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THE MADILL 171 IN NEW ZEALAND

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ABSTRACT

The first Madill 171 to work in New Zealand was studied extracting tree length radiata pine at Mohaka Forest. The operation also used two hydraulic knuckleboom loaders for clearing the chute, sorting, stacking, and loading.

Hourly productivity was 31m³/scheduled machine hour with short average haul distance of 111m and a drag volume of 3.47m³. Regression equations for outhaul and inhaul times are given. Utilisation was 65% and the main source of operational delay to the hauler was from lineshifts.

Comparisons were made between the use of one and two breakerouts and no significant differences were found. Small pieces were found to take 50% longer to hook on than tree lengths.

INTRODUCTION

The development of the Madill 171 by S.Madill Limited arose from modifications and improvements made over the earlier Madill 071. The Madill 171 features a telescoping tower which can be operated at either 15m or 21m height. It also has increased line pulls, speeds, and drum capacities.

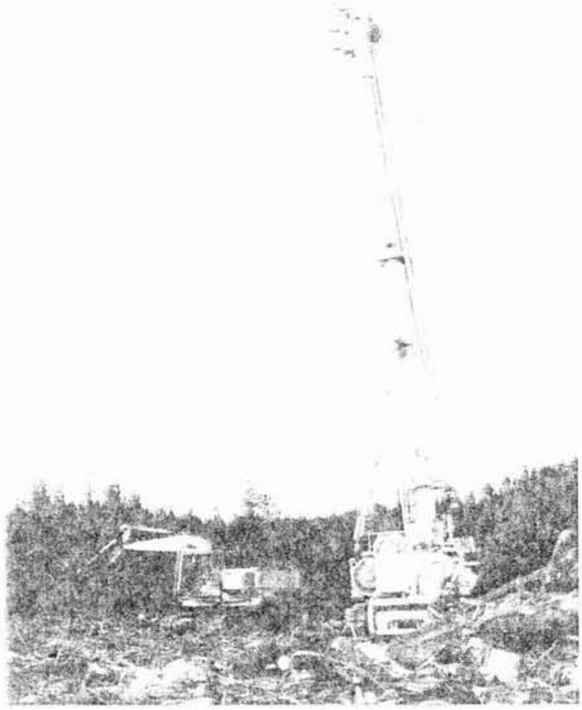

Figure 1 - The Madill 171 working in Mohaka Forest

An earlier LIRA study of a Madill 171 working in the Pacific Northwest found the hauler had an hourly productivity of 35m^3/scheduled machine hour (SMH). The hauler was using a dropline carriage and pulling cut-to-length timber with a piece size of 0.84m^3. Given the high productivity of the Madill 171 and the adherence to tree length logging in New Zealand, it was suggested that systems changes may be necessary in order to match the processing capacity at the landing with the productive capacity of the hauler (Prebble, 1989).

In May 1990, the first Madill 171 arrived in New Zealand and started work at Mohaka Forest on the east coast of the North Island. The operation included two hydraulic knuckleboom loaders at the landing for sorting, stacking and loading. In July 1991, LIRO undertook an evaluation of the hauler operating in terrain and piece size timber typical of Mohaka Forest.

The objective of the project was to study and document the performance of the Madill 171 hauler and the associated landing operations.

OPERATION DESCRIPTION

The 29 year old radiata pine stand in which this study took place had been damaged by fire at age 11 years (Table 1). It was felled

Age	29years
Fire damage	1973
Height	38m
Stocking	269stems/ha
Volume/ha	603m^3/ha
Piece size	2.25m^3

Table 1 - Stand Details

by two fallers, who laid the trees across the contour where possible. Some trees were trimmed, and slovens were not removed.

Two 8m strops were used and one or two breakerouts hooked up the trees. The hauler, with its tower operating at 21m height, pulled them across a gully using a Northbend system. The landing covered an area of 0.12ha and was sited on a spur. A Cat 225 (25 tonne) knuckleboom loader moved the trees from the chute to an adjacent processing area where three skiddies trimmed and cut eleven log sorts. A Cat EL300B (30 tonne) knuckleboom loader sorted, stacked and loaded the processed logs on to trucks for transport. Mixed stacks were used at the landing, but separate stacks were used for storing the fire damaged logs off the landing (Figure 2).

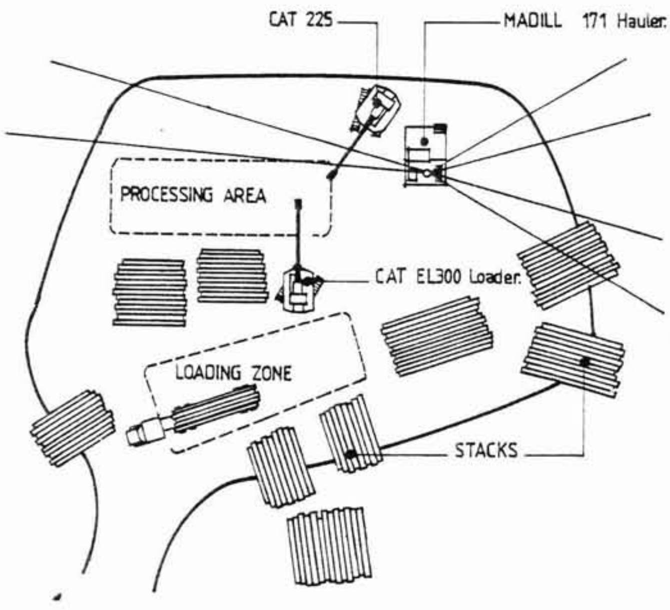

Figure 2 - Landing layout

METHOD

A continuous time study was carried out on the hauler for defined elements of the work cycle. For each drag, haul distance was estimated to within 5 metres and the drag

Element	Time per Cycle (min)	Range (±)*
(n=276)		
Raise Rigging	0.17	0.01
Outhaul	0.32	0.01
Position	0.14	0.02
Hook	(1.9 pieces) 2.10	0.10
Break out	0.30	0.02
Haul	(111 metres) 0.71	0.02
Unhook	0.63	0.04
Delay Free Total	4.37	0.13
Delays:		
Operational	1.30	
Mechanical	0.05	
Personal	1.00	
Total Cycle Time	6.72	

*Range for 95% confidence interval.

Table 2 - Cycle Time Summary

volume was estimated using a one dimensional volume table derived from trees scaled in the setting. During the course of the study, the terrain difficulty and distance walked by the breakerouts was rated for each cycle. All delays were measured and any changes in the method of operation were noted. Landing activities were sampled at 1 minute intervals for the three skidworkers and the two loaders. Smoko breaks were not included in the data collection for the landing activities.

RESULTS

The study was carried out over 31.4 hours (3.4 days) during which 276 full cycles were timed. All trees and short lengths extracted were scaled at the landing. Average volume per cycle was 3.47m^3 which was pulled over an average distance of 111m. Delay free cycle time was 4.37 minutes (Table 3). Utilisation was 65% and availability was 99.3%. Equations for outhaul and inhaul of the carriage are given :

Equation 1:

Outhaul time (mins) =
0.1580 + 0.0015 x *Distance (m)*
$(r^2 = 0.51)$

Equation 2:

Inhaul time (mins) =
0.2359 + 0.0028 x *Distance (m)*
+ 0.05 x *Volume (m^3)*
$(r^2 = 0.41)$

Extracted piece size	$1.85m^3$
Drag volume	$3.47m^3$
Productivity	$30.6m^3$/SMH
Production	$247m^3$/day(8 hours)

Table 3 - Average values for setting logged

Hourly productivity based on total cycle time with delays included, was $30.9m^3$/SMH. Given an eight hour working day, daily production would be $247m^3$ (Table 4). The crew worked on average 9.2 hours per day, resulting in a daily production of $285m^3$.

The hook-on phase of the cycle was the most significant contributor (48%) to the delay free cycle time. This was considered to be due to the combination of the short average haul distance and the fast line speeds of the Madill 171, giving a low proportion of machine time per cycle. Modelling hook-on time by regression, using the number of tree length and pieces picked up per drag, indicated that pieces took 50% longer than tree lengths to hook up (Equation 3). The addition of a long, smaller diameter strop which is lighter may help reduce hook times for pieces.

Equation 3:

Hook-on time (mins) =
$1.24 + 0.60 \times$ *No. of pieces*
$+ 0.40 \times$ *No. of trees*
$(r^2 = 0.17)$

When deriving the model, a comparison of hook-on times with one or two breakerouts was made using multiple regression analysis. No significant difference was found in hook-on time with one or two breakerouts. Other variables tested for use in the model included the terrain difficulty, distance walked, the number of trees and pieces hooked on per cycle, and the drag volume. None of these variables were found to vary significantly when the operation changed from using one to two breakerouts. It is likely that some other source of variation such as changes in the wood lay or interaction between the breakerouts was influencing the hook-on element.

DELAY ANALYSIS

Over the study period, 35.0% (10.9 hours) of the total time was spent in delay. Personal delays took 42.6%, operational delays took 55.3% and mechanical delays took 2.1% of total delay time.

Closer inspection of the operational delays shows lineshifts to be the major component at 46.8%. The skyline was tied back to a mobile back anchor and 22 line shifts were recorded during the study. The average time to shift the skyline was 7.7 minutes with an average of 13 cycles for each skyline road logged. Two hauler position changes were recorded and they took 34.2% of the operational delay time. The large proportion of operational delay time attributed to shifting machinery and ropes is a reflection of the short average haul distance of 111m. The use of a slackpulling carriage to increase lateral reach may have reduced the number of line shifts required and allowed more productive time per shift. The four guyline configuration for the tower gives little opportunity for a reduction in hauler shifts when close hauling, due to the limited tolerance to changing lead angle.

Interferences to the hauler from the landing arose primarily from the Cat 225 loader dedicated to clearing the chute area. These interferences generally occurred when the loader encountered trees which were too large for it to extract from the chute and as a result assistance was required from the Cat EL300 loader.

Fouled lines accounted for 5.2% of operational delay time and included one long delay due to the tailrope becoming jammed in the track of the mobile tailhold. Other delays included the time taken for the breakerouts to walk back to the face after a lineshift (Figure 3).

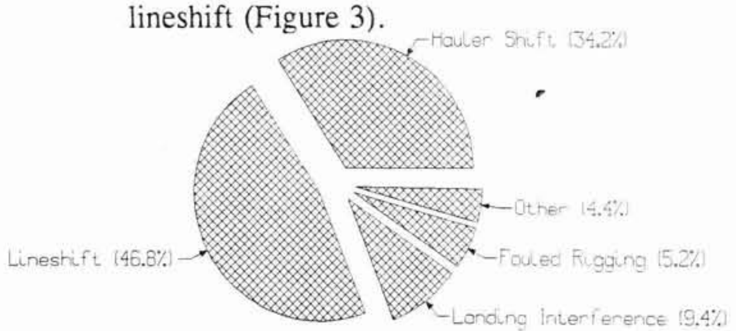

Figure 3 - Summary of Operational Delays

LANDING ANALYSIS

Data from the four skiddies was combined to give an average task distribution per skidworker. Processing trees (measure, trim, crosscut) took 37.1% of the skiddies' time. Loader interference (6.7%) occurred mainly when logs were being transferred from the chute to the processing area. Skiddies assisted the hauler (11.0%) with guyline and hauler shifts around the landing. Chainsaw sharpening and refuelling accounted for 19.5% of the skiddies' time. This is high when compared with levels of 10% to 12% for other hauler landings (Kellogg, 1989; Robinson, 1991). The skiddies were waiting for work 10.7% of the time suggesting excess capacity, some of which may have been used sharpening chainsaws (Figure 4).

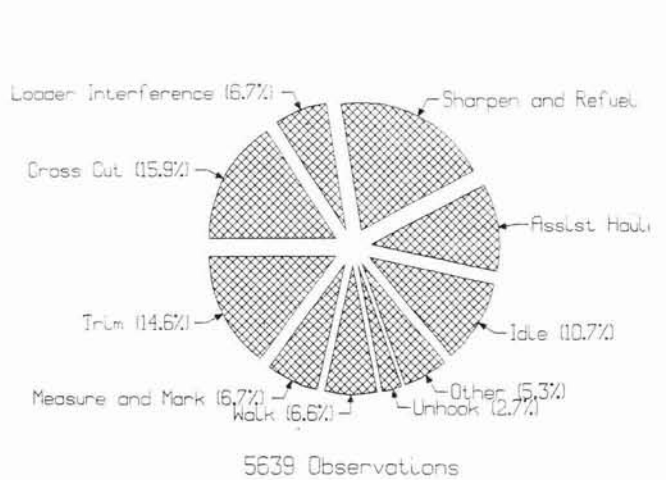

Figure 4 - Skidworker Analysis

Each loader had separate designated tasks and as a result they have been analysed separately. The Cat EL300B was dedicated to fleeting (54.5%) and loading (21.5%). On average, 8 trucks were loaded each shift and early morning load-outs were normal. The loader spent short periods of time assisting skiddies (3.0%) and the Cat 225 with large trees in the chute area (2.0%). Idle time incurred was 4.0% which indicates the loader was working near to capacity. This may be due to the large number of log sorts and restacking required by landing re-organisation as the hauler shifted with the logging of the setting (Figure 5).

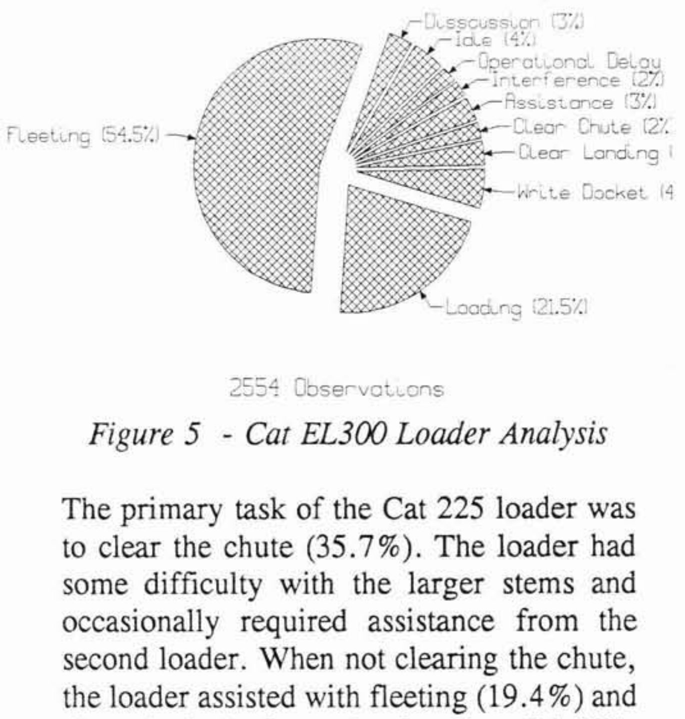

Figure 5 - Cat EL300 Loader Analysis

The primary task of the Cat 225 loader was to clear the chute (35.7%). The loader had some difficulty with the larger stems and occasionally required assistance from the second loader. When not clearing the chute, the loader assisted with fleeting (19.4%) and cleared slash from the landing (31.3%). Working close to the hauler, this loader was the cause of some interferences to extraction. Given the excess capacity (16.3%), these interferences could be minimised (Figure 6).

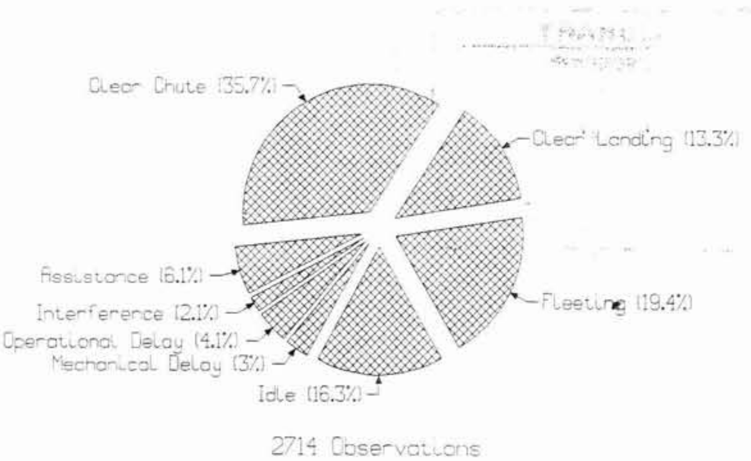

Figure 6 - Cat 225 Loader Analysis

COSTING

An indicative costing using the LIRA costing format was carried out for a new Madill 171, two 30 tonne loaders, nine men and a mobile back anchor (Wells, 1981) (Table 4). The daily cost for this operation including operating supplies, overheads and profit was $3871/day (8 hours).

Cost Centre	Daily Cost ($/Day)
Hauler	1108
Loaders (2x30 tonne)	890
Mobile Tailhold	110
Labour	1165
Operating Supplies	177
Overhead (2½%)	69
Profit (10%)	352
Total	$3871

Table 4 - Summary of Costs

CONCLUSIONS

The hauler produced 30.9m^3/SMH for an average haul distance of 111m and an extracted piece size of 1.85m^3. Utilisation for the hauler was 65% and availability was 99.3%.

Hook-on time was 48% of the delay free cycle time. Terrain difficulty, number of breakerouts and distance walked by breakerouts were found to have no significant influence in the hook-on time. Broken pieces from the tops of trees were found to take 50% longer to hook on than trees.

Interferences due to the Cat 225 caused 11.4% of the hauler's operational delay time. Given the excess capacity of the loader, these interferences could be minimised. Interferences between the landing operations (clear chute, process, sort, stack, load) were low; the highest being 6.7% interference to the skidworkers by the Cat EL300. This loader had little excess capacity (4%) and as a result was the limiting factor governing landing productivity. Re-organisation of the landing to increase the proportion of fleeting for the Cat 225 may enable some gains in landing productivity to be made.

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The costs stated in this Report have been derived using the procedure shown in the LIRA Costing Handbook for Logging Contractors. They are an indicative estimate and do not necessarily represent the actual costs for this operation.

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