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Research outputs:

An urban consolidation center in the city of Copenhagen: A simulation study
Urban consolidation centers (UCCs) have a key role in many initiatives in urban logistics, yet few of them are successful in the long run. The high costs often prevent attracting a sufficient number of UCC users. In this paper, we study sustainable business models and the supporting role of administrative policies. We perform an agent-based simulation applied to the city of Copenhagen and collect data from a variety of sources to model the agents. Both the data and case setup are validated by means of expert interviews. We test 1,458 schemes that combine several administrative measures and cost settings. Most schemes yield significant environmental benefits; many of them reduce the truck kilometers driven by about...
65% and emissions by about 70%. The key challenge is to identify schemes that are also financially sustainable. We show the importance of committing carriers to the UCC as soon as possible, as carriers potentially generate the bulk of the revenue. Subsequent revenues may be generated by offering value-adding services to receivers. Based on the numerical experiments, we pose various propositions that aid in providing favorable conditions for a UCC, improving its chances of long-term success.

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Passenger service optimization through timetabling with free passenger route choice
Designing a public transport timetable that maximizes passenger service, measured in weighted travel time, is an intricate problem. The weighted travel time depends on the free route choice of passengers. Passenger route choice depends on the timetable. In turn, the timetable that minimizes weighted travel time depends on the route choice of passengers – and therefore requires passenger route choice information. Consequently, a sequential approach where timetables are designed provided pre-fixed passenger assignment to routes, may not find the optimal timetable. This paper aims to integrate passenger route choice and timetabling. It addresses the problem of designing maximal passenger service public transport timetables in systems with free route choice within a budget for operating costs. Operating costs are defined by the minimal cost vehicle schedule required to operate the timetable. The proposed methodology integrates a matheuristic for timetabling and vehicle scheduling with a passenger assignment model in an iterative framework, where different forms of integration are evaluated. Focus is on long to medium term timetabling, provided an initial timetable. Results for a realistic case study in the Greater Copenhagen area indicate that our approach consistently leads, at no additional cost, to timetables that represent a reduction in passenger weighted travel time in comparison to both an initial timetable and a non-integrated timetabling method that receives a single passenger assignment as input.

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A matheuristic for transfer synchronization through integrated timetabling and vehicle scheduling
Long transfer times often add unnecessary inconvenience to journeys in public transport systems. Synchronizing relevant arrival and departure times through small timetable modifications could reduce excess transfer times, but may also directly affect the operational costs, as the timetable defines the set of feasible vehicle schedules. Therefore better results in terms of passenger service, operational costs, or both, could be obtained by solving these problems simultaneously.

Electric bus fleet size and mix problem with optimization of charging infrastructure
Battery electric buses are seen as a well-suited technology for the electrification of road-based public transport. However, the transition process from conventional diesel to electric buses faces major hurdles caused by range limitations and required charging times of battery buses. This work addresses these constraints and provides a methodology for the cost-optimized planning of depot charging battery bus fleets and their corresponding charging infrastructure. The defined problem covers the scheduling of battery buses, the fleet composition, and the optimization of charging infrastructure in a joint process. Vehicle schedule adjustments are monetized and evaluated together with the investment and operational costs of the bus system. The resulting total cost of ownership enables a comparison of technical alternatives on a system level, which makes this approach especially promising for feasibility studies comprising a wide range of technical concepts. Two scenarios of European cities are analyzed and discussed in a case study, revealing that the cost structure is influenced significantly by the considered bus type and its technical specifications. For example, the total energy consumption of the considered lightweight bus is up to 32% lower than the total consumption of the high range bus, although the deadheading mileage increases. However, the total costs of ownership for operating both bus types are relatively close, due to the increased fleet size and driver expenses required for the lightweight bus system. The case study furthermore reveals that a mixed fleet of different bus types could be advantageous depending on the operational characteristics of the bus route.
Synchronizing transfers through integrated timetabling and vehicle scheduling - an iterative matheuristic approach with public transit traffic assignment

Transfer times add inconvenience to journeys and thus synchronizing departures and arrival times of relevant lines improves the service for passengers. As the timetable changes passengers may also change their travel itineraries. Additionally, introducing small timetable modifications may also affect the operational costs, as the timetable defines a set of feasible vehicle schedules. We address the Integrated Timetabling and Vehicle Scheduling Problem (IT-VSP) with Public Transit Traffic Assignment (PTTA). The IT-VSP is formulated as a MILP that minimizes transfer costs with a budget on operational costs. Given an initial noncyclical timetable, time-dependent service times and passenger demands, the transfer time cost is minimized by allowing modifications to the timetable that respect a set of headway constraints. Timetable modifications consist of shifts in departure time and addition of dwell time at intermediate stops. We propose to solve the problem iterating between solving a matheuristic for the IT-VSP and re-computing the PTTA. The matheuristic solves the ITVSP MILP allowing timetable modifications for a subset of timetabled trips only, while solving the full vehicle scheduling problem. Results for the Greater Copenhagen area indicate that our approach finds better solutions faster than a commercial solver and that allowing the addition of dwell time creates a larger potential for reducing transfer costs. We also show that the integration with the PTTA model generated solutions with lower transfer costs then the solutions obtained with a version that does not compute new passenger assignments once the timetables change.

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A matheuristic approach for solving the Integrated Timetabling and Vehicle Scheduling Problem

The Integrated Timetabling and Vehicle Scheduling Problem (IT-VSP) is a generalization of the well-known Vehicle Scheduling Problem (VSP). In the IT-VSP the trips in the original timetables may be modified in terms of arrival and departure times in order to minimize a new objective function that considers both operational costs and passenger transfer costs. Starting from a base timetable, the allowed modifications include shifting the departure time from the first station of each trip and also the extension of dwell times at important stops where large flows of passengers are expected to transfer between different trips. We consider transfers between bus trips scheduled by the model, but also transfers to other fixed lines that intersect the lines considered in the IT-VSP. We present a MIP formulation of the IT-VSP able to solve small instances of the problem, and a matheuristic approach that uses the compact MIP to solve larger instances of the problem. The idea is to iteratively solve restricted versions of the MIP selecting at each step a subset of trips where modifications are allowed, while all other trips remain fixed. The performance of the proposed matheuristic is shown on a case study with real-life instances provided by the main service provider in the greater Copenhagen area. The effect of allowing dwell times is compared to previous approaches to the problem where trips are only allowed to be shifted in time.

General information
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The multi-port berth allocation problem with speed optimization and emission considerations

The container shipping industry faces many interrelated challenges and opportunities, as its role in the global trading system has become increasingly important over the last decades. On the one side, collaboration between port terminals and shipping liners can lead to costs savings and help achieve a sustainable supply chain, and on the other side, the optimization of operations and sailing times leads to reductions in bunker consumption and, thus, to fuel cost and air emissions reductions. To that effect, there is an increasing need to address the integration opportunities and environmental issues related to container shipping through optimization. This paper focuses on the well known Berth Allocation Problem (BAP), an optimization problem assigning berthing times and positions to vessels in container terminals. We introduce a novel mathematical formulation that extends the classical BAP to cover multiple ports in a shipping network under the assumption of strong cooperation between shipping lines and terminals. Speed is optimized on all sailing legs between ports, demonstrating the effect of speed optimization in reducing the total time of the operation, as well as total fuel consumption and emissions. Furthermore, the model implementation shows that an accurate speed discretization can result in far better economic and environmental results.

An adaptive large neighborhood search heuristic for the Electric Vehicle Scheduling Problem

This paper addresses the Electric Vehicle Scheduling Problem (E-VSP), in which a set of timetabled bus trips, each starting from and ending at specific locations and at specific times, should be carried out by a set of electric buses or vehicles based at a number of depots with limited driving ranges. The electric vehicles are allowed to be recharged fully or partially at any of the given recharging stations. The objective is to firstly minimize the number of vehicles needed to cover all the timetabled trips, and secondly to minimize the total traveling distance, which is equivalent to minimizing the total deadheading distance. A mixed integer programming formulation as well as an Adaptive Large Neighborhood Search (ALNS) heuristic for the E-VSP are presented. ALNS is tested on newly generated E-VSP benchmark instances. Result shows that the proposed heuristic can provide good solutions to large E-VSP instances and optimal or near-optimal solutions to small E-VSP instances.
The Simultaneous Vehicle Scheduling and Passenger Service Problem with Flexible Dwell Times

In this talk, we deal with a generalization of the well-known Vehicle Scheduling Problem (VSP) that we call Simultaneous Vehicle Scheduling and Passenger Service Problem with Flexible Dwell Times (SVSPSP-FDT). The SVSPSP-FDT generalizes the VSP because the original timetables of the trips can be changed (i.e., shifted and stretched) in order to minimize a new objective function that aims at minimizing the operational costs plus the waiting times of the passengers at transfer points. Contrary to most generalizations of the VSP, the SVSPSP-FDT establishes the possibility of changing trips’ dwell times at important transfer points based on expected passenger flows. We introduce a compact mixed integer linear formulation of the SVSPSP-FDT able to address small instances. We also present a meta-heuristic approach to solve medium/large instances of the problem. The effectiveness of the proposed solution methods is shown on a set of real-life instances provided by the main bus operator on the greater Copenhagen area. The effects of considering extensible dwell times on the objective function and on the provided solutions are also analysed.

General information

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Electronic versions:

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Source ID: 125884995
Research output: Contribution to conference » Conference abstract for conference – Annual report year: 2016 » Research » peer-review

Integrated Berth Allocation and Quay Crane Assignment Problem: Set partitioning models and computational results

Most of the operational problems in container terminals are strongly interconnected. In this paper, we study the integrated Berth Allocation and Quay Crane Assignment Problem in seaport container terminals. We will extend the current state-of-the-art by proposing novel set partitioning models. To improve the performance of the set partitioning formulations, a number of variable reduction techniques are proposed. Furthermore, we analyze the effects of different discretization schemes and the impact of using a time-variant/invariant quay crane allocation policy. Computational experiments show that the proposed models significantly improve the benchmark solutions of the current state-of-art optimal approaches.

General information
Hybrid Heuristic Approaches for Tactical Berth Allocation Problem

Tactical berth allocation problem deals with: the berth allocation (as- signs and schedules vessels to berth-positions), and the quay crane (QC) assignment (finds number of QCs that will serve). In this work, we strengthen the current mathematical models (MM) with novel lower bounds and valid inequalities. And, we propose a hybrid heuristic which combines MM with greedy and search heuristics. Results show that problem can be solved efficiently respect to optimality and computational time.

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Contributors: Iris, C., Larsen, A., Pacino, D., Røpke, S.
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The Simultaneous Vehicle Scheduling and Passenger Service Problem

Passengers using public transport systems often experience waiting times when transferring between two scheduled services. In this paper we propose a planning approach that seeks to obtain a favourable trade-off between the two contrasting objectives, passenger service and operating cost, by modifying the timetable. The planning approach is referred to as the simultaneous vehicle scheduling and passenger service problem (SVSPSP). The SVSPSP is modelled as an integer programming problem and solved using a large neighborhood search metaheuristic. The proposed framework is tested on data inspired by the express-bus network in the Greater Copenhagen area. The results are encouraging and indicate a potential decrease of passenger transfer waiting times in the network of up to 20%, with the vehicle scheduling costs remaining mostly unaffected.

Improved Models to Integrated Berth Allocation-Quay Crane Assignment Problem: A Computational Comparison and Novel Solution Approaches

Nowadays, over 60% of the world’s deep-sea cargo is being placed in containers and transported by ship via container terminals and seaports. Hence, the need for optimization in container terminal operations has become more and more important in recent years. The productivity of container terminals heavily relies on the efficiency of quay cranes operations, and the usage of the berthing area. Optimizing the allocation of ships to berth and the related assignment of cranes are important problems that are mostly covered as two separate cases in the literature. However, since the handling time of the vessels primarily depends on the number of containers to be handled and the number of cranes deployed, it would be beneficial to consider the integration of those two problems. This work extends the state-of-the-art by strengthening the current best mathematical formulation. Computational experiments are carried out to analyze the performance of the new formulation with respect to solution quality and execution time.
Integrated Berth Allocation-Quay Crane Assignment Problem: Reformulations, Improved Constraints and Computational Results

Nowadays, large container terminals can process more than 30 million containers a year, and are constantly in search for the best ways to optimize processing time and deliver high quality, and profitable, services. Most of the operational problems on a container terminal are interconnected. The productivity of container terminals heavily relies on the efficiency of quay cranes operations, and the usage of the berthing area. Optimizing the allocation of ships to berth and the related assignment of cranes are important problems that are mostly covered as two separate cases in the literature. However, since the handling time of the vessels primarily depends on the number of containers to be handled and the number of cranes deployed, it would be beneficial to consider the integration of those two problems. In this work we extend the current state of the art by strengthening the current best formulation and by proposing novel set partitioning models. Finally, computational experiments are carried out to analyze the performances of the new formulations with respect to modeling capabilities, solution quality and execution time. Considerable amount of studies have been done on the berth allocation problem (BAP) and the quay crane assignment problem (QCAP). Such integrated problem is known in the literature ([1]) as the Berth Allocation and Crane Assignment Problem (BACAP). The state-of-the-art [1] models this problem using two decision variables X_{ij} and Y_{ij}, representing respectively the partial order of the time and space dimension of the berth assignment, where i and j are two vessels. Moreover the variables r_{ij} define the number of cranes q to be assigned to vessel i at time t, and a set of auxiliary variables such as the vessel start time S_{i}. An optimal solution to the BACAP minimizes a number of operational costs, such as the tardiness of the schedule, vessel speedup cost, and crane operation cost. The contribution of this work is twofold. First, we improve the model presented in [1] by proposing a number of valid inequalities. Second, we introduce a novel set partitioning formulation and present preliminary results.

We propose an improved version of this model in the form of a set of valid inequalities aimed at improving the LP bound of the formulation. First we focus on the vessel start time. Increasing these bounds will, most likely, increase the lower bound obtained from LP relaxation since start-time variables S_{i} are integrated into objective function. Inequality (1) is based on the following two observations. First, if vessel i berths before vessel j (X_{ij}=1), then the start time of vessel j (S_{j}) should be larger than the start time of vessel i plus its minimum expected processing time (m_i R_{max}^i). Second, the start time of j cannot be earlier than the earliest possible time of arrival (EST). Another inequality forces at most one kind of crane assignment plan for each of periods and vessels (2). The berthing time of vessel should be within the interval of minimum and maximum possible processing time (3). Finally, there cannot be any processing before the earliest arrival time of vessels (4). Preliminary results on the first 10 instances of the benchmark in [1] are presented in Table 1. The table compares the model from [1] and our improved version (BACAP+). It is observed that given the time limit of 10 minutes, BACAP+ finds improvements

Table 1. CPLEX Results for BACAP+

<table>
<thead>
<tr>
<th>Meisel and Bierwirth [1] Results</th>
<th>Valid Inequalities (BACAP+)</th>
<th>Obtained LB</th>
<th>Integer Solution</th>
<th>Obtained GAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ins.ZLBGAP1</td>
<td>184,184,00,12%76,0X0,10,6%600*84,180,794,10%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obtained GAP2</td>
<td>253,953,90,0%53,9+0,00%289,853,930,00%31,4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPU Time</td>
<td>377,475,22,93%66,6X16,25%600*78,471,210,07%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>476,275,80,52%68,1X11,30%600*X73,13,60%l600</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>556,856,80,0%56,8+0,00%45%56,856,80,00%368</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>657,657,60,00%57,2X0,79%600*57,657,60,00%27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>768,067,50,74%63,0X7,97%600*68,067,90,19%600</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>856,184,00,0%51,3X9,42%600<em>56,184,00,05%600</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>975,175,00,13%74,9X0,33%600<em>75,175,00,15%600</em></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

BACAP can also be formulated as Generalized Set Partitioning Problem (GSPP). The model is an extension of the BAP formulation in [2] where we add new set definitions and constraints that relate to the crane assignment. Here each column represents a feasible assignment plan for a vessel (that includes both crane allocation and berth assignment). Let the variable \lambda_{p\in\omega}\in\{0,1\} be the selection of the assignment plans \ p\in\omega. The model minimizes the time dependent costs (D_{p}) and the crane assignment costs (C_{p}). Constraints ensure that each vessel is assigned to one plan, that at a given time t and position s at most one plan can be selected, and that at most one crane amount can be selected in a given plan with the knapsack constraint \sum_{p\in\omega} D_{p} \lambda_{p\in\omega} \leq Q \ V t \in T, where the number of cranes is captured by the parameter Q. The results shown in Table 2 are for fixed number of QC through stay at port.

Table 2. CPLEX Results for GSPP and [1]

<table>
<thead>
<tr>
<th>Meisel and Bierwirth [1] results for Fixed QC number</th>
<th>GSPP results for Fixed QC number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ins.ZLBGAP1</td>
<td>1X81,1-14,50%120*89,089,031241050,56590,42</td>
</tr>
<tr>
<td>Number of columns</td>
<td>Column Time</td>
</tr>
</tbody>
</table>
Results show that model [1] is not capable to find an integer solution in most cases where number of QC is not changing through the stay of vessel at terminal. However, set partitioning formulation obtains optimum values in reasonable computational time.

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Routing of Electric Vehicles: Case Study of City Distribution in Copenhagen
In Copenhagen, Denmark, the preliminary steps of introducing an Urban Consolidation Centre (UCC) in the perimeter of the city centre has been taken. By implementing a UCC, interests of customers and distributors, as well as improvement of the local urban environment are sought considered [1]. The UCC service aims to consolidate urban freight, as well as implement additional aspects such as off-peak delivery and utilisation of alternatively fuelled vehicles.

In the specific case of Copenhagen, a comprehensive traffic survey was conducted in May 2011. The aim of the survey was to estimate freight magnitude and the distribution of goods in the old city centre. Based on the survey, analysis of
Distribution from the UCC is assumed to be conducted with electric vehicles (EVs) as they are considered suitable for the overall aim. However, compared to conventional distribution vehicles they have a limited driving range and a limited freight capacity. In this work, an Electric Vehicle Routing Problem with Time Windows (EVRPTW) is addressed. The EVs are allowed to recharge at certain customers or replenishment stations in order to continue a tour. Furthermore, intelligent location of these recharging points is considered. The objective is to find a least cost plan for routing and recharging the vehicles so that each customer is serviced by exactly one vehicle within its time windows and the vehicle capacity and driving range constraints are satisfied. The EVRPTW is a new problem that only has received little attention in the literature; see for example [2] and [3]. The costs are compared to distribution conducted by conventional vehicles. A heuristic method is developed and tested on the data generated on the basis of real-life collected data.

References


Routing of Electric Vehicles: City Distribution in Copenhagen

In this work, a Vehicle Routing Problem with Time Windows considering EV constraints of limited driving range and freight capacity is addressed (EVRPTW). The EVs are allowed to recharge at certain locations, and aspects of intelligent location of these recharging points are considered. The objective is to find the least cost plan for EV routing and compare this to conventional routing. A heuristic method is developed and tested on data based on real-life collected data on distribution vehicles in central Copenhagen, Denmark. The EVRPTW has so far received little attention in the literature.
The waste collection vehicle routing problem with time windows in a city logistics context
Collection of waste is an important logistic activity within any city. In this paper we study how to collect waste in an efficient way. We study the Waste Collection Vehicle Routing Problem with Time Window which is concerned with finding cost optimal routes for garbage trucks such that all garbage bins are emptied and the waste is driven to disposal sites while respecting customer time windows and ensuring that drivers are given the breaks that the law requires. We propose an adaptive large neighborhood search algorithm for solving the problem and illustrate the usefulness of the algorithm by showing that the algorithm can improve the objective of a set of instances from the literature as well as for instances provided by a Danish garbage collection company.

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Organisations: Department of Transport, Transport optimisation and technique
Contributors: Buhrkal, K. F., Larsen, A., Røpke, S.
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Solving a Vehicle Routing Problem with a non-linear load dependant cost function

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Contributors: Spoorendonk, S., Larsen, A., Pisinger, D., Røpke, S.
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Source: orbit
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Truende mangel på trafikplanlæggere og vejingeniører

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Contributors: Larsen, A., Hansen, C. B., Jørgensen, A. S.
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Ratings:
Disruption Management - Foreword

General information
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Contributors: Clausen, J., Larsen, A., Larsen, J.
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Web of Science (2010): Impact factor 1.769
Web of Science (2010): Indexed yes
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Source: orbit
Source ID: 260445
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Disruption management in the airline industry-Concepts, models and methods

This paper provides a thorough review of the current state-of-the-art within airline disruption management of resources, including aircraft, crew, passenger and integrated recovery. An overview of model formulations of the aircraft and crew scheduling problems is presented in order to emphasize similarities between solution approaches applied to the planning and recovery problems. A brief overview of research within schedule robustness in airline scheduling is included in the review, since this proactive measure is a natural complement to disruption management.

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Web of Science (2010): Impact factor 1.769
Web of Science (2010): Indexed yes
The Simultaneous Vehicle Scheduling and Passenger Service Problem

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Event: Abstract from Tristan VII: Triennial Symposium on Transportation Analysis, Tromsø, Norway

Intelligent Freight Transport Systems: Visions for real-time distribution planning
The Danish innovation project entitled “ Intelligent Freight Transport Systems” aims at developing prototype systems integrating public intelligent transport systems (ITS) with the technology in vehicles and equipment as well as the IT-systems at various transport companies. The objective is to enhance the efficiency and lower the environmental impact in freight transport. In this paper, a pilot project involving real-time waste collection at a Danish waste collection company is described, and a solution approach is proposed. The problem corresponds to the dynamic version of the waste collection problem which can be formulated as a dynamic version of the vehicle routing problem with time windows (VRPTW).

A Data Set for the Simultaneous Vehicle Scheduling and Passenger Service Problem

General information
Publication status: Published
Organisations: Operations Research, Department of Management Engineering, Logistics & ITS, Department of Transport
Contributors: Petersen, H. L., Larsen, A., Madsen, O. B., Repke, S.
Publication date: 2008
Dynamic Airline Scheduling: An Analysis of the Potentials of Refleeting and Retiming

We present a Dynamic Airline Scheduling (DAS) technique which is able to change departure times and reassign aircraft types during the booking process to meet fluctuating passenger demands. The procedure is tested on several different days before departure, resulting in a significant profit increase for a major European airline. The results also indicate that applying DAS close to departure yields the largest potential.

General information
Publication status: Published
Organisations: Department of Transport, Logistics & ITS, Jeppesen Systems AB, Scandinavian Airlines Sweden
Contributors: Warburg, V., Hansen, T. G., Larsen, A., Normann, H., Andersson, E.
Publication date: 2008

Host publication information
Title of host publication: INFORMS Annual Conference Proceedings
Publisher: Institute for Operations Research and the Management Sciences
Source: orbit
Source ID: 237857
Recent developments in dynamic vehicle routing systems

General information
Publication status: Published
Organisations: Logistics & ITS, Department of Transport, Northeastern University
Contributors: Madsen, O. B., Larsen, A., Solomon, M. M.
Number of pages: 590
Pages: 199-220
Publication date: 2008

Host publication information
Title of host publication: The Vehicle Routing Problem: Latest Advances and New Challenges
Volume: 43
Publisher: Springer
Editors: Golden, B., Raghavan, S., Wasil, E.
Edition: 1
ISBN (Print): 978-0-387-77777-1
Source: orbit
Source ID: 232763
Research output: Chapter in Book/Report/Conference proceeding › Book chapter – Annual report year: 2008 › Research › peer-review

The Simultaneous Vehicle Scheduling and Passenger Service Problem

General information
Publication status: Published
Organisations: Operations Research, Department of Management Engineering, Logistics & ITS, Department of Transport
Contributors: Petersen, H. L., Larsen, A., Petersen, B.
Publication date: 2008

Publication information
Place of publication: Kgs. Lyngby
Publisher: DTU Transport
Edition: 1
Original language: English
(DTU Transport Technical Reports; No. 2008-7).
Keywords: vehicle scheduling, passenger service
Source: orbit
Source ID: 232360
Research output: Book/Report › Report – Annual report year: 2008 › Research

Airline Disruption Management - Perspectives, Experiences and Outlook
Over the past decade, airlines have become more concerned with developing an optimal flight schedule, with very little slack left to accommodate for any form of variation from the optimal solution. During operation the planned schedules often have to be revised due to disruptions caused by for example severe weather, technical problems and crew sickness. Thus, the field of Airline Disruption Management has emerged within the past few years. The increased focus on cutting cost at the major airlines has intensified the interest in the development of new and cost efficient methods to handle airline disruptions. The purpose of this paper is twofold. In the first part it offers an introduction to airline disruption management provides the readers with a description of the planning processes and delivers a detailed overview of the numerous aspects of airline disruption management. In the second part we report on experiences from a large research and development project on airline disruption management. Within the project the first prototype of a multiple resource decision support system at the operations control center in a major airline, has been implemented.

General information
Publication status: Published
Organisations: Department of Informatics and Mathematical Modeling, Logistics & ITS, Department of Transport, Operations Research, British Airways, Carmen System A.B.
Contributors: Kohl, N., Larsen, A., Larsen, J., Ross, A., Tiourine, S.
Pages: 149-162
Publication date: May 2007
Peer-reviewed: Yes
Classification of Dynamic Vehicle Routing Systems

This chapter discusses important characteristics seen within dynamic vehicle routing problems. We discuss the differences between the traditional static vehicle routing problems and its dynamic counterparts. We give an in-depth introduction to the degree of dynamism measure which can be used to classify dynamic vehicle routing systems. Methods for evaluation of the performance of algorithms that solve on-line routing problems are discussed and we list some of the most important issues to include in the system objective. Finally, we provide a three-echelon classification of dynamic vehicle routing systems based on their degree of dynamism and the system objective.

Dynamic Airline Scheduling: An Analysis of the Potentials of Refleeting and Retiming

We present a Dynamic Airline Scheduling (DAS) technique which is able to change departure times and reassign aircraft types during the booking process to meet fluctuating passenger demands. The procedure is tested on several different days before departure, resulting in a significant profit increase for a major European airline. The results also indicate that applying DAS close to departure yields the largest potential.
Dynamic Airline Scheduling: An Analysis of the Potentials of Refleeting and Retiming

General information
Publication status: Published
Organisations: Department of Transport, Technical University of Denmark, Jeppesen Systems AB, Scandinavian Airlines
Sweden
Contributors: Warburg, V., Hansen, T. G., Larsen, A., Norman, H., Andersson, E.
Publication date: 2007
Peer-reviewed: Yes
Event: Abstract from Nordic Optimisation Symposium, Oslo, Norway.
Source: orbit
Source ID: 210398
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2007 › Research › peer-review

Analysis and Comparison of Typical Models within Distribution Network Design
Efficient and cost effective transportation and logistics plays a vital role in the supply chains of the modern world’s manufacturers. Global distribution of goods is a very complicated matter as it involves many different distinct planning problems. The focus of this presentation is to demonstrate a number of important issues which have been identified when addressing the Distribution Network Design problem from a modelling angle. More specifically, we present an analysis of the research which has been performed in utilizing operational research in developing and optimising distribution systems.

General information
Publication status: Published
Organisations: Traffic Modelling, Department of Transport, Logistics & ITS
Contributors: Jørgensen, H. J., Larsen, A., Madsen, O. B.
Number of pages: 4
Publication date: 2006
Peer-reviewed: Yes
Electronic versions: SCM_paper_Odysseus_140306.pdf
Source: orbit
Source ID: 195488
Research output: Contribution to conference › Paper – Annual report year: 2006 › Research › peer-review

Analysis and Comparison of Typical Models within Distribution Network Design
This paper investigates the characteristics of typical optimisation models within Distribution Network Design. During the paper fourteen models known from the literature will be thoroughly analysed. Through this analysis a schematic approach to categorisation of distribution network design models on a tabular form is introduced. The analysis provides a framework for a categorisation of models based on their structure. The models which are analyzed cover both strategic as well as tactical planning issues, as the categorisation framework seeks to avoid making this distinction. The features which are covered in the categorisation include fixed vs. general networks, specialised vs. general nodes, linear vs. nonlinear costs, single vs. multi commodity, uncapacitated vs. capacitated activities, single vs. multi modal and static vs. dynamic. The models examined address both strategic and tactical planning issues but do include considerations on the operational level. The paper should prove to be useful to both theoretically well-founded and experienced readers as well as to inexperienced readers as it provides a broad but easy accessible literature survey. This also makes this paper ideal for educational purposes. Furthermore, the paper can be seen as a practical introduction to network design modelling as well as a being an art manual or recipe when constructing such a model.

General information
Publication status: Published
Organisations: Department of Transport
Contributors: Jørgensen, H. J., Larsen, A., Madsen, O. B.
Publication date: 2006

Publication information
Publisher: Technical University of Denmark, Centre for Traffic and Transport
Original language: English
Source: orbit
Source ID: 210400
Research output: Book/Report › Report – Annual report year: 2006 › Research
Disruption Management in the Airline Industry - Concepts, Models and Methods

General information
Publication status: Published
Organisations: Operations Research, Department of Informatics and Mathematical Modeling
Contributors: Clausen, J., Larsen, A., Larsen, J.
Publication date: 2005

Publication information
Original language: English
Electronic versions:
imm3763.pdf
URLs:
http://www2.imm.dtu.dk/pubdb/p.php?3763
Source: orbit
Source ID: 185941
Research output: Book/Report › Report – Annual report year: 2005 › Research › peer-review

Airline Disruption Management - Perspectives, Experiences and Outlook
Over the past decade, airlines have become more concerned with developing an optimal flight schedule, with very little slack left to accommodate for any form of variation from the optimal solution. During operation the planned schedules often have to be revised due to disruptions caused by for example severe weather, technical problems and crew sickness. Thus, the field of Airline Disruption Management has emerged within the past few years. The increased focus on cutting cost at the major airlines has intensified the interest in the development of new and cost efficient methods to handle airline disruptions. The purpose of this paper is twofold. In the first part it offers an introduction to airline disruption management, provides the readers with a description of the planning processes and delivers a detailed overview of the numerous aspects of airline disruption management. In the second part we report on experiences from a large research and development project on airline disruption management. Within the project the first prototype of a multiple resource decision support system at the operations control center in a major airline, has been implemented.

General information
Publication status: Published
Organisations: Department of Informatics and Mathematical Modeling, Department of Transport, Operations Research
Contributors: Kohl, N., Larsen, A., Larsen, J., Ross, A., Tiourine, S.
Number of pages: 36
Publication date: 2004

Publication information
Original language: English
Electronic versions:
imm3311.pdf
URLs:
Source: orbit
Source ID: 154854
Research output: Book/Report › Report – Annual report year: 2004 › Research

Modelling and Solving the International Freight Service Network Timetabling Problem (IFSENT)

General information
Publication status: Published
Organisations: Logistics & ITS, Department of Transport
Contributors: Larsen, A., Pedersen, M. B.
Publication date: 2004

Host publication information
Title of host publication: TRISTIAN V - Trennial Symposium on Transportation Analysis
Volume: CD-rom proceedings
Source: orbit
Source ID: 159047
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 2004 › Research › peer-review
The A-priori Dynamic Traveling Salesman Problem with Time Windows

In this paper we examine the traveling salesman problem with time windows for various degrees of dynamism. In contrast to the static problem, where the dispatcher can plan ahead, in the dynamic version, part or all of the necessary information becomes available only during the day of operation. We seek to minimize lateness and examine the impact of this criterion choice on the distance traveled. Our focus on lateness is motivated by the problem faced by overnight mail service providers. We propose a real-time solution method that requires the vehicle, when idle, to wait at the current customer location until it can service another customer without being early. In addition, we develop several enhanced versions of this method that may reposition the vehicle at a location different from that of the current customer based on a priori information on future requests. The results we obtained on both randomly generated data and on a real-world case study indicate that all policies proved capable of significantly reducing lateness. Our results also show that this can be accomplished with only small distance increases. The basic policy outperformed the other methods primarily when lateness and distance were equally minimized and proved very robust in all environments studied. When only lateness was considered, the policy to reposition the vehicle at a location near the current customer generally provided the largest reductions in average lateness and the number of late customers. It also produced the least extra distance to be traveled among the relocation policies.
The a-priory dynamic traveling salesman problem with time windows

General information
Publication status: Published
Organisations: Logistics & ITS, Department of Transport, Department of Informatics and Mathematical Modeling, Northeastern University
Contributors: Madsen, O. B., Larsen, A., Solomon, M. M.
Pages: 459-472
Publication date: 2004
Peer-reviewed: Yes

Publication information
Journal: Transportation Science
Volume: 38
Issue number: 4
ISSN (Print): 0041-1655
Ratings:
Scopus rating (2004): SJR 2.074 SNIP 2.326
Web of Science (2004): Indexed yes
Original language: English
Source: orbit
Source ID: 232829

The A-priori Dynamic Traveling Salesman Problem with Time Windows

General information
Publication status: Published
Organisations: Logistics & ITS, Department of Transport, Northeastern University
Contributors: Larsen, A., Madsen, O. G., Solomon, M.
Publication date: 2003

Publication information
Place of publication: Lyngby
Publisher: Center for Traffic and Transport, Technical University of Denmark
Original language: English
(Technical Report; No. 2003-1).
Source: orbit
Source ID: 36028

Partially dynamic vehicle routing - models and algorithms

General information
Publication status: Published
Organisations: Department of Informatics and Mathematical Modeling
Contributors: Larsen, A., Madsen, O. B., Solomon, M.
Pages: 637-646
Publication date: 2002
Peer-reviewed: Yes

Publication information
Journal: Journal of the Operational Research Society
Volume: 53
Issue number: 6
Ratings:
Scopus rating (2002): SJR 0.731 SNIP 1.024
Staff Scheduling within the Retail Business in Denmark

General information
Publication status: Published
Contributors: Leedgaard, J., Mortensen, K. H., Larsen, A., Larsen, J.
Publication date: 2002

Host publication information
Title of host publication: Proceedings of Nordic MPS 2002
URLs:

Bibliographical note
ISSN 0333-3590

Disruption management

General information
Publication status: Published
Organisations: Operations Research, Department of Informatics and Mathematical Modeling, Department of Transport
Contributors: Clausen, J., Hansen, J., Larsen, J., Larsen, A.
Pages: 40-43
Publication date: 2001
Peer-reviewed: No

Publication information
Journal: OR/MS Today
Volume: 28
ISSN (Print): 1085-1038
Original language: English
URLs:
Source: orbit
Source ID: 57810
Research output: Contribution to journal › Journal article – Annual report year: 2001 › Research

Disruption management - operations research between planning and execution

General information
Publication status: Published
Organisations: Operations Research, Department of Informatics and Mathematical Modeling, Department of Transport
Contributors: Clausen, J., Larsen, J., Larsen, A., Hansen, J.
Publication date: 2001

Publication Information
Original language: English
Electronic versions:
imm144.pdf
URLs:
The dynamic vehicle routing problem

General information
Publication status: Published
Organisations: Department of Informatics and Mathematical Modeling
Contributors: Larsen, A.
Number of pages: 183
Publication date: Dec 2000

Publication information
Place of publication: Kgs. Lyngby, Denmark
Publisher: Technical University of Denmark
Original language: English
(IMM-PHD; No. 2000-73).
Keywords: IMM-PHD-2000-73
Electronic versions:
imm143.pdf
Source: orbit
Source ID: 274540

Partially Dynamic Vehicle Routing-Models and Algorithms

General information
Publication status: Published
Organisations: Department of Informatics and Mathematical Modeling
Contributors: Larsen, A., Madsen, O. B. G., Solomon, M. M.
Publication date: 1999

Publication information
Original language: English
URLs:
http:/www.ala.imm.dtu
Source: orbit
Source ID: 172868
Research output: Book/Report › Report – Annual report year: 1999 › Research › peer-review

The A-Priori Dynamic Travelling Salesman Problem with Time Windows

General information
Publication status: Published
Organisations: Department of Informatics and Mathematical Modeling, Northeastern University
Contributors: Madsen, O. B. G., Larsen, A., Solomon, M.
Number of pages: 25
Publication date: 1999

Publication information
Original language: English
Source: orbit
Source ID: 172682
Research output: Book/Report › Report – Annual report year: 1999 › Research › peer-review

Dynamic Vehicle Routing - An Overview of Systems with Varying Degree of Dynamism

General information
Publication status: Published
Organisations: Department of Informatics and Mathematical Modeling
Contributors: Madsen, O. B. G., Larsen, A.
Publication date: 1998
Solving the multiple depot vehicle scheduling problem in a major Scandinavian city

**General information**
Publication status: Published
Organisations: Department of Informatics and Mathematical Modeling
Contributors: Larsen, A., Madsen, O. B. G.
Number of pages: 18
Publication date: 1997

**Publication information**
Original language: English
Source: orbit
Source ID: 168623

An Evaluation of the Strategy for Calling in Vehicles for Inspection.

**General information**
Publication status: Published
Organisations: Department of Informatics and Mathematical Modeling
Contributors: Larsen, A., Madsen, O. B. G., Rygaard, J. M.
Number of pages: 40
Publication date: 1996

**Publication information**
Original language: English
Source: orbit
Source ID: 164791

Computer based crew rostering (in Danish).

**General information**
Publication status: Published
Organisations: Department of Informatics and Mathematical Modeling
Contributors: Larsen, A., Madsen, O. B. G.
Publication date: 1996
Projects:

**EUFAL: Electric Urban Freight And Logistics**
Knowledge and tools for electric vehicle fleets

The EUFAL project, standing for Electric Urban Freight and Logistics, aims at providing a platform of exchange as a decision support system for companies willing to integrate electric vehicles (EV) in commercial vehicle fleets. The EUFAL platform will provide tools for companies at different stages of EV implementation: early planning of EV use, implementation of EV use, optimisation of the EV implementation. It will uptake and unite existing research results and technological developments of ongoing research projects (national, transnational, European) in commercial transport including fleet management and optimizing their composition.

The Challenge of EV Implementation

Although it is commonly believed that EVs are suited to perform last mile deliveries in particular in urban areas, only some companies make use of electric delivery vehicles. Up to now, electric vehicles have been considered as perfect substitutes of conventional vehicles. But there are still problems to be solved: difficulties to deal with the inter-day variability of tour-lengths, problems to integrate EVs into existing fleets and working forces, and missing own and reported experiences. The potential for electric vehicles is much greater if logistics concepts and the use of electric vehicles are jointly optimized taking into account the speciality of different spatial areas. EVs, integrated into mixed fleets, could be used in urban areas, while traditional vehicles could operate in surrounding areas.

Alternatively, the use of micro-distribution centres in connection with urban distribution could be imagined.

The Implementation of the EUFAL platform: demonstration and early stakeholder engagement

Projects in the field of electric mobility in commercial transport have shown that there is a lack of information for decision makers and fleet managers concerning technical possibilities and costs of EVs. EUFAL closes this gap by means of providing and demonstrating the platform of exchange and involving stakeholders right from the outset of the project. For this experienced EV users and developers of EV business models will be addressed. Developed tools for the platform of exchange will include the next stage development of the routes optimisation platform DYNATOP. It will showcase a multi-purpose city logistics system which is both economically and environmentally sustainable based on the use of EVs supported by ICT optimisation tools. The project will analyse the status of EV implementation in cities based on examples. The demonstration and evaluation of the implementation and application of electric mobility includes urban freight and city logistics in several countries. Environmental impacts of EVs in city deliveries and expectations for battery charging infrastructure development will be analysed. Use patterns of corporate fleets will be analysed and EV potentials identified. National framework and business environment for EV deployment in urban commercial transport will be assessed.

The Added Value: “everything from a single scientifically proved source” on EV implementation in commercial vehicle fleets

EUFAL is the first user-friendly web-based open source platform of knowledge exchange providing all available data centrally. This supports a more accurate and cost-efficient implementation of EV in commercial vehicle fleets in Europe. This top-down-information-providing-online tool will also offer access to planning tools for optimal fleet composition, planning urban micro-hub solutions, a long-lasting experts network for further consultancy and other. The added value is the “everything from a single scientifically proved source” approach. EUFAL will support companies with information for EV implementations at the best level possible. The platform of exchange will allow companies to handle the implementation of EVs in mixed fleets and multi-level distribution concepts. The project will test and validate the joint optimisation of existing vehicle technologies and new concepts of logistics organisation in urban and suburban environments. Necessary development of vehicle technology will be analysed. Integrating project partners from Germany, Austria, Denmark, Poland, and Turkey, the project will contribute to the transfer of knowledge on electric mobility between stakeholders and countries.

Project goals

EUFAL results will play a key role in the European research focus for electric mobility in urban and suburban freight and city logistics and create a significant leverage effect on the implementation of EV in fleets until 2020 and beyond. By providing scientifically proved policy support to identify the most appropriate measures (regulations, incentives, etc.) for urban and governmental, regional and urban authorities, one of the largest leverage effects in boosting the implementation of EV in European cities is guaranteed.

**EUFAL Project partners**
- DLR Institute of Transport Research, Germany
- AIT Austrian Institute of Technology GmbH, Austria
- Borusan Lojistik Dagıtım, Depolama, Tasimacilik ve Ticaret A.S., Turkey
- Copenhagen Electric, Denmark
- DTU Management Engineering, Denmark
- eM-Pro Elektromobilität GmbH, Germany
- Maritime University of Szczecin, Poland

Project duration: 30 months
The project EUFAL is co-funded by the ERA-NET Cofund Electric Mobility Europe (EMEurope) and national funding organizations. EMEurope is co-funded by the European Commission within the research and innovation framework programme Horizon 2020 (Project No. 723977).

Pacino, D., Project Participant, Department of Management Engineering, Management Science, Transport DTU, Operations Research
Christensen, J. M., Project Participant, Department of Management Engineering, Management Science, Operations Research
Larsen, A., Project Participant, Department of Management Engineering, Management Science, Transport DTU, Operations Management
Malladi, S. S., Project Participant, Department of Management Engineering, Management Science
Barfod, M. B., Project Participant, Department of Management Engineering, Management Science, Transport DTU, Operations Management

Machine Learning and Mobility
Markou, I., PhD Student, Department of Management Engineering
Pereira, F. C., Main Supervisor
Larsen, A., Supervisor
Rich, J., Examiner
Jenelius, E. A., Examiner
Viti, F., Examiner
Technical University of Denmark
15/12/2015 → 30/09/2019
Award relations: Machine Learning and Mobility
Project: PhD

Optimization of timetables in integrated public transport planning
Fonseca, J. F. P., PhD Student, Department of Management Engineering
Larsen, A., Main Supervisor
Roberti, R., Supervisor
Lusby, R. M., Examiner
Corman, F., Examiner
Klewer, N., Examiner
van der Hurk, E., Supervisor
Samfinansieret - Andet
01/10/2015 → 10/08/2019
Award relations: Optimization of timetables in integrated public transport planning
Project: PhD

Optimization of operations in public transportation
Farina, F., PhD Student, Department of Management Engineering
Repke, S., Main Supervisor
Larsen, A., Supervisor
Roberti, R., Supervisor
Pisinger, D., Examiner
Groth, J. J., Examiner
Cacchiani, V., Examiner
Samfinansieret - Andet
01/10/2015 → 02/05/2019
Award relations: Optimization of operations in public transportation
Project: PhD

Cargo-mix optimisation
Christensen, J. M., PhD Student, Department of Management Engineering
Pacino, D., Main Supervisor
Psaraftis, H. N., Supervisor
Larsen, A., Examiner
Alvarez-Valdes, R., Examiner
Andersson, H., Examiner
Forskningsrådsfinansiering
01/09/2014 → 01/02/2018
Award relations: Cargo-mix optimisation
Project: PhD

Green corridors in freight logistics
Panagakos, G., PhD Student, Department of Management Engineering
Psaraftis, H. N., Main Supervisor
Larsen, A., Supervisor
Rich, J., Examiner
Cullinane, K., Examiner
Ojala, L., Examiner
Samfinansieret - Andet
15/08/2014 → 25/11/2016
Award relations: Green corridors in freight logistics
Project: PhD

Optimal Aircraft Gate Assignment on a Strategic, Tactical and Operational Level
Justesen, T. F., PhD Student, Department of Management Engineering
Larsen, J., Main Supervisor
Dohn, A. H., Supervisor
Meincke, D., Supervisor
Larsen, A., Examiner
Vaaben, B. V., Examiner
Cohn, A. E. M., Examiner
ErhvervsPhD-ordningen VTU
01/10/2010 → 26/05/2014
Award relations: Optimal Aircraft Gate Assignment on a Strategic, Tactical and Operational Level
Project: PhD

Sustainable Disruption Management
Vaaben, B. V., PhD Student, Department of Management Engineering
Altus, S., Supervisor
Hansen, J., Supervisor
Larsen, A., Examiner
Cohn, A. E. M., Examiner
Granberg, T. A., Examiner
ErhvervsPhD-ordningen VTU
01/11/2009 → 04/04/2013
Award relations: Sustainable Disruption Management
Project: PhD

The dynamic vehicle routing problem
Larsen, A., PhD Student, Department of Transport
Madsen, O. B. G., Main Supervisor
Clausen, J., Examiner
Gendreau, M., Examiner
Pisinger, D., Examiner
Anden sektorministeriel finansiering - SU
01/01/1997 → 17/04/2001
Award relations: The dynamic vehicle routing problem
Project: PhD

Disaggregate activity-based traffic assignment modelling
Rasmussen, T. K., PhD Student, Department of Transport
Nielsen, O. A., Main Supervisor
Frederiksen, R. D., Supervisor
Prato, C. G., Supervisor
Larsen, A., Examiner
Cantarella, G. E., Examiner
Bekhar, S., Examiner
Technical University of Denmark
01/05/2011 → 23/02/2015
Award relations: Disaggregate activity-based traffic assignment modelling
Project: PhD

Models and Algorithms for the Vehicle Routing Problem with Cross Docking
Wen, M., PhD Student, Department of Management Engineering
Larsen, J., Main Supervisor
Clausen, J., Supervisor
Larsen, A., Examiner
Hasle, G., Examiner
Nielsen, J. B., Examiner
DTU stipendium
01/02/2006 → 24/03/2010
Award relations: Models and Algorithms for the Vehicle Routing Problem with Cross Docking
Project: PhD

Network Effects within Railway Networks
Jensen, L. W., PhD Student, Department of Transport
Nielsen, O. A., Main Supervisor
Landex, A., Supervisor
Larsen, A., Examiner
Goverde, R. M. P., Examiner
Preston, J., Examiner
Technical University of Denmark
01/10/2012 → 07/04/2016
Award relations: Network Effects within Railway Networks
Project: PhD

Efficient Algorithms for integrated Container Terminal Activities
Iris, C., PhD Student, Department of Transport
Larsen, A., Main Supervisor
Pacino, D., Supervisor
Repke, S., Supervisor
Psaraftis, H. N., Examiner
Meisel, F., Examiner
Vis, I. F. A., Examiner
Technical University of Denmark
01/02/2013 → 04/07/2016
Award relations: Efficient Algorithms for integrated Container Terminal Activities
Project: PhD

The Framework of phase-based planning of railway
Li, R., PhD Student, Department of Management Engineering
Larsen, A., Main Supervisor
Landex, A., Supervisor
Salling, K. B., Supervisor
Psaraftis, H. N., Examiner
Madsen, S. N., Supervisor
Preston, J., Examiner
Vicencio, A. A. N., Examiner
Technical University of Denmark
15/01/2013 → 21/09/2017
Award relations: The Framework of phase-based planning of railway
Project: PhD

Cable Aerodynamic Control
Kleiissi, K., PhD Student, Department of Civil Engineering
Georgakis, C. T., Main Supervisor
Solving Recovery Problems using Optimisations Methods
Rasmussen, M. S., PhD Student, Department of Management Engineering
Larsen, J., Main Supervisor
Ryan, D., Supervisor
Larsen, A., Examiner
Gustafsson, T., Examiner
Rönnqvist, M., Examiner
Technical University of Denmark
01/05/2008 → 28/09/2011
Award relations: Solving Recovery Problems using Optimisations Methods
Project: PhD

ConCoord: ConCoord
The project focuses on the important area of city logistics. It investigates an integrated urban freight simulation environment, a unique measurement framework for the environmental footprint of transport and logistics, and the performance measurement of new innovative urban transport and logistics concepts. Specifically dealing with the different and important considerations of new transportation solutions, new mechanisms for execution and control of city logistics, and research on the urban distribution of goods reducing urban freight movements and its impact on residents and the environment.

The fundamental idea is to stop considering each shipment, actor (e.g. shippers, Logistics Service Providers, etc.) and vehicle in isolation, but as components of an integrated logistics system to be optimized. The keywords are CONsolidation and COORDination (CONCOORD) of the urban distribution flows that are currently fragmented. CONCOORD involves key players in the urban transportation field, both from leading European universities and world-class Europe-based companies, who have expertise and experience in city distribution and who have the willingness to explore this issue for the benefit of all those in Europe.

Olsen, A., Project Manager, Department of Transport, Transport optimisation and technique
Larsen, R., Project Participant, Department of Transport, Transport optimisation and technique
Larsen, A., Project Applicant, Department of Transport, Transport optimisation and technique
Psaraftis, H. N., Project Manager, Department of Transport, Transport optimisation and technique
Wen, M., Project Participant, Department of Transport, Transport optimisation and technique
01/01/2013 → 01/06/2016
Project: Research

GreCOR: Green Corridor in the North Sea Region
GreCOR – Green Corridor in the North Sea Region – is an Interreg IVB North Sea Region project that started the 1st of January 2012. GreCOR will promote the development of a co-modal transport corridor in the North Sea Region. Important in this collaborative approach, is the focus on secondary networks and the hubs, and the regional hinterland around the Green transport corridor Oslo-Randstad from a co-modal perspective.

GreCOR has 14 partners and a total budget of 3.7 M€. It started the 1 January 2012 and will be finalized 31 December 2014.

The Swedish Transport Administration is the responsible lead partner for GreCOR

GreCOR works in close collaboration with public and private stakeholders, and its overall aim is to improve knowledge about the logistic needs and conditions and develop and implement the first green corridor in the North Sea Region in a strategic policy setting.

The main idea of the project is to influence the green corridor consisting of infrastructure and transport development in the area. Furthermore, GreCOR aims to:
- Improve knowledge about the logistics needs and conditions in the corridor
- Test innovative logistics solutions through the development of pilot projects
- Promote the development of sustainable transport in the North Sea Region
- Focus on the role of the hubs and the regional hinterland
- Understand and develop the logistics utility creation in a green corridor taking a co-modal perspective.

One very important tool for reaching the goals of corridor development is a liaison group to which we invite all relevant organizations, stakeholders and companies to join.

Olsen, A., Project Manager, Department of Transport, Transport optimisation and technique
Farina, F., Project Participant, Transport optimisation and technique
Larsen, R., Project Participant, Department of Transport, Transport optimisation and technique
Simultaneous Optimisation of Operating Costs and Passenger Service in Public Transit

In the Greater Copenhagen area approximately 200,000 hours are lost every day when passengers are waiting for a connecting bus or train. Hence, an enormous socio-economic potential lies within the development of new methods that can be used to generate timetables which have better temporal correspondences. Naturally, this can be achieved by assigning more resources to cover the timetables. However, the public transit companies are faced with administrative claims for cutting operating costs which renders improvements of the service intractable. Hence, efficient and near-optimal use of the resources is of paramount importance for the public transit companies.

The project addresses the multiple objective planning problem of generating timetables that on the one side is economically feasible for the transport companies and on the other hand also offers high-quality service to the passengers by minimising the unproductive time spent on waiting between one or more shifts.

Madsen, O. B. G., Project Manager, Department of Transport
Larsen, A., Project Participant, Department of Transport
Pedersen, M. B., Project Participant, Department of Transport
Petersen, B., Project Participant, Department of Transport
Forskningsrådene - Andre: DKK840,000.00
01/09/2005 → 31/05/2008
Award relations: Simultaneous Optimisation of Operating Costs and Passenger Service in Public Transit
Project: Research

TGB: Traffic Plan for Greenland: Decision Support Tool TGB
Leleur, S., Project Manager, Department of Transport
Rich, J., Project Manager, Department of Transport
Jensen, A. V., Project Participant, Department of Transport
Salling, K. B., Project Participant, Department of Transport
Nielsen, O. A., Project Participant, Department of Transport
Hansen, S., Project Participant, Department of Transport
Larsen, A., Project Participant, Department of Transport
Knudsen, M. A., Project Participant, Department of Transport
Project ID: 35105
Indtægtsdækket virksomhed UK 90: DKK1,500,000.00
06/06/2005 → 31/12/2005
Award relations: Traffic Plan for Greenland: Decision Support Tool TGB
Project: Research

Dynamic vehicle routing.

Dynamic vehicle routing is dealing with vehicle routing problems in which not all information is available at the start of the planning period. Vehicles are dispatched to satisfy service requests, that evolve in real time. In 1996 a simulator was developed. The simulator generated problem instances which were solved by a static algorithm. The purpose was to analyze how the degree of dynamism influenced the quality of the static solution procedure. Furthermore an algorithm has been developed for dispatching medical doctors serving patients in their homes at night. The algorithm was combined with a very fast shortest route algorithm and a road network database.

Madsen, O. B. G., Project Manager, Department of Informatics and Mathematical Modeling
Rygaard, J. M., Project Participant, Department of Informatics and Mathematical Modeling
Lund, K., Project Participant, Department of Informatics and Mathematical Modeling
Larsen, A., Project Participant, Department of Informatics and Mathematical Modeling
Ukendt: DKK148,023.00
01/09/1994 → …
Collaborators: COWI A/S
Award relations: Dynamic vehicle routing.
Project: Research

Crew and vehicle scheduling.

The objective of the project is to develop methods for finding the optimal or near optimal scheduling of crews and vehicles. Rules concerning e.g. working periods and union regulations have to be taken into consideration. In 1996 a system ACROS has been developed for computer based crew rostering, in particular applicable for medium term planning for allocation of bus drivers. ACROS was developed in cooperation with the company TR-Partners. Furthermore a system concerning the scheduling of duties for nurses has been developed. The system is based on set partitioning and constrained branch and bound, and it was developed in cooperation with Hovedstadens Sygehussselskab and Andersen
Consulting.
Madsen, O. B. G., Project Manager, Department of Informatics and Mathematical Modeling
Larsen, A., Project Participant, Department of Informatics and Mathematical Modeling
Ukendt: DKK100,000.00
01/01/1996 → 31/12/1998
Collaborators: TR Partner
Award relations: Crew and vehicle scheduling.
Project: Research

Calling in vehicles for inspection.
In 1998 and the following years all cars which are more than three years old must be inspected by the Danish Car Inspection (Statens Bilinspektion) every second year. Therefore the Danish Car Inspection needed to know how, when and where should the cars be called in for inspection and which capacity was necessary. To answer these questions we developed a large aggregated optimization model. The results from the model was used by the management of the Danish Car Inspection to make decisions concerning the overall structure of the future process for car inspection.

Madsen, O. B. G., Project Manager, Department of Informatics and Mathematical Modeling
Larsen, A., Project Participant, Department of Informatics and Mathematical Modeling
Rygaard, J. M., Project Participant, Department of Informatics and Mathematical Modeling
Ukendt: DKK105,000.00
01/11/1995 → 31/05/1996
Collaborators: Applus+ Bilsyn
Award relations: Calling in vehicles for inspection.
Project: Research

CLG: Centre for Logistics and Freight Transport
The Centre for Logistics and Freight Transport (CLG) is a multi-disciplinary research centre on logistics and freight transport. The Centre is headed by CTT. CLG is a cooperation between a number of Danish and international universities and companies. CLG is funded by The Danish Technical Research Council (STVF).

The objective of the Centre is to strengthen the Danish research on logistics and transport. This is achieved through specific research projects and through networking activities within the center. A number of the research projects are multi-disciplinary.

The scope of the Centre is to obtain an increased knowledge about the various stakeholders within the logistics and transport sector and to develop new methods and concepts which are applicable to the stakeholders. This includes organisatorial and management concepts as well as methods based on mathematical models in order to support the various stakeholders which briefly can be characterized as follows:

Manufacturers and consumers of goods (transport users).
Transporters (operators, forwarders, etc.).
Transport infrastructure owner (public authorities, ports, airports, etc.).
Public authorities (political means and control).
National economics (derived effects of the transport system and the external influences).

Nielsen, O. A., Project Manager, Department of Transport
Madsen, O. B. G., Project Participant, Department of Transport
Leleur, S., Project Participant, Department of Transport
Overgård, C. H., Project Participant, Department of Transport
Rich, J., Project Participant, Department of Transport
Jørgensen, R. M., Project Participant, Department of Transport
Larsen, A., Project Participant, Department of Transport
Pedersen, M. B., Project Participant, Department of Transport
Salling, K. B., Project Participant, Department of Transport
Jensen, A. V., Project Participant, Department of Transport
Sørensen, M. V., Project Participant, Department of Transport
Landex, A., Project Participant, Department of Transport
Holvad, T., Project Participant, Department of Transport

Project ID: 421-35044
Statens Teknisk Videnskabelige Forskningsråd : DKK15,723,006.00
25/06/2001 → 31/12/2006
Award relations: Centre for Logistics and Freight Transport
Project: Research

Activities:
A rich two-echelon electric vehicle routing problem with satellite versatility

Period: 23 Jun 2019 → 26 Jun 2019

Dario Pacino (Speaker)
Satya Sarvani Malladi (Other)
Jonas Mark Christensen (Other)
Allan Larsen (Other)

Management Science
Operations Research
Department of Technology, Management and Economics
Operations Management

Description
This talk studies a Two-Echelon Electric Vehicle Routing problem, aimed at enabling urban electromobility of freight. The first echelon consists of routing trucks carrying goods to parking lots (satellite location) from depots. The truck will stay at the parking lot for an amount of time and thereafter continues on its route. The second echelon concerns the routing of smaller electric vehicles, originating at the satellite locations, to serve all customers. The beginning of the day, a number of electric vehicles are available at each satellite location. In this work we do not require the small vehicles to return to the same satellite at the end of the day, and they can visit any satellite to get replenished with additional goods en-route. However, they can only be replenished at a satellite if there is a truck at the time. This requires continuous synchronization between the first echelon routing and the second echelon routing. Along with acting as a source of goods for the electric vehicles, the trucks will also provide spare batteries and battery swapping services giving the electric vehicles a driving range boost. However, regular charging stations are also available for en-route charging. In this talk, we wish to formally describe this problem, how it differs from most two-echelon VRPs and present preliminary results.

Degree of recognition: International

Related event
30th European Conference On Operational Research
24/06/2019 → 26/06/2019
Dublin, Ireland
Activity: Talks and presentations › Conference presentations

Evaluating electric mobility in urban service logistics

Period: 23 Jun 2019 → 26 Jun 2019

Satya Sarvani Malladi (Speaker)
David Ramirez-Marti (Other)
Jonas Mark Christensen (Other)
Allan Larsen (Other)
Dario Pacino (Other)

Operations Management
Management Science
Department of Technology, Management and Economics
Operations Research

Description
Electric mobility is characterized by a clean and noiseless drive alongside a limited driving range. It serves the purpose of urban logistics almost perfectly catering to short distances in city centers and to the onus to maintain air quality and reduce noise pollution in densely populated areas. A general urban service logistics problem with a mixed fleet including electric vehicles, compatibility specification between customers’ requests and drivers’ skills, and time windows is considered. In our formulation, we propose an upgrade to the energy consumption model to account for auxiliary loads during the drive. We develop a novel adaptive large neighborhood search algorithm to solve the operational problem on each day.

To understand the influence of factors such as temperature, time window tightness, spread of customers, etc. on the total cost of fleet ownership, we perform a simulation analysis on two real case studies from Copenhagen. In the first case study, we look into electrician routing for a construction firm, MT Hojgaard, using a mixed fleet of vehicles (both electric and non-electric), while in the other, we work with Region Hovedstaten to efficiently plan the pick-up logistics of temperature-controlled, time-sensitive transport of blood samples from clinics to a testing laboratory using a mixed fleet of...
electric vehicles.
This work is aimed towards developing decision-making tools that enable a smooth transition to electric mobility.
Degree of recognition: International

Related event

30th European Conference On Operational Research
24/06/2019 → 26/06/2019
Dublin, Ireland
Activity: Talks and presentations › Conference presentations

Using Electric Vehicles for Commercial Urban Transports
Period: 4 Nov 2018 → 7 Nov 2018
Allan Larsen (Speaker)
Operations Management
Transport DTU
Management Science
Department of Management Engineering
Degree of recognition: International
Documents: EUFAL_INFORMS_Annual_Meeting_DTU_071118

Related organisation

Using Electric Vehicles for Commercial Urban Transports
Allan Larsen (Speaker)
4 Nov 2018 → 7 Nov 2018
Activity: Talks and presentations › Conference presentations

Mere effektiv transport
Period: 26 Sep 2018
Allan Larsen (Invited speaker)
Operations Management
Transport DTU
Management Science
Department of Management Engineering
Degree of recognition: National
Documents: Transportens_Dag_Allan_Larsen_DTU_260918

Related event

Transportens Dag: DI Transports Årsdag 2018
26/09/2018 → 26/09/2018
København, Denmark
Activity: Talks and presentations › Conference presentations

A matheuristic approach for Integrated Timetabling and Vehicle Scheduling Problem
Period: 17 May 2017
Joao Filipe Paiva Fonseca (Speaker)
Roberto Roberti (Other)
Evelien van der Hurk (Other)
Allan Larsen (Guest lecturer)
Department of Management Engineering
Management Science
Related event

Mini-Workshop on Integrated Timetabling
15/05/2017 → 17/05/2017
Goettingen, Germany
Activity: Talks and presentations › Conference presentations

City Logistics – constraints and opportunities. E-mobility and city logistics – for citizens, goods and business
Period: 2 Feb 2017
Allan Larsen (Guest lecturer)
Department of Management Engineering
Management Science
Transport DTU
Operations Management
Degree of recognition: National

Related event

E-MOBILITY & CITY LOGISTICS - for citizens, goods, and business: Region Hovedstaden seminar om E-mobility
02/02/2017 → …
København, Denmark
Activity: Talks and presentations › Conference presentations