The Vehicle Routing Problem with Cross-Docking (VRPCD) is a variant of the Pickup and Delivery Problem with Transfers with one compulsory transfer point: vehicles start by collecting items, then return to the cross-dock where they unload/reload some items and eventually visit delivery locations. The VRPCD has been proposed to model the routing part of the cross-docking distribution strategy, whict has been largely used since 1980s and is known to help reducing delivery costs compared to traditional distribution systems. In the VRPCD, it is assumed that a truck undergoes consolidation operations as soon as it arrives at the cross-dock. However, in real life the processing capacity of the cross-dock is a limiting factor, and as such several recent articles have outlined the need for a model that would take it into account in the routing problem. To that end, we introduce an extension of the VRPCD in which the number of vehicles that can simultaneously be processed at the cross-dock is limited. We call it the Vehicle Routing Problem with Cross-Docking and Dock Resource Constraints (VRPCD-DR). To solve it, we adapt a recently proposed method for VRPCD that relies on large neighborhood search and periodic calls to a set partitioning based problem. In particular we focus on feasibility tests in the reinsertion part of the LNS, as the capacity constraints at the cross-dock makes the scheduling subproblem NP-Hard. Our method has been tested on instances adapted from the VRPCD.

4 - Design and Analysis of a Proposed Nested Genetic Algorithm to Solve a Vehicle Routing Problem with Cross Docking

Mahdi Bashiri, Ali Baniamerian

Implementation of an appropriate distribution strategy in order to manage the physical flow of materials is one of the most important factors in the success of the companies. Cross docking is an efficient distribution strategy which todays is practically used by many companies to improve their servicing in the lower cost with the high level of customer satisfaction. In this paper because of the NP_hardness of the problem a nested Genetic algorithm is designed to solve a vehicle routing problem with cross docking and time windows. Review on the literature of cross docking shows that at most one part solution representations in different algorithms were proposed to the problem. The length of one part solution representations in the larger instances leads to high computational time to search which is an important issue in the evolutionary algorithms. In the proposed algorithm we introduce a two part solution representation and an efficient approach to search the solution space called nested approach. A good feasible solution of delivery part is obtained in the first phase and the best pickup part solution is created according to the obtained delivery part in the second phase. The consolidation operations are then added to the complete solution. In order to evaluate the performance of the proposed algorithm of this paper, different examples of a real data set from small to large sizes are solved and analyzed.

■ TA-13

Tuesday, 8:30-10:00 - Building CW, ground floor, Room 3

VeRoLog: Routing In Practice 1

Stream: Vehicle Routing and Logistics Optimization
Chair: *Sameh Haneyah*

1 - Departure Time Optimization in Real-life Vehicle Routing Problems

Gerben Groenendijk, Leendert Kok

Optimizing departure times in vehicle routes is a crucial step in developing efficient vehicle route schedules. For Real-life vehicle routing problems in particular, this is a challenging task. On the one hand, customers request more extensive vehicle routing models to better fit their business. On the other hand, problem sizes grow, while the urge of quickly finding the optimal departure time grows as well. Optimized departure times are highly valued in practice. Not only in order to reduce costs by a better utilization of resources, but it is also required to find feasible schedules with respect to driving and working time legislation. Although literature contains some research on departure time optimization, the combination of restrictions that needs to be taken into account for Real-life vehicle routing problems isn't considered yet. In this talk, we illustrate some of the restrictions that need to be taken care of in practice and we describe how we try to cover them in our vehicle routing solutions. Next, we disclose recent trends in logistics that challenge our model and that may serve as an agenda for future research.

2 - Solving Integrated Vehicle Routing and Resource Assignment Problems from Practice

Sameh Haneyah, Leendert Kok

We address a problem from practice on vehicle routing and resource assignment. Our solution approach decomposes the problem into two phases. The first phase constructs trailer routes by solving a capacitated vehicle routing problem with time windows, driving legislation, and congestion. The second phase assigns trailer routes to resource shifts, i.e., truck and driver combinations, by solving a scheduling problem. To provide greater flexibility and better utilization of resources, we may divide trailer routes into segments and assign the segments to resource shifts. The latter case increases the complexity due to dependency issues when segments of the same trailer route are assigned to different resource shifts. Currently, we have a software product that uses column generation, where complete trailer routes are assigned to resource shifts (columns), but this approach is not fully applicable with segments, because then the columns are no longer independent. In literature, we see few papers on this problem where limitations are introduced on the segments resulting from the first phase, to make them independent in the second phase. However, we need a solution method that handles the dependencies, because circumventing them diminishes the benefits of planning with segments. Moreover, we need a method that works well in practice. In this talk, we discuss the different solution methods we developed and propose the suitable method to use for a difficult case from practice.

3 - Practical Ways to Solve Real-life Extensions to Routing Problems

Bryan Kuiper

Vehicle routing problems in practice appear with many restrictions such as capacities, time windows, calendar openings, forbidden or required capabilities, drivers' working and driving regulations, etc. At ORTEC we have a generic software product that employs state-of-the-art algorithms to solve different variants of such problems. However, we are often encountered with new requirements from special business cases that the generic framework cannot immediately handle. In some cases, it is sensible to extend the framework to cover the new requirements, but in other cases it makes more sense not to extend the algorithms and increase their complexity considerably only to cover a fraction of customer cases. For the latter cases, we develop some procedures that can complement the main algorithmic framework in order to solve certain sub-problems or complicated business restrictions. In this talk, we first describe the existing algorithmic framework in general, and second present few customer cases with requirements not fully covered by the generic framework. Finally, we present procedures and tricks implemented to handle the additional requirements. A main example comes from a customer case where combinations of pallets and large doors need to be transported in trailers with flexible floors. The construction of flexible floors depends on the assignment of doors and pallets to be transported, and this changes for every optimization call.

4 - Properties of Good Solutions for the Vehicle Routing Problem

Florian Arnold, Kenneth Sörensen

The Vehicle Routing Problem (VRP) is probably the most-studied problem in Operations Research. However, in the race for faster algorithms and better solutions, few research has been performed to shed light on the problem itself. Even though problem-specific knowledge is an important ingredient in the design of heuristics, such knowledge is rare for the VRP. As an example, it is proven that in the Traveling Salesman Problem does no optimal solution contain intersecting edges. Even though such a statement is not true for the VRP, it should be possible to deduct general guidelines such as: "In general, solutions can