Research Project Title: *Location Problems in the Forestry Industry*

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<th>Research Project Start Date: September 2009</th>
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**Executive Summary**

**Problem Description:**

Log harvest planning in the forestry sector has changed throughout the last decades. Both silviculture and harvesting in Canada have become more sophisticated and now pose complex planning problems to get the most from the available regions and harvest cycles. Based on a wide variety of considerations, a long-term plan is designed to determine the volume and regions for wood logging. These decisions are commonly divided into smaller time periods, as logging activities and road construction within a single logging region typically take several months.

Due to political and environmental issues, as well as the size of the country, harvesting plans tend to cover wider territories than they used to. Often, sparse logging is necessary to certify the forestry operations. Several questions arise such as the location and capacity for administrative services, sorting yards and central log processing stations. Similarly, the location where the workers involved in forestry activities are accommodated gains in importance. If villages or cities are close, workers can be hosted at their homes or at motels. However, logging regions in Canada are often widely distributed and located far from such hosting options. In that case, accommodating the workers in the closest village or city is rarely an attractive option, as the commuting time and transportation costs are too high. Transportation times would consume a significant portion of the potential productive time. Furthermore, an additional salary is commonly paid when the transportation times exceed a certain threshold.

A common solution to this problem is the construction of logging camps in which the workers are accommodated. Logging camps are typically located close to the logging regions so that the transportation costs for the workers are reasonable. When allocating each work crew to a camp, the accommodation costs are given as a cost per day per worker. In order to host all workers, the construction of new accommodations may be necessary. The larger a camp, the smaller the daily cost per person. Hence, a small number of large camps results in smaller accommodation costs than a large number of small camps. However, the fewer camps are available, the higher the transportation costs tend to be, because their location is less flexible. The construction of a new camp or the relocation of an existing one may pay off in the long term as the traveling costs to the logging regions may be much lower.
This research investigates the possibility of constructing and relocating camps for the accommodation of workers, considering the harvest planning for the next five years. The problem is motivated by the needs of a Canadian logging company. It consists in finding the number of camps that have to be constructed or relocated, their size and their location such that the total costs for accommodation and transportation are minimized. The interesting question is whether such an investment in camp construction and relocation pays off, considering the operational logging and road construction planning for the next five years. It is important to note that the actual work crew assignment between accommodations and work regions is not relevant in practice. It is only used to determine the minimum capacity level necessary to host all workers. For the operational work crew assignment, other planning tools will be used. It is assumed that all information about work crews, logging regions and distances are known at the beginning of the planning and are not subject to uncertainty.

Methodology and Results:

In a first step, different mathematical models have been evaluated to represent the given problem. Closely related works include those of Shulman (1991), Peeters and Antunes (2001), Melo et al. (2005) and Troncoso and Garrido (2005). Valid inequalities have been derived to facilitate the solution and vast experiments have been performed with the commercial Mixed-Integer Programming (MIP) solver CPLEX. Two case studies have been explored in detail. The results can be found in Jena et al. (2012). In a second step, alternative MIP formulations have been proposed for a simplified version of the problem. These results have been summarized in Jena et al. (2013). As the original problem is still difficult to solve by commercial MIP solver, mathematical decomposition approaches are evaluated to solve the problem. A number of simplified versions of the original problem have been solved by a Lagrangean Relaxation heuristic. Such heuristic is also presented for the model presented in Jena et al. (2013). In a final step, these decomposition approaches will be enhanced to solve the original problem. The aim is to find good quality solutions in short computation times.

The case studies presented by Jena et al. (2012) illustrate that the proposed planning holds large potential to improve manual planning practice in terms of cost reduction. As the use of such tool drastically reduces the effort necessary to perform the planning, it enables the decision maker (i.e., the logging company) to efficiently compare different scenarios.

**Fit within Network Research Theme(s)**

The project fits within Theme IV of the Network Program “Value optimizing, scheduling and control”. The project focuses on the strategic decisions to locate logging camps, given the demands for logging and road construction in the harvesting areas for the next five years. It aims at providing a cost-efficient schedule of logging camps, indicating size and locations, to provide appropriate hosting for the workers involved in the harvesting activities.

The research project has been carried out in cooperation with FPInnovation, involving the efforts of Mathieu Blouin and Jean Favreau.
References


