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WOOD TRANSPORT USING A A LONG REACH SKYLINE

David Robinson

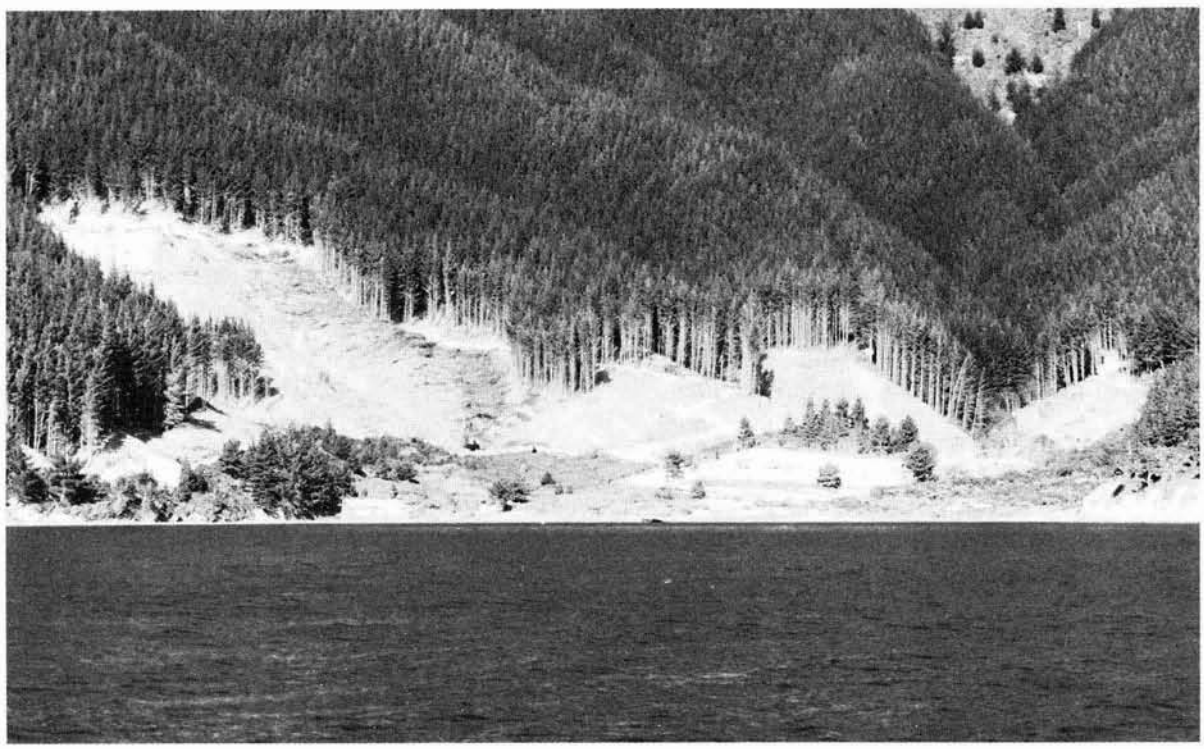

Figure 1 - A view of the study site at Onepua Bay, Marlborough Sounds

ABSTRACT

Two standing skylines rigged 20m apart were used for transporting wood extracted by a swing yarder from an environmentally sensitive site. The system was studied under three methods of operation: tree length and log length transportation for a single working skyline and log length transport for two skylines working together.

Time study data yielded skyline transport productivities for the different methods of operation. Activity sampling data indicated the effect of changing work method on skid worker activities at the processing deck from which the wood was transported. A cost appraisal of the operation was made.

INTRODUCTION

European multispan skyline systems have a number of inherent advantages over conventional New Zealand cable logging systems. These include their low capital cost, long reach capability, ability to work over broken and convex terrain, and their potential to minimise soil disturbance through full suspension of log lengths.

The multispan system concept has been in New Zealand since the 1950s but has not gained wide acceptance as an efficient clearfell logging method. Capital cost of the small sled-mounted single drum units is low when compared with the increasingly popular five drum mobile haulers, but several reasons have precluded their acceptance by the logging industry. These factors include their low daily productivity and comparatively high rigging and set up time per unit volume logged. New Zealand forests also generally have a well developed infrastructure of roads making them well suited to mobile integral towered haulers.

Notwithstanding the above, multispan has some potential as a transport system for situations where conventional hauler systems may be required, but the cost of a road suitable for logging trucks prohibits the profitable clearfelling of the stand. This is most likely to arise in the logging of woodlots and small forests located far from a road or on sites too sensitive for roading. Such a situation occurred in the proposal to log a 138 ha woodlot at Onepua Bay in the Marlborough Sounds (Figure 1). Transport alternatives were either to build a new road to the highway 5km away, or to barge the wood to a nearby port, which was the preferred method. The terrain was steep with a constant slope averaging 30° (58%) and a maximum distance to the proposed barging point of 1.25km. The logging system comprised: a swing yarder pulling tree lengths to appropriately placed mid-slope tracks, two staging to a small deck where the trees were partially processed, and transport by either single, or multispan standing skylines, to a lower deck and barging point.

In 1993, LIRO undertook a study of this transport system with the objective of describing the system, measuring the productivity and characterising the skid worker activities at the processing decks.

ACKNOWLEDGEMENTS

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OPERATION DESCRIPTION

Tree lengths were extracted downhill by a Washington 88 swing yarder located on a mid-slope track 400m from the cableway processing deck. A Timberjack 450C grapple skidder two staged trees to the processing deck. Due to a grapple failure, the skidder was operated as a rope machine for the first day, and was used with the grapple for the rest of the study.

Trees were processed into log lengths at the upper deck by three skid workers. The first skid worker was mostly dedicated to log making whilst the second delimbed and crosscut. The third skid worker hooked up loads for the skyline, aiming to achieve an optimum payload of 3 m^3/load.

Two standing skylines were rigged approximately 20m apart on either side of the processing deck which was 0.1 ha in size and located on a widened section of the track. The skylines were single spans rigged through radiata spar trees. One of these was a standing tree which had been topped and the other was a large tree which had been felled, brought to the deck and stood up due to the absence of any other suitable trees. Each 28mm skyline

Figure 2 - The Gantner HSW80 winch unit

was operated by a single drum Gantner HSW80 winch unit using 12 mm mainrope (Figure 2). An hydraulic clamping Koller 2.5 tonne manual slackpulling carriage was used on the skyline and wood was transported fully suspended through a span of 650m to the lower deck; the descent was controlled by a fan brake at the winch.The size of the paddles on the fan brake could be changed to dictate the speed at which the load travelled down the skyline and hence cycle time.

Under a normal production situation only one of the Gantners was operated. However, during surges in production, the second Gantner was used to avoid the deck becoming a bottleneck to production from the Washington 88. Wood was transported mainly in log lengths, although a short trial using tree length transportation was undertaken to assess the effect on skyline loadings.

At the lower deck, two skid workers unhooked the loads and completed the processing. A Cat 936 wheeled loader fleeted the logs firstly to a processing area and then into stacks and on to the barge for transport to the port at Picton.

METHOD

Production data were gathered using the LIRO remote tension monitors to collect skyline tension data from which peak tensions were derived for each cycle. A sample of 10 loads was scaled and then correlated by linear regression with the peak tensions for their corresponding loads. Gross cycle time and the terminal time for the carriage at the upper deck were measured by stopwatch. A count was made of the number of pieces transported per load.

Activity sampling data were collected at one minute intervals for each of the skid workers at the upper and lower decks and for the loader working on the lower deck. Gross cycle time data were collected for the skidder which was supplying the upper deck with tree lengths from the Washington 88 swing yarder.

RESULTS

The landing area at the swing yarder was beneath live ropes and sited on the track. Drags for the skidder had to be accumulated when it was safe to work within this zone. Gross cycle time data for the skidder was collected at the processing deck for each of the two methods used during the study (Table 1). A 3.4 minute reduction in cycle time was observed between using the skidder as a cable machine and as a grapple.

During the study, 100 loads were timed for a single working Gantner, and a further 21 loads were timed for two Gantners working together (Table 2). Cycle time data includes operational and mechanical delays, although only minor delays were observed during the study. Personal delays were not included. The carriage time at the upper deck was a combination of waiting time for a load to accumulate and the time to hook on the load. For a single working Gantner

Table 1 - Skidder cycle time

Work method	*Cycle time (min ± 95% confidence interval)*	*Significant difference (Two sample t test; p<0.1)*
Cable skidder	16.8 ± 2.9	Yes
Grapple skidder	13.4 ± 2.7	

Table 2 - Summary data from Gantner time study

	Single Gantner Log length	Single Gantner Tree length	Two Gantners Log length
Mean cycle time (min)	10.4 ± 1.4[a] (87)[b]	9.5 ± 2.2 (13)	8.4 ± 0.5 (21)
Carriage time at upper deck (min)	3.9 ± 1.0 (86)	4.2 ± 4.1 (13)	2.6 ± 0.4 (20)
Mean number of pieces transported per cycle	4.9 ± 0.5 (32)	2.8 ± 0.7 (12)	4.1 ± 0.9 (20)
Mean load volume (m^3)	2.5 ± 0.1 (85)	2.3 ± 0.2 (9)	2.2 ± 0.1 (10)
Production per Gantner (m^3/SMH)	14.4	14.5	15.7

[a]The error term is the 95%confidence interval for the mean.
[b]Numbers in brackets represent the number of observations.

transporting log lengths, the average cycle time was 10.4 minutes with an average load volume of 2.5m^3 from 4.9 pieces. Hourly productivity was estimated at 14.4 m^3/ scheduled machine hour (SMH) which equates to 94 m^3/6.5 machine hour day.

Time, piece and volume data were compared for the different methods (Table 3). The operation method was briefly changed from log length to tree length transport to see if there was a change in production. No significant change in overall cycle time or carriage waiting time was observed. The number of pieces hooked per load decreased by 43% as would be expected when transporting larger pieces. Load volume also decreased by 9% and this was due to the difficulty in getting the optimum payload from larger pieces. Productivity change between the systems was less than 3%.

A change from one Gantner to two during surges in production from the swing yarder saw an 18% decrease in cycle time from 10.4 minutes to 8.5 minutes. Carriage time at the upper deck also

Table 3 - Testing means for significant differences

Method Changes tested	Significant Difference (Two sample *t* test; $p<0.05$)	Percent change (where significant)
Log length vs Tree Length:		
Cycle time	No	-
Carriage time at upper deck	No	-
Number of pieces	Yes	42.6% decrease
Load volume	Yes	9.2% decrease
One Gantner vs Two Gantners:		
Cycle time	Yes	18.4% decrease
Carriage time at upper deck	Yes	33.9% decrease
Number of pieces	No	-
Load volume	Yes	10.8% decrease

decreased by 34% and, although load volume decreased by 11%, production increased from 14.4m³/SMH to 15.7 m³/SMH per skyline. Potential system productivity for the two skylines is estimated at 31 m³/SMH or 200m³/6.5 machine hour day.

Activity sampling at the upper deck yielded a total of 1628 observations made over the three skid workers at the upper deck. Observations were grouped into skidder cycle times. For ease of analysis, activity data were combined and summarised to give results as an average skid worker at the deck (Figure 3).

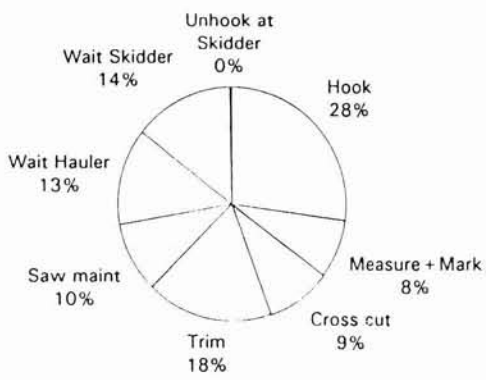

Figure 3 - Skid worker activities at the upper deck

Processing trees - a combination of measure and mark, cross cut, and trim - was the main work component on the upper deck at 35%. Hooking on loads was the next largest at 28% of the work. Waiting for work was made up of two components: either for wood to arrive with the skidder, or for the return of the carriage for the next load. These took similar proportions of the time at 14% and 13% respectively.

Skid worker activities were separated by work method into log length, tree length, and two Gantners operation (Figure 4). Comparisons were made between the major time components for each period. A further set of comparisons were made between the skidder operating as a cable machine and as a grapple (Table 4).

Changing from log length to tree length transport saw a number of significant changes to the skid worker activities at the upper deck. Tree length transport reduced the amount of processing required by 31%. Hooking on time increased by 49% with fewer pieces hooked on per load. However, this had no effect on carriage waiting time at the upper deck.

Table 4 - Testing skid worker activity proportions for significant differences

Proportions tested for method changes	Significant Difference (X^2 test; $p < 0.05$)	Percent change (where significant)
Log length vs Tree length:		
Hook load	Yes	49.2% increase
Process trees	Yes	31.4% decrease
Wait for Gantner	Yes	117.5% increase
Wait for wood	No	-
One Gantner vs Two Gantners (log length transport):		
Hook load	Yes	114.9% increase
Process trees	Yes	31.4% decrease
Wait for Gantner	Yes	75.7% increase
Wait for wood	Yes	63.9% decrease
Cable Skidder vs Grapple Skidder (log length transport):		
Hook load	No	-
Process trees	Yes	26.2% increase
Wait for Gantner	No	-
Wait for wood	Yes	30.7% decrease

The minimal change in production between the two systems was due to a lack of wood arriving from the swing yarder. In this case, total system production was limited by primary extraction. The increase in hooking on time could be explained by a reduced pressure to produce. The 117% increase in time waiting for the Gantner suggests that the upper deck was working below capacity and that production could have been sustained with fewer men.

When the system was operated with two Gantners, the largest activity change was the 115% increase in hooking on time even though the cycle time for the Gantner decreased. This increase was sustained by the assistance of a second skid worker and, although load volumes decreased slightly, the number of pieces per load remained the same. A 64% decrease in time waiting for wood indicates that plenty of wood was available at the deck due to the surge in production from the skidder. The 31% reduction in processing time was possibly due to the substitution of processing with hooking up. The 75% increase in waiting time for the skylines suggests that during surges in production from the swing yarder, the productivity of the total system became limited by the Gantners.

The change from cable skidder to grapple skidder saw no significant change in elements related to the Gantner (hook on trees, wait for Gantner). However, the skidder related "waiting for wood" element decreased by 30% suggesting some relationship with the reduced cycle time. The proportion of time processing trees increased by 26% suggesting an increase in processing capacity at the deck when the skidder operated with the grapple.

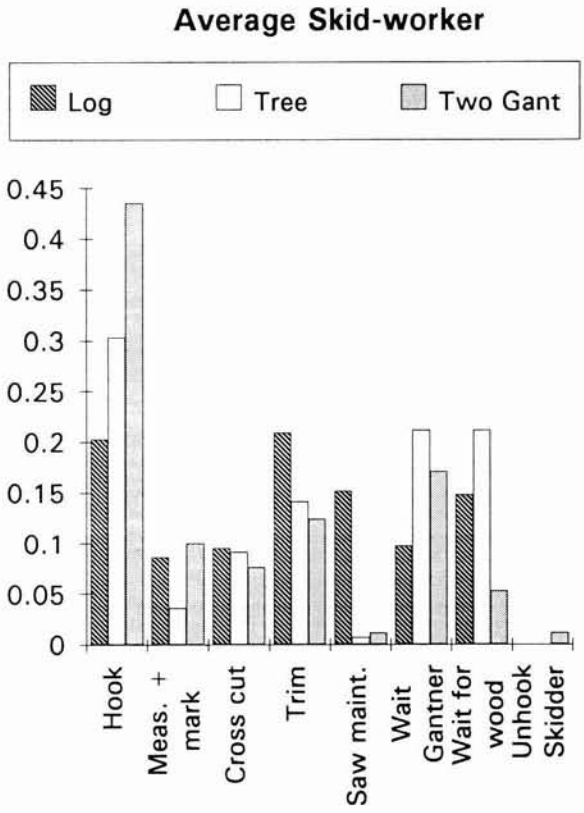

Figure 4 - Skid worker activities by work method

The activity sample of the two skid workers at the lower deck yielded a total of 1796 observations. The primary task of these men was to complete the processing of wood from the upper deck. These activities included further measurement, trimming, and cross cutting of logs which occupied 56% of their delay free time (Figure 5). Unhooking logs took 14% of the time, and 17% of the time the lower deck skid workers were waiting for wood. The lower deck did not appear to cause any restrictions on the wood flow through the system, and as such was not analysed in any great detail.

TRANSPORTATION COSTS

The daily cost of the transport system was estimated using the LIRO costing format (Wells, 1981). Included in the costing were two Gantner HSW 80 units with

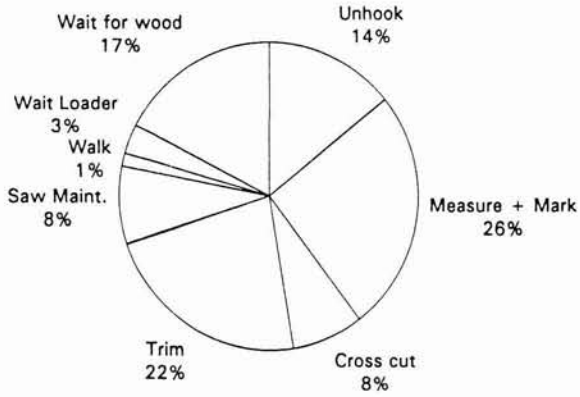

Figure 5 - Skid worker activities at the lower deck

1500 metres of reach capability, two operators, two chainsaws, and one and a half men for hooking on and unhooking loads. Operating supplies and transport were not included as these would be carried by the full operation. The estimated daily cost for the operation including a 10% return for management and risk was $1, 320 (Table 5).

Table 5 - Summary of costs

Cost Centre	Cost per day ($ / 6.5 machine hours)
Two Gantner skylines	704
Two chainsaws	32
Four men	464
Management and risk	120
Total	$1,320

SUMMARY

The productivity of the transport skyline varied from 14 m^3/SMH for one Gantner to 31 m^3/SMH for two Gantners operating together. Sample sizes were not large for the tree length and two Gantner work methods but results give an indication of the productive capability of a transport skyline of this configuration. A number of other factors will impact on the system productivity. These include the total span and the chord slope over which material is to be transported. The system is also

capable of pulling material uphill and, although this was not measured, it is expected that productivity would be significantly lower owing to the carriage speed relying on the power and line speed of the machine.

Attaining the maximum cost/m^3 efficiency out of a transport system of this type will be determined by a number of factors. Perhaps the most important factor is balancing the productive capacities of each machine working in the system to avoid becoming over capitalised. Secondly, identification of potential bottlenecks within the total system and their alleviation through carefully distributed labour should ensure minimum wood flow disruption. During this short duration study, it was apparent that there were occasions when there was more manpower than necessary at the upper deck. Under the circumstances, this was justified owing to the fluctuating production from the swing yarder which should not be disrupted by operations further along the system.

This skyline system appears suited to situations where access from a road or transport network is limited and expensive. Wood transported in log form is fully suspended which reduces impact of the system on the environment, a relevant consideration in deciding an appropriate transportation system when other options are available.

BIBLIOGRAPHY

Bloomberg M.J., Liley. W.B., (1985) : "The Wyssen Hauler". In Limited Scale Logging Seminar Proceedings. LIRO.

Chundra R., (1982) : "Transport Planning and Operational Activities Under Steep Mountainous Conditions in Developing Countries". In Planning and Technique of Transportation and its Relation to Operational Activities in Forestry. IUFRO.

Drummond S., (1989) : "Multispan Skylines". In Cable Logging Seminar Proceedings. LIRO.

Hensel W.A., Leonard R.J., (1979) : "Operating Characteristics and Production Capabilities of the Wyssen Skyline System" . A.S.A.E, Vol. 22 No. 4.

Hughes J., (1991). "The Wyssen Logging Trial at Rai Valley - Jan/Feb 1991". N.Z. Tree Grower. August.

Liley W.B., (1985) : "An Aerial View of the Small Scale Forest Resource". In Limited Scale Logging Seminar Proceedings. LIRO.

Liley W.B., (1985) : "The Small Scale Forest Resource". In Limited Scale Logging Seminar Proceedings. LIRO.

Larsen W.E., Gonsior M.J, Taylor W.R., (1985). "Cable Forwarding - Proof of Test Facility Design". Council on Forest Engineering. 8th Annual Meeting, Tahoe City.

Malone J., (1985) : "European Long Span Skylines in North America". Council on Forest Engineering. 8th Annual Meeting, Tahoe City.

Myers T., (1986) : "Skyline System Solves Sensitive Soils Logging Problem". Forest Industries, Vol. 16 No. 12.

Ryan C., (1984) : "The Swiss Log Trick". Soil and Water, Vol. 20 No. 3.

Wells, G. (1981) : Costing Handbook for Logging Contractors. LIRA Handbook.

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.
