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THE BELLIS HAULER

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ABSTRACT

The Bellis Hauler is the most recent New Zealand designed and built hauler. It was studied working in a stand of 29 year old radiata pine at Golden Downs Forest in the Nelson region. A continuous time and motion study was carried out and a total of 299 full cycles were recorded with a sample of 70 cycles being scaled for volume.

The hauler was pulling whole trees downhill on easy terrain over an average distance of 242m. Daily production was estimated at 230m^3. Haul distance was found to be the best estimator for inhaul and outhaul times. Neither the drag volume nor the number of pieces hooked on were found to have any significant influence on net cycle time.

The landing operations were studied using an activity sampling method. The results showed an even distribution of workload between the skidworkers and a low proportion of idle time for the loader.

INTRODUCTION

In the 1980s there were few New Zealand built haulers with the flexibility of the popular integral spar five drum haulers available from the United States. One enterprising Nelson contractor had a four drum hauler designed and built to his own specifications incorporating an integral spar and better brakes than previously available on New Zealand machines. Bellis haulers are built at Brightwater Engineering in Nelson. There are currently two Bellis haulers commissioned and working in the Nelson area.

Figure 1 - Bellis Hauler working in Golden Downs Forest

A study was undertaken in May 1991 with the objective to document a machine of potential future interest to the New Zealand logging industry.

ACKNOWLEDGEMENT

LIRO acknowledges Tasman Forestry Limited and Zeke Bellis for their assistance with this study.

HAULER SPECIFICATIONS

The hauler is trailer mounted driven by a CAT 3306T 200kW (265hp) engine with an Allison CRT5331 automatic transmission. All clutch, brake and engine controls are activated by low pressure air. The transmission uses multi disk clutches and braking to the main and tail drums is by Wichita water cooled brakes. The tubular steel tower has a height of 19.8m (65 feet) to the skyline sheave and is raised using rope blocks powered by the mainline winch. Line diameters and capacities for the winch drums are shown in Table 1.

Drum	Line Diameter (mm)	Line Capacity (m)
Mainline	25	600
Tailrope	16	900
Skyline	32	600
Strawline	10	500

Table 1 - Drum Capacities for the Bellis Hauler

METHOD

A continuous time and motion study was carried out on the hauler using defined elements of the extraction cycle (Table 2). The number of whole trees and pieces were recorded for each drag as was the haul distance. A sample of drags was scaled to quantify production and the effect of drag volume on cycle time. The landing operations of the loader and skiddies were measured by activity sampling. Crew job allocation and landing layout were documented.

STUDY AREA

The study was carried out in Compartment 130 of Tasman Forestry Limited's Golden Downs Forest. The setting boundary ran from the landing up a spur road to the main ridge and down an adjacent spur. This gave a downhill concave profile with a chordslope of 2.5 degrees and a maximum horizontal distance of 374m. The stand comprised 29 year old radiata pine with 359 stems/ha and 683.5 m^3/ha. Extracted tree size was estimated at 1.75m^3 (Tasman Forestry Limited inventory records).

Element	Time per Cycle (min)	Range (±)[a]
(n=299)		
Raise Rigging	0.18	0.01
Outhaul	0.56	0.01
Position	0.09	0.01
Hook on	1.02(1.9pieces)	0.04
Breakout	0.29	0.02
Inhaul	1.10(242metres)	0.04
Unhook	0.36	0.04
Delay Free Total	3.60 (sd*=0.88)	0.10
Delays:		
Mechanical	0.02	
Operational	0.50	
Personal	0.54	
Total Cycle Time	4.66	

[a]Range for the 95% Confidence Interval.
*sd = standard deviation.

Table 2 - Summary of Cycle Times

RESULTS AND DISCUSSION

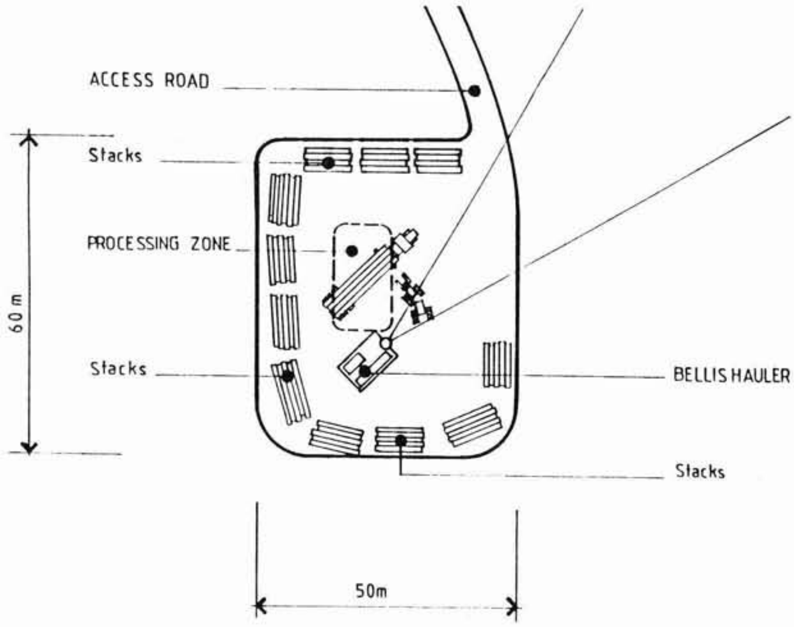

Figure 2 - Landing Layout for the Bellis Hauler

OPERATION LAYOUT

The landing covered an area of 0.3ha, a standard size for a spur landing in Golden Downs Forest (Figure 2). The skyline was anchored to tail trees for the first two skyline roads, then was transferred to the Cat D6 mobile tailhold. Two breakerouts hooked up the trees which were hauled downhill using a Northbend system. Sorting was carried out by a CAT 950 wheeled loader which pulled trees away from under the ropes and spread them out in a processing area. Three skiddies trimmed and cut the trees to length which were sorted into eight log sorts. The logs were then stacked around the perimeter of the landing. Trucks were loaded on the processing area which was cleared prior to their arrival.

WORK CYCLE SUMMARY

During the study 299 cycles were recorded over three days. From the 299 drags, 70 were scaled for drag volume upon arrival at the landing. Hooking up the logs and hauling them in were the largest contributors to the delay free cycle time at 1.02 minutes and 1.10 minutes respectively (Table 2). Hook on times were fast and regular reflecting good wood presentation and the use of two breakerouts.

No reliable model could be developed for delay free cycle time. Equations for the outhaul and inhaul phases are shown below. Evaluation of the 70 scaled cycles showed neither drag volume nor the number of pieces hooked on had any significant influence on inhaul time. Haul distance was found to be the best parameter for estimating the extraction element of the cycle.

Equation 1 :

Outhaul time (min) =

0.133 + 0.0017 x Distance (m)

(r^2 = 0.58)

Equation 2 :

Inhaul time (min) =

0.113 + 0.004 x Distance (m)

(r^2 = 0.63)

The contractor stated his preference for achieving production by fast light drags which he had found reduced wear on the lines and machine. This may explain why drag volume was found to have no significant influence on inhaul times.

Hourly productivity including all delays was 28.8m^3/scheduled machine hour (SMH) (Table 3.). Based on an 8 hour day this

Pieces per cycle	1.90
Volume per peice	1.19m^3
Average drag volume	2.24m^3
Productivity	28.8m^3/SMH*

Table 3 - Productivity Information

gives a daily production of 230m^3. This result is in accordance with production levels of the more productive crews currently working in New Zealand (Robinson, 1991). Only one mechanical delay was recorded giving a machine availability of 99.6%. Utilisation with no landing shifts and three line shifts was calculated as 77.3% which is high when compared with an average of 63% for long term machine utilisation (McConchie,1989). This is not surprising given the short duration of this study.

DELAY ANALYSIS

During the study delays accounted for 22.7% (5.26hours) of the total time. Of this, smoko breaks took 50.3% of total delay time. Mechanical delays were very low representing 2.4% and operational delays made up the balance of 47.3%.

Further analysis of the operational delay times indicates the specific areas where delays occurred (Figure 3). Skyline shifts took a major proportion of the operational delays. Block shifts arose from bridling the first part of the setting using a Caterpillar D6 as a mobile tailhold. Fouling of the carriage often occurred during the bridling phase when it became bound on high stumps at the road edge. This problem could have been alleviated by keeping these stumps low during the falling of the stand.

The soft landing brought about a number of early delays as the hauler settled and the guy lines required retensioning.

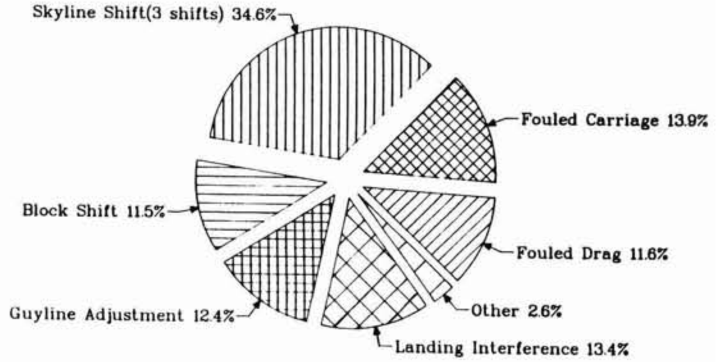

Figure 3 - Summary of Operational Delays

Landing interferences made significant contribution to the operational delays at 13.4%. These delays included interferences from the loader carrying out skid maintenance work. Although these interferences were often short they had a cumulative effect. The second source of landing interference arose from load-outs carried out during the shift. Access of trucks to the landing caused delays to the hauler due to the placement of the skyline and tailrope across the road and the limited turning space available on the landing. As a result, most load-outs took place in the early morning. Road placement and landing orientation were considered to be the main cause of these delays. This was to some extent unavoidable due to the terrain constraints. In an ideal situation where rigging changes are the only source of operational delay production would increase by 4.3% or 9.1m^3/day (Table 4).

Source of Delay	Equivalent Production (m^3/day)
Fouled Carriage	3.3
Fouled Drag	2.7
Landing	3.1
TOTAL	9.1

Table 4 - Potential Production Gains

LANDING ANALYSIS

Activity sampling of the loader shows a machine availability of 99.3% with utilisation of 76%. The activity sample for the loader covers the operational time, excluding smokos (Figure 4). The loader frequently started work two to three hours prior to the crews arrival. This time was used to load out trucks from the landing in a cold deck situation. The loader spent only 0.9% of in-shift time loading trucks. Other studies have found that a wheeled loader undertaking early morning load-outs spends 33% of in-shift time loading trucks (Murphy, 1978). The low idle time of 7.7% suggests that it may not have had the ability to keep up with production and load trucks had they been scheduled in-shift.

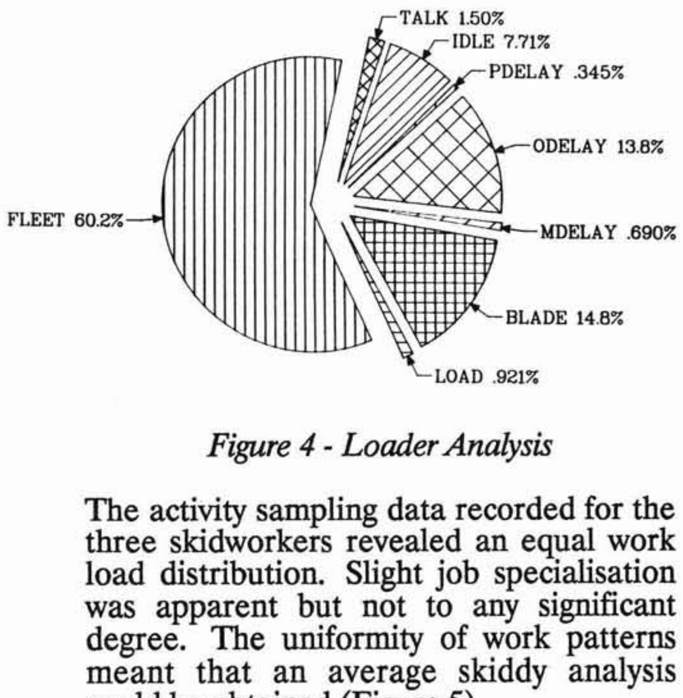

Figure 4 - Loader Analysis

The activity sampling data recorded for the three skidworkers revealed an equal work load distribution. Slight job specialisation was apparent but not to any significant degree. The uniformity of work patterns meant that an average skiddy analysis could be obtained (Figure 5).

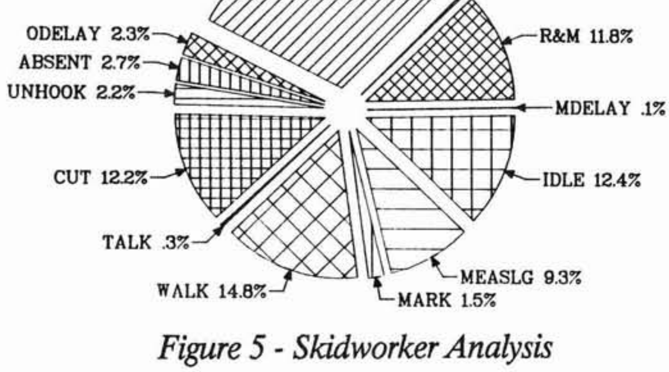

Figure 5 - Skidworker Analysis

The average operational delay of 2.2% consists mainly of loader and truck interference due to the congested nature of the landing. The average idle time for the skidworkers was 12.4% and arose from the loader leaving the landing to assist trucks departure. The result being drag accumulation under the ropes preventing full processing until the return of the loader. Log cutting and trimming accounted for 42.2% of the skiddies time.

The layout of the landing meant that skiddies returned to a safe area next to the hauler after processing each drag. As a result travel between these two areas (walk) was the second highest occupier of time at 14.8%. Interference from the skiddies to the loader accounted for most of the loader's operational delay time (Figure 5).

COSTS

An indicative costing for the hauler, nine men, a wheeled loader,and a mobile back anchor was carried out using the LIRA costing format (Wells, 1981). The resulting daily cost including overheads, profit, and operating supplies totalled $2,781 per 8 hour day (Table 5).

Cost Centre	Daily Cost ($/day)
Hauler	809
Loader	422
Tractor	113
Labour	972
Operational Supplies	163
Overhead (2½%)	49
Profit (10%)	253
TOTAL	2781

Table 5 - Summary of Costs

CONCLUSIONS

The Bellis Hauler achieved a daily production of 230m^3 for an average haul distance of 242m and drag volume of 2.24m^3. Drag volume and the number of pieces hooked on per drag did not have any influence on the inhaul phase of cycle time. This was likely due to the downhill setting and the adherence to light drags for fast cycle times. Availability and utilisation were both high at 99.6% and 77.3%. Operational delays accounted for 47% of delay time and although made up mostly of expected rigging adjustments there were some areas where improvements could have been made.

The landing conditions made it necessary to load out trucks before work start. The loader was well utilised with only 7.7% in-shift operational time spent idle. Had trucks been scheduled only during the shift, the loader may not have been able to keep up with production. There was an even workload distribution between the skid workers.

As a New Zealand designed and built machine the Bellis hauler has shown itself to be a competitive machine in terms of both cost and production when compared with similarly powered machines working in New Zealand today.

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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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