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Issues in Dynamic Fleet Management

In local pick-up and delivery, there is a huge potential for improvement of logistics performance. For operations of some size, dynamic, real-time routing is a very complex co-ordination task. Despite this fact, logistics management of local distribution, is predominantly performed by human dispatchers, even for large companies. Commercial VRP software is predominantly used for generation of static routes. Very few cases of real-life, real-time, dynamic routing supported by ICT tools based on VRP optimization are known to this author. The major VRP software vendors claim that their VRP tools support dynamic routing. What are the reasons for this mismatch?

There are a number of plausible reasons. Firstly, fleet management systems for real-time routing must be based on a rich VRP model. Generally, existing VRP tools are inflexible, and based on an idealized model. Configuration to the application at hand may be impossible or very costly. Secondly, there are very strong response time versus plan quality demands, both for plan generation and plan maintenance. VRP tools of today (to the extent that we know their workings) seem to be based on fairly old and simple construction heuristics, or, general techniques for solving MIP-formulations of the VRP. Such techniques are not powerful enough, or they find the optimal solution to an irrelevant question due to inadequacy of their underlying VRP model. Also, there are important software engineering issues. Real time fleet management systems need to be tightly integrated with order handling systems, systems for vehicle position tracking, and communication systems. Availability and quality of information on transportation orders, road network, vehicle positions, and traffic situation is crucial for Finally, a possible explanation are related with organizational issues such as lack of education, resistance from employees, lack of support from management, and bad project management. Recent and current research at our Department aims at resolving the technical part of the issues alluded to above. A major goal for us is to develop VRP technology for resolution of real-life applications in transportation management, for different transportation modalities, and for supply-chain coordination.

A major part our recent research has concentrated on the development of generic tools for VRPs with focus on local distribution. This entails development of a rich VRP model and corresponding efficient algorithms for construction, optimization and repair of routing plans. A crucial, basic component of this technology is a highly efficient cheapest path calculator for road networks, which takes driving restrictions into consideration. We have developed such a component based on transformation of the road network graph, and a variant of Dijkstra's algorithm extended with hash-tables. A second component is functionality for last minute optimization of tours before a vehicle is loaded or dispatched. Here, we have investigated exact methods for TSPs with side constraints based on branch and bound. The last part is effective algorithms for construction, iterative improvement, and repair of routing plans for dynamic, rich VRP models. Our research and development has focused on insertion-based construction techniques, coupled with iterative improvement methods based on local search, constraint propagation and meta-heuristics. Based on our research efforts in VRP, the Department develops a generic VRP software toolkit. The toolkit includes functionality for automated configuration, a client-server architecture that supports multiple users and "organic" planning, as well as standardized interfaces to external systems.

Another part of our current research and technology development related with VRP deals with methods for solving complex vessel routing problems with additional constraints related with supply-chain coordination. One case is shipment of ammonia between producer and consumer ports of raw materials in process industries, where there are hard stock level constraints. For this case we have developed a hybrid method which combines a heuristic method for the combinatorial part with an LP solver for feasibility checking and detailed decisions on timing and volumes.

The Department also conducts more fundamental research on solving non-standard constraint satisfaction problems, i.e., problems with preferential constraints, over-constrained problems, and problems with multiple optimization criteria.

In this talk, the author shall describe the status of ongoing research and technology development related with VRP within the Department. He shall also point to challenges that will set the agenda for future research.