GOR Gesellschaft für Operations Research e.V.

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GOR-Arbeitsgruppe: Praxis der Mathematischen Optimierung

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Herewith we would like to invite you to the 96th meeting of the GOR working group "Real World Mathematical Optimization" at Volkswagen (*www.**volkswagen**.de*) in Wolfsburg, Germany. This meeting is being held as a symposium with the topic

Mathematical Optimization in the Automotive Industry

The workshop takes place on April 14th and 15th in 2016. The event will take place in German language (abstracts and presentations are also accepted in English).

Please note that the participation in a GOR-AG-Workshop for non-members is subject to a registration fee, unless you are a speaker or a host.

Please register yourself online using https://www.redseat.de/pmo96/ as soon as possible, but ideally not later than Apr 01st, 2016. The latest information on the meeting is available on the homepage of the GOR (https://gor.uni-paderborn.de/index.php?id=54).

Yours sincerely,

Josef Kallrath (GOR AG) & Steffen Rebennack (Colorado School of Mines) & Jan-Hendrik Jagla (Volkswagen AG)

GOR Gesellschaft für Operations Research e.V.

Mathematical Optimization in the Automotive Industry

The Volkswagen Group (http://www.volkswagen.de/) with its headquarters in Wolfsburg is one of the world's leading automobile manufacturers and the largest carmaker in Europe. In 2014, the Group increased the number of vehicles delivered to customers to 10.137 million. The share of the world passenger car market amounts to 12.9 percent. In Western Europe, more than one in four new cars (25.1 percent) is made by the Volkswagen Group. Group sales revenue in 2014 totaled €202 billion while profit after tax amounted to €11.1 billion.

The Group comprises twelve brands from seven European countries: Volkswagen Passenger Cars, Audi, SEAT, ŠKODA, Bentley, Bugatti, Lamborghini, Porsche, Ducati, Volkswagen Commercial Vehicles, Scania and MAN. Each brand has its own character and operates as an independent entity on the market. The product spectrum ranges from motorcycles to low-consumption small cars and luxury vehicles. In the commercial vehicle sector, the products include ranges from pick-ups, buses and heavy trucks. In addition, the Volkswagen Group offers a wide range of financial services, including dealer and customer financing, leasing, banking and insurance activities, and fleet management. The Group operates 119 (May 26, 2015) production plants in 20 European countries and a further 11 countries in the Americas, Asia and Africa. The Volkswagen Group sells its vehicles in 153 countries.

This two-days event will attempt to give an overview of the current state of the art of mathematical optimization in the automotive industry. In talks, each approx. 40 minutes experts from practice, research institutions or software companies, will present selected problems and the corresponding solutions.

Please contact:

Jan-Hendrik Jagla,
Volkswagen Aktiengesellschaft, Assistant IT Production und Logistics (K-SIPB)

Tel.: +49 5361 9-80703
e-mail: jan-hendrik.jagla@volkswagen.de,

Steffen Rebennack (srebenna@mines.edu) or Josef Kallrath (josef.kallrath@web.de), if you are interested in presenting.

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Presentations from the following speakers (all from Germany) have been confirmed:

Lennart Bochmann (Doktorand im Rahmen Industrie 4.0 im Smart.Production:Lab, VW Konzern-IT)
Layout Planning and Production Scheduling in Future Intelligent Manufacturing Systems

M. Sc. Christian Grob (Volkswagen AG, Baunatal)
Inventory Control: Multi-Echelon Optimization in a Spare Parts Network

Dr. Martin Grunewald (TU Braunschweig, Braunschweig)
Multi-item dynamic lot-sizing with detailed consideration of transportation capacities - A case study from the automotive industry

Prof. Dr. Gerd J. Hahn (German Graduate School of Management and Law Heilbronn)
Robust Planning in Production Networks of Automotive Suppliers: Preparing for Economic Crises

M. Sc. Tobias Hofmann (TU Chemnitz, Chemnitz)
Optimizing Cycle Times in Robot Based Manufacturing Lines

Verena Hutterer (IBM Deutschland GmbH, München)
All-Time Parts Prediction for Automotive Spare Parts Management

Jan-Hendrik Jagla (Volkswagen Aktiengesellschaft, Wolfsburg)
Vorstellung der Organisation der Konzern-IT

Prof. Dr. Siegfried Jetzke (Ostfalia Hochschule für Angewandte Wissenschaften, Salzgitter)
Finding consistent decisions operating logistics networks

Eduard Kiemele (Module für das Auftragsmanagement Fahrzeuge, VW Konzern-IT)
Einblicke in die Konzepte und Algorithmen für die Verwaltung variantenreicher Produkte bei Volkswagen

Dr. Peter Korevaar (IBM Deutschland GmbH, Mannheim)
K-Curve Method and Budget Optimization for Automotive Spare Parts Management

Dipl.-Inf. Robert Krämer (Mathesis GmbH, Mannheim)
Work Visually with Complex Data

Beier Meng (Produkt-Projekte in Vorserienlogistik und Änderungsmanagement der Volkswagen Nutzfahrzeuge, VW AG)
Optimierungstool zur Unterstützung der globalen Einsatzsteuerung technischer Änderungen am Fahrzeug

Prof. Dr. Esther Mohr (University of Mannheim, Mannheim)
Optimal replenishment under price uncertainty - the example of copper in the automotive industry

Iulian Nitescu (Graphmasters GmbH, Hannover)
Bridging the gap between theoretical and real-world VRP

Dr. Tim Schöneberg (Inbound Logistik in der Konzern-IT der Volkswagen AG)
Ansätze zur Optimierung der Beschaffungsneben- und Lagerhaltungskosten in Gebietsspeditions-netzwerken der Automobilindustrie unter Berücksichtigung der Nivellierung von Anlieferspitzen

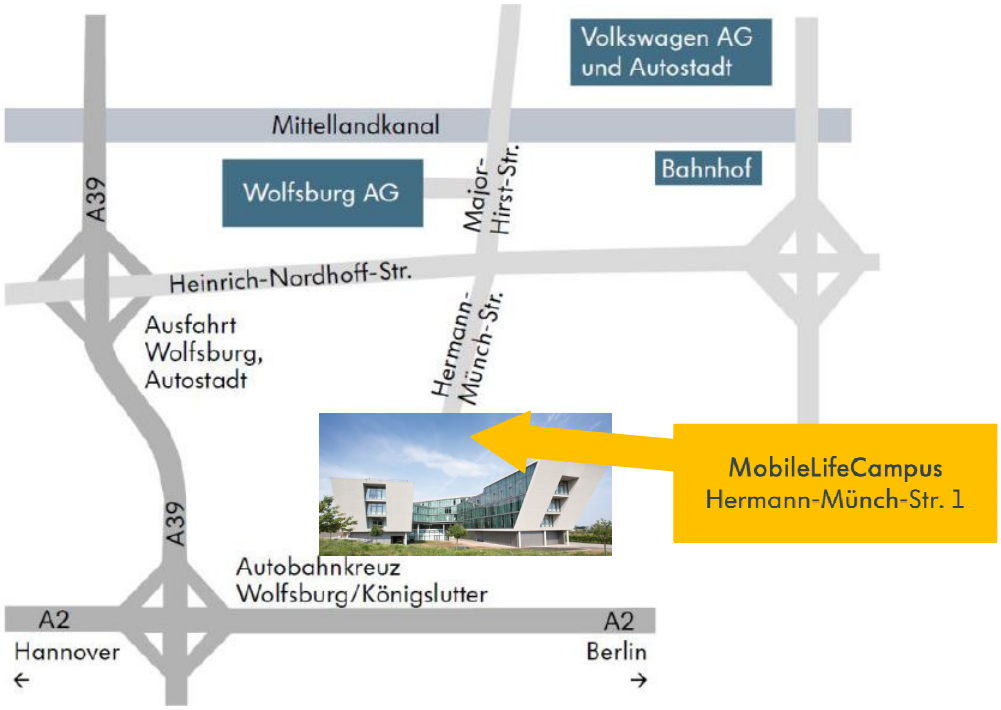
Dr. Elke Wolf (Dr. Wolf Managementconsulting, Köln)
Mathematische Optimierung bei strategischen Unternehmensbeteiligungen in der Automobilindustrie - Möglichkeiten und Grenzen

Dipl.-Wi.-Ing. Felix Zesch, Senior Researcher, 4flow AG, Berlin
Integrierte Planung von Produktion und Distribution auf Tagesprogrammebene in der Automobilindustrie

Location

Address: **MobileLifeCampus (MLC)**
Hermann-Münch-Straße 1
38440 Wolfsburg

Room: "Touareg" 4th floor



Excursion:
On Thursday afternoon, an excursion (Guided Tour through VW Autostadt - http://www.autostadt.de - will be arranged for up to 40 participants (first registered, first served). The conference dinner will take place in "Restaurant Lagune", one of the Autostadt restaurants:
http://www.autostadt.de/de/autostadt-erkunden/konzernforum/restaurants-im-konzernforum/lagune/

Hotel list:

City Wolfsburg
- Global Inn , Tryp , Innside , Ritz Carlton Hotel
- Leonardo Hotel Wolfsburg
- Hotel Strijewski

Outside Wolfsburg
- Brackstedter Mühle
- Best Western Hotel an der Wasserburg
- Best Western Hotel in Weyhausen

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96th Meeting of the GOR Working Group
„Real World Mathematical Optimization“

Mathematical Optimization in the Automotive Industry

Volkswagen Aktiengesellschaft, Wolfsburg, April 14 & 15, 2016
MobileLifeCampus (MLC), Hermann-Münch-Straße 1, 38440 Wolfsburg

Thursday, April 14 - 2016: 09:30 – 21:00

09:00-09:30 **Welcomes** to the first day ; coffee and refreshments

09:30-09:40 **Opening and Welcome** (J. Kallrath & S. Rebennack, J.-H. Jagla)

09:40-10:00 **Jan-Hendrik Jagla** (Volkswagen Aktiengesellschaft, Wolfsburg)
Vorstellung der Organisation der Konzern-IT

10:00-10:45 **Dr. Elke Wolf** (Dr. Wolf Managementconsulting, Köln)
Mathematische Optimierung bei strategischen Unternehmensbeteiligungen In der Automobilindustrie - Möglichkeiten und Grenzen

10:45-11:05 ---------- Coffee Break ----------

11:05-11:30 **Prof. Dr. Gerd J. Hahn** (German Graduate School of Management and Law Heilbronn)
Robust Planning in Production Networks of Automotive Suppliers: Preparing for Economic Crises

11:30-12:00 **Eduard Kiemele** (Module für das Auftragsmanagement Fahrzeuge, VW Konzern-IT, Wolfsburg)
Einblicke in die Konzepte und Algorithmen für die Verwaltung variantenreicher Produkte bei Volkswagen

12:00-13:00 ---------- Lunch Break ----------

13:00-13:30 **Dipl.-Wi.-Ing. Felix Zesch**, Senior Researcher, 4flow AG, Berlin
Integrierte Planung von Produktion und Distribution auf Tagesprogrammebene in der Automobilindustrie

13:30-14:05 **Dr. Martin Grunewald** (TU Braunschweig, Braunschweig)
Multi-item dynamic lot-sizing with detailed consideration of transportation capacities - A case study from the automotive industry

14:05-14:25 ---------- Coffee Break ----------

14:25-14:45 **Beier Meng** (Produkt-Projekte in Vorserienlogistik und Änderungsmanagement der Volkswagen Nutzfahrzeuge, VW AG)
Optimierungstool zur Unterstützung der globalen Einsatzsteuerung technischer Änderungen am Fahrzeug

14:45-15:30 **Prof. Dr. Siegfried Jetzke** (Ostfalia Hochschule für Angewandte Wissenschaften, Salzgitter)
Finding consistent decisions operating logistics networks

15:30-15:55 ----- Driving to **Autostadt,** Wolfsburg ----------

16:00-18:00 **Visit & Guided Tour:** Excursion to the Autostadt (Wolfsburg)

18:15-21:00 **Conference Dinner** at "Restaurant Lagune in der Autostadt, Wolfsburg"
Celebrating the 96th meeting of our GOR Working Group
----- Taking a Group Photograph for the OR News and Press -------

GOR Gesellschaft für Operations Research e.V.

Friday, April 15 - 2016: 09:30 – 16:30

09:00-09:30 Welcomes to second day ; coffee and refreshments

09:30-10:00 **Verena Hutterer** (IBM Deutschland GmbH, München)
All-Time Parts Prediction for Automotive Spare Parts Management

10:00-10:30 **Dr. Peter Korevaar** (IBM Deutschland GmbH, Mannheim)
K-Curve Method and Budget Optimization for Automotive Spare Parts Management

10:30-10:55 ---------- Coffee Break ----------

10:55-11:25 **M. Sc. Christian Grob** (Volkswagen AG, Baunatal)
Inventory Control: Multi-Echelon Optimization in a Spare Parts Network

11:25-11:55 **Prof. Dr. Esther Mohr** (University of Mannheim, Mannheim)
Optimal replenishment under price uncertainty - the example of copper in the automotive industry

12:00-13:10 ---------- Lunch Break ----------

13:10-13:40 **Dr. Tim Schöneberg** (Inbound Logistik in der Konzern-IT der Volkswagen AG)
Ansätze zur Optimierung der Beschaffungsneben- und Lagerhaltungskosten in Gebietsspeditionsnetzwerken der Automobilindustrie unter Berücksichtigung der Nivellierung von Anlieferspitzen

13:40-14:15 **Iulian Nitescu** (Graphmasters GmbH, Hannover)
Bridging the gap between theoretical and real-world VRP

14:15-14:50 **Dipl.-Inf. Robert Krämer** (Mathesis GmbH, Mannheim)
Work Visually with Complex Data

14:50-15:10 ---------- Coffee Break ----------

15:10-15:45 **M. Sc. Tobias Hofmann** (TU Chemnitz, Chemnitz)
Optimizing Cycle Times in Robot Based Manufacturing Lines

15:45-16:20 **Lennart Bochmann** (Doktorand im Rahmen Industrie 4.0 im Smart.Production:Lab, VW Konzern-IT)
Layout Planning and Production Scheduling in Future Intelligent Manufacturing Systems

16:20-16:30 **Final Discussion – End of the Workshop – Coffee Break**

Location: MobileLifeCampus (MLC), Hermann-Münch-Straße 1, 38440 Wolfsburg
Room: "Touareg" 4th floor

Gesellschaft für Operations Research e.V.

The Speakers and Organizers

Lennart Bochmann is a PhD student at the Smart Production Lab of the Volkswagen Group. His work is supervised by the Institute of Machine Tools and Manufacturing (IWF) of the Department of Mechanical and Process Engineering at ETH Zurich, where he also received a MSc ETH in Mechanical Engineering. His research is focused on future intelligent manufacturing systems with special interest on the design, planning and control of manufacturing systems for multi-variant products.

Christopher Grob is a Research Analyst at Volkswagen AG in the area of inventory control and a PhD Student in the discrete optimization research group at the University of Kassel. He received an M.Sc. in Industrial and System Engineering from Virginia Tech as well as an M.Sc. in Industrial Engineering and Management at the Karlsruhe Institute of Technology.

Martin Grunewald is an assistant professor at the Technische Universitt Braunschweig. He studied business mathematics in Magdeburg and got his doctoral degree of business science from Braunschweig. His research interests are planning and control of logistics and production systems especially under consideration of the new possibilities regarding the digitization in this field.

Gerd J. Hahn is a Professor of Operations Management and Process Innovation at the German Graduate School of Management and Law in Heilbronn, Germany. Prior to this, he held a position as an Assistant Professor of Supply Chain Management at the University of Mannheim, Germany. Furthermore, he has worked several years as a Management Consultant on strategic IT and operations management issues. He received his PhD from the Catholic University of Eichstaett-Ingolstadt, Germany, in 2011. His research interests include robust optimization methods, supply chain finance, and decision support systems in operations management.

Tobias Hofmann is a PhD student at the Professorship of Algorithmic and Discrete Mathematics at TU Chemnitz and received a MSc in Finance at TU Chemnitz. His research interests are focused on Discrete and Combinatorial Optimization.

Verena Elisabeth Hutterer works as data scientist at IBM Global Business Services. She studied finance and information management at the Technical University of Munich and the University of Augsburg and obtained a Master of Science with honours. After joining IBM in 2013 she worked as SME for analytics and data mining using structured data. In 2016 she joined the IBM Global Automotive Center of Competence and works on various automotive analytics topics, including long-time demand prediction.

Jan-H. Jagla holds a degree in mathematical economics from the Technical University Braunschweig, Germany and the University of Zaragoza, Spain. He received his degree for a joined project with Greenmont Energy Consulting developing an integrated optimization model for US American electricity market. After joining GAMS Development Corporation in 2006 he worked as optimization analyst focusing on consulting and further developing GAMS in joined projects with universities in Germany and the US. In 2012 he joined Volkswagen Group-IT working as project manager focusing on group-wide IT projects within the MES scope. Since 2014 he works as assistant to the Head of IT Production and Logistics of Volkswagen Group-IT.

Siegfried Jetzke is professor for *Technische Grundlagen und Logistik* at the *Ostfalia Hoch-*

schule für angewandte Wissenschaften in Salzgitter and head of good*S*ync, a small company developing software for simulation and optimization for logistics and production. He studied physics and mathematics and received his doctoral degree in theoretical physics. Before becoming engaged in logistics he worked non-linear optics, simulation and optimization problems in genetics as well as transportation problems of nuclear particles. Nowadays he feels to be positioned between the practitioners in logistics, software developers and theoreticians.

Josef Kallrath obtained his PhD in astrophysics from Bonn University (Germany) in 1989. He is is with BASF's Scientific Computing group at BASF in Ludwigshafen since 1989, is a professor at the University of (Gainesville, FL, www.astro.ufl.edu/∼kallrath), and solves real-world problems in industry using a broad spectrum of methods in scientific computing, from modeling physical systems to supporting decisions processes by mathematical optimization. He has written review articles on the subject, about 100 research papers in astronomy and applied mathematics, and several books on mixed integer optimization, as well as one on eclipsing binary stars.

He leads the Real World Optimization Working Group of the German Operations Research Society. His current research interests are polylithic modeling and solution approaches to solve large-scale or difficult optimization problems, for instance, by decomposition techniques such as column generation, or hybrid methods.

Peter Korevaar works as analytics and optimization expert at IBM Global Business Services. He studied Physics and Astronomy at the University of Utrecht (Netherlands). After his PhD he joined IBM in 1991. For about 20 years he worked on optimization of logistics networks and on inventory optimization. From May 2012 till April 2014 Peter was Senior Research Associate at the Karlsruhe Service Research Institute with a focus on Industrial Services and Service Analytics. Back at IBM Peter joined the IBM Global Automotive Center of Competence and since then works on various automotive optimization and analytics topics, including inventory management and demand prediction.

Robert Krämer studied computer science at the University Kaiserslautern. He has been working in the central computer department of BASF until 1999 und then joined the company MATHESIS in the role of technology advisor for web based developments and interfacing. Currently he is engaged in extending the company's VisPlain product.

Esther Mohr is assistant professor at the University of Mannheim. She holds a diploma from Karlsruhe Institute of Technology (KIT) and a PhD from Saarland University / Max-Planck-Institute for Informatics. Esther explores to what extent companies are able to practice optimal decision-making without a complete range of relevant data. The Ministry for Science, Research and Arts Baden-Württemberg is funding her research project 'Decision-making with Limited Information'. In general, her research is concerned with the development of models and methods that provide decision support under uncertainty. Results have recently appeared in Discrete Applied Mathematics, Surveys in Operations Research and Management Science as well as Annals of Operations Research.

Iulian Nitescu is the CTO and co-founder of Graphmasters. His main focus is on distributed algorithms and machine learning for large-scale dynamic road networks. He is leading the development of various systems based on these core modules such as collaborative routing and distributed meta-heuristics for logistics optimisation. Iulian studied Computer Science at

King's College and Cambridge and has worked on a wide range of software projects ever since.

Steffen Rebennack is Associate Professor at the Colorado School of Mines, USA. He obtained his PhD at the University of Florida in 2010. His research interests are in dimension-reduction techniques for large-scale optimization problems, particularly with applications in power systems, stochastic optimization and global optimization. He is the vice-president of the "Real World Optimization" working group of the "German Operations Research" (GOR) society.

Tim Schöneberg works as Project Manager at Volkswagen Group IT. He holds a diploma of business information technology from University of Paderborn. After his diploma he was a member of the Daimler AG founded international graduate school class of the University of Paderborn where he finished his PhD. His focus is on IT-Systems for inbound logistics, especially those involving application of methods of Operations Research in practice.

Elke Wolf is a professional consultant for finance and investment decisions who has gained independent consulting experience with banks and the financial services industry since 1998 (Dr. Wolf Managementconsulting). Her current focus is on institutional and corporate investments (e.g. Private Equity/ Unternehmensbeteiligungen, Fondsinvestments). Further, she offers governance and interim management support. Prior industry experience includes process automation in the chemical industry.
She holds a PhD in information systems on risk management in banks and a Master's degree in economics. Her last academic position was as a Senior Lecturer/ Assistant Professor in information systems at a triple-accredited (AACSB, EQUIS, AMBA) international Business School.

Layout Planning and Production Scheduling in Future Intelligent Manufacturing Systems

Lennart Bochmann
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Future intelligent manufacturing systems (FIMS) are of major interest within the concepts of Industry 4.0, the next industrial revolution. They aim at facing the tradeoff between market demands for highly individualized products with increased uncertainty and the demand of todays production systems for well-balanced and strongly deterministic production programs. Therefore, they need to be capable of handling increased manufacturing complexity caused by decreased production volumes per product variant. The basic design approach of FIMS concentrates on highly flexible product as well as material transport units to allow the selection of individual and non-dedicated material flow paths by decentralized decision-making processes for each order. This approach has major impacts on the layout planning and the production scheduling of such manufacturing systems. In the context of layout planning, challenges regarding the optimal positioning of manufacturing cells as well as distributing process capabilities among these cells arise. Concerning production scheduling, increased flexibility is needed to allow improved utilization of information about the systems current state and the adaption of production schedules. The research my colleagues and me tackle within the concepts of FIMS aims at building a simulation model for the behavior of FIMS. Therefore, we built simulation models for new concepts of layout planning and optimization, production scheduling, and path finding including collision avoidance. The talk will introduce the challenges and the developed concepts in these topics, give insights in the applied optimization methods, and demonstrate a prototype of the simulation tool with the implemented concepts and methods.

Multi-item dynamic lot-sizing with detailed consideration of transportation capacities - A case study from the automotive industry

Martin Grunewald
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Inbound logistics is concerned with purchasing and arranging the inbound movement of parts to facilitate a given production plan with minimum transportation and inventory holding costs over a multi-period planning horizon. Typically, material requirements and transport relations are known for the next delivery days with certainty. For this period the shipment plan must dynamically specify the timing and contents for each shipment, i.e., the number of trucks required, the number of parts to be delivered and the assignment of load carriers to the trucks on a rolling horizon basis. Due to the consolidation of less-than-truckload shipments in order to increase truck utilization, strongly heterogeneous cargo is transported in mixed truckload shipments. Consequently, classical lot-sizing approaches considering capacities at a highly aggregated level (e.g., volume) are unsuitable for this planning problem as they could result in an infeasible or costly shipment plan. In this paper we present a new approach for this lot-sizing problem that considers transportation capacities in detail. The approach combines a multi-item dynamic lot-sizing problem with a multi-dimensional bin-packing procedure. A heuristic solution procedure for the resulting problem is presented. In a case study from the automotive industry we evaluate the shipment plan obtained by using the presented approach compared to approaches from the literature as well as plans currently implemented in practice, thereby establishing the advantage of using this new approach.

Robust Planning in Production Networks of Automotive Suppliers: Preparing for Economic Crises

Gerd J. Hahn
German Graduate School of Management and Law Heilbronn
Professorship of Operations Management and Process Innovation
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e-mail: gerd.hahn@ggs.de

Automotive suppliers are concerned with the flexibility of their production networks and aim for robust mid-term plans in order to cope with persisting economic instability. This instability could involve the risk of a new demand slump as seen during the financial crisis. In this presentation, we investigate the issues of managing flexibility and implementing robust planning approaches while considering the specific requirements of automotive suppliers in a disruptive demand environment. Our contribution is twofold: first, we develop a robust optimization approach for strategic-tactical supply chain planning and provide a procedure for demand modeling in such a setting. For this purpose, we rely on Conditional Value-at-Risk (CVaR) as a prevalent risk measure. Second, the value and inter-dependencies of process and volume flexibility are analyzed for supplier production networks which are related to product (re-)allocation and capacity balancing decisions. An extensive numerical study is used to evaluate the approach and to derive managerial insights based on a real-life case example from the industry.

Optimizing Cycle Times in Robot Based Manufacturing Lines

Tobias Hofmann
TU Chemnitz
Professorship of Algorithmic and Discrete Mathematics
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The use of industrial robots in the automotive industry noticeably changed the view of production plants and led to a tremendous increase in productivity. Nonetheless, rising technological complexity, the parallelization of production processes, as well as the crucial need for respecting safety issues pose new challenges for man and machine. Furthermore, the progress shall proceed – production cannot be too fast, too safe or too cheap.

This is the topic that me and my colleagues from TU Chemnitz tackle within the ERDF research project viRAL (Validierte Inbetriebnahme von Roboteranlagen mit automatischer Logik- und Lageprüfung) joint with Voith Engineering Services GmbH and Fraunhofer IWU in Chemnitz. Our goal is to create tools that make the commissioning process more reliable by verifying the programs of robots and logical controllers. This in particular includes optimizing the schedule of robots in order to ensure desired cycle times already in the planning phase.

The talk will be about a periodic scheduling problem as it typically appears in the context of generating train timetables as well as why and how the mathematical models used in this field are well applicable to our scheduling problem. We will adapt a proposed model by Serafini and Ukovich in 1989 to the industrial environment, yielding a Mixed Integer Linear Program.

All-Time Parts Prediction for Automotive Spare Parts Management

Verena Elisabeth Hutterer
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e-mail: verena.hutterer@de.ibm.com

We present a new approach for predicting the demand of service parts for so-called All-Time-Buy decisions. Such buys shall cover the demand for the next 15-20 years. Since this demand is generally difficult to estimate there is a clear tendency to buy too much in order to avoid stock-outs. Many automotive and other companies struggle with this issue. The new approach aims at predicting All-time demands with high accuracy.

The approach comprises various prediction models to account for the different demand patterns of service parts (fast movers, slow movers, non-movers): Parts with full historic life cycles are used to predict the demand for parts which are in the middle of their life cycle. For slow movers a neural network approach is used. For new parts a combination of clustering and decision trees is chosen.

Finding consistent decisions operating logistics networks

Siegfried Jetzke
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In the first part we will outline some basic aspects for consistency in logistics networks.

The ultimate goal of any activity within some logistics networks must be to operate processes to fulfill given requirements. Starting from planning production plants, designing the supply chain or network ending with delivering the goods to the customer, all decisions involved depend on each other. The total process can take months or even years involving various actors – often aiming different goals. This leads to vertical and horizontal conflicts: Vertical considering the run - time of a process and horizontal means to consider different actors. Even if these goals are – sometimes – obvious for the decision makers himself, they change during the process, either because of new boundary conditions entering the process or simply because decision maker enter or leave the process. In many cases the goals are formulated in a manner not suited for starting optimization processes. One of the obvious reasons for problems faced with is the use imprecise terms describing problems, goals or tasks. Long and short range time dependencies induce additional difficulties. Every viewpoint that does not take into account dynamic effects will give insufficient results.

The second part of the talk will discuss an approach to overcome the vertical and some of the horizontal conflicts. We will sketch our model for describing and operating large scale logistics networks. We will give an overview of software program being under way and present what kind of results are expected and how these approach is intended to be used in practice. We will outline how this tool can be used starting from tender management via disposing towards tracking & tracing and analyzing operational data to continuously improve the previous steps. The actual version still has to be seen as a prototype. It is in the field with a company operating more than thousand vehicles daily for several months. It is supposed to become productive for tender management as a first application within the next few weeks. This version already gives reasonable results operating hundreds of vehicles in a transportation process up to three stages. We will discuss progress and still open difficulties towards a consistent operation of logistics networks.

This talk will be given in German.

Einblicke in die Konzepte und Algorithmen für die Verwaltung variantenreicher Produkte bei Volkswagen

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In der Automobilindustrie vollzieht sich seit Jahren ein Wandel von einem Verkäufer- hin zu einem Käufermarkt. Der Kunde mit seinen individuellen Bedürfnissen rückt immer stärker in den Fokus der Fahrzeugproduktion. Damit einher nimmt auch die Bedeutung der Produktdifferenzierung als wesentlicher Wettbewerbsfaktor stark zu und resultiert in einer rasant steigenden Variantenvielfalt. Neue Entwicklungen im Bereich des autonomen Fahrens sowie die wachsende Bedeutung der Digitalisierung verstärken diesen Effekt zusätzlich.

Die durch die hohe Produktvarianz hervorgerufene Komplexität, welche in diesem Ausmaß nahezu einmalig im Automobilsektor anzutreffen ist, stellt Fahrzeugproduzenten vor große Herausforderungen über alle Unternehmensbereiche hinweg. Der Einsatz geeigneter Algorithmen und entscheidungsunterstützender Systeme ist unabdingbar, um auch in Zukunft hoch komplexe und personalisierte Fahrzeuge anzubieten und den hohen Anforderungen der Kunden gerecht zu werden. Mitunter ergeben sich dabei auch Problemstellungen aus dem Bereich der mathematischen Programmierung, die wir in unserem Vortag exemplarisch vorstellen werden. Dazu vermitteln wir im ersten Teil unseres Vortrags einen Einblick in das Variantenmanagement bei Volkswagen. Der zweite Teil beschäftigt sich mit Algorithmen und Konzepten, die zur Beherrschung der Komplexität entwickelt wurden. Ihre Anwendung wird mit Hilfe des entstandenen Prototypen veranschaulicht.

K-Curve Method and Budget Optimization for Automotive Spare Parts Management

Peter Korevaar
IBM Deutschland GmbH
Gottlieb Daimlerstrasse 12, D-68165 Mannheim, Germany
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We describe a method for optimizing replenishment quantities under the condition that inventory holding and replenishment costs are unknown. This so-called K-Curve method uses a replenishment frequency classification and optionally obeys minimum order quantities and rounding quantities. The method allows for chosing to reduce inventory levels or replenishment costs or a combination of both, by varying the value of the parameter K.

Further we describe a budget optimization logic for determining the minimum total cost for providing parts through a regional warehouse, whereby the part assortment, the part's individual service levels and the rush order re-order points are determined such that the total cost for delivery (stock holding, handling, transportation) is minimized under the condition that given target service levels are met on pre-defined part groups. This budget optimizer has been realized using the evolutionary Threshold Accepting algorithm (similar to simulated annealing).

Work Visually with Complex Data

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The current hype on big data may overshadow the problems inherent in complex data.

Complex data constellations, which are nothing new to large companies, are gaining importance by:

- more process information getting available to computer systems,
- demand for views of the overall picture require to correlate earlier separate information pools,
- computer power and mathematical progress making optimization computation feasible in instantly computed what if scenarios.

Complexity in above situations shows up in multiple, often not explicitly known relationships between the data items.

The knowledge worker's job is not merely to look at and understand data items in certain locations, but to find out about relationships within those data items.

The end user has to deal efficiently and safely with complexity in his day to day work.

It may be argued, that information presented as lists or common business graphics, is not the optimal solution for above task.

Look at a child given a new toy:

- It will grab it with its hands and turn it to be able to look from all sides on it.
- It will open it to see what's inside; it will twist and press to see what will happen to the toy's structure.
- It will try to combine it with other toys it already has and understands to find out if something bigger can be made out of it.

Shouldn't a knowledge worker be given the same capabilities?

Couldn't current computer assistance be enhanced to better support human brain's capacity to understand and work with complex constellations of information ?

Isn't vision, especially in a short feedback loop of applying change and viewing the result a more human way of understanding the 'whole picture' ?

In this speech we will discuss an approach which works with information based on digraphs consisting of nodes connected by directed edges and a highly interactive handling and viewing layer above it.

Pros and cons will be discussed based on real examples in the food and chemical businesses targeting logistic and production planning.

It will be shown how a complex manual planning situations and the output of a mathematical optimization computation can be examined and composed visually; in scenarios for the end user and the knowledge worker.

Optimal replenishment under price uncertainty

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We aim to find optimal replenishment decisions without having the entire price information available at the outset. Although it exists, the underlying price distribution is neither known nor given as part of the input. Under the competitive ratio optimality criterion, we design and analyze online algorithms for two related problems. Besides the reservation price based decision how much to buy we additionally consider the optimal scheduling of orders. We suggest an online algorithm that decides how much to buy at the optimal point in time and experimentally explore its decision making. Results show that the problem of finding a replenishment strategy with best possible worst-case performance guarantees can be considered as an extension of the online time series search problem.

Bridging the gap between theoretical and real-world VRP

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We present Nunav Courier - a tactical planning (depot optimisation) and route optimisation platform. While most systems solve the VRP problem statically, Nunav continuously updates the tour of each driver as they drive, taking into account live traffic conditions. This leads to minute accurate arrival times at nodes even in real world driving conditions.

As opposed to other solvers that can give very good theoretical tours, our aim is to bring the improvements to the driver such as to narrow the gap between theoretical and actual tours that drivers follow. This brings us at the intersection of VRP, distributed in-memory graphs and a granular traffic model built from millions of real-time probes. To the best of our knowledge, this is the first of such systems.

We show a significant improvement to current systems in use. Real world usage shows a decrease of 30% in distance and a 10% reduction of vehicles.

Inventory Control: Multi-Echelon Optimization in a spare parts network

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Ein in der Automobilindustrie weit verbreitetes Konzept zur Organisation der Inbound-Logistik für Stückgutsendungen sind Gebietsspeditionsnetzwerke. Typischerweise wird zwischen Spediteur und OEM ein Risk-Sharing Modell vereinbart das auf degressiven Tarifstrukturen beruht. Für den OEM ist es dabei vorteilhaft, zur Minimierung der Frachtkosten Anlieferungen zusammenzufassen um eine höhere Auslastung zu erzielen und somit von einer günstigeren Tarifstufe zu profitieren. Die höhere Auslastung wird in der Regel im Gegenzug mit höheren Lagerhaltungskosten erkauft, so dass eine Abwägung zwischen beiden Kostenkomponenten notwendig ist. Ein in der Praxis weit verbreiteter Ansatz zur Steuerung der Anlieferhäufigkeit sind Anlieferschemata bzw. Anlieferprofile. Ein Anlieferschema gibt ein Muster von Anliefertagen vor, an denen der Lieferant anliefern darf und kann im Rahmen des MRP-Laufes zur Lieferabrufbildung eingesetzt werden. In der Literatur gibt es bereits Ansätze zur Auswahl des optimalen Anlieferschemata. Ein Aspekt der in der Praxis große Relevanz besitzt aber in der Literatur nicht betrachtet wird ist die Auswirkung der eingestellten Anlieferschemata auf die Auslastung der betroffenen Anlieferstellen. Eine ungleichmäßige Verteilung der Anlieferungen (z.B. eine verstärkte Anlieferung zu Wochenbeginn) kann in der Praxis zu einer Überlastung führen die wiederum hohe Standzeiten und daraus resultierende Entschädigungszahlungen an die Spediteure hervorrufen. In der Literatur gibt es unterschiedliche Ansätze um die Gleichmäßigkeit der Anlieferungen abzubilden. Ziel der vorliegenden Arbeit ist es, eine gleichmäßige Auslastung der Anlieferstellen herzustellen.

Mathematische Optimierung bei strategischen Unternehmensbeteiligungen in der Automobilindustrie - Möglicheiten und Grenzen

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Strategische Unternehmensbeteiligungen sind ein zunehmend wichtiges Instrument für die Automobilindustrie, um neue Märkte zu erschließen und Innovationen für neue Mobilitätsanforderungen in der Zukunft vorzubereiten. Aufgrund der charakteristischen Illiquidität eines solchen Investments ist ein fundierter Entscheidungsprozess maßgeblich für den Erfolg.

Dieser Vortrag beleuchtet verschiedene Möglichkeiten, wie Akquisitionsentscheidungen durch mathematische Optimierungsansätze unterstützt werden können. Gleichzeitig werden Grenzen und Schwierigkeiten aufgezeigt, die im Entscheidungsprozess zu berücksichtigen sind.

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Strategic acquisitions have gained increasing importance in the automotive industry in order to seize new market opportunities and capitalize on innovative ideas for future forms of mobility. Due to the inherent illiquidity of such an investment a sound decision making process is crucial.

This presentation will provide an overview on the potential of mathematical programming approaches to support managerial decision making such as the strategic acquisition of new subsidiaries. Limitations and pitfalls that need to be considered will be discussed.