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Better Planning for Better Road Maintenance: reducing transportation and maintenance costs by focusing maintenance on the sections that need it most

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Abstract

Growing transportation costs have led FERIC's member companies to request assistance in improving the management of their road systems, thereby lowering road maintenance costs. In response, FERIC developed a modified approach to grading that met their needs. This approach involves focusing road maintenance on the road segments that most need grading, thereby making the most efficient use of graders, lowering grading costs, and improving the performance of the roads.

Background

The Forest Engineering Research Institute of Canada (FERIC) works directly with its members in the Canadian forest industry to improve the efficiency and effectiveness of forest operations. In recent years, transportation of material from the forest to the mill has become an increasingly expensive part of industry operations. This has resulted from several long-term trends in the industry, including:

- an increased dependence on haul trucks for long-distance transportation as a result of the end of river drives, and increasing dependence on "just in time" delivery;
- great improvements in the efficiency of harvesting operations; and
- increased distance between mills and harvest sites, because sustainable management plans have taken operations to more expensive harvest sites.

In 1970 less than 50% of the transportation of forest products used trucks; by 1985, this proportion had increased steadily to more than 75% (Douglas, 1992). Today, in the year 2000, almost every cubic metre of wood cut in Canada is transported by a truck for at least part of its journey to the mill. Increasing costs and an increasing reliance on trucks has led to increased interest in improving the efficiency of hauling forest products.

One approach that is currently being considered involves improving the management of road maintenance activities. Unlike most other industries, which rely mainly on public road networks for transportation, the Canadian forest industry often owns all or a large portion of the road network they use to transport forest products from the forest to the mill; even where they don't own the road network, they may still be responsible for building and maintaining it. The necessity to maintain the road network in good enough condition to permit efficient operations creates the need for a strong management system.

Current Situation

In the forest industry, one person is commonly responsible for management of the company's road network as well as management of all the trucking operations. This person must have excellent knowledge of the operations and operating conditions and must be able to alter plans quickly and effectively to cope with machinery breakdowns and changes in the weather. These managers may lack the engineering background that would help them understand the details of road condition and capacity. As a result, road maintenance often receives a relatively low priority and is done solely to keep the road in reasonably usable condition for the trucks. Although this seems at first glance to be a reasonable method of maintaining the road, it is often a poor solution in terms of the effect of road quality on the overall operating costs. For one thing, the approach leads to interventions after the road's quality has already deteriorated to the point at which it is affecting transportation efficiency, and thus represents a poor choice.

The approach also assumes that since each section of a road experiences similar traffic levels, each segment should require the same level of maintenance; this is usually not true (Provencher and Méthot, 1994). Thus, managers often schedule graders to follow a repeating schedule that covers the entire road currently in use. In most cases, this requires having one grader available for every 80 to100 km of road being maintained so as to allow weekly grading of the complete road. Graders start at one end of their assigned sections, and cover 16 to 20 km per day until they reach the end of their section towards the end of the week. Though this approach does maintain the road in an acceptable condition, rough sections are often left in poor condition for several days before the grader arrives, whereas sections in relatively good condition undergo unnecessary grading. The result is overuse of the grader for sections that need little grading and underuse of the grader on the sections that need grading the most.

New Approach

The first step in improving the decisionmaking aspect of managing grading operations involves collecting information on which to base decisions. Several standards and methods describe how to measure road conditions, but most are too time-consuming or too expensive to be practical in planning the maintenance of forestry roads. To deal with this difficulty, FERIC has developed an approach based on automatically collecting the necessary data; these data don't directly measure the road's condition, but instead provide an indirect measure based on measurements of the effect of road's condition on the user. In this approach, a haul truck travelling on the road network is equipped with an instrument that measures the effect of road condition on the truck and provides the locations of areas that have unusually serious effects on the truck.

In the next step, managers analyze the data. In FERIC's system, the data is gathered in a database so it can be displayed graphically and in table format. Managers can then examine the magnitude of the effects of poor road conditions on their trucks. Based on past experience, input from the drivers, and the actual range of problems detected in the data, managers can select thresholds beyond which a section must be graded; additional sections of road close to this threshold are marginal, and can either be treated or left for the next grading intervention, whereas sections with values below the threshold do not need to be graded. The data can be displayed graphically to facilitate interpretation, with color codes that indicate which of these three categories a section of road falls into. Managers can then use this information to establish a grading schedule that efficiently targets sections in need of grading.

Example

A prototype of this approach was tested during the summer of 1999 by FERIC on an active forest road in eastern Quebec. Although the schedules produced by the management system were not used in the company's actual operations because of existing contracts with road maintenance crews and the need to validate the approach prior to implementation, the results were all positive.

The data was collected daily, with the road condition during the last round-trip of each shift being used as the input data. For a period of about 3 weeks, this raw data was studied to determine the level of variability in the data, the range of road conditions being encountered, and whether that range of conditions was relatively consistent. Once this data was understood, FERIC developed software capable of processing the data, and produced preliminary schedules based on the daily information that was collected. The schedules were evaluated by a trucking contractor, the road maintenance supervisor, and the grader operator. Each person felt that the schedule provided a good reflection of where the rough sections of the roads were found, and that the schedule was practical to implement. Table 1 provides an example of an optimized schedule produced with this system for the 90-km section of road that was studied. Table 2 shows the same road, but with the traditional grading schedule. The schedules are based on the assumption that graders grade roads at about 1.8 km/h, drive at about 30 km/h when not grading, work for 12-hour shifts, and do productive work during about 83% of the shift (i.e., 10 hours). The time savings from using the optimized schedule are obvious.

Table 1.

Table 2.

Discussion

Table 1 presented only a single typical example of the types of schedules produced for this road; other schedules required from 9.7 to 22.5 hours of work. Even with the longest of these optimized schedules, the grader still covered the entire road in only 45% of the time required with traditional methods. The actual time savings would vary from operation to operation, depending on the threshold used by drivers and managers to determine when grading is necessary. Even so, we feel confident that a 25% saving in grading time should be *easy* to achieve in any operation, and that savings of more than 50% are also possible. Based on the example in Table 2, the total cost of the traditional method would be about \$3700/week with a grader cost of \$75/h; this compares unfavorably with costs of \$1850 with a 50% cost savings, or \$2780 with the more conservative estimate (25% savings). The initial cost of a suitable monitoring and management system would be about \$7500 installed, with a weekly operating cost of about \$100. Based on a conservative estimate of the cost savings, the payback period would be just over 2 months, with a net savings of around \$40 000 in the first year and more in subsequent years. With better savings, the paybacks and ongoing benefits would be greater still.

These paybacks and savings assume that the goal of FERIC's system is only to reduce the amount of grading time, but there are other alternatives. It's also possible to use this system to *improve* the road's condition and thus attain the savings and advantages associated with travelling on better roads. In this modified approach, managers would continue to grade roads throughout the week, but graders would treat the roughest sections of the road each day. This could mean grading the same section three times in a week, with other sections going 3 weeks without grading. The savings in this case would arise from decreased maintenance costs, but also from decreased haul costs as a result of faster turnaround times. There would also be lower remedial road maintenance costs to repair severe damage to the road, and potentially lower maintenance costs for the trucks themselves. Though we expect the potential savings could be as great as those based solely on reduced use of the grader, an extensive study of the system is required to confirm the magnitude of the savings.

The greatest advantage of FERIC's new system is the ease with which it can be adopted in forest operations. In addition to the low capital cost, short payback period, and improvements in operating conditions, the system is easy to use. The data is collected automatically, with no user input and no effect on normal operations. With an investment of 30 minutes or less per day by the roads supervisor, this data can be turned into a grading schedule.

Conclusions

With the application of easy-to-use, currently available technology, Canada's forest industry has the potential to both increase the quality of their unpaved road network and to save money through improved grader scheduling.

References

Douglas, R.A. 1992. Canadian forest access roads and trucks: a technical survey of the country's "shadow" transportation system. Compendium of Technical Papers, 1992 Joint Annual Conference, Institute of Transportation Engineers (ITE), District 1 (NE USA) and District 7 (Canada). Paper 6A-1. 10 p.

Provencher, Y. and Méthot, L. 1994. Controlling The State of The Road Surface Through Grading Management. FERIC Technical Report 110, Quebec, Canada.

Table 1. An example of an optimized schedule for a 90-km stretch of road

Start (km)	End (km)	Activity	Shift	Time (h)
0.0	14.0	Leave	Start	0.47
14.0	24.0	Grade		5.97
24.0	26.5	Leave		6.05
26.5	32.0	Grade		9.08
32.0	33.0	Leave		9.11
33.0	34.0	Grade		9.66
34.0	35.5	Leave		9.71
35.5	36.0	Grade		9.98
36.0	45.5	Leave	Stop	10.30
45.5	50.5	Grade	Start	2.75
50.5	53.0	Leave		2.83
53.0	53.5	Grade		3.11
53.5	56.5	Leave		3.21
56.5	58.0	Grade		4.03
58.0	60.0	Leave		4.10
60.0	61.0	Grade		4.65
61.0	70.0	Leave		4.95
70.0	72.5	Grade		6.33
72.5	77.0	Leave		6.48
77.0	78.0	Grade		7.03
78.0	82.0	Leave		7.16
82.0	84.5	Grade		8.53
84.5	90.0	Leave	Stop	8.72
	Total productive time:			19.02

Table 2. A schedule for the road in Table 1 based on a traditional approach

Start	End	Activity	Shift	Time
0.0	18.0	Grade	Start/stop	9.9
18.0	36.0	Grade	Start/stop	9.9
36.0	54.0	Grade	Start/stop	9.9
54.0	72.0	Grade	Start/stop	9.9
72.0	90.0	Grade	Start/stop	9.9
	Total Productive Time:			49.5