applying multi-agent</p>	

approach and GRN to solve the problem of agents co-ordination in virtual enterprises is given.

11:40-12:00

ThA9.6

*Optimization of Engineering Processes in Factory Planning*, pp. 371-376

Wagner, Ulf	Chemnitz Univ. of Tech.
Oehme, Daniel	Chemnitz Univ. of Tech.
Riedel, Ralph	Chemnitz Univ. of Tech.
Müller, Egon	Chemnitz Univ. of Tech.

Currently, social media software is being widely used for many fields but not yet in factory planning and specifically for cooperative planning and realization of production systems. Motivated by the growing potential of factory planning and the need to eliminate shortcomings within communication and cooperation during planning and realization of production systems, this paper describes a procedure and a prototype for supporting communication, collaboration and knowledge management in factory planning projects. This procedure was developed in cooperation with the factory planners of Chemnitz UT and the software specialists of the community4you GmbH. The procedure is comprised of a reference model and building blocks for planning assignments that can be later on used for different planning projects and planning cases. Thus, the existing technical procedure for factory planning will be extended, in this case, by adding a procedure for cooperation and communication. A prototype is developed, following the guidelines of the mentioned procedure, and the building blocks are transferred to software modules.

ThB1

Aud.11 (ITMO)

**Supply Planning under Uncertainties** (Invited Session)

Chair: HNAIEN, Faicel	UTT,
Co-Chair: Riezebos, Jan	Univ. of Groningen

13:20-13:40

ThB1.1

*Supply Planning and Inventory Control under Lead Time Uncertainty: A Review*, pp. 377-388

Ben Ammar, Oussama	École Nationale Supérieure des Mines de Saint Étienne
Dolgui, Alexandre	Ec. Nationale Supérieure des Mines de Saint-Etienne
Hnaïen, Faicel	Univ. of Tech. of Troyes
Ould Louly, Aly Mohamed	King Saud Univ.

In literature, most papers examine stochastic demand processes where order lead times are constant. In reality, lead time is rarely constant; unpredictable events in the supply system cause unpredictable delays. It is true that in certain special cases, lead time uncertainty has essentially no effect and can be ignored. Nevertheless more often, lead time fluctuations strongly degrade performance, just as demand uncertainty does. Seemingly, lead time uncertainty has been neglected for a long time in favor of studying demand uncertainties. Industry agrees that it is overdue and there is a need to rectify this oversight. Nowadays, this gap in research activity begins to be filled in order to respond to companies having non-deterministic lead-times constraints. This paper reviews some of existing literature of supply planning under uncertainty of lead times. A classification scheme for supply planning under uncertainty is defined.

14:00-14:20

ThB1.3

*Predictive Production Planning in an Integrated Pulp and Paper Mill (I)*, pp. 389-394

Figueira, Gonçalo	INESC-TEC, Faculdade de Engenharia, Univ. do Porto
Furlan, Marcos	ICMC - Univ. de São Paulo
Almada-Lobo, Bernardo	INESC-TEC, Faculdade de Engenharia, Univ. do Porto

Disturbance Management is a major issue in process industries like the pulp and paper (P&P) industry. In this paper, a case study in an integrated P&P mill is examined. Production plans for the whole mill need not only to be optimized concerning company's indicators, but also to be robust so that disturbances can be avoided. We present a simulation-optimization approach that generates plans, correctly weighting their quality (regarding various indicators) and robustness. A discrete-event simulation model replicates the dynamics of implementation and adaptation of production plans in practice. The simulation model gives then feedback to optimization, in order to enhance the analytical model, which is thus able to generate robust plans.

14:20-14:40

ThB1.4

*Analysis Method of the Relations between MRP Parameter and Performance Indicator Based on a Literature Review (I)*, pp. 395-400

DAMAND, David	Humanis, EM Strasbourg
BEN AMMAR, Oussama	École Nationale Supérieure des Mines de Saint Étienne
LEPORI, Elvia	Humanis, EM Strasbourg
BARTH, Marc	Humanis, EM Strasbourg

Since the 1970s, extensive research has been conducted to improve the performance of MRP systems (Material Requirement Planning). We identified 86 papers in this domain. These papers examine the influence of configuration on performance measurement indicators in defined operating and instability conditions. These studies, in principle, provide production planners with a decision-making aid. The initial objective of this paper is to measure and characterize the accumulated knowledge in the 86 papers identified. The potential generalization of the knowledge gained is subsequently discussed. We propose a method of analysis of this knowledge.

14:40-15:00

ThB1.5

*Integration of Additional Purchase Cost to Reduce the Lead Time Uncertainty for One Level Assembly System (I)*, pp. 401-406

HNAIEN, Faicel  
Afsar, Murat  
Dolgui, Alexandre

UTT,  
Univ. of Tech. of Troyes  
Ec. Nationale Supérieure des Mines de Saint-Etienne

We consider the supply planning for one level assembly system under uncertainty of lead times. The finished product need several components for the assembly operation. The lead times can be uncertain for different reasons such as machine breakdowns, transport delay, strike, etc. In literature, this type of problem was studied in the case of random lead times that follow continuous distributions as well as in the case of any discrete laws with known distribution. We consider the case of discrete distributions to be closer to the industrial reality because often in real life situations the lead time is expressed as the number of periods. Typically, this is an inventory control problem where the objective is to minimize the component holding and backlog costs for the finished product due to the uncertainty of lead times. Indeed, as the finished product is assembled by using several types of components, the assembly is stopped even if a single type of component is delayed. The other components are stored between their arrival and the arrival of the latest component. To reduce stock and backlog costs, we propose to pay the supplier more, if he/she agrees to decrease his lead time uncertainty. A model describing this choice is suggested.

15:00-15:20

ThB1.6

*Mathematical Model for Supply Planning of Multi-Level Assembly Systems with Stochastic Lead Times (I)*, pp. 407-412

BEN AMMAR, Oussama  
Marian, Hélène  
Wu, Dash  
Dolgui, Alexandre

École Nationale Supérieure des Mines de Saint Étienne  
École Nationale Supérieure des Mines de Saint Étienne  
Univ. of Toronto  
Ec. Nationale Supérieure des Mines de Saint-Etienne

The deal for industrial companies is to satisfy their customers with the best quality, the most reliable lead times, and the lowest costs. One of the keys to achieve it is in the inventory control in the Supply Chain. Moreover, it is mandatory to possess necessary components in order to produce the requested products by the due date. But, as the components lead time is an unpredictable parameter, it is difficult to take it into account correctly. In this paper we deal with this question considering that each component has a fixed unit inventory cost; the finished product has an inventory cost and a backlogging cost per unit of time. Then, a general mathematical model for supply planning of multi-level assembly system is presented to calculate the expected value of the total cost which equals to the sum of the inventory holding costs for the components, the backlogging and the inventory holding costs for the finished product. The aim is to propose tools to adapt and parameterize the MRP method under lead time uncertainty.

**ThB2**

Oak Hall (ITMO)

**Reverse Supply Chains - 2 (Invited Session)**

Chair: Dejax, Pierre  
Co-Chair: Gupta, Surendra M.

Ec. des Mines de Nantes / IRCCyN  
Northeastern Univ.

13:20-13:40

ThB2.1

*Queueing Modeling of Material Sorting Disassembly System with Overflows (I)*, pp. 413-418

Yamada, Tetsuo  
Hariadi, Rizka Aisha Rahmi  
Tsuchiya, Shota

The Univ. of Electro-Communications  
Bandung Inst. of Tech.  
The Univ. of Electro-Communications

This study focuses on a material sorting disassembly system with overflows for recycling, and models it using queueing analysis to measure quantitatively the productivity and effectiveness by their design parameter such as arrival rate at system, service rate and the number of buffers at each station, and the number of the disassembly stations. The material sorting system has multiple and different disassembly stations and one sorting station, and the arriving units to each station are inevitably overflowed when the finite capacity of buffers is full because conveyors are often used as a material handling for large and heavy End-of-Life products.

13:40-14:00

ThB2.2

*Analytical Modelling and Control of a Hybrid Manufacturing/remanufacturing System (I)*, pp. 419-424

Kouedeu, Annie  
Kenné, Jean-Pierre  
Dejax, Pierre  
Songmene, Victor  
Polotski, Vladimir

Ec. de Tech. Supérieure  
École de Tech. Supérieure  
Ec. des Mines de Nantes / IRCCyN  
Ec. de Tech. Supérieure  
Ec. de Tech. Supérieure

A production system consisting of parallel machines deteriorating with the production dependent failure rates of the machine is investigated in this paper and extended within the framework of a manufacturing/remanufacturing system within a closed loop reverse logistics system. The machines produce one type of final products. The demand rate for the final commodity is constant and unmet demand is backlogged. The goal is to find the production rates of both machines so as to minimize a long term average expected cost which includes backlogging as well as inventory costs. In the proposed model, the main machine (characterized by a higher production rate) is more robust than the second machine. The failure rate of the main machine depends on its production rate, while the failure rate of the second machine is constant. This paper proposes a stochastic dynamic programming formulation of the problem and derives the optimal production policies numerically. A simulation example is included, and sensitivity analyses with respect to the system parameters are examined to illustrate the effectiveness of the proposed methodology.

14:00-14:20

ThB2.3

*L-Shaped Algorithm for Stochastic Disassembly Line Balancing Problem (I)*, pp. 425-429

Bentaha, Mohand Lounes  
Battaïa, Olga  
Dolgui, Alexandre

Ec. des Mines de Saint-Etienne  
Ec. des Mines de Saint-Etienne  
Ec. Nationale Supérieure des Mines de Saint-Etienne

Disassembly Line Balancing Problem considered here both chooses the best disassembly alternative for an end of life product and assigns the corresponding disassembly tasks to the workstations of the line with the aim to reduce the line cost. Precedence and cycle time constraints are observed. Task times are assumed stochastic with known normal probability distributions. The line cost includes the investment and operation costs for workstations as well as penalty costs generated by the cycle time constraints violations. To deal with uncertainties, a stochastic linear mixed integer formulation is developed. To solve efficiently the problem, L-shaped algorithm combined with Latin Hypercube Sampling is proposed.

14:20-14:40

ThB2.4

*Inventory Placement Optimisation in Complex Supply Chains*, pp. 430-435

HAMMAMI, Ramzi

ESC Rennes School of Business

Frein, Yannick

Grenoble INP

We propose an inventory placement model for general multi-echelon supply chains where manufacturing facilities have finite capacities and both input and output items are considered in every facility. Holding inventories is motivated by the necessity of satisfying the customer lead time constraints.

14:40-15:00

ThB2.5

*Comparing Inventory Policies for Closed-Loop Supply Chain Using Simulation-Based Optimization*, pp. 436-441

godichaud, matthieu

Univ. de Tech. de Troyes UTT

Amodeo, Lionel

UTT

Sustainable development principles lead to new challenges for supply chains management. To cope with these new challenges, one of the answers is to develop new activities related to reverse logistic which aim at recovered product from customer to valorization facilities (disassembly, recycling, remanufacturing ...). These activities contribute to reduce use of new materials and negative impact of end-of-life products but they also generate more complex information and material flows. In this context, inventory control of return product and new product is a critical issue. New inventory control policies have to be developed to manage both return and new product supply. In this paper, a supply chain model based on simulation and multi-objective optimization is proposed to determine best control policies and their parameters for multi-echelon closed-loop supply chain.

15:00-15:20

ThB2.6

*Benefits and Limitations of the SCOR Model in Warehousing*, pp. 442-447

LEPORI, Elvia

Humanis, EM Strasbourg

DAMAND, David

Humanis, EM Strasbourg

BARTH, Marc

Humanis, EM Strasbourg

In the Supply Chain, the flows of goods are the result of exchanges between two major parties: the manufacturer / industrial company / supplier on the one hand and the distributor / customer on the

other. There are many intermediaries between these two parties who, depending on the nature of the service provided, can be classified as 3PL (Third-Party Logistics provider) or 4PL (4th-Party Logistics Provider). This paper focuses on the 3PL provider. A 3PL provider is a logistic services provider of the Supply Chain responsible for implementing all or part of their customers' logistics. This form of subcontracting concerns warehouse management and transport activities as well as all associated services such as co-packing. The objective of subcontracting is to improve the performance of the logistical process. Modelling and evaluating the performance of these processes helps improve the performance of the Supply Chain. SCOR model (Supply Chain Operations Reference), proposed by the Supply Chain Council, gives a modelling and an evaluation of the performance in Supply Chain. In the context of 3PL, the objective of this paper is to identify the benefits and limitations of the SCOR. The study is illustrated by a distribution warehouse case in an international logistic services provider.

**ThB3**

Aud.41 (ITMO)

**Scheduling and Optimization** (Regular Session)

Chair: Sarin, Subhash

Virginia Tech.

Co-Chair: DUPONT, Lionel

Ec. des Mines d'Albi-Carmaux

13:20-13:40

ThB3.1

*Scheduling Tasks with Comb Precedence Constraints on Dedicated Machines*, pp. 448-453

Nicosia, Gaia

Univ. Roma Tre

Pacifici, Andrea

Univ. di Roma "Tor Vergata"

A set of nonpreemptive tasks are to be scheduled on dedicated machines in order to minimize the overall makespan. Precedence constraints among the tasks, deterministic processing times and processing machine of each task are given. We present lower bounds of the minimum makespan and heuristic algorithms for two relevant cases in manufacturing applications, namely when the precedence constraints form a "comb" or a "caterpillar". Promising preliminary computational tests are also reported proving the efficiency and effectiveness of the proposed solution algorithm.

13:40-14:00

ThB3.2

*A Genetic Algorithm for Hybrid Flowshop Problem with Mixed Blocking Constraints*, pp. 454-459

Trabelsi, Wajdi

LGIPM / Univ. of Lorraine ; INRIA Nancy Grand Est

Sauvey, Christophe

Paul Verlaine Univ. of Metz - France

Sauer, Nathalie

Paul Verlaine Univ. of Metz - France / INRIA Grand Est- COS

This paper deals with makespan minimization in hybrid flowshop scheduling problems where mixed blocking constraints are considered. This flexible production system can be encountered in some industrial environments where number of machines at each



stage may be more than one and buffer capacities between successive stages may be unlimited or null.

After a problem description and different blocking constraints definitions, a classical genetic algorithm is proposed for solving these flowshop problems. Originality stands in evaluation function, developed to take into account both hybrid and mixed blocking constraints problems. Experimental results confirm the accuracy of developed method and evaluation function.

14:00-14:20

ThB3.3

*A Multi-Start Procedure for the Minimum Latency Problem*, pp. 460-465

Angel-Bello, Francisco

Tecnológico de Monterrey

Alvarez, Ada

Univ. Autónoma de Nuevo León, Graduated Program in System

Garcia, Irma

Univ. Autónoma de Coahuila

In this paper we address a minimum latency problem and propose a multi-start strategy for solving it. For constructing initial solutions two procedures are designed, which are based on metaheuristic GRASP. We also develop a post-processing procedure based on Path Relinking to improve the obtained solutions. We carry up an extensive experimentation with 225 symmetrical instances to evaluate our procedures. In addition, using instances from literature, we compare our best procedure with previously reported methods, showing that the proposed procedure outperforms them in terms of solution quality and in elapsed CPU time to reach the solution.

14:20-14:40

ThB3.4

*Generalized Covering Location Problem with Multiple-Coverage: Exact and Heuristic Method*, pp. 466-471

DUPONT, Lionel

Ec. des Mines d'Albi-Carmaux

LAURAS, Matthieu

Centre de Génie Industriel, Mines d'Albi

Yugma, Claude

Ec. des Mines de Saint Etienne

This paper considers some extensions of the basic covering set location problem. The purpose of the covering set location models is to select a set of facilities (public facilities, antennas, etc.) to be implemented in order to satisfy all or a part of the demand of a given area. A facility has a constant coverage radius  $R$  and a demand node is covered, if it is within distance  $R$  of an established facility. We introduce an original model, in which we take into account: (i) the costs incurred to establish a facility, (ii) the costs incurred if a demand node is not covered, (iii) the cost or gain incurred if a demand node is covered by more than one facility. We introduce some properties of an optimal solution and derive heuristic algorithms and a branch and bound method from these properties. We illustrate this approach with numerical examples.

14:40-15:00

ThB3.5

*Two-Stage, Multiple-Lot, Lot Streaming Problem for a 1 + 2 Hybrid Flow Shop*, pp. 472-477

Sarin, Subhash

Virginia Tech.

Cheng, Ming

Virginia Tech.

In this paper, we address a multiple-lot lot streaming problem for a two-stage hybrid flow shop, which consists of one machine at Stage 1 and two parallel (identical) machines at Stage 2. Each item of a lot requires for its processing only one of the machines at Stage 2 after its processing at Stage 1. A lot can be split into sublots where the items in a subplot are processed together. The problem is to determine an optimal sequence in which to process the lots, number of sublots for each lot, subplot sizes, and the allocation of sublots to the machines at the second stage so as to minimize two objectives: makespan, and the sum of the completion times of all the lots. We exploit some basic results derived for the single-lot problem in order to develop mathematical programming-based heuristic methods for the solution of both problem instances. Our computational investigation reveals the efficacy of these methods.

15:00-15:20

ThB3.6

*Development of Intelligent Decision Support System Based on Unified Concept for Distributed Manufacturing Planning*, pp. 478-483

Minhas, Sarfraz UI Haque

Chair of Automation Tech. Brandenburg Univ. of Tech.

Juzek, Christian

BTU Cottbus

Berger, Ulrich

Brandenburg Univ. of Tech. Cottbus

Lehmann, Christian

Brandenburg Univ. of Tech. Chair of Automation Tech.

The optimization processes in production planning often encounter problems due to unavailability of skilled workers in the concerned production departments since the decisions made in uncertain situations rely mainly on the knowledge possessed by the relevant planners. This paper further presents and elaborates the unified web-based knowledge based decision support system concept to automate and reuse implicit knowledge generated during interaction with the dedicated software tools as well as during interaction with real hardware setups in an industrial environment. The unified concept has been devised considering two pilot cases i.e. decision making on eco-efficient decentralized production schemes for manufacturing customized products and decision support for solving problems in ramp-up management process. This paper further discusses the development issues concerning web-based knowledge based decision support system to demonstrate the unified concept. The software modules from both pilot cases are validated considering two pilot cases.

**ThB4**

Aud.51 (ITMO)

**Facility Planning and Warehousing** (Regular Session)

Chair: Nagi, Rakesh

Univ. at Buffalo (SUNY)

Co-Chair: Rozin, Boris

United Inst. of Informatics Problems

13:20-13:40

ThB4.1

*Optimal Placement of a Finite-Size Facility: A Computational Study of Sequential and Parallel Implementations*, pp. 484-489

Nagi, Rakesh

Univ. at Buffalo (SUNY)

We present a computational study related to the optimal placement of a single, finite-size, rectangular facility in presence of other rectangular facilities. All the facilities interact with each other through the input/output points located on their boundary. The objective is to locate the new facility optimally so as to minimize the total weighted rectilinear distance between the interacting facilities. We explore two different solution procedures: (1) a parallel explicit enumeration procedure using message passing interface (MPI); and (2) the sequential dominance procedure. We test both procedures on randomly generated layouts and compare the benefits of parallelization versus the dominance rules.

13:40-14:00

ThB4.2

*Designing Public Storage Warehouses with High Demand for Revenue Maximization*, pp. 490-494

Gong, Yeming

EMLYON Business School

Our research question is to design public storage facilities to meet varying market demand in an environment of high demand, with an objective of revenue maximization when considering price factors. Considering the influence of price, this paper presents a stochastic design optimization model, which is embedded with demand models. We conduct numerical experiments, and show the optimization model can significantly improve the expected revenue of public storage warehouses with high demand.

14:00-14:20

ThB4.3

*MILP Formulations for the Order Batching Problem in Low-Level Picker-To-Part Warehouse Systems*, pp. 495-500

ONCAN, TEMEL

GALATASARAY Univ.

CAGIRICI, MERVE

ETI PAZARLAMA ve SANAYII AS

In this work we introduce Mixed Integer Linear Programming (MILP) formulations for the Order Batching Problem considering traversal and return routing policies. The proposed MILP formulations have been tested on randomly generated instances and compared with the well-known savings algorithm. According to our extensive computational experiments we can say that the proposed MILP formulations are quite useful to yield good upper bounds and hence, they can be used for benchmarking purposes.

14:20-14:40

ThB4.4

*Planning Flow of Material and Energy for Photovoltaics Industry*, pp. 501-506

Horbach, Sebastian

Chemnitz Univ. of Tech.

Schaarschmidt, Frank

Chemnitz Univ. of Tech.

Schulze, Robin

Chemnitz Univ. of Tech.

Ackermann, Jörg

Chemnitz Univ. of Tech.

Müller, Egon

Chemnitz Univ. of Tech.

Due to the continuously increasing need for renewable energy, the demand for photovoltaic components is significantly growing. Therefore, many highly productive factories for solar cells will be built in the coming years. The development of tools and methods for rapid planning of state of the art and highly automated production facilities for photovoltaic equipment is the objective of the Saxon PV Automation Cluster (S-PAC). So far the focus of factory planning was strongly on discrete part manufacturing while in contrast the production of solar panels involves a lot of chemical processes with different by-products, even though the final output is discrete parts. Hence, it is investigated how methods and tools of discrete manufacturing still can be applied to photovoltaic industry or where adaptations are necessary. From a methodical point of view the Flow System Theory, comprising material, energy, information, value and personnel flow, as well as Component-based Planning, considering planning process and object components, will be in the focus. While in the past the emphasis was on the optimisation of the material flow, the significance of the energy flow is increasing. The realisation of the information flow requires appropriate tool support. The base of the tool support is provided by the concept of the Net Planning Assistant with the Production Database as central storage component. The Production Data Model as foundation for the Production Database has to be adapted to the differing object domain. A reference database of typical objects of photovoltaic cell, wafer and module production is developed as a basis for datasets of particular projects. Models for visualisation and simulation of the photovoltaic objects are connected to the data model. Interfaces to the Manufacturing Execution System (MES) and the quality management system need to be defined.

14:40-15:00

ThB4.5

*Study of the Transferability of Properties Used for Designing Production Systems Layouts to Distribution Warehouse Layout Design*, pp. 507-512

LEPORI, Elvia

Humanis, EM Strasbourg

HERR, Nathalie

FEMTO-ST Inst.

DAMAND, David

Humanis, EM Strasbourg

BARTH, Marc

Humanis, EM Strasbourg

The performance of distribution warehouses plays an important role in the global performance of any Supply Chain. Logistic services providers need to plan the layout evolution of the physical system they manage to adapt to their customers' requests. A clear, global and detailed vision of logistic activities is therefore necessary. A considerable amount of research has been conducted on the design of production systems. This article proposes a study of the transferability of certain production system design properties to distribution warehouse design.

15:00-15:20

ThB4.6

*A Hybrid Genetic Algorithm for Solving Machine Layout Problem with Consideration of Industrial Constraints*, pp. 513-518

Manita, Ghaith

ESSECT Tunis

KORBAA, Ouajdi

ISITCom Hammam Sousse, MARS Unit

This paper focuses on loop layout problem in flexible manufacturing systems using one load and unload machine. The objective of this problem is to determine the ordering of machines around a loop, to minimize the total cost of transporting parts within each

manufacturing cell. The novelty of this study lies on the reformulation of the problem while taking into account new variables generally neglected by recent researches like proximity constraints and machine dimensions. Hence, we aim to place these machines on a grid that represents the surface of the cell, in order to construct a loop layout while respecting proximity constraints. And as objective, we try to minimize the total cost of transporting parts within each manufacturing cell. This new formulation led us to propose a two-stage approach to solve this problem. The first step consists in positioning the machines on a grid while respecting the proximity constraints and machines dimensions. The second step aims to optimize the path between these machines already positioned in order to minimize number of the loops travelled by parts. In this paper, we are interested in the second step. To solve this problem, we use genetic algorithms. This choice is motivated by the well-known efficiency of genetic algorithms to solve quadratic assignment problems. Hence, we proposed three hybrid genetic algorithms. The effectiveness of our approaches is demonstrated through numerical examples.

<b>ThB5</b>	Aud.52 (ITMO)
<b>Stochastic Models (Regular Session)</b>	

Chair: Gershwin, Stanley	Massachusetts Inst. of Tech.
Co-Chair: Amodeo, Lionel	UTT

13:20-13:40	ThB5.1
-------------	--------

*Solving the Problems of Inspection Planning under Parametric Uncertainty of Underlying Models*, pp. 519-524

Nechval, Nicholas	Univ. of Latvia
-------------------	-----------------

Certain fatigued structures must be inspected in order to detect fatigue damages that would otherwise not be apparent. A technique for obtaining optimal inspection strategies is proposed for situations where it is difficult to quantify the costs associated with inspections and undetected failure. For fatigued structures for which failures (fatigue damages) are only detected at the time of inspection, it is important to be able to determine the optimal times of inspection. Fewer inspections will lead to lower fatigue reliability of the structure upon demand, and frequent inspection will lead to higher cost. When there is a fatigue reliability requirement, the problem is usually to develop an inspection strategy that meets the reliability requirements. It is assumed that only the functional form of the underlying invariant distribution of time-to-failure is specified, but some or all of its parameters are unspecified. The invariant embedding technique proposed in this paper allows one to construct an optimal inspection strategy under parametric uncertainty. This strategy represents a sequence of inspection times satisfying the specific criterion, which takes into account the predetermined value of the conditional fatigue reliability of the structure. The numerical examples are given.

13:40-14:00	ThB5.2
-------------	--------

*Risk Analysis in Project Early Phase Taking into Account the Product Lifecycle: Towards a Generic Risk Typology for Bidding Process*, pp. 525-530

Botero Lopez, Juan Diego	Ec. Nationale d'ingénieurs de Tarbes ENIT - Univ.
Béler, Cédric	Lab. Génie de Production / INP-ENIT - Univ. ofToulou
Noyes, daniel	école nationale d'ingénieurs de tarbes

During the project early phase, considering a bidding process (BP), a client makes a request for a work or service to potential providers and then he chooses, by analyzing the responses, the one that will be accepted. From the bidder point of view, there are several risks when responding because he must develop a response based on a future development. Different in nature, these risks can be grouped into different categories. We propose a risk typology throughout the product lifecycle on which we rely to assist the bidder during BP via a methodology for decision support, based on the experience acquired during past projects in order to detect, report and minimize the risks in current BP.

Keywords: bidding process (BP), risk analysis, product lifecycle, project management, lessons learned system (LLS).

14:00-14:20	ThB5.3
-------------	--------

*Performance Analysis of Serial Production Lines with Deteriorating Product Quality*, pp. 531-536

Naebulharam, Raed	Univ. of Wisconsin-Milwaukee
Zhang, Liang	Univ. of Wisconsin-Milwaukee

In manufacturing systems with perishable products (e.g., food, metal processing, etc.), the quality of a part is highly dependent on its residence time within the system. However, behavior and properties of these systems have not been studied systematically, and, therefore, is carried out in this paper. Specially, we assume that the probability that each unished part is of good quality is a decreasing function of its residence time in the preceding buer. Then, in the framework of serial production lines with machines having Bernoulli reliability model, we derive closed-form formulas for performance evaluation in the two-machine line case, and develop an aggregation-based procedure to approximate the performance measures in  $M > 2$ -machine lines. In addition, we study monotonicity properties of these production lines using numerical experiments. Finally, a case study in an automotive stamping plant is discussed.

14:20-14:40	ThB5.4
-------------	--------

*An Optimal Production Planning and Maintenance Policy for a Multiple-Product and Single Machine under Failure Rate Dependency*, pp. 537-542

Mifdal, Lahcen	LGIPM-Lorraine Univ. Metz
Hajej, Zied	Univ. de Metz
Dellagi, Sofiene	Univ. de Metz
REZG, Nidhal	Metz Univ.

This paper addresses the production and maintenance problem of multiple-product manufacturing system satisfying several random demands corresponding to every product. The goal of this study is to establish an economical production planning followed by an optimal maintenance strategy, taking into account the influence of the multiple-product production rate on the materiel degradation. Analytical models are developed in order to minimize sequentially the production/holding costs and the total maintenance cost. A numerical example is presented to prove the developed approach.

---

14:40-15:00 ThB5.5

*Optimal Production Planning for a Manufacturing System: An Approach Based on PA*, pp. 543-548

TURKI, sadok  
Hajej, Zied  
REZG, Nidhal

Univ. de Lorraine  
Univ. de Metz  
Metz Univ.

In this paper, a manufacturing system composed by a single-product machine, a buffer and a stochastic demand is considered. A discrete flow model is adopted to describe the system and to take into account the lost demands. The objective of this paper is to determine the optimal production planning taken into account service level. This optimal production planning minimizing the sum of production, inventory, and lost sales costs. Perturbation analysis method is used for optimizing the proposed system. Using the discrete flow model, the trajectories of production rate, buffer level and lost demands are studied and the perturbation analysis estimators are evaluated. These estimators are shown to be unbiased and then they are implanted in an optimization algorithm which determines the optimal production planning in the presence of service level.

---

15:00-15:20 ThB5.6

*Analysis and Optimization of a Single-Item Production System with Lead Time under General Periodic Review Inventory Policy*, pp. 549-554

Nakade, Koichi

Nagoya Inst. of Tech.

In this paper, a single-product inventory system with a general periodic review policy is considered on a discrete time. The number of products in inventory is reviewed periodically with a positive integer time interval, and new products are ordered under base stock policy. The amounts of demand are mutually independent and identically distributed with a general distribution. There is integer production lead time, which may not be a multiple of the order interval. Zhang and Zhang (2007) derived an expression for the fill-rate of the demand. In this paper, we derive an expression for the average inventory and backlogs theoretically. We also consider an optimization problem for determining the optimal amount of base stock to minimize the long-time average inventory holding and backlog costs. An algorithm for deriving the optimal value is developed by using reverse Laplace transforms. The number of base stocks for minimizing the average cost is also compared with the one satisfying the required fill rate.

---

**ThB6** Aud.31 (ITMO)  
**Theory and Applications of Ahp and Anp for Decision Making in Manufacturing Systems - 1 (Invited Session)**

Chair: Pecchia, Leandro  
Co-Chair: Petrillo, Antonella

Univ. of Nottingham  
Univ. of Cassino

---

13:20-13:40 ThB6.1

*Analytic Hierarchy Process to Support the Safety and Ergonomic Assessment of Alternatives in "manuable" Material Handling (I)*, pp. 555-560

Rossi, Diana  
Bertoloni, Enrico  
Fenaroli, Marco  
Marciano, Filippo  
Alberti, Marco

Dipartimento di Ingegneria Meccanica e Industriale, Univ. d  
Dipartimento di Ingegneria Meccanica e Industriale, Univ. d  
Dipartimento di Ingegneria Meccanica e Industriale, Univ. d  
Dipartimento di Ingegneria Meccanica e Industriale, Univ. d  
Dipartimento di Ingegneria Meccanica e Industriale, Univ. d

This paper has two objectives: to describe a multi-criteria ergonomic approach for choosing the best alternative for "manuable" material handling, and to show the application of this methodology to a case study. In this paper, the authors use the single-word term "manuable" to refer to the definition "can be performed manually". The case study results validated the approach and indicated that the use of the manipulator tested may be ergonomically preferable to manual material handling in situations in which the handled weight is large (20 kg) and when the weight of the load is low (5 kg), albeit slightly.

---

13:40-14:00 ThB6.2

*AHP and ANP As Particular Cases of Markov Chains (I)*, pp. 561-566

Stavrovsky, Evgueny  
Krasilnikova, Marina  
Pryadko, Sergey

Gazprom Promgaz Company  
Inst. VNIIPromgaz  
Russian State Univ. of oil and gas

The models and methods of AHP/ANP analysis are considered. It is shown that AHP/ANP models are the particular cases of finite Markov chains, i.e. discrete random processes with Markov property. Applying models, methods and algorithms of Markov chains theory will stimulate the progress in researches on multicriteria decision making problems and its application in various spheres and particularly in investment planning and management. A new approach to sensitivity analysis in intervals of uncertainty of data is proposed.

---

14:00-14:20 ThB6.3

*Proposal of a Multi Criteria Approach for a Sustainable Management Model of Electrical and Electronic Equipment (I)*, pp. 567-572

De Felice, Fabio  
Petrillo, Antonella  
Autorino, Claudio

Univ. of Cassino and Southern Lazio  
Univ. of Cassino  
Univ. of Naples Parthenope

Electrical and Electronic Equipment (EEE) is developing fast and spreading over every part of modern life. This equipment includes diverse substances that may cause serious damage to the environment and have adverse effects on human health so it is essential to manage the waste (WEEE) resulting from EEE properly. The present paper proposes a multicriteria approach based on the Analytic Hierarchy Process, a useful method for the measurement of intangible criteria along with tangible ones through ratio scales, in order to

improve WEEE management. In fact, a proper WEEE management system is difficult because it is based on a lot of criteria so AHP represents the strategic solution. The AHP model presented is based on the analysis of design, collection, treatment and recovery phases that may affect a successful implementation of a model for improving the environmental sustainability of WEEE.

14:20-14:40 ThB6.4

*Decision Making on Smart Grids Projects Moving Using AHP Method: The Case of Algerian Network (I)*, pp. 573-578

Iberraken, Fairouz Univ. of Bejaia  
 Medjoudj, Rabah Univ. of Bejaia  
 Aïssani, Djamil, aissani Univ. of Béjaia

This paper critically examines the effects of the integration of smart systems in preventing cascading degradation of electrical networks, their economic aspects in the insertion of the production of renewable energy to transmission and distribution networks. It investigates their effects on the monitoring of changes in operating conditions considering the continuity of service and power quality. We also developed a process for aiding the managers of networks in developing countries to choose the best scenario from a large sample highlighted by experiences of USA and by some emerging and some European countries. An application is made for the Algerian case, a country which moves to renewable energy and Smart Grids development. It is adapting AHP method, considering some pertinent criteria such as energy efficiency, renewable energy development and protection of the environment.

14:40-15:00 ThB6.5

*Analysis of Complex Decisional Situations in Companies with the Support of AHP Extension of Vroom-Yetton Contingency Model (I)*, pp. 579-584

Mls, Karel Univ. of Hradec Kralove  
 Otcenaskova, Tereza Univ. of Hradec Kralove

Decision-making processes are crucial for individuals, groups, and organisations to gain and sustain the competitive advantage. The choice of the most appropriate decision style remains the very complex issue. Weaknesses of the original Vroom-Yetton contingency model, referring to the validity and reliability of the model were addressed by fuzzy decision trees or expert systems utilization. In AHP approach to decision making, priorities of alternatives are derived objectively after subjective judgments are made. In practical part, three individual decision making personalities on four different situational cases are exemplified to compare recommendations provided by the contingency tree with subjective preferences of decision makers in AHP model.

15:00-15:20 ThB6.6

*Interactive Management Control Via Analytic Hierarchy Process (AHP). an Empirical Study in a Public University Hospital (I)*, pp. 585-590

Pecchia, Leandro Univ. of Nottingham

Management control in public university hospitals is a challenging task because of continuous changes due to external pressures (e.g. economic pressures, stakeholder focuses and scientific progress) and internal complexities (top management turnover, shared leadership, technological evolution, and researcher oriented mission). Interactive budgeting contributed to improving vertical and horizontal communication between hospital and stakeholders and between different organizational levels. This paper describes an application of Analytic Hierarchy Process (AHP) to enhance interactive budgeting in one of the biggest public university hospital in Italy. AHP improved budget allocation facilitating elicitation and formalization of units' needs. Furthermore, AHP facilitated vertical communication among manager and stakeholders, as it allowed multilevel hierarchical representation of hospital needs, and horizontal communication among staff of the same hospital, as it allowed units' need prioritization and standardization, with a scientific multi-criteria approach, without using complex mathematics. Finally, AHP allowed traceability of a complex decision making processes (as budget allocation), this aspect being of paramount importance in public sectors, where managers are called to respond to many different stakeholders about their choices.

**ThB7** Aud.61 (ITMO)

**Information Systems and Mass Customization (Regular Session)**

Chair: Wortmann, Hans Univ. of Groningen  
 Co-Chair: Poulin, Marc Zayed Univ.

13:20-13:40 ThB7.1

*Modelling the E-Business Requirements of Manufacturing Organisations*, pp. 591-596

Kochhar, Ashok Kumar Aston Univ.  
 Dilworth, John Ageus Systems Consultants Limited

This paper describes a model designed to recommend solutions to an organisation's e-business needs. It is designed to produce objective results based on perceived characteristics, unbiased by prejudice on the part of the person using the model. The model also includes a way of encapsulating the potential management concerns that may change for good or ill the likely relevance and probability of success of such solutions. The model has been tested on 13 case studies in small, medium and large organizations.

13:40-14:00 ThB7.2

*Modelling Collaborative-Driven Supply Chains: The ComVantage Method*, pp. 597-602

Buchmann, Robert Univ. of Vienna, Faculty of Computer Science  
 Karagiannis, Dimitris Univ. of Vienna, Faculty of Computer Science, Knowledge Eng

The paper gives a design view on the first version of the ComVantage modelling method, aimed to support the design and analysis of supply chains that are collaborative, product-centric, process-driven and mapped on IT systems which rely on mobile apps and Linked Data resources. The specification is the result of the conceptualization phase, in the context of a metamodelling specification framework comprising a modelling language, a modelling procedure and a set of mechanisms to be implemented in a modelling tool. The aim is to bridge the business-IT gap and to support modelling activities in the Future Internet Enterprise supply chains on multiple

abstraction and detail levels, and also to facilitate their alignment to domain-specific frameworks such as SCOR or VRM.

14:00-14:20

ThB7.3

*ICT and Business Alignment in Partner Network: Will the Alignment Depend on Maturities?*, pp. 603-608

Kangilaski, Taivo

Tallinn Univ. of Tech.

Effective Business/IT (BIT) alignment enables business organization to use information technology to achieve business objective more easily. In case of Partner Networks (PN), it appears through improved marketplace competitiveness, for certain organization through improved financial performance. In real world, there is always a gap between IT, business people and different companies belonging into PN, as the employees in the companies have differences in objectives, culture, mutual ignorance of others' knowledge etc. The result is a situation where cooperation in some extent is not so effective in PN as it was initially planned and which will influence the improvements in business value. The current article contributes to the BIT alignment in PN, analyzing if PN maturities influence the BIT alignment.

14:20-14:40

ThB7.4

*A Modeling Approach towards an Extended Product Data Model for Sustainable Mass-Customized Products*, pp. 609-613

Osorio, Joycer

Tecnológico de Monterrey

Romero, David

Tecnológico de Monterrey, Campus Ciudad de México

Molina, Arturo

Tecnologico de Monterrey

This paper presents an extension of a generic Product Data Model (PDM) to Mass-Customization (MC) and Sustainability (S) paradigms with the aim to fulfill the requirements to support a Sustainable Mass-Customized (S-MC) product design process. The extended PDM (ePDM) is focused on a product's Bill of Materials (BOM), which gathers the main information related to a product and its specifications in terms of its design and manufacturing processes. Therefore, the ePDM developed and presented in this research work is capable to provide either product components/parts, product sustainability and product mass-customization related information in order to support the design of S-MC products.

14:40-15:00

ThB7.5

*Product Modelling for Simulating Business Networks Offering Mass Customization*, pp. 614-619

Poulin, Marc

Zayed Univ.

Montreuil, Benoit

Faculté des sciences de l'administration, Univ. Laval

In the past decade, mass customization has shown to be one of the effective business models in developed economies. Key success factors include modularization and standardization of product platforms, production postponement strategies, and customer interaction. A major challenge is how to implement the success factors and design a suitable business network. One approach is to simulate the performance of a business network with the input of detailed mass customization orders. This paper presents a simulation-based methodology to configure a mass customization network. The contribution of the paper focuses on the approach to create product models that include personalization details, the generation of demand profiles, and the creation of generic process routings for mass customized products. The paper uses examples from the golf club industry to illustrate the methodology.

15:00-15:20

ThB7.6

*Incorporating Text in Enterprise Information Systems*, pp. 620-625

Ittoo, Ashwin

RuG

Wortmann, Hans

Univ. of Groningen

Enterprise Information Systems (EIS), the core ICT backbone of organizations, are based on structured data, which are stored in relational databases. These databases may contain text fields as attributes of objects, but lack functionalities to analyze text data. As a result, the considerable amount of valuable texts that is contained in enterprise systems' database cannot be exploited to enrich corporate activities and processes. At the same time, Natural Language Processing (NLP) techniques have been developed to analyze texts from other sources, such as emails and social media. However, these techniques fail to leverage upon the high quality additional information that is inherent in the structure or schema of the EIS database in order to improve their performance. In this paper, we reconcile the seemingly dichotomous worlds of EIS and NLP. We posit that our approach allows to enrich and incorporate text in enterprise systems.

**ThB8**

Aud.42 (ITMO)

**Artificial Intelligence and Machine Learning Approaches** (Regular Session)

Chair: Grabot, Bernard

ENIT France

Co-Chair: Bobtsov, Alexey

Sainr Petersburg National Res. Univ. of ITMO

13:20-13:40

ThB8.1

*Smart and Green Adaptive Cruise Control for an Electric Vehicle: First Results*, pp. 626-631

Potarusov, Roman

IFSTTAR

nouveliere, lydie

Lab. des Systemes Complexes

Orfila, Olivier

IFSTTAR

Glaser, Sébastien

INRETS-LCPC

This paper concerns the development of the Smart and Green Adaptive Cruise Control aiming at controlling the ego vehicle speed taking into account the road data in order to optimize the energy consumption while improving safety (no collision, under the legal speed, up to the safe headway). A graph search algorithm of Dijkstra is used to build up a velocity pattern offering the best compromise between energy consumed and covered time.

13:40-14:00

ThB8.2

*A Novel Training Algorithm for Artificial Hydrocarbon Networks Using an Energy Model of Covalent Bonds*, pp. 632-638

Ponce, Pedro  
Molina, Arturo  
Ponce, Hiram

ITESM-CCM  
Tecnologico de Monterrey  
ITESM-CCM

Computational algorithms for modeling problems are widely used in control engineering systems. Several algorithms for modeling systems are proposed in literature. However, they have some drawbacks like stability of algorithms and absence of information inside the model acting as black boxes. Recently, a novel technique called artificial hydrocarbon networks (AHNs) was proposed to improve the latter drawbacks in computational algorithms; but there is no training algorithm that specifies how to build the structure and tune all parameters involved on it. Thus, this paper introduces a new training algorithm for AHNs using an energy model of covalent bonds inspired on organic chemistry observations. Results report that this training algorithm can be used for designing the structure of AHNs while obtaining the parameter values, both at the same time.

14:00-14:20

ThB8.3

*Control Approaches for Complicated Self-Unstable Plants with Applications for Two-Wheel Mobile System*, pp. 639-643

Bobtsov, Alexey  
Borgul, Alexandr  
Zimenko, Konstantin  
Pyrkin, Anton

Sainr Petersburg National Res. Univ. of ITMO  
St. Petersburg National Res. Univ. of ITMO  
St. Petersburg National Res. Univ. of ITMO  
Saint Petersburg National Res. Univ. of Information Tec

In this paper a model of autonomous mobile robot Motobot is described. There is the model of two-wheeled motorbike. The mathematical model of motion of two-wheeled single-track robot on the horizontal flat is analyzed and the automatic control algorithms are designed. Problem can be solved by controlling the steering wheel and the speed of the driving wheel.

14:20-14:40

ThB8.4

*Human-Machine Interface for Mechatronic Devices Control*, pp. 644-648

Bobtsov, Alexey  
Borgul, Alexandr

Sainr Petersburg National Res. Univ. of ITMO  
St. Petersburg National Res. Univ. of ITMO

This article presents a system of intuitive control of any mechatronic devices with EMG and EEG. It can be used both as in rehabilitation devices and in manufacturing as a human-machine interface. The technology allows to control device mentally. Various identification methods for control signals like neural networks, wavelet analysis, fastICA, Fourier series are given. Algorithms were tested on real objects and simulator.

14:40-15:00

ThB8.5

*A New AR Interaction for Collaborative E-Maintenance System*, pp. 649-654

Zenati, nadia

Centre de Developpement des Tech. Avancées

This paper describes a prototype of a collaborative e-maintenance system based on distributed Augmented Reality (AR). This technology is implemented to support specific assistance for users, which consists of providing all the information known as augmentation such as 3D virtual models and instructions required to perform tasks. The distributed aspect of this system will allow the remote collaboration between a distant expert and a local user equipped with a wearable computer. Two main aspects are studied and developed. The first aspect addresses a new collaboration strategy based on Service Oriented Architecture (SOA). The second aspect ensures the virtual objects transfer from the remote expert in real time. Experimental results are presented

15:00-15:20

ThB8.6

*Improving Maintenance Strategies from Experience Feedback*, pp. 655-660

Potes Ruiz, Paula  
Kamsu-Foguem, Bernard  
Grabot, Bernard

Lab. Génie de Production / INP-ENIT - Univ. de Toulou  
Lab. Génie de Production / ENIT  
ENIT France

A huge amount of rough data is available in companies on past maintenance activities as a result of the implementation of CMMS (Computerized Maintenance Management System). In that context, we focus on an experience feedback system dedicated to maintenance, allowing the capitalization of past interventions by means of a formal knowledge representation language, and the extraction from these interventions of new knowledge for future reuse.

**ThB9**

Aud.32 (ITMO)

**Computer Modeling and Simulation of Complex Technical and Manufacturing Systems - 1 (Invited Session)**

Chair: Senichenkov, Yuri Borisovitch  
Co-Chair: Korytkowski, Przemyslaw

Saint Petersburg State Pol. Univ.  
West Pomeranian Univ. of Tech. in Szczecin

13:20-13:40

ThB9.1

*Management Risks Integrated Modelling with Regards to Complex Organizational and Technical Systems (I)*, pp. 661-666

Sokolov, Boris  
Yusupov, Rafael Midhatovich  
Merkuryev, Yuri  
Potryasaev, Semyon

SPIIRAS  
Inst. of the Russian Acad. of Sciences St.PetersburgInst  
Riga Tech. Univ.  
St.Petersburg Inst. for Informatics and Automation of the Ru

Different approaches of determination and formalization for uncertainty and risk factors are studied. Concept of risk integrated modelling and corresponding structure of choice are described. This concept is based on mathematical structuring and functorcategory description. Proposed methodology and techniques were implemented in the area of active mobile objects automatic control system.

---

13:40-14:00 ThB9.2

*Cloud Technology in Simulation Studies: GPSS Cloud Project (I)*, pp. 667-671

Vlasov, Stanislav Russian Acad. of Sciences  
Deviatkov, Vladimir Elina-Computers Ltd.  
Devyatkov, Timur Elina - Computer, Ltd

New editor is designed for simulation professionals that use GPSS. Principles and cloud system building peculiarities on simulation studies automation (SSAS) are defined. Cloud (SSAS) architecture and mathematical presentation based on GPSS World is described. Project result applications are presented.

---

14:00-14:20 ThB9.3

*Dynamic Business Process Management Based on the Combined Control and Data Networks (I)*, pp. 672-677

Yatsutko, Aleksandra Inst. of Control Sciences  
Vykhovanets, Valeriy Intitute of Control Science

The approach for dynamic business process management, based on the use of graphical notation with the combined control and data networks, is considered. Due to the explicit instructions of the data stream it is possible to overcome the automatic semantic gap that arises between the graphical and executable model of business processes. This leads to an increase in the quality control of production and technological processes in enterprises.

---

14:20-14:40 ThB9.4

*Application of Decision Support System BPsim.DSS to Logistical Processes of Fuel Transportation Company (I)*, pp. 678-682

Aksyonov, Konstantin Ural Federal Univ. named after the first President of Russi  
Bykov, Eugene Ural Federal Univ.  
Smoliy, Elena Ural Federal Univ.  
Aksyonova, Olga Ural Federal Univ.  
Nevolina, Alena Ural Federal Univ.

The paper describes deployment experience of a decision support system for planning fuel supplies within a network of gas stations, which is based on simulation, multi-agent and expert modeling. Authors focus on various methods used in decision support system BPsim.DSS. Mainly the system is used by logistical management and planning departments. The system implement such features as forecasting next day fuel sales, searching for effective fuel supply plan, planning trips for each fuel tanker. Simulation model estimates fuel sales. Planning is implemented in BPsim.MSN on the basis of logical output visual machine, based on UML diagrams and T-SQL language scripts. Testing results prove effectiveness of decisions: sales volume can be increased by optimizing usage of fuel tankers.

---

14:40-15:00 ThB9.5

*A System for Computer Simulation of Technological Processes (I)*, pp. 683-688

Rudometov, Sergey Design Tech. Inst. of Digital Tech. of Siberian  
Okolnishnikov, Victor Design Tech. Inst. of Digital Tech. of Siberian

In the paper a system for computer simulation of technological processes, named MTSS is described. The paper contains a brief description of the system and its characteristics, in comparison to analogous commonly used systems. Also there is a description of existing and perspective applications for this simulation system that proves its usability and reliability

---

15:00-15:20 ThB9.6

*Planning and Bottleneck Analysis of Construction Enterprise Project Portfolio (I)*, pp. 689-693

Aksyonov, Konstantin Ural Federal Univ. named after the first President of Russi  
Bykov, Eugene Ural Federal Univ.  
Smoliy, Elena Ural Federal Univ.  
Aksyonova, Olga Ural Federal Univ.  
Wang, Kai Ural Federal Univ.

The paper dives into a set of tasks that emerge when planning activities of a corporation, involved into construction of multiple objects. This task is referred to as the problem of project portfolio. Problem of planning construction works and its software implementation are solved with aid of integration of multi-agent modeling and critical path method.

---

**ThC1** Aud.11 (ITMO)  
**Automotive Manufacturing & Supply Chain Management - 2 (Invited Session)**

Chair: Poler, Raul Univ. Pol. de Valencia  
Co-Chair: Meerkov, Semyon M. Univ. of Michigan

---

16:00-16:20 ThC1.1

*A Sustainable Order Quantity Model under Uncertain Product Demand (I)*, pp. 694-699

Digiesi, Salvatore Pol. of Bari  
Mossa, Giorgio Pol. di Bari  
Mummolo, Giovanni Pol. of Bari

The Economic Order Quantity (EOQ) model is one of the most known classical continuous review inventory model based on the trade-off between holding and order costs. In actual logistic systems, transport costs play a key role, and in case of stochastic



variability of product demand and/or supply lead time, a safety stock is required. Transport and safety stock costs affect the solution of the lot size problem. Recently, wide attention is being paid to sustainable manufacturing and in particular on negative effects of transport. Transports are the main source of air pollutant emissions in EU and are expected to increase in magnitude in the future. Costs evaluations of transport emissions are defined in EU documents based on Kyoto protocol. When transport environmental costs are considered in the logistic cost function a new lot-sizing problem can be defined. In [1], the Sustainable Order Quantity (SOQ) analytical model is proposed aiming at identifying optimal lot-size and transport means which minimize the logistic and environmental costs in case of a deterministic product demand. In this paper, the authors propose an SOQ model in case of stochastic variability of product demand. Analytical model solutions rely on sustainable (in terms of both logistic and environmental costs) order size, transport means and safety stocks. Results obtained in a full case study from automotive supply chain case study are presented.

---

16:20-16:40

ThC1.2

*Standardized Information Exchange in Automotive Distribution Processes (I)*, pp. 700-705

Werthmann, Dirk	BIBA – Bremer Inst. für Produktion und Logistik GmbH
Brandwein, Dennis	BIBA – Bremer Inst. für Produktion und Logistik GmbH
Ruthenbeck, Carmen	BIBA – Bremer Inst. für Produktion und Logistik GmbH
Scholz-Reiter, Bernd	Univ. of Bremen

Managing automotive supply chains becomes even more challenging, because vehicles are getting more complex and customers and production plants spread all over the world. To cope with this, the RAN – RFID-based Automotive Network project has developed a standardized platform for information exchange. Thus it is possible to develop and implement software systems to improve supply chains by realizing better process control. How vehicle distribution can benefit from better information exchange as well as better information processing and supply is described in this paper.

---

16:40-17:00

ThC1.3

*Production Lead Time Problem: Formulation and Solution for Bernoulli Serial Lines (I)*, pp. 706-711

Meerkov, Semyon M.	Univ. of Michigan
Yan, Chao-Bo	Univ. of Michigan

This paper is intended to formulate the so-called production lead time problem, which is the problem of throughput optimization under a constraint on production lead time. A solution is provided for serial lines with Bernoulli machines and infinite buffers. Specifically, analytical formulas are derived for raw material release rates, which guarantee the desired lead time, while maximizing the throughput. Based on this solution, a method for selecting design parameters of kanban- and CONWIP-controlled systems, which ensure the desired lead time, is provided.

---

17:00-17:20

ThC1.4

*Supply Chain Management As the Company Engine in Automotive Manufacturing (I)*, pp. 712-717

Ferriols, Francisco J.	Univ. Pol. de València
Mula, Josefa	Univ. Pol. de València
Díaz-Madroño, Manuel	Univ. Pol. de València

The objective of this paper is to define how to create a supply chain management (SCM) organizational structure with roles and responsibilities in a multinational company with a big part of the supply chain inside of the company. SCM means having under control the complete supply chain to decide the global optimal instead of summing up the optimal of each node independently. We propose, based on the systems thinking concept, how to develop an organizational structure where the SCM acts as the engine of the organization. There must be a strategy to create this structure starting from the bottom to the top of an organization. An illustration example is given in a first tier supplier of an automotive supply chain.

---

17:20-17:40

ThC1.5

*Enhancing Enterprise Resilience through Enterprise Collaboration (I)*, pp. 718-723

Andres, Beatriz	Univ. Pol. de València
Poler, Raul	Univ. Pol. de Valencia

Current environments, characterised by turbulent changes and unforeseen events, consider resilience as a decisive aspect for enterprises to create advantages over less adaptive competitors. Furthermore, the consideration of establishing collaborative processes among partners of the same network is a key issue to help enterprises to deal with changeable environments. In this paper both concepts, resilience and collaborative processes establishment, are associated in order to help organisations to handle disruptive events. The research objective is to identify collaborative processes whose positive influences assist enterprises against disruptions, reducing the effects of disturbances in dynamic environments.

---

17:40-18:00

ThC1.6

*Analysis of Order Promising Process in BTF Products with High Variability and Long Manufacturing Lead Times Application to a Machine-Tool Manufacturer (I)*, pp. 724-729

Saiz, Eduardo	IK4-IKERLAN
Castellano, Eduardo	IK4-IKERLAN
Besga, Juan Manuel	IK4-IKERLAN
Sanchis, Raquel	Univ. Pol. de Valencia

This paper analyzes issues involved in the negotiation process between customers and companies to reach an agreement on the features, price and delivery of the final product to be. In particular, it is focused on products with high potential for customization and long Manufacturing Lead Times (MLT) which are manufactured to forecast (BTF – Built To Forecast) due to response times demanded by the market are shorter than MLT, as in the case of a machine tool manufacturer used in the study. Alternatives offered to the customer such as substitute or reconfigured products are considered trying to meet Market Response Times (MRT). Through the combined use of simulation and experiment design techniques, different customer and company behaviours during negotiation are evaluated considering several assumptions of Product Variability (PV) and MRT. As a result of the study, effects of each variable

analyzed on delivery times of customer orders are presented.

18:00-18:20

ThC1.7

*Definition of a Framework to Support Strategic Decisions to Improve Enterprise Resilience (I)*, pp. 730-735

Sanchis, Raquel

Univ. Pol. de Valencia

Poler, Raul

Univ. Pol. de Valencia

Enterprise resilience is a complex concept that involves different properties and research areas. Based on the literature review, three main properties related to enterprise resilience have been identified: vulnerability, adaptative capacity and recovery ability. On the other hand, an analysis of the current literature approaches to measure and assess enterprise resilience has been described. However, approaches that assess and measure simultaneously the three main properties of enterprise resilience have not been found. To bridge this gap, the paper presents the definition of a conceptual framework to support strategic decisions related to enterprise resilience by defining the main research areas of the identified enterprise resilience properties to provide the basis for further research.

**ThC2**

Oak Hall (ITMO)

**Coordinated Logistics and Supply Chain Optimization (Invited Session)**

Chair: Ivanov, Dmitry

Berlin School of Ec. and Law

Co-Chair: Jiang, Zhibin

Shanghai Jiao Tong Univ.

16:00-16:20

ThC2.1

*Dynamic Service Selection at Runtime for Service Supply Chain (I)*, pp. 736-741

Huang, Shuangxi

Tsinghua Univ.

Fan, Yushun

Tsinghua Univ.

Su, Wei

Tsinghua

Xi, Yu

Tsinghua

Most of the research on service selection treat the quality of service (QoS) as deterministic quantities and only consider the optimization of service supply chain at design time. However, the stochastic nature of services and the dynamic execution of service supply chain are unavoidable. The paper explicitly takes into account the QoS-related uncertainty. Based on the four execution structures of service supply chain, the dynamic Quality-of-Service (QoS) aware selection problem is formulated as a Stochastic Linear Programming (SLP) model. Based on Expected Value Model, the branch and bound algorithm can be used to find the optimal solution for service supply chain at runtime. Compared with the current methods in which the QoS measures are deterministic and the services are selected on the fly, the proposed approach is novelty and can support the optimal execution of service supply chain effectively.

16:20-16:40

ThC2.2

*Optimal Scheduling Policies for a Production Service System with Two Items (I)*, pp. 742-747

Wang, Kangzhou

Shanghai Jiao Tong Univ.

Jiang, Zhibin

Shanghai Jiao Tong Univ.

Xie, Wenming

Shanghai Jiao Tong Univ.

In this paper, we address the capacity allocation rules for a flexible production service system consisting of one flexible manufacturing facility and one service centre. The manufacturing facility produces two items in the first stage and the service centre serves two customers in the second stage. Each order served by the service centre depletes one unit of dedicated item produced by the manufacturing facility. The manager must make production and service capacity allocation decisions. The objective is to find an effective production and service scheduling rule to minimize the expected total cost over an infinite horizon. The service capacity allocation problem is formulated as a Markov decision process and use this formulation to characterize the structure of the optimal service allocation policy. We show that the optimal service scheduling policy is an extension of the well-known optimal service scheduling policy for classical service system. Then the characteristics of the optimal production policy are studied numerically since the analytic characteristics are not available.

16:40-17:00

ThC2.3

*A Contribution to the Reentrant Flow-Shop Scheduling Problem (I)*, pp. 748-753

Hinze, Richard

Tech. Univ. Dresden

Sackmann, Dirk

Hochschule Merseburg

Buscher, Udo

Tech. Univ. Dresden

Aust, Gerhard

Tech. Univ. Dresden

This paper considers a flow-shop scheduling problem which is characterized by reentrants and aims on the minimization of makespan. Reentrants are events of a repeated processing of a specific job on a machine, which can occur due to, e.g., quality reasons. In the following, we focus on missing operations which did not receive adequate attention in the literature so far. After describing different types of reentrants, a specific level formulation is given in order to cope with processing times equal to zero in an appropriate way. Finally, we perform first computational tests with different problem sizes and compare our results with an already existing formulation with respect to solution quality and computation times. Our main results are as follows: (i) it turns out that our formulation is well suitable when zero processing times occur, as we derive better objective values for makespan; (ii) however, longer computation times have to be accepted compared to traditional formulations; (iii) the computation times are mainly influenced by the total number of jobs.

17:00-17:20

ThC2.4

*A Procedural Framework for Hybrid Decentralized Decision Problem Solving (I)*, pp. 754-759

Schönberger, Jörn

Univ. of Bremen

Kopfer, Herbert

Univ. of Bremen

Mathematics, Operations Research, Computer Sciences and Artificial Intelligence have contributed ideas and techniques to solve

decision models since the middle of the last century. Recently, an enforced trend towards the integration of different techniques has been initiated. Hybrid approaches, in which different decision making agents cooperate for solving one decision model are investigated. This article proposes a procedural framework for setting up distributed decision making algorithms using two or even more decision making agents. We propose generic procedures for a hybrid distributed decision making. As an example, we describe a metaheuristic, which combines a metaheuristic with an analytical optimization algorithm for solving a multiple constrained decision making model of a decision problem from logistics.

17:20-17:40

ThC2.5

*Minimization of the Storage and the Transportation Costs in an Elementary Supply Chain with the Multiple Transporter Case (I)*, pp. 760-765

hammoudan, Zakaria  
Grunder, Olivier  
El-Moudni, A

Univ. of Tech. of Belfort-Montbeliard (SeT/UTBM)  
Univ. de Tech. de Belfort-Montbéliard  
UTBM

This paper is aimed at studying the batch production and delivery integrated scheduling in a single supply chain with identical jobs. These jobs are delivered by a fleet of heterogeneous transporters, with the time and cost parameters dependent on the batch size. We assume that there is no time lag between the execution time of the production batch and that of the onset of the loading batch. Each job has to be delivered before a given due date. The product may arrive before his due date, thus incurring a holding cost for those concerned in some cases. Hence, the problem becomes finding a coordinated production and delivery schedule in which the sum of the delivery and holding cost is minimized. A mathematical formulation of the problem is given as a non-linear model in a general way and provides a dominant properties. We propose a general dynamic programming scheme, which can solve small to middle size instances of the problem. The evaluation of the efficiency of this method is measured by the comparison with a genetic algorithm.

17:40-18:00

ThC2.6

*Dynamic Models for Green Logistic Networks Design*, pp. 766-771

Serrano, Christian  
Aggoune-Mtala, Wassila  
Sauer, Nathalie

École Nationale d'Ingénieurs de Metz  
Public Res. Centre Henri Tudor  
Paul Verlaine Univ. of Metz - France / INRIA Grand Est- COS

Nowadays, the relationship industry-environment plays a significant role in business and supply chain management. Due to legislation pressures, consumer awareness and economic interest in used products, the concept of Green Supply Chain Management was born, with Reverse Logistics as principal driver. Designing a green logistic network consists in integrating environmental aspects in strategic decision making towards the location of logistic facilities. In this work mixed integer linear programming models are proposed for the design of a reverse logistic network. The innovative aspects of this study are: the assumption of a dynamic, multi-product environment and the uncertainty of used products returns. CPLEX software is used to formulate and solve the models. A results analysis is presented as well as possible research avenues

18:00-18:20

ThC2.7

*A MIP-Based Heuristic for the Stochastic Economic Lot Sizing Problem with Remanufacturing (I)*, pp. 772-777

Kilic, Onur A.

Hacettepe Univ.

We consider the stochastic economic lot sizing problem with remanufacturing under customer service level constraints. The problem is a stochastic extension of the classical lot sizing problem where demand can be met via two alternative sources: manufacturing new products and remanufacturing returned products. It is known that even the deterministic version of this problem is NP-hard. We propose a mixed integer programming based heuristic for the problem building on a static-dynamic uncertainty strategy.

**ThC3**

Aud.41 (ITMO)

**Optimal Design of Production and Assembly Lines** (Invited Session)

Chair: Kovalyov, Mikhail Y.  
Co-Chair: yalaoui, farouk

United Inst. of Informatics Problems  
Univ. of Tech. of Troyes

16:00-16:20

ThC3.1

*Evaluating the Performance of Recombination Operators with Island Parallel Genetic Algorithms (I)*, pp. 778-783

Dokeroglu, Tansel  
Tosun, Umut  
Cosar, Ahmet

Middle East Tech. Univ.  
Middle East Tech. Univ.  
Middle East Tech. Univ.

Obtaining exact results for larger problem instances of the intractable problems is still an important issue. Genetic algorithms can provide good solutions for such problems by using appropriate recombination and mutation operators to search the solution space, provided that they are given a sufficient population size of individuals and enough time to iterate through generations. There are numerous proposed recombination operators that programmers use for this purpose. Most of the time, one of these operators are randomly selected to solve a problem without knowing its capabilities. In this study, we analyze the most used recombination operators and propose a new swap-based operator, Bubble Recombination Operator (BRX), for the intractable permutation problems. The proposed operator swaps iteratively and outperforms most of the well-known permutation recombination operators. BRX provides either the optimum or very close to the best available solutions reported so far for the problem instances of the Quadratic Assignment Problem.

16:20-16:40

ThC3.2

*The Additive Property in Long Line Optimization (I)*, pp. 784-789

Shi, Chuan  
Gershwin, Stanley

Massachusetts Inst. of Tech.  
Massachusetts Inst. of Tech.

In this paper, we study an additive property in long line optimization. The property is that the effect of a set of local bottlenecks on the

optimal buffer distribution (in which profit is maximized subject to a production rate constraint) is approximately the same as the sum of the effects of each local bottleneck by itself. A similar property is observed with a mixture of bottlenecks and anti-bottlenecks. Both heuristic explanations and numerical experiments are provided to demonstrate the property. Finally, some limitations about the additive property are also examined.

---

16:40-17:00

ThC3.3

*Distributed Genetic Algorithm for Integrated Process Planning and Scheduling Based on Multi Agent System (I)*, pp. 790-795

Zhang, Luping  
Wong, T. N.

The Univ. of Hong Kong  
The Univ. of Hong Kong

Process planning and scheduling are two crucial functions in manufacturing systems which are usually carried out sequentially. The scheduling is totally based on the outcomes of process planning, and the process planning may be restricted by manufacturing resources. Hence, conducting the process planning and scheduling separately is much likely to ruin the feasibility and optimality of both process planning and scheduling functions. The integration of process planning and scheduling (IPPS) is therefore fairly important for an efficient manufacturing system. In this paper, a distributed genetic algorithm (DGA) is suggested to cater for the IPPS problems domains, and the multi-agent system (MAS) is adopted to accommodate the algorithm. Here it is called the MAS-DGA system. Due to good properties of the MAS, a new agent-based architecture is proposed to accommodate subpopulations, support the traditional GA and provide channels for individuals' immigration. Furthermore, a negotiation mechanism is provided to support bilateral selections between individuals and subpopulations. Benchmark problems have been tested in the experiments, and the results are compared with a symbiotic evolutionary algorithm (SEA) and a cooperative co-evolutionary genetic algorithm (CCGA), which reveals that the proposed MAS-DGA system is feasible and efficient for the resolve of IPPS problems.

---

17:00-17:20

ThC3.4

*Optimization of Multi-Tool Cutting Modes in Multi-Item Batch Manufacturing System*, pp. 796-801

Rozin, Boris  
Levin, Genrikh  
Dolgui, Alexandre

United Inst. of Informatics Problems  
United Inst. of Informatics Problems of the NationalAcademy  
Ec. Nationale Supérieure des Mines de Saint-Etienne

The problem of optimization of cutting modes for multiple position machines and transfer lines equipped with multi-spindle heads is considered. Parts of several types are grouped into batches. Each tool can be used for machining different parts of a batch. The cutting modes to be defined should provide a required throughput, meet the constraints on the cutting process characteristics and minimize the batch production cost. Decomposition techniques are proposed. These techniques are based on the method of Lagrange multipliers, the concept of fragmentary parameterization and techniques for separable programming problems.

---

17:20-17:40

ThC3.5

*Formulation of Multi-Level Workforce Skill Constraints in Assembly Line Balancing Models*, pp. 802-807

Koltai, Tamas

Budapest Univ. of Tech. and Ec.

The objective of assembly line balancing (ALB) is to assign tasks to workstations organized to perform tasks with precedence constraints. An important element of proper assignment of tasks to workstations is the consideration of skill requirement of tasks, and skill level of workers. This paper provides a general framework to model skill requirements and skill conditions for assembly line balancing models. Three types of skill constraints are defined. Low skill constraints determine workstations for workers who are able to perform only some simple tasks. High skill constraints consider tasks which require higher than average skills of workers. Finally, exclusive skill constraints consider situations where a group of workers is specialized in a subset of tasks. The paper summarizes the mathematical description of the different skill constraints, and shows how simple assembly line balancing models can be completed with skill considerations.

---

17:40-18:00

ThC3.6

*A Transfer Line Design Problem with Setup Times and Costs*, pp. 808-813

Dolgui, Alexandre  
Kovalev, Sergey  
Kovalyov, Mikhail Y.  
Nossack, Jenny  
Pesch, Erwin

Ec. Nationale Supérieure des Mines de Saint-Etienne  
Ec. Nationale Supérieure des Mines de Saint-Etienne  
United Inst. of Informatics Problems  
Univ. of Siegen  
Univ. of Siegen

A transfer line has to be designed for the mass production of parts of several types. Each part requires a specific set of operations. The superset of all required operations has to be distributed between stations of the line. No operation re-distribution is allowed when switching between types. A station is set up if at least one operation is executed on it. This incurs setup time and cost. Each operation has a size and a processing time. Operations on the same part assigned to the same station are performed sequentially. Precedence relations are given on the superset of all operations. There are upper bounds on the total size of operations assigned to the same station and on the total setup and operation processing time for a part on the same station for all types. The primary objective is to minimize the number of stations and the secondary objective is to minimize the total setup cost. We establish computational complexity of various special cases and present integer linear programming formulations.

---

18:00-18:20

ThC3.7

*Extensions of the Unidirectional Flow Path Design Problem Solved by Efficient Metaheuristics (I)*, pp. 814-819

Rubaszewski, Julie  
Yalaoui, Alice  
Amodeo, Lionel  
Fuchs, Sylvain

Univ. of Tech. of Troyes  
Univ. of Tech. of Troyes  
UTT  
ANDRA

The flow path design problem is one of the most important issues in AGV (automated guided vehicles) systems design. It consists in the determination of each segment direction and the paths to be used for automated vehicles in production units. Performances of a

system is influenced by organization of these roads because the transport time and the number of necessary vehicles depends on. This work deals with flow path design problem for a conventional unidirectional network. Some new extensions of the total travel distance minimization considering both loaded and empty travels is presented and solved by efficient metaheuristics. Extensions consist in adding different type of vehicle, not allowed some segments and taking into account construction costs. This study is made in collaboration with ANDRA (National Agency for Radioactive Waste Management).

---

**ThC4** Aud.51 (ITMO)  
**Robotics in Manufacturing** (Regular Session)

---

Chair: Pashkevich, Anatol Ec. des Mines de Nantes  
 Co-Chair: Bobtsov, Alexey Sainr Petersburg National Res. Univ. of ITMO

---

16:00-16:20 ThC4.1

---

*Modelling of the Gravity Compensators in Robotic Manufacturing Cells*, pp. 820-825

Klimchik, Alexandr Ec. des Mines de Nantes  
 Wu, Yier Ec. des Mines de Nantes  
 Caro, Stéphane CNRS, IRCCYN  
 Dumas, Claire Univ. of Nantes  
 Furet, Benoit Univ. of Nantes  
 Pashkevich, Anatol Ec. des Mines de Nantes

The paper deals with the modeling and identification of the gravity compensators used in heavy industrial robots. The main attention is paid to the geometrical parameters identification and calibration accuracy. To reduce impact of the measurement errors, the design of calibration experiments is used. The advantages of the developed technique are illustrated by experimental results .

---

16:20-16:40 ThC4.2

---

*Robot Force/Torque Control in Assembly Tasks*, pp. 826-831

Winkler, Alexander Chemnitz Univ. of Tech.  
 Suchý, Jozef Chemnitz Univ. of Tech.

Force/ torque control of robot manipulators has been quite intensively investigated during the last decades and it becomes more and more important in manufacturing tasks. However, most of industrial robots are predominantly position-controlled. In this article we will show examples to perform challenging assembling or disassembling tasks by manipulators using standard commercial robot controllers. This fact reduces the possibilities of force/torque control with respect to controller structures and parameters. Two experiments were chosen to demonstrate force controlled robot assembly. First task is to mount a nut on a thread bolt by a single robot using hybrid position/force control. In the second task two cooperating robots assemble the screw fitting using force/torque control. In this work the tasks are divided into some subtasks. For every scenario the convenient controller structure and the controller parameters have to be found out. The example tasks are successfully verified by practical experiments and the corresponding results are presented.

---

16:40-17:00 ThC4.3

---

*Efficiency Improvement of Measurement Pose Selection Techniques in Robot Calibration*, pp. 832-837

Wu, Yier Ec. des Mines de Nantes  
 Klimchik, Alexandr Ec. des Mines de Nantes  
 Pashkevich, Anatol Ec. des Mines de Nantes  
 Caro, Stéphane CNRS, IRCCYN  
 Furet, Benoit Univ. of Nantes

The paper deals with the design of experiments for manipulator geometric and elastostatic calibration based on the test-pose approach. The main attention is paid to the efficiency improvement of numerical techniques employed in the selection of optimal measurement poses for calibration experiments. The advantages of the developed technique are illustrated by simulation examples that deal with the geometric calibration of the industrial robot of serial architecture.

---

17:00-17:20 ThC4.4

---

*Robust Algorithm for Calibration of Robotic Manipulator Model*, pp. 838-842

Klimchik, Alexandr Ec. des Mines de Nantes  
 Wu, Yier Ec. des Mines de Nantes  
 Abba, Gabriel Ec. Nationale Supérieure des Arts et Métiers  
 Garnier, Sébastien Univ. of Nantes  
 Furet, Benoit Univ. of Nantes  
 Pashkevich, Anatol Ec. des Mines de Nantes

The paper focuses on the robust identification of geometrical and elastostatic parameters of robotic manipulator. The main attention is paid to the efficiency improvement of the identification algorithm. To increase the identification accuracy, it is proposed to apply the weighted least square technique that employs a new algorithm for assigning of the weighting coefficients. The latter allows taking into account variation of the measurement system precision in different directions and throughout the robot workspace. The advantages of the proposed approach are illustrated by an application example that deals with the elasto-static calibration of industrial robot.

---

17:20-17:40 ThC4.5

---

*Robot Joint Modeling and Parameter Identification Using the Clamping Method*, pp. 843-848

Lehmann, Christian Brandenburg Univ. of Tech. Chair of Automation Tech.

Olofsson, Bjorn	Lund Univ.
Nilsson, Klas	Lund Univ.
Halbauer, Marcel	Brandenburg Univ. of Tech. Chair of Automation Tech.
Haage, Mathias	Lund Univ.
Robertsson, Anders	LTH, Lund Univ.
Sornmo, Olof	Lund Univ.
Berger, Ulrich	Brandenburg Univ. of Tech. Cottbus

The usage of industrial robots for milling tasks is limited by their lack of absolute accuracy in presence of process forces. While there are techniques and products available for increasing the absolute accuracy of free-space motions, the mechanical weaknesses of the robot in combination with the milling forces limits the achievable performance. If the dynamic effects causing the deviations can be compensated for, there would be several benefits of using industrial robots for machining applications. To enable the compensation, the causes of the path deviations have to be adequately modeled, and there must be a method for determining the model parameters in a simple and inexpensive way. To that end, we propose a radically new method for identification of robot joint model parameters, based on clamping of the robot to a rigid environment. The rigidity of the environment then eliminates the need for expensive measurement equipment, and the internal sensors of the robot give sufficient feedback. An experimental validation shows the feasibility of the method.

17:40-18:00 ThC4.6

*Workpiece Placement Optimization in Robotic-Based Manufacturing*, pp. 849-854

Caro, Stéphane	CNRS, IRCCYN
Dumas, Claire	Univ. of Nantes
Garnier, Sébastien	Univ. of Nantes
Furet, Benoit	Univ. of Nantes

Roboticians are faced with new challenges in robotic-based manufacturing. Up to now manufacturing operations that require both high stiffness and accuracy have been mainly realized with computer numerical control machine tools. This paper aims to show that manufacturing finishing tasks can be performed with robotic cells knowing the process cutting conditions and the robot stiffness throughout its Cartesian workspace. It makes sense that the finishing task of large parts should be cheaper with robots. However, machining robots have not been adapted for such operations yet. As a consequence, this paper introduces a methodology that aims to determine the best placement of the workpiece to be machined knowing the elastostatic model of the robot and the cutting forces exerted on the tool. Therefore, a machining quality criterion is proposed and an optimization problem is formulated and solved. The KUKA KR270-2 robot is used as an illustrative example throughout the paper.

18:00-18:20 ThC4.7

*Quality Certification and Productivity Optimization in Robotic-Based Manufacturing*, pp. 855-860

Garnier, Sébastien	Univ. of Nantes
Dumas, Claire	Univ. of Nantes
Caro, Stéphane	CNRS, IRCCYN
Furet, Benoit	Univ. of Nantes

The use of industrial robots for machining operations is more and more common. Nevertheless the geometric quality of pieces milled with machining robots is not as good as the quality obtained with CNC machine tools. This paper aims to show that manufacturing finishing tasks can be performed with machining robots knowing the process cutting phenomena and the robot stiffness throughout its Cartesian workspace.

This paper introduces a machining quality criterion that is used to optimize the workpiece placement and the kinematic redundancy of the robot with respect to the task. However, the robot may not be stiff enough for the geometric quality of the machined workpiece to respect a prescribed tolerance interval. In this paper, a productivity criterion is introduced and a methodology is developed for the robot machining operation to be the most productive while certifying the required quality of the machined workpiece.

**ThC5** Aud.52 (ITMO)

**Balancing and Sequencing of Assembly and Machining Lines - 1** (Invited Session)

Chair: Delorme, Xavier	Ec. Nationale Supérieure des Mines de Saint-Etienne
Co-Chair: Cohen, Yuval	The Open Univ. of Israel

16:00-16:20 ThC5.1

*Integrated Decision Making in Flow Line Balancing*, pp. 861-868

Battaïa, Olga	Ec. des Mines de Saint-Etienne
Delorme, Xavier	Ec. Nationale Supérieure des Mines de Saint-Etienne
Dolgui, Alexandre	Ec. Nationale Supérieure des Mines de Saint-Etienne
Grimaud, Frédéric	Ec. des Mines de Saint-Etienne

A flow line consists of a sequence of workstations through which one or more products move one way in order to be processed. Designing such a line represents a long-term decision problem involving different crucial decision stages, often solved iteratively because of their complexity. Line balancing problem is one of them; it mostly deals with assigning the set of indivisible units of work (named tasks or operations) to a sequence of lineally ordered workstations. In this paper, we present a brief overview of flow lines balancing problems recently appeared in the literature, which try to expand the core optimization problem dealing with assigning tasks by solving it jointly with other decision problems, such as process planning, configuration design or detailed line scheduling. In spite of the fact that, previously, the most attention was paid for the balancing problems concerning the assembly systems, the approaches and formulations of flow line balancing in machining environment are analyzed as well.

---

16:40-17:00 ThC5.3

*Extended Models for TSALBP with Ergonomic Risk Constraints (I)*, pp. 869-874

Bautista Valhondo, Joaquín Univ. Pol. de Catalunya  
Batalla García, Cristina ETSEIB/EPSEB UPC  
Alfaro Pozo, Rocío ETSEIB/EPSEB UPC  
Cano Pérez, Alberto ETSEIB/EPSEB UPC

In this paper, we present an extension to the TSALB problem (Time and Space constrained Assembly Line Balancing) with ergonomic risk restrictions. This ergonomic risk is defined from the task durations and their categories regarding to the risk factor for the workers. A study is presented through a case linked to an engine assembly line in the Automobile industry, considering variable demand.

---

17:00-17:20 ThC5.4

*Assembly Line Balancing with Resource Dependent Task Times: An Application to Parallel Assembly Lines (I)*, pp. 875-880

Kara, Yakup Selcuk Univ.  
Atasagun, Yakup Selcuk Univ.

Abstract: In this study, Resource Dependent Assembly Line Balancing approach is adapted to the concept of Parallel Assembly Line Balancing and this problem is called Parallel Assembly Line Balancing with Resource Dependent Task Times (RDALB\_P). A binary integer linear mathematical model is proposed for RDALB\_P. The proposed model is validated on an illustrative example and a scenario analysis is performed by comparing the proposed RDALB\_P solutions of the illustrative problem with independent RDALB solutions for four different cycle time values. The results show that, the RDALB\_P provides better solutions in total cost for three out of four different cycle time scenarios. The average cost improvement of RDALB\_P is 8.8% compared to independent RDALB solutions.

---

17:20-17:40 ThC5.5

*On Capacity Planning for Multi-Stage Multi Model Production Lines with Parallel Machines (I)*, pp. 881-886

Cohen, Yuval The Open Univ. of Israel

This paper deals with designing a multi-stage production line to satisfy demand that is much greater than the pace of a single machine in most of the production stages. In addition, the pace of machines in a certain stage is typically different than the pace of machines in other stages. Examples of such an environment could be found in production of Printed Circuit Boards (PCBs), cosmetics, food processing, and variety of other industries. The paper discusses the main considerations related to the product life cycle management (PLM), and suggests a strategic, rough-cut solution approach that enables some flexibility during the operation period. (setting the number of machines and operators at each stage), the line's operation period may face demand changes that require adjustments. This paper discusses these situations and proposes a solution approach. Simple examples are illustrating both a static initial design, and a dynamic approach for planning changes based on demand realization.

---

17:40-18:00 ThC5.6

*Cyclic Scheduling of Flexible Mixed Model Assembly Lines (I)*, pp. 887-892

Öztürk, Cemalettin Izmir Univ. of Ec.  
Tunali, Semra Izmir Univ. of Ec.  
Hnich, Brahim Izmir Univ. of Ec.  
Örnek, Arslan M. Izmir Univ. of Ec.

Mixed model assembly lines are used to produce multiple copies of given minimum part set (MPS). Considering only one copy (cycle) of the MPS while solving the mixed-model balancing and scheduling problem yields suboptimal solutions since blocking and idle times of stations between repeated copies are ignored. Modeling and solving this problem in a cyclic manner can significantly overcome these inefficiencies and improve the throughput of the line. In this paper, after investigating the nature of the problem, we propose exact and heuristic methods for practical applications and evaluate their performances on various size test instances.

---

18:00-18:20 ThC5.7

*Implementation of a Methodology for Consideration of Product Quality within Discrete Manufacturing*, pp. 893-898

Foehr, Matthias Siemens AG  
Jäger, Tobias Siemens AG  
Turrin, Claudio Whirlpool Europe srl  
Petrali, Pierluigi Whirlpool Europe srl  
Pagani, Arnaldo Whirlpool Wurope srl  
Leitão, Paulo Pol. Inst. of Bragança

The present paper deals with the questions how product quality can be influenced within product manufacturing and how production control can be optimized for increasing product quality. It focuses on discrete manufacturing processes and presents a methodology to gather and analyze relevant influences on product quality and a multi-agent architecture for flexible and quality focused production control. It will be shown how both approaches can be implemented to achieve a flexible, adaptable and quality focused production process control.

---

**ThC6** Aud.31 (ITMO)

**Theory and Applications of Ahp and Anp for Decision Making in Manufacturing Systems – 2** (Invited Session)

Chair: Bruno, Giuseppe Univ. of Naples Federico II  
Co-Chair: Shams, Nasim Alsadat Univ. of Waterloo

---

16:00-16:20 ThC6.1

*Factors Affecting RFID Adoption in Chinese Manufacturing Firms: An Investigation Using AHP (I)*, pp. 899-904

Rahman, Shams  
Yang, Laura  
Waters, Stephen

RMIT Univ.  
Shanghai Inst. of Foreign Trade  
Univ. of Western Sydney

The aim of this study is to determine and prioritise factors affecting RFID adoption in Chinese manufacturing firms. Using six case studies and employing the analytical hierarchy process (AHP) approach this study suggests that the critical factors affecting RFID adoption are top management support, hardware & software cost, tag cost, industry force, and compatibility. These factors belong to soft factor-category as well as hard factor-category. For effective adoption of RFID technology management of the manufacturing firms must take these factors into account.

16:20-16:40

ThC6.2

*The Value-Analytic Hierarchy Process: A Lean Multi Criteria Decision Support Method (I)*, pp. 905-910

Compagno, Lucio  
Trapani, Natalia  
D'Urso, Diego  
Latora, Antonio Giuseppe

Univ. of Catania  
Univ. of Catania  
Univ. of Catania  
Univ. of Catania

The Analytic Hierarchy Process uses pairwise comparison in order to define priorities for criteria and for alternatives, obtaining an overall ranking which represents a "rational decision". In literature there are many examples of AHP applications where, in order to operate the ranking of alternatives according to qualitative and quantitative criteria, authors assign an utility value to the judgments on qualitative criteria but also to the values assumed on the basis of quantitative criteria. A modified approach, that was called Value-Analytic Hierarchy Process (V-AHP), was developed as a combination of traditional AHP rating on qualitative criteria and a "lean" rating on quantitative criteria. Such procedure allows to limit the use of the traditional AHP method only to criteria expressed by qualitative judgments and/or by scales different from ratio ones. A numerical example was carried out, according to the introduced methodology, in order to rank 15 potential simulated industrial investments evaluated by qualitative and quantitative criteria. The V-AHP can be defined a "lean" Multi Criteria Decision Support Method potentially applicable to any multi-criteria decision-making context.

16:40-17:00

ThC6.3

*Hybrid Supplier Selection Methodologies: Problems and Perspectives (I)*, pp. 911-916

Bruno, Giuseppe  
Esposito, Emilio  
Genovese, Andrea  
Rosa Rossella, Longobardo  
Passaro, Renato

Univ. of Naples Federico II  
Univ. of Naples  
Univ. of Sheffield  
Univ. of Naples "Federico II"  
Univ. of Naples "Parthenope"

This paper presents a hybrid model for coping with the supplier selection problem, based on the combination of the two main approaches proposed in the extant literature, the Analytic Hierarchy Process (AHP) and Fuzzy Set Theory (FST). The proposed model combines the strengths of the two approaches, overcoming some of their weaknesses. An empirical study is provided, to check the usability and the usefulness of the developed approach in a real-life context.

17:00-17:20

ThC6.4

*Multiple Consensus for Multicriteria Decision*, pp. 917-920

Guenoche, Alain

CNRS

To select an item, according to several concurrent preferences on the item set is a common task in business management and decision theory. Among a huge number of methods to aggregate preferences, we develop here an approach based on the consensus of linear orders. It is a median consensus, that is a linear order on the items having a minimum sum of distances to the given preference orders. If there is only one item to select, it is the first ranked item of this median order. But if there are k items to select, rather than keeping the k first ranked elements, it could be better to decompose the profile into k classes, to compute a median linear order for each one, and to retain the first ranked item of each order. This is what we call a Multiple Consensus.

17:20-17:40

ThC6.5

*Process Efficiency of Multistage Production Systems*, pp. 921-926

Lozano, Sebastián

Univ. of Seville

Relational Network DEA allows the assessment of the overall efficiency of a multistage production system. However, when estimating the process efficiencies, there is uncertainty in the sense that different efficiency decompositions are feasible thus leading to interval process efficiency estimations. Recently, Nash bargaining game theory has been proposed to compute point estimates of process efficiencies for two-stage systems. In this paper that approach is extended to handle the multiple-stage case.

17:40-18:00

ThC6.6

*An Approach to Analysis of Expert Estimation Validity in Cognitive Mapping*, pp. 927-932

Abramova, Nina  
Telitsyna, Tatyana

Inst. of Control Sciences of the Russian Acad. of Sciences  
Inst. of Control Sciences V. A. Trapeznikov Acad. of Scien

Increasingly popular cognitive mapping of ill-structured socio-economic, manufacturing and other systems and situations carries risks for validity of end results. The problem of validity of expert estimates on prescribed normalized universal scales is raised. The main factor of risk is supposed to be the conceptual vagueness of expert knowledge on ill-structured systems and situations and knowledge of theoretical models for their cognitive mapping. An approach to analysis of expert estimation validity of variable values in cognitive mapping is proposed. In the approach the model of conceptual interpretation of a prescribed universal scale for an estimated variable is proposed. The model of conceptual interpretation enables to refine the influence of conceptual vagueness onto the expert estimation validity. Some results of empirical testing of the proposed approach operability in cognitive mapping are presented.



---

18:00-18:20

ThC6.7

[Measuring the Utilization Index of Advanced Manufacturing Technologies: A Case Study \(I\)](#), pp. 933-938

Singh, Harwinder  
Kumar, Raman

Guru Nanak Dev Engineering Coll. Ludhiana  
Chandigarh Univ. Gharaur, Punjab

Advanced manufacturing technology (AMT) is important for improving manufacturing system competitiveness. In this research work, six sub-objectives such as operational performance, managerial activities, productive capacity, education & training to employee, competitive strategic of worker and organizational strength have been selected to measure the utilization index. This present work includes hierarchical structure, fuzzy and de-fuzzy set theory following this utilization index is achieved for six parameter included in this study. A case study has been discussed to show effectiveness of proposed methodology in computing the utilization index. It has been found that the utilization index is higher in operational performance.

---

ThC7

Aud.61 (ITMO)

**Control of Complex Systems under Extremal Random Risks** (Invited Session)

Chair: Markovich, Natalia  
Co-Chair: Gomes, Ivette

V.A.Trapeznikov Inst. of Control Sciences  
CEAUL and DEIO, FCUL, Univ. de Lisboa

---

16:00-16:20

ThC7.1

[Robust Mirror Decent Algorithm for a Multi-Armed Bandit Governed by a Stationary Finite Markov Chain \(I\)](#), pp. 939-943

Nazin, Alexander V.  
Miller, Boris

Inst. of Control Sciences RAS  
Monash Univ.

This paper develops adaptive approach to the controlling observable Markov chains with a finite number of states. We apply Robust Mirror Descent Randomized Control Algorithm (RMDRCA) to a class of homogeneous finite Markov chains governed by the multi-armed bandit with unknown mean losses. It develops approach represented in [18], [19], and [20]. As opposed to the partially observable Markov decision process an adaptive approach does not presuppose the knowledge of probabilistic characteristics of random perturbations and permits to obtain the control strategy with known rate of convergence to the optimal solution. We propose the concrete RMDRCA and prove the explicit, non-asymptotic upper bound for the mean losses at any current time.

---

16:20-16:40

ThC7.2

[Nonparametric Gamma Kernel Estimates of Density Derivatives on Positive Semiaxis \(I\)](#), pp. 944-949

Dobrovidov, Alexander V.  
Markovich, Liubov

Inst. of Control Sciences, RAS  
Inst. of Control Sciences of Russian Acad. of Sciences

We consider nonparametric estimation of probability density derivative function with the support  $[0, \infty)$ . Estimates are looked up in the class estimates with asymmetric gamma kernel functions. Use of gamma kernels is due to the fact they are non negative, change there shape depending on the position on the axis and possess other good properties. We found analytical expressions for bias, variance, mean integrated squared error (MISE). An optimal bandwidth, optimal MISE and rate of mean square convergence of the estimattss for density derivative have also been found.

---

16:40-17:00

ThC7.3

[Reliability Control of Complex Systems through Penultimate Approximations \(I\)](#), pp. 950-955

Gomes, Ivette  
Reis, Paula  
Canto e Castro, Luisa  
Dias, Sandra

CEAUL and DEIO, FCUL, Univ. de Lisboa  
CEAUL and Escola Superior de Tecnologia de Set'ubal  
CEAUL and DEIO, FCUL, Univ. de Lisboa  
CM---UTAD, Univ. de Tr'as-os-Montes e Alto Douro, Vila R

In statistical quality management, the control of the reliability of a system is a topic of primordial relevance in manufacture industry. After a brief reference to the importance of order statistics in reliability, the fact that any coherent system can be represented as either a series-parallel (SP) or a parallel-series (PS) system is referred. The lifetime of such a system can thus be written as the minimum of maxima or the maximum of minima, which reveals the relevant role of extreme value theory (EVT) in the field of reliability. Indeed, for large-scale coherent systems can be sensible to assume that the number of system components goes to infinity. And then, the possible non-degenerate extreme value distributions either for maxima or for minima are eligible candidates for the system reliability or at least for the finding of adequate lower and upper bounds for such a reliability. The main limiting results in EVT will be briefly mentioned, and the identification of the possible ultimate limit laws for maxima of a min-stable distribution and for minima of a max-stable distribution are identified. Considering a fixed large number of components, pre-asymptotic or penultimate models can lead to an improvement of the convergence rate and are provided. On the basis of a small-scale Monte-Carlo simulation study, we further make clear the attained gain in accuracy when a penultimate approximation is used instead of the ultimate limiting approximation.

---

17:00-17:20

ThC7.4

[Stochastic Inferences of Packet Transmission in Peer-To-Peer Overlay Networks \(I\)](#), pp. 956-961

Markovich, Natalia

V.A.Trapeznikov Inst. of Control Sciences

The paper contributes to the teletraffic analysis and quality of service of packet transmission of peer-to-peer systems. We look at the packet transmission processes that are induced by a peer-to-peer overlay disseminating real-time traffic from a statistical perspective. Applying the theory of extreme events, we derive that the asymptotic distribution of the end-to-end packet delay (i.e. packet delivery time between sender and receiver peers) is subexponential heavy-tailed if the inter-arrival times between packets are regularly varying heavy-tailed distributed. To evaluate the probability to miss a packet as a quality-of-service attribute one requires a set of observable variables based on the realized flows such as the end-to-end packet delays, the packet inter-arrival times and packet lengths of single or aggregated streams associated with a peer.

---

17:20-17:40

ThC7.5

A new estimate of the hazard rate function is proposed, specifically designed for situations when the underlying data are heavy tailed. The estimate is nonparametric in nature and is based on the concept that estimation bias is reduced both in body and in the tail through an appropriate transformation of the sample. With the use of a practical bandwidth choice rule the estimate is illustrated graphically on distributional and real world data.

17:40-18:00

ThC7.6

*On Relationship between Score Functions and Extremal Index (I)*, pp. 967-972

Markovich, Natalia  
Stehlik, Milan

V.A.Trapeznikov Inst. of Control Sciences  
Johannes Kepler Univ. Linz

Score functions like the logarithmic derivative of a probability density function and the t-score are applied in many control problems of dynamic systems. However, their estimation by samples of moderate sizes may require nonparametric estimation of the density and its derivative that is difficult. To overcome this problem we attract a new random variable that is equal to inter-cluster times  $T_1(u)$  of the underlying process  $\{X_n\}$  normalized by its tail function  $1-F(u)$ . A cluster contains consecutive exceedances of the process over a threshold  $u$  and intercluster issues of the process run under  $u$ . We found that the logarithmic derivative of the  $(1-F(u))T_1(u)$  may be approximated by extremal index. The latter can be easily estimated by one of the nonparametric estimators. Another aim is to find a relationship between score functions of a marginal variable  $X_t$  generating the process and of the normalized  $T_1(u)$ . The first score function carries the information about distribution, while the other one about dependence structure. We also consider Fisher score that is the gradient, with respect to some parameter, of the logarithm of the likelihood function. The relationships are demonstrated on ARMAX, moving maxima, moving average and AR(1) processes to illustrate this methodology.

18:00-18:20

ThC7.7

*Delusions in System Identification: Professor Pashchenko's School*, pp. 973-978

Chernyshov, Kirill

V.A. Trapeznikov Inst. of Control Sciences

The present paper demonstrates ways and methods, both analytical and simulation ones, to be applied to analyze delusions concerned with various attempts of generalization of conventional techniques and notions relating to such a brand of control theory as system identification. The paper presents methods to reveal the delusions concerned with information theoretic approaches: application of the mutual (Shannon) information and attempts of generalization of the notion of entropy, as well as application of consistent measures of dependence in system identification, and entropy based approaches in robust control problems.

**ThC8**

Aud.42 (ITMO)

**Artificial Intelligence and Machine Learning Approaches to Industrial Automation and Decision Making (Invited Session)**

Chair: Sheremetov, Leonid  
Co-Chair: Avdeeva, Zinaida

Mexican Petroleum Inst.  
V.A. Trapeznikov Inst. of Control Sciences of Russian Acad. of Sciences

16:00-16:20

ThC8.1

*Improving the Estimation of Mean Flow Stress within Hot Rolling of Steel by Means of Different Artificial Intelligence Techniques (I)*, pp. 979-984

Vannucci, Marco  
Colla, Valentina  
Dimatteo, Antonella

Scuola Superiore Sant'Anna  
Scuola Superiore Sant'Anna  
Scuola Superiore Sant'Anna

Prediction of mean flow stress within the hot rolling of steel products can lead to significant improvement in the manufacturing. In this paper this problem is dealt on data coming from a real industrial plant and it is shown how inadequate well known literature models are. Alternative models are then proposed by improving existing formulae by means of genetic algorithms based optimization and by the development of artificial neural networks based models. The performance of the proposed methods are compared and put into evidence the advantages of the use of artificial intelligence techniques within the handled industrial problem.

16:20-16:40

ThC8.2

*Ontology Mapping Approach for Fault Classification in Multi-Agent Systems (I)*, pp. 985-990

Jirkovsky, Vaclav  
Obitko, Marek

Czech Tech. Univ.  
Czech Tech. Univ.

One of the most important abilities of control systems is diagnostics. The ability to detect faults, to explain them to an operator, and possibly also to propose and execute a recovery is an important feature of an advanced control system. We present ontology mapping approach for error classification in this paper, with the focus on multi-agent systems. Fault descriptions are kept in global error ontology which facilitates reusability of this approach as well as easier maintenance. Fault classification method utilizes HMM-based diagnostic system for automatic fault detection and offers effective and easy option of describing faults and inferring non-trivial dependencies using reasoning. Fault classification system is demonstrated on a testing example of automobile camshafts process.

16:40-17:00

ThC8.3

*Time Series Forecasting: Applications to the Upstream Oil and Gas Supply Chain (I)*, pp. 991-996

Sheremetov, Leonid  
González-Sánchez, Arturo  
López-Yáñez, Itzamá  
Ponomarev, Andrew

Mexican Petroleum Inst.  
Mexican Petroleum Inst.  
Mexican Petroleum Inst.  
St.Petersburg Inst. for Informatics and Automation of the Ru

This paper describes different models which are used for forecasting in the time series context of petroleum engineering. The objective is to reproduce and further predict future oil production in different scenarios in an adjustable time window. Such time series are very similar to those from the sequential manufacturing processes which are usual in many areas of manufacturing industries. We mainly focus on a feedforward neural network model and a Gamma classifier and compare them both on a benchmark and real industrial data under univariate and multivariate settings. While the former model has become recently a standard tool for modeling and prediction, time series forecasting is not the kind of tasks envisioned while designing and developing the Gamma model. The Gamma classifier is inspired on the Alpha-Beta associative memories, taking the alpha and beta operators as basis for the gamma operator. As experimental results show, pattern recognition based classifier shows very competitive performance. The advantages and limitations of each model are discussed.

17:00-17:20

ThC8.4

*Diagnosing of the Problem Situation in Manufacturing System Development Based on Cognitive Map (I)*, pp. 997-1002

Avdeeva, Zinaida  
Kovriga, Svetlana

V.A. Trapeznikov Inst. of Control Sciences of Russian Acad.  
V.A. Trapeznikov Inst. of Control Sciences of the Russian Ac

In this paper we propose the scheme of diagnosing the problem situation of complex system development based on the analysis of structural properties of a cognitive-map-based model of the system development. It allows exploring different types of problem situations related to the interaction of active agents, the adverse effect of the environment and the structural features of the system. The distinctive feature of the proposed scheme is that the problem situation is considered in the whole. This is aimed to determine priorities for problem solving, depending on their causes.

17:20-17:40

ThC8.5

*Remarks on an Adaptive-Type Direct Controller Using Quantum Neural Network with Qubit Neurons*, pp. 1003-1008

Takahashi, Kazuhiko  
Kizaki, Hiroko  
Hashimoto, Masafumi

Doshisha Univ.  
Doshisha Univ.  
Doshisha Univ.

This paper proposes an adaptive-type direct controller designs based on a quantum neural network and investigates its characteristics for control systems. A multi-layer quantum neural network using qubit neurons as an information processing unit is utilized to design the adaptive-type quantum neural direct controller that conducts the training of the quantum neural network as an online process. Computational experiments to control a single-input single-output nonlinear discrete time plant are conducted in order to evaluate the learning performance and capability of the direct controller. The results of these computational experiments confirm both the feasibility and the effectiveness of the adaptive-type quantum neural direct controller.

17:40-18:00

ThC8.6

*Soft Computing Based on LabVIEW*, pp. 1009-1015

Ponce, Pedro  
Molina, Arturo  
MacCleery, Brian

ITESM-CCM  
Tecnologico de Monterrey  
National Inst.

When we are dealing with online dynamical systems, i.e. Adaptive-Network-Based Fuzzy Inference Systems (ANFIS), one of the major problems is the time used into the learning process. In this way, Backpropagation algorithm is used for training the premise parameters in a hybrid learning procedure. However, it depends on parameters that must be tuned heuristically. This provides that, in some way, training is not useful completely. Nevertheless, fuzzy logic can be put into practice and assume parameters involved in the backpropagation algorithm could be treated as fuzzy elements. In this paper, we implement fuzzy logic controllers inside the backpropagation algorithm and expand this model for training Neural Networks and ANFIS to achieve convergence in short periods of time in order to decrease the time process on-line. At this point, LabVIEW will be used as platform to validate this approach.

18:00-18:20

ThC8.7

*A Switching Q-Learning Approach Focusing on Partial States*, pp. 1016-1020

Matsumoto, Keinosuke  
Ikimi, Taisuke  
Mori, Naoki

Osaka Prefecture Univ.  
Osaka Prefecture Univ.  
Osaka Prefecture Univ.

Recently, applications of multi agent systems are expected from the viewpoint of parallel and distributed processing of systems. Reinforcement learning attracts attention as an implementing method of the multi agent systems. However, there is a problem that the more the number of agents to deal with increases, the slower the speed of learning becomes. To solve this problem, we propose a new reinforcement learning that can learn quickly and reduce the amount of memory. It tries to increase efficiency of the learning on hunter games by using a method paying attention to partial state of two agents among a large number of agents.

**ThC9**

Aud.32 (ITMO)

**Advanced Industrial Engineering** (Invited Session)

Chair: Sihm, Wilfried  
Co-Chair: Sandkuhl, Kurt

Vienna Univ. of Tech. Fraunhofer Austria Res. GmbH  
The Univ. of Rostock

16:00-16:20

ThC9.1

*Supporting Regulatory Compliance by Pattern Detection in Enterprise Models: Approach and Application (I)*, pp.

1021-1026

Dunkel, Kalle Aid  
Sandkuhl, Kurt  
Wißotzki, Matthias

Rostock Univ.  
The Univ. of Rostock  
Rostock Univ.

Many industries are facing a continuously changing business environment which partly is caused by new regulations and bylaws from regulating authorities. Ensuring compliance can cause substantial efforts, since conformance checks of business processes and organizational structures often have to be performed manually. The paper contributes to reducing these efforts by proposing tool support for analyzing enterprise models with the aim to use patterns for identifying potentially non-compliant parts of such models. Design patterns have been a fundamental tool for software development for many years. The approach of having predefined solutions can be beneficial for the purpose of compliance assessment as well. To this end a method to search and detect patterns within enterprise models is an important step. Based on a motivating scenario from automotive supplier industries, the paper proposes an approach and introduces a prototypical tool that finds similar matches to a given pattern by use of template matching with the normalized cross correlation as metric.

---

16:20-16:40

ThC9.2

*Modelling of Social Relationships and Human Communication Processes within Collaborative Manufacturing Networks (I)*, pp. 1027-1032

Schütze, Jens  
Baum, Heiko

Chemnitz Univ. of Tech.  
Chemnitz Univ. of Tech.

Small and medium enterprises collaborating in temporary networks are one of the most viable business structures of the 21st century. However, the lack of hierarchy creates huge amount of communication and collaboration processes. Lots of problems are resulting from that and many of them can be assigned to the social or communicative field. To address to these issues, ways have to be found for analysing social and communicative relationships in collaborative manufacturing networks. In this paper, a notation for modelling of social relationships and human communication processes will be presented. It uses the approach of Business Process Modelling, but is strongly influenced by social science, psychology, linguistics and communication studies.

---

16:40-17:00

ThC9.3

*Systematic and Continuous Improvement of Value Streams (I)*, pp. 1033-1037

Kuhlang, Peter  
Hempfen, Sabine  
Edtmayr, Thomas  
Deuse, Jochen  
Sihn, Wilfried

Vienna Univ. of Tech.  
TU Dortmund Univ.  
Vienna Univ. of Tech.  
TU Dortmund Univ.  
Vienna Univ. of Tech. Fraunhofer Austria Res. Gmb

Within the framework of "Value stream oriented process management" value stream mapping and the short-cyclic improvement routine are integrated into the organizational framework of process management in order to enable a methodically fostered improvement of value streams in different levels of detail. Therefore an advanced and sustainable continuous improvement process is enabled.

---

17:00-17:20

ThC9.4

*Renaissance of Group Technology: Reducing Variability to Match Lean Production Prerequisites (I)*, pp. 1038-1043

Deuse, Jochen  
Konrad, Benedikt  
Bohnen, Fabian

TU Dortmund Univ.  
TU Dortmund Univ. Inst. of Production Systems  
TU Dortmund Univ. Inst. of Production Systems

Although, Group Technology was invented to transfer benefits of economies of scale to job-shop production during the 1960s, its underlying methodologies are still relevant for modern production, which follows the lean production paradigm. This paper discusses how Group Technology has developed towards an essential tool in industrial engineering in the last decades and how it is applied in the context of Lean Production. Moreover, the authors present two examples of current research in the field of Group Technology and Lean Production: Levelling of low volume, high mix production and mixed-model assembly line balancing.

---

17:20-17:40

ThC9.5

*PLM Ontology Exploitation through Inference and Statistical Analysis: Case Study for LCC*, pp. 1044-1048

Milicic, Ana  
Perdikakis, Apostolos  
El Kadir, Soumaya  
Kiritis, Dimitris

EPFL Univ. LICP Lab.  
EPFL Univ. LICP Lab.  
EPFL  
EPFL

In a time of growing complexity and amount of a product related data, ontology has show to be an efficient and convenient method for structuring and modeling the domain of interest. It provides a clear picture of all relevant concepts, their relationships and the rules they follow. It is a structured, centralized data base, that allows fast updates and prevents redundancy. Still, fast, real-time functions of today's companies impose additional requirements on a operational domain model and in this paper, we argue that product life-cycle management (PLM) ontology can meet those requirements. In that sense, tools that we propose for ontology exploitation are mainly inference on ontology rules on one side, and ontology instances extraction for the purpose of visualization and data mining on the other side. We implement these tools for the case of manufacturing company on a real life data provided and analyze benefits from the aspect of non-expert end-user. This research is done as a part of FP7 project LinkedDesign.

---

17:40-18:00

ThC9.6

*Changeable Production Systems by the Use of a Holistic Modularization: Considering of Technology, Organization and Staff (I)*, pp. 1049-1054

Meier, Horst  
Schröder, Stefan  
Kreggenfeld, Niklas

Chair of Production Systems, Ruhr-Univ. Bochum  
Chair of Production Systems, Ruhr-Univ. Bochum  
Chair of Production Systems, Ruhr-Univ. Bochum

The steadily alternating and unpredictable requirements for industrial companies implicate the challenge to enhance production systems. As a consequence, the need for action leads to a paradigm shift in production. A transformation from a flexible production to a changeable company occurs. In this context, changeability will be decisive for the desired success. Production systems are used for

the purpose of manufacturing products and are attributed to socio-technical systems. A production system is a unit used to realize the production and can include a single machine as well as a complete production area or the whole factory. The staff is also part of production systems and does not only assume organizational responsibilities but also technical tasks. Many already known drivers of change, e.g. new innovations in technologies, have an impact on these socio-technical systems. One chance to react to changing requirements is to apply the principle of modularization. Conventionally, modularization is considered in a technical context. The consideration of staff and organization is disregarded. This article introduces a new approach to design changeable production systems on the basis of modularization, including the dimensions of technology, organization and staff, which will enable industrial companies to make these complex socio-technical systems manageable.

18:00-18:20 ThC9.7

*Industrial Symbiosis Optimization Control Model for the Exchanges of the Material/energy Flows in an Industrial Production Park (I)*, pp. 1055-1060

GU, Chao	Univ. du Havre
LEVENEUR, Sébastien	Inst. national des sciences appliquées (INSA) de Rouen
ESTEL, Lionel	Inst. national des sciences appliquées (INSA) de Rouen
YASSINE, Adnan	Univ. du Havre

The focus on the green manufacturing production is becoming more and more important in France. Le Havre is a city located in the north-western France, which concentrates more than a third of French refining capacity. However, simultaneously, the pollution caused by industries needs to be controlled. Furthermore, Le Havre would like to be the first city that does really ecological industrial park in France. Industrial symbiosis is a key concept of industrial ecology, which studies the physical flows of materials and energy in the local industrial systems. There are few studies that support the assumption of economic and environmental benefits of industrial symbiosis. So, in order to have a WIN-TO-WIN situation, we proposed a mathematical multi-objective optimization control model. The model will help the manufacturing industries to reduce related costs, and the negative environmental impact would be decreased simultaneously. Best to our knowledge, currently, it does not exist any other general mathematical optimization model for constructing and optimizing an eco-industrial park. Some graphic results of simulations are included in this paper.

**ThI1** Steve Jobs' Atrium (ITMO)  
**Information Control and Cybersecurity in Manufacturing Systems** (Poster/Interactive Session)

Chair: Promyslov, Vitaly	V.A. Trapeznikov Inst. of Control Sciences
Co-Chair: Jharko, Elena	V.A. Trapeznikov Inst. of Control Sciences

10:00-12:00 ThI1.1

*Automated Electric Energy Consumption Forecasting System Based on Decision Tree Approach*, pp. 1061-1066

Shcherbakov, Maxim	Volgograd State Tech. Univ.
Kamaev, Valeriy	VSTU
Shcherbakova, Nataliya	VSTU

Optimal energy usage and consumption require continuous monitoring and forecasting electric energy consumption in buildings. It could be carried out by the implementation of Building Energy Management Systems (BEMSs). But in the case of multi-instance data, the forecasting procedure becomes more expensive if experts are involved in this process. Moreover, the competitive environment requires a development of decision support systems based on data mining techniques that allow managers to make efficient decisions. We propose the design of the EFAS - a web system for automated electric energy consumption forecasting for multiple instances (buildings). A solution based on a web system for storing and obtaining data could reduce the cost of monitoring processes and increase the people's awareness in energy management. The proposed system includes an intelligent maintenance unit for an appropriate forecasting model selection. This unit implements a decision tree approach including conditions which are based on available variables (electric energy consumption, status of building, outdoor temperature, etc.). The results of implementation of EFAS have been represented in the case study of the paper. They indicate a decrease of forecasting error (up to 1.75 times) due to usage of decision tree for forecasting model selection.

10:00-12:00 ThI1.2

*The Construction of Homogenous Structured Programmed Transmission Medium*, pp. 1067-1071

Putilin, Alexander	Moscow State Open Univ. (Pol. Inst.)
--------------------	--------------------------------------

The paper deals with a fundamentally new trend of systems development based on the use of physical control medium. These methods are particularly promising as a means of information processing about objects that have a physical nature and appropriate to ensure control of the object in the same physical medium. It is substantiated that it is actually necessary to complexly solve triune task – signals logging, their evaluation, and creation of back controlling action. Questions of informative features transfer, converting signals with continuous systems and the principles of practical devices construction are considered.

10:00-12:00 ThI1.3

*Digitally Controlled Assets Subjected to Cyberattacks: Definitions and "Cyberproof" Criteria Based on the Analysis of Explicit and Hidden Functions*, pp. 1072-1076

Promyslov, Vitaly	V.A. Trapeznikov Inst. of Control Sciences
Poletikin, Alexey	Inst. of Control Sciences

A formal security definition for digital control system of the critical or hazard assets is discussed. The problem of ensuring the cyber security is considered at all stages of the life cycle beginning from the design of the plant. The formal mathematical notion of cyberproofness is given.

10:00-12:00 ThI1.4

*Solving Five Instances of the Artificial Ant Problem with Ant Colony Optimization*, pp. 1077-1082

Chivilikhin, Daniil	St. Petersburg National Res. Univ. of InformationTechno
---------------------	---

Ulyantsev, Vladimir  
Shalyto, Anatoly

St. Petersburg National Res. Univ. of Information Tech.  
St. Petersburg National Res. Univ. of Information Techno

The Artificial Ant problem is a common benchmark problem often used for metaheuristic algorithm performance evaluation. The problem is to find a strategy controlling an agent (called an Artificial Ant) in a game performed on a square toroidal field. Some cells of the field contain "food" pellets, which are distributed along a certain trail. In this paper we use Finite-State Machines (FSM) for strategy representation and present a new algorithm - MuACOsm - for learning finite-state machines. The new algorithm is based on an Ant Colony Optimization algorithm (ACO) and a graph representation of the search space. We compare the new algorithm with a genetic algorithm (GA), evolutionary strategies (ES), a genetic programming related approach and reinforcement learning on five instances of the Artificial Ant Problem.

10:00-12:00

Th1.5

*Test-Based Induction of Finite-State Machines with Continuous Output Actions*, pp. 1083-1088

Buzhinsky, Igor  
Ulyantsev, Vladimir  
Shalyto, Anatoly

Saint Petersburg National Res. Univ. of Information Tec  
St. Petersburg National Res. Univ. of Information Tech.  
St. Petersburg National Res. Univ. of Information Techno

In this paper we improve an earlier developed method of finite-state machine (FSM) induction for controlling objects with complex behavior. This method allows to construct FSMs with continuous (real-valued) output actions. A set of human-created training samples serves as input data for it. We apply an ant colony optimization algorithm and a ( $\mu$ ,  $\lambda$ )-evolution strategy for solving the problem as more effective than a genetic algorithm used in the initial method. The modification of the method is evaluated on the problem of unmanned aircraft control.

10:00-12:00

Th1.6

*Physical Human-robot Interaction in the Handshaking Case: Learning of Rhythmicity Using Oscillators Neurons*, pp.

1089-1094

Melnyk, Artem  
Khomenko, Viacheslav  
Borissenko, Volodymyr  
henaff, Patrick

Donetsk National Tech. Univ.  
Donetsk National Tech. Univ.  
Donetsk National Tech. Univ.  
Univ. of Cergy-Pontoise

This paper presents experimental results on the learning of synchrony between human and a robot arm when they interact in a handshaking situation. The controller is based on two coupled non-linear neurons (central pattern generator, CPG) that are able to learn to oscillate at different frequencies depending on a biological inspired learning mechanism. This mechanism uses interaction force measured in the robot joint as a learning signal. Results show that the CPG learns and follows the human rhythm easily and then enjoy it.

10:00-12:00

Th1.7

*Effect Driven Evolution: Information Systems Architecture for Large Dynamic Organizations*, pp. 1095-1100

Znamenskij, Sergej Vitaljevich

Ailamazyan Program System Inst. of RAS

A new approach is proposed to evolutionary information system engineering. The approach aims to provide high-quality support for large and complex socio-technical systems. The main idea is to replace usual developer framework of formal restrictions and tasks with the developer framework of local transparency and high motivation to increase total system quality as far as possible.

This idea assumes a monitoring subsystem which records, measures properly and displays the real income of each developer activity to system quality (and evolve with the system itself). The quality indicators should reflect related changes in users satisfaction, resource usage and system transparency, which is necessary for successive selection of promising evolution direction.

Another assumption is that system not only allows such a monitoring, but allows local changes to be safely tested and adopted independently (and also in a safe way rejected later if necessary). System should be inconsistency tolerant and extremely truthwise.

It may look like mashup of Wikipedia, social network and BPM, but it can't be obtained as combination of them. The sketch of possible innovative system architecture to support all the features together is briefly described.

10:00-12:00

Th1.8

*Multi-Agent Technologies in Stability Control of Multimodal Large-Scale Energy Network*, pp. 1101-1101

Bakhtadze, Natalia  
Yadykin, Igor  
Lototsky, Vladimir  
Maximov, Eugene  
Vorobjev, Georgy

V.A. Trapeznikov Inst. of Control Sciences, Russian Acad.  
V.A. Trapeznikov Inst. of Control Sciences, Russian Acad.  
V.A. Trapeznikov Inst. of Control Sciences  
Inst. of Control Sciences of Russian Acad. of Sciences  
V.A. Trapeznikov Inst. of Control Sciences

This paper offers a concept of developing an intelligent multi-agent system that maintains stability of Russia's Smart Grid incorporating an active analytical network (AAN) and new algorithms to determine the degree of the system's stability by using Gramians.

10:00-12:00

Th1.9

*Take-Grant Hierarchical Model for Digital Control System*, pp. 1102-1107

Korshunova, Olga  
Promyslov, Vitaly

Inst. of Control Sciences  
V.A. Trapeznikov Inst. of Control Sciences

A formal security hierarchical take-grant model for digital control system is discussed. A simplified security policy for nuclear power plant digital control system is formulated. The realization of formal security model for the proposed security policy is given.

10:00-12:00

Th1.10

*Formal Models of the Scenario-Indicator Approach in the Study of Security Problems in Railway Transport*, pp. 1108-1112

Kulba, Vladimir  
Somov, Dmitry  
Somov, Andrey

Inst. of Control Sciences of Russian Acad. of  
Inst. of Control Sciences of Russian Acad. of Sciences  
Inst. of Control Sciences of Russian Acad. of Sciences

The article considers a set of models of the scenario-indicator approach, including the graph model of the disturbance distribution in a complex technical system (CTS) and the scenario model of an influence of internal factors on parameters of the environment. The problem of optimizing the placement of indicators in CTS is formalized.

10:00-12:00 Th1.11

*Development of Models and Methods of Optimal Control in the Production of Sheet Rolled Metal*, pp. 1113-1118

Genkin, Arkady  
Nikulina, Irina

Inst. of Control Sciences  
Inst. of Control Sciences

Problems are defined that arise in improving the efficiency of hot sheet rolling. A furnace – hot strip mill model is designed that helps overcome these problems and analyze and evaluate the proposed optimization techniques.

10:00-12:00 Th1.12

*Calculation of Technical and Economical Indices for the "Kudankulam" NPP*, pp. 1119-1124

Jharko, Elena

V.A. Trapeznikov Inst. of Control Sciences

The problem of calculation of technical and economical indices and its place in the make-up of the application software of the unit level control system of the automated process control system of the nuclear power plant "Kudankulam" is considered.

10:00-12:00 Th1.13

*An Example of Industrial System Databases Security Assurance During the Maintenance Stage*, pp. 1125-1129

Baybulatov, Artur

RAS ICS

The Nuclear Power Plant Unit Top-level Control System databases are very complex. They are developed and modified as at the stage of design, and maintenance. At the maintenance stage the databases development is more convenient to spend out directly on the site. Exactly for these works the data preparation system was created. With the aid of this system some security and safety assurance measures are provided: unauthorized access protection, limitations of possibility for change making, obligatory verifying of made changes and support the private channel of data transfer from development to system operation.

10:00-12:00 Th1.14

*A Transformation Model to Express Business Rules from Natural Language to Formal Execution: An Application to Nuclear Power Plant*, pp. 1130-1135

Fortineau, Virginie  
Paviot, Thomas  
Guissé, Abdoulaye  
LAMOURI, Samir

Arts et Métiers Paristech  
Arts et Métiers Paristech  
LIPN, Univ. Paris 13  
Arts et Métiers ParisTech

Expressing and implementing business rules is a way to enhance product or business models efficiency. However, business rules are made of, by and for the business. Because information system experts do not master business issues and business experts do not master formal languages and computational issues, expressing business rules within an IS system is a challenge. To overcome the semantic part of this challenge, we propose a semantic transformation framework in four steps, from natural language assertions to formal rules. This transformation model uses semantic web technologies. The application domain is the nuclear industry.

10:00-12:00 Th1.15

*Quality Assurance for Nuclear Power Plant Control System Software*, pp. 1136-1141

Jharko, Elena

V.A. Trapeznikov Inst. of Control Sciences

Most important issues of implementation works on quality assurance of software for plants of high risk operation by use of an example of software for nuclear power plants are considered.

10:00-12:00 Th1.16

*Convergent Decision Support System with Genetic Algorithms and Cognitive Simulation*, pp. 1142-1147

Raikov, Alexander  
Panfilov, Sergey

Inst. of Control Sciences RAS  
Artificial Intelligence department of Moscow State Inst. of

For speeding-up consent achievement in a group of distributed actors it is worth to stabilize and organize underlying factors. For coordination and for mutual understanding among group members, we propose technology, which is based on fundamental thermo-dynamical principles and utilizes soft computing, cognitive simulations and ill-defined problem solution techniques. Based on proposed methodology a cloud service is realized. System was tested on a number of real life problems during branch and corporate strategies development.

10:00-12:00 Th1.17

*Structured Design of Interactive Electronic Technical Manuals Based on Virtual Reality Means*, pp. 1148-1152

Artamonov, Evgeniy  
Balabanov, Andrey  
Romakin, Vladimir

Inst. for Control Sciences of Russian Acad. of Sciences  
Inst. for Control Sciences of Russian Acad. of Sciences  
Inst. for Control Sciences of Russian Acad. of Sciences

This paper represents a method of structured design of interactive electronic technical manuals based on virtual reality means. Results

of applying the method to design of a dedicated program system for creating interactive electronic technical manuals, training systems and simulators based on three-dimensional geometrical models and virtual reality means are reported. A generalized network model of the system, its structure chart, databases of 3D-models for implementing virtual assembling of engineering products are considered.

10:00-12:00 Th1.18

*A Software Tool for Simulation of Motion Control Systems for Maritime Objects*, pp. 1153-1156

Dorri, Manucher Inst. of Control Sciences RAS  
Roschin, Alexander Inst. of Control Sciences RAS

The paper considers features that help to create software tools for developing models of ships as well as their control systems and to model the maritime objects motion processes. These features are realized in the instrumental software complex RDS (Research of Dynamic Systems) developed by the authors.

10:00-12:00 Th1.19

*Automated Dispatch Control; Problems and Details of Modeling*, pp. 1157-1161

Grigoriev, Leonid Russian State Univ. of Oil and Gas  
Kostogryzov, Andrey RIAMC  
Tupysev, Anton Gubkin Russian State Univ. of Oil and Gas

Automated Dispatch Control is the main direction of process control systems development. Automated Dispatch Control Systems (ADCS) play a special role in the continuous production processes control, which include the basic processes of the petroleum industry. To obtain the integrated performance indicators for the ADCS it is necessary to have different estimates, reflecting characteristics of the dispatcher, as the link of man-machine control system. Scientific and methodological basis of man-machine control systems construction are being formed.

The paper presents the features and major tasks for the man-machine control systems development, describes mathematical tools for the ADCS study (including modeling).

10:00-12:00 Th1.20

*Intelligent System for Financial Time Series Prediction and Identification of Periods of Speculative Growth on the Financial Market*, pp. 1162-1167

Ivanyuk, Vera V.A. Trapeznikov Inst. of Control Sciences, 65 Profsoyuznaya  
Tsvirkun, Anatoly Inst. of Control Sciences

The paper presents the author's technique of building intelligent forecasting system based on artificial intelligence methods and statistics. The system makes a prediction for a few periods ahead. Also, the system has a unit identification periods speculative growth in the financial market. In many countries of the world are constantly inflate and deflate "financial bubbles". All this may lead to a new crisis, and therefore, every day, analysts analyze markets, provide various projections, trying to do everything possible to prevent negative consequences. This paper analyzes the model of bubbles. The main part of the work is the construction of the author's system of forecasting and identification.

**ThN1** Steve Jobs' Atrium (ITMO)  
**Advanced Modeling, Algorithmic, and Simulation Tools for Manufacturing Applications** (Poster/Interactive Session)

Chair: Chernyshev, Kirill V.A. Trapeznikov Inst. of Control Sciences  
Co-Chair: Aristova, Natalia V.A. Trapeznikov ICS RAS

13:20-15:20 ThN1.1

*Production Line Performance by Using Queuing Model*, pp. 1168-1173

Marsudi, Muhammad King Abdulaziz Univ.  
Shafeek, Hani King Abdulaziz Univ.

The efficiency of a production system is mainly characterized by batch size and throughput. To ensure system efficiencies, batch size and throughput must be in conformity to achieve optimum utilization. This paper discusses the use of Queuing Network Theory to study the effect of batch size and throughput in optimizing resource utilization, particularly machine resources in a manufacturing system. A factory in the manufacturing industry performing assembly operations in its production lines was the focus of this study. The result of the study was that when batch size and throughput are increased, the utilization also increases proportionately. Bottleneck will occur when the capacity is not enough to meet the demand requirement.

13:20-15:20 ThN1.2

*The Projection Method for Reaching Consensus in Discrete-Time Multiagent Systems*, pp. 1174-1179

Chebotarev, Pavel Inst. of Control Sciences of the Russian Acad. of Sciences  
Agaev, Rafiq Inst. of Control Sciences of the Russian Acad. of Sciences

In the coordination problems for multi-agent systems, a well-known condition of achieving consensus is the presence of a spanning arborescence in the communication digraph. The paper deals with the discrete consensus problem in the case where this condition is not satisfied. Let  $\mathcal{P}$  be a row stochastic influence matrix, whereas  $\mathcal{T}_{\mathcal{P}}$  is the subspace of initial opinions that ensure consensus in DeGroot's iterative pooling model. We propose a method of coordination that consists of: (1) transformation of the vector of initial opinions into the closest vector in  $\mathcal{T}_{\mathcal{P}}$  and (2) subsequent DeGroot process with the matrix  $\mathcal{P}$ .

13:20-15:20 ThN1.3

*Multi-Agent Approach to Design of Multimodal Intelligent Immune System for Smart Grid*, pp. 1180-1185

Bakhtadze, Natalia V.A. Trapeznikov Inst. of Control Sciences, Russian Acad.  
Yadykin, Igor V.A. Trapeznikov Inst. of Control Sciences, Russian Acad.



Lototsky, Vladimir  
Maximov, Eugene  
Sakrutina, Ekaterina

V.A. Trapeznikov Inst. of Control Sciences  
Inst. of Control Sciences of Russian Acad. of Sciences  
V.A. Trapeznikov Inst. of Control Sciences, Russian Acad.

The design of intelligent control system for active adaptive smart grid is considered. To avoid the loss of stability of electric energy systems, and to detect inner and outer threats, the multi-agent based concept of design of universal intelligent immune system is suggested.

13:20-15:20

ThN1.4

*Nonlinear Models of Oil Frontal Displacement and Shock Waves*, pp. 1186-1191

Akhmetzyanov, Atlas  
Kushner, Alexei  
Lychagin, Valentin

Inst. of Control Sciences, Russian Acad. of Sciences  
Inst. of Control Sciences of the Russian Acad. of Sciences  
Tromsø Univ.

The goal of this paper is to use geometrical theory of nonlinear partial differential equations and singularities theory to obtain the general scheme for constructing an optimal control for fronts of petroleum displacement by active reagent. We illustrate our geometric approach to evolutionary models of petroleum deposits. Original simulation methods for the frontal displacement of oil by water and solutions of active reagents in porous medium of oilfield reservoirs with and without capillary forces has been developed. For simplicity and clarity of presentation the only one-dimensional models of fluid filtration between parallel batteries of production and injection wells (Buckley-Leverett and Rapoport-Liss models) has been considered. The model for oil displacement by solutions of active reagents in hot water has been also analyzed. The proposed results are generalized for two- and three-dimensional filtration models in reservoir engineering using vertical and horizontal wells, which greatly facilitates the statement and development of simulation and optimal control methods for reservoir engineering in general

13:20-15:20

ThN1.5

*Efficient Mechanism for Resource Allocation with Quadratic Payments and Its Realization Via an Iterative Bargaining Process*, pp. 1192-1197

Korgin, Nikolay

V.A. Trapeznikov Inst. of Control Sciences

The problem of Pareto-efficient resource allocation among rational agents is considered. The mechanism that implements efficient allocation as Nash equilibrium in case when utility is transferable among agents is offered. The approach to solution of allotment problems as multicriteria public choice problems lies in the basis of this mechanism, that allows to implement Groves-Ledyard mechanism, which was initially designated to the solution of public good problems. It is shown, that there is exist the only Nash equilibrium in a game among agents induced by the mechanism developed. For the case when utility functions are private information of agents, it is shown, that efficient allocation may be realized via an iterative bargaining process based on this mechanism, if agents behave according to Cournot dynamics. Possibility to reduce agent's messages space to a scalar one in iterative bargaining process is demonstrated. It is also shown that mechanism developed may be inconsistent for some nontrivial agent's behavior – there exist some game solutions which can be reached via iterative bargaining process but are not Nash equilibrium and don't yield efficient resource allocation.

13:20-15:20

ThN1.6

*A Sliding Mode Algorithm for Non-Stationary Parameters Identification*, pp. 1198-1203

Kochetkov, Sergey

Istitute of Control Sciences

The problem of the parameters identification is considered for the linear time varying systems presented in a canonical block form. The main algorithm is based on sliding mode observers or observers with high-gain coefficients. The asymptotic convergence of parameters estimations is proved under assumption that the non-stationary parameters are changed according to some known dynamical models. The simulation results show the efficiency of the proposed algorithm.

13:20-15:20

ThN1.7

*State Observers for the Control Systems of Induction Motor Drives*, pp. 1204-1209

Utkin, Victor  
Krasnova, Svetlana  
Utkin, Anton

ICS  
ICS  
ICS

The problem of tracking is considered for a given speed of rotation of asynchronous motor with a certain flux. It is assumed that only the stator currents are measured. To obtain current unmeasured variables synthesis procedure of state observers on sliding modes for the drive shaft with the sensor and sensorless induction motor is developed.

13:20-15:20

ThN1.8

*Estimation of Ensemble Group Stability in Large-Scale Socio-Economic Systems*, pp. 1210-1215

Kleparskiy, Vadim

V.A. Trapeznikov Inst. of Control Sciences

Estimation of ensemble group-stability changes, that were observed after the 1998 default in Russian ferrous metallurgy, is obtained by means of "passive" experiment on the basis of entropy approach, ergodic hypothesis and transversal surface Poincare method.

13:20-15:20

ThN1.9

*Modern Control Theory Applied to Inventory Control for a Manufacturing System*, pp. 1216-1221

Azarskov, Valerii  
Skurikhin, Vladimir  
Zhiteckii, Leonid  
Lypoi, Roman

National Aviation Univ.  
Int. Centre of Inform. Tech. & Systems, Inst. of Cybe  
Inst. of Cybernetics  
National Aviation Univ.

This paper deals with controlling the in-process inventories for the manufacturing system of a typical machine-building enterprise which

includes the machining, the transport, the storage bunker and the assembly line. To this end, the modern control theory concepts are used. Within these concepts, the inventory control problem as the so-called I1 optimization problem is stated and solved. Based on the developed results, a new reorder policy allowing to improve the behavior of the inventory control system is advanced. A simulation example is provided to demonstrate the advantage of this policy.

---

13:20-15:20

ThN1.10

*Multilevel Parallelization of Simulation and Control Problems of Gas Fields Development*, pp. 1222-1227

Akhmetzyanov, Atlas  
Grebennik, Oleg  
Salnikov, Anton

Inst. of Control Sciences, Russian Acad. of Sciences  
Inst. of Control Sciences of Russian Acad. of Sciences  
Inst. of Control Sciences, Russian Acad. of Sciences

Correct statement of control problems of gas fields development is provided by a balanced selection of technological parameters and control actions included in the model equations. The proposed approach is universal for the simulation of fluid filtration in porous media for oil and gas fields development. The proposed schema of domain (homogeneous units of reservoir) decomposition (splitting) to the superelements is a highly successful and provides a high efficiency of hierarchical schemes for parallelization of computations for solving the considered problems of simulation and control with minimal time consumption. The implementation of algorithms is focused on multiprocessor systems using parallel computing interfaces and frameworks like MPI, OpenMP, OpenCL, etc.

---

13:20-15:20

ThN1.11

*The Use of Reversible Structural Models for Modelling of the Drill String*, pp. 1228-1233

Verlan, Anatoliy  
Fedorchuk, Volodymyr  
Ghazi, Ameer

Pukhov Inst. for Modelling in Energy Engineering, National A  
Kamyanets-Podilskiy National Univ.  
King Saud Univ. Riyadh

A structural reversible model of the distributed nonlinear links of the drilling unit is obtained. Proposed model takes into account: drill string inhomogeneity caused by using drilling pipes of different types; derrick load-caused deformation and its dynamics; resistance forces, caused by interaction of drilling liquid with the drill string's walls; popping force; drilling liquid column flywheel action; resistance forces, caused by the chisel interaction with formation. Demonstrated modeling results indicate that the derived model can be successfully used: on the drilling device composition calculation stage; in control system for maintaining optimal behaviors by drilling; for round-trips operations optimization.

---

13:20-15:20

ThN1.12

*Macroeconomic Disequilibrium and Stimulation of Economic Growth*, pp. 1234-1239

Nizhegorodtsev, Robert  
Goridko, Nina

V.A. Trapeznikov Inst. of Control Sciences RAS  
Inst. for Control Studies RAS

The paper invents the main principles of so called disequilibrium paradigm in a macroeconomic theory. It deals with two types of disequilibrium macrosystems, in recessionary gap and inflation gap. The realities of Russian regions' disequilibrium are discussed. The relationship between GDP growth and GDP per capita in different types of countries is under consideration. The main conclusion is that the macroeconomic realities of stagnating developed countries are not the proper example for contemporary Russian economy. The path of new industrialization is a way for stimulation of innovative activities in Russia.

---

13:20-15:20

ThN1.13

*The Design of High Precise Discrete Control Systems for Linear Plants and the Approximate Inversion Problem*, pp. 1240-1245

Bunich, Alexander  
Nikulina, Irina

V.A. Trapeznikov Inst. of Control Sciences  
Inst. of Control Sciences

The LQ-problems of controller design for discrete-time plant with prescribed upper stabilization accuracy limit with respect to stationary response variance criterion is considered. It is proved that control purpose is attainable in the class of stationary perturbations of fixed power and known spectrum localization. The iterative design procedure is suggested and exponential dependence of upper accuracy limit on number of iterations is established.

---

13:20-15:20

ThN1.14

*Analysis of Identifiability of Nonlinear Plants with Weakly Formalized Structure*, pp. 1246-1251

Mozharovskii, Igor  
Torgashov, Andrey  
Digo, Galina  
Digo, Natalia

Inst. of automation and control processes Far Eastern branch  
Inst. for Automation and Control Processes FEB RAS  
Inst. of automation and control processes Far Eastern branch  
Inst. of automation and control processes Far Eastern branch

The method for determining identifiability of complex nonlinear plants with unknown (weakly formalized) model structure based on the algorithm of alternating conditional expectations has been proposed. The paper contains examples that illustrate the use of this method.

---

13:20-15:20

ThN1.15

*Simulation of Discrete Manufacturer with an End Product Feedback*, pp. 1252-1255

Chadeev, Valentin M.  
Aristova, Natalia

V.A. Trapeznikov Inst. of Control Sciences, Russian Acad.  
V.A. Trapeznikov ICS RAS

It is shown that for effective management of a discrete manufacturer with an end product feedback, the hierarchy strategy accompanied by the control of involved technological operations is to be applied. The mathematical tools are proposed and implemented in the simulation system that allows to determine the most effective schemes for a feedback discrete manufacturer control.

---

13:20-15:20 ThN1.16

*The Study Method of Adaptive Manufacturing Control System*, pp. 1256-1261

Chertovskoy, Vladimir

Nord-West Printing Inst.

Abstract: A homogeneous method of dynamic linear programming is suggested for the mathematical description and study of diverse processes of planning and control. Features of the adaptive control system and applications of the method are considered. Results of the study of structural elements interactions during planning and control in a three-level system are shown. Results of a computer realization of the method are shown.

---

13:20-15:20 ThN1.17

*On Solving Optimization Problems with Inexact Data*, pp. 1262-1267

Latipova, Alina Taihovna

South Ural State Univ.

There are considered two kinds optimization problems with interval uncertainty. The first kind is interval linear programming (ILP), the second kind is finding equilibrium position for interval von Neumann's model (bilinear problem). Definitions of different types of solutions for both kinds of problems and methods for finding these solutions are given. These methods imply using matrices of upper and lower bounds of initial interval data and reducing interval optimization problems to exact (ordinary) linear programming problems.

---

13:20-15:20 ThN1.18

*Analytical Evaluation of Sustainable Competitive Advantage*, pp. 1268-1271

Takala, Josu

Univ. of Vaasa

Liu, Yang

Univ. of Vaasa

Feng, Bin

Vaasa Univ. of Applied Sciences

Yang, Wenshan

Univ. of Vaasa

This paper introduces a novel idea to model and evaluate the level of sustainable competitive advantage (SCA) in a company's operations, basing on the development directions of the manufacturing strategy and the effectiveness/sufficiency of its supporting resource allocation. The SCA evaluation model explores whether the real resource allocation supports the desired operations strategy and provide a guidance to help decision makers to find out the sustainability of the company's current operational competitiveness. The model has been undergoing weak market tests in a multinational case company and the analysis results are promising according to the feedback opinions.

---

13:20-15:20 ThN1.19

*Development of Intelligent Identification Models and Their Applications to Predict the Submarine Dynamics by Use of Computer Simulation Complexes*, pp. 1272-1277

Bakhtadze, Natalia

V.A. Trapeznikov Inst. of Control Sciences, Russian Acad.

Pavlov, Boris

V.A. Trapeznikov Inst. of Control Sciences, Russian Acad.

Sakrutina, Ekaterina

V.A. Trapeznikov Inst. of Control Sciences, Russian Acad.

A conception of constructing intelligent virtual analyzers as an implementation of the identification approach within control systems is presented, enabling one to develop and adjust prediction models in the most effective manner. Specifically, the paper presents an approach constructing identification models of a submarine by us the associative search applying the technological archives and knowledge base created by use of simulation complexes.

---

13:20-15:20 ThN1.20

*Simulation Technologies for Long-Term Target Planning and In-Flight Management of the Spacecraft Control Systems*, pp. 1278-1283

Somov, Sergey

Samara State Tech. Univ.

Butyrin, Sergey

Samara State Tech. Univ.

Somova, Tatyana

Samara State Tech. Univ.

The paper presents a brief description of developed software for simulation and animation, long-term target planning and in-flight management of the land-survey spacecraft control systems and gives recommendations for its industrial application.

Technical Program for Friday June 21, 2013

<b>FrA1</b>	Aud.11 (ITMO)
<b>Analysis of Supply and Production Systems - 1 (Invited Session)</b>	

Chair: Georgiadis, Michael	Univ. of Western Macedonia
Co-Chair: Colledani, Marcello	Pol. di Milano

10:00-10:20	FrA1.1
-------------	--------

*A Bernoulli Model of Multi-Product Manufacturing Systems (I)*, pp. 1284-1289

Zhao, Cong	Univ. of Wisconsin - Madison
Li, Jingshan	Univ. of Wisconsin - Madison

Modeling and analysis of multiple products manufacturing systems are of significant importance. In this paper, a Bernoulli model of multi-product manufacturing system with unreliable machines and finite buffers is introduced. In such a model, each machine is capable of processing multiple product types, and each buffer is shared for all types of products. All machines process the parts following the same sequence of different product types. By aggregating different product types into a single one, closed formulas have been derived to evaluate the production rate of the line with one or two machines, and recursive procedures are used to analyze longer lines. Numerical studies indicate that such a method has a high precision in performance evaluation. In addition, system-theoretic properties, such as asymptotic property, monotonicity and reversibility, have been investigated.

10:20-10:40	FrA1.2
-------------	--------

*Integration of Sale and Leaseback in the Optimal Design of Multi-Echelon Supply Chain Networks (I)*, pp. 1290-1295

Longinidis, Pantelis	Univ. of Western Macedonia
Georgiadis, Michael	Univ. of Western Macedonia

Research on integrated supply chain network (SCN) design models that capture financial matters is still in its infancy. However, as SCN managers require holistic decision support models that quantify the financial impact of their production and distribution decisions, this research stream is likely to become a mainstream. This paper aims to enrich the relevant literature by providing a mixed integer non linear programming (MINLP) SCN design model that incorporates the sale and leaseback (SLB), a method that releases the value of real estate, improves balance sheet, and realises tax benefits. The model will assist SCN managers in strategic decision making during a capital budgeting process.

10:40-11:00	FrA1.3
-------------	--------

*Scheduling Energy Cogeneration Units under Energy Demand Uncertainty (I)*, pp. 1296-1301

Kopanos, Georgios M.	Imperial Coll. London
Georgiadis, Michael	Aristotle Univ. of Thessaloniki
Pistikopoulos, Efstratios N.	Imperial Coll.

This work presents a methodology for the scheduling of networks that consist of various energy cogeneration units (i.e., generate both electrical energy and heat) under high energy demand uncertainties of bounded form. First, a mathematical framework for the problem in question is developed, and then we present a reactive scheduling approach that relays on multiparametric programming and a receding horizon. In brief, the original mathematical scheduling model is reformulated into a multiparametric programming problem, wherein we consider as uncertain parameters: the energy demands as well as the initial and the final state of the overall system. The resulting parametric optimization problem is solved once and off-line, and afterwards a receding horizon-like approach is applied for the reactive scheduling –that acts on the fly in the energy demand realizations– by performing just function evaluations and avoiding the on-line optimization of such systems. A couple of problem instances are solved to shed light on the potential benefits of the suggested method. The proposed concept has highly practical interest and is very promising since could find application in several other optimization problems that can involve: large-scale optimization problems and process scheduling problems under uncertainty.

11:00-11:20	FrA1.4
-------------	--------

*Optimal Disposition of Returns Based on Inaccurate Quality Assessment Procedures (I)*, pp. 1302-1307

Nenes, George	Univ. of Western Macedonia
Panagiotidou, Sofia	Aristotle Univ. of Thessaloniki
Tagaras, George	Aristotle Univ. of Thessaloniki
Zikopoulos, Christos	Aristotle Univ. of Thessaloniki

In order to obtain timely quality information of returns, remanufacturers have to rely on inexpensive, fast, yet inaccurate classification procedures. Quality assessment of returned products is usually based on the comparison of certain product characteristics or usage conditions to predetermined thresholds. Classification inaccuracies typically occur because it is very rare to identify a product attribute, which is easily evaluated and, at the same time, in perfect correlation with product quality condition. Therefore, in the majority of industrial applications, classification procedures are subject to errors, i.e., rejection of good quality units and acceptance of inferior quality units. The objective of the current research is to identify the economic trade-offs related to the determination of the acceptance / rejection criterion taking into account the inevitable classification errors, under different assumptions regarding the available quality classes and demand characteristics.

11:20-11:40	FrA1.5
-------------	--------

*Recovery Planning with Stochastic Lot-Processing Times (I)*, pp. 1308-1313

Zikopoulos, Christos	Aristotle Univ. of Thessaloniki
----------------------	---------------------------------

Although the issue of uncertain quality of used products has a central role in reverse logistics and recovery process planning, little work has been done to study the impact of the different effort and time required for the recovery of units with different quality condition on the inventory management decisions and the resulting service levels. In the present paper we examine this issue in a multi-period horizon setting to determine the optimal parameters of a (Q, s) continuous review inventory management policy. Furthermore, we

quantify the increase in costs because of quality uncertainty, as well as the economic benefits of taking into account this uncertainty during recovery planning.

11:40-12:00

FrA1.6

*Analysis of a Three Machine-One Buffer Merge System with Quality and Operational Failures (I)*, pp. 1314-1319

Maria Koteoglou, Msc.

Aristotle Univ. of Thessaloniki, Department of Ec.

Alexandros Diamantidis, Dr.

Aristotle Univ. of Thessaloniki, Department of Ec.

This paper examines a three machine- one buffer merge system with quality and operational failures. It is assumed that the buffer has two immediate preceding machines, performing the same operations and one immediate succeeding machine that receive material from the buffer. For the case where the buffer reaches its own capacity, one of the two preceding machines has priority over the other to dispose its processed part into the buffer. Processing times are assumed to be deterministic and identical for all machines and are taken as the time unit. Operational, quality failures and repair probabilities are geometrically distributed. All possible transition equations for the examined model are derived and a recursive algorithm that generates the transition matrix for any value N of the storage level is developed. Such a model can be used as a building block in a decomposition method for the performance evaluation of large production systems with split/merge operations (for example, flow lines with rework loops).

FrA2

Oak Hall (ITMO)

**Towards Modeling, Management, Control of Sensing and Green Enterprise As Complex Adaptive System of Systems (Invited Session)**

Chair: Dumitrache, Ioan

Univ. Pol. of Bucharest

Co-Chair: Jardim-Goncalves, Ricardo

UNINOVA - Inst. de Desenvolvimento de Novas Tecnologias

10:00-10:20

FrA2.1

*Sustainable Interoperability of Sensing Enterprise (I)*, pp. 1320-1325

Danila, Cristian

Univ. Pol. of Bucharest

Stanescu, Aurelian M.

Univ. Pol. of Bucharest

Jardim-Goncalves, Ricardo

UNINOVA - Inst. de Desenvolvimento de Novas Tecnologias

Agostinho, Carlos

UNINOVA

Florea, Adina magda

Univ. Pol. of Bucharest

Serbanescu, Cristina

Univ. Pol. din Bucuresti

The integration of Web-Services, smart agents and "smart objects" enables enterprise innovation and competitiveness in a globalized economy. The paper proposes a multi view modelling framework that enables enterprises to develop context-awareness and to achieve self-sustainable interoperability.

10:20-10:40

FrA2.2

*The Enterprise of Future As a Cyber-Physical System (I)*, pp. 1326-1331

Dumitrache, Ioan

Univ. Pol. of Bucharest

Caramihai, Simona Iuliana

Pol. Univ. of Bucharest

The paper presents a conceptual model of the manufacturing enterprise of the future, which is centered on knowledge. It is introduced the concept of organizational wisdom, as an intelligence level that allows manufacturing enterprise to take sustainable decisions. Cyber-Physical Systems concept is the most promising approach to implement the knowledge/ wisdom model of the enterprise.

10:40-11:00

FrA2.3

*Quality Management in Sensing Enterprise (I)*, pp. 1332-1337

Stegaru, Georgiana

Univ. Pol. of Bucharest

Moiescu, Mihnea Alexandru

Univ. Pol. Bucharest

Sacala, Ioan Stefan

Univ. Pol. Bucharest

Costetchi, Natalia

Univ. Pol. of Bucharest

Quality management has begun in manufacturing organizations with product inspections and has evolved into methodologies and standards that are used today in many domains. Sensing Enterprise represents a new challenge for quality engineers because of the dynamic and novelty behind this concept that brings together Internet of Things and Internet of Services. We present in this paper a framework that addresses essential requirements such as interoperability, adaptability, performance, security and manageability to achieve quality driven service based manufacturing in Sensing Enterprise.

11:00-11:20

FrA2.4

*Standard Blueprints for Interoperability in Factories of the Future (FoF) (I)*, pp. 1338-1343

Ferreira, Jose

Faculdade de Ciências e Tecnologia, FCT, Univ. Lisb

Beca, Miguel Ferro de

Uninova

Agostinho, Carlos

UNINOVA

Nunez, Maria Jose

ADIMA

Jardim-Goncalves, Ricardo

UNINOVA - Inst. de Desenvolvimento de Novas Tecnologias

Globalisation has become attractive to small companies, as it has allowed them to enter in new markets and increase their profits. However, they still face some challenges, as larger corporations are also increasing their market share in those new markets, leaving little room for the others to compete. Therefore, SMEs need to join efforts with other SMEs and form consortiums. Still, consortium formation is not without its problems. Some issues arise because the various SMEs in a consortium utilize different systems, different standards, and in the case of international consortiums, there are also language and culture barriers, which cause difficulties in

communication. One way to avoid the issues is the creation of a central system, which will relate with the different systems belonging to the various SMEs. This is the aim of the IMAGINE project, which aims to use blueprints as a standard for company, product and process information. This paper presents a proposal for an extension of the Partner and Product Blueprint to be integrated in the IMAGINE platform.

11:20-11:40

FrA2.5

*Intelligent Negotiation Mechanism for Supporting the Interoperability within the Sensing Enterprise (I)*, pp. 1344-1349

Stanescu, Aurelian M.	Univ. Pol. of Bucharest
Cretan, Adina	"Nicolae Titulescu" Univ. of Bucharest
Coutinho, Carlos	Faculdade de Ciencias e Tecnologia, Univ. Nova de Lisboa,
Jardim-Goncalves, Ricardo	UNINOVA - Inst. de Desenvolvimento de Novas Tecnologias

The Sensing Enterprise is a novel concept that refers to an enterprise anticipating future decisions by using multi-dimensional information captured through physical and virtual objects. The Sensing Enterprise concept is shifting focus towards a borderless enterprise, having at its core the collaboration and continuous interactions among smart objects and systems. But in the actual competitive and global business context, the maintenance of the collaboration environment through the interoperation among heterogeneous smart virtual and physical objects in a collaborative organizational environment becomes difficult to achieve. Therefore, in a dynamic context a change in any component of the networked partners affects the others, creating difficulties to sustain operating networked environment. In this respect, this paper proposes an intelligent negotiation framework as a key mechanism to achieve and maintain the interoperability between the organisations' smart objects and applications, and its validation in an industrial scenario. To allow a sustainable, flexible and generic approach towards the infrastructure implementation in global scale, a cloud-based platform is proposed for setting of the Sensing Enterprise framework.

11:40-12:00

FrA2.6

*Interoperability Scenarios in Serious Games Ecosystems: The Impact on FInES (I)*, pp. 1350-1355

Stanescu, Ioana Andreea	Advanced Tech. Systems
Stefan, Antoniu	Advanced Tech. Systems
Filip, Florin Gheorghe	Romanian Acad.
Kittl, Christian	evolaris next level GmbH
Lim, Theodore	Heriot-Watt Univ.

Traditional companies have transformed their approaches under the impact of globalization, competition, information technology and the Internet. They integrate into a volatile network of collaborating business – the business value network that has become increasingly important in the world's economy of the future. Their appropriate IT support must efficiently realize business collaborations and interactions between globally spread organizations. This paper presents the impact of serious games ecosystems on Future Internet Enterprise Systems (FInES) and discusses interoperability-based perspectives that aim to increase efficiency and performance.

**FrA3**

Aud.41 (ITMO)

**Scheduling and Transportation Systems - 1 (Invited Session)**

Chair: Lazarev, Alexander	Inst. of Control Sciences, Russian Acad. of Sciences
Co-Chair: Werner, Frank	Otto-von-Guericke-Univ. Magdeburg

10:00-10:20

FrA3.1

*A Graphical Approach for Solving Single Machine Scheduling Problems Approximately (I)*, pp. 1356-1361

Gafarov, Evgeny R.	Inst. of Control Sciences of the Russian Acad. of Sciences
Dolgui, Alexandre	Ec. Nationale Supérieure des Mines de Saint-Etienne
Lazarev, Alexander	Inst. of Control Sciences, Russian Acad. of Sciences
Werner, Frank	Otto-von-Guericke-Univ. Magdeburg

For five single machine total tardiness problems a fully polynomial-time approximation scheme (FPTAS) based on a graphical algorithm is presented. The FPTAS has the best running time among the known approximation schemes for these problems.

10:20-10:40

FrA3.2

*A Bicriteria Problem of Synthesizing Optimal Object Flow Service Policies (I)*, pp. 1362-1367

Kuimova, Anastasia S.	Volga State Acad. of Water Transport
Kogan, Dmitriy I.	Moscow state Univ. Inst. making and computer science
Fedosenko, Yury S.	Volga State Acad. of Water Transport

We propose a mathematical model of binary object flow servicing in a uniprocessor system with two refillable storage components. This model is used to solve a problem of synthesizing optimal object flow service policies subject to two minimization criteria. This problem is known to be NP-hard. We propose three exact algorithms based on the dynamic programming and the branch-and-bound approaches to handle this problem and present results of computational experiments of their software implementation. The designed model gives an adequate description of some control processes in water-transport systems, such as delivery of fuel oil to the Northern Territories in Russian Federation. The model and the developed algorithms are going to be adopted in a special decision support system in transportation.

10:40-11:00

FrA3.3

*Solving a Job-Shop Scheduling Problem by an Adaptive Algorithm Based on Learning (I)*, pp. 1368-1373

Sotnikov, Yuri	Acad. of Sciences of Belarus
Gholami, Omid	National Acad. of Sciences of Belarus
Werner, Frank	Otto-von-Guericke-Univ. Magdeburg

A learning stage of scheduling tends to produce knowledge about a benchmark of priority dispatching rules which allows a scheduler to improve the solution quality for a set of similar job-shop problems. Once trained on the sample job-shop problems (usually with small sizes), the adaptive algorithm solves a similar job-shop problem (with a moderate size or a large size) better than heuristics used as a benchmark at the learning stage of scheduling. Our adaptive algorithm does not guarantee to perform as an exact algorithm or better than a more sophisticated heuristic algorithm (like e.g. the shifting bottleneck one) which need a large running time. For an adaptive algorithm with a learning stage, the job-shop scheduling problem is modeled via a weighted mixed (disjunctive) graph with the conflict resolution strategy used for finding an appropriate schedule.

11:00-11:20

FrA3.4

*Optimal Management of Shuttle Robots in a High-Rise Warehouse Using Timed Automata Models (I)*, pp. 1374-1379

Subbiah, Subanatarajan  
Schoppmeyer, Christian

Tech. Univ. Dortmund  
Process Dynamics and Operations Group, Department  
of Biochemical

De La Fuente Valdès, Josè Manuel  
Sonntag, Christian  
Engell, Sebastian

M+W Group,  
Tech. Univ. Dortmund  
TU Dortmund

In warehousing systems, the speed of the removal and distribution of goods often represents a bottleneck as it limits the achievable throughput and, thus, the efficiency of the complete warehousing system. Consequently, an optimal management of the distribution of goods can lead to large efficiency and financial gains. In this contribution, it is shown for an accurate model of an industrial real-world high-rise warehouse (HRW), which is connected to a polymer production plant, that rigorous optimization of the distribution procedure can lead to a large efficiency increase in comparison to standard techniques. To this end, the distribution problem is modelled using timed automata (TA) in which the jobs arrive one after the other and are not known in advance. The TA-based approach, which was originally developed for standard scheduling problems, is extended to a reactive moving window approach that employs a cost-optimal reachability algorithm to compute optimal plans for the goods distribution. We show that compared to a typical first-come first-served dispatching rule, this approach can lead to throughput gains of more than 40%.

11:20-11:40

FrA3.5

*Makespan Minimization for a Two-Machine Scheduling Problem with a Single Server (I)*, pp. 1380-1385

Hasani, Keramat  
Kravchenko, Svetlana  
Werner, Frank

Islamic Azad Univ. Branch  
Acad. of Sciences of Belarus  
Otto-von-Guericke-Univ. Magdeburg

We consider the following problem. A set of non-preemptable jobs has to be scheduled on two identical parallel machines such that the makespan is minimized. Before processing, each job must be loaded on a machine, which takes a given setup time. All these setups have to be done by a single server which can handle at most one job at a time. For this problem, we propose three mixed integer linear programming formulations. We compare our results with known heuristics.

11:40-12:00

FrA3.6

*A Multi-Agent Distributed Framework for Collaborative Transportation Planning (I)*, pp. 1386-1391

MEMON, Muhammad Ali  
Archimede, Bernard

LGP-ENIT  
Univ. de Toulouse, Lab. GeniedeProduction, Ec. Nati

Today enterprises are organized in network of several distributed production sites in a geographical area more and more extended, where sites use the intermediary products of other sites to manufacture the final products. Therefore they transport raw materials and intermediate products between plants for manufacturing. Additionally these enterprises have to distribute their final products to far away consumers. In this context, it is difficult and not cost effective for these enterprises to manage their own transport vehicles. Thus they outsource their transportation tasks to third party logistics enterprises. These enterprises group transport orders of multiple enterprises together in order to reduce cost and travels number. The objective of this paper is to present a distributed architecture planning of transportation activities aimed at better utilize transport resources by grouping several orders of transport for each effective displacement.

**FrA4**

Aud.51 (ITMO)

**Maintenance & Reliability** (Invited Session)

Chair: REZG, Nidhal  
Co-Chair: Vladova, Alla

Metz Univ.  
Orenburg State Univ.

10:00-10:20

FrA4.1

*Jointly Optimal Preventive Maintenance under Spare Parts Order Strategy (I)*, pp. 1392-1396

BA, Kader  
Erray, Walid  
Dellagi, Sofiene  
REZG, Nidhal

Univ. de Lorraine  
ArcelorMittal Maizières Res. Res. SA  
Univ. de Metz  
Metz Univ.

In this paper, we deal with the problem of preventive maintenance combined with an efficient spare parts strategy. In fact, we established simultaneously the optimal preventive maintenance period and the optimal quantity of spare parts to order for non-self announcing systems. We considered a manufacturing system of one type of product. The preventive and corrective maintenance actions consists both in replacing the defective part by a new identical one. A mathematical model is developed based on cost criteria and a numerical procedure is used to find the optimal maintenance actions and spare parts quantity to order minimizing operating costs over finite horizon.

Keywords: Economic order quantity, maintenance costs, spare parts order, preventive maintenance, corrective maintenance,

optimization

10:20-10:40

FrA4.2

*Multigraph Models of Gas-Transport Objects States and Identification Method with Intelligent Processing of Information (I)*, pp. 1397-1402

Vladova, Alla

Orenburg State Univ.

Vladov, Jury

Orenburg State Univ.

This article presents a method for reducing a dimension of the identification problem of gas-transport objects technical condition. Within this method there were created special types of multigraph models with interval-valued states of geometric characteristic of metal shell damages. Depending on gas-transport objects operation time, the behavior of proposed models has been examined and operating performance with due account for states identification has been determined, also the possibility of reducing the scope of diagnostics and repair works was shown.

10:40-11:00

FrA4.3

*A Bi-Criteria Flow-Shop Scheduling with Preventive Maintenance (I)*, pp. 1403-1408

HNAIEN, Faicel

UTT,

yalaoui, farouk

Univ. of Tech. of Troyes

In this study, a bi-criteria flow-shop scheduling with preventive maintenance tasks is considered. The objective function of the scheduling is the minimization of the makespan and for the preventive maintenance is the minimization of the sum of the variation (advance or delay) between theoretical and actual frequency for two machines. The integer programming model is presented and can be solved only small size problems. For large size problem, four meta-heuristics methods are presented. Two genetic algorithms (NSGAI and SPEAI) are implemented. 2 new versions of NSGAI (noted HY-NSGAI) and SPEAI (noted HY-SPEAI) based on Johnson algorithm are presented. To evaluate the proposed approaches several tests and metrics are proposed.

11:00-11:20

FrA4.4

*Application of Integrated Human Error Identification Techniques for Chemicals Cylinder Change Task (I)*, pp. 1409-1414

Cheng, Ching-Min

National Tsing Hua Univ.

Hwang, Sheue-Ling

National Tsing-Hua Univ.

LIN, I-KAI

Department of Occupational Safety and Health, Chung Shan Medical

This paper outlines the human error identification techniques currently existent to assess and analyze the risk and human error. Even if many formal error identification techniques have existed for years, none could be validated for use to every different domain. This study considers lots of possible error modes that include external error modes, internal error modes, performance shaping factors and psychological error mechanisms, and integrates a number of execution procedures of human error identification techniques, including task analysis, criticality analysis and reliability analysis, to assess the latent human error and hazard risk in a case plant. It is concluded that the integrated methods is a valuable aid to develop much safer operational processes and can be used to predict human error rates of critical tasks in the plant.

11:20-11:40

FrA4.5

*Spare Part Returns in Stochastic Deteriorating Manufacturing System under a Condition-Based Maintenance Policy: Simulation-Based Genetic Algorithm Approach (I)*, pp. 1415-1420

Boudhar, Hamza

Lorraine Univ.

DAHANE, Mohammed

ENIM

REZG, Nidhal

Metz Univ.

This paper deals with the problem of spare part returns and its impact on the degradation of a production unit. The main motivation in this context is how to reuse a recovered spare part and at what level (quality) the remanufacturing action should be performed. The manufacturing under study consists of one failing and repairable machine. Our objective is to determine the decision thresholds  $d_s$  and  $d_r$  based on the inspected degradation level  $d(t)$ . Failure occurs when the degradation level exceeds the critical threshold  $d_{max}$ . When the degradation level exceeds  $d_r$ , a preventive maintenance action is performed.  $d_s$  is threshold to manage the spare part order policy.

11:40-12:00

FrA4.6

*Condition Based Maintenance Applied to Reduce Unavailability of Machines in Flexible Job Shop Scheduling Problem (I)*, pp. 1421-1426

ZHENG, Yahong

Ec. Centrale de Lille, LAGIS

mesghouni, Khaled

Ec. Centrale de Lille

Collart-Dutilleul, Simon

IFSTTAR/ESTAS

Maintaining the reliability of a system is one of the most critical and challenging tasks for manufacturing system during production. In this paper, we suggest to use condition based maintenance (CBM) in order to reduce unavailability of machines. CBM is a kind of preventive maintenance (PM), based on condition monitoring. This paper focuses on solving the flexible job shop scheduling problem with preventive maintenance (FJSPPM), adding PM into FJSP. Application of CBM makes the scheduling problem dynamic, as the moment of carrying on maintenance is not deterministic. In order to solve this dynamic FJSPPM (DFJSPPM), firstly, we apply an integrated genetic algorithm (IGA) for FJSP, and then, we use an inserting algorithm (IA) to add PM into solutions of FJSP found by (IGA). To demonstrate efficiency of IA for treating maintenance scheduling, we compare it with our simultaneous scheduling algorithm (SSA) and with neighborhood search called hGA in numerical examples of literature. A new better solution for an instance in benchmark of FJSP is obtained with our approach.

FrA5

Aud.52 (ITMO)

**Design and Reconfiguration of Manufacturing Systems (Regular Session)**



10:00-10:20

FrA5.1

*Design Principles of Scalable Reconfigurable Manufacturing Systems*, pp. 1427-1432

Wang, Wencai  
Koren, Yoram

the Univ. of Michigan  
Univ. of Michigan

This paper explains the importance of cost-effective volume scalability of existing manufacturing systems, which enables enterprises to meet market demand in a timely manner. The system must be designed at the outset for future scalability in order to enable its rapid and cost-effective volume expansion, exactly when needed. Accordingly, this paper offers a set of principles to guide manufacturing systems design for scalability, and presents several examples.

10:20-10:40

FrA5.2

*Reconfigurable Micro-Machine Tool Design for Desktop Machining Micro-Factories*, pp. 1433-1438

Pérez, Roberto  
Davila-Ramirez, Oscar  
Molina, Arturo  
Ramírez-Cadena, Miguel

Tech. de Monterrey  
ITESM  
Tecnologico de Monterrey  
Tecnológico de Monterrey (ITESM)

Today, the micro-factory concept of downsizing production systems is essential to manufacturing small products in sustainable growth. Concerning this, this paper presents the developments accomplished during the recent years at Tecnológico de Monterrey (Mexico) introducing new findings related to the design of reconfigurable micro-machine tools for micro-factories. Shows the framework related to the conceptualization of micro-factories for manufacturing system layouts based-on reconfigurable micro-machine tools, identifying the basic steps. The methodology for design reconfigurable micro-machine tools was exposed, and a reconfigurable first-generation CNC micro-machine tool for micro-factories, was designed and tested, using the Universal Numerical Control concept

10:40-11:00

FrA5.3

*Evaluation Pattern for Self-Configuring Communication Systems Leveraging Plug&Play Field Device Integration*, pp. 1439-1444

Hodek, Stefan  
Langfinger, Michael  
Schlick, Jochen

German Res. Center for Artificial Intelligence  
German Res. Center for Artificial Intelligence (DFKI)  
German Res. Center for Artificial Intelligence, DFKI

Within the setup or reconfiguration of production lines and machines, commissioning is the last and most crucial step regarding expenditure of time and predictability of commissioning tasks. Major reasons are the large number of communication systems and the required expert knowledge. The key to overcome these obstacles lies in the self-configuration of the communication systems. To plan the further development of such systems and to evaluate existing communication technologies, precise guidelines are needed. The Plug&Play evaluation pattern presented in this article describes such specifications in form of a technology independent task.

11:00-11:20

FrA5.4

*Geometric Environment Modeling System*, pp. 1445-1450

Dietrich, Andre  
Zug, Sebastian  
Kaiser, Jörg

Univ. of Magdeburg  
Otto-von-Guericke-Univ. Magdeburg  
Otto-von-Guericke-Univ. Magdeburg

Flexible system configurations and adaptability to changing environments and environmental conditions are key concerns for autonomous systems in future applications, either in industrial production processes, building automation, or health-care scenarios. New technologies for instrumented and smart environments support the distribution and acquisition of a diversity of information, but the organization, selection, validation, and interpretation according to certain contexts are still open issues.

Therefore we propose a concept for separating environmental perception and modeling from the application logic. We apply a general model related to the idea of "mental models" used in cognitive science. It combines geometrical data with knowledge about sensors and actuators. This model is used to derive all information, which is required by an application, and to generate different environmental representations.

We show that this approach is capable of solving different problems in the fields of distributed systems as well as instrumented environments and demonstrate its usability.

11:20-11:40

FrA5.5

*Buffer Allocation Using Exact Linear Programming Formulations and Sampling Approaches*, pp. 1451-1456

Stoltetz, Raik  
Weiss, Sophie

Univ. of Mannheim  
Univ. of Mannheim

Several sampling approaches have been proposed to analyze flow lines with stochastic processing times and finite buffer capacities. If the number of buffers between the stations is given, the system's performance can be evaluated via a linear programming formulation. This work presents several mixed integer programming approaches to optimize the buffer allocation in flow lines with stochastic processing times. The processing times are sampled according to different approaches. The objective is to minimize the overall number of buffer spaces obtaining at least a given goal production rate. Numerical experiments are carried out in order to evaluate different sampling approaches and model formulations. The sampling approaches are compared regarding the robustness of the allocation decision with respect to the sample sizes.

11:40-12:00

FrA5.6

*An Integrated Engineering Concept for the Model-Based Development of Service-Oriented Control Procedures*, pp. 1457-1462

The control system development as a part of the plant engineering is a planning discipline with growing importance. Since the complexity of automation tasks is steadily increasing the development of control procedures requires high engineering efforts. This is due to a restricted reusability and integration capacity of the control software and inadequate engineering methods. This paper introduces a new planning concept that improves the development of control procedures. The main objective is to increase the manageability, adaptability, and reusability of control procedures by means of the SOA paradigm. Therefore, a model-based engineering concept with defined concretization levels for the development of service-oriented control procedures is presented.

---

**FrA6** Aud.31 (ITMO)  
**Product Lifecycle Management and Product Design Support Systems - 1 (Invited Session)**

---

Chair: Lentès, Joachim Fraunhofer IAO  
Co-Chair: Fanti, Maria Pia Pol. of Bari

---

10:00-10:20 FrA6.1

---

*The Exploitation of an Ontology-Based Model of PLM from a SME Point of View (I)*, pp. 1463-1468

Bruno, Giulia Pol. di Torino  
VILLA, Agostino Pol. di Torino

---

The wide range of functionalities offered by PLM systems are often not fully exploited by companies, especially small and medium enterprises, in which the management of data and information about product lifecycle is done without computer software systems. Consequently, a lot of time is spent in managing information "by hand". In this paper we aim at providing an example of a methodology to exploit the potentiality of PLM systems from the point of view of a SME, by using an ontology-based model of PLM. The presented case study regards an assembly process of a small Romanian enterprise.

---

10:20-10:40 FrA6.2

---

*Generic Colored Petri Nets Model for the Makespan Optimization in Flexible Manufacturing Systems (I)*, pp. 1469-1474

ZAIRI, Sajeh LIP2 Lab.  
Madhbi, Zeineb LIP2 Lab.  
Zouari, belhassen FST Tunis

---

This paper introduces an optimization method of the makespan in a Flexible Manufacturing Systems (FMS) while considering the whole system behavior (operation, transport and preparation). A formal specification model well-adapted to describe a large class of FMSs is presented. Based on such a model, a user may specify its manufacturing system in FMS-oriented terms (machines, storage, transport equipment, manufacturing process, ...). The introduced specification is automatically transformed into a colored Petri net (CP-net) model. Hence, existing formal verification CP-net methods are exploited, and especially the state space generation and handling, in order to deduce the optimal makespan. This is obtained by determining the operation sequence minimizing the execution duration of a given manufacturing process. An important advantage of the developed approach is that it is parameterized. Thus, it may be adapted to a large class of existing FMSs. The implementation of the presented methodology was integrated into an experimental environment, called MAC-FMS, allowing graphical specification, supervisory control and formal verification based on CP-nets.

---

10:40-11:00 FrA6.3

---

*A Simulation Model for Product Lifecycle Management (I)*, pp. 1475-1480

Boschian, Valentina Univ. of Trieste  
Fanti, Maria Pia Pol. of Bari  
Iacobellis, Giorgio Pol. di Bari  
Ukovich, Walter Univ. of Trieste  
Augenti, Noemi Pol. of Bari

---

Product lifecycle management (PLM) is a systematic, controlled concept for managing and developing products and product related information. The aim of the paper is contributing in the definition of a software tool suitable to tackle this important issue. In order to specify a simulation module that is the core of an integrated PLM platform, we analyze and describe by the Unified Modelling Language (UML) the processes that are relevant for the generic PLM concepts. Moreover, the UML activities diagrams are translated in a discrete event simulation model in order to quantitatively evaluate the performance of the PLM system and to detect possible blockings or bottlenecks. Finally, a simulation study illustrates the efficiency of the module and shows how it can help in the PLM application.

---

11:00-11:20 FrA6.4

---

*Possibilities and Challenges of an Integrated Development Using a Combined SysML-Model and Corresponding Domain Specific Models (I)*, pp. 1481-1486

Kernschmidt, Konstantin Tech. Univ. München  
Barbieri, Giacomo Univ. degli studi di Modena e Reggio Emilia  
Fantuzzi, Cesare Univ. of Modena and Reggio Emilia  
Vogel-Heuser, Birgit Tech. Univ. of Munich

---

The development of a production system, with multiple involved disciplines, requires many different models such as simulation models for the physical domain or models of the control-software. As all these models represent parts of the same system, it is inefficient to develop every model from scratch. Rather an integrated model, which considers all relevant aspects, should be set up first and from this the required domain specific models should be generated through model transformations. For the integrated model, the Systems Modeling Language (SysML) poses a suitable possibility to integrate the views of the different disciplines. Based on a literature research, existing model transformations from the integrated model to specific models as well as necessary extensions are presented.

In this way a framework for an integrated development, where the SysML-model forms the integrating core model of the system, while the simulation of the different parts is carried out in domain specific simulation tools, can be established. Core benefits of this method are the data consistency of the models, and the fast and cost-efficient simulation and testing of the system at different points of the development cycle and with different levels of detail.

11:20-11:40

FrA6.5

*An Engineering Prototype Workflow Management System (I)*, pp. 1487-1492

Daniels, Matthew	Univ. of Limerick
Ghadimi, Pezhman	Univ. of Limerick
Lanning, Ivor	Univ. of Limerick
Heavey, Cathal	Univ. of Limerick
Ryan, Alan	Univ. of Limerick
Southern, Mark	Univ. of Limerick

Engineering workflow management is a key focus for European manufacturing companies, however, issues such as time required to gather data, develop systems and integrate into current manufacturing environments presents obstacles for adoption. This paper presents a high level prototype of an engineering workflow system developed in conjunction with a medical device company to address this gap. The prototype data was used to construct a high level artifact which illustrates how the implementation of Advanced Platform for Manufacturing Engineering and Product Lifecycle Management (7th Programme, "amePLM") engineering workflow management system can improve product design and development processes through increased productivity by capturing workflows which previously went unquantifiable.

11:40-12:00

FrA6.6

*Parallel Machining of Multiple Parts on Rotary Transfer Machines with Turrets (I)*, pp. 1493-1498

Battaia, Olga	Ec. des Mines de Saint-Etienne
Dolgui, Alexandre	Ec. Nationale Supérieure des Mines de Saint-Etienne
Guschinsky, Nikolai	United Inst. of Informatics Problems of the National Academy of Sciences
Levin, Genrikh	United Inst. of Informatics Problems of the National Academy of Sciences

A problem of design of rotary transfer machines with turrets for parallel machining of multiple parts is considered. Parts are located at the loading position of rotary table in a given sequence and they are processed simultaneously. Operations are partitioned into groups which are performed by spindle heads or by turrets. Constraints related to the design of spindle heads, turrets, and working positions, as well as precedence constraints related to operations, are given. The problem consists in minimizing the estimated cost of the transfer machine, while reaching a given output and satisfying all the constraints. The proposed methods to solve the problem are based on its MIP formulation. An industrial example is presented.

**FrA7**

Aud.61 (ITMO)

**Advanced Control of Complex Dynamical Plants - 1 (Invited Session)**

Chair: Mitrishkin, Yuri	V.A. Trapeznikov Inst. of Control Sciences
Co-Chair: Sakamoto, Noboru	Nagoya Univ.

10:00-10:20

FrA7.1

*Modeling and Control of Temperature Field of the Secondary Cooling Zone in Continuous Casting of Steel As Distributed Parameter System (I)*, pp. 1499-1504

Ondrejko, Karol	Faculty of Mechanical Engineering
Bucek, Pavol	Slovak Univ. of Tech.
Noga, Pavol	Slovak Univ. of Tech.
Tkáč, Lukáš	Slovak Univ. of Tech.
Hulko, Gabriel	Slovak Univ. of Tech.

This paper presents some results on modeling and control of temperature field in a steel continuous casting, demonstrating the possibilities of using engineering methods for control of distributed parameter systems along with virtual engineering environments. A system to be controlled is considered as lumped-input and distributed-parameter-output system. Dynamics and control synthesis are decomposed into time and space components, respectively. Demonstrations of PID and adaptive model-based predictive control are being presented via cosimulation, utilizing virtual software environments for continuous casting simulation and distributed parameter control systems, respectively.

10:20-10:40

FrA7.2

*Suboptimal Control of Nonlinear Object: Problem of Keeping Tabs on Reference Trajectory (I)*, pp. 1505-1509

Afanas'ev, Valery	Moscow Inst. of Electronics and Mathematics
-------------------	---

An optimal control problem is formulated for a class of nonlinear systems which can be presented by system with linear structure and state-dependent coefficients (SDC). The system being under the influence of uncontrollable disturbance is supposed. The linearity of the transformed system structure and the quadratic functional make it possible to pass over from the Hamilton-Jacoby-Bellman equation (HJB) to the state dependent Riccati equation (SDRE) upon the control synthesis. In this paper the optimal control problem by nonlinear system in a task of Keeping Tabs on Reference Trajectory we decide in a key of differential game. The presented example illustrates the application of the proposed control method.

10:40-11:00

FrA7.3

*Identification of Parameters and Restoring of State Vector of Dynamical Plant (I)*, pp. 1510-1515

Kopysov, Oleg Yu.	DesCartes Science Center
-------------------	--------------------------

The iterative algorithm of identification of parameters and restoring of state vector of dynamic plants whose models have a form of differential (ordinary or partial) equations is offered. The simulation results show the efficiency of the proposed algorithm.

11:00-11:20

FrA7.4

*Toroidal Current Control in the Problem of Plasma Equilibrium Evolution (I)*, pp. 1516-1521

Zaitsev, Fedor

Moscow State Univ.

The results of application of automatic control methods to the problem of total current sustainment in a toroidal plasma are presented. Plasma current control is performed mainly by means of the solenoid using electromagnetic inductance effect. The mathematical problem is formulated, the methods and developed software are described, the solutions of test and real problems are given. Comparison of experimental and numerical data allows to draw a conclusion on the nature of plasma conductivity in spherical tokamaks.

11:20-11:40

FrA7.5

*A Recent Progress in the Optimal Control Design under Various Constraints (I)*, pp. 1522-1527

Sakamoto, Noboru

Nagoya Univ.

This paper surveys the recent development in the optimal control design accommodating a variety of constraints in control systems. The design is based on the recently proposed approach for solving Hamilton-Jacobi equation using stable manifold theory. The constraints include input magnitude limitation, state magnitude limitation, input norm constraint and input rate limitation. The design for each constraint is confirmed via concrete physical applications with experiments and/or simulations.

11:40-12:00

FrA7.6

*Output Feedback H-Infinity Control Design for Synchronizing of the Main Drives of the Pipe-Rolling Mill (I)*, pp. 1528-1533

Chestnov, Vladimir

V.A. Trapeznikov Inst. of Control Science of Russian Acad.

Zatsepilova, Zhanna

Elektrostal Heavy Machine Building Plant, JSC (EZTM JSC)

We formulate the discrete-time output feedback controller design problem where the desired accuracy of controlled variables in the mean-square sense is guaranteed in the presence of bounded polyharmonic disturbances with a priori unknown number of harmonics, amplitudes, and frequencies. The amplitudes of the harmonics must satisfy a condition that results in the boundedness of the power of each polyharmonic component. The solution is based on the discrete-time  $H^\infty$ -optimization procedure by properly choosing the corresponding weighting matrices of the minimax cost criterion. Numerical solution in state-space is based on the method of linear matrix inequalities, using the LMI Control Toolbox (MATLAB application). We give a synthesis algorithm for a digital controller in the LMI Control Toolbox package and a numerical example for the main drives pipe-rolling mill.

**FrA8**

Aud.42 (ITMO)

**Modeling, Simulation, Control and Monitoring of Manufacturing Processes – 2 (Regular Session)**

Chair: Bakhtadze, Natalia

V.A. Trapeznikov Inst. of Control Sciences, Russian Acad. of Sciences

Co-Chair: HERAUD, NICOLAS

Univ. de Corse

10:00-10:20

FrA8.1

*Evaluating Sensor Placement on Extended System with Polynomial Symbolic Calculus*, pp. 1534-1539

wailly, Olivier

Univ. of Corsica

HERAUD, NICOLAS

Univ. de Corse

SAMBATRA, Eric Jean Roy

Inst. Supérieur de Tech. D'Antsirana

System observability analysis has constant interest for several authors. Previously, we presented a novel method based on polynomial symbolic calculus. An evaluation of time computing of this method is here presented. The computation time, known as an inconvenient for symbolic algorithm, has never been precisely determined previously for this method. Here, we not only evaluate the time, but we also look closer the hardware requirement needed for the method, applying a novel test to precisely determine the efficiency. Finally, we implement the method to a large scale example

10:20-10:40

FrA8.2

*Neural Networks Models for Wear Patterns Recognition of Single-Point Dresser*, pp. 1540-1545

Martins, Cesar Henrique

Electrical Engineering Department, UNESP, Bauru

Aguiar, Paulo Roberto

Univ. Estadual Paulista - UNESP

Frech Junior, Arminio

Univ. Estadual Paulista - UNESP

Bianchi, Eduardo Carlos

Univ. Estadual Paulista - UNESP

Grinding is a workpiece finishing process for advanced products and surfaces. However, the constant friction between workpiece and grinding wheel causes the latter to lose its sharpness, thereby impairing the result of the grinding process. When this occurs, the dressing process is essential to sharpen the worn grains of the grinding wheel. The dressing conditions strongly influence the performance of the grinding operation; hence, monitoring them throughout the process can increase its efficiency. The purpose of this study was to classify the wear condition of a single-point dresser using intelligent systems whose inputs were obtained by digitally processing acoustic emission signals. Two multilayer perceptron (MLP) neural networks were compared for their classification ability, one using the root mean square (RMS) statistics and another the ratio of power (ROP) statistics as input. In this study, it was found that the harmonic content of the acoustic emission signal is influenced by the condition of the dresser, and that the condition of the tool under study can be classified by using the aforementioned statistics to feed a neural network.

10:40-11:00

FrA8.3

*Condition Monitoring at Rolling Mills with Data-Driven Residual-Based Fault Detection*, pp. 1546-1551

Serdio, Francisco  
Lughofer, Edwin  
Buchegger, Thomas  
Pichler, Kurt  
Efendic, Hajrudin

Johannes Kepler Univ.  
Johannes Kepler Univ. Linz  
Austrian Competence Center of Mechatronics  
Linz Center of Mechatronics GmbH  
Siemens VAI Metals Tech. GmbH & Co Linz

We propose a residual-based approach for fault detection in rolling mills which is based on data-driven soft computing techniques. The basic idea is to transform original measurement signals into a feature space by (i) identifying multi-dimensional relationships in the system, (ii) representing the nominal fault-free case, and (iii) analyzing residuals with incremental/decremental statistical techniques. Model identification and fault detection are conducted in a completely unsupervised manner, that is, solely based on the data streams recorded online. Thus, neither annotated samples nor fault patterns/models, which are often very time-intensive and costly to obtain, must be available a priori. We use purely linear models, a new genetic variant of Box-Cox models (termed Genetic Box-Cox) that consider weak non-linearities, and Takagi-Sugeno fuzzy models, which are able to express more complex non-linearities, trained with an extended version of SparseFIS. Using three typical scenarios from rolling mill production, we compare our method to state-of-the-art approaches that are based on principal components analysis and multi scale principal components analysis. The results show that our method outperforms these state-of-the-art approaches.

11:00-11:20

FrA8.4

*Evaluation of Minimal Data Size by Using Entropy, in a HMM Maintenance Manufacturing Use*, pp. 1552-1557

Roblès, Bernard  
Avila-Gomez, Manuel  
Duculty, Florent  
Vrignat, Pascal  
Bégot, Stéphane  
Kratz, Frederic

Univ. Orleans, Prisme  
Univ. Orleans, Prisme  
Univ. Orleans, Prisme  
Univ. Orleans, Prisme  
Univ. Orleans, Prisme  
ENSIB

In this paper, we wish to find a minimal data size in order to better conceptualize industrial maintenance activities. We based our study on data given by a Synthetic Hidden Markov Model. This synthetic model is intended to produce real industrial maintenance observations (or "symbols"), with a corresponding degradation indicator. These time series events are shown as Markov chains, also called "signatures". The production of symbols is generated by using a uniform and a normal distribution. The evaluation is made by applying Shannon entropy on the HMM parameters. The results show a minimal number of data for each distribution studied. After a discussion about the use of a new "Sliding Window" of symbols usable in a Computerized Maintenance Management System, we developed two industrial applications and compare them with the best optimized "signature" previously found.

11:20-11:40

FrA8.5

*MSPCA with KDE Thresholding to Support QC in Electrical Motors Production Line*, pp. 1558-1563

Ferracuti, Francesco  
Giantomassi, Andrea  
Longhi, Sauro

Univ. Pol. delle Marche  
Univ. Pol. delle Marche  
Univ. Pol. delle Marche

In this paper a Fault Detection and Isolation (FDI) procedure is applied for the defects detection and analysis of electrical motors at the end of production line in hood factories. The objective consists of developing a fast and robust methodology to detect defective motors and to identify defects for quality analysis on production line. Using a signal based FDI procedure, an end of a line bench system is designed, which is able to analyze the defects of produced motors. Multi-Scale Principal Component Analysis (MSPCA) is used for defect detection and a Kernel Density Estimation (KDE) algorithm is used for fault isolation on the PCA residual contributions. Also a method to choose the WT levels is adopted. MSPCA with KDE thresholding advantage is demonstrated by experimentations on test bench, using vibration measurements. Experiments show that the stochastic method used to compute thresholds on PCA residuals is robust and at the same time accurate.

11:40-12:00

FrA8.6

*Developing a Universal Numeric Control Based-On Linux Real-Time Software*, pp. 1564-1569

Davila-Ramirez, Oscar  
Pérez, Roberto  
Fernando, Garduno  
Ramírez-Cadena, Miguel  
Molina, Arturo

ITESM  
Tech. de Monterrey  
Tech. de Monterrey  
Tecnológico de Monterrey (ITESM)  
Tecnologico de Monterrey

Currently, there is a strong interest in the process of technological upgrading of conventional machine tools to CNC machine tools, because of the advantages that this process offers. The process of conversion to computerized numerical controls involves a huge effort in conceptualizing and control of the key components of each machine tool, including the high cost of the hardware used. This paper presents the design of a software set-up wizard, to develop a Universal Numeric Control based-on Linux real-time, using universal numerical controllers in open source. The developed software allows the generation of numerical controls based on low-cost software for each machine tool converted, ensuring its universality. Describes the system architecture, the core and all associated tools. The selection of components, the G code preprocessor, different interpolation algorithms and various types of hardware options allow the user to build specific numerical controllers for each machine tool. We present two case studies. The first case concerns the generation of a numerical control for a conventional machine tool. The second case study concerns the development of a numerical control for a reconfigurable micro machine tool. Both cases showed the feasibility of using this numerical control generator based-on low cost software.

**Manufacturing Simulation (Invited Session)**

Chair: Korytkowski, Przemyslaw

West Pomeranian Univ. of Tech. in Szczecin

Co-Chair: Abramova, Nina

Inst. of Control Sciences of the Russian Acad. of Sciences

10:00-10:20

FrA9.1

*Multivariate Simulation Analysis of Production Leveling (heijunka) - a Case Study (I)*, pp. 1570-1575

Korytkowski, Przemyslaw

West Pomeranian Univ. of Tech. in Szczecin

Wisniewski, Tomasz

West Pomeranian Univ. of Tech. in Szczecin

Rymaszewski, Szymon

West Pomeranian Univ. of Tech. in Szczecin

Production leveling (heijunka) is one of the lean tool that is used to stabilize a manufacturing system (reduce the bullwhip effect). Production leveling is a kind of cyclic scheduling that creates production regularity and coordination simplicity. This article describes simulation modeling and multivariate analysis of an assembly production line in a microelectronics factory. The assembly line is organized according to lean principles with heijunka-kanban production control. The simulation technique is applied to evaluate the performance of the manufacturing system which requires modifications to achieve two objectives, i.e. to minimize the average throughput time and to minimize the average work-in-progress. The case study is meant to gain an understanding of the way the appropriate arrangement of heijunka improves both throughput time and work-in-progress, and to supply an illustrative example of discrete event simulation as a useful tool in facilitating heijunka.

10:20-10:40

FrA9.2

*Control of NURBS-Based Surface Error Factor Using a Manufacturing Cost Optimization in Rapid Prototyping Process (I)*, pp. 1576-1581

Sikder, Snahungshu

UOIT

Barari, Ahmad

Univ. of Ontario Inst. of Tech.

Kishawy, Hossam

UOIT

Adaptive slicing in Rapid Prototyping Manufacturing (RPM) allows selection of the layer thickness based on the desired quality of the final product. This paper proposes an improved adaptive direct slicing technique for rapid prototyping where Computer Aided Design (CAD) model is directly expressed in standard Initial Graphics Exchange Specification (IGES) format. Using the developed computational platform, the IGES file is sliced based on the user defined allowable surface error factor and the layer thickness range of the RP machine. The total surface error is computed with the developed error function to verify slicing efficiency with respect to cost, production time and accuracy. Variety of experiments was conducted to find the accuracy of the developed procedure and the cost effective surface error factor.

10:40-11:00

FrA9.3

*Petri-Net Modelling for Batch Production (I)*, pp. 1582-1587

Gradisar, Dejan

Inst.

Music, Gasper

Univ. of Ljubljana

Timed Petri nets can be used for the modelling and analysis of a wide range of concurrent discrete-event systems, e.g. batch production systems. The present paper describes how to do so while starting from the information about the structure of a production facility and about the products usually given in production-data management systems. We describe a method for using these data to algorithmically build a Petri-net model. The method was used to study the multi-product batch plant and to identify bottleneck situations.

11:00-11:20

FrA9.4

*Rand Model Designer in Manufacturing Applications (I)*, pp. 1588-1593

Senichenkov, Yuri Borisovitch

Saint Petersburg State Pol. Univ.

Kolesov, Yuri Borisovitch

CP\_Center

Inikhov, Dmitry Borisovitch

MvSoft

Equation based computer modeling is used traditionally for investigation, simulation, and optimization a test subject at the early stage of designing. And with it a computer model may be a real time embedded component of a hardware-software system. Manufacturing models especially for hardware-software system are large-scale models designing by teams usually. Such complex projects demand using special tools for joint operation. Designing large-scale models in business competition at a stated time also needs using special tools for modeling and simulation such as the family of tools developed by MathWorks Inc. for example. In this paper we present a new tool named Rand Model Designer and demonstrate its properties and possibilities using examples of manufacturing models.

11:20-11:40

FrA9.5

*Markov Chain Simulation of Supply Chain Traffic and Market Competition*, pp. 1594-1599

CHIANG, Johannes K.

National Chengchi Univ. Taipei

Traffic behavior in a large-scale logistic network can be viewed as a complex non-linear system. It is very difficult to illustrate the long-term traffic behavior in a large-scale network. The underlying modern SCM network can be seen as the combination of Service Providers (SPs) and Exchange providers (XPs). There are increasing professional logistic service providers become brick-and-mortar SP-firms in e-business. Due to market competition among SPs and XPs, Internet users, such users of logistic services, will experience a different and enhanced quality of services (QoS), consequently affecting the network traffic model. This paper presents a traffic simulation model drawing on Markov-Chain in the XPs/SPs environment. The model simulates XPs/SPs market competition behavior and determines that XPs' market share will be diluted through market competition. Routing as well as service binding strategies are presented in this paper. This paper will also present routing strategies to vary according to the different competing environments resulting in a model that is meant to lead competitive pricing strategies and capacity allocation for intelligent SCM decision support. Last but not least, the model is expended for the situation by more XPs coming into the competition

11:40-12:00

FrA9.6

*Modeling the Competence Acquiring Process in Higher Education Institution (I)*, pp. 1600-1605

Malinowska, Magdalena  
Kusztina, Emma  
Zaikin, Oleg  
Reng, Lars  
Busk Kofoed, Lise  
Żyławski, Andrzej

Univ. of Szczecin  
West Pomeranian Univ. of Tech.  
Warsaw School of Computer Science  
Aalborg Univ.  
Aalborg Univ.  
Warsaw School of Computer Science

Changes in human capital management, new requirements regarding knowledge and skills of employees compel higher education institutions to redefine their learning programmes. This requires evaluation of the didactic process realization, which should be oriented on competences. In the article authors presents an approach to competence modeling. New tools and collaboration mechanisms are proposed, which allow defining the structure of competence, analyzing the level of competence development, and assessing the competence process realization in relation "expected benefit-required expense".

**FrB1** Aud.11 (ITMO)  
**Supply Network Optimization and Control - 1 (Invited Session)**

Chair: Ivanov, Dmitry Berlin School of Ec. and Law  
Co-Chair: Hartl, Richard F. Univ. of Vienna

13:20-13:40 FrB1.1

*Control of Supply Networks by Robust Optimal Control and Using Observers (I)*, pp. 1606-1611

van Zwieten, Dirk Eindhoven Univ. of Tech.  
Lefeber, Erjen Eindhoven Univ. of Tech.  
Adan, I.J.B.F. Eindhoven Univ. of Tech.  
Rooda, J.E. Eindhoven Univ. of Tech.

The control strategy to organize the flow of goods is extremely important in managing supply networks. Handling of uncertainty, e.g. customer demand, is often a considerable challenge. We introduce methods of constrained robust optimal control, a technique from control theory, to compute the explicit control strategy for small-sized demand-driven discrete-time controlled dynamical systems with uncertainties. This allows us to avoid any assumptions about the form of the policy a priori. We aim to show the applicability of the methods, instead of finding innovative policies as the resulting policies are well known. Another control problem arises when control actions depend on the information of multiple states and these states are not (completely) known, e.g. due to communication issues. We use observers, another technique from the control theory, to derive the required state information based on the in- and output. By means of an example, it is shown that by using these observers, the control policy can be perfectly utilized and no longer depends on communication.

13:40-14:00 FrB1.2

*Tabu Search for a Preemptive Scheduling Problem with Job Incompatibilities*, pp. 1612-1617

Thevenin, Simon Univ. of Geneva  
Zufferey, Nicolas Univ. of Geneva  
Potvin, Jean-Yves Univ. of Montreal

In this paper, the problem of scheduling  $n$  jobs of different durations on parallel machines is considered. Preemption is allowed and there exist incompatibilities between jobs. Furthermore, a global deadline is set to make it impossible to perform all jobs. The problem is to select the jobs to be performed and to schedule them to maximize the total gain. To generate realistic solutions, a multi-objective approach is used which considers both penalties for preemption and the time spent by the jobs in the production shop. The problem is modeled as an extension of the  $k$ -multi-coloring problem. A greedy algorithm and two local search approaches are designed, based on five different neighborhood structures. The results show the efficiency of the tabu search method.

14:00-14:20 FrB1.3

*Robust Model Predictive Control of Constrained Supply Networks Via Invariant Ellipsoids Technique (I)*, pp. 1618-1623

Lyubchyk, Leonid National Tech. Univ. KhPI  
Dorofiev, Yuri National Tech. Univ. "kharkiv Pol. Inst.  
Nikulchenko, Artem National Tech. Univ. "kharkiv Pol. Inst.

The problem of robust control strategy synthesis for distributed supply network under demand uncertainty, time delays and state and control constraints is considered. An invariant ellipsoids approach is used for robust control problem solving, since the uncertain demands are regarded as an external disturbance. On the base Model Predictive Control approach, the designed control law implements in the form of linear feedback signal based on mismatch between the current state and safety stock level and provides external disturbances effect suppression with simultaneous robust stabilization of closed-loop system. Via invariant ellipsoids technique the considered problem was presented in the terms of Linear Matrix Inequalities and a solution of corresponding semi-definite optimization problem was also obtained. As an example, the three-tier supply network with five nodes robust control problem is considered.

14:20-14:40 FrB1.4

*Game-Theoretic Model on a Cognitive Map and Its Tolerance to Errors in Input Data (I)*, pp. 1624-1629

Kulivets, Sergei V.A. Trapeznikov Inst. of Control Sciences RAS

Some problems of complex control in the fields connected with public life (i.e., social-economic, political and other fields) include semistructured control object. Situation appears semistructured if the basic parameters have qualitative (not quantitative) nature, and their values are subjective expert evaluations. Cognitive maps serve to solve control problems for semistructured situations. Cognitive

map is a model representing knowledge of the expert (or a group of experts) regarding situation; this model is described in the form of weighted directed graph. The nodes of cognitive map correspond to those concepts being employed to describe the situation. The concept may be treated as a variable (for instance, "national defence capacity") which may have different values, such as "high," "low" and so on. Weighted arc is interpreted as direct cause-effect relationship between two concepts. Suppose several decision-makers (agents) take part in the process of decision making in an semistructured situation given that the utility of each of them depends both on his self actions and the actions of the others, than interactions of the agents can be seen as a game on the cognitive map. In the game cognitive map represents a model of semistructured control object and clearly describe the dynamics of the situation. The use of cognitive maps in the game gives more detailed and visual modeling of the conflict environment in the form of simple causal links, so as to describe the goals and strategies of the agents in terms of the environment which makes it more convenient to model the real conflicts adequately. Since the input data for the model are expert evaluation prone to subjectiveness, it is necessary to estimate the tolerance of model results to errors in input data. Experts evaluate the "importance percentage" of a target concept compared the others target concepts and the weight of edges in cognitive map. The sign of edge weight indicates the type of the causal link and the value of edge weight indicates the strength of the causal link. In this paper we consider the problem of model tolerance to errors in input data and illustrate it on the material of conflict of interests between Russia and Norway in the Barents S

14:40-15:00 FrB1.5

*A Centralized Model Predictive Control Strategy for Dynamic Supply Chain Management (I)*, pp. 1630-1635

FU, Dongfei	Ghent Univ.
Ionescu, Clara	Ghent Univ.
Aghezzaf, El-Houssaine	Ghent Univ.
De Keyser, Robin M.C.	Ghent Univ.

Abstract: Reducing the Bullwhip effect is one of several crucial problems in supply chain management. In this paper, a centralized Model Predictive Control (MPC) strategy is applied to control inventories in a 4 echelons supply chain. The single MPC controller used in this strategy optimizes globally and finds an optimal ordering policy for each node. The controller relies on a linear discrete-time state-space model to predict process output and the prediction can be approached by two multi-step predictors, which depend on measurability of the controller states. The objective function takes a quadratic form and thus the resulting optimization problem can be solved via standard quadratic programming. Simulation results show that centralized MPC strategy can track customer demand and maintain a proper inventory position level with reduced Bullwhip effect.

15:00-15:20 FrB1.6

*Designing Supply Chain with Robustness Analysis (I)*, pp. 1636-1641

Artsiomchyk, Yuliya	Belarusian State Univ. of Informatics and Radioelectronics
Zhivitskaya, Helena	BSUIR (Belarusian State Univ. of Informatics and Radioelect

Supply chain management is the 21st century global operations strategy for achieving organizational competitiveness. Companies are attempting to find ways to improve their flexibility and responsiveness. However, in recent years there have been reported many events that have led to disturbances in supply chains processes (e.g. supplier failures caused by natural disasters or fires in the warehouses, delivery delays due to traffic accidents, product recalls due to lack of fulfillment of quality or safety requirements, etc.). This paper models for designing supply chains that are robust (i.e., perform well with respect to uncertainties in the data, such as demand) and reliable (i.e., perform well when parts of the system fail).

**FrB2** Oak Hall (ITMO)

**Analysis of Supply and Production Systems - 2 (Invited Session)**

Chair: Tagaras, George	Aristotle Univ. of Thessaloniki
Co-Chair: Georgiadis, Michael	Univ. of Western Macedonia

13:20-13:40 FrB2.1

*Manufacturing-Remanufacturing Failure-Prone Systems under Random Demands (I)*, pp. 1642-1647

Polotski, Vladimir	Ec. de Tech. Superieure
Ouaret, Samir	Ec. de Tech. Superieure
Kenné, Jean-Pierre	École de Tech. Supérieure
gharbi, ali	École de Tech. Supérieure

The problem of production control for a hybrid manufacturing/remanufacturing system under uncertainties is analyzed. Two sources of uncertainties are considered: machines random breakdowns and repairs are modeled as a Poisson process, and demand level variations are modeled as a diffusion type process. The solution to optimal control problem is determined numerically by solving the Hamilton-Jacobi-Bellman (HJB) equations which are shown to be second order partial differential equations (PDEs). The optimal policy for manufacturing is of hedging-point type, while for remanufacturing it is a three-value function. We illustrate obtained results by simulation examples and analyze how the optimal production policy and optimal cost evolve while the statistical characteristics of the random demand vary.

13:40-14:00 FrB2.2

*A Comparison of Three Search Algorithms for Solving the Buffer Allocation Problem in Reliable Production Lines (I)*, pp. 1648-1653

Demir, Leyla	Pamukkale Univ.
Alexandros Diamantidis, Dr.	Aristotle Univ. of Thessaloniki, Department of Ec.
Eliyi, Deniz	Izmir Univ. of Ec.
O'Kelly, Michael	Waterford Inst. of Tech.
Papadopoulos, Chrissoleon	Aristotle Univ. of Thessaloniki
Tsadiras, Athanasios	Aristotle Univ. of Thessaloniki



This paper investigates the performance of three search algorithms: Myopic Algorithm, Adaptive Tabu Search and Degraded Ceiling to solve the buffer allocation problem in reliable production lines. DECO algorithm is used to calculate throughput. This algorithm is a variant of a decomposition algorithm specifically developed to solve large reliable production lines with parallel machines at each workstation and exponentially distributed service times. The measures of performance used are the CPU time required and closeness to the maximum throughput achieved. The three search algorithms are ranked in respect to these two measures and certain findings regarding their performances over the experimental set are given.

14:00-14:20

FrB2.3

*Resource Availability Optimization for Green Courier Service (I)*, pp. 1654-1659

Platis, Agapios

Univ. of the Aegean

Koutras, Vasilis

Univ. of the Aegean

Salagaras, Christoforos

Univ. of the Aegean

In this paper an environmentally friendly bike messenger service with clients of different priorities is modeled using Markov chains. The aim is to examine how operation's resource availability provided to the clients can be optimized. The paper proposes a methodology based on reserving resources for higher priority classes. Based on data from a bike messenger company, the probabilities of each clients' class is optimized through a multiobjective optimization problem. The result is that the company, or a similar one, could use the proposed methodology in order to maximize its services levels.

14:20-14:40

FrB2.4

*Performance Evaluation of Two-Stage Buffered Production Systems with Discrete General Markovian Machines (I)*, pp. 1660-1665

Colledani, Marcello

Pol. di Milano

This paper presents an exact analytical method for the performance evaluation of buffered two-stage production systems where machines are modeled as generally complex discrete time Markov reward models. The method is based on the exact solution of the difference equation describing the dynamics of the system in the internal states. Then, a unique solution is obtained by imposing boundary conditions at the limiting buffer levels. The method results to be computationally stable and efficient even for large number of machine states. The generality of the model allows evaluating a wide set of previously uninvestigated systems. For example, systems with machines having generally distributed failure and repair times, systems with quality deteriorating machines or with flexible machines processing multiple part-types can be modeled. Furthermore, the developed model can be used as a building block to extend the analysis to generally long production lines via system decomposition.

14:40-15:00

FrB2.5

*A Decomposition Method for the Analysis of Long Buffered Production Systems with Discrete General Markovian Machines (I)*, pp. 1666-1671

Colledani, Marcello

Pol. di Milano

This paper presents a new decomposition method for the approximate performance evaluation of buffered multi-stage production systems where machines are modeled as generally complex discrete time Markov chains with reward. The method is based on the exact solution of smaller two-machine sub-systems, also referred as building blocks, with machines that also feature such general characteristics. A decomposition approach is developed that propagates all the possible interruptions of flow due to starvation and blocking conditions throughout the pseudo-machines of each building block. In order to deal with such general settings, new decomposition equations are developed. A new algorithm is proposed for solving these decomposition equations. The proposed method proves to be very fast and accurate over a wide range of test cases, partly reported in this paper. To prove the generality of the framework, reported cases are focused on systems with generally distributed up and down times and systems with degrading machines. This method paves the way to the analysis of a wider class of previously un-investigated systems.

15:00-15:20

FrB2.6

*Healthcare Product Procurement in Dual Supplied Systems (I)*, pp. 1672-1677

Gurgur, Cigdem

Purdue Univ.

In this study we consider supplier selection and quantity allocation decisions for a health care provider/hospital that may purchase new products, as well as refurbished products. New products are more expensive than the used ones, but can be delivered any time and in any quantity. Refurbished products have the same quality, but they are sold in bundles. If the hospital accepts to purchase a specific bundle, it purchases the whole package, which may involve products it does not use or the quantities exceeding its need. The solution of the problem suggests that if the cost of excess inventory is high relative to the cost of understocking, the firm tends to rely on purchases through spot market. Which products are bundled at what quantity would also determine the attractiveness of the bundle. If some bundles involve items with positively correlated demand rate, this would make these bundles more attractive to the hospital, since it reduces the cost of over/under stocking.

**FrB3**

Aud.41 (ITMO)

**Scheduling and Transportation Systems - 2 (Invited Session)**

Chair: Werner, Frank

Otto-von-Guericke-Univ. Magdeburg

Co-Chair: Lazarev, Alexander

Inst. of Control Sciences, Russian Acad. of Sciences

13:20-13:40

FrB3.1

*Optimal Search and Detection of Clustered Hidden Targets under Imperfect Inspections (I)*, pp. 1678-1683

Levner, Eugene

Ashkelon Acad. Coll.

Kriheli, Boris

Ashkelon Acad. Coll.

We formulate and solve a discrete-time search-optimization problem where a single searcher or several searchers (for example,

unmanned aerial vehicles UAVs or robots) operate and move in a discretized 3-dimensional airspace, looking for static or moving targets in a finite set of locations. Prior probabilities of target location are known for each target, and each searcher (UAV) has to sequentially inspect the locations. The inspections are imperfect: a probability of overlooking the failed element (that is, a false-negative outcome) and a probability of a "false alarm" (that is, a false-positive outcome) exist. The objective is to find the targets as effectively as possible within a given level of confidence. Common measure of effectiveness for the search/detection process are: the expected time of the search; the expected cost of the search; the expected losses; and the expected averted risk. An effective index-based search algorithm is developed. An example for an automatic device (UAV or robot) searching for a target moving along a highway is discussed.

13:40-14:00

FrB3.2

*Schedule for One Locomotive in a 3 Station Circuit (I)*, pp. 1684-1687

Lazarev, Alexander  
Musatova, Elena  
Khusnullin, Nail

Inst. of Control Sciences, Russian Acad. of Sciences  
Inst. of Control Sciences V. A. Trapeznikov Acad.  
V.A.Trapeznikov Inst. of Control Sciences of Russian Acad.

In this research it was considered the particular case of a railway problem, specifically, the construction of orders delivery schedule for one locomotive plying among three railway stations. In this paper it was suggested a polynomial algorithm and were shown the results of a computing experiment.

14:00-14:20

FrB3.3

*Agent-Based Model Predictive Control for the Holding Problem in a Metro System (I)*, pp. 1688-1693

Reyes Leiva, Francisco  
Cipriano, Aldo

Pontificia Univ. Catolica de Chile  
Pontificia Univ. Catolica de Chile

Train-based systems are the principal means of public transportation in many of the world's cities, and continue to grow in the face of rising demand. Expanding infrastructure is costly, however, and at a certain point becomes unsustainable. When this occurs the only feasible solution is to improve the management system. This can be done using on line approaches, such as pre-programming schedules that use historic information, or online approaches that employ system status information obtained during operation. In this paper the metro system is partitioned into sub-systems each of them associated to an agent based predictive controller in charge of local optimization. Each controller has its own state estimator that gives online information of the subsystem. By means of communication between agents the optimization of the whole metro system is achieved. The reduction in waiting times can be greater than 20%, depending on the ridership of the line.

14:20-14:40

FrB3.4

*Scheduling Partially Ordered UET Tasks on Dedicated Machines (I)*, pp. 1694-1699

Zinder, Yakov  
Memar, Julia  
Singh, Gaurav

Univ. of Tech. Sydney  
Univ. of Tech. Sydney  
CSIRO

The paper is concerned with scheduling partially ordered unit execution time tasks on dedicated machines. The considered scheduling model is important in control of different systems, in particular computer systems. The presented algorithm is an alternative to the conventional branch-and-bound method. In contrast to the branch-and-bound method with its single search tree, corresponding to partitioning of the feasible region, the presented method involves a sequence of search trees each associated with a certain portion of the domain of the objective function. The branching is based on a generalisation of the Garey-Johnson due date modification. The performance of the presented algorithm is compared by means of computational experiments with a version of the branch-and-bound algorithm.

14:40-15:00

FrB3.5

*Optimization of Matching and Scheduling on Heterogeneous CPU/FPGA Architectures*, pp. 1700-1705

SOUISSI, OMAR  
duvivier, david  
BEN ATITALLAH, RABIE  
Artiba, Abdelhakim

Univ. of Valenciennes  
Univ. of Valenciennes  
Univ. of Valenciennes  
Univ. de Valenciennes

The continuous improvements in several application domains such as telecommunications, aerospace or multimedia lead to additional design constraints on power budget and architecture scalability. The heterogeneous CPU/FPGA (Central Processing Unit/Field-Programmable Gate Array) architecture is one of the most promising solutions in this context leading to high performance reconfigurable computing. In such systems, multi-core processors (CPU) provide high computation rates while the reconfigurable logic (FPGA) offers high performance and adaptability to the application real-time constraints. However, there is a lack of CAD (Computer Aided Design) tools able to deal with the development of applications on such heterogeneous systems. This research investigates the problem of the optimisation of static and run-time task mapping on a real-time computing system CPU/FPGA used to implement intimately coupled hardware and software models.

15:00-15:20

FrB3.6

*A Multi-Machine Scheduling Problem with Global Non Idling Constraint*, pp. 1706-1711

Deleplanque, Samuel  
Quilliot, Alain

LIMOS, UMR CNRS 6158, Bat. ISIMA, Blaise Pascal Univ. - Cle  
CNRS and Blaise Pascal Univ.

We deal here with a multi-machine scheduling problem with non idling constraints, i.e constraints which forbids the interruption of the use of the processors. We reformulate the problem, while using specific pyramidal profile functions, next get a min-max feasibility criterion and finally derive a polynomial algorithm for both the feasibility problem and the makespan optimization problem.

**Forecasting and Inventory Control (Invited Session)**

Chair: Koo, Pyung-Hoi  
 Co-Chair: DUCQ, Yves

Pukyong National Univ.  
 Bordeaux Univ.

13:20-13:40

FrB4.1

*A Review on Control Strategies of Batch Processing Machines in Semiconductor Manufacturing*, pp. 1712-1717

Koo, Pyung-Hoi  
 Moon, Dug Hee

Pukyong National Univ.  
 Changwon National Univ.

Batch processing machines process several jobs simultaneously as a batch. When a batch machine completes the service of a batch and there is at least one product waiting in queue, a realtime control decision is made to decide whether to start a job with a partial batch or wait until future job arrivals occur. This paper provides a review of research works on real-time control strategies of batch processing machines in semiconductor manufacturing. We relate the research works with some distinct characteristics of semiconductor manufacturing and discuss the issues for future works.

13:40-14:00

FrB4.2

*The Impact of Temporal Aggregation on Demand Forecasting of ARMA(1, 1) Process: Theoretical Analysis (I)*, pp. 1718-1723

ROSTAMI TABAR, Bahman  
 BABAI, Mohamed Zied  
 Syntetos, Aris  
 DUCQ, Yves

Univ. of Bordeaux1  
 BEM Bordeaux Management School  
 Cardiff Univ.  
 Bordeaux Univ.

Demand forecasting performance will be challenged by demand dispersion underlying the time series related to the Stock Keeping Units (SKUs). Among the strategies that may be used to reduce the demand dispersion, an intuitively appealing approach is to aggregate demand in lower-frequency 'time buckets'. This paper focuses on the impact of non-overlapping temporal aggregation on the performance of demand forecasting by investigating the mean square error (MSE) before and after aggregation. We assume that the non-aggregated demand follows a first-order autoregressive moving average process [ARMA(1,1)] and a Single Exponential Smoothing (SES) procedure is used to estimate the level of demand. The theoretical analysis shows that the temporal aggregation approach has a great potential to improve the forecasting accuracy. The improvement is a function of process parameters, the aggregation level, and the smoothing constant values. We present some insights into the impact of different control parameters on the performance of each approach. The paper concludes with an agenda for further research in this area.

14:00-14:20

FrB4.3

*A New Up-To Level Inventory Model for Deteriorating Products with Non-Linear Holding Cost (I)*, pp. 1724-1729

Sazvar, Zeinab  
 Rekik, Yacine  
 Akbari Jokar, Mohammad Reza  
 BABOLI, Armand  
 Mirzapour Al-e-hashem, Seyed Mohammad Javad

Department of Industrial Engineering, SharifUniversityofTechnolo  
 EMLYON Business School  
 Department of Industrial Engineering, Sharif Univ. of Tech.  
 INSA-Lyon, DISP Lab. F-69621,France  
 Emlyon business school

Inventory management of deteriorating items faces major challenges by uncertain demand, uncertain lead time, perishability, and high customer service level requirements. So, this issue is extremely important in many corporations today. The periodic up-to level policy for deteriorating products under stochastic demand and stochastic lead time is not paid enough attention up to now. In this paper we propose a new approach to study inventory up-to level policy of deteriorating products under normal distributed demand and lead time by considering service level requirements. To model deterioration process, a non-linear increasing holding cost function is considered. After developing the mathematical model, a solving procedure is proposed to determine the global optimum value of decision variables. Finally, a sensitivity analyses is done to demonstrate the applicability and validity of the proposed model.

14:20-14:40

FrB4.4

*On Controller Design for the Inventory Regulation Problem in Production Systems (I)*, pp. 1730-1735

ABBOU, Rosa  
 MOUSSAOUI, CHARIFA  
 Loiseau, Jean Jacques

IRRCyN - Univ. IUT de Nantes  
 Inst. de Recherche en Communications et Cybernétique deNantes  
 Inst. de Recherche en Communication et en Cybernétique de  
 Nantes

In this paper, we are interested on the inventory regulation problem in production systems which must respond to the customer demands of finite products. Such systems are characterized by the presence of delays due to production processes, the saturations of the input command and the constraints due to the finite capacities of stocks. In our study, the customers demand are considered to be unknown but bounded by a given value. The proposed approach is based on a saturated predictor-feedback structure, in which the constraints and the physical limitations of the production system are taken into account. The concepts used in this approach are the Bounds Calculus for Input-Output systems and Intervals and sets properties. This approach gives necessary and sufficient conditions on the controller parameters, for which the system requirements will be completely met. The accuracy of the proposed methodology is illustrated through simulation results of a basic production unit.

14:40-15:00

FrB4.5

*Sales Forecasting Using Combination of Diffusion Model and Forecast Market – an Adaption of Prediction/preference Markets (I)*, pp. 1736-1741

Meeran, Sheik  
 Dyussekeneva, Karima  
 Goodwin, Paul

Univ. of Bath  
 Univ. of Bath  
 Univ. of Bath

Forecasting sales accurately for a new product is difficult and complex due to non-availability of past data. However, such forecast

information is crucial for successful introduction of new products which, in turn, determines the survival of companies, in many cases. Decisions relating to new products depend critically on reliable period-by-period sales forecasts (otherwise called forecast time series) as early as possible in the new product development cycle. This information is crucial in assessing cash flow and NPV relating to the new product. There have been many attempts to use growth curves (otherwise called diffusion models), such as the Bass model. These models made use of past data about analogous products to do this task. However, this method, although considered the best method, available, has many problems, such as identifying analogous products which can reliably mimic the new product in its sales characteristics. These difficulties explain why the accuracy of forecasts reported by such methods is, at best, 50%. Here we propose an innovative conceptual framework to obtain time series data required for forming the growth curve for the new product by bootstrapping the growth curve models with a novel 'Forecast market' mechanism. The effectiveness of the 'Forecast market' in obtaining accurate estimates of the time series data itself is likely to be enhanced by letting the 'Forecast market' participants use product information ranging from simple pictures of the product to high-end virtual reality systems which enable them to visualise and appreciate the features of the new product.

15:00-15:20

FrB4.6

*1913-2013: The EOQ Theory and Next Steps towards Sustainability*, pp. 1742-1747

Andriolo, Alessandro	Univ. of Padua
Battini, Daria	Univ. of Padua
Gamberi, Mauro	Univ. of Padua
Sgarbossa, Fabio	Univ. of Padua
Persona, Alessandro	Univ. of Padua

The paper is divided in two parts. Firstly, we discuss the evolution of the lot sizing theory during one hundred years of history, starting from the basic model developed by Harris in 1913, up to today. After Harris' work in fact, several researchers added new conditions attempting to reflect real cases as well as possible. The evolution of the EOQ theory strongly reflects the evolution of the last century industrial systems. The second part of the paper is concerned with the discussion of a "Sustainable Inventory Management Framework", identifying the associated sub-problems, the associated decision variables, and the sources of sustainable achievement. Two main factors were identified as being significant in turning a benefit in terms of sustainability: the first is linked with the in-bound logistics area in which material transportation and waste act as a major role to address system environmental sustainability, the second is linked with the social impact of manual material handling activities performed inside the plant (in-house logistics).

FrB5

Aud.52 (ITMO)

**Balancing and Sequencing of Assembly and Machining Lines - 2** (Invited Session)

Chair: Falkenauer, Emanuel	Optimal Design,
Co-Chair: Delorme, Xavier	Ec. Nationale Supérieure des Mines de Saint-Etienne

13:20-13:40

FrB5.1

*Balancing Mixed-Model Assembly Lines in Real World Complex Workstations (I)*, pp. 1748-1753

Zeltzer, Luiza	Ghent Univ.
Limère, Veronique	Ghent Univ.
Aghezaf, El-Houssaine	Ghent Univ.
Van Landeghem, Hendrik	Ghent Univ.

In an attempt to react to the increasing customization, the same mixed-model assembly line is required to assemble a large variety of products. As a consequence, workstations become more complex due to the resulting variability of the assembly tasks. Thus, the need for new mixed-model assembly line balancing solutions, taking this complexity into account is raising. This paper discusses the issue of mixed-model line balancing of complex workstations using real data from some automotive assembly lines. Using an earlier developed complexity analysis model, the complexity of each workstation was evaluated. Then an optimization Mixed Integer Linear Program (MILP) model was developed and used to determine a line balance that optimizes overloads. The complexity results and the overload of each workstation are analysed to determine how these two models are related. The complexity model measures complexity of each workstation based on collected data and the MILP model determines an optimal balance. The complexity and overload results are then analysed and opposed to determine where improvements are required.

13:40-14:00

FrB5.2

*Idle Times Analysis in Two-Sided Assembly Line Balancing Problem (I)*, pp. 1754-1759

Grzechca, Waldemar	The Silesian Univ. of Tech.
--------------------	-----------------------------

This paper considers idle times in two-sided assembly line structure. In the last two decades a large variety of heuristics and exact solutions procedures have been proposed to balance two-sided assembly line. Some measures of solution quality have appeared in line balancing literature: balance delay (BD), line efficiency (LE), line time (LT) and smoothness index (SI). These measures are very important for estimation the balance solution quality. Author of this paper modified and discussed the line time and smoothness index for two-sided assembly line. Special attention was given to idle times in discussed problem. A new measure of delay times is considered and at the end final remarks are presented.

14:00-14:20

FrB5.3

*Stable Optimal Line Balances with a Fixed Set of the Working Stations (I)*, pp. 1760-1765

Sotskov, Yuri	Acad. of Sciences of Belarus
Zatsiupa, Aksana	United Inst. of Informatics Problems
Dolgui, Alexandre	Ec. Nationale Supérieure des Mines de Saint-Etienne

A simple assembly line balancing problem is considered provided that number  $m$  of working stations is fixed. In such a problem, denoted as SALBP-2, it is necessary to minimize a cycle time for processing a partially ordered set of operations  $V = \{1, 2, \dots, n\}$  on a set of  $m$  linearly ordered (working) stations. An initial vector of the processing times  $t$  of the operations  $V$  is given. And for each

automated operation, the processing time cannot vary during a life cycle of the assembly line. For each manual operation, the processing times may vary, since different workers may have different skill, experience, etc. We investigate a stability of the optimal line balance of the simple assembly line with respect to simultaneous variations of the processing times of the manual operations. An optimal line balance is stable if it remains optimal for any sufficiently small variations of the processing times of the manual operations. We propose an algorithm and a program in C++ for constructing all the stable optimal line balances for the problem SALBP-2. Computational results for the modified benchmark instances have been presented.

14:20-14:40 FrB5.4

*Real-World Line Balancing of Very Large Products (I)*, pp. 1766-1771

Falkenauer, Emanuel

Optimal Design,

Line Balancing (LB) is a classic, well-researched Operations Research (OR) optimization problem of significant industrial importance. However, we have previously argued that many OR approaches to solving the problem fall short of handling its full complexity, yielding solutions unusable in the real-world industry. Here we report on additional computational challenges that arise when very large products, such as aircraft, are being assembled.

14:40-15:00 FrB5.5

*A Workshop Scheduling and Optimization Method Based on Multi-Process Workflow Simulation*, pp. 1772-1777

Liu, Yi

Tsinghua Univ.

Fan, Yushun

Tsinghua Univ.

Liu, Bojun

Tsinghua Univ.

Workshop producing systems can be described by different types of models. As some systems are too sophisticated for mathematical model or petri-net to use, a multi-process workflow model for workshop scheduling and optimization is proposed. With which, the workshop producing process can be modeled and simulated in workflow simulation systems and important running statistics including waiting time or queue length can be obtained. Based on basic Particle Swarm Optimization (P.S.O) algorithm, a new scheduling algorithm taking advantage of the average waiting time of activities is developed and applied to a real world scenario. The results of basic P.S.O algorithm and the new algorithm are analyzed and compared, while the new algorithm is found to be more efficient than the basic one.

15:00-15:20 FrB5.6

*Cell Design and Loading with Alternative Routing in Cellular Reconfigurable Manufacturing Systems*, pp. 1778-1783

Eguia, Ignacio

Univ. OF SEVILLE

Lozano, Sebastián

Univ. of Seville

Racero, Jesus

Univ. OF SEVILLE

Guerrero, Fernando

Univ. OF SEVILLE

This paper deals with the design and loading of a Cellular Reconfigurable Manufacturing System (CRMS) in the presence of alternative routing. A CRMS consists of multiple reconfigurable machining cells, each of which has Reconfigurable Machine Tools (RMT) and Computer Numerical Control (CNC) machines, a setup station and an automatic material handling and storage system. Each RMT has a library of feasible auxiliary machine modules for achieving a particular operational capability of the RMT. Each CNC machine has an automatic tool changer and a tool magazine of a limited capacity. The machine cell design problem involves the grouping of machines into machine cells. This problem is performed once, prior to the cell loading, using two cell formation methods from the literature. Once the resulting cells are physically implemented, a mixed-integer linear programming problem is developed for determining the routing mix (i.e. which proportion of each part type to be assigned to each alternative route) and the tool and module allocation (i.e. how many auxiliary modules and tools of each available type to be assigned to each RMT and CNC machine within each formed cell) in order to minimize total intercellular movements of parts. An illustrative problem and experimental results are presented.

**FrB6** Aud.31 (ITMO)

**Product Lifecycle Management and Product Design Support Systems - 2 (Invited Session)**

Chair: Lentjes, Joachim

Fraunhofer IAO

Co-Chair: Daniels, Matthew

Univ. of Limerick

13:20-13:40 FrB6.1

*Product Lifecycle Management Requirements Gathering: Industrial Pilot Cases (I)*, pp. 1784-1789

Daniels, Matthew

Univ. of Limerick

Lanning, Ivor

Univ. of Limerick

Ghadimi, Pezhman

Univ. of Limerick

Heavey, Cathal

Univ. of Limerick

Ryan, Alan

Univ. of Limerick

Southern, Mark

Univ. of Limerick

Product Lifecycle management (PLM) is a concept that aims to integrate the various processes and phases involved during a typical product lifecycle. This paper reports on the capture of requirements for PLM from five Industrial Partners in a FP7 project "advanced Platform for manufacturing engineering and Product Lifecycle Management" (amePLM). The objective of amePLM is to develop a software platform which will provide a collaborative extensible engineering platform that will leverage state-of-the art research on semantics, heuristics and visualization. The five Industrial Partners in amePLM vary in size (micro, SME to large) and by sector, from electronics, healthcare, advanced technology to engineering services. Independent of the company size and the sector it operates in the PLM requirements gathering reported in this paper shows that there are deficiencies in the support for collaboration, project management and visualization in the current PLM tools used by these companies. To capture requirements from the companies a new PLM requirements gathering methodology was developed which is reported on in the paper.

---

13:40-14:00

FrB6.2

*Group Decision Support and Social Software Techniques for PLM Decision Making (I)*, pp. 1790-1795

Pasley, Robert Charles  
MacCarthy, Bart

Univ. of Nottingham  
Univ. of Nottingham

Product Lifecycle Management (PLM) is a common concern in industry. The whole cycle view allows faster product development with more control of risks and processes. Through PLM quality and effectiveness of product development and planning can be improved. Portfolio of products can be considered rather than single products alone. Throughout the PLM phases many decision are made, and Group Decision Support Systems (GDSS) can be useful in supporting these. This is especially true where Concurrent Engineering (CE) practices are used to compress the lifecycle through parallelism and crossfunctional teams. This paper argues that social media software will change many aspects of work engagement and specifically aspects of product lifecycle management processes. We investigate popular social software systems with a view to using them as group decision support systems. We discuss the functionalities and how they would be useful within decision making in terms of group decision making processes. We discuss advantages and disadvantages of various aspects of social software in decision making and conclude that social software techniques are useful within a business context, but not as they are currently implemented for social purposes.

---

14:00-14:20

FrB6.3

*Fostering PLM Implementation in SMEs: Modelling and Managing Verification Processes (I)*, pp. 1796-1801

Sauza Bedolla, Joel  
Ricci, Francesco  
Martinez Gomez, Javier Mauricio  
Chiabert, Paolo

Pol. di Torino  
Pol. di Torino  
Univ. Industrial de Santander  
Pol. di Torino

PLM is largely recognized as the most effective business strategy by all those companies committed to deliver complex and continuously-evolving products, particularly if these operate at a multinational level. However, only a small number of these companies, the larger ones, has reached the level of maturity necessary to implement it in an effective manner. SMEs are not usually amongst these. This paper proposes a user-friendly Visualization Model (VM), that can guide the implementation of PLM philosophy in whatever scale company, provided its processes have been standardized. The model has been tested with major and smaller companies operating in the field of precision manufacturing showing encouraging results. However, as SMEs would get the greatest benefits, it is presented, in this paper, by means of a case study involving a small metrology company. A further content of novelty here, is represented by the fact that the case study's company is using this method to start operating according to the new ISO Geometrical Product Specification and Verification (GPS) standards.

---

14:20-14:40

FrB6.4

*A Platform Providing Information Provision in Engineering (I)*, pp. 1802-1807

Lentes, Joachim  
Eckstein, Holger  
Zimmermann, Nikolas

Fraunhofer IAO  
Fraunhofer Inst. for Industrial Engineering IAO, Stuttgart, G  
Univ. of Stuttgart IAT, Stuttgart, Germany

In industrial companies, the proceeding for the engineering of products and production systems is typically distributed in different organizational units. Each of these units uses its specific methods and tools, resulting in distributed sources of data and information for engineering. In this paper, an integrating but open platform for the engineering of products and production systems is introduced. An essential aspect of the platform is the semantic backend as means for appropriate information provision in engineering.

---

14:40-15:00

FrB6.5

*Optimal Product Lifecycles with Similar Durations (I)*, pp. 1808-1813

Sadeh, Arik

HIT Holon Inst. of Tech.

The question of when to stop marketing a given product and to initiate another lifecycle for that product is addressed in this paper, together with the R&D period and issues of timing. In the proposed model, decision-makers are faced with a given technology and have a single product of their own in the market. The criterion for success is to maximize the discounted net cash flow or the equivalent annuity stream for a given period of time, e.g. a year, a decade etc. The initiation of another cycle is independent of when the current cycle terminates, but is functionally related to its length. Managerial and operational constraints are included, as well as market share constraints. The problem is solved for a representative single cycle assuming that technology is constant i.e. for a low- to mid-technology product. The resulting rules are expressed in managerial terms, for example, as a function of peak of cash flow, cumulative cash flow, level of cash flow, and the length of the R&D period. Some numerical examples for all cases are provided to illustrate the rules resulting from the models.

---

15:00-15:20

FrB6.6

*Information System and Systems Thinking: A Compulsory Marriage? (I)*, pp. 1814-1819

Antonelli, Dario  
Chiabert, Paolo  
Romagnoli, Vittorio

Pol. di Torino  
Pol. di Torino  
Pol. di Torino

Information systems play a fundamental role in enterprise management and development. Moving from MRP to ERP and from CAD to PLM, the amount of information stored in the enterprises' computers increased exponentially. Nowadays enterprises face a double-faced risk: on one side they have increasing difficulties in the management of large amount of information and sometimes they lose the access to important data; on the other side the availability of large amount of information allows for unconstrained modification of product development process and sometimes it promotes solutions which do not preserve the enterprises' core competences. Both problems could be solved by experts trained to manage complex data in complex systems. The evolution of information systems from MRP to ERP and from CAD to PLM may require a new approach based on a holistic view or, in engineering words, on system thinking. The paper deals with such hypothesis: the adoption of system thinking approach in product development process and the skills required to people involved in the process.

FrB7		Aud.61 (ITMO)
<b>Advanced Control of Complex Dynamical Plants - 2 (Invited Session)</b>		
Chair: Mitrishkin, Yuri	V.A. Trapeznikov Inst. of Control Sciences	
Co-Chair: Iftar, Altug	Anadolu Univ.	
13:20-13:40	FrB7.1	
<i>Plasma Vertical Position, Shape, and Current Control in T-15 Tokamak (I)</i> , pp. 1820-1825		
Mitrishkin, Yuri	V.A. Trapeznikov Inst. of Control Sciences	
Kartcev, Nikolai	V.A. Trapeznikov Inst. of Control Sciences of the Russian Ac	
Zenckov, Semjon	Inst. of Control Sciences V. A. Trapeznikov Acad. of Scien	
<p>The paper is devoted to plasma shape, current, vertical position, and vertical speed control systems in T-15 tokamak. Brief definition of control problem statement and T-15 tokamak itself as a plant under control is given. A cascade plasma shape and current control system is designed using control channels decoupling matrixes in the inner cascade and Hinf controller in the outer cascade obtained by means of Hinf optimization theory based on normalized coprime factorization of plant model. Proportional and Hinf controllers are used to stabilize plasma vertical position as well as plasma vertical speed. The first one is applied to DINA code. During simulation some essential difference between linear DINA-L model and plasma-physics DINA code itself was discovered which led to the conclusion to apply some identification procedure on DINA code to get more accurate linear models for the feedback controller design.</p>		
13:40-14:00	FrB7.2	
<i>Typical Controllers Adjustment for Multivariable Objects of Industrial Automation (I)</i> , pp. 1826-1831		
Yakovis, Leonid	Saint-Petersburg State Pol. Univ.	
Sporyagin, Kirill	Sysauto	
<p>Multivariable objects of industrial automation are characterized by interconnections of a number of indexes, different response times and time delays to control actions by channels. Typical controller's adjustment methods for such objects are presented in the article. These methods are based on automatic control theory and computer simulation.</p>		
14:00-14:20	FrB7.3	
<i>Self-Tuning PID-I Controller with a New Algorithm of Tuning of Test Signal (I)</i> , pp. 1832-1837		
Alexandrov, A. G.	Intitute of Control Science, RAS	
Palenov, Maxim	Intitute of Control Science, RAS	
<p>The self-tuning PID/I controller (ST-PID-2) with new algorithm of tuning of test signal is proposed. This controller is based on the self-tuning PID/I controller (ST-PID-1) but have better algorithm of tuning of test signal. It is assumed that plant is described by first order with time delay. Coefficients of plant are unknown and can be changed in some isolated time moments. Self-tuning PID/I controller for the plant is proposed in the presence of unknown-but-bounded external disturbances. The test signal with sum of two harmonics is used for identification of plant coefficients. To guarantee the stability of the closed-loop system the special switching technique between I- and PID-controllers is used. The I-controller is selected to provide stability of the plant independently on its mode. The obtained results are supported by experimental applications.</p>		
14:20-14:40	FrB7.4	
<i>Package "Automatica": New Opportunities (I)</i> , pp. 1838-1843		
Alexandrov, A. G.	Intitute of Control Science, RAS	
Shatov, Dmitriy	Inst. of Control Sciences RAS	
<p>Package "Automatica" is intended for analysis and development of control algorithms for plants, considering parametric and structural uncertainty and influence of unknown-but-bounded disturbance. The package is intended for scientists and developers of real-world control systems. The goal of an engineer is to guarantee given steady-state error tolerance for each of the controlled variables while the disturbance is unknown but bounded and the uncertain plant parameters change their values slowly. Consequently the periodic identification of the plant model and appropriate redesign of the controller are required. The structure of the package is specially oriented for such kind of problems. The basis of this structure consists of so called directives that solve some defined class of problem.</p>		
14:40-15:00	FrB7.5	
<i>Robust Control of Complex Systems with Distributed Time-Delay (I)</i> , pp. 1844-1849		
Iftar, Altug	Anadolu Univ.	
<p>Robust controller design problem for time-delay systems with distributed time-delay is considered. A robustness bound, which accounts for the uncertainties in the system is defined. A controller design approach, which uses this bound, is then proposed. Once the robustness bound is obtained, the proposed approach is completely based on the nominal model and satisfying a simple condition guarantees that the actual system is robustly stable. An example is also presented to demonstrate the proposed approach.</p>		
15:00-15:20	FrB7.6	
<i>Directional Change Issues in Lqg Control with Actuator Failure (I)</i> , pp. 1850-1854		
horla, dariusz	Poznan Univ. of Tech.	
<p>A discrete-time LQG control with actuator failure is considered with directional change taken into account, as a result of actuator saturation case included. The control problem is analyzed in terms of algebraic Ricatti equations. Results of numerous computer simulations of two-input two-output system are given to illustrate the performance of the reliable LQG controller.</p>		
FrB8		Aud.42 (ITMO)
<b>Probabilistic and Statistical Models in Industrial Control and Logistics (Invited Session)</b>		

Chair: Mandel, Alexander Solomonovich  
Co-Chair: Dorofeyuk, Julia

Trapeznikov Inst. of Control Sciences of Russian Academy  
Insitute of Control Sciences of RAS

13:20-13:40

FrB8.1

*Demand-Wise Closed-Loop Inventory Control Models (I)*, pp. 1855-1859

Mandel, Alexander Solomonovich

Trapeznikov Inst. of Control Sciences of Russian Academy

An inventory control problem is resolved by using demand-wise closed-loop control models. The fact that the demand is dependent on the degree to which it was met makes a strong impact on computed values of inventory replenishments. Modified inventory control algorithms based on demand-wise closed-loop inventory control models are suggested. Separately analyzed are cases of regressive and multiplicative descriptions of demand distributions.

13:40-14:00

FrB8.2

*Transformation of the Structure and Parameters of a Shaping Filter into Confidence Intervals for Correlation Function Estimate (I)*, pp. 1860-1865

aung phyo winn, phyo

MIET

Serdyuk, Olga Aleksandrovna

National Res. Univ. of Electronic Tech.

Troyanovskiy, Vladimir Mikhailovich

National Res. Univ. of Electronic Tech.

Analysis is carried out for evaluation of the correlation function, calculated on the base of limited length realization. Confidence intervals of the estimates are determined in the case of "white noise" and "colored signal." Computer simulation confirmed the adequacy of the results. These results allow calculating the estimation deterioration degree of weighting function into the identification.

14:00-14:20

FrB8.3

*The Expert-Analytical Forecasting Model in the Problem of Railway Track Facilities Control (I)*, pp. 1866-1871

Dorofeyuk, Julia

Insitute of Control Sciences of RAS

Dorofeyuk, Alexander

Insitute of Control Sciences of RAS

Pokrovskaya, Irina

ICS RAS

In the paper the application of intellectual data analysis methods for industrial plant control systems efficiency estimation and modeling is considered. To solve this problem the expert-classification and expert-statistical analysis is used. For the prediction model development, the structural forecasting method is used. Developed methods were applied for railway track condition analysis, modeling and forecasting in the framework of OJSC «Russian Railways» track facilities analysis problem.

14:20-14:40

FrB8.4

*Diagnostics of Data Outliers Using Subspace Identification (I)*, pp. 1872-1877

ALMutawa, Jaafar

King Fahd Univ. of Petroleum & Minerals

We propose a diagnostics technique for the state space model fitting formed by deleting observations from the data and measuring the change in the estimates of the parameters. A method is proposed for distinguishing an observational outlier from an innovational one. The presented subspace system identification algorithm is robust and less sensitive to outliers. We give a numerical result to show effectiveness of the proposed method.

14:40-15:00

FrB8.5

*Optimization Model of Routing-And-Searching Process Performed by Unmanned Aerial Vehicles in Special Target-Detection Operations*, pp. 1878-1882

Kriheli, Boris

Ashkelon Acad. Coll.

Levner, Eugene

Ashkelon Acad. Coll.

Spivak, Alexander

Holon Inst. of Tech.

We model the stochastic problem of routing and searching of hidden targets in a directed graph in which nodes represent possible target locations and arcs correspond to possible move of an unmanned aerial vehicle (UAV) between them. Prior probabilities of locations are known for each target, and the decision maker has to sequentially inspect the locations so that to find targets within a priori given level of confidence. The inspections are imperfect: a probability of overlooking the hidden target and a probability of a "false alarm" exist. An greedy algorithm for finding the optimal search strategy is developed.

15:00-15:20

FrB8.6

*Combining Knowledge Modeling and Machine Learning for Alarm Root Cause Analysis*, pp. 1883-1888

Abele, Lisa

Tech. Univ. München

Anic, Maja

Tech. Univ. München

Gutmann, Tim

Tech. Univ. of Munich

Folmer, Jens

Tech. Univ. München, Faculty of Mechanical Engineering

Kleinsteuber, Martin

Tech. Univ. München

Vogel-Heuser, Birgit

Tech. Univ. of Munich

Industrial alarm systems inform the operator of abnormal plant behavior and are required to guarantee safety, quality, and productivity of the plant. However, modern alarm systems often produce large amounts of false or nuisance alarms which leads to alarm floods. To reduce these alarm floods, we developed an alarm system that performs Root Cause Analysis (RCA) upon an alarm model constructed with causal or Bayesian networks. In this paper, we present methods to construct such networks for RCA with a knowledge-based and a machine learning approach. Finally, a small case study is given to illustrate its applicability in practice and we propose an architecture to combine both approaches.



Chair: Su, Chun-Yi	Concordia Univ.
Co-Chair: Moraru, Sorin-Aurel	Univ. "Transilvania" Brasov

13:20-13:40	FrB9.1
-------------	--------

*Prescribed Adaptive Control of a Class of Nonlinear System Preceded by Actuators with Hysteresis*, pp. 1889-1894

Li, Zhi	Concordia Univ.
Feng, Ying	South China Univ. of Tech.
Liu, Sining	Concordia Univ.
Su, Chun-Yi	Concordia Univ.

Control of nonlinear systems preceded by actuators with hysteresis is a challenging task. To design an appropriate control law, it generally requires a model to describe the hysteresis nonlinearity. In the literature review, several models are developed for the purpose of describing the hysteretic behaviors including Prandtl-Ishlinskii (PI) model. In this paper, we attempt to fuse PI model with the prescribed adaptive control techniques to ensure global stability of the systems and guarantee the transient and steady-state performance of the tracking error without knowledge on both parameters of Prandtl-Ishlinskii model and system parameters. Finally, simulation results attained validate the effectiveness of the proposed control scheme.

13:40-14:00	FrB9.2
-------------	--------

*Command-Control-Monitoring of a Dual-Axis Tracking Photovoltaic Platform (I)*, pp. 1895-1900

Badea, Milian	Transilvania Univ. of Brasov
Moraru, Sorin-Aurel	Univ. "Transilvania" Brasov
Visa, Ion	Transilvania Univ. of Brasov
Burduhos, Bogdan Gabriel	Transilvania Univ. of Brasov
Comsit, Mihai	Transilvania Univ. of Brasov

The main goal of this paper is to present the electrical components and the optimal step-wise program of a photovoltaic tracking platform developed for testing different types of photovoltaic modules in the geographical and meteorological conditions of the mountain area Braşov, Romania. In the paper there are presented: firstly the functioning mode of the command-control component; the Modbus communication between the first component and the monitoring PC; the PC user interface able to allow the changing of the tracking modus; the algorithm used for identifying the optimal tracking program and lastly several monitoring results obtained from the installed tracked vs. fixed PV modules.

14:00-14:20	FrB9.3
-------------	--------

*Study of the Effect of Coating Parameters and Substrates on 3D Surface Roughness in Diamond-Like-Carbon Coating Process (I)*, pp. 1901-1906

Mordo, Sergio	UOIT
Popravko, Valery	Intellectual Alliance Inc.
Barari, Ahmad	Univ. of Ontario Inst. of Tech.

This paper presents an experimental platform which is used to study the effect of Diamond-Like-Carbon (DLC) coating on surface roughness. Variety of experiments is conducted and the effect of variation of the coating process parameters and type and combination of sub-layers on the surface roughness of the coated part is discussed. It is shown how DLC coating can decrease the surface roughness and the amount of decrease has direct relationship with the coating thickness. It is shown that with a thick enough coating, approximately the same surface roughness results can be obtained from surfaces with different uncoated roughness. This means that if a part is going to be DLC coated to achieve a certain tribological property, the surface finishing process during machining can be reduced.

14:20-14:40	FrB9.4
-------------	--------

*Dynamic Positioning System for Nonlinear MIMO Plants and Surface Robotic Vessel*, pp. 1907-1912

Pyrkin, Anton	Saint Petersburg National Res. Univ. of Information Tec
Bobtsov, Alexey	Sainr Petersburg National Res. Univ. of ITMO
Kolyubin, Sergey	St. Petersburg NRU ITMO
Surov, Maksim	Saint-Petersburg State Univ. of InformationTechnologies Mec
Vedyakov, Alexey	Saint Petersburg National Res. Univ. of Information Tec
Feskov, Alexey	Saint-Petersburg National Res. Univirity of Information Tehn
Vlasov, Serge	SPb NRU ITMO
Krasnov, Aleksandr	Saint Petersburg National Res. Univ. of Information Tec
Borisov, Oleg	Saint Petersburg National Res. Univ. of Information Tec
Gromov, Vladislav	Saint Petersburg National Res. Univ. of Information Tec

In this paper the new control approach for a class of nonlinear MIMO systems with unknowns is proposed. The mathematical model is divided on two parts: static MIMO transformation and a few SISO channels that allows to design the control law in two steps. At the first step we design the virtual controls for each SISO channel and then after the inverse MIMO transformation we propose the control law for considered system. In the paper the recent advantages in the development of adaptive output control approach using high-gain principle named by the authors as "consecutive compensator" is applied for SISO channels. We present the robotic research setup designed for analysis of control algorithms oriented to complex technical objects. This setup is a model of real plant with similar constraints for developers: parametric uncertainty, delay, disturbances, and bounded control. The most important advantages is modeling of the real plant with maximum equivalence. The paper deals with the robotic research complex in the form of vessel with several actuators which allows to investigate different control problems such as stabilization of the motion along a given trajectory, the

dynamic positioning of a point, etc.

14:40-15:00

FrB9.5

*Simple Output Stabilization Approach for Robotic Systems*, pp. 1913-1918

Pyrkin, Anton	Saint Petersburg National Res. Univ. of Information Tec
Bobtsov, Alexey	Sainr Petersburg National Res. Univ. of ITMO
Kolyubin, Sergey	St. Petersburg NRU ITMO
Surov, Maksim	Saint-Petersburg State Univ. of InformationTechnologies Mec
Shavetov, Sergei	Saint-Petersburg state Univ. of informationtechnologies, me
Borisov, Oleg	Saint Petersburg National Res. Univ. of Information Tec
Gromov, Vladislav	Saint Petersburg National Res. Univ. of Information Tec

The problem of control design for a class of nonlinear system is considered. It is assumed that the linear part is unknown and minimum phase. The nonlinear part is known inaccurately, it is irreducible to an input of the linear block, and generally does not satisfy sector restrictions. A regulator ensuring semiglobal stability is designed. The output of a plant, but not its derivatives is used as a measured variable. Some application results of proposed output control algorithm for a number of Lego Mindstorms NXT mobile robots (track, wheel and walking ones) are presented in the paper.

FrC1

Aud.11 (ITMO)

**Automotive Manufacturing & Supply Chain Management - 3** (Invited Session)

Chair: Gusikhin, Oleg	Ford Motor Company
Co-Chair: Heinecke, Georg	Siemens AG Corp. Tech. ETH Zurich

16:00-16:20

FrC1.1

*Dynamic Modeling of Operator Overload Conditions in Mixed Model Automotive Assembly (I)*, pp. 1919-1924

Gusikhin, Oleg	Ford Motor Company
Jin, Xiaoning	Department of Industrial & Operations Engineering, Univ. of
Klampf, Erica	Ford Motor Company
Reich, Daniel	Ford Motor Company
Visintainer, Randal	Ford Motor Company

The analysis of overload conditions for each cell and the assembly operator is carried out based on micro modeling of operator movement patterns for the actual sequence of vehicles entering trim and final assembly. To achieve this, the system integrates the broadcast signal of the vehicle VIN number as the vehicles are released to final assembly with detailed information on the work elements from the direct labor management system and the workcell layout from the e-workcell system. This system gives advance warning to assembly line management and work group leaders of potential operator overload and/or interference, allowing time to dispatch auxiliary workers and eliminate potential line stoppages.

16:20-16:40

FrC1.2

*Modeling Quality Propagation in Automotive Paint Shops: An Application Study (I)*, pp. 1925-1930

Ju, Feng	Univ. of Wisconsin - Madison
Li, Jingshan	Univ. of Wisconsin - Madison
Xiao, Guoxian	General Motors Corp.
Arinez, Jorge	General Motors Res. & Development Center

Improving paint quality is of significant importance for vehicle manufacturing. In this paper, a quality propagation model is presented to analyze and improve quality in automotive paint shops. Specifically, we study the vehicle painting process with multiple inspection stations. After each inspection, vehicles failed to achieve quality requirement will be repaired before sending to the next operation. In such systems, the quality variations may propagate along the painting process. To study it, a three-state quality propagation model has been developed, and analytical formulas to evaluate product quality have been derived. In addition, to improve quality performance, a bottleneck analysis method has been introduced to identify the most critical stage that impedes product quality in the strongest manner so that its improvement will lead to the largest improvement of the whole system. To illustrate the applicability of the method, a case study to improve paint quality at an automotive paint shop is introduced.

16:40-17:00

FrC1.3

*Optimal Break and Job Rotation Schedules of High Repetitive – Low Load Manual Tasks in Assembly Lines: An OCRA – Based Approach (I)*, pp. 1931-1936

Romano, V.A.	Pol. di Bari
Boenzi, Francesco	Pol. di Bari
Digiesi, Salvatore	Pol. of Bari
Mossa, Giorgio	Pol. di Bari
Mummolo, Giovanni	Pol. of Bari

Human labor still plays a crucial role in many work contexts. However, increases in production rate require increases in human workloads. The authors propose two integer programming models aiming at finding both optimal break and job rotation schedules in work-environments characterized by low load manual tasks with high frequency of repetition. In such a work environment a major risk consists of work-related musculoskeletal disorders. Workload risk and acceptability are evaluated by the OCRA index (ISO 11228-3:2007). Models proposed are applied to an assembly line from the automotive industry. Results obtained revealed the effectiveness of the models as they proved to be adequate tools to jointly address the reduction and balancing of human workloads among employees, which are consistent with acceptable workload limits and required production levels.

17:00-17:20

FrC1.4

**Advanced Supply Chain Information for Rule-Based Sequence Adaptions on a Mixed-Model Assembly Line with Unreliable Just-In-Sequence Deliveries (I)**, pp. 1937-1942

Heinecke, Georg	Siemens AG Corp. Tech. ETH Zurich
Lamparter, Steffen	Siemens AG
Lepratti, Raffaello	Siemens AG
Kunz, Andreas	ETH Zurich

The proliferation of just-in-sequence (JIS) deliveries has raised the vulnerability of assemblies to costly production stoppages or rework due to missing components. Through a comprehensive real-time supply chain monitoring systems these supply issues can be detected early and affected orders removed from planned assembly sequences in time to avoid production disturbances. Using simulation analysis, this paper explores the impact of unreliable JIS deliveries and the mitigation potential of transparent supply chains that allow a rule-based order resequencing on a mixed-model assembly line. The results indicate that (i) rework due to unreliable JIS deliveries can be eliminated and (ii) the trade-off between schedule nervousness and optimality can be balanced, making the proposed rule a feasible approach.

17:20-17:40

FrC1.5

**Hybrid Procedure Based on Bounded Dynamic Programming and Linear Programming for Solving a Variant of the MMSP-W (I)**, pp. 1943-1948

Bautista Valhondo, Joaquín	Univ. Pol. de Catalunya
Cano Pérez, Alberto	ETSEIB/EPSEB UPC
Alfaro Pozo, Rocío	ETSEIB/EPSEB UPC
Batalla García, Cristina	ETSEIB/EPSEB UPC

In this paper, we propose a hybrid procedure based on Bounded Dynamic Programming (BDP) and linear programming to solve the Mixed-Model Sequencing Problem with Workload Minimization (MMSP-W), with serial workstations, free interruption of the operations and with production mix restrictions. We performed a computational experiment with 225 instances from the literature. The results of our proposal are compared with those obtained through the Gurobi solver and previous procedures.

17:40-18:00

FrC1.6

**Alternative Refilling Policies for an Assembly Line Managed by Kanbans (I)**, pp. 1949-1954

Gamberini, Rita	Univ. of Modena and Reggio Emilia
Meli, Matteo	Univ. of Modena and Reggio Emilia
Galloni, Luca	Univ. of Modena and Reggio Emilia
Rimini, Bianca	Univ. di Modena e Reggio Emilia
Lolli, Francesco	Univ. of Modena and Reggio Emilia

Assembly lines managed by means of lean production philosophy are usually characterized by workstations with inline stock areas, supplied by means of items contained in a larger supermarket zone. Furthermore, inline components necessities are usually showed by means of the use of kanbans. In this work, the number of kanbans and the number of carriers serving the line are computed by means of Erlang-C approach, in order to minimize a total cost function obtained as the sum of an estimation of cost of inline stock and of cost of refilling operations. Specifically, the Erlang-C approach is adopted since assures fast re-design of the system when variations in input data occur. Finally, a real-life case study in a company manufacturing items for the automotive market field is presented in order to highlight the approach potentialities when alternative scenarios are studied.

**FrC2**

Oak Hall (ITMO)

**Supply Network Optimization and Control - 2 (Invited Session)**

Chair: Sokolov, Boris	SPIIRAS
Co-Chair: Huang, George Q.	The Univ. of Hong Kong

16:00-16:20

FrC2.1

**Structure Dynamics Control-Based Integration of Aggregate Distribution and Dynamic Transportation Planning (I)**, pp. 1955-1960

Ivanov, Dmitry	Berlin School of Ec. and Law
Sokolov, Boris	SPIIRAS
Hartl, Richard F.	Univ. of Vienna
Pavlov, Alexander	SPIIRAS

We study dynamic planning decisions of a logistics service provider that in charge of the integrated supply chain (SC) planning. We examine an SC with multiple products, suppliers, transit nodes, and customers. The logistics service provider is responsible for aggregate distribution planning and operative dynamic transportation planning. It is to decide on aggregate distribution flows as well as on the time-dependent intensities (i.e., transportation order quantities). These decisions are tightly incorporated but previous research considered them mostly isolated. This is quite naturally since these problems contain data of different detail degree which can be hardly incorporated in only one model. To resolve this problem, we present a hybrid multi-period distribution-transportation model as an optimal control problem blended with linear programming. This contribution has some particular features. First, it extends previous research by elaborating on the dynamic optimal control model. Second, it considers multi-period problem statement with multiple products and alternative transportation channels. Third, we represent the integrated SC planning in terms of structure dynamics control theory in order to take into account execution stage and adaptation. With the results of this study, the dynamic issues in integrated logistics planning in the SC can be addressed, and an intelligent solution to the important problem of SC management has been proposed.

*Application of Control Theoretic Tools to Supply Chain Disruptions Management (I)*, pp. 1961-1966

Ivanov, Dmitry Berlin School of Ec. and Law  
Sokolov, Boris SPIIRAS  
Dolgui, Alexandre Ec. Nationale Supérieure des Mines de Saint-Etienne  
Solovyeva, Inna St. Petersburg State Univ.

Supply chain disruptions management aims at real-time supply chain monitoring, alerting supply chain participants about deviations and possible disruptions as well as elaborating adjustment control actions. A basis for the alerting and disruption recovery is a tolerance area of execution parameters' admissible deviations. Two important questions still remain open: (i) how to determine the borders of the tolerance area and (ii) what adjustments steps should be taken to overcome a disruption. In this paper, we propose to use dynamic robustness analysis on the basis of attainable sets and the adaptive adjustment on the basis of positional optimization as an integrated framework to extend existing techniques. We consider supply chain robustness as a dynamic supply chain property that emerges through controlled adaptability on the basis of feedback loops. With the results of this study, the borders of deviations' sectors within the tolerance area can be determined. In each of these sectors, certain adjustment actions at different adaptation levels can be interrelated.

*Impact of Backorder on Supply Chain Performance – an Experimental Study*, pp. 1967-1972

Pillai, Madhusudan National Inst. of Tech. Calicut  
Talari, Chinna Pamulety National Inst. of Tech. Calicut

Increase in order variance from downstream stage to upstream stage in a supply chain is called bullwhip effect. Bullwhip effect is one of the performance measures of a supply chain. In the present study the impact of backorder in supply chain performance is studied under small lead time of one period by conducting experiments under lost sales and backorder settings using supply chain role play software package. The performance of supply chain under both settings is compared using Wilcoxon statistical test. The results show that the variance of orders is high under backorder than the lost sales setting. The study concludes that backorder is also one of the causes of bullwhip effect.

*A Genetic Algorithm Based Heuristic for the Design of Pick-Up and Delivery Routes for Strategic Alliance in Express Delivery Services*, pp. 1973-1978

Ko, Chang Seong Kyungsoong Univ.  
Ferdinand, Friska Natalia Pusan National Univ.  
Kim, Kap Hwan Pusan National Univ.  
Koh, Shieghyun Pukyong National Univ.

Diverse management of activities such as collection, transshipment, sort/storage, and delivery are included in the express delivery service. The delivery service network consists of customer zones, service centers, and consolidation terminals typically. This study suggests an approach to solve the PDP (Pick-up and Delivery Problem) of service centers having low demands and a consolidation terminal for express delivery service companies strategically allied to share their own resources. The purpose of the study is to maximize the incremental profits of allied companies considering strategic alliance belongs to the PTP (Profitable Tour Problem) class. A genetic algorithm based heuristic is developed after the PTP is converted to an m-TSP (Multiple Traveling Salesman Problem) with the same objective. An example problem is conducted to assess its validity for practical application.

*The Impact of Information and Knowledge Sharing on the Buyer-Supplier Relationship and Performance in Electronics Industry*, pp. 1979-1984

Luo, Hao The Univ. of Hong Kong  
Sha, Sha The Univ. of Hong Kong  
Huang, George Q. The Univ. of Hong Kong

Supply chain dynamic has been drawn a lot of attention by researchers and entrepreneurs in past years. Many authors recognize that effective information sharing has a great influence on supply chain performance. As the information technology development, partners among the supply chain network are willing to work in closer relationship for the supply chain collaboration and coordination. Base on the previous literature which is emphasized on the individual impact of information sharing or with focus on the buying firm perspective, this research project is trying to examine the individual and combined effect of information and knowledge sharing on buyer-supplier relationship and performance from supplier perspective. The conceptual framework is a path diagram consists of information sharing, knowledge sharing, buyer-supplier relationship and supplier performance. A survey instrument was developed based on extant researches and valid data was collected through face-to-face interview with 117 electronic components supplying firms. The conceptual diagram is tested through path analysis and the output from multiple regressions. The result shows information sharing can prompt the knowledge sharing and improve the buyer-supplier relationship as well as the supplier performance. Besides, it is also demonstrated as evidence that a closer buyer-supplier relationship can enhance the supplier performance significantly. The findings presented in this study can be employed as a practical implication for electronics suppliers to understand how to improve their supply chain performance under the impact of information and knowledge sharing.

*Mining Standard Operation Times for Real-Time Advanced Production Planning and Scheduling from RFID-Enabled Shopfloor Data*, pp. 1985-1990

Zhong, Runyang Department of Industry and Manufacturing Systems Engineering,  
Th  
Huang, George Q. The Univ. of Hong Kong  
Dai, Qingyun School of Information Engineering, Guangdong Univ. of Tech.

Production planning and scheduling require standard operation times (SOTs) which have been obtained from time studies or based on past experiences. Wide variations exist and frequently cause serious discrepancies in executing plans and schedules. Radio frequency identification (RFID) technology has recently been applied to create a real-time ubiquitous manufacturing environment, where real-time shopfloor operational data about men, machines, materials, and orders could be captured and collected. Such data carry invaluable information and knowledge which might be used for supporting advanced production planning and scheduling (APS). APS usually needs precise SOTs for perfect decision-making within the RFID-enabled real-time ubiquitous manufacturing environment. This paper proposes a data mining model to estimate realistic SOTs and their standard deviations from RFID-enabled shopfloor data. Key impact factors on SOTs are examined, including working shifts, different machines, gender, and technology complexity. It is observed that working shifts and the learning curves of three types of operators (junior, intermediate, and senior) greatly influence the SOTs. The other factors have minor affection in this case. Considering the two significant impact factors, precise and reasonable SOTs could be worked out, aiming at improving the quality and stability of production plans and schedules.

18:00-18:20

FrC2.7

*A Multi-Objective Stochastic Programming Model for Designing Supply Chain Networks*, pp. 1991-1995

Azaron, Amir

Univ. Coll. Dublin

A multi-objective stochastic programming model is developed for supply chain design under uncertainty using an interactive approach. This is a comprehensive model, which includes both the strategic and tactical levels. The uncertainty regarding demands, supplies, processing and transportation costs is captured by generating discrete scenarios with given probabilities of occurrences. The objective functions involved are the expected total cost (min), the variance of the total costs (min) to get a robust design, and the probability of not meeting a certain budget (min). Then, an interactive multi-objective technique with explicit trade-off information given named surrogate worth trade-off (SWT) method is used to solve the multi-objective model.

FrC3

Aud.41 (ITMO)

**Recent Fuzzy Logic Applications in Manufacturing** (Invited Session)

Chair: Benyoucef, Lyes

Univ. of Aix-Marseille

Co-Chair: Tiwari, Manoj K

Indian Inst. of Tech. Kharagpur

16:00-16:20

FrC3.1

*Optimizing Order Dates of Items for Complex Projects with Fuzzy Requirement Dates and Lead Times (I)*, pp. 1996-2001

Dixit, Vijaya

IIM L

Srivastava, Rajiv

IIM L

Chaudhuri, Atanu

IIM L

Material procurement is a vital activity particularly for manufacturing complex products like ships, air crafts with long cycle times. The production process is mainly assembly based with complex activities' duration that cannot be defined precisely at planning stage. Most of the materials required for these activities are in modular or sub-assembly form and are procured from different suppliers with lead times that are not accurately known. Both these issues make procurement scheduling challenging, particularly for budget constraint scenario. In this work, we have developed a multi-objective procurement scheduling model with fuzzy requirement dates and lead times of items. The objectives are to minimize the sum of inventory costs and to maximize the confidence of timely arrival of items. Fuzzy linear programming approach has been used to solve the model which gives ordering dates of items as the output. A shipbuilding project has been studied in detail and above model applied to do procurement scheduling of its items.

16:20-16:40

FrC3.2

*A Simulation-Based Genetic Algorithm Approach for Process Plans Selection in Uncertain Reconfigurable Environment (I)*, pp. 2002-2007

Bensmaine, Abderrahmane

ENIM

DAHANE, Mohammed

ENIM

Benyoucef, Lyes

Univ. of Aix-Marseille

Reconfigurable Manufacturing Systems (RMSs) are a new paradigm of manufacturing able to customize its capacity and functionality when needed, to be reactive to market changes and uncertainties. In this paper, to take full advantage of the reconfigurability of RMSs, we propose a new approach using genetic algorithms and a simulation based optimization for process planning for a single product type. The proposed approach copes with market uncertainty and demands fluctuation in order to satisfy demands within their deadlines and with a minimum total cost. The total cost consists of five major costs: machine using cost, machine changing cost, configuration changing cost, tool using cost and tool changing cost. An illustrative example is presented to show the applicability of the approach.

16:40-17:00

FrC3.3

*A Hybrid Approach Combining Fuzzy Consensus and Goal Programming for Information Systems Selection (I)*, pp. 2008-2013

Igoulalene, Idris

Aix-Marseille Univ.

Benyoucef, Lyes

Univ. of Aix-Marseille

Supply chain coordination (SCC) is nowadays one of the active research topic in production and operations management (POM). This paper deals with the development of a fuzzy consensus based multi-criteria approach dedicated to information systems selection. More specifically, the problem of information systems selection is formulated as a group multi-criteria decision making (GMCDM) problem and is solved by a hybrid approach combining consensus and goal programming methods in fuzzy environment. To illustrate the applicability of the proposed approach, an illustrative example is presented and the numerical results analyzed.

17:00-17:20

FrC3.4

*Manufacturing Vendor Selection Based on Cross-Entropy Measure with Fuzzy VIKOR Method*, pp. 2014-2019

Zhao, Xinye

National Univ. of Defense Tech.

Kedi, Huang  
Ge, Li

National Univ. of Defense Tech.  
National Univ. of Defense Tech.

Effective and accurate vendor selection decisions are important components for supply chain management in manufacturing factories to enhance their organizational performance. This study presented a novel performance evaluation method for tackling these group multiple criteria decision making (GMCDM) problems based on combining VIKOR method and cross-entropy measure under interval-valued fuzzy sets environment. On the other side, a new interval-valued intuitionistic fuzzy prioritized ordered weighted average operator is used to aggregate all decision matrices into a collective decision matrix. Finally, a case study of vendor selection for a manufacturing factory is given demonstrating the effectiveness of the proposed method and showing that it's more efficient and advantageous than existing TOPSIS method.

17:20-17:40

FrC3.5

*Modeling Cyclic Interactions within a Production Environment Using Transition Adaptive Recurrent Fuzzy Systems*, pp. 2020-2025

Stahl, Benjamin	Tech. Univ. München
Diepold, Klaus Jürgen	Tech. Univ. München
Pohl, Johannes	Tech. Univ. München, Inst. for Machine Tools and
Greitemann, Josef	Tech. Univ. München, Inst. for Machine Tools and
Plehn, Christian	Tech. Univ. München, Inst. for Machine Tools and
Koch, Jonas	Tech. Univ. München, Inst. for Machine Tools and
Lohmann, Boris	Tech. Univ. München

Numerous dynamic influences affect producing companies and require a continuous adaptation of the production. At present, modeling these influences and their interdependencies is mainly limited to quantitative factors. In this paper, an approach is proposed that allows to model the missing qualitative influences and their interdependencies via recurrent fuzzy systems (RFS), where the transitions between the state variables are additionally weighted (transition adaptation). This allows an easy adaption of a production environment's behavior while maintaining the interpretability of the model and the model-based analysis results. To handle the complexity of the resulting models, a structured way to simplify a large fuzzy rule base, to reduce the number of required weighting coefficients, and to merge the state variable onto a single production effectiveness value is shown. All of this is directly illustrated by exemplarily modeling the influence of some relevant qualitative factors onto a production environment.

17:40-18:00

FrC3.6

*An Integrated Fuzzy Approach for Information Technology Planning in Collaborative Product Development*, pp. 2026-2031

Arsenyan, Jbid	Bahcesehir Univ.
Buyukozkan, Gulcin	Galatasaray Univ.

Collaborative Product Development processes are generally based on technological infrastructures and various information technologies are proposed every day to facilitate collaboration, integration, co-design and co-development processes. In this highly uncertain environment, a systematic methodology is essential to plan the Information Technology infrastructure needed to start and maintain the collaborative process. This study offers an integrated Information Technology planning methodology combining Fuzzy Quality Function Deployment, Fuzzy Axiomatic Design and Fuzzy Rule Based Systems. The methodology is tested in a Collaborative Product Development case and the outcome presents an improvement path for Information Technologies for each of the collaborative parties.

**FrC4**

Aud.51 (ITMO)

**Computational Methods for Stochastic Inventory Control** (Invited Session)

Chair: Tarim, Armagan	Hacettepe Univ.
Co-Chair: Rossi, Roberto	Univ. of Edinburgh Business School

16:00-16:20

FrC4.1

*On Service Level Measures in Stochastic Inventory Control (I)*, pp. 2032-2037

Rossi, Roberto	Univ. of Edinburgh Business School
----------------	------------------------------------

We consider the issue of modeling service level measures in stochastic decision making via chance constraints. More specifically we focus on service level measures in production/inventory control under stochastic demand and alpha service level constraints, which are constraints enforcing a prescribed non-stockout probability for the system. We introduce multiple ways of expressing these chance constraints by using conditional probability. Then we demonstrate that, when these constraints are formulated by using expressions that do not involve a conditional probability, a base stock policy is optimal for this problem only under a number of assumptions. To demonstrate this, we discuss a number of examples for simple cases in which it is possible to find better policies and we also present some analytical results. In contrast, when our novel measure involving a conditional probability is used, a base stock policy is optimal under much less restrictive assumptions, although the cost performance of the system tends to deteriorate.

16:20-16:40

FrC4.2

*Optimal Lot Sizing with NPV Approach for Inventory Systems with Constant Demand (I)*, pp. 2038-2043

Dural Selcuk, Gozdem	METU
Cimen, Mustafa	Lancaster Univ.

This paper presents two new economic order quantity (EOQ) formulations supplemented with net present value (NPV) approach. While NPV approach is broadly accepted as the most realistic framework in modelling inventory systems, the literature possesses rather contradicting results on the application. In this paper, we introduce a NPV based EOQ model for an inventory system with constant demand, under fixed ordering cost and linear holding and penalty cost assumptions. For this particular problem, Gurnani

(1983) is the first to provide some results on NVP approach. His study is criticized by Kim and Chung (1985) afterwards. In this study, we show that the earlier works of Gurnani, and Kim and Chung are both flawed, and we provide the optimal formulations for both cost minimization and profit maximization objectives. Through an extensive numerical study, we demonstrate that classical EOQ model may lead to sub-optimal solutions without an embedded cash flow analysis. Meanwhile, we also show how EOQ models proposed by Gurnani and Kim and Chung deviate from optimality.

16:40-17:00

FrC4.3

*Stochastic Linear Systems under Control Constraints: A Supply Chain Planning Tool (I)*, pp. 2044-2049

Tarim, Arman

Hacettepe Univ.

Control of stochastic linear systems with quadratic objective function is considered under the assumption that control variables are constrained. Production-inventory control in a stochastic environment is a typical example of such systems. To control stochastic linear systems, a suboptimal closed-loop control law is derived by using Lagrange multipliers in a dynamic fashion. In terms of ease of implementation, the derived suboptimal algorithm is comparable with that of the well-known unconstrained Linear-Quadratic-Gaussian (LQG) control law. The problem of inventory balancing in distribution systems is used to evaluate the performance of the proposed algorithm. The test results indicate that, under control constraints, the new algorithm significantly reduces the loss compared with that of the simple saturated LQG algorithm. It is proven that the proposed algorithm outperforms the saturated control.

17:00-17:20

FrC4.4

*A Reformulation for Static-Dynamic Uncertainty Strategy under Service Level Constraint (I)*, pp. 2050-2055

Tunc, Huseyin

Hacettepe Univ.

Eksioglu, Burak

Mississippi State Univ.

In this paper, we revisit the mixed integer programming (MIP) model developed by Tarim and Kingsman (2004) and provide a new and time efficient formulation for solving a stochastic lot-sizing problem with service level constraint under the static-dynamic uncertainty strategy – namely (R,S) policy. We constructed our model based on the fact that the relaxation of the dependency between replenishment periods in the original problem enables us to represent it as a shortest path problem. To be able to utilize this property, we provide a new shortest path based MIP formulation. In the result, we show that in the majority of instances LP relaxation of our model provides the optimal solution. Additionally, even if the LP relaxation of our model gives infeasible solutions, it still provides a very tight lower bound for the original problem.

17:20-17:40

FrC4.5

*Approximate Dynamic Programming Algorithms for Multidimensional Inventory Optimization Problems (I)*, pp. 2056-2061

Cimen, Mustafa

Lancaster Univ.

Kirkbride, Christopher

Lancaster Univ.

An important issue in the supply chain literature concerns the optimization of inventory decisions. Single-product inventory problems are widely studied and have been optimally solved under a variety of assumptions. However, as supply chain systems become more complex, inventory decisions become more complicated for which the methods/approaches for optimizing single-product inventory systems are incapable of deriving optimal policies. Manufacturing process flexibility provides an example of such complex application areas. Interrelated products and production facilities form a highly multidimensional, non-decomposable system for which optimal policies cannot be obtained by classical methods. We propose the methodology of Approximate Dynamic Programming (ADP) to overcome the computational challenge imposed by this multidimensionality. Incorporating a sample backup approach, ADP develops policies by utilizing only a fraction of the computations required by classical Dynamic Programming. However, there are no studies in the literature that optimize production decisions in a stochastic, multifactory, multiproduct inventory system of this complexity. This paper aims to explore the feasibility of ADP algorithms for this application. We present the results from a series of numerical experiments that establish the strong performance of policies developed via temporal difference ADP algorithms in comparison to optimal policies.

17:40-18:00

FrC4.6

*Periodic Review for a Perishable Item under Non Stationary Stochastic Demand (I)*, pp. 2062-2067

Rossi, Roberto

Univ. of Edinburgh Business School

We consider the periodic-review, single-location, single-product, production/inventory control problem under non stationary demand and service-level constraints. The product is perishable and has a fixed shelf life. Costs comprise fixed ordering costs and inventory holding costs. For this inventory system we discuss a number of control policies that may be adopted. For one of these policies, we assess the quality of an approximate Constraint Programming (CP) model for computing near optimum policy parameters.

**FrC5**

Aud.52 (ITMO)

**Manufacturing Resources Design, Development and Optimization** (Invited Session)

Chair: Stachowiak, Agnieszka

Poznan Univ. of Tech.

16:00-16:20

FrC5.1

*A Model for a Multidimensional Analysis of the Supply Chain Indicators in the Context of Sustainable Development (I)*, pp. 2068-2073

Cyplik, Piotr

Poznan School of Logistics

Adamczak, Michal

Poznan School of Logistics

Hadas, Lukasz

Poznan School of Logistics

The Authors of this article presents a model for evaluating the supply chain sustainability developed by the authors. The model involves the following levels: a holistic presentation of results, a formal assessment, an informal diagnosis. The first level includes a holistic presentation of the results obtained in the course of the indicator analysis. This analysis has a pyramid form. The second level of the presented evaluation model involves a formal assessment of the supply chain from the point of view of sustainable development.

The supply chain effectiveness was reflected in the integrated indicator employed in its evaluation. The third level of the model describes a methodology for an informal diagnosis of the current state of the supply chain from the point of view of sustainable development. The diagnosis methodology is based on the Sustainable Supply Chain Virus Analysis. SSCVA is a practical conceptual process framework for identifying and analyzing problems which occur in a supply chain from the point of view sustainable development. This diagnosis tool is also used to provide feedback for the formal analysis model. SSCVA provides an answer to the question on how to improve the indicator and what is the root cause of its unsatisfactory value.

---

16:20-16:40

FrC5.2

*Decision Model for Sustainable and Agile Resources Management (I)*, pp. 2074-2079

Stachowiak, Agnieszka

Poznan Univ. of Tech.

Hadaś, Łukasz

Poznan Univ. of Tech.

Cyplik, Piotr

Poznan Univ. of Tech.

Fertsch, Marek

Poznan Univ. of Tech.

there are two important trends in manufacturing management nowadays: sustainability and agility. Sustainability is an approach applicable in every area of company's activity including manufacturing, maintenance, logistics and others. It offers solutions referred to economic, environmental and social aspects providing limitation of resources use (thanks to changes in technology and equipment, especially important for natural and non-renewable resources), higher resources efficiency (thanks to decreased media and materials use, especially important for technical resources) and improved resources exploitation balance resulting in higher cost effectiveness, ecology and human-centric approach. Agility on the other hand is the approach focused on meeting customers' demand concerning products' structure and logistics. It is a consequence of globalization, innovations in technology, products' lifecycle shortening and growing expectations and requirements of customers. Combining sustainability and agility is a difficult task, however potential results of such combination are key factors of success, including adaptability and flexibility of green and customer-oriented resources and processes. The following paper is to present a decision model for resources management including sustainability criteria and meeting agility requirements.

---

16:40-17:00

FrC5.3

*Identifying the Change Time of the Rate Parameter of a Multistage Poisson Count Process (I)*, pp. 2080-2085

Davoodi, Mehdi

Sharif Univ. of Tech. Department of Industrial Engine

Niaki, S.T.A.

Sharif Univ. of Tech.

Asghari Torkamani, Elnaz

Amirkabir Univ. of Tech.

Most often, researchers face count processes in today's manufacturing environments. Moreover, multistage processes have attribute data that must be controlled. Estimating a process change time would simplify the search efforts to identify special cause(s). To provide a contribution in dealing with multistage count processes, this paper presents a model based on the first-order integer-valued auto-regressive INAR(1). Due to diversity of problem types, the model is developed considering Poisson marginal distribution. In the proposed model, Newton's method is used to approximate the rate parameter, and the maximum likelihood method (MLE) is used to estimate the out-of-control sample and the out-of-control stage.

---

17:00-17:20

FrC5.4

*A Semidefinite Optimization Approach to the Directed Circular Facility Layout Problem (I)*, pp. 2086-2091

Hungerländer, Philipp

Univ. of Klagenfurt

We propose a new combinatorial optimization problem, the so-called Directed Circular Facility Layout Problem (DCFLP). The DCFLP seems to be quite interesting as it contains several other problems that have been discussed extensively in literature as special cases. We show that the DCFLP is closely related to the Single-Row Facility Layout Problem (SRFLP) and hence we adapt the leading algorithmic method for the SRFLP by suggesting an appropriate modelling approach for the DCFLP. Finally we show that this algorithmic approach yields promising computational results on a variety of benchmark instances.

---

17:20-17:40

FrC5.5

*The Role and Contribution of Maintenance in Sustainable Manufacturing (I)*, pp. 2092-2097

Jasiulewicz-Kaczmarek, Małgorzata

Poznan Univ. of Tech.

Considering sustainable development as an approach to processes and actions performed in technical objects' maintenance area is a challenge but in the same time a necessary support for sustainable manufacturing realization. It is the challenge because it is not a separated action but a process which includes and integrates requirements of external and internal stakeholders. It requires developing a maintenance strategy and a set of goals which are coherent with general strategy and commitment and participation of all the employees as well as knowledge, experience and consistent performance (evolutionary character of the process). It is also a necessary support because maintenance is a key process for internal supply chain and if the process is omitted or neglected, sustainable development strategy is declaration of managers board made only "on paper".

---

17:40-18:00

FrC5.6

*Detailed Dynamic Layout Planning: An Adaptive Layout Approach (I)*, pp. 2098-2103

Pillai, Madhusudan

National Inst. of Tech. Calicut

Thazhathu Valiyaveetil, Krishna Mohan

National Inst. of Tech. Calicut

Layout planning deals with the arrangement of facilities in a plant. Layout planning is said to be dynamic when the problem deals with the design of multi period plan with changes in demand. This paper formulates the dynamic layout problem as a quadratic assignment problem. An adaptive approach is considered to solve the problem. Simulated annealing is proposed for the development of solution in the form of a block plan for the dynamic plant layout problem. Addition of details such as flow plans, aisle width, department input/output location, etc. to the block plan gives a new detailed layout called net aisle and department layout. An integer linear programming model is used for the formulation of this detailed layout. A LINGO program is developed to solve the model. Net aisle and department layout provide a more realistic layout than a block layout with a better estimation of material handling cost.



FrC6	Aud.31 (ITMO)
<b>Engineering and Delivering Industrial Services (Invited Session)</b>	
Chair: Gaiardelli, Paolo	Univ. of Bergamo
Co-Chair: Smirnov, Alexander	St.Peterburg Inst. for Informatics andAutomationoftheRussian Acad. of Sciences
16:00-16:20	FrC6.1
<i>Multilevel Self-Organisation and Context-Based Knowledge Fusion for Business Model Adaptability in Cyber-Physical Systems (I)</i> , pp. 2104-2109	
Smirnov, Alexander	St.Peterburg Inst. for Informatics andAutomationoftheRussian
Sandkuhl, Kurt	The Univ. of Rostock
Shilov, Nikolay	St.Peterburg Inst. for Informatics and
Cyber-Physical Systems (CPS) tightly integrate physical systems and cyber (IT) systems based on interaction between these systems in real time. Operation and configuration of manufacturing logistics CPS require approaches for managing the variability at design time and the dynamics at runtime caused by a multitude of component types and changing application environments. Multilevel self-organization and knowledge fusion contribute to this task. Furthermore, self-organization within CPS also opens the avenue towards providing new services at runtime, which need to be accommodated in the business models. Adaptable business models are a promising approach to this challenge.	
16:20-16:40	FrC6.2
<i>Assessing the Value of an Installed Base Information Management System: A Simulation-Based Case Study (I)</i> , pp. 2110-2115	
Tucci, Mario	Florence Univ.
Rapaccini, Mario	Univ. degli Studi di Firenze
Visintin, Filippo	Univ. of Florence
Rizzi, Alberto	Univ. of Florence
This paper presents the results of a simulation study concerned with the assessment of the cost and the benefits associated with the implementation and operation of Installed Base Information Management systems. This study demonstrates that geo-referred discrete event simulation models can be successfully used to assess the value of these systems especially when the installed bases are big and geographically dispersed. This study is based on the real case of a product manufacturer providing field service to its installed base	
16:40-17:00	FrC6.3
<i>The Individual Level of Servitization: Creating Employees' Service Orientation (I)</i> , pp. 2116-2121	
Rese, Mario	Ruhr-Univ. Bochum, Marketing Department
Maiwald, Kira	Ruhr-Univ. Bochum
Nowadays traditional manufacturers realize the growing importance of service provision, since a simple offering of stand-alone products makes a differentiation from increasing competition difficult. That is why manufacturing organizations turn out providing product-service systems, running through a specific organizational change process called servitization. While literature focuses on setting up appropriate organizational structures on an organizational level, it neglects recommendations helping organizations to overcome existing product orientation on the individual level of employees. The paper at hand presents a framework including the most important aspects a servitizing organization has to consider in dealing with the individual level of servitization.	
17:00-17:20	FrC6.4
<i>ICT Functionalities in the Servitization of Manufacturing (I)</i> , pp. 2122-2127	
Dotti, Stefano	Univ. of Bergamo
Gaiardelli, Paolo	Univ. of Bergamo
Pinto, Roberto	Univ. of Bergamo
Resta, Barbara	Univ. of Bergamo
The role of technology as enabler of servitization is recognised by many authors as essential. However, a unique approach to identify the best set of technologies that support this journey is still lagging behind. In such a context this paper introduces a discussion to understand the characteristics of ICT that enable the integration between service providers and customers, and are related to different levels of Product-Service offerings. The discussion is based upon the combination of two different models: the first one provides an interpretation of the servitization phenomenon, using a set of PS offering dimensions. The second presents the role of ICT functionalities in the servitization. An empirical case in the textile machinery industry is described and practical insights are then discussed.	
17:20-17:40	FrC6.5
<i>A Semantic Mapping Approach to Retrieve Manufacturing Information Resources: STMICROELECTRONICS' Case Study</i> , pp. 2128-2133	
Bouزيد, Sara	LSIS / STMICROELECTRONICS
Cauvet, Corine	LSIS - Univ. of Aix-Marseille
Frydman, Claudia	LSIS - Univ. of Aix-Marseille
Pinaton, Jacques	STMICROELECTRONICS
Controlling a manufacturing process in a company requires using same manufacturing indicators among company engineers. However, the generalization of Commercial Off-The-Shelf systems in manufacturing companies to get such indicators has rapidly entailed the increase of the quantity of manufacturing information resources, where a resource represents an indicator in a specific	

format. As a consequence, retrieving such resources has become a real challenge for the engineers because these resources usually lack of semantic description. We propose in this paper a semantic mapping approach to associate business semantics to the resources during their search. The core contents of the approach are presented in general and an implementation example is given.

17:40-18:00

FrC6.6

*An Energy Management Initiative for the Calcium Compound Processing Industry*, pp. 2134-2139

Nadarajah, Jayaseelan	Plantmac Engineering Consultant
Abdul Aziz, Faieza	Univ. Putra Malaysia
Baharudin, B.T.Hang Tuah	Univ. Putra Malaysia
N.K.Thomas, Mathew	Plantmac Engineering Consultant
Chin, Kuan Hwa	Syarikat Elektrik Chee Lee

Malaysian Industries in general, are plagued with their own day to day problems and activities. Engineers are called upon not only to identify, but also to resolve technical and non-technical issues. Energy Management is therefore deemed a burden and non-profitable to the organization as a whole [7]. Energy management initiatives are also viewed as a Cost-Centre than as a Profit-Centre. A well-structured and engineered approach, however, if well-presented can be acceptable to industry. The presentation could include the objectives of energy management (EM); past, present and future energy tariffs; roles and responsibilities; SEU; time-line for the energy project to be implemented; specialist and precision measuring equipment to be used; data collection, analysis and finally the report format and submission. The results also indicate a progressive increase in energy tariff is inevitable and that EM should be holistically viewed meant to also increase productivity, reduce breakdowns etc. This paper will entail an energy management proposal submitted to industry for their acceptance. The contents are based on the input and requirements from the engineers in industry.

18:00-18:20

FrC6.7

*A Collaborative Enterprise Framework to Support Engineering Changes in Manufacturing Planning and Control (I)*, pp. 2140-2145

Sriram, Kumar, Pavan	NTNU
Alfnes, Erlend	NTNU
Petersen, Sobah	Sintef
Kristoffersen, Steinar	Møreforskning AS Molde

The main challenges for the enterprises are complexity of the products and uncertainty of the processes. This challenge involves engineering change that frequently requires redesign or altering the products which may call for enterprise agility and flexibility. To meet such a requirement, enterprises require better tools for resilient manufacturing planning and control, and execution. Due to the limitations of the enterprise resource planning (ERP), there is a question how would the future enterprise systems will look like. To approach an answer to this question, this research paper provides an analysis of engineering changes, its characteristics, problems and their implications. Against the background, a conception of future collaborative enterprise model (CoPIDSS: Collaborative planning, information and decision support system) is proposed. In this paper, we discuss the importance of collaborative planning for enterprise resilient manufacturing planning and control. We have analysed user stories provided by industry as scenarios, to understand the collaborative processes in their workplaces and their needs for collaborative platform support. This paper aims to address the following research questions: How does engineering changes and error handling affect the degree of collaboration and decision making within and across enterprises and how CoPIDSS helps to overcome this? Is the storage and management of knowledge the one of the key factor to engineering changes and error handling control in a collaboration and decision environment?

FrC7

Aud.61 (ITMO)

**Multimodal Networks Modelling and Design** (Invited Session)

Chair: Zaikin, Oleg	Warsaw School of Computer Science
Co-Chair: Pesikov, Eduard	St. Petersburg State Univ. of Tech. and Design

16:00-16:20

FrC7.1

*Scheduling of Composite Bridge Components Transportation in Just in Time System (I)*, pp. 2146-2150

Bozejko, Wojciech	Wrocław Univ. of Tech.
Hejducki, Zdzisław	Wrocław Univ. of Tech.
Uchroński, Mariusz	Wrocław Centre for Networking and Supercomputing
Wodecki, Mieczysław	Univ. of Wrocław

This paper presents a mathematical model, the theoretical basis and an outline of a computer module system supporting scheduling of transportation and assembly of composite beam bridge structures implemented in the just in time system (called JIT for short). In the optimization procedures there were used algorithms based on the tabu search method.

16:20-16:40

FrC7.2

*Robustness of Multimodal Processes Itineraries (I)*, pp. 2151-2156

Bocewicz, Grzegorz	Koszalin Univ. of Tech.
Banaszak, Zbigniew	Warsaw Univ. of Tech.
Nielsen, Izabela	Aalborg Univ.

This paper concerns multimodal transport systems (MTS) represented by a supernetworks in which several unimodal networks are connected by transfer links and focuses on the scheduling problems encountered in these systems. Assuming unimodal networks are modeled as cyclic lines, i.e. the routes determining stream-like moving transportation means, a problem of an alternative itinerary selection for an origin–destination (O-D) trip in the context of emergency relief is considered. Emergency relief dealing with the contingency events and deciding on MTS robustness can be evaluated in terms of feasible itineraries for assumed (O-D) trip. Since itinerary planning problem, constitutes a common routing and scheduling decision faced by travelers, hence the main question regards

of itinerary re-planning and particularly a method aimed at prototyping of mode sequences and paths selections. The declarative model of multimodal processes driven itinerary planning problem is our main contribution. Illustrative examples providing alternative itineraries in some cases of MTS malfunction are presented. At last, the simulated results manifest the promising properties of the proposed model.

---

16:40-17:00

FrC7.3

*Modelling and Scheduling Autonomous Mobile Robot for a Real-World Industrial Application (I)*, pp. 2157-2162

Quang, Vinh Dang

Aalborg Univ.

Nielsen, Izabela

Aalborg Univ.

Bøgh, Simon

Aalborg Univ.

Bocewicz, Grzegorz

Koszalin Univ. of Tech.

The paper deals with a real-world implementation of autonomous industrial mobile robot performing an industrial application at a factory of a pump manufacturer. In the implementation, the multi-criteria optimization problem of scheduling tasks of a mobile robot is also taken into account. The paper proposes an approach composing of: a mobile robot system design ("Little Helper"), an appropriate and comprehensive industrial application (multiple-part feeding tasks), an implementation concept for industrial environments (the bartender concept), and a real-time heuristics integrated into Mission Planning and Control software to schedule the mobile robot in the industrial application. Results from the real-world implementation show that "Little Helper" is capable of successfully serving four part feeders in three production cells within a given planning horizon using the best schedule generated from the real-time heuristics. The results also demonstrated that the proposed real-time heuristics has capability of finding the best schedule in online production mode.

---

17:00-17:20

FrC7.4

*Approach for Color Management in Printing Process in Open Manufacturing Systems (I)*, pp. 2163-2168

Olejnik-Krugly, Agnieszka

West Pomeranian Univ. of Tech. in Szczecin

Różewski, Przemysław

West Pomeranian Univ. of Tech. in Szczecin

Zaikin, Oleg

Warsaw School of Computer Science

Sienkiewicz, Piotr

Warsaw School of Computer Science

In this paper an approach for a quality assurance for manufacturing systems is developed. This problem comes directly from the printing industry where many companies are struggling with correct overprint color reproduction. Color management systems assure correct color control on prepress stage, integrating all devices into one common color space. Such action requires calibration of these devices, which in case of a typical printing machine is highly expensive and time consuming. The article presents author's method of complex printing machine calibration based on regression models. The method allows obtaining a mathematical model describing printing machine characteristics that constitutes a basis for on-going print colorimetric correction.

---

17:20-17:40

FrC7.5

*Multimodal Approach to Model and Design Supply Chain (I)*, pp. 2169-2174

Pawlewski, Pawel

Poznan Univ. of Tech.

This paper discusses issues related to the analysis of supply chains using multimodal approach. Author identifies the gap in the SCOR model, regarding the need for multimodal approach. Multimodal processes in the supply chain in the automotive industry are identified. The problem of just-in-sequence deliveries and suggesting a solution based on a simulation experiment is defined. In the paper the reasons which drove the choice of the tool to aid the analysis and improvement of multimodal processes are presented. Author shows the way of identifying multimodal processes in a supply chain (especially in logistics operators – logistics centers), defines the methods of solving practical problems in a multimodal network using simulation tools. At last, the structure of build model, tool construction and some of the experiments which were made on the simulation model are described.

---

17:40-18:00

FrC7.6

*Conducting Market Segmentation and Diagnostics of the Consumer Printed Products by Using Methods of Multivariate Statistical Analysis and Artificial Intelligence (I)*, pp. 2175-2180

Pesikov, Eduard

St. Petersburg State Univ. of Tech. and Design

Zaikin, Oleg

Warsaw School of Computer Science

Kozlova, Ekaterina

St.Petersburg State Univ. of Tech. and Design

The approaches to the construction methodology for market segmentation and consumer diagnostics, based on the joint application of multivariate statistical analysis and artificial neural networks. Solution to the problem is proposed to conduct market segmentation using Kohonen self-organizing map and subsequent refinement of the results using the k-means method, and the solution of the consumer diagnostics by using discriminant analysis and multilayer perceptron. The results of the comparative analysis of numerical experiments to address the challenges of market segmentation printed products and diagnostics of the new customer.

---

18:00-18:20

FrC7.7

*Privacy-Preserved Distributed Coordination of Production Scheduling in B2B Networks: A Multiagent Approach*, pp. 2181-2186

Gorodetsky, Vladimir

SPIIRAS

Bukhvalov, Oleg

Intelligent Platforms and Systems Ltd.

Karsaev, Oleg

Intelligent Platforms and Systems

Samoylov, Vladimir

Intelligent Platforms and Systems

Kudryavtsev, Gennady

Izhevsky Motozavod "Axion Holding"

The paper presents an efficient privacy preserving distributed algorithm intended to coordinate local production schedules of B2B plant network involved in joint fulfillment of multiple dynamically incoming orders. This task is challenging and has no satisfactory solution of industrial scale so far. The proposed solution exploiting multi-agent software architecture is validated based on a case study dealing with industrial scale distributed coordination of production schedules of autonomous shops of a big production plant.

Chair: Promyslov, Vitaly

V.A. Trapeznikov Inst. of Control Sciences

Co-Chair: Pietre-Cambacedes, Ludovic

EDF

16:00-16:20

FrC8.1

*Applying a Security Conceptual Model for Coverage Analysis (I)*, pp. 2187-2192

Raspotnig, Christian

Inst. of Energy Tech.

Katta, Vikash

Inst. of Energy Tech.

In areas important to security or safety, the development of computer-based systems follows more complex processes for developing the system and achieving the needed safety or security assurance. As security and safety aspects are merging in new systems that are critical, but more openly interconnected, there is a need to relate the three different processes: development, safety and security. This paper proposes a conceptual model for security, which consist of artefacts belonging to development and security assessment processes. The security conceptual model can be used as a stand alone model to understand and address how security aspects should be integrated during the development of computer-based systems, or can be combined with safety models to address both safety and security aspects in a more harmonised manner. The model is applied on a newly developed method for unifying the safety and security assessments. The security conceptual model is however only based on a particular standard, and further work is needed to evaluate the model.

16:20-16:40

FrC8.2

*A Preliminary Report on Static Analysis of C Code for Nuclear Reactor Protection System (I)*, pp. 2193-2198

Lee, Jong-Hoon

Konkuk Univ.

Kim, Eui-Sub

Konkuk Univ.

Yoo, Junbeom

Konkuk Univ.

Lee, Jang Soo

Korea Atomic Energy Res. Inst.

Cybersecurity regulations require new I&C (Instrumentation & Control) systems in nuclear power plants to develop software in accordance with secure software development methodology to prevent the digital systems from cyber attacks. One of the common aspects of various secure software development methodologies is that widely-accepted practices should be followed throughout programming. As PLC (Programmable Logic Controller) is used to implement digital I&Cs, C programs are often translated automatically from design specifications such as FBD programs. This paper tries to analyze a part of preliminary version of C codes of a Korean I&C system with a static source code analysis tool of Microsoft. It showed that the automatic translator from FBD to C had some critical defects, not concerned with security directly. It also recommends to select appropriate analysis tools and rule sets to check best practices in secure programming, even if the C code is produced mechanically.

16:40-17:00

FrC8.3

*Introduction of a Cyber Security Risk Analysis and Assessment System for Digital I&C Systems in Nuclear Power Plants (I)*, pp. 2199-2203

Lee, Cheol Kwon

Korea Atomic Energy Res. Inst.

The application of security controls specified in the RG 5.71 in a specific I&C system still requires many analysis efforts based on an understanding of the security controls, since the guideline does not provide the details to system designers or developers regarding what, where, and how to apply the security controls. The Cyber Security Risk Analysis and Assessment System (CSRAS) has been developed as a tool for analyzing security requirements and technical security controls based on a general cyber security risk assessment procedure with the consideration of characteristics of I&C systems and the lifecycle of development in nuclear power plants.

17:00-17:20

FrC8.4

*Formal Hierarchical Model of Security of the Upper Level of Instrumentation & Control System of a Nuclear Power Plant (I)*, pp. 2204-2209

Promyslov, Vitaly

V.A. Trapeznikov Inst. of Control Sciences

Poletikin, Alexey

Inst. of Control Sciences

The present paper considers a formal hierarchical model of the cybersecurity policy of the digital upper unit level system of (UULS) of the nuclear power plant (NPP). The relations and transfer of the access rights between the subjects and objects of the model are analyzed. The standard NPP UULS is characterized by way of example of the UULS developed at the Trapeznikov Institute of Control Sciences (Russian Academy of Sciences) for the NPP's and of its simplified cybersecurity model.

17:20-17:40

FrC8.5

*Safety Analysis of Combined FMEA and FTA with Computer Software Assistance (I)*, pp. 2210-2214

Liu, Chi-Tang

National Tsing Hua Univ.

Hwang, Sheue-Ling

National Tsing-Hua Univ.

LIN, I-KAI

Department of Occupational Safety and Health, Chung Shan Medical

Failure mode and effects analysis (FMEA) is one of the most widely used method for safety analysis which can find out the effects of failure modes in components and system. Generally, the result of FMEA can be the foundation for more detailed safety analysis like fault tree analysis (FTA), and some computer software is released to assist the data linking, calculating, and documentation. However, with the larger scope and higher demand of hazard analysis in the emerging industry such as semiconductor or photovoltaic (PV) industry, it is difficult and time-consuming to go through the traditional analysis way by manual work to catch the critical element which may play an important role in safety and system, especially in early. The modified safety design and management after analysis are

also major topics that can prevent potential risk to happen, but the inspection and modification of documents and data linking are also difficult without automation. This paper introduces the combination way of FMEA and FTA with computer software assistance to solve the problems as listed, and this proposed method is also applied into a manufacture process in a PV plant for case study.

17:40-18:00 FrC8.6

*Cyber Security of Nuclear Instrumentation & Control Systems: Overview of the IEC Standardization Activities (I)*, pp. 2215-2219

Pietre-Cambacedes, Ludovic EDF  
 Quinn, Edward L. Tech. Res.  
 Leroy, Hardin U.S. Nuclear Regulatory Commission

This paper provides an overview of the work of the International Electrotechnical Committee (IEC) on the development of a series of standards dealing with the cyber security of nuclear power plant (NPP) instrumentation and control (I&C) systems. In particular, the status and content of the first, top level document of the series, IEC 62645, is described. A more recent draft, IEC 62859, dealing with the coordination between safety and cyber security aspects, is also presented. Future work and perspectives associated with this new series of standards are finally discussed.

18:00-18:20 FrC8.7

*ARMATURE: A Structurally Adaptive Connectivity Manager for Critical Communication Services Preservation (I)*, pp. 2220-2225

Hecker, Artur Télécom ParisTech  
 Benchaib, Yacine Télécom ParisTech  
 Chaudet, Claude Télécom ParisTech

In this paper, we present ARMATURE, a peer-to-peer overlay that provides highly resilient communication service for critical infrastructure control. ARMATURE can encapsulate all control traffic, e.g. SCADA sessions, within secure and highly resilient transport tunnels. Herein, it does not rely on any particular ISP provisions and can use any available IP interface. Most importantly, the constructed overlay network is able to structurally reshape, i.e. to change its structural graph properties, to face different situations and to reunite otherwise conflicting service requirements. ARMATURE can be easily deployed in the current critical infrastructures to protect their monitoring and control communications.

**FrC9** Aud.32 (ITMO)

**Computer Modeling and Simulation of Complex Technical and Manufacturing Systems - 2 (Invited Session)**

Chair: Senichenkov, Yuri Borisovitch Saint Petersburg State Pol. Univ.  
 Co-Chair: Awasthi, Anjali Concordia Univ.

16:00-16:20 FrC9.1

*Software Support for Intellectual Control of Anthropogenic Objects Technical Condition (I)*, pp. 2226-2231

Vladova, Alla Orenburg State Univ.

This article discusses structures of software and knowledge base which were designed to support a new method of intelligent control of anthropogenic objects technical condition. This method reduces an identification problem dimension, defines potentially hazardous sections and evaluates technical condition of metal shells with help of aggregated models, which accumulate extensive information about geometric characteristics of damages registered with nondestructive testing.

16:20-16:40 FrC9.2

*Simulation of Technological Processes in Coal Mining (I)*, pp. 2232-2237

Okolnishnikov, Victor Design Tech. Inst. of Digital Tech. of Siberian  
 Rudometov, Sergey Design Tech. Inst. of Digital Tech. of Siberian  
 Zhuravlev, Sergey Design Tech. Inst. of Digital Tech. of Siberian

This paper describes the new visual interactive simulation system of technological processes intended for the development and execution of simulation and emulation models for process control systems. A set of simulation models was developed with the help of this simulation system. These models were developed with the goal to be used as a quality assurance tool for new process control systems of coal mining. Simulation models of various subsystems of coal mining were united to create simulation environment of coal mining. Simulation environment is visually interactive, include emulation models of technological equipment and allow to simulate complex situations in mines and working faces visually as well as to check the response of process control system developed for these situations. Simulation environment was used for testing of algorithms of programmable logic controllers as a part of process control systems prior to commissioning. Simulation environment can be used not only for existing coal mining techniques but also for perspective (robotized) techniques.

16:40-17:00 FrC9.3

*Event-Driven Simulation of Control Systems with Variable Parameters (I)*, pp. 2238-2243

Denisova, Ludmila Omsk State Tech. Univ.

An approach is suggested for analysis of control systems with variable parameters; the approach involves the method of event-driven simulation. A mathematical model of a discrete-continuous control system which was implemented in MATLAB/Simulink/Stateflow is represented. In addition, we describe a mathematical model of a steam generator feed system at a power unit of a nuclear plant with variable values of transfer function coefficients.

17:00-17:20 FrC9.4

*Visual Modeling of Dynamical Systems by Instrumental Facilities (I)*, pp. 2244-2249

Shornikov, Yury NSTU

Novikov, Evgeny  
Dostovalov, Dmitry  
Myssak, Maria

ICM SB RAS  
NSTU  
NSTU

Peculiarities of computer analysis of discrete-continuous systems in the simulation environment are reviewed. Union of standard elements in the macro blocks and import of nonlinear functions from external applications are used to build block diagrams. Solver is configured for numerical analysis of stiff systems by original methods and supplemented with tools of active computational experiment.

17:20-17:40

FrC9.5

*Using OpenMVLShell in Research and Education (I)*, pp. 2250-2255

Isakov, Andrey

St. Petersburg Pol. State Univ.

OpenMVL Project is considered by author as the starting point of discussion and the first executed step in the direction of the new standard for tools for modeling and simulation of complex dynamical systems (CDS). OpenMVLShell is the open source software for comparison different approaches to the problem of designing modern environments for CDS modeling and simulation first of all. However it may be used in Education too as its analog OpenModelica. OpenMVLShell is based on Object-Oriented Modeling (OOM) approach and uses Model Vision Language (MVL) suggested by MvStadiumGroup. MVL is object-oriented language for modeling and simulation of hierarchical multi-component systems with event-driven behavior based on differential-algebraic equations (hybrid systems). Possibilities of OpenMVLShell are illustrated by two examples. The first one demonstrates how to use OpenMVLShell for comparison different DAE solves. The second one illustrates using OpenMVLShell in «Modeling and Simulation» course as instrument of active learning.

17:40-18:00

FrC9.6

*Component Modelling of Ship Systems in TRANSAS Liquid Cargo Handling Simulators (I)*, pp. 2256-2259

Tarasov, Sergey  
Lebedev, Dmitriy  
Nikolaev, Ilya

TRANSAS Tech.  
TRANSAS Tech.  
TRANSAS Tech.

Analysis of requirements of physical realism and computational performance for mathematical models, used in liquid cargo handling simulators is presented. Depth of physical modelling, necessary to satisfy the requirements, is considered. Approaches to composition of mathematical models are outlined. Component-based approach with "RanD Model Designer" visual modelling software is described. Component library, applied for development of mathematical models for Liquid Cargo Handling Simulators of "TRANSAS Technologies" company, is presented. Employed techniques of computation performance enhancement, and result of their application, are presented.

18:00-18:20

FrC9.7

*Adaptive and Predictive Control Architecture of Inland Navigation Networks in a Global Change Context: Application to the Cuiarchy-Fontinettes Reach (I)*, pp. 2260-2265

Duviella, Eric  
Rajaoarisoa, Lala  
Blesa, Joaquim  
Chuquet, Karine

Ec. des Mines de Douai  
Res. Inst. on Embedded System  
Univ. Pol. de Catalunya (UPC)  
VNF

In this paper, an adaptive and predictive control architecture is proposed to improve the management of inland navigation networks in a global change context. This architecture aims at ensuring the seaworthiness conditions of inland navigation networks, and to improve the efficiency of the water resource management. It is based on supervision and prognosis modules which allow the estimation of the current state of the network, and the forecasting of the extreme event occurrence. According to these indicators and to the management constraints and objectives, control strategies of the inland navigation networks will be adapted to limit the impacts of the extreme events. To achieve this aim, three challenges are considered and discussed in this paper. The first one consists in proposing an accurate modeling approach of navigation reaches which are characterized by large scale, nonlinearities, time delays, unknown inputs and outputs, etc. The second one is to increase the knowledge about potentiality of extreme events, consequences of the climate change. The prediction of these events is rather complex due to their rarity, the spacio-temporal scale of the networks, etc. Finally, the third one is the pooling of the two first contributions, {it i.e.} the model of the system and the knowledge about extreme events. Thus, the resilience of the system and the adaptation of the management strategies could be realized.