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# A MECHANISED SWING YARDER OPERATION IN NEW ZEALAND

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***ABSTRACT***

*A mechanised cable operation was studied working clearfell radiata pine. The operation consisted of a swing yarder, a stroke boom delimber, and an hydraulic heelboom loader.*

*The operation layout and work method is described, and productivity and utilisation levels are given for the swing yarder and delimber. Activities of the skidworkers and loader were measured and have been summarised.*

*The swing yarder operational delays were found to be the main contributor to the delimber's non-productive time. Both the processing and loading systems were found to have excess capacity, indicating that they were capable of sustaining higher levels of productivity from the swing yarder.*

## INTRODUCTION

During 1991, a mechanised cable operation was set up in Lismore Forest, Wanganui. The operation comprised a swing yarder, stroke delimber, and an hydraulic heelboom loader. The use of a stroke delimber in a cable operation is not new as the concept has been applied in the Pacific Northwest where the high cost of felling and processing prior to extraction has made the option economically viable (Schuh and Kellogg, 1989). Mechanised processing at a New Zealand cable operation becomes an appropriate system where the terrain allows only small landing areas which compromise manual processing.

There are a number of issues which must be considered when mechanising a cable operation in clearfell radiata pine. These include:

- landing organisation and stack placement
- interaction and interference levels between the equipment
- the number of log sorts required
- the crop charactaristics (form, tree size, branching habit).

The objective of this study was to evaluate the system with respect to productivity, utilisation, and interaction between the various landing based operations.

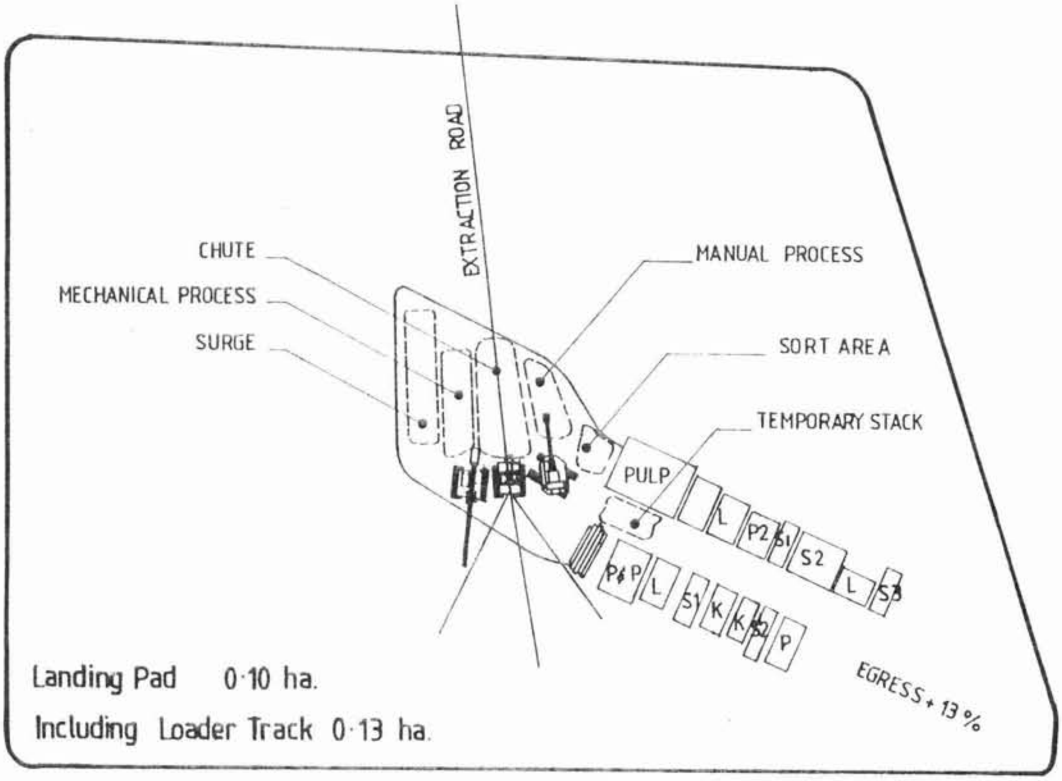


*Figure 1 - Landing organisation*

*ACKNOWLEDGEMENT*

*LIRO acknowledges the co-operation of PND Logging Limited during this study.*

## OPERATION DESCRIPTION

The terrain at Lismore Forest is characterised by sharp spurs 300 to 400 metres apart and space for landings on the spurs was restricted. At the landing studied, the formed pad was 0.1 ha in size (Figure 1). The machinery used at the landing included the Thunderbird TSY 255 swing yarder for extraction, a Thunderbird 736 stroke delimber (using a Denis DM3000 head) for processing, and a Thunderbird 838 (38 tonne) heelboom loader for fleeting and loading.

Placement of machinery on the landing was dictated by the position of the hauler. Ideally the hauler was positioned centrally on the landing, with the delimber located to one side and the loader to the other. Positioning the delimber to the right side of the hauler (facing the setting) gave the delimber operator the best view of the landing activities.

The distribution of labour in the operation included three breaker-outs, three machine operators, two skidworkers, and one man fully dedicated to presetting ropes and blocks for line shifts. Felling for the operation was by two fallers working under sub-contract.

The hauler used a running skyline system with a Danebo mechanical slack pulling carriage and three, eight metre strops to extract material uphill to the landing. The breaker-outs hooked up tree lengths and butt logs which had been cut to length on the flatter ground. As the drags were landed, the hauler slewed far enough to one side to align the wood for the delimber. Trees, which were too large for the delimber to handle, either had their butts removed by the skidworkers, or were cleared away to a separate zone where they were processed manually. The delimber processed the tree lengths, passing them across the chute to the loader which fleeted them into individual stacks. Trucks reversed down the loader track and were loaded from the rear.

## METHOD

Two and a half days continuous time data was collected on the hauler and the delimber, and an activity sample using a 30 second sampling interval was carried out on the loader and the two skidworkers. Drag volumes for the hauler were estimated using a piece count and an average piece volume determined from 100 pieces scaled within the setting. Volume processed by the delimber was estimated by applying a piece count and scaling a sample of trees awaiting processing in the surge area.

## RESULTS

### Swing Yarder

During the study, 165 cycles were timed over a 26 hour period. The delay free cycle time was 6.34 minutes for an average distance of 233m and haul volume of 4.15m$^3$. The hauler utilisation for this short duration study was 67% and availability was 99.8% (Table1).

Hourly productivity was 26.35 m$^3$/scheduled machine hour (SMH). The crew worked on average 10.3 hours/day giving a daily production of 271m$^3$.

Times for carriage outhaul and inhaul were modelled using regression analysis. The equations are given below.

*Outhaul time (min)* = 0.353 + 0.002 x *Haul distance (m)* ($r^2 = 0.59$)

*Inhaul time (min)* = 0.237 + 0.004 x *Haul distance (m)* + 0.027 x *Lateral distance (m)* + 0.058 x *Drag volume (m$^3$)* ($r^2 = 0.52$)

Delays to the hauler made up 33% (8.45 hours) of the total study time. Of this,

*Table 1 - Cycle time data for swing yarder*

| Element (n=165) | Time (minutes) | Range (±)* |
|---|---|---|
| Raise Rigging | 0.24 | 0.03 |
| Outhaul | 0.88 | 0.04 |
| Walk in | 0.08 | |
| Untangle | 0.54 | 0.06 |
| Pull Slack | (15.5metres) 0.48 | 0.04 |
| Hook on trees | (2.9pieces) 1.09 | 0.10 |
| Walk out | 0.39 | 0.03 |
| Total Hooking time | (4.15m$^3$) 2.58 | 0.15 |
| Break-out | 0.62 | 0.04 |
| Haul in | (233metres) 1.28 | 0.08 |
| Drop | 0.21 | 0.01 |
| Unhook | 0.53 | 0.03 |
| Delay Free Cycle time | 6.34 | 0.26 |
| Operational Delays | 2.44 | |
| Personal Delays | 0.66 | |
| Mechanical Delays | 0.01 | |
| Total Cycle time | 9.45 | |

* Range for the 95% confidence interval.

personal delays made up 22%, operational delays comprised 78% and mechanical delays totalled less than 1%.

Analysis of the operational delays showed that splicing delays were the major component. These delays were due to a mainrope failure requiring a long splice and the daily necessity of resplicing the eye of the dropline. This was the result of poor deflection close to the landing combined with attaching too many pieces at the start of a new extraction road causing fouled drags and overloading the ropes. The operator noted that, under average conditions, the eye of the dropline may be expected to last up to one week.

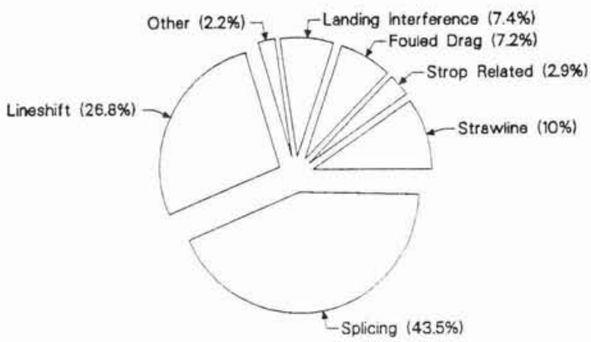


*Figure 2 - Swing yarder operational delays*

Three lineshifts were made during the study and these made up 28% of the operational delay time (Figure 2). Blocks were preset for lineshifts. The 10% strawline delay arose from sending bundles of strawline (for presetting) out on the rigging. Strop related delays arose from changing the numbers or lengths of strops used.

**Delimber**

The delimber was positioned on the landing within two metres of the hauler. Tree lengths were picked out of the chute, measured with the front knives open giving a partial delimb, and the first log was cut off. Once cut, the log length would be repeatedly delimbed, a process involving dropping the log and turning it in the knives to complete the job. The log was then put in front of the hauler for the loader to stack, and the process repeated to complete the tree.

During the study, 242 trees were processed over a 13.2 hour period (Table 2). The total cycle time per tree was 3.28 minutes translating to a production rate of 18.3 trees/SMH, or 28.2 trees/productive machine hour (PMH). On average, 2.0 logs were processed from each tree length. The mean tree size processed by the delimber was 1.53m$^3$ (over bark) which gave a productivity of 27.5m$^3$/SMH, 43.1 m$^3$/PMH.

Utilisation of the delimber during the study was 65%. Processing logs took 52.4% of the total time. Clearing the tower made up a further 7.9% and sorting and stacking made up the balancing 4.7% of productive time.

Delays to the delimber made up 35% of the total study time. The three categories of delay were; operational, mechanical, and personal delay. The most significant delay was operational delay contributing 25% of the total time. The primary cause of operational delay was the delimber

*Table 2 - Time data for delimber*

| Element (242 cycles) | Mean time per cycle (minutes) | % | 95% Conf.limits |
|---|---|---|---|
| Process<br>Clear tower<br>Sort<br>Stack | 1.72<br>0.26<br>0.02<br>0.13 | 52.4<br>7.9<br>0.7<br>4.0 | 0.17<br>0.12<br>0.02<br>0.08 |
| Sub-total | 2.13 | 65.0 | 2.0 processed logs per cycle |
| Delays :<br>Operational<br>Mechanical<br>Personal | <br>0.85<br>0.21<br>0.09 | <br>25.9<br>6.4<br>2.7 | |
| Sub-total | 1.15 | 100 | |
| Total | 3.28 min./tree | | |

waiting for wood, mostly during the lineshifts, and splicing delays. Mechanical delays were 6.4% of the total time, which was due to saw chain or bar related delays, and one incident of a blown hose. Personal delays made up 2.7% of the total time. Breaks were taken sporadically as the operation allowed.

Owing to the different study time intervals for the hauler and delimber, it is difficult to compare their productivity and utilisation. Production of the delimber, however, was limited by the necessity to wait for wood during lineshift and splicing delays. This suggested the delimber was under-utilised for the haulers' observed production. Under conditions of greater productivity by the hauler, the delimber could utilise the adjacent surge area to store unprocessed trees for processing during normal hauler delays (Figure 1). The separate manual processing area also gives further flexibility to deal with surges in production.

**Skidworkers**

The primary tasks of the two skidworkers were to unhook incoming drags, remove slovens, and cut butt logs from the larger tree lengths for the delimber. The skidworkers also fully processed some tree lengths in a separate processing area. Only one day of study data was collected for the skidworkers and loader owing to the presence of the fallers assisting at the skid at other times.

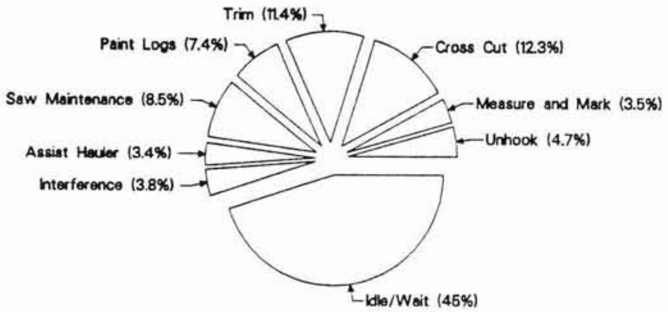


*Figure 3 - Average times for skidworkers*

Averaged time values for the skidworkers showed productive work accounted for 39.3% of the study time (Figure 3). Non-productive time made up the balance of 60.7% of which a high proportion (45%) was spent idle or waiting for wood. The low utilisation and high waiting time suggests that at this level of production, one skidworker may have been adequate at the landing.

## Loader

Sampling of the loader operations was confined to when there were two skidworkers on the landing. Personal delays were not included in the activity sample.

The primary task of the loader was to clear processed logs away from the chute area. This component took the greatest proportion (30.8%) of the study time (Figure 4). Processed logs were fleeted either to the sort area or a temporary stockpile before being cleared to their individual stacks. This took 24.8% of the time. Using the temporary stockpile helped reduce the amount of walking the loader had to do. Trucks were loaded from the rear, their trailer units being placed to one side on the stacks. Utilisation for the loader was 73.2%.

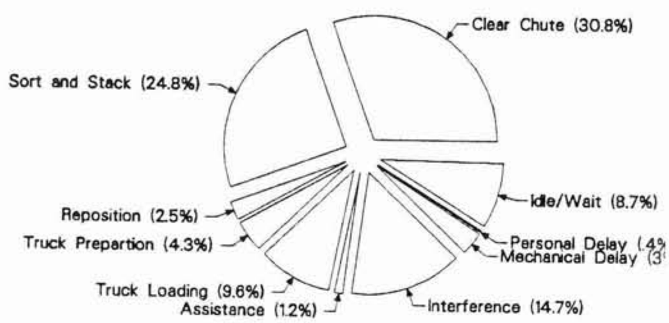


*Figure 4 - Loader time summary*

Interferences to the loader made up 14.7% of the time and arose mainly from the skidworkers as they worked in, and moved between, the chute area and their safe position behind the hauler. Small amounts of time were taken assisting skidworkers (1.2%), and several short mechanical delays were noted (3%). The loader had 8.7% of the time waiting for wood suggesting some excess capacity.

## COSTING

*Table 3 - Summary of Costs*

| Cost Centre | Daily Cost ($/day) |
|---|---|
| Hauler | 1,456 |
| Stroke delimber | 623 |
| Heelboom Loader | 785 |
| Operating Supplies | 190 |
| Vehicles | 92 |
| Labour | 1,801 |
| Overhead (2%) | 99 |
| Profit (10%) | 494 |
| Total | $ 5,540 |

Using the LIRA costing format (Wells, 1981), an indicative costing is presented based on a new Thunderbird TSY 255 yarder, a Denis stroke delimber, a 38 tonne knuckleboom loader, and eleven men (including fallers). The daily cost for this operation including operating supplies, overheads and profit was \$5,540/day (Table 3).

## CONCLUSIONS

The swing yarder had a utilisation of 67% and produced 26.3m$^3$/SMH for an average haul distance of 233m and drag volume of 4.15m$^3$. Delimber utilisation and productivity were 65% and 27.5m$^3$/hour respectively. Productivity and utilisation of the delimber were limited by the hauler's non-productive time, suggesting the delimber could sustain higher levels of production.

The two skidworkers on the landing were found to be significantly under-utilised at the observed level of production. Interferences to the loader were primarily due to skidworkers interference as they crossed the landing between the hauler and the chute area. The loader had some excess capacity which, in light of the excess capacity for both the skidworkers and the delimber, suggests the processing system could cope with higher production levels.

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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 only an indicative estimate and do not necessarily represent the actual costs for this operation.*

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