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PARTIAL PROCESSING FOR EXTRACTION WITH A MADILL 171

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ABSTRACT

A Madill 171 hauler was studied extracting both partially processed logs and tree lengths uphill in Tairua Forest. The operation featured a Bell Ultralogger for fleeting and clearing the chute, a Kato/Barko hydraulic loader for sorting, stacking and loading, and three skid workers for trimming and log making.

Hourly productivity for the hauler was 36m³/productive machine hour, average haul distance was 119 metres and mean haul volume was 4.05m³. Of the 842 pieces extracted, 227 (27%) were partially processed logs. Daily utilisation averaged 67%.

Time study data and haul volume per cycle values were tested for differences between those haul cycles containing no partially processed logs and haul cycles containing at least one partially processed log. Tests of significance showed significant differences for haul volumes and delays due to the Bell. Delays were longer and haul volumes smaller when extracting tree lengths. Analysis of time study data on a daily basis, showed that partially processed log extraction was more productive than for tree length extraction.

Figure 1 - Ross Sutton's Madill 171 operation in Tairua Forest

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INTRODUCTION

There are several tree processing options available in cable logging operations, one of which is partial tree processing at the stump. A partially processed log refers to the largest product of a single pre-emptive cut made to a tree at the felling site. In this study, such a log was comprised of two measured sawlogs. As a consequence, only the largest trees were selected for a pre-emptive cut; the operation was termed a partial processing one.

Cutting to length processing at the stump is a means of log preparation that has potential advantages for the contractor and the forest owner. These are perceived to be :

- smaller landings resulting in less soil disturbance
- improved deflection (the tower can be placed closer to the edge of the landing)
- easier hook on
- easier breakout for the hauler
- less slash on the landing

Other studies have focussed on 100% log length processing in the bush.

Murphy (1977) found log length extraction gave the lowest production and the highest cost when comparing three log preparation scenarios. He also found that the savings on landing costs were outweighed by the extra costs of processing at the stump.

Galbraith (1986) concluded that possible reasons for the lack of log length extraction in New Zealand were small tree sizes, rapid deterioration of radiata pine in the bush, low value differential between log sorts and the reliance by the industry on logging systems that emphasised large haul volumes and slow haul cycles. This latter reason is less valid now that haulers such as the Madill 171, that have fast line speeds, are being used in the industry.

Prebble (1988) compared log length and tree length extraction with a Washington 88 swing yarder. Productivity in log length extraction was not significantly higher. Faster hook on, break out and inhaul times were achieved in the log length operation, although these advantages were offset by larger haul volumes for the tree length operation.

Some contractor concerns regarding partial processing at the stump in cable operations have centred around extracted piece size, which is reduced in any log length extraction operation, and reduced faller productivity. Also noted however, is an easing of the burden on breaker outs and the requirement that fallers process trees only under safe conditions. The effect of tree length processing on landing based productivity is also a concern, mainly because of the limited operating space available on smaller landings (Tim Sutton, pers.comm).

In order to examine the effects of this processing method, a study was undertaken of Ross Sutton's Madill 171 working in Tairua Forest at a time when partially processed logs were being extracted to a relatively small landing of 0.2 hectares. Partial processing was being phased out over the four days of the study because of sapstain problems. This presented an opportunity to compare partially processed log extraction, with tree length extraction to a small landing.

Age	35 years
Mean height	32 metres
Mean diameter	43 cm.
Stocking	456 stems/ha
Recoverable Volume	815 m^3/ha
Mean Merchantable tree size	1.79 m^3

Table 1 - Stand details (Source: MARVL)

The objectives of the study were to quantify hauler productivity for extracting partially processed trees and to determine the work content of the associated landing operation. In this report, unprocessed full length stems are referred to as "trees", partially processed logs as "logs".

OPERATION DESCRIPTION

The trial took place in a stand of 35 year old radiata pine, with a live stocking of 456 stems/ha and a mean merchantable over bark volume of 1.79m^3/tree (Table 1). Trees were directionally felled where possible and, where safety and tree size permitted, larger trees were cut into logs of length 16 to 18 metres.

Five strops were used in the course of the study, three of about 3.5 metres and two of 8 metres. Two breakerouts hooked on the logs and the hauler, using a 21 metre tower, pulled them uphill to the skid using a scab skyline system. A mobile back anchor (Komatsu D65) was used. Figure 2 shows terrain profiles of extraction "roads" for days 1 to 4.

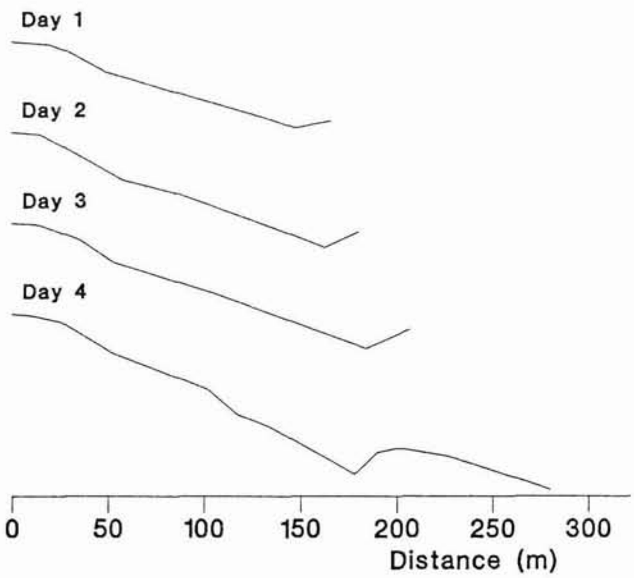

Figure 2 - Terrain profiles for Days 1, 2, 3 and 4 off the study

The skid was 0.2 ha in area of which approximately 0.13 ha was metalled. The skid was sited on a spur, with a high bank abutting one side of the landing. This created difficulties for the hydraulic loader in that it hindered the stacking of logs under the guy ropes.

Logs and trees were unhooked in the chute by one of the skiddies and the tower cleared by a Bell Ultralogger. Tree processing on the skid was phased. Trees from several hauls were dragged by the Bell and stacked on runner logs at a separate processing area before one skid worker measured and marked the stems and another 2 skid workers trimmed and cut into eleven log sorts. When the skid workers had completed processing, they moved aside and a Kato/Barko 330 hydraulic loader sorted, stacked and loaded out. In this way, the activities of the Bell, the skid workers and the loader were kept separate. The Bell presented processed logs to the loader and assisted in sorting and stacking, as in a constricted landing the loader could not access all of the stacks.

METHOD

A continuous time study was carried out on the hauler for defined elements of the work cycle. For each haul, the haul distance was measured to within 5 metres and the haul volume (under bark) estimated using a one dimensional table derived from trees scaled in the setting. Log volumes were estimated in a similar manner based on a nominal fixed length of 16 metres.

All delays were timed and any changes to the operation were noted. Landing operations (Bell Ultralogger, Kato/Barko loader, one logmaker, two skid workers) were assessed at one minute intervals using activity sampling.

RESULTS

Extraction

Two hundred and nine full cycles were timed over 4 days. All trees, logs and shorts were scaled at the landing. Overall, average volume per cycle was 4.05m^3 with an average 3.7 pieces per haul. Average haul distance was 119 metres with a maximum distance of 230 metres. Delay free cycle time was 6.81 minutes (Table 2). Average daily values for utilisation and availability were 67% and 98% respectively. Equations for outhaul time and inhaul time are given:

<u>Equation 1</u> - Outhaul time (mins) = 0.1373 + 0.0025 x Distance (m) $(r^2=0.50)$

<u>Equation 2</u> - Inhaul time (mins) = 0.2683 + 0.0060 x Distance (m) + 0.0002 x Haul Volume (m^3) $(r^2=0.47)$

Hourly productivity based on delay free cycle time was 35.7m^3/productive machine hour (PMH). Given an eight hour working day and 67% utilisation (5.3 productive hours), daily production would be 191m^3/day (Table 3). Average daily hours worked were 8.7 hours and at 67% utilisation (5.8 productive hours), daily production is calculated at 207m^3. Over 7 days, including the study period, weighbridge data gave an average loadout volume of 212m^3 per day.

ELEMENT	TIME PER CYCLE (mins)	± 95% Confidence Interval
Raise rigging	0.17	0.01
Outhaul	0.41	0.02
Position	0.18	0.02
Hook on (3.73 pieces)	3.68	0.22
Break out	0.21	0.03
Inhaul	0.98	0.05
Unhook	1.18	0.09
Delay free total	6.81	
Operational Delays	1.44	
Mechanical Delays	0.21	
Personal Delays	1.70	

Total Delays	3.35	
TOTAL CYCLE TIME	10.16	

Table 2 - Cycle time summary (n = 209)

Variable	Mean value	Total Volume (m^3)	Total Number of pieces
Mean overall extracted piece size (m^3)	1.08	841	779
Means extracted size of partially processed logs (m^3)	1.18	268 (31%)	227
Mean extracted size of trees (m^3)	1.11	551 (65%)	496
Mean extracted size of shorts (m^3)	0.40	22 (4%)	56
Mean haul volume (m^3)	4.05		
Productivity/Scheduled Machine Hour*	24 m^3/SMH		
Daily Production (8.0 scheduled hours)	192 m^3/day		
Productivity/PMH	35.7 m^3/PMH		
Daily Production (8.7 scheduled hours, 67% Utilisation)	208 m^3/day		

* Scheduled machine hours are "on-job" hours which include smokos, maintenance and all delays.

Table 3 - Average values for the setting

Figure 3 shows the time distribution for the hauler (including delays).

In a previous study of the Madill 171 (Robinson, 1992) hook on times were 48% of the delay free cycle. In this study, hook on time comprised 54% of the delay free cycle time giving a mean hook on time of 0.99 min/piece.

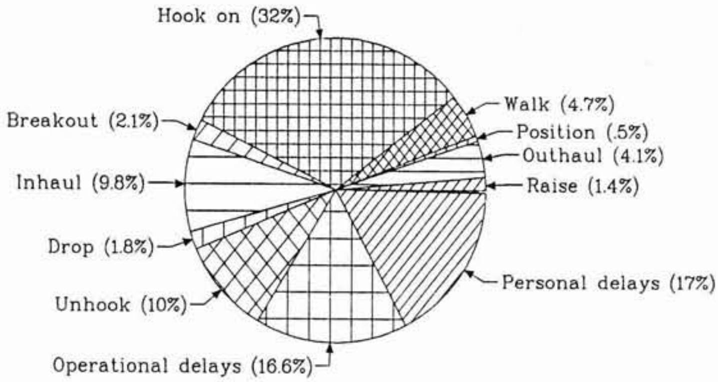

Figure 3 - Time distribution for the hauler

EXTRACTION DELAY ANALYSIS

In the study period, 33% of the total time was spent in delay. This is comprised of personal delay which includes smokos (50% of total delay), operational delays (43%) and mechanical delays of 6% (Figure 4).

Of the operational delay time, the major component was interference delay (15% of total delays) caused by the Bell Ultralogger not having the chute sufficiently clear to land the incoming haul. This delay varied on a daily basis from 8% of the total delay on Day 1 to 20% of total delay on day 4. This increase in delay time may reflect the Bell's difficulty in extracting large trees from the

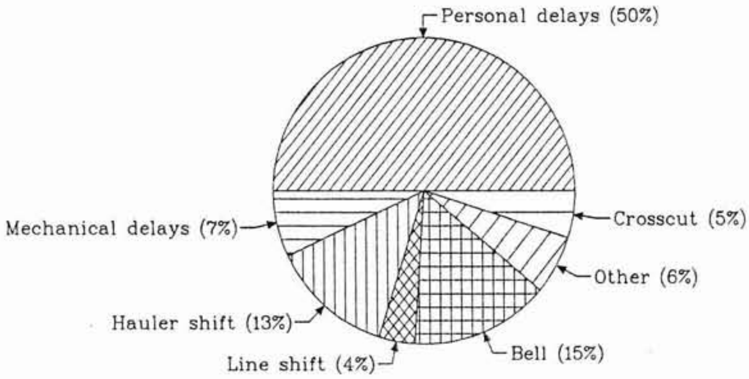

Figure 4 - Distribution of hauler delays

chute and the reluctance of the hauler operator to further load the chute with another drag. On day 4, 91% of extracted volume was in tree lengths of 1.5m^3 mean tree volume.

Minor operational delays also increased from day 1 to day 4. Ropeshifts comprised 4% of total delays with 7 shifts recorded averaging 3.5 minutes per shift. This minimal time per shift can be attributed to the use of a mobile back anchor. An average of 30 cycles were pulled for each skyline road logged. The large number of cycles per ropeshift may be due to the effect of log length extraction increasing the number of pieces on the ground for extraction. Three hauler position changes were recorded and these took 13% of total delay time. An additional 5% delay was caused by skid workers crosscutting large logs in the chute so that the Bell could extract them.

LANDING ACTIVITIES AND DELAY ANALYSIS

Skid Workers

The activity sampling data from the logmaker and two skid workers were combined and the percentage total time spent on different activities was calculated (Figure 5). Thirty-seven percent of the skid workers' time (measure, mark, trim and crosscut) was taken up with processing trees and logs. The activity sampling data was segregated by work period assuming three work periods per day and the percentage of partially processed logs extracted was also sorted by work period. This data was tested for a correlation between percentage of partially processed log recovery and percentage time spent on trimming and crosscutting.

A correlation was found between partially processed log recovery and crosscutting time. There was less crosscutting time when a high percentage of processed log extraction occurred. Interference from the Bell accounted for 21% of the skid workers' time. This high value was partially due to the phased nature of the operation, and having only one processing zone. Two-thirds of this Bell interference consisted of the skid workers waiting for work. Use of a second processing zone may have solved this problem.

The loader contributed 2% interference to the skid workers' activities. Skid workers assisted with guyline and hauler shifts

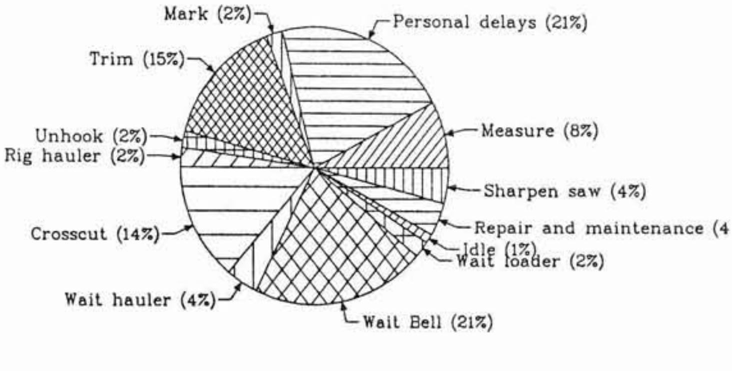

Figure 5 - Time distribution for all skid workers

around the landing (2%), and also unhooked the hauls in the chute (2%). Sharpening and refuelling took up 8% of the skid workers' time.

Bell Ultralogger

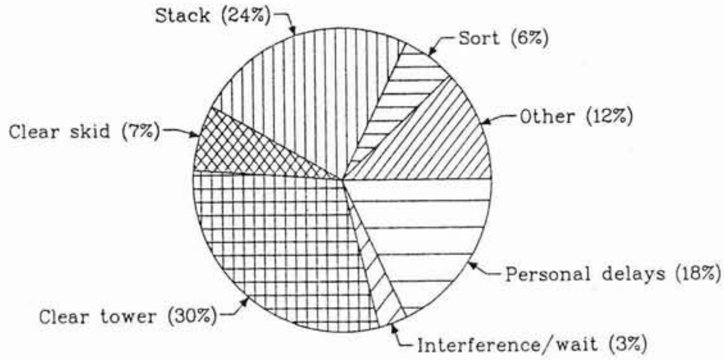

Figure 6 - Time distribution of the Bell Ultralogger

The Bell Ultralogger fleeted (30% of the time), cleared the chute (30%) and also cleared the skid of slash (7%) (Figure 6). By virtue of its importance to landing operations, the Bell's activities clearly took precedence over those of log processing. Only 3% of total time was taken up with interference, this coming mainly from the skid workers. The Bell had virtually no idle time. Twelve percent of total time was spent on other activities such as directing landing operations, personal time and repair and maintenance. Due to the constricted landing, the loader was unable to access all of the processing zone, thus leaving the Bell to sort and stack logs as well as presenting processed logs for the loader to stack. Occasionally, the Bell would present extracted trees or logs for the loader to lay on the runners for processing. This method was used infrequently because of the demands of loading out and the time available for clearing the chute.

Activity sampling data was analysed to determine whether time spent sorting and

Thirty-one percent of the total volume was extracted in partially processed logs. This reduced the total extracted piece size to 1.1m^3 for partial processing. Study results suggest that partially processed log extraction under these conditions, with mean log volumes of 1.1 - 1.3m^3, was more productive than 100% tree length extraction mainly because more pieces per haul were hooked on and hence a larger haul volume was extracted than with tree length extraction.

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stacking and clearing the tower was affected by the percentage of partially processed logs extracted. A correlation was found with time spent clearing the tower. This is probably because more pieces per haul were extracted in log length extraction.

Loader

The loader sorted and stacked (32% of the time) and loaded trucks (23%) (Figure 7). On average, seven trucks a day were loaded each shift. Early morning and evening loadouts were a normal procedure. The loader assisted the Bell to load the runners for processing by the skid workers (2%). Ten percent of the loader's time was spent in interference delay. Over half of this time was due to waiting for logs to sort and stack, with the balance being skid worker interference.

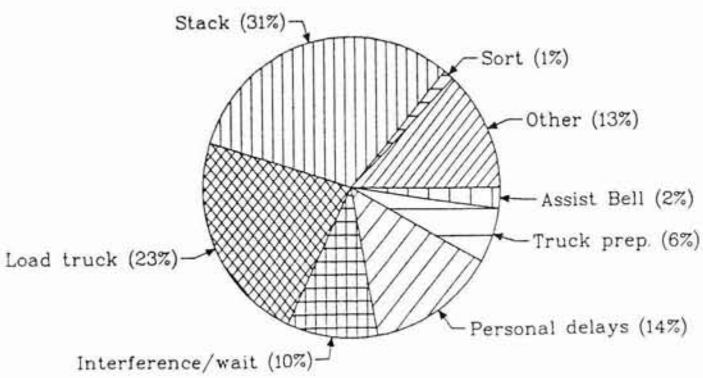

Figure 7 - Time distribution of the loader

COMPARISON OF PARTIALLY PROCESSED LOG EXTRACTION WITH TREE LENGTH EXTRACTION

As the setting was logged, the percentage of logs recovered per day varied as log length processing was discontinued. Time study data was analysed by day and in total. Analysis of the combined data showed that of the 209 hauls, 123 (59%) had at least one partially processed log. Data from 86 hauls which had no cut to length material were compared with the 123 hauls that had at least one partially processed log. T tests of significance showed significant differences for haul volumes and delays due to the Bell. Delays were longer and haul volumes smaller when extracting tree lengths. This finding was confirmed when data was analysed by day. No significant differences were found for hook on, unhook and inhaul.

Since the percentage of logs recovered varied with time, time study data was also analysed on a daily basis. The largest difference in percentage of logs partially processed occurred on days 2 and 4. (Table 4). Inhaul and outhaul times contributing to delay free cycle times in Table 4 have been standardised at 120 metres haul distance to facilitate a daily comparison.

Variation in haul size, and extracted piece size is evident together with percentage of log lengths recovered. Testing of data showed there was no significant difference between mean piece size on days 2 and 4.

There were significant differences between haul volumes and number of pieces per haul. It appears that mean extracted piece size was not significantly reduced with partial processing, more pieces per haul were hooked on and consequently larger hauls were extracted on day 2 than on day 4. This resulted in a 17% increase in hourly productivity.

	DAY 2 52 Cycles	$\pm$ 95% Confidence limits	DAY 4 48 Cycles	$\pm$ 95% Confidence limits
DELAY FREE CYCLE TIME (min)	6.70	-	6.58	-
MEAN EXTRACTED PIECE SIZE (m^3)	1.12	0.13	1.29	0.18
NO. OF PIECES PER HAUL	3.9	0.38	2.9	0.32
MEAN HAUL VOLUME (m^3)	4.37	0.40	3.74	0.42
PERCENT LOG LENGTHS EXTRACTED	43	-	6	-
PRODUCTIVITY (m^3/PMH)	41	-	35	-

Table 4 - Daily time study and volume data from day 2 and day 4

CONCLUSIONS

Under partial log processing conditions, the hauler produced 36m^3/PMH for an average haul distance of 119 metres and an extracted piece size of 1.08m^3. Utilisation for the hauler was 67% and availability was 98%.

Limited partially processed log extraction had an effect on skid activities. Analysis of activity sampling data from skid-based operations showed that less time was devoted to crosscutting and more time to clearing the chute, when a high proportion of pieces extracted had been partially processed on the cutover. Because more pieces were in the chute per haul, more time was spent clearing the chute and transferring extracted pieces to the processing zone. On shorter haul distances, this resulted in delays to the haul cycle. As a consequence, less time was available for the Bell to sort and stack. This led to interference with logmaking activities on the skid.

An alternative may have been to either organise two processing zones or to have found space to stockpile unprocessed extracted material. However, these alternatives may have been impractical on a small landing, given that hauler shifts were necessary and required relocation of the processing zone.