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Forwarding operations in forestry

Forestry is of major importance to the Swedish economy. The need to increase productivity has been a major incentive for rationalization of harvesting operations. Heavy rationalization has been very important for Swedish forest industries to cope with international competition. However, considering that mechanization is almost complete, the potential for dramatically increased cost efficiency in harvest operations seems to be small. A general opinion in Swedish forestry today, is that the potential rather lies in improved integration between different parts of the wood-flow chain. Furthermore, customer orientation is at the center of attention. Customer orientation will dramatically increase the demands put on the logistics system in Swedish forestry. The number of assortments will increase as well as the need and request for timed deliveries. Storage must be reduced since maintaining the inherent quality of the raw material until it is delivered, is one of the basic ideas of customer orientation.

To cope with these demands, transportation will have to be carried out in an optimal or near optimal way. For example, while having to travel further away from customers to collect a sufficient amount of specific raw materials, efficient routing and scheduling of trucks is a mean of moderating the increase in transportation. As the planning becomes increasingly complicated there is a need to assist the planner with operative tools. OR techniques can be used to suggest e.g. routes and overall flows. However, to use such techniques there is a need to have access to information about e.g. actual roads, supplies and orders. It should also be easy to collect and update the information. Geographical Information systems (GIS) provide that link to the OR tools.

An important operative problem is to extract roundwood from actual felling points to forest roads. Once at the pickup point, logging trucks collect it for further secondary transportation to saw- and pulp-mills. The actual extraction problem is to move logpiles in as short time as possible from the felling piles to the pickup point. Harvesting of full trees are mechanized and there are two types of vehicles operating in the forest. The vehicle which actually fell and buck trees is the harvester. The harvester puts the bucked logs in small piles based on assortment as it moves around. These piles are then collected by a forwarder and moved to larger piles adjacent to forestry roads. In principle all sawlogs are extracted by a forwarder for the first distance. The overall cost for this operation is estimated to be $US 200-250 million. A small increase in efficiency may obviously have a large impact on operational costs.

We formulate the extraction problem in a set-covering model where the potential number of routes is huge. A complicating factor is the difficulty to accurately find the forwarding time for a single route as we do not a priori know the underlying road network. Another is the need for detailed information about each pile. The approach studied therefore involved equpping a forwarder with a Global Positioning System (GPS) unit which automatically displays the position of all the piles of timber and the roads travelled. These particulars are linked to the data on assortments and volumes recorded by the merchandising computer on board the harvester. From this data we have been able to detect an underlying road network. As solution methods we have used a number of heuristics and column generation based methods. These methods have been tested on some cases provided by a major Swedish forest company. Compared to manual solutions we have found an increase in efficiency of about 10 percent. This accounts for either total time or total distance. Optimized route planning for forwarders also offers environmental benefits, such as lower fuel consumptions, reduced emmisions and less damage to the ground. The same approach can also be used to:

- enable priority assesments to be extracted first. For instance, routes can be planned to ensure that fresh Norway-spruce pulpwood is extracted as quickly as possible.
- find piles of timber after heavy snowfall.