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LOG TRUCK DESPATCHING IN THE AUCKLAND REGION

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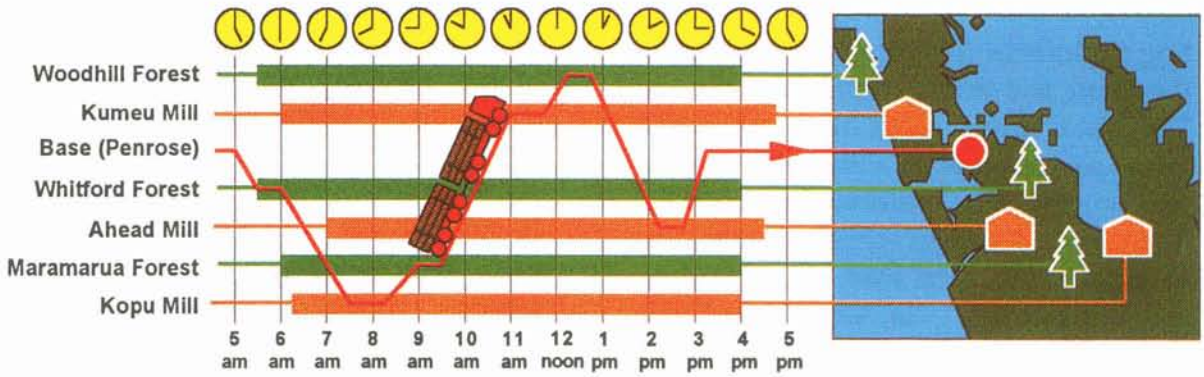

Figure 1 - Space-time diagram for scheduling

INTRODUCTION

Log transport by truck costs the New Zealand forest industry over $500,000 a day. Log trucks cost over $300,000 to buy, and over a $1000 a day to run (running costs plus standing costs). It is therefore important to organise log transport efficiently, so that trucks are not standing idle or travelling unloaded any more than necessary.

Many forestry transport managers suspect that their fleets could be better organised, perhaps with computer aided despatching, Global Positioning Systems (GPS), or real-time log inventory. Before spending a lot of time and money on such a system, it is important to form a realistic idea of the benefits as well as the costs.

Reports from overseas and other industries mention impressive savings in transport costs (Cossens 1993, Win 1996), well over 10%. Can computer aided despatching achieve this level of savings in the New Zealand forest industry?

LIRO used computer generated schedules to assess the quality of "manual" despatching at Carter Holt Harvey Forests (CHHF) Northern Region. The aims of the project were:

1) to calculate the theoretical least cost of delivering the logs, using the best possible schedules;
2) to compare the manual despatching with the best schedules.

This report is in three sections. The first section is a general introduction to log truck scheduling and despatching. The second section describes log transport in the CHHF Northern Region and some features specific to that operation. The third section covers the study method, results and conclusions.

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SCHEDULING AND DESPATCHING

Log trucks exist to pick up loads of logs in the forest and deliver them to customers. The truck driver needs to know which forest compartment to visit, what load to pick up, and what customer to deliver to. It requires a degree of central co-ordination to ensure that each load is assigned to exactly one truck. In New Zealand, this central co-ordination is supplied by a *despatcher*: a person whose job it is to decide which truck will carry which load, and when.

Despatching

A typical log truck despatch operation (such as CHHF Northern) works as follows. At the end of the day, the despatcher tells the truck drivers when and where to pick up their first load for the following morning. When a driver has delivered that load to the customer, he or she calls up the despatcher and ask where to pick up the next load. This process is repeated throughout the day.

The despatcher makes decisions based on log stock information provided by loader drivers, orders from customers, and knowledge and experience of the transport operation.

Despatching is a very stressful job (Theobald 1994). The despatcher must serve many masters: the forestry company, logging crews, customers and truck drivers. Stock and order information changes constantly throughout the day, and the despatcher must make instant decisions with long range consequences.

Scheduling

If the whole day could be planned in advance, this would constitute a *schedule*, listing every pickup and delivery for every truck in the fleet. A schedule may be set out as a table of words and numbers, or it can be displayed as a *space-time diagram* (Fig. 1). Each driver would receive a copy of the schedule the night before, and in theory there would be no need for a despatcher at all.

In practice, it is very difficult to run a log truck fleet according to a prearranged schedule. Unexpected delays, breakdowns and queues mean that some logs are delivered late or not at all. If the schedule is particularly tight, then the trucks must be loaded and unloaded in the order given by the schedule, not on a "first come first served" basis. If a truck is running ahead of schedule, any "spare time" is wasted and cannot be used to carry an extra load. In practice, it is essential to have a despatcher on hand to plug the gaps and repair the schedule during the day.

To sum up, truck movements should neither be totally planned nor totally unplanned; one must have some kind of plan but be prepared to modify it according to changing conditions.

Despatching offers greater flexibility than scheduling and is more consistent with a customer oriented philosophy. However, scheduling is much easier to automate.

Despatch Elements

The despatcher faces a problem with five basic elements:

Logs

Logs are distinguished by *grade* and *length*.

Trucks

Trucks differ according to the length of logs they can carry.

Space

The despatcher must know where forests, customers, weighbridges and truck bases are located, and the roads between them.

Time

Vehicle travel, loading, unloading, queueing and rest breaks all take time, time that must be fitted into the drivers permitted hours and the business hours of forests and customers.

Money

To a despatcher, money is just another name for time: the cheapest route is the quickest, and the best use of truck capital is the best use of the driver's hours.

Despatch Objectives

The most fundamental despatching objective is to make sure all the required loads get delivered on time, and to the right customers. But a good despatcher can do more.

By reducing the amount of unloaded travel and keeping the trucks busy, a good despatcher saves money for the truck operator that eventually flows back to the company through reduced haulage rates.

Distributing the work evenly among the truckies can also bring benefits to the company.

Despatch Quality

Many transport operators use *loaded running percentage* as a measure of their success. The loaded running percentage is the total loaded distance divided by the total distance (loaded and unloaded), expressed as a percentage:

$$loaded\ running\ percentage = \frac{loaded\ distance}{total\ distance} * 100\%$$

A shuttle operation has 50% loaded running, because every loaded trip is followed by an unloaded trip of equal distance. Long *garage trips* (to and from the truck base) will reduce the loaded running percentage. *Back loading* (finding extra cargoes to carry on otherwise unloaded trips) will raise the loaded running percentage. The loaded running percentage is determined partly by geography, partly by the wood flow manager, and partly by the despatcher.

The other important factor is *time utilisation*. If the driver has 14 hours available, but only works 12, then two hours are wasted. Log trucks have very high standing costs; to lose an hour a day costs around $10,000 a year. It is not easy to raise time utilisation, because it depends on drivers reaching home after their last deliveries just before their legal hours run out. This requires good management and equipment that doesn't break down.

CHHF NORTHERN REGION

Carter Holt Harvey Forests (Northern Region) manages transport for wood grown in the Auckland, Hauraki and

Coromandel regions (Fig. 2). Trucks are despatched by weighbridge staff at Kumeu and Kopu mills. The despatchers communicate with truck drivers and loader operators by radio, and record their despatch decisions on preprinted despatch sheets. Neither despatcher has any kind of despatch aid.

On the whole, the two despatchers work independently. The Kumeu despatcher coordinates the transport of logs from Woodhill, Riverhead and Whitford to Kumeu and the Port of Auckland. The Kopu despatcher organises logs from Maramarua and Ṫairua to the Kopu mill. Occasional loads reach the ports of Whangarei and Mount Maunganui and the CHH complex at Kinleith.

The trucks used by CHHF Northern are owned and operated either by their individual drivers or by small contractors with three or four vehicles. Trucks despatched from Kumeu are mostly based in Waimauku, Kaukapakapa, Northcote or Auckland city, while the Kopu trucks are based at Waihi or in Kopu itself.

Figure 2 - Geography of CHHF Northern Region

Special Features of Northern Region

There are three factors specific to CHHF Northern Region that makes their despatching problem more difficult than most: rush hour traffic in Auckland, tight time windows, and on-carts.

Auckland Traffic

CHHF Northern has a problem faced by few forestry companies: a city of over a million people lies across its most important transport artery. About 40% of CHHF Northern's logs must travel into or through the Auckland isthmus, on roads that are choked with urban traffic for many hours of the day.

Time Windows

A *time window* is a restriction on the time of day when loads may be picked up or delivered; in its simplest form, this is the business hours of the forest loader or the customer.

Time windows exist in many scheduling problems, but those faced by CHHF Northern are particularly severe. It is rare for a crew to be working or a customer to be open more than eleven hours a day; the Port of Auckland is open for less than ten. It is difficult to schedule fourteen hour truck shifts in this environment!

On-Carts

An *on-cart* occurs when a truck loads up with logs in the evening, but doesn't deliver them until the next morning. On-carts bring benefits whenever the driver has time to pick up a load but not to deliver it. This can happen when the driver is close to his or her permitted shift length, or when the customer closes too soon after the forest, as is often the case in the Northern Region. Without on-carts, the pickup cannot be made and the driver must go home early.

A Sample Truck Tour

Many features of a log truck tour may be visualised more easily in a *space-time diagram* (Fig. 1), like those used for planning train and bus timetables. Figure 1 shows the tour of duty for a single truck, based at Penrose in Auckland city. The horizontal axis represents time and the vertical axis represents space, with the forests, customers and truck base arranged from north to south. The coloured horizontal bars are the time windows for the forests (green) and customers (orange). For example the Ahead mill (near Pokeno) is open from 7:00 am to 4:30 pm.

Notice that the mills tend to open and close about half an hour later than the forests; it might in fact be more convenient if this gap were *longer*, so that the last load from each forest could be delivered the same day, avoiding on-carts.

The jagged red trace shows the movements of the truck. When the trace is horizontal, this means the truck is stationary, generally because it is being loaded or unloaded. When the trace slopes downwards, the truck is travelling south, and an upward slope means the truck is going north. The horizontal parts of the trace lie within the coloured bars, because loading and unloading must take place during business hours.

In this example, the truck driver may not leave the base any earlier than 5:00 am because they would arrive too early to load at Whitford forest. They may not leave home later than 6:45 am because they could not finish unloading at Ahead before the mill closes. However, the driver may leave the base at any time between 5:00 am and 6:45 am; this is the *launch window*.

This tour contains no on-carts, but it is easy to see that there is just time after the Ahead delivery to pick up another load from Whitford or Maramarua. However, there would not be time to deliver this load and it would have to stay on the truck overnight.

STUDY METHOD

CHHF Northern supplied two months worth of despatch records from both despatchers. Of these, twenty-seven days of "manual schedules" were selected for detailed analysis. The reason for this selection are outlined below. The aim was to create computer schedules (Robinson, 1995b) for each day so as to make the same pickups and deliveries (including on-carts) as cheaply as possible. Indicative costings were obtained as described by Goldsack (1988).

Model Elements

The assessment of CHHF Northern's scheduling efficiency was based on a model: an approximation of reality that is easier to work with but still gives useful results. Building a model is a subjective process, and it is inevitable that some elements will be modelled in detail (slack time), some superficially (queues), and others not at all (rush hour traffic).

Logs

All logs were measured in loads rather than tonnes or cubic metres.

Split loads were treated as full loads; for example, where a truck carried half a load of JA 4 and half a load of K 3.7, this was treated as a complete load of the fictitious grade "JA4/K3.7".

The model included only those log loads that were actually picked up and delivered by the manual schedules. Loads that were known to the despatcher but not delivered do not appear in the model.

Each load was assumed to be available from the moment the loader driver arrived in the morning.

Trucks

The CHHF Northern truck fleet is composed of shorts units and convertibles. Within each class, all trucks were considered identical, except that each truck could have a different base.

Space

The grid locations of relevant facilities and road junctions were recorded to the nearest kilometre. The lengths of road segments were also recorded in kilometres, and travel times calculated from truck speed and road length.

Every load was treated as having a single pickup point and a single delivery point. So if the manual schedule took one load of short sawlogs from Tairua to Ahead, and one from Maramarua to Kopu, the computer was not permitted to send the Tairua logs to Kopu nor the Maramarua logs to Ahead. It is unlikely that this restriction had much effect on the results, as most log grades were purchased by only one customer.

Time

Time was measured to the nearest minute, which is more than adequate.

Drivers were assumed to take one thirty minute rest break if they drove for more than 330 minutes. In reality, some drivers take their rest breaks while waiting for the truck to be loaded or unloaded, but this was not permitted by the model.

Log handling times were obtained from Bates and Robinson (1994). Truck speeds were calibrated by examination of despatching records.

Money

The stated costs were calculated using the method of Goldsack (1988).

On-Carts

The computer model incorporated on-carts but required the computer schedules to use the same on-carts as the manual schedules.

Time Windows

Time windows were very easy to enforce: the whole of each loading and unloading operation had to take place during the business hours of the facility. In particular, it was not enough for the truck to *arrive* at the customer before closing, it had to be unloaded and leave before the customer closed.

Selection of Manual Tours

All the manual schedules were examined closely and defective tours were removed:

Tours over 1000 minutes

The law allows for a maximum shift length of 840 minutes, including a thirty minute rest break. Since the calculated shift length and the true shift length may differ, tours were not discarded unless they exceeded 1000 minutes.

Shared trucks and tours under 500 minutes

When a truck worked for several companies on the same day, CHHF despatch records did not show the whole tour. Tours were eliminated if the truck was explicitly marked as shared, or if the recorded tour was less than 500 minutes.

Checking for Time Windows

The computer was able to calculate whether the loads could be picked up and delivered within normal business hours; tours that made deliveries outside normal hours were discarded.

Forcing the manual schedules to comply with a set of standard time windows may seem rather arbitrary. For comparison, two sets of runs were performed.

In the "selected tours" run, manual tours were only accepted if they complied with the time windows. Computer schedules were then created to carry the same loads within the same business hours.

In the "general tours" run, manual tours were permitted to violate the time windows. Obviously, there are more general tours than selected tours, and hence more loads (819 loads in the selected tours, 1222 loads in the general tours). Computer schedules were created to carry these loads, but within the nominal business hours.

Table 1 shows the total measures for "selected" tours over the 27 days of the study. The selected manual tours used a total of 241 truck days with an average loaded running of 49.3% and a time utilisation of 73.7%. Computer tours to deliver the same loads on the same days used 231 truck days; saving just a third of a truck per day. The statistics show that this was achieved by better loaded running (53.7%); the time utilisation actually declined (73.2%). The computer schedules were 7% cheaper than the manual schedules, indicating that the manual schedules were 93% efficient.

Table 1 - Analysis of "Selected" Tours

Measures (Total of 27 days)		Manual Schedules	Computer Schedules	Absolute Difference	Percent Difference
Loads Carried		819	819	0	0%
Trucks Used		241	231	10	4%
Driving Time	*(minutes)*	95101	87693	7408	8%
Standing Time	*(minutes)*	54304	54304	0	0%
Rest Time	*(minutes)*	5490	4950	540	10%
Slack Time	*(minutes)*	47885	47093	792	2%
Total Shift Time	*(minutes)*	202780	194040	8740	4%
Overshift	*(minutes)*	340	0	340	100%
Loaded Distance	*(km)*	51365	51365	0	0%
Unloaded Distance	*(km)*	52800	44359	8441	16%
Combined Distance	*(km)*	104165	95724	8441	8%
Running Cost	*(dollars)*	99050	89802	9248	9%
Standing Cost	*(dollars)*	139922	131851	8071	6%
Combined Cost	*(dollars)*	238973	221654	17319	7%
Loaded Running		49.3%	53.7%		
Time Utilisation		73.7%	73.2%		

Table 2 - Analysis of "General" Tours

Measures (Total of 27 days)		Manual Schedules	Computer Schedules	Absolute Difference	Percent Difference
Loads Carried		1222	1222	0	0%
Trucks Used		333	342	-9	-3%
Driving Time	*(minutes)*	140605	130421	10184	7%
Standing Time	*(minutes)*	80873	80873	0	0%
Rest Time	*(minutes)*	8280	7680	600	7%
Slack Time	*(minutes)*	53027	68306	-15279	-29%
Total Shift Time	*(minutes)*	282785	287280	-4495	-2%
Overshift	*(minutes)*	3065	0	3065	100%
Loaded Distance	*(km)*	76822	76822	0	0%
Unloaded Distance	*(km)*	76267	64613	11654	15%
Combined Distance	*(km)*	153089	141435	11654	8%
Running Cost	*(dollars)*	147500	134565	12935	9%
Standing Cost	*(dollars)*	193073	195072	-1999	-1%
Combined Cost	*(dollars)*	340573	329637	10936	3%
Loaded Running		50.2%	54.3%		
Time Utilisation		78.3%	73.5%		

Note that the standing time and the loaded distance were identical for both manual and computer schedules: these measures depend only on the logs being delivered and are not influenced by despatch decisions.

Table 2 shows the equivalent information for "general" tours. Since the computer is still trying to work within business hours, it cannot match the manual schedule's time utilisation (73.5% for the computer against 78.3% for manual). This forces the computer to use more truck days (342) than the manual schedule (333), with a corresponding increase in standing costs. Nevertheless, the computer schedules were still 3% cheaper because they reduced the unloaded running.

DISCUSSION

The Pan Pac study (Robinson 1995a) found that time utilisation offered much greater potential for improvement than loaded running percentage. At CHHF Northern Region, the reverse was true: the study found almost no room for improved time usage, but considerable scope for better loaded running.

Some trucks contracted by CHHF Northern were based a considerable distance from the main forests and mills. For example, one truck based in Orewa did not lie on any of the main log routes in use at that time and had to drive for 25 unproductive kilometres at the start and end of each day.

The Kumeu and Kopu despatchers are largely independent of each other, which may cause unnecessary unloaded running. The computer scheduler treats the whole region as a single unit and thus obtains better co-ordination between the Kopu and Kumeu operations.

CONCLUSIONS

According to the computer model, the schedule efficiency of Carter Holt Harvey Northern Region was 93%. The "manual" schedules have been given the benefit of the doubt in terms of shift length, but not with regard to business hours at forests and customers.

The greatest potential for improvement lies in raising the loaded running percentage. Given the assumptions used, the "general" and "selected" comparisons show that the loaded running percentage could be raised by about four points, saving about 9% of running costs.

If fleet size could also be reduced by 6%, the cost of transport would be reduced about 7% overall.

REFERENCES

Bates, S. and Robinson, T.F. (1994) : "Log Truck Unloading", LIRO report Vol. 19 No. 10.

Cossens, P. (1993) : "Evaluation of ASICAM for Truck Scheduling in New Zealand", LIRO report Vol. 18 No. 7.

Goldsack, R. (1988) : "Costing Handbook for Log Truck Contractors", LIRO Publication.

Robinson, T.F. (1995a) : "Truck Despatching Case Study: The Cost Efficiency of Log Truck Despatching in Hawke's Bay", LIRO Project Report 56.

Robinson, T.F. (1995b) : "Improvement Methods for Log Truck Scheduling", Proceedings of the 31st Annual Conference of the Operational Research Society of New Zealand.

Theobald, R. (1994) : "Log Truck Despatching - A Despatcher's View", Proceedings of the 1994 LIRO Seminar "Forestry Transport 2000", session 3b.

Win, A. (1996) : "Computer Scheduling for Customer Service", Proceedings of the LIRO Log Truck Scheduling Workshop (in press).