LOGGING INDUSTRY RESEARCH ASSOCIATION

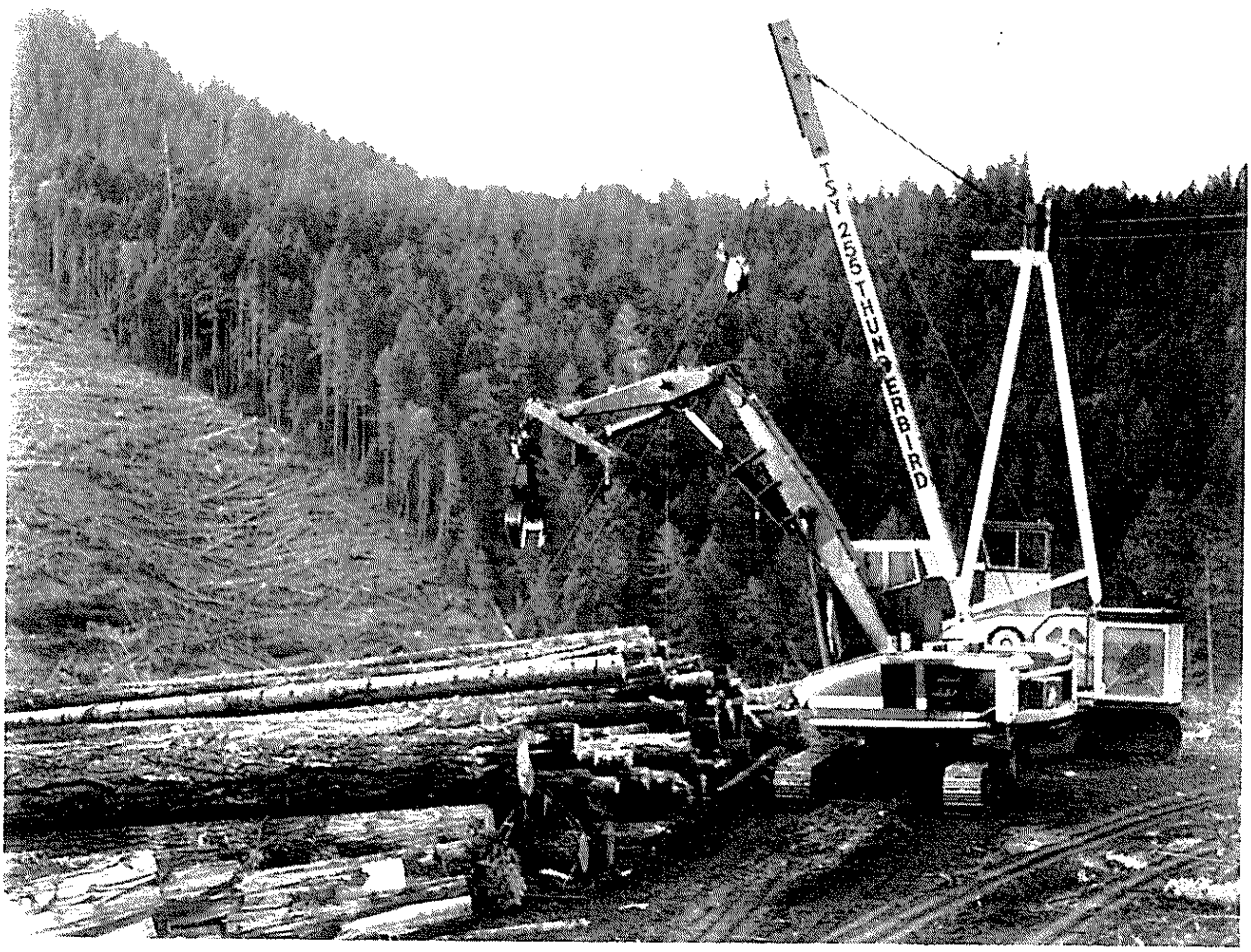
NEW ZEALAND

PROJECT REPORT

A Study Tour of Cable Logging Operations in the Pacific Northwest

JUBILEE SCHOLARSHIP REPORT

ROB PREBBLE



Project Report

P.R.49

New Zealand Logging Industry
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NEW ZEALAND

A Study Tour of Cable Logging Operations in the Pacific Northwest

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P.R. 49 1990

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Research Association (Inc.)
MAY 1990

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ACKNOWLEDGEMENTS

Elders Resources NZFP for funding the tour, Consultant Dallas Hemphill for his assistance in arranging the visits, Contractors Dancer, Hopkes, Jurhs and Whitaker for their cooperation during the studies and Forest companies Weyerhaeuser, Willamette Forest Industries and Roseburg Lumber for allowing the studies to be done in their forests.

ABSTRACT

A study tour of cable logging operations in Oregon, USA is described. Production studies were undertaken on two 21m tower skyline haulers and two swing yarders. With the assistance of hired help, the utilisation of the loader and chasers in each operation was also sampled.

A Thunderbird TMY70 working in the Coastal Oregon area was producing 306m^3 per eight hour shift in a mixed stand of Hemlock and Noble fir. Extraction was in log length and the average extracted piece size was 1.42m^3 which is larger than the expected average log volume from radiata new crop.

The first of the new Madill 171 haulers was studied logging a Douglas fir stand in Northwestern Oregon. Productivity was around 274m^3 per eight hour shift in wood that had an average extracted piece size of .84m^3. The Madill 171 was considered ideally suited to logging New Zealand's new crop resource.

A Madill 122 swing yarder was operating with a scab skyline system in 45 year old Douglas fir. The average extracted piece size was .71m^3 and productivity of approximately 325m^3 was recorded over a nine hour shift. Working the extra hour reduced the unit cost by 7%.

The last machine to be studied was a Thunderbird TSY255 swing yarder working in a mixed stand of 80 year old Douglas fir. The average extracted piece size was 1.05m^3 and productivity per eight hour shift was estimated at 280m^3. Limitations on loader capacity and longer than usual rigging delays lowered overall productivity.

The implications of introducing these new high cost haulers to New Zealand operations is discussed along with some of the subtle differences between New Zealand and Pacific Northwest logging practices. Changes to the traditional methods of handling logs on cable hauler landings are recommended for the successful introduction of these new machines.

Relevant papers from the November 1988 International Mountain Logging and Pacific Northwest Skyline Symposium are reviewed. Items of specific interest are the development of guyline tension monitors, the use of substitute earth anchors and the development of a cable towed vehicle to replace a skyline carriage. Other information on the performance of centrally inflated tyres on trucks, mechanised delimbing at a cable landing and a loss control programme in Montana are described.

INTRODUCTION

The proportion of wood cable logged in New Zealand is expected to increase from its current level of 18%, to between 35 and 44% over the next 15 years (Olsen, 1989; Tustin, 1983). Our industry has neither the equipment or the manpower to meet this increase.

The first reaction of most forest managers when faced with the prospect of having to cable log, is to look around for a cheap secondhand machine that might be able to do the job. Is this the right approach to take? Planning exercises done on some of these new forest areas have indicated that skyline haulers will be the best machines to use. The range of suitable skyline haulers available in New Zealand however is limited.

Loggers are faced with a dilemma. Should they be fitting integral towers onto old skyline haulers designed for independent spars, or should they be buying secondhand 15m tower machines out of the Pacific Northwest? Are secondhand 30m skyline towers a viable option or will we have problems shifting them around and guying them back? Can local manufacturers produce a suitable machine with all of the necessary hardware or should loggers be investing in the new technology 21m tower machines now available?

Payload analysis done from profiles in many of the planning exercises suggest that the higher tower and increased capacities of these 21m tower machines will have significant advantages over the smaller 15m models. Cost calculations done on these options show that on paper, investing in the 21m tower machine would be a paying proposition. The only uncertainty really facing the logger now is whether or not in practical terms this new machine can produce enough extra volume to pay its way.

In 1987 LIRA outlined a five year research program on cable logging and one aspect of that program was to investigate these new 21m tower machines, (scheduled for the year 1990). Industry representatives called for this research to be brought forward in the program and extended to include swing yarders. Application was made for a Jubilee Scholarship(1) to fund the project. The application was successful and in 1988 a study tour was undertaken to the Pacific Northwest of the U.S.

The objectives of the tour were: to document the performance of the new 21m tower haulers and the latest swing yarders operating in the PNW and determine whether they will be suitable for logging P.radiata new crop. Information was also to be collected on machine system capabilities so that loggers can make informed decisions on their machinery requirements.

A secondary purpose of the trip was to attend the International Mountain logging and Pacific Northwest Skyline Symposium held in Portland Oregon (Atkinson & Sessions 1988). A paper was presented to this symposium outlining the challenges in cable logging facing the New Zealand industry (Prebble 1988).

The hauler studies were completed and individual reports have been written on each machine. Comprehensive video coverage was taken of all operations visited and this is available from the LIRA Video Library. This report summarises the results of all the studies, adds details of other items of interest observed during the tour, and makes recommendations for the introduction of 21m tower haulers and swing yarders into New Zealand. A glossary of terms is listed in the back of the report.

STUDY METHOD

For each machine, detailed cycle times were recorded on an electronic data recorder. The number of logs in every drag was counted and an average piece size, derived from the scaled truckloads, was used to establish cycle volumes. Ground profiles were taken prior to each study commencing and these were used to record hauling distances.

Loader and chaser activities were activity sampled concurrently with the hauler studies. The data was collected at 30 second intervals and it included; noting the arrival and departure times of the trucks, keeping a piece count of the number of logs on each truckload, and recording when any of the personnel on the landing were closer than 3m from the loaded ropes.

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(1) *Jubilee scholarship - an award granted by Elders Resources NZFP Limited for the advancement of education and knowledge in the academic and practical fields of forestry.*

MACHINES STUDIED

THUNDERBIRD TMY70

The Thunderbird TMY70 is a five drum rubber or track mounted hauler with an integral 21m steel tower (see Figure 1). Details of the specifications are shown in Appendix 1. The particular machine studied was owned by Hopkes Logging Company in Tillamook, Oregon. Hopkes Logging is a family business and they have three Thunderbird haulers, a TY90, TSY50 and the new TMY70. They also have a Skagit 739 and an assortment of heelboom loaders, tractors and motorised carriages. It is not uncommon in PNW for contract operations like Hopkes Logging Company to have a range of logging equipment because in their situation they have to competitively bid for jobs and often the successful bidder is the one who has the right machine to do the work most efficiently. A contractor has the prerogative to use whichever machine he thinks will be most productive and he can even change machines part way through a setting if he sees fit.

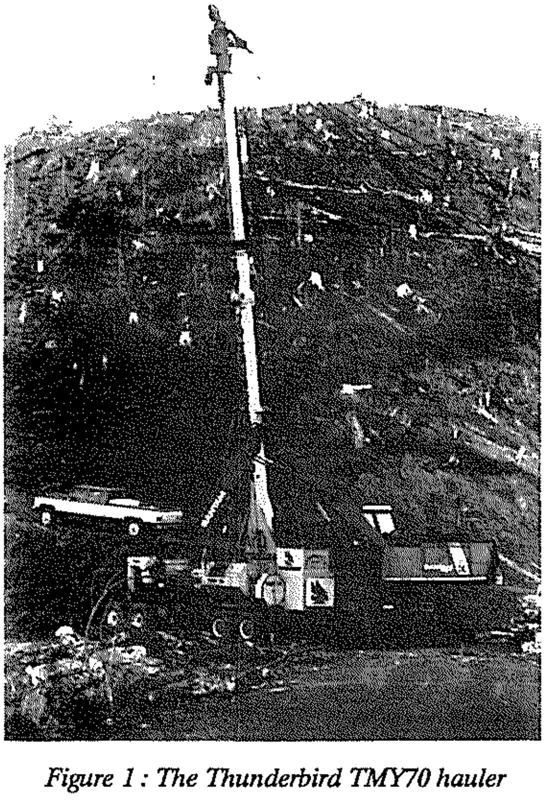


Figure 1 : The Thunderbird TMY70 hauler

The TMY70 under study was logging a mixture of Hemlock and Noble fir. It was located on a small .04 ha landing which was just a Y section in the corner of the road (see Figure 2). Trees had been cut into log lengths at the stump by contract fallers. A rubber mounted Koehring 389 loader was used to fleet and load out at the landing.

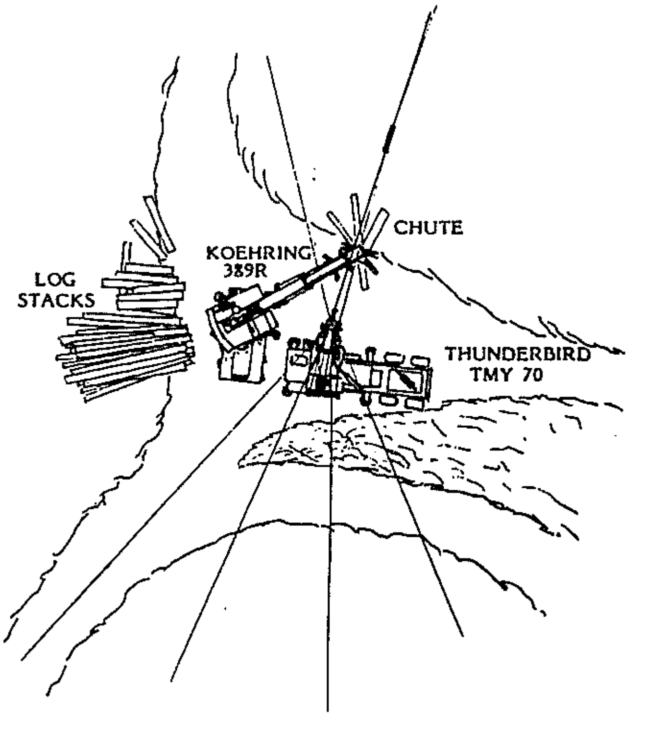


Figure 2 : Landing layout - TMY70 operation

Initially the hauler was rigged as a slackline system with a Danebo miny G2 carriage but this was only a temporary measure to log out an inaccessible area below to the access road so that the hauler could be shifted to a new location and the remainder of the area shotgun logged. A small corner of the setting had to be logged with a scab skyline system before the hauler could be shifted to the new landing. Total operating time expected on the first (Y section) landing was 4 days.

Figure 3 : View of the logging area, from the first landing, showing piece to be shotgun logged

The areas around the setting had been previously logged some 25 years ago leaving a patchwork type pattern and creating all sorts of problems for anchoring guylines. Initially the guylines were attached to stumps on the hillside immediately behind the hauler but three of the four rear stumps pulled out on the first skyline setting. The hauler slewed around on the one remaining guy stopping just short of edge of the landing. Needless to say extensive guyline rigging had been done following this episode and up to six extensions were added to each of the two guys in the back quadrant to anchor them to stumps over the hill behind the hauler (see Figure 4).

The guy that actually held the hauler up during the failure of the stumps was rigged to a block in the bight of a section of rope secured between two stumps and straddling the access road (see Figure 5). Trucks had to pass under this to be loaded out.

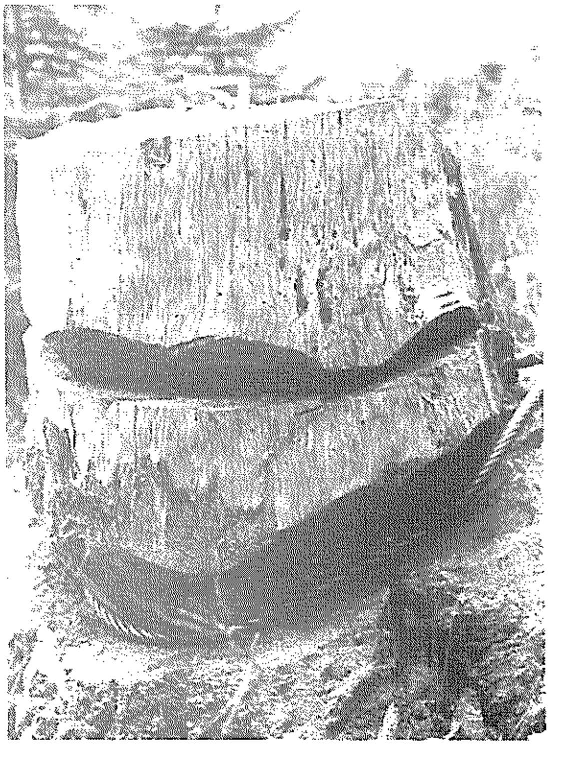


Figure 4 : An example of the stumps that the TMY70 was anchored to

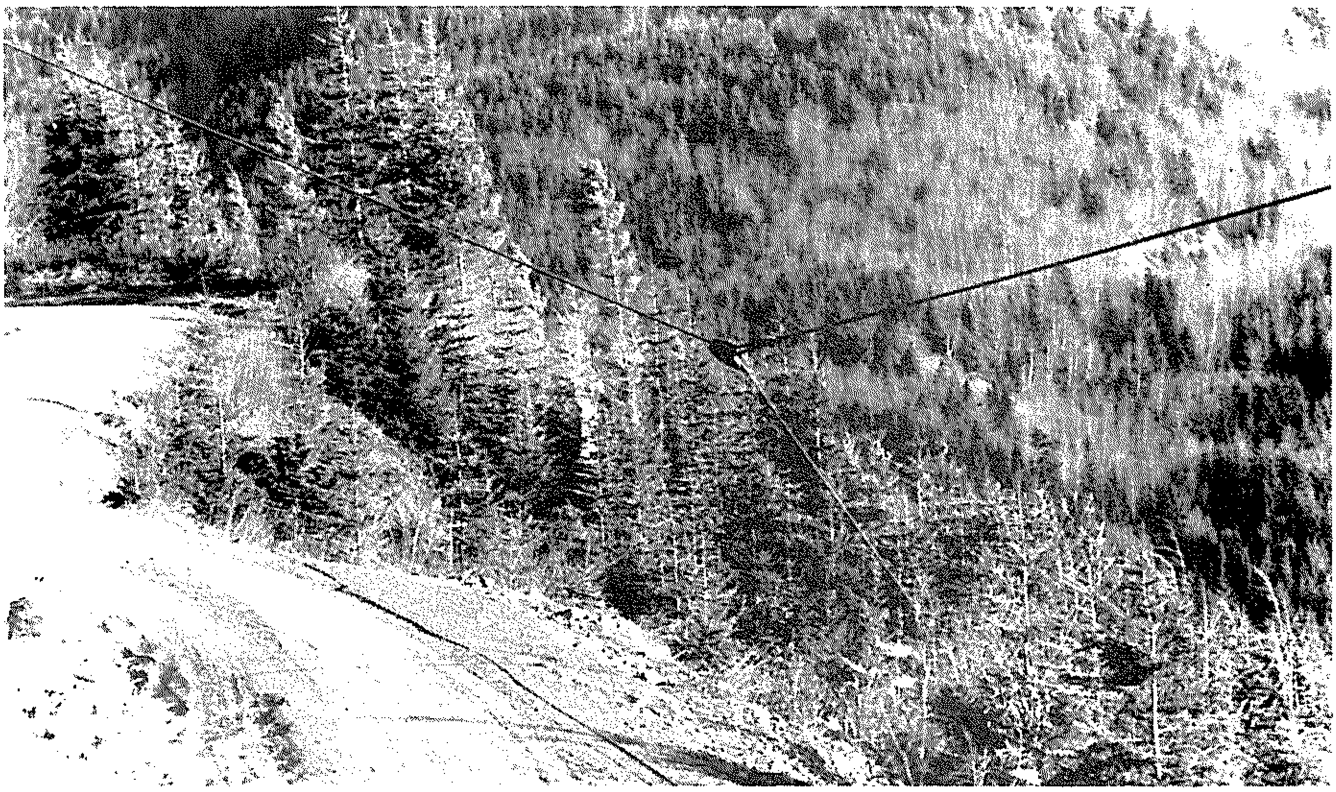


Figure 5 : Guyline rigged to a block in the bight of an extension

A pass chain with a ring connected to one end was used to pull slack for skyline shifts (Figure 6). To attach it, the chain is wrapped along the rope to be pulled, away from the direction of pull. The loose end of the chain is then fed through the ring and connected to the pulling rope. This method of using a pass chain eliminated the need to tie a knot and was very easy to release once sufficient slack had been pulled.

Figure 6 : The pass chain used to pull slack in the skyline

Crew size during the study period fluctuated between six and seven men but this excluded the fallers. A three man contract falling crew were working about two weeks ahead of the hauler on this setting. The wood was felled across slope and crosscut to length at the stump. Five logsorts were being cut. Some log damage was evident where trees had fallen over old stumps (see Figure 7).

Figure 7 : Some log damage was evident where trees had fallen over old stumps

Table 1 : Cycle Times for TMY 70 Using Slackline System

Element	Time, mins
Sample size	94
Raise rigging	.29
Outhaul	.67 (200m)
Position*	.79
Lower Strops	.17
Hook on	1.90 (3.55pcs)
Breakout	.31
Inhaul	.91 (200m)
Lower rigging	.24
Unhook	.42
Delay free total	5.70 (SD = 1.75)
Production delays	.15
Landing delays	.05
Rigging	1.31
Other	.58
Total cycle time	7.79
No of pieces	3.55
Ave piece size	$1.42m^3$
Ave drag size	$5.04m^3$
Production/hour	$39m^3$ (27 pcs)

* Position includes untangling strops

SD = Standard deviation, an indication of the spread of data around the mean.

Outhaul and inhaul times have been standardised to a 200m haul distance by the equations:

$$Out = .154 + .0026 (x), r^2 = .67$$
$$Inh = .212 + .0035 (x), r^2 = .50$$

Productivity at the hauler was high at around $39m^3$ per available machine hour (see Table 1). When machine availability is taken into consideration (predicted at about 98%) the production per 8 hour shift would be around $306m^3$ [i.e. 39 x 8 x .98]. Utilisation was 72%. From the contractors records, average daily productivity of this crew was around $370m^3$/day.

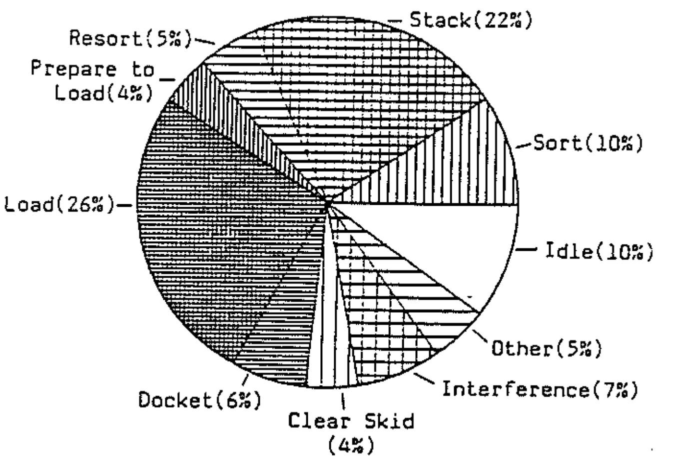
Using the LIRA costing format (Wells, 1981) a daily rate can be generated for the TMY70 operation in New Zealand (see Table 2). This costing is based on a new hauler, a 30 tonne loader and nine men. Given the recorded productivity of the TMY70 the price per m^3 to log and load would be around $11.90 (including falling). A brief report has been written on this study (Prebble 1989a).

Table 2 : Estimated daily cost for TMY70 operation

Item	Cost $NZ
TMY70	1120
Loader	525
Labour	1375
Operating supplies	230
Overheads	65
Profit (10%)	330
Total	3645

Based on an exchange rate of $NZ1.00 = $US0.61

KOEHRING 389 LOADER



CHASER

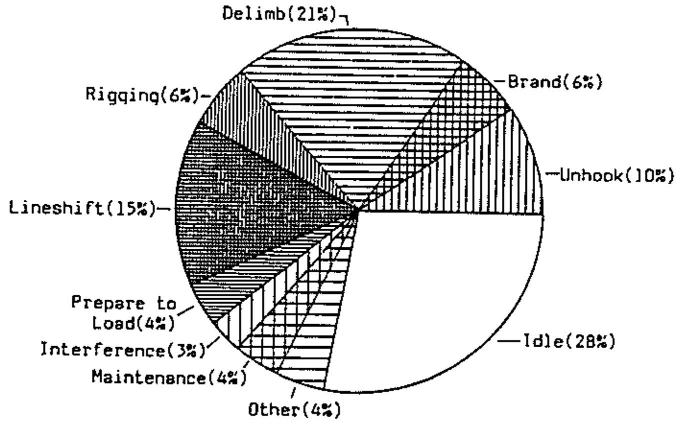


Figure 8 : Loader and chaser activities in the TMY70 operation

A breakdown of the loader and chasers activities are shown in Figure 8. Loading occupied the highest proportion of the 389R's utilised time (26%) and 12 trucks were loaded during that period. Average total loading time was 18.4 minutes but only 49% of that was spent physically loading the truck. The remainder was taken up with unloading trailers, writing dockets and clearing the chute in front of the hauler. Most loads consisted of 15-16 logs with the highest number of logs being 20 and the lowest 11. Average load size was 26 m^3.

The chaser in this operation was very active when he was working, but spent 28% of his time idle, waiting for work. A lengthy lineshift (which actually included a system change) occupied most of the 15% spent on lineshifts. Unhooking, branding and delimbing accounted for 37% of the chasers time. Even with the high volume of wood passing through the landing the frequency of the chaser working within 3m of the loaded ropes was low (less than 2%). Specific details of the landing activity studies are contained in a brief report (Prebble 1989b).

MADILL 171

The Madill 171 is not just an upgraded 071 Madill, it is a completely new machine. Improvements over the 071 include:

- increased engine power with a smoother, quieter engine
- a choice of engine brands, either Cat or Cummins
- greater line pulls
- faster line speeds
- the ability to take larger ropes
- increased rope capacity
- a telescoping tower with the capability of operating at 15 or 21m
- a more robust undercarriage with larger footprint area
- helical cut gears for reduced wear and less vibration
- a choice of clutch and brake combinations, Wichita or Eatons.

The 171 is manufactured in Madills Kalama plant in Washington. Basic specifications are shown in Appendix 2.

The first of these new 171 Madills is owned by Jurhs Logging from Falls City in Oregon (Figure 9). This is also a family business but they have just the one hauler and associated support machines such as a loader, a tractor, a skidder and a couple of trucks. Jurhs were logging an area of almost pure Douglas fir about 70 years old. The land was owned by Willamette Industries Inc.

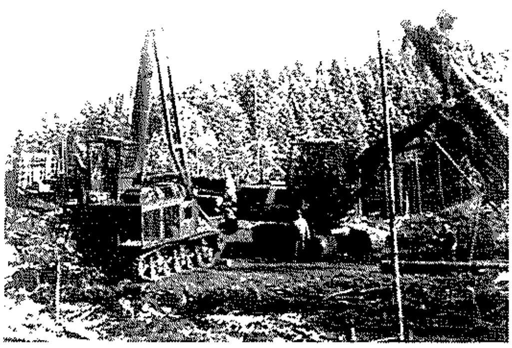


Figure 9 : The Madill 171 skyline hauler

The hauler was rigged with a three drum Interstate I-DLC 36s dropline carriage (see Figure 10). This carriage is designed for five drum skyline haulers and is capable of powering slack out to the breaker-outs. The dropline is independent and is overwound onto the centre drum of the carriage. The tagline is underwound onto the right hand drum (facing the carriage from the hauler) and the mainrope is overwound onto the left hand drum. All three drums are fixed to a common shaft. The carriage is rigged up so that when the tagline and dropline drums are full, the mainrope drum is almost empty. By pulling in on the tagline (and holding the carriage in place with the tailrope) the dropline is spooled off the middle drum and the mainrope wound on to its drum. When the procedure is reversed the dropline and tagline are wound into the carriage as the mainrope feeds off and this brings the drag up to the carriage.

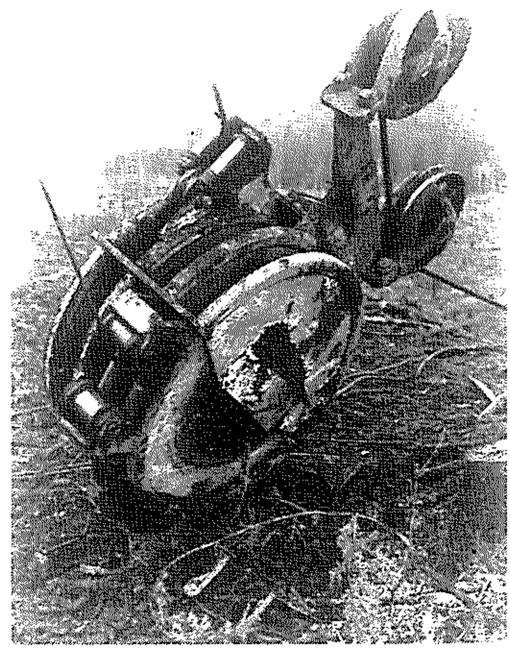


Figure 10 : An Interstate I - DLC 36S was used with the Madill 171

The core diameter of the mainrope drum in the carriage is 15cm bigger than the dropline drum core and this 1.43 to 1 ratio gives higher torque but less speed when the drag is being hauled into the carriage. It also reduces the amount of braking necessary to keep the drag up to the carriage during inhaul. A similar reduction ratio between the tagline and dropline ensures that the dropline does not come out of the carriage too quickly for the breaker-outs.

Extraction in this operation was in log length and average log size about $84m^3$. During the study the operation shifted from the original landing, located at the end of a spur road, to a second landing which was basically a turn-out in the road (see Figure 11). Landing size was about .06 ha. To shift the 171 with the tower standing it is necessary to return the tower from the operating position (inclined 8^o) to the vertical position and telescope it down to 15m (see Figure 12). The whole process to pull the ropes in, release the guys, move and re-set the hauler up took 76 minutes (excluding running the lines). A further 79 minutes were required to run the skyline out and get the machine operational.

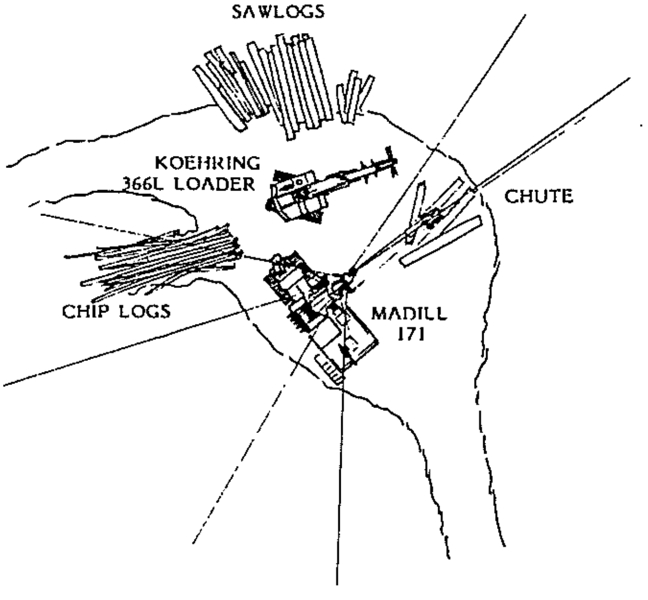


Figure 11 : Landing layout - 171 Madill operation

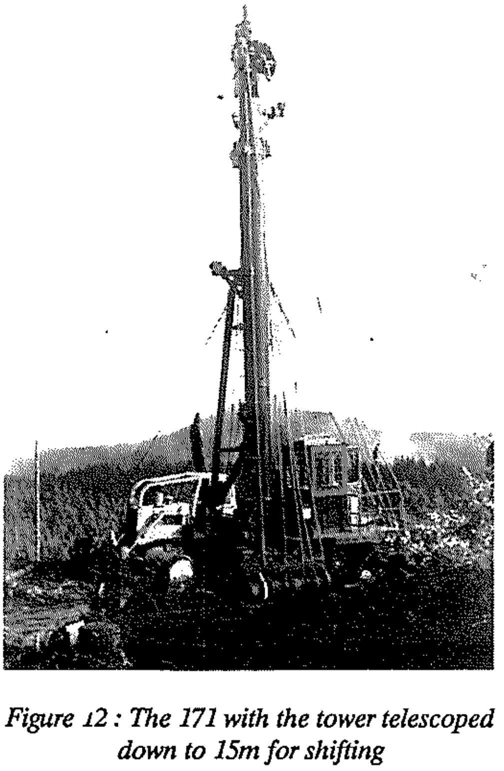


Figure 12 : The 171 with the tower telescoped down to 15m for shifting

This machine shift occurred earlier than the hook tender had expected and therefore guyline stumps had not been selected, no extensions were prepared and the strawline was still being pre-set when the machine was ready to shift. The skyline had to be rigged through standing trees on the new setting which meant that the tower had to be located on the landing before the last section of strawline could be set through the trees. Fog closed in during the process making it impossible to get a straight line of sight from the tailhold to the hauler. Attempts to overcome this with a light held up in front of the tower in the grapple of the loader were unsuccessful. A simple compass would have solved the problem and reduced the set-up time by at least 50%.

The guylines on the 171 were 28mm PFV rope and this was very difficult to get a good grip on for pulling rope off the drum (Figure 13). It was necessary to power the guylines out when setting them.

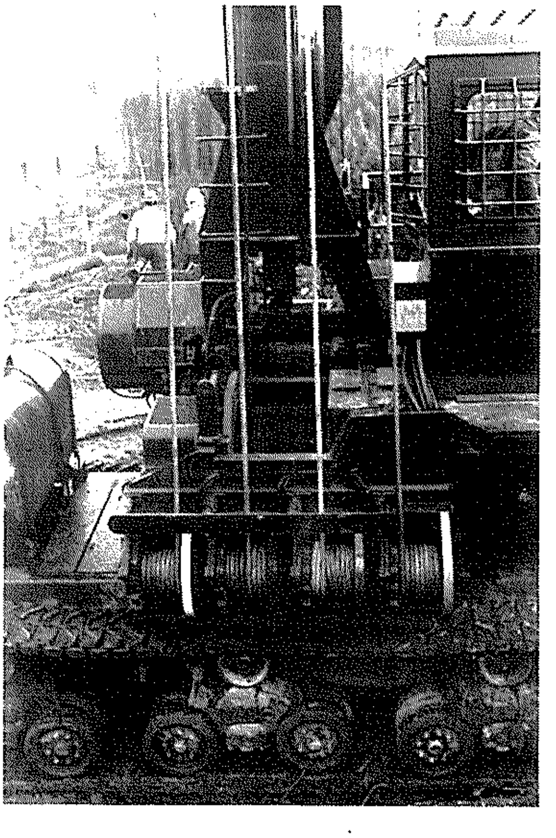


Figure 13 : PFV guylines on the 171 were difficult to handle

Table 3 : Cycle Times for Madill 171

Element	*Time, mins*
Sample size	*127*
Raise rigging	*.20*
Outhaul	*.50 (200m)*
Position(1)	*.44*
Lateral out	*.21 (5.5m)*
Hook on	*.80 (3.83pcs)*
Breakout(2)	*.26*
Inhaul	*.76 (200m)*
Lower rigging	*.15*
Unhook	*.36*
Delay free total	*3.68 (SD = .76)*
Production delays	*.04*
Landing delays	*.08*
Rigging(3)	*1.69*
Other	*.09*
Total cycle time	*5.58*
Pieces/cycle	*3.83*
Ave piece size	*.84*m^3
Ave drag size	*3.22*m^3
Production/hour	*35*m^3 *(41 pcs)*

(1) Position includes untangling strops
(2) Lateral in to the carriage is part of breakout
(3) Includes machine shift to a new landing
SD = Standard deviation, an indication of the range of 67% of the data around the mean.

Outhaul and inhaul times have been standardised to a common 200m distance by the equations:

$Out = .127 + .00185\ (dist),\ r^2 = .82$
$Inh = .173 + .00292\ (dist),\ r^2 = .77$

The loader in this operation was a Koehring 366L with a live heel and a Pierce grapple. It had an operating weight of 30.5 tonnes and a maximum reach of 11m. The crew size was six men (excluding the fallers). For most of the study three 4m long strops were attached to the dropline but occasionally an extra one was added to pick up smaller pieces. Generally there were two breaking out although the hook tender assisted whenever he could.

Table 3 shows that the average cycle time was very fast (5.58 minutes including long rigging and machine shifting delays). When related to average drag size hourly productivity was around 35m^3 but this really under-represents the machines' capabilities because of the long rigging delays. Production per 8 hour shift was calculated using the hourly productivity of 35m^3 and considering availability to be around 98% (from previous availability records of cable machines) [i.e. 35 x 8 x .98 = 274m^3]. According to scalers records (for 2 months following the study) the productivity of the 171 was estimated at 390m^3/day (Hemphill pers coms).

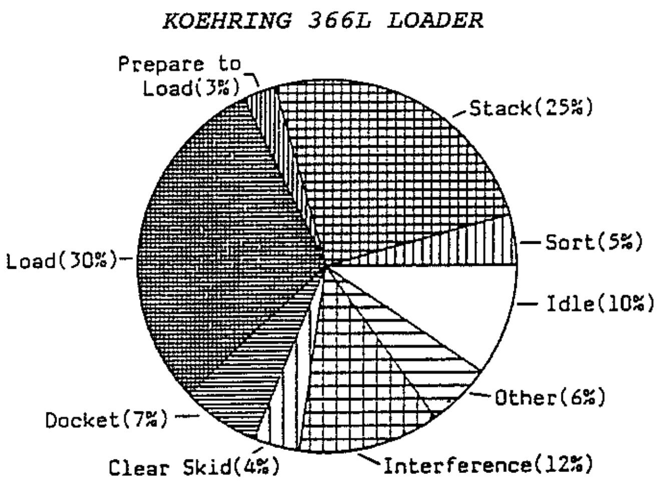
Utilisation in this study was 65% which is low by PNW standards. One of the reasons for this was the full machine shift which reduced utilisation by an estimated 7%. Daily production would have been approximately 304m^3 at a utilisation level of 72%.

Using the same costing format as for the TMY70 analysis, daily cost for the 171, including falling, comes out at around $3600 (see Table 4). Based on that, unit cost would be $13.10 for 274$m^3$ or $11.80 for 304$m^3$. A brief report has been written on this study (Prebble 1989c).

The proportion of time spent on the various loader and chaser activities are shown in Figure 14. The 366L spent 30% of its time loading (higher than the 389R in the TMY70 operation and with fewer trucks being loaded per day). The smaller log size was the main reason for the increase in loading time. Average loading time was 21.7 minutes and of that 64% was spent actually putting logs on the truck. The average truckload was 35 logs.

Table 4 : Estimated daily cost of a Madill 171 operation

Item	Cost $NZ
Hauler	1060
Loader	525
Labour	1375
Operating supplies	230
Overheads	65
Profit	325
Total	3580



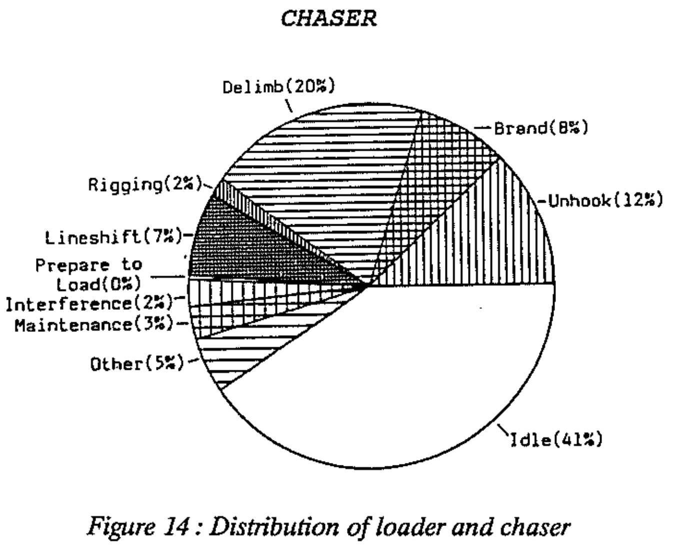


Figure 14 : Distribution of loader and chaser activities on the Madill 171 landing

The chaser in this operation spent a similar proportion of time unhooking, branding and delimbing as the chaser in the TMY70 operation. Sampling was discontinued during the machine shift because it was impossible to keep track of his movements. Up to 41% of the chasers time was spent idle, waiting for work. A brief report (Prebble 1989b) covers more details of the landing activity studies. He was observed working within 3m of the loaded ropes for 4% of the observations. The main task he was performing at the time was delimbing.

MADILL 122

The Madill 122 interlock swing yarder is designed primarily for grapple yarding, although it can be used for carriage operation. Grapple yarding is only efficient over short distances, (up to 200m) so generally the machines have limited rope capacity. The 122 can take 880m of 22mm tailrope which would restrict the distance that it could log with a carriage. Basic specifications are in Appendix 3.

The 122 is track mounted and has a 16m live boom. It is interlocked in both inhaul and outhaul directions. Having interlock on the outhaul improves control of the unloaded grapple when grapple yarding.

Don Whitaker Logging Inc. is a large scale contracting business with 11 logging operations including five highlead towers, two skylines and a swing yarder side. Associated with the logging operations is a large workshop and a dealership in secondhand equipment. Whitakers swing yarder is a Madill 122 (Figure 15) and at the time of the study it was working on Weyerhaeusers land near Springfield in Oregon. The stand was 45 year old Douglas fir which had been cut to length at the stump. Average extracted piece size was .71m^3.

Originally the area was planned for whole tree extraction with a Denis stroke delimber at the landing (Figure 16) but the use of the delimber was restricted by a high cut bank and standing trees behind the delimber (there was insufficient room for the full stroke of the delimber).

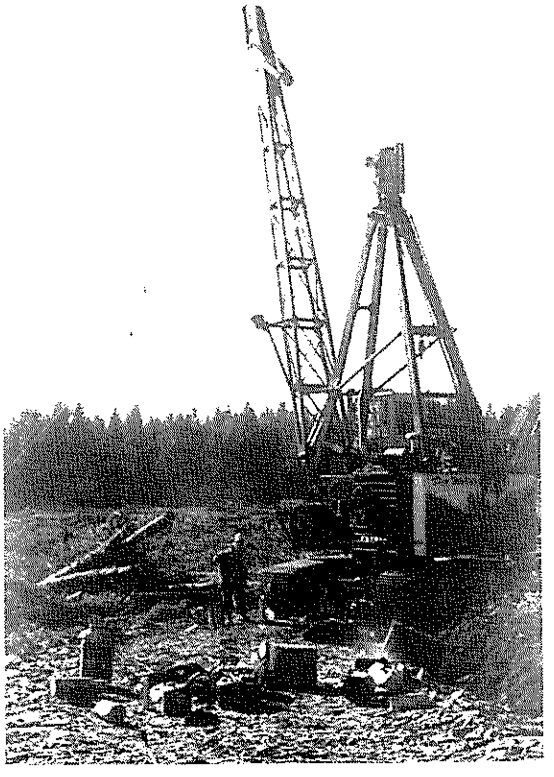


Figure 15 : The Madill 122 was rigged in a scab skyline configuration

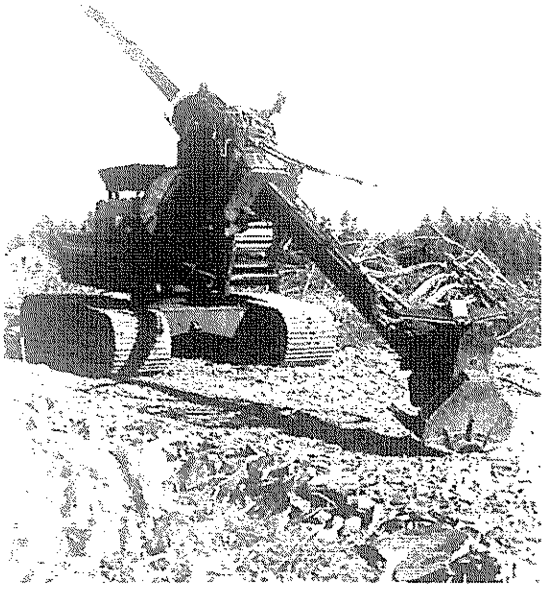


Figure 16 : The area was planned for whole tree extraction with a Denis stroke delimber at the landing but there was insufficient room for it to operate

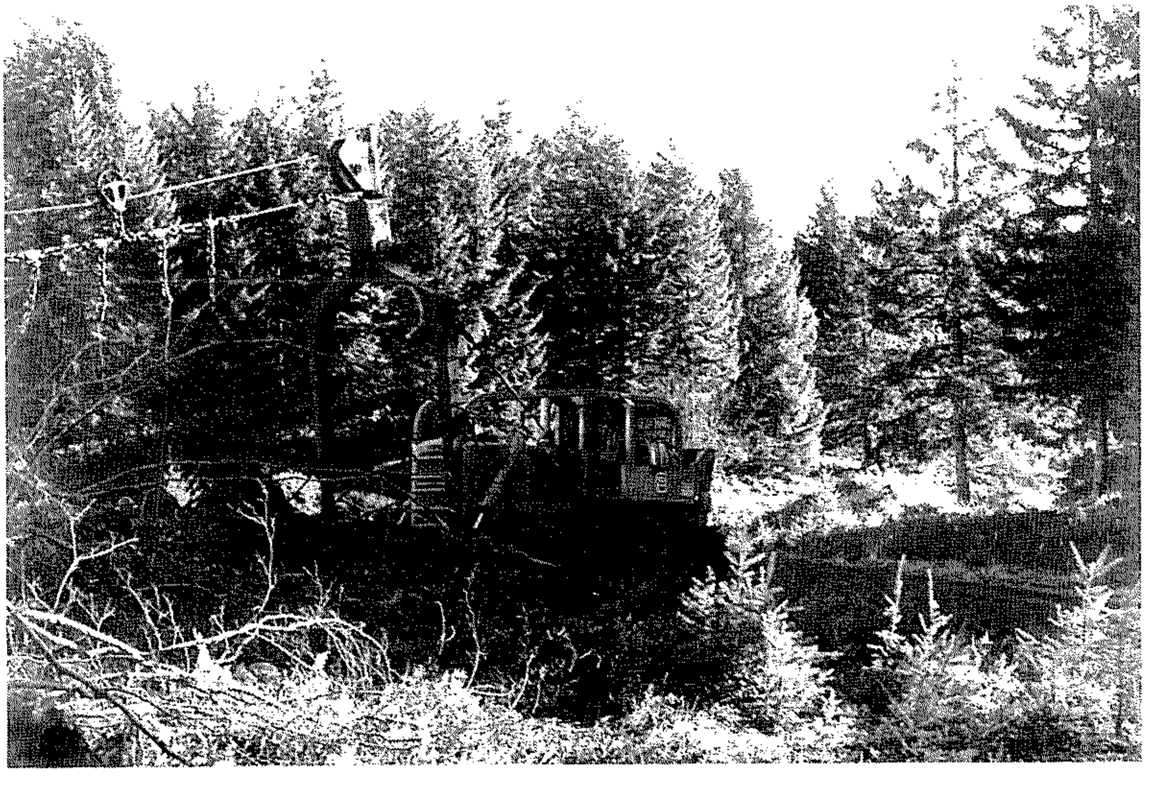


Figure 17 : A Cat D7 with a blade mounted "A" frame fairlead was used as a mobile tailhold

The 122 was rigged as a scab skyline using a Cat D7 as a mobile tailhold (see Figure 17). A single tailrope block was located in a blade mounted "A" frame on the D7. The crew size was seven men (4 breaker-outs, a chaser and 2 machine operators) but for half of the observed time, a side rod assisted the chaser.

Plastic filled valley (PFV) rope had been on the 122 from new and after nearly two years of operation, it was still in use.

The landing in this operation was located on a widened curve in the road (see Figure 18) logs were being pulled uphill to the road edge and swung to within reach of the loader. Landing space was tight and some of the four log segregations had to be stacked in multiple sort piles. The loader was a 38 tonne Barko 475 which had a live heel and an 11m reach.

Since purchasing the 122 in 1987, Whitaker has found that the machine is under-utilised pulling log length logs in small timber. During 1988 the system was changed to a tree length operation with a Denis Stroke delimber at the landing. While this improved the productivity of the hauler, the delimber was under-utilised. At the time of the study, Whitaker was considering mechanising the felling and using a grapple on the rigging.

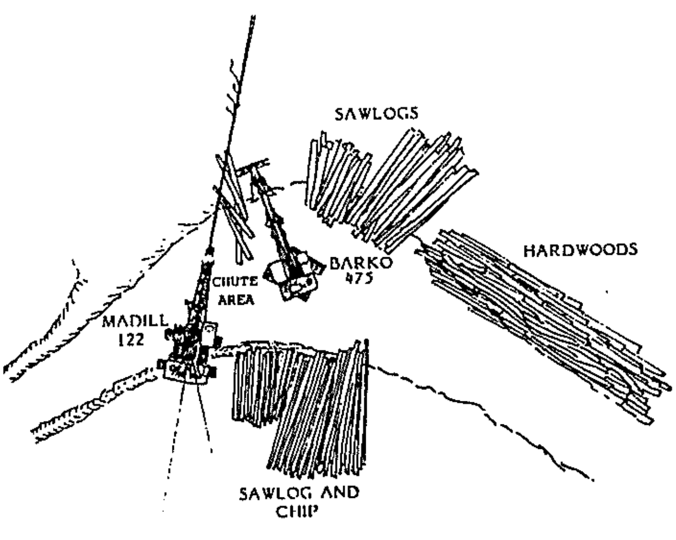


Figure 18 : Landing layout for 122 Madill operation

Study results are shown in Table 5. The Madill 122 was producing 38m^3 per available machine hour which is high for the piece size being extracted (5.8 logs were being attached per cycle). Assuming an availability of 95% for a swing yarder (derived from Prebble 1988a, McDonald 1987) productivity would have been

Table 5 : Average Cycle Times for Madill 122

Element	*Time, mins*
Sample size	*70*
Raise rigging	*.25*
Outhaul	*.64 (200m)*
Position$^{(1)}$	*.66*
Hook on	*1.87 (5.77pcs)*
Breakout	*.25*
Inhaul	*.92*
Lower rigging	*.22*
Unhook	*.77*
Delay free total	*5.58(SD = 1.35)*
Production delays	*.09*
Landing delays	*.08*
Rigging	*.37*
Other	*.39*
Total cycle time	*6.51*
Pieces/cycle	*5.77*
Ave piece size	*.71m^3*
Ave drag size	*4.09m^3*
Production/hour	*38m^3 (53pcs)*

(1) Position includes untangling strops and lowering rigging in the bush.
SD = Standard deviation

Outhaul and inhaul times have been standardised to 200m distance by the equations:

$$Out = .315 + .0016\ (dist),\ r^2 = .49$$
$$Inh = .428 + .0025\ (dist),\ r^2 = .50$$

around 285m^3 per eight hour shift [i.e. 38 x 8 x .95]. This particular crew actually worked nine hours per shift and their productivity would have been closer to 320m^3 per day. The side-rod indicated that he expected to produce 16 loads per day (about 430m^3) from this crew. It wasn't clear however whether that was with or without the delimber.

Table 6 shows an estimated daily cost for the 122 using 10 men and a 30 tonne loader (based on LIRA's costing format). Over a nine hour day the unit cost to log and load would be about $13.60/m^3. This assumes however that the machine and system is capable of sustaining 320m^3 on a daily basis. A brief report on the 122 study has been prepared (Prebble 1989d).

Table 6 : Indicative costings for Madill 122

Cost Centre	8 hr day	9 hr day
Hauler	1410	1440
Loader	525	555
Labour (10 men)	1530	1650
Operating supplies	230	230
Overheads	75	75
Profit (10%)	370	390
Total	4150	4345

The Barko 475 loaded out 12 loads during the period of observation and yet loading time only occupied 24% of the total (see Figure 19). Average loading time from unloading the trailer to writing the docket, was 17 minutes. Fifty-eight percent of the loading time was spent actually putting logs on the truck. The loader operator was continually attending to the chute during the loading process. The average truckload was 26 logs.

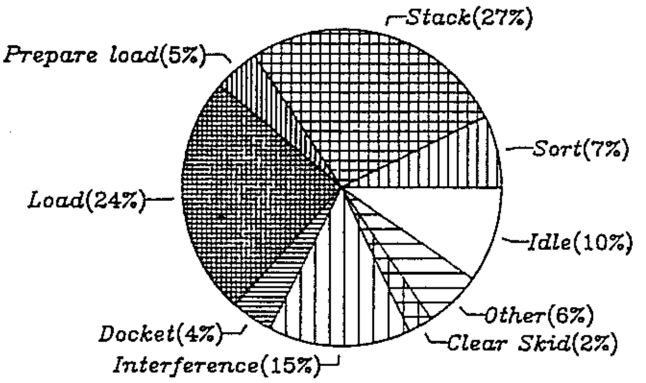
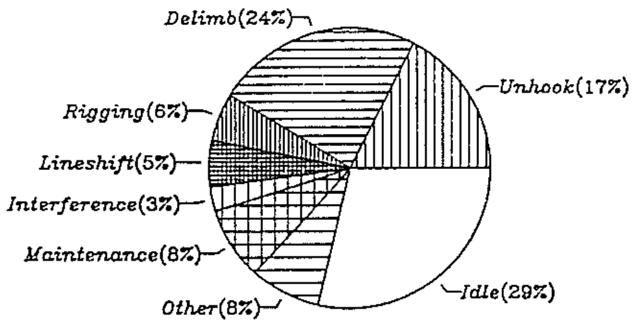


Figure 19 : Time utilisation of the Barko 475 in the 122 Madill operation

CHASER



SIDE-ROD

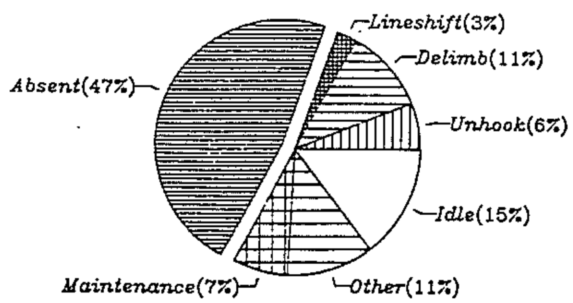


Figure 20 : The chaser and side-rod activities on the Madill 122 landing

The chaser in the 122 operation was reasonably well occupied with 41% of his time taken up with unhooking and delimbing. When the side-rod was on site, he also spent a fair proportion of his time unhooking and delimbing (32%). Even with the extra work associated with the smaller piece size, the chaser on the 122 landing still had nearly 30% of his time idle, waiting for work (see Figure 20). Both he and the side-rod were observed working closer than 3m from the loaded ropes for less than 2% of the time. Details of the landing activity studies are contained in a brief report (Prebble 1989e).

THUNDERBIRD TSY255

The Thunderbird TSY255 swing yarder is similar to the Madill 122 except that it has greater line capacities and has been designed primarily for Mechanical Slackpulling Carriage (MSP) operation. It has interlocking between the tailrope and mainrope drums for inhauling but no interlock on the outhaul. The main reasons for this are that interlock loses efficiency over long high speed outhaul distances and the slipping clutch mechanism adds to the cost of the machine. Specifications are included in Appendix 4.

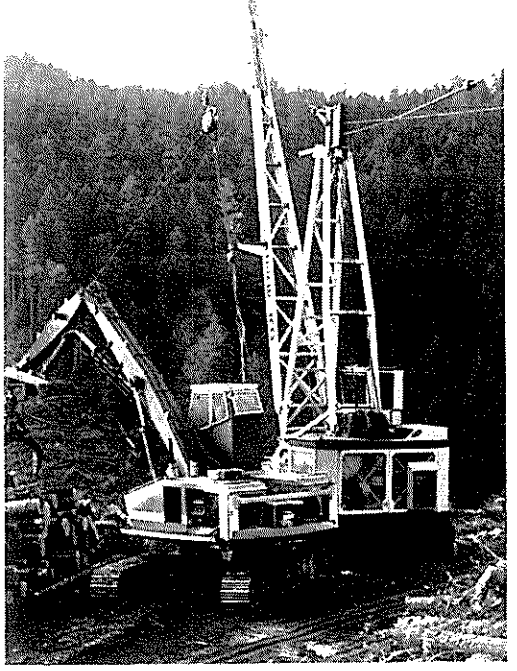


Figure 21 : The TSY255 Thunderbird rigged with a Danebo MSP carriage

The machine studied during the Jubilee Scholarship tour was owned by contractor Pete Dancer. Dancer also owns TY90 and TSY50 Thunderbirds. The TSY255 (Figure 21) was working in a stand of 80 year old Douglas fir with a 10% mix of incense cedar, ponderosa pine and white fir. The land was owned by Roseburg Lumber Company and Dancer was contracted to supply their mill. Average extracted piece size was 1.05m^3.

A Danebo MSP carriage was on the rigging with four 7.5m long strops attached to the dropline. The tailrope on the TSY255 was also PFV (similar to the 122 Madill). All the trees had been cut to length at the stump by contract fallers. A steep sided gully dissected the area and the setting boundary was in the gully even though the tailhold was rigged 150m up the slope on the opposite side (see Figure 22). Having such a steep slope immediately below the tailhold block caused lineshift problems because the hook tender had difficulties getting enough slack to trip the block.

Two landing sites were used during the study. On the first site no formation had been done and the chute was just a cleared area on the cutover below the road (about a 20% slope). The second landing was a turnout in the road which allowed more space to land the logs (see Figure 23).

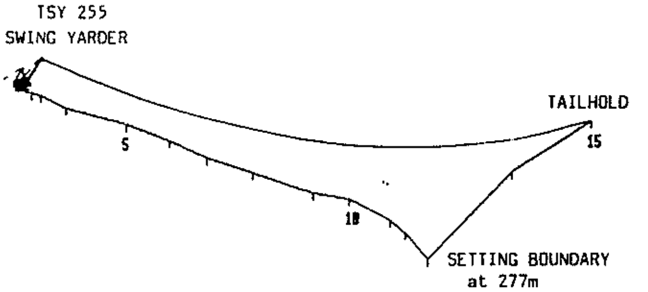


Figure 22 : A typical ground profile of the logging area

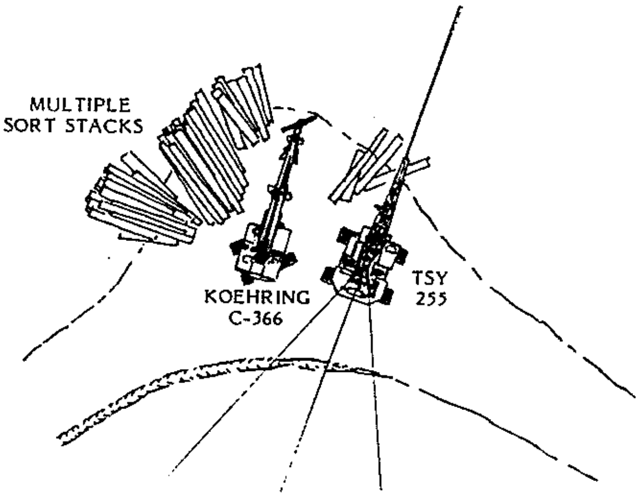


Figure 23 : Landing layout for Thunderbird TSY255 operation

Figure 24 : One of the guyline stumps had been twitched back with two strops

The crew size was 9 men (excluding the fallers) with four, sometimes five breaking out and two chasers on the landing. For nearly two-thirds of the observed time the breaker-outs were pre-stropping drags. Only logs lying directly under the rigging or very close to the landing were not pre-stropped. The loader was a track mounted C-366 Koehring with a live heel but partway through the study it was taken out of service for mechanical repairs and replaced with a Prentice 600B mounted on a Pierce rubber-tyred carrier.

Trees in the area behind the hauler were small and relatively scattered and the hook tender had obviously found difficulty locating guyline stumps. Two strops had been used to twitch back one of the stumps (see Figure 24). Towards the end of the study day, a blown hose on the swing yarder caused the operation to shut down prematurely. Machine utilisation was still high though at 69%.

The study results are shown in Table 7. The TSY255 had relatively fast cycle times at 6.62 minutes but the machine obviously had the capacity for higher performance. Inhaul and lower rigging times were longer when the Prentice 600B was under the ropes because drags had to be brought in closer and swung around further to enable it to reach them. Hourly productivity of the TSY255 was estimated at $37m^3$ but when some consideration is given to the time lost to maintenance and repairs (typically about 5% with swing yarders) production per 8 hour shift would have been $280m^3$ [i.e. 37 x 8 x .95]. Contractor Pete Dancer however recorded a much higher $420m^3$/day for a 6 week period immediately after the study. The delays caused by the loader failure and the swing yarder breakdown obviously reduced overall productivity.

Table 7 : Average Cycle Times for Thunderbird TSY255

Element	Time, mins
Sample size	70
Raise rigging	.45
Outhaul	.56 (200m)
Position(1)	.61
Lateral out	.21 (6.7m)
Hook on	.64 (3.89pcs)
Breakout	.36
Inhaul	1.05 (200m)
Lower rigging	.33
Unhook	.56
Delay free total	4.77 (SD = .54)
Production delays	.04
Landing delays	.09
Rigging	.89
Other	.86
Total cycle time	6.62
Pieces/cycle	3.89
Ave piece size	1.05m^3
Ave drag size	4.08m^3
Production/hour	37m^3 (35 pcs)

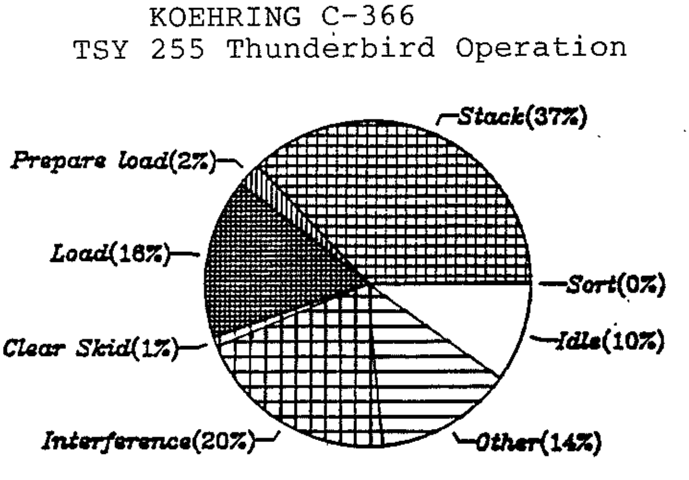
(1) Position includes sorting strops
SD = Standard deviation

Table 8 : Indicative Costings, TSY255 Operation

Item	Cost $NZ
Hauler	1395
Loader	525
Labour (10 men)	1530
Operating supplies	230
Overheads	75
Profit (10%)	375
Total	4130

An estimate of daily costs is given in Table 8. This is based on 10 men and a 30 tonne loader. Given the daily production of 280m^3 from the study data, unit cost would be around $14.75/$m^3$. A brief report, covering this study, has been written (Prebble 1989f).

Time distribution for the Koehring C-366 and the Prentice 600B are shown in Figure 25. It can be seen that a high proportion of both loaders utilised time is taken up with stacking (37 and 50% respectively). This is particularly evident when the Prentice 600B was in service. It had limited lifting capability and reach which also influenced



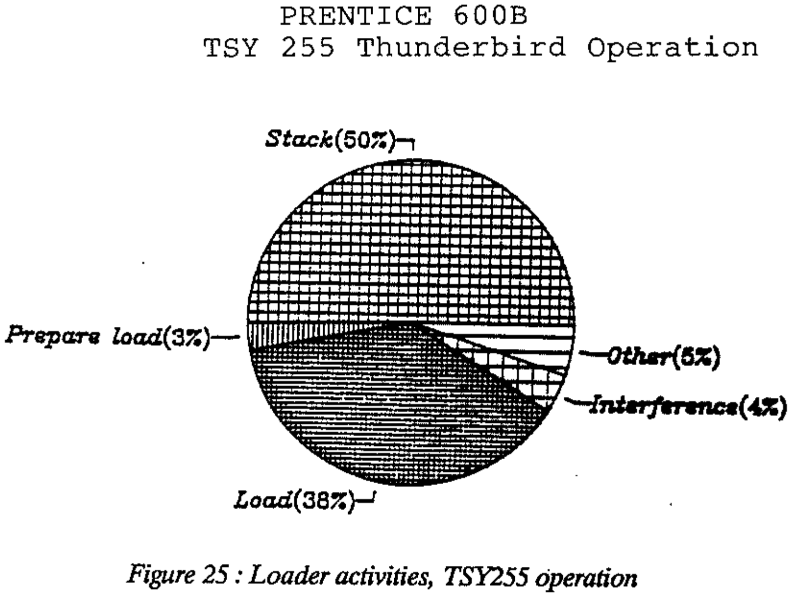


Figure 25 : Loader activities, TSY255 operation

both loaders utilised time is taken up with stacking (37 and 50% respectively). This is particularly evident when the Prentice 600B was in service. It had limited lifting capability and reach which also influenced its loading times. The Koehring took an average of around 14 minutes to load with 73% of that time spent physically putting logs on the truck. The Prentice was taking 21 minutes per load but a smaller proportion of that (55%) was spent actually loading. Average load size was 21 logs. The Prentice operator couldn't afford to let too much of a stockpile build up in the chute as it took him too long to clear once he had finished loading. It was unfortunate that the Prentice was brought into service at the beginning of a new line because the higher productivity of the short hauls compounded its ineffectiveness.

Elements from the activities of the two chasers are shown in Figure 26. For most of the study period (74%) there were two chasers on the landing. Once again unhooking, branding and delimbing occupied between 30 and 40% of their activities. While the chasers were quite busy when the TSY 255 was close hauling, they both had a large proportion of idle time (36-37%). They were observed working closer than 3m from the loaded ropes for less than 1% of the time. The brief report (Prebble 1989e) contains more information from the landing studies.

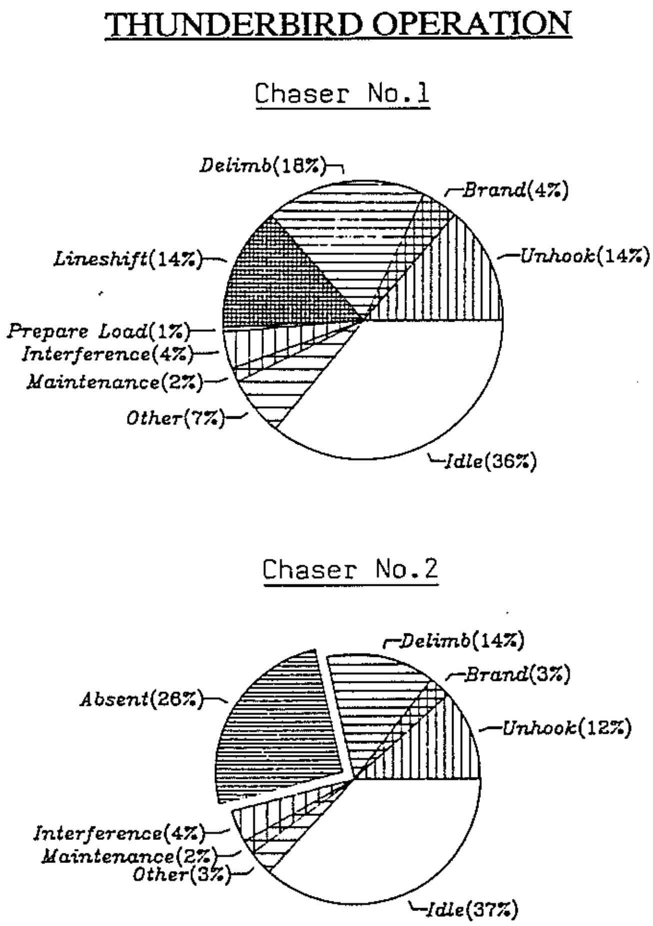


Figure 26 : Time distribution for the two chasers in the TSY255 operation

DISCUSSION

HAULERS

The studies have shown that given suitable operating conditions, the new 21m tower skyline haulers are capable of high production in timber with a piece size similar to New Zealand's new crop. Comparisons can be drawn between the cycle times of these new machines and previous studies of Madill 071 haulers currently being used in this country (McConchie & Mythen, 1987; Mythen & McConchie, 1987; Duggan, 1989; Prebble 1989a). Most of the machine related elements (i.e. outhaul, breakout, inhaul) are significantly faster with the newer machines, some by as much as 95% (Prebble, 1989g). Add to that the extra payload capacity that would be possible with the larger ropes, increased engine power and improved braking systems, and these new 21m tower haulers have the potential to be a lot more productive than the existing 15m tower machines. At the 1989 Cable Logging Seminar, Hemphill believed that PNW loggers realise about a 20% increase in productivity when they move from an 071 to a 171 Madill (Prebble 1989h).

It is not just machine performance alone that makes up the difference in productivity between cable operations in the PNW and new Zealand, manpower also has a big influence. In fact, hook on can have the greatest effect on hauler cycle times because it occupies a major proportion of the delay free cycle time (typically 20-30%). Rigging time and delays generally seem to be longer in New Zealand operations. Are our operating conditions so unique that these man related elements should be so much longer or is it our equipment? PNW loggers still seem to be able to produce impressive tallies with 071 Madills (Donovan, 1988). Is it a skill factor or does motivation play a greater part in performance than we realise? Indications are that when 071 Madills were turned over from company ownership to contracting in New Zealand, there was a quantum leap in productivity.

Secondhand 071 Madills and TMY50 Thunderbirds are appearing on the PNW markets now as loggers upgrade to the new 21m tower machines. some are relatively cheap (US$100,000 or thereabouts) but generally for that price they are in poor condition and require considerable work to bring them up to standard. For around US$180,000 - US$250,000 a newer 071 or TMY50 can be purchased and some of these more expensive machines have had a factory refit and could even carry a limited warranty. Things to look for with the 071 Madills are the 4 guyline models with extra tailrope and tagline capacity and higher line speeds. Having a transmission makes the TMY50's a bit more expensive than the Madills (which only have 2 speed torque converters) but more attention should be paid to mechanical components on these machines. Repairs can be expensive.

One of the main differences between PNW and New Zealand cable operations is the form in which the wood is extracted. Most North American loggers process the trees to log length at the stump whereas in this country whole tree lengths are extracted to the landing. While tree length extraction reduces the number of pieces to be hooked on, it doesn't necessarily result in larger payloads and requires more breakout force to get the logs moving. In log length operations logs can be attached from either end without fear of breakage or loss of log control. It is common practice to see two and sometimes three logs attached to the one strop. The problem of getting drags over the lip of the landing is significantly reduced with log length extraction. There are fewer problems with logs catching in the heads of previous drags lying in the chute.

While it is conceded that cutting to log length at the stump in new Zealand is not just a matter of superimposing PNW practices onto our operations, we can still learn a lot from their techniques. The only tangible differences between North American fir and New Zealand pine are:

1) The susceptability of pine to decay once cut

2) Pine has heavier branching than fir

3) Fir stands straighter (vertically) than pine.

The decay problem results in the felling and extraction having to be very close together and apart from changes in market demand or a relaxing of the sapstain standards there is little that can be done about the degree of degrade that occurs, especially in Spring. Some PNW operators do fell "just ahead of the ropes" but it is usually through lack of organisation or a change in plan that makes it happen.

The heavier branching of pine has two effects on log length extraction. Firstly it takes the faller longer to delimb the tree and the resilience of the branches often means that more retrimming is necessary on the landing. Delimbing and processing in pine is therefore more difficult than in fir. Generally teams of two or three contract fallers work in the PNW and they are paid on results. They set their own hours of work, often employ their own manpower, have their own equipment and vehicles and basically they are professionals. In some states, fallers are not allowed to work any more than 6 hours per day yet they still manage to keep well ahead of the extraction.

The second effect that the heavier branching of pine has on log length extraction is the increase in slash on and around the logs which slows the hook on time down and creates difficult working conditions for the breaker-outs i.e. footing is not as secure, it is harder to find the logs and assess their lay and it is more difficult to get strops under them amongst the tops and branches.

Generally New Zealand stands appear to have heavier undergrowth, especially the tended new crop stands. This is offset however by easier terrain than in the bulk of the PNW logging operations, and the absence of old growth stumps and dead spars which hinder lineshifts etc.

The lean of trees in New Zealand's radiata pine stands tends to restrict directional felling more than comparable Douglas fir stands in the PNW. This restriction has implications for:

- the lay of the ground where the trees can be felled
- the possibilities of delimbing and crosscutting, especially if the trees have to be felled straight down the slope
- the extraction direction and the type of pull possible i.e. head pull or butt pull.
- the pattern in which trees can be felled.

Successful in-bush crosscutting relies on: the trees being felled as near as possible to across the slope, clean delimbing to facilitate accurate length measurement, careful pre-assessment so that defects up the stem are not "hidden" after falling, skilled crosscutting techniques to eliminate draw wood or slabbing, and reliable markets so that log specifications are not subject to frequent changes. The characteristics of radiata make it more difficult to cut to length at the stump, but it is not impossible.

LOADERS

Heelboom loaders are commonly used in Pacific Northwest cable operations and these tend to be in the 35 - 45 tonne machine weight capacity. The reason for having such a large machine stems once again from the need for a contractor to have the flexibility to be able to handle small second growth to 1.5m diameter old growth logs. The advantages of a heelboom are:

- they can reach in under the tower, without having to relocate, to pick up logs in the chute
- logs can be stacked in multiple sort piles and sorted during load-out
- log stacks can be higher than with a front-end loader and they can be placed on the cutover or on sidecasting
- very precise log control when stacking or loading trucks
- individual logs can be picked out of a chute full of logs without having to move other logs for access
- small landing areas can be tolerated with them
- they do not compact the landing as much as a wheeled loader
- they can be track mounted and can traverse the cutover for shovel logging.

Disadvantages are:

- heelboom loaders need about a 30 tonne machine weight excavator base and these are expensive (they tend to be track mounted)
- efficiency drops off if the machine has to relocate during the stacking or loading
- they cannot sweep the skids like a front-end loader
- heelboom loaders are less suited to tree length operations
- they are not designed to skip back to the previous landing to load out the last couple of loads left behind
- a transporter is required for on-highway travel.

In summary there appears to be more advantages than disadvantages with heelboom loaders although the whole system must be designed to enhance their advantages and minimise the disadvantages. Rubber mounted base machines can be used but they require stabilising when operating and the separately powered undercarriage is more expensive.

MANPOWER AND ORGANISATION

At first glance, cable operations in the PNW appear to be over-manned but with minor exceptions, manpower levels are roughly the same as equivalent New Zealand operations. The two to three skiddies that we normally have measuring and cutting up on the landing are re-deployed out in the bush breaking out in the PNW. This is a direct result of the log length extraction because most of the processing is done by the fallers and the emphasis is concentrated on optimising machine performance and utilisation, not trying to maximise value around the extraction system.

There appears to be more stratification of the workforce in Oregon and Washington with skill and seniority being recognised through higher pay or more benefits. A hook tender for example could be receiving up to 60 - 70% more than a chaser in the same operation. Hook tenders are key personnel and good ones are usually well rewarded.

The lack of an identifiable Hook Tender in New Zealand operations is apparent at line-shift and machine shift times. The key role of the hook tender is to:

- plan setting layout and decide which system to use
- organise landing layout giving due consideration to where the logging will start
- prepare guyline stumps (or anchors) and pre-set the guyline extensions
- rig tail trees or intermediate supports as required
- pre-set strawline for lineshifts
- fill in for any of the workers in the event of absenteeism
- generally run the operation making day to day decisions, keeping records and ensuring repairs and maintenance is kept up to date.

The hook tender therefore has to be able to competently operate all the machinery or perform any of the functions of the various crew members.

Pre-rigging guyline extensions, strawline etc. reduces line shifting and machine shifting times. PNW operators rely on frequent machine shifts to optimise system efficiency. On average they would spend no more than 10 - 12 days on one setting before moving to the next location (often in the same stand of trees). For this reason landing size and formation costs have to be kept to a minimum.

The type of contracts that exist between the logging contractor and the wood buyer varies from state to state and depends very much on the ownership of the forest being harvested. In the past most of the work has been competitively bid for by the contractor. This arrangement is frequently part of a sale agreement in which the contractor is responsible for road and landing construction and sometimes even the marketing of the wood. Larger forest companies and even some of the smaller local sawmills are starting to move towards employing a contractor on a tender basis with unit rates negotiated for each block of trees that is harvested. This results in longer term contracts for the loggers but takes away some of the speculative opportunity that the contractor may have had to market high value logs himself for maximum return. In the competitive bid situation contract terms could be as short as three months.

Contract logging operations have for generations been family businesses in the PNW and many of these have developed into large enterprises with a wide range of equipment and capable of tackling most logging jobs. As the old growth forests slowly disappear or get locked up for preservation purposes, the luxury of having a machine for every purpose is becoming harder to justify. Environmental pressures combined with smaller tree sizes and increased competition has resulted in a leaning down of these contract operations. One contractor commented, "It's not as easy to make a buck in trees these days" and his business was almost the same size as the large Kaingaroa Logging Company or NZFP company operations of the 1970's.

INTERNATIONAL MOUNTAIN LOGGING AND PACIFIC NORTHWEST SKYLINE SYMPOSIUM

This was the seventh Pacific Northwest Skyline Symposium and it was held in Portland from the 12th to the 16th of December 1988. It was hosted by the Oregon State University's Forest Engineering Department and co-sponsored by the International Union of Forest Research Organisations (IUFRO) subgroup 3.06-02, Harvesting in Mountain Forests.

Factors contributing towards the need for increased efficiency and improved technology were identified as:

1. A gradual but steady transition from the harvest of old growth timber to smaller second growth trees.
2. Tightening environmental regulations which require greater attention be paid to minimising impacts from road construction and logging activities.
3. The relatively high and increasing labour costs associated with skyline logging.

The conference consisted of a series of papers on advances in skyline technology, papers on operations planning and analysis, environmental issues and regional challenges in mountain logging. Part way through the seminar was divided up into small groups for technical workshops. A total of 34 papers were presented and the six technical workshops were repeated 6 times during the course of events. Over 400 delegates attended the conference.

All of the papers presented are reproduced in proceedings (Atkinson and Sessions, 1988). The purpose of this review is to highlight papers of specific interest to cable loggers in New Zealand.

Advances in Skyline Technology:

Cable Logging Mechanics Research at Oregon State University, by J Mann and M Pyles.

After detailed structural analysis of various components in the skyline system, field verification is necessary. This paper reviews some of the techniques used to electronically monitor line tensions. The use of a guyed wooden spar (or standing tree) for tailspar and intermediate support elevation is common practice. Field measurements of spar deflection have been related to predictions from computer modelling and comparisons drawn. Initial results showed slippage at the attachment point up the spar or at the stump allowed more movement than expected. By changing the rigging practices more accurate results were achieved and it was found that the Modulus of Elasticity of spar stiffness could be 25-40% greater than predicted. This has important implications when estimating spar capacity.

The degree of pre-tension in a guyline can influence the amount of deflection a spar has under load. Measured spar deflection under the same skyline load could be as much as five times greater if pre-tension is too low. Over tightening can also have an adverse effect on spar capacity.

An electronic data collection device located in the carriage is currently under development. This device will transmit load information to the hauler operator or a logging superintendent by means of radio signals for comparison of actual loading against predicted loads and as a safety device in the event of an overload.

Guyline Tension Monitors for Improved Safety and Productivity, by J Miles, B Hartsough, N Smith.

An electronic monitoring system has been developed to continuously measure dynamic forces in guylines under operating conditions. Preliminary results show that in a three guyline set-up, one guy can have a tension two to three times greater than the guy with the least load. It was also found that invariably the shortest guyline carried the greatest load. The perception of guyline tension by the hauler operators in this project improved as they were made aware of the results.

While the load tension measuring device was low cost and effective, the authors believe that it would not become an acceptable operational tool until the signal wires are eliminated. Another system has been designed which replaces wires with radio signals. These tension monitors require battery power to both excite the loadcell (for a tension measurement) and to transmit that signal to the receiving station. Both the cell excitation and the transmitter are de-energised when not reading or sending signals. This reduces power consumption. Power is also saved by shutting down the transmitter when the tension is below a certain threshold setting.

Computerised Tension Monitoring for Work Studies, by Rainer Sperisen.

This paper describes a mobile data recording system which automatically records time study data (from the control levers in the operators cab). Electronic sensors record rope tensions and hydrostatic pulls and the hauling distances both along the skyline and laterally. The system allows the monitoring of cable tensions concurrently with cycle times.

A truck mounted Koller K600 (206kw) rigged with a Mayer-Melnhof MM carriage was set up with this electronic monitoring system. The hydrostatic drive of the mainrope and tailrope drums made measurement of line pulls simple. Hardware and software requirements are specified.

Considerations for the Use of Stump Anchors in Second Growth Harvesting: A Technical Commentary, by M Pyles, J Mann and J Anderson.

Concern is expressed about the lack of knowledge on the security of second growth stumps as guyline anchors. Smaller machines with lighter ropes may not necessarily be the answer to the problem because over long spans, more and more of the payload capacity is taken up with the ropes own weight. If larger machines are used, a better understanding of the ultimate capacity of the anchor stumps will be essential.

By using payload analysis in reverse, tower height for a given drag size can be predicted. The analysis shows that tower height has to increase significantly as line size decreases. The difficulties of anchoring these taller towers is expected to be compounded in the second growth thinning operations.

Previous research into stump anchor capacity has proven expensive and yielded variable results. A comprehensive programme of stump testing is recommended, followed by performance characterisation of the principal species within a geographic region. Variables such as:

- stump diameter
- soil depth
- soil type
- soil moisture
- prevailing wind
- wind strength and
- ground slope,

will influence tree stability. A formula based on the DBH of the tree has been used to calculate ultimate capacity of stumps from 35cm to 40cm. If a safety factor of 3 is applied to this ultimate yield, multiple stump rigging would be required for every stump. The authors suggest that with a more reliable base of information on stump capacity, a lower factor of safety may be acceptable. Instrumentation of cable haulers is suggested to record system load versus capacity information load data needs to be collected on both line tensions and the associated movement of guyline and tailhold anchors.

Earth Anchors for Cable Logging, by D Studier

The three types of tipping plate anchors researched by the USDA are described and installation techniques explained. The arrowhead type is the smallest anchor tested and it is driven into the ground with a vibrating hammer. At an installation depth of 1.5m , pull out forces of up to 6800kg were recorded in sandy soils and over 7200kg in stiff clay soils. The Manta-ray type anchor is also installed with a vibrating hammer. Research results showed the following pull-out forces when installed to a depth of 1.5m.

- 12 200kg in silty sands
- 10 900kg in clayey sands
- 16 300kg in gravely sands

In stiff or rocky soils, a pilot hole is recommended for the installation of the arrowhead and Manta-ray anchors.

Soil toggles are made in two sizes, 14 x 30cm and 19 x 36cm. To install them, a hole 1-2cm larger than the length of the anchor has to be augered to the required depth. The anchor with the strap attached, is lowered into the hole and back filled behind it. The larger toggle returned a holding capacity greater than 34 000kg in silty sand soil.

The angle at which the anchor is installed is decided once the direction of pull is determined relative to the slope of the ground. For pulls in the down slope or up slope direction, the anchor should be installed perpendicular to the ground. As the angle of pull approaches perpendicular to the ground, the anchors should be installed vertically. The individual anchors in a bridled anchorage should be installed far enough apart so that their zones of influence do not overlap. Rigid bridles may be used in soft soils but non-rigid bridles are better suited in stiffer soils.

On a cost basis, tipping plate anchors were found to be competitive with deadman anchors but the tipping plate anchors can be used in remote areas more readily than a deadman. A supplementary paper detailing some specific test results was presented by R Copstead. His research showed that a battery of six anchors in each of three different locations with the same soil type had a range of pull out forces from 4300kg to 16 500kg. It is recommended that either a standard soil penetration test or a prototype pull out test be done on any site before anchors can be installed for a production situation.

Epoxy - Grouted Rock Anchors for Cable Logging in Southeast Alaska, by V Henry, P Cole and W Schroeder.

Results are presented from preliminary static axial tension tests on full column grouted rock anchors. The anchors used in the study were 35mm bars with bonded lengths from .9m to 2.4m. Three field sites were selected and holes ranging from 54mm to 70mm were drilled into moderately to severely weathered phillite/schist and slightly weathered diorite gneiss. The anchors were cemented in place with a polyester epoxy resin grout (see Figure 27).

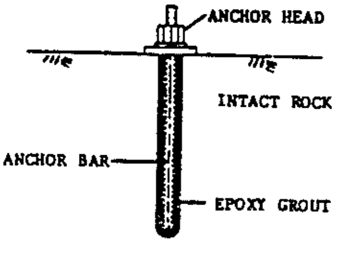


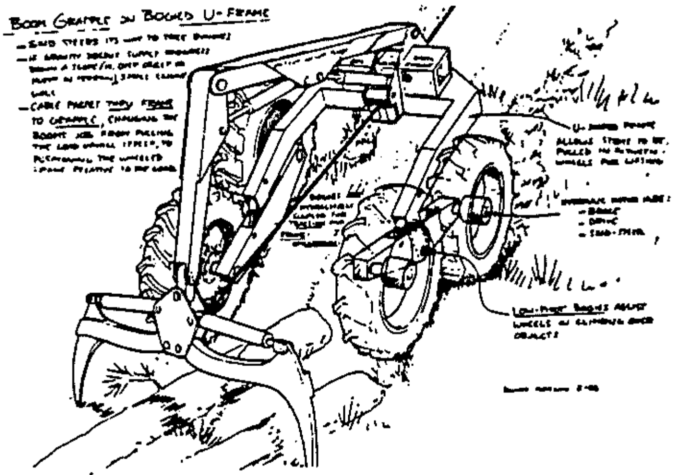
Figure 27 : Diagram of rock bolt anchor

Ultimate anchor capacity was found to be directly related to the length of the epoxy grout column and the rocks intact strength. No correlation between rock joint spacing and anchor capacity was observed. Ultimate yields of 36 300kg to 63 600kg were obtained from anchors embedded to depths of 2.4m.

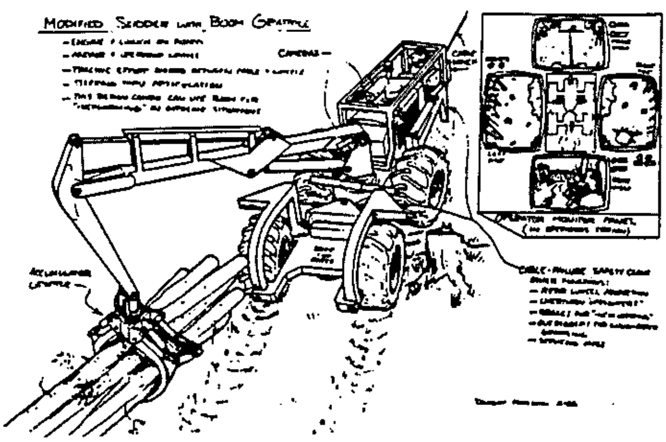
Cable Towed Vehicles for Harvesting on Mountainous Terrain, by B Hartsough, J Miles, C Goo and A Frank.

The concept of a cable towed vehicle for logging steep terrain is being investigated. By combining the advantages of a cable system with a ground based machine, lower logging costs are expected on steep country, with the possibility of reduced soil disturbance. The system would be based on trees being pre-bunched with a steep terrain feller buncher.

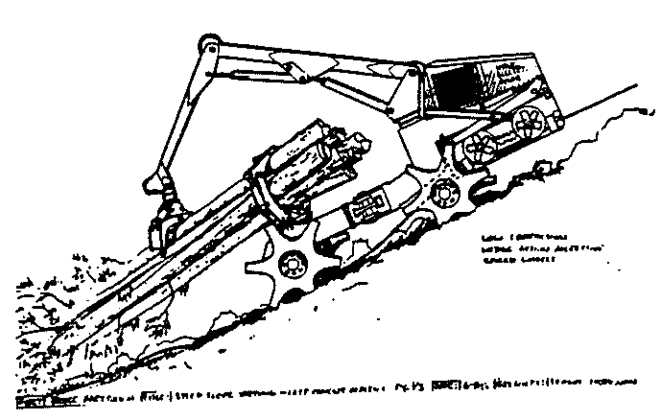
Computer modelling has indicated that payloads can be logged at lower tensions by using a towed vehicle in place of a skyline carriage. Scale models have been built and it is concluded that the machine would need to be un-manned yet still have the facility to negotiate around obstacles (see Figure 28).



Cable-towed arch.



Self-towed vehicle equipped with winch.



Self-towed vehicle equipped with capstan.

Figure 28 : Illustrations of cable towed vehicles

A prototype vehicle is being built to test steering methods and to evaluate sideslope stability.

Downhill Yarding with Skyline, by V Binkley and L Starns.

Different downhill cable logging systems are discussed. Downhill logging enables extended distances to be logged without access road construction to the ridge tops or the need for mid slope roading. Downhill logging generally costs more than uphill logging for the following reasons:

- Extra time to rig up and rig down due to limited access
- Lower production rates due to lower payloads when logs are suspended
- Reduced production rates because of hang-ups and slower inhaul speeds when logs are partially suspended.

The best opportunities for downhill skyline logging are on settings that can be designed for full log suspension with landing and hauling machines located for safe operation.

Partial suspension can result in damage to the carriage (see Figure 29) and trenching under the skyline. If partial suspension were to be used, it should be limited to clearfelling on slopes of 35% or less with a maximum distance of 300m.

Landings must incorporate a run-out area in front of the hauler for safety reasons. This distance is usually 2-3 times the average log length (see Figure 30).

New concepts in mountain logging:

National Central Tyre Inflation Program, by D Taylor.

Operational tests with low tyre pressures on low speed forest roads may have resulted in reduced road surfacing and maintenance costs. Vehicle operating costs are also lower and driver fatigue is less. Appropriate tyre pressure is dictated by vehicle speed, tyre construction loading and road surface strength. The use of Central Tyre Inflation systems enables a vehicle to adjust tyre pressure to an appropriate level from inside the vehicle cab.

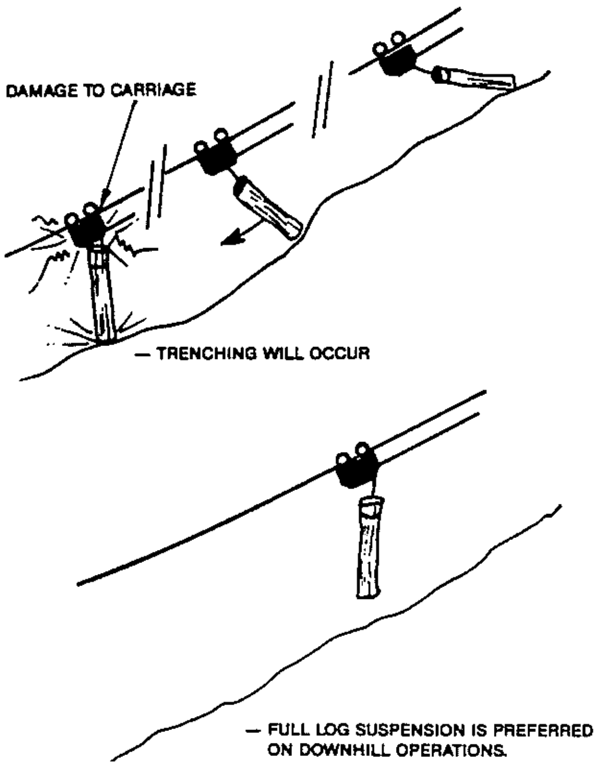


Figure 29 : Comparison between one end and full log suspension on downhill operations

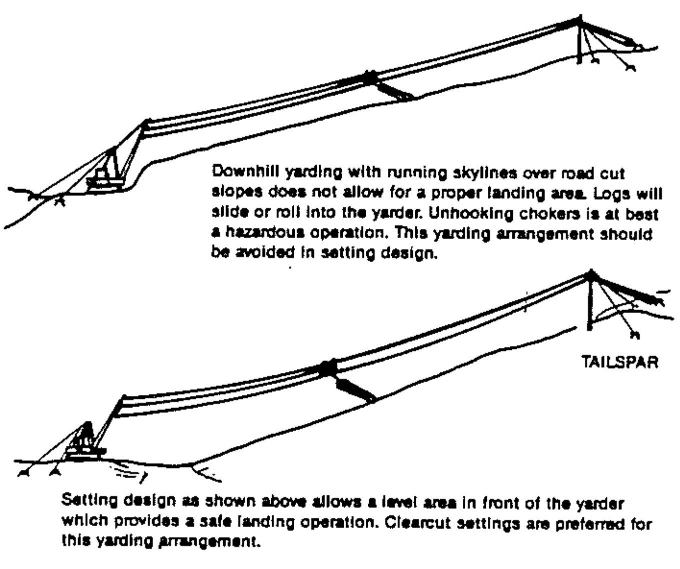


Figure 30 : Downhill logging over cutslopes is not recommended, run out areas in front of the hauler are necessary

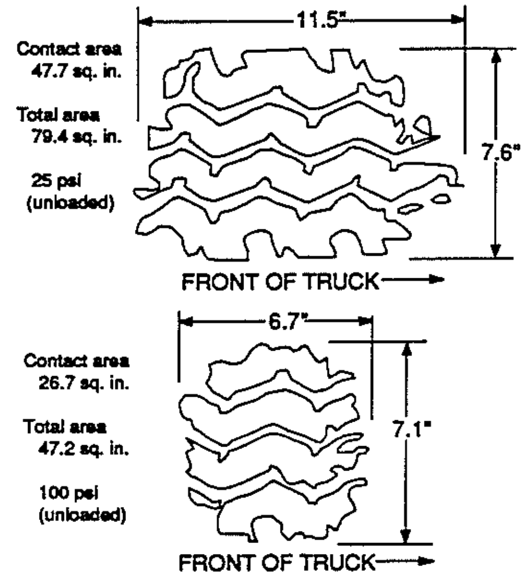


Figure 31 : Comparison of driving axle tyre footprints at 25 and 100psi

Low tyre pressures result in a larger footprint area which improves the traction of the vehicle and reduces the damage to the pavement but results in higher tyre wear, especially at high speeds. In an unloaded situation, reducing the pressure in tyres on the driving axle from 100psi to 25psi increases footprint area by 90% (see Figure 31). The effect that the lower tyre pressure has on the pavement is shown in Table 9.

A test course was set up and two 18 wheel logging trucks were operated over them, one with tyre pressures of 90psi and the other with lower pressures (21% deflection). Results were as follows:

- Tyres at low pressure had 15% less wear
- Tyre damage was 2-3 times more with the high pressure tyres
- Fuel continuation was <3% lower for the truck with tyres at higher pressures
- Repairs and maintenance were 8 times higher for the truck with high pressure tyres

Table 9 : Comparison of Contact Areas for Unloaded Third-Axle Dual Tyres

Tyre pressures (psi)	Footprint dimensions Length (in)	Width (in)	Contact area (sq in)*	Total load per tyre (lb)	Average static ground contact pressure (psi)
25	10.8	7.6	45.5	1,300	28.6
100	6.2	7.1	24.0	1,300	54.2

* Area of general purpose tread that was contacting ground

- There was more aggregate loss from the road with the high pressure tyres
- There was less "washboarding" with the low pressure tyres
- Surface cracking on the sealed section of the road was less with the low pressure tyres
- Tests with a flooded pavement indicated that the high pressure tyres caused far more surface damage than the low pressure tyres
- Ride comfort was greatly improved with the lowered tyre pressures

Operational tests were run on a number of forest stations and all demonstrated that the lower type pressures had considerable advantages for off-highway transportation. Being able to control tyre pressures from the cab of the truck will enable the flexibility to travel on highway with high pressure tyres and off-highway with lower pressure tyres.

Mechanised Delimbing at a Cable Landing, by D Schuh and L Kellogg.

A study was set up to determine the productivity of a Denis Roger Stroke delimber working under a Madill 122 swing yarder. The average tree size was 40cm Dbh and the stand stocked at 200m^3/ha. Two landing sites were used during the study.

The delimber produced 82 logs or 76.7m^3 per productive hour but utilisation was low at only 43%. The hauler was producing around 50m^3 per hour which partially explains the low level of utilisation with the delimber. The loader was also under utilised at only 45%.

Recommendations were made to mechanise the falling process and put a grapple on the swing yarder to balance the system. It was also suggested that swinging trees away to a separate processing site would reduce delimber/yarder interference and facilitate the feeding of the delimber with an adjacent ground based operation.

A LIRA technical release has been published summarising this paper (Schuh and Kellogg, 1989).

Modelling Truck Performance, by J Balcom and J Sessions.

Truck performance models are simulated on computer. Parameters that can be analysed are:

- Truck selection, aimed at helping a purchaser decide on the right rig
- Route identification, finding out the fastest or lowest cost route to take
- The level of investment that can be put into a road for R&M costs against vehicle operating costs
- Estimation of truck operation costs

The inputs required include geometry and weight of vehicle and trailer, details of the power train, braking system etc and information on operating costs, road condition and the type of load carried. The output is a prediction of the time and cost of a single round trip assuming loaded travel in one direction and unloaded travel in the other. Additional information such as velocity, gear selection, engine rpm, fuel consumption etc could be made available at the end of each road section or at periodic time intervals. A truck performance model could also issue warnings when brake temperatures, maximum speeds or traction limits are exceeded.

Computers in the Logging Business, by J Sedlak.

Business software packages can convert a contractors manual book-keeping into an automated information system using a personal computer. Income and expenditure can be monitored with accounting reports and the contractor can use spreadsheets to track his logging production and generate production reports.

A contractor with more than one crew can monitor the profitability of each logging operation and compare his bid estimate with the crews performance. Enoch Skirvin & Sons Incorporated (ESSI) have been using a computer in its logging operations since 1983. Logging foremen, truck drivers and managers submit input data on a daily basis. The computer processes this data into payroll, job cost, accounts payable, accounts receivable, general ledger and log production reports.

The four log production data bases of: fuel consumption, equipment used, daily log hauling and completed logging jobs are shown in Figure 32.

The success of computerised accounting procedures and log production records relies on the support of the entire company from logging foreman to manager. Finally, these reports must be reviewed and by doing this management can adjust operations to improve performance and ultimately profits, while the operation is in progress.

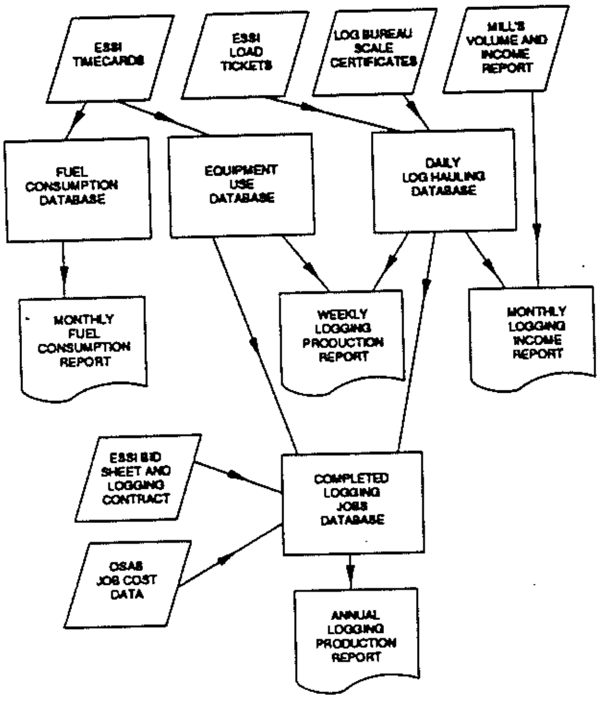


Figure 32 : ESSI logging production databases and reports

Steep Slope Logging and Loss Control - Montana Style, by B Clinch and J Okonski.

Montana is the sixth largest forestry state in the US and unlike the North Western States it has smaller timber, typically from 25-50cm diameter. Approximately 15% of Montana's logging is done with cable systems and there appears to be little difference in logging accidents or liabilities between cable logging and other ground based operations. Increasing claims combined with liberal court decisions have resulted in a severely under funded workers comp situation. The three causes of claims are:

- Accidents
- Pre-existing conditions
- Fraud

There is little that the logging industry can do about fraud as it required legislative change to rectify. Pre-existing conditions can be better controlled by careful screening of employees at recruitment time. A basic loss control programme is recommended incorporating the following:

- Management Commitment - this is the first step in loss control.
- Proper Hiring Procedures - a standard application form is suggested with well documented company rules as part of it. Medical checks are also recommended.
- Orienting and Training New Employees - ensure the new recruit understands his job and all the correct safety standards are met.
- Ongoing Supervision - without constant, appropriate supervision, all loss control efforts will gradually erode.
- Safety Services and Training - safety services should be used and innovative approaches to hazard reduction implemented.

The results from companies implementing a loss control programme have been impressive, one company yielded a direct dollar saving of $55,000 in one year as a result of a loss control programme. Indirect benefits are:

1. Prevention of debilitating injuries.

2. Fewer production losses from downtime or loss of moral.

3. Reduced extraneous equipment repairs and maintenance.

4. Lower turnover resulting in less hiring and training effort.

5. Increased camaraderie, moral and loyalty with management commitment.

6. More efficient operation with a flexible allocation of employee skills.

Observations indicative that people management aspects of hiring, interviewing screening, training and supervision have as much impact on the bottom line as the traditional concerns of logging system, equipment, terrain and slope.

Other papers of interest, by various authors.

Other papers presented on the challenges in regional areas included:

- *Skyline logging in the Usambara Mountains of Tanzania*
- *Cable crane logging in high hill forests in Pakistan*
- *Cable logging in New Zealand*
- *Harvesting plantation forests in Western South America*

A series of technical workshops were run over two of the four days. These sessions included:

1. **Vendor displays** - with 12 specialised equipment suppliers represented and three consulting or computer marketing firms present.

2. **Tail trees, guylines and anchors** - the results of recent skyline tension monitoring research at UC - Davis. This work focused on the correct balancing of tension between rear guylines to prevent over-stressing. The use of statistics to predict probability of spar failure was demonstrated as a practical tool for use in the day to day logging decisions. To make these predictions it is necessary to know:

    - Top movement of the spar
    - Tree base rotation
    - Tension in the guylines
    - Tree characteristics, taper stiffness etc
    - Tightening sequence and pre-tension load
    - Skyline pre-tension and load magnitude
    - Anchors for the guyline

    The condition required is that actual imposed stress is less than the strength of the component. The finite elements of each section of the spar can be calculated on the X, Y and Z axis and by rotational forces. It is the maximum load that is critical to tail spars, not the average.

    A computer model has been developed to predict the failure mode of tail spars and the input data for this is:

- Tree taper for cross sectional area
- Modulus of elasticity
- Guyline strengths, rope strengths etc
- Geometry ie angles, guyline pre-tension, skyline load etc

It has been found that guyline pre-tensioning is important for tail tree security. The load bearing guys (generally the rear guylines) should be tightened first and pre-tension should be 70-90kg.

The load carrying capacity of stumps can also be estimated if certain characteristics about the stumps in the area are known. The two important considerations are load and movement. Unfortunately this method of estimating strength requires expensive stump testing in the area concerned for reliable predictions.

3. **Skyline analysis techniques with micro-computers** - demonstrating the use of micro-computers to analyse components in the skyline system. This session concentrated on Version 1.3 of the LOGGERPC planning package.

4. **Selection, training and motivation of the logging labour force** - a comprehensive review of current practices and opportunities emerging in the future was presented in this workshop. The process for incorporating safety into selection, training and motivation of the logging force was promoted.

   Surveys have shown that Oregon loggers generally have a higher education than average. In the past their wage levels have been about $3,000/year higher than other states but this margin is reducing.

   Oregon logging is characterised by independent contractors with over 1300 firms employing an average of 10 people per firm. In the peak logging season, this increases to 1600 firms. The largest independent contractor organisation employees 275 people.

   By New Zealand standards, workers compensation rates are high in Oregon. A total of $US57,000,000 was lost to workers comp payments in the state during 1988 which excluded the 24 deaths that had been recorded. Based on the statistics, the average logger in Oregon faces a 1 in 600 chance of getting killed each year.

   Research has shown that investment in training will return dividends quickly. One company for example, found that $US2,000 spent on training a choker-setter was re-couped in 6 weeks. Even quicker returns are possible with training machine operators as Weyerhaueser Co found when selecting loader-operators.

5. **The use of Network Analysis for transportation systems planning** - this session demonstrated the use of Network programmes to develop transport systems and identify transfer yard or sort yard locations. Included was a review of TRUCKPC which evaluates vehicle performance for alternative truck specifications and MAXLOAD which is used for determining maximum legal truck loading for given legal requirements.

   Within the specified Gross Vehicle Weight (GVW) restrictions, the number of axles and axle spacing have a major influence on the payload a truck can carry. The footprint area of the tyre is also used to calculate the maximum weight an axle or group of axles can carry. Take for example a tyre with a ground pressure of $272kg/6.45cm^2$. The maximum weight that an axle with those tyres on can carry in Oregon is 9.080kg. A 7 axle truck therefore should be able to carry a 63 000kg GVW but spacing and distance from first to last axle reduce the allowable gross weight to little over 40 000kg. Network analysis can be used to determine the optimum axle layout and spacing.

   Decisions on the use of transfer yards as opposed to mixed sort loading can be made using Network Analysis. Super nodes can be entered in to the network to impose volume or value restrictions on the different segregations. If proportional supply is required from each entry node, supernodes can also be used to restrict the supply from the areas by entering artifically high values in the link between the supernode and the end user.

6. **Optimal bucking with handheld computers** - This presentation described the available computer hardware and software available for optimal bucking decisions to be made at the stump. User experience was summarised and a demonstration package made available. The two types of computer used in the session were the Hewlett Packard 94 supplied by Oregon Digital Systems, and Paravant. The Hewlett Packard was small and compact but had a small screen and was not completely waterproof. The Paravant computer is more waterproof and has a larger screen but is heavier and more cumbersome to carry (the hand held computer is carried on the belt of the faller).

   At the worksite, the faller keys in the relevant information about the tree he is working on. Log qualities and diameters are entered at the appropriate distances from the start reference point. When everything is entered, the programme is run and the optimal solution for that tree is displayed on the screen. Along with the reference point for crosscutting, the value of each log and the mill it should be sent to is displayed. This information is then sorted in the computers memory.

   Where a faller encounters a difficult bucking situation, he can describe a "must buck" or "can't buck" command and the computer will take these into account in the final solution.

   The accumulated days work can be downloaded from the hand held to a PC back at the office each night. This gives the logging manager an up to date inventory of the logs cut in the bush which he can use for log allocation, production scheduling and inventory control.

   While the hand held computer is in the office, changes in mill prices can be updated on a mill by mill basis through the PC. Oversupply of a particular product can be countered by entering an artificially low value on that product until demand again increases.

   A special optimal bucking workshop was run after the symposium where the full working BUCK programme was demonstrated and the appropriate software handed out with a users manual.

Overall, the symposium was of a technical nature and as such tended to be dominated by theoreticians rather than practitioners. There was however a lot of useful and interesting information presented.

The full proceedings from the seminar are available from the LIRA library.

RECOMMENDATIONS

For new machines such as the 21m tower skyline haulers or interlocked swing yarders to be economically viable in New Zealand, they must be used in situations where their production is not constrained by other components in the system. You cannot afford to have a $750,000 hauler idle waiting for wood or parked up because there is a huge stockpile under the tower. The following recommendations are made to enhance the smooth introduction of new cable machinery into the New Zealand logging industry.

1. The contract structure should be geared towards maximising profit, not minimising cost.

2. Pre-rigging of machine shifts, line shifts, system changes etc should be planned and done well in advance.

3. Processing of trees into log lengths or partial processing in the bush should be given further consideration.

4. If 3 (above) is implemented the rubber-tyred front-end loader, common to many hauler operations, should be replaced with a live heel excavator based loader.

5. Hauler utilisation must be kept above 65-70%. This may entail increasing manpower to reduce hook on times or two staging away to a separate processing area if tree length extraction is perservered with.

6. Where appropriate, frequent machine shifts and system changes should be made to achieve optimum efficiency. If log length extraction is adopted, landing construction (and subsequent costs) can be reduced.

7. Forest owners or logging managers may have to accept a reduced number of sorts being cut in cable operations. If fewer "optimum value" segregations are made, overall productivity will undoubtedly increase and the reduced logging cost could more than compensate for the potential value loss due to fewer sorts.

8. Mechanisation of delimbing and processing at the landing should be considered if swing yarders are to be introduced. This may also necessitate mechanised felling and grapple yarding to be successful.

9. The transportation system should be engineered to optimise harvesting efficiency, not as a means to control mill yard stocks or defer monthly payments as is apparent in our existing operations. This means that the contractor (through his loader operator) will have more control over truck arrival times.

10. Contractors should aim to increase operating hours by either working extended shifts or double shifting.

Studies have shown that the new 21m tower skyline haulers have the capacity to produce high volumes in timber of similar size to New Zealand's new crop. The extra height in the tower and increased rope sizes, drum capacities etc offer significant advantages over the smaller 15m tower machines. The current New Zealand logging systems will have to be modified to fully exploit the productive capability of these machines.

GLOSSARY OF TERMS

Chaser	The chaser is similar to a New Zealand skiddy and his job is to unhook the incoming drags, brand the logs (when required) and assist with rigging. He also has to do a final trim and carry out any re-processing that is necessary.
Chute	The dropping zone under the tower of the hauler where drags are unhooked after inhaul. With swing yarders the chute area could extend either side of the machine depending on how far the logs are swung.
Five-drum	Describes the total number of drums on a cable hauler ie four working drums and a strawline. The strawline drum is generally only used for lineshifts and rigging.
Heelboom	A hydraulic excavator based machine with a purpose built logging boom incorporating a live heel at the end of the boom.
Hook tender	A hook tender is basically the crew boss (employed by the contractor) and his responsibilities are to plan operational details such as machine moves, which system to use, manpower deployment etc. He also pre-rigs line shifts and guyline extensions.
Motorised carriage	A skyline carriage with its own self contained engine which is used to power slack out to the breaker-outs and on some of the larger carriages it also breaks the drag out and hauls it in to the carriage.
Side-rod	A supervisor employed by the contactor who has overall control over several operations.
Swing yarder	A cable logging machine (usually track mounted) capable of pivoting around the centrepoint of the turntable without adjusting guyline length. This is achieved with an "A" frame boom which houses the guyline fairleads directly above the turntable centrepoint. The main logging boom operates in the inclined position and is held in that position with wire rope from the "A" frame. The logging boom can be live (ie raised and lowered by a separate drum) or fixed (with set length connecting strops).
Tagline	Lightweight wire rope spooled onto a separate drum on the hauler and used to mechanically power slack out of a Mechanical Slackpulling carriage.

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APPENDIX 1 : BASIC SPECIFICATIONS - THUNDERBIRD TMY70

The Thunderbird TMY70 is a five-drum, rubber or track mounted hauler with an integral tubular steel tower which can be operated at 15 or 21m. It is manufactured by Ross Equipment in Eugene, Oregon. Basic specifications are:

Engine	-	317 kw Detroit Diesel 8V92TA or 298 kw Cummins NTA 855C
Transmission	-	Twin Disc, 5 speed forward, 1 reverse
Undercarriage	-	4-axle rubber tyre mount with Clark drive axles, or TTY70 hydrostatic track drive capable of counter-rotating and negotiating grades of up to 50%
Travel speeds	-	64kph for the TMY70 and 6kph for the TTY70
Tower	-	Tubular steel construction, hydraulically raised and tilted into the operating position
Working height to top of tailrope fairlead	-	15.3m or 21.4m

Drum Capacities and Performance

Drum	Rope Size (mm)	Capacity (kg)	Maximum * line pull (kg)	Maximum ** line speed (m/min)
Skyline	28	610	54 250	1 110
Mainrope	22	640	50 760	1 260
Tailrope	19	1340	47 760	1 310
Tagline	13	945	24 990	1 530
Strawline	10	1370	-	-
Guylines (5)	22	91	7 350	-

* Calculated at stall on bare drum
** In a full drum, no load situation

Clutches and Brakes

Drum	Clutch	Brake
Skyline	24x5 Hydraulic, Internal expanding band	Water cooled Eaton WCB224, 36" x 6" Band brake
Mainrope	24x5 Hydraulic, Internal expanding band	Water cooled Eaton WCB218, 36" x 22.5" Band brake
Tailrope	24x5 Hydraulic, Internal expanding band	Water cooooled Eaton WCB218 36" x 6" Band brake
Strawline	Multi-plate	40" disc

Operating weight - 42 220kg
Length - 8.8m, undercarriage only, 16.0m with the tower lowered
Price as at December 1988 $US415,000

APPENDIX 2 : BASIC SPECIFICATIONS - MADILL 171

The Madill 171 is a self-propelled, track mounted machine with 5 drums and a telescoping tower. Basic specifications are as follows:

Engine	-	298 kW Cummins NTA
	-	855C or 298 kW Cat 3406 BTA
Converter	-	Twin Disc 11500 MS 340 three stage hydraulic torque converter
Undercarriage	-	M4A3 army surplus with a footprint area of 4.48 m^2
Gradeability	-	15% without assistance
Tower	-	Tubular steel, hydraulically raised and tilted into the 8^o operating position
Working height to top of skyline fairlead	-	15.4 or 21.4 m
Gears	-	Helical cut from heat treated 8637 steel

Drum Capacities and Performance

Drum	Rope size (mm)	Operating Capacity (m)	Mid drum Line pull (kg)*	Mid drum Line speed (m/m)**
Skyline	28	610	46,989 (2nd wrap)	-
Mainrope	22	610	21,565	532
Tailrope	19	1220	14,092	567
Tagline	13	653	6,456	766
Guylines (4)	28	69	2,960	34

* At stall on the torque converter ** With no load

Clutches and Brakes

Drum	Clutch	Brake
Skyline	218 Pancake Wichita	Wichita 244 water cooled, 37" x 6" Band brake
Mainrope	26 x 5 BF Goodrich	Wichita 218 water cooled, 30" x 4" Band brake
Tailrope	26 x 5 BF Goodrich	Wichita 218 water cooled, 30" x 4" Band brake
Tagline	218 Wichita water cooled	30" x 4" Band brake
Strawline	216 Wichita	23.5" x 2.5" Band brake

Controls- low pressure air system
Operating weight- 46 300 kg
Length - Carrier only, 7.1m, with tower lowered 16.5m
Price as at December 1988 $US375,000

APPENDIX 3 : BASIC SPECIFICATIONS - MADILL 122

The Madill 122 is a track mounted swing yarder manufactured by S. Madill Limited in their Nanaimo plant on Vancouver Island. Basic specifications are:

Engine	- 317 kw G.M. 8V92TA or 298 kw Cummins NTA855C
Converter	- Twin Disc type 4
Transmission	- Twin Disc 2800 series Ratio 2:1
Undercarriage	- 087 hydraulically driven track mount capable of speeds of 4kph
Swing speed	- 0 - 3.5 rpm
Gradeability	- 36% unassisted
Tower	- live boom lattice steel construction
Working height to top of tailrope fairlead	- 16m

Drum Capacities and Performance

Drum	*Rope Size (mm)*	*Operating Capacity (m)*	*Mid drum Line pull* (kg)*	*Mid drum Line speed** (m/m)*
Mainrope	*22*	*427*	*23908*	*673*
Slackpuller	*22*	*427*	*12853*	*673*
Tailrope	*22*	*884*	*11186*	*819*
Strawline	*10*	*1341*	*3463*	*1364*
Guylines(2)	*26*	*60*	*6520*	*34*

**At stall on the torque converter*
***In a no load situation.*

The 122 also has a topping drum which is used to raise and lower the main boom.

Clutches and Brakes

Drum	*Clutch*	*Interlock*	*Brakes*
Mainrope	*B.F. Goodrich 26x5*	*Wichita 124, Water cooled*	*30" x 4" Band*
Slackpuller	*B.F. Goodrich 26x5*	*Wichita 124, Water cooled*	*30" x 4" Band*
Tailrope	*B.F. Goodrich 26x5*	*Wichita 224, Water cooled*	*30" x 4" Band*
Strawline	*Wichita 216*	*-*	*32"x2.5" Band*

Operating weight - 52 300 kg
Length - 5.5m carrier only, with tower lowered, 18.9m overall
Price as at December 1988 - US$575,000

APPENDIX 4 : BASIC SPECIFICATIONS - THUNDERBIRD TSY255

The Thunderbird TSY 255 can be mounted on a rubber-tyred carrier, but most machines are track mounted. Basic specifications are:

Engine	-	313 kw Detroit Diesel 8V92T
Transmission	-	Twin Disc, 5 speed forwards, 1 reverse
Undercarriage	-	Track mount, hydrostatic drive capable of speeds up to 6 kph
Gradeability	-	up to 50%
Tower	-	lattice steel construction
Working height to top of tailrope fairlead	-	15.1m

Drum Capacities and Performance

Drum	Rope Size (mm)	Operating Capacity	Mid drum linepull* (kg)	Mid drum linespeed** (m/min)
Mainrope	22	610	30,872	671
Slackpuller	22	610	30,872	671
Tailrope	22	1220	27,830	732
Strawline	10	1403	-	-
Guylines (3)	28	38	-	-

*At stall
**In a no load situation

Clutches and Brakes

Drum	Clutch	Interlock	Brake
Mainrope	24x5 Internal expanding	-	Eaton WCB 218 36x2 1/2 Band
Slackpuller	24x5 Internal expanding	-	Eaton WCB 218 36x2 1/2 Band
Tailrope	24x5 Internal expanding	Eaton WCB-224	Two 36x3 Bands
Strawline	Disc clutch	-	-

Operating weight - 52 210 kg
Length - 5.8m, carrier only, with tower lowered 16.5m
Price as at December, 1988 - US$555,000