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MADILL 122 INTERLOCK SWING YARDER

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ABSTRACT

A Madill 122 was studied operating with a scab skyline system clearfelling 45 year old Douglas Fir in Oregon, USA. The trees had been cut into log length at the stump and average extracted piece size was .71m^3.

From the data, estimated productivity was around 290m^3 for an eight hour shift but this particular crew actually worked nine hours and productivity was closer to 325m^3. Working that extra hour reduced the unit cost per m^3 by 7%. Machine utilisation was high at 82% and one of the contributing factors was the use of a mobile tailhold which kept lineshift times to a minimum.

Extended hours of operation with regular cycles and consistent drag volumes will be essential for a machine like the Madill 122 to be successful in New Zealand. Loggers may be forced to mechanise felling and delimbing to attain the increased productivity necessary.

If mechanical slack pulling (MSP) operation is anticipated over long haul distances (375m or greater), the Madill 123 swing yarder would be a better machine.

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Figure 1 : Madill 122 with scab skyline system

INTRODUCTION

Swing yarders are popular logging machines in the Pacific Northwest. They are predominantly used as grapple yarders in Washington and British Columbia especially in the younger second growth clearfelling operations (Peterson, 1987, Peterson, 1988). Loggers in Oregon and further south tend to use swing yarders more with carriage and choker systems in old growth as well as second growth stands. Some of the larger contractors use their swing yarders to log areas where access is too difficult, or hauling distances too short and uneconomic for their 27m tower machines.

Most swing yarders manufactured these days have an interlock mechanism between the tailrope drum and the mainrope drums. Interlock allows energy, normally lost to heat generated by the braking required to restrain the outwinding drum, to be regenerated to the shaft or shafts driving the inwinding drum(s), through a slipping clutch or planetary gear system. The degree of interlocking must be infinitely adjustable to account for variations in rope tensions and the changing diameter of the drums. Some machines have interlock operating in both directions i.e. outhaul and inhaul, while others just have interlocking on the inhaul.

The geometry of the "A" frame guyline fairlead on swing yarders enables the machine to pivot around the centre point of the turntable without adjusting guyline length. This allows drags to be dropped alongside the machine which reduces landing requirements and makes the logs more accessible for the next phase of the operation. Generally swing yarders are mounted on hydrastatically driven track undercarriages which gives them good traction and gradeability to negotiate difficult access tracks.

One of the most popular swing yarders in the Canadian industry has been the Madill 044, a 95 tonne grapple yarding crane with a 335 kW V-12m engine. These machines are designed for high speed logging over short distances and while they have a history of good performance, they are very heavy machines, have a high capital cost and are relatively expensive to run. (The 044 does not have interlock which means that it relies on a powerful V-12 engine and water cooled brakes on the tailrope drum to maintain tension in the lines).

With the development of interlock, manufacturers are moving towards lighter, faster machines with more flexibility. The Madill 122 is one of these new machines designed primarily for grapple yarding but quite capable of MSP carriage logging. It has interlock in both directions and having interlock on the outhaul improves control of the unloaded grapple during outhaul. The 122 has a proven record of efficiency and reliability in British Columbia (MacDonald, 1987) and two are now working in Tasmania.

The potential for swing yarders in New Zealand is in areas where the terrain is relatively easy but soil instability is going to restrict road and landing construction to a minimum e.g. Mangatu and Ruatoria Forests on the East Coast. To effectively plan for these machines, logging managers need good base information to work from. Knowledge of machine cycle times, payload capacity and the type of terrain and systems they are best suited to are essential ingredients.

A Madill 122 swing yarder working on Weyerhaeuser's land, near Springfield, Oregon was production studied in December 1988. This report summarises the data collected.

THE MACHINE

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

LOGGING SYSTEM

The Madill 122 was working in 45 year old Douglas fir clearfell. It was rigged as a scab skyline with four 7m long strops on the butt rigging. The trees had been cut into log length at the stump by contract fallers. Four log segregations had been cut with two main sorts and two minor sorts. Average extracted piece size was .71m^3.

For most of the study there were three breaker-outs and a hook tender (crewboss) hooking logs on (see Figure 2). Towards the end of each line the hook tender would leave the breakout site to prepare for the lineshift. A cat D7 with a blade mounted "A" frame was used as a mobile tailhold.

The landing was located on a widened curve in the road. Logs were being pulled uphill to the road edge and swung to within reach of the loader. The loader was a track mounted 38 tonne Barko 475 with a live heel and an 11m boom reach. One chaser (unhooker) was on the landing and occasionally the side-rod (a supervisor employed by the contractor) assisted with the unhooking and delimbing.

Figure 2 : There was usually 1 man per strop hooking logs on in the 122 operation.

Since purchasing the 122 in 1987, contractor Don 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 stroke boom delimber at the landing. While this improved the productivity of the hauler (Pease, 1988) the delimber was then under-utilised. To overcome this, a grapple was put on the rigging in 1989 and a feller buncher added to bunch trees for the grapple. This change has balanced the system but the capital cost of the equipment alone is somewhere in the region of NZ$2,300,000. Neither the delimber or the feller buncher were in operation during the study that this report is based on.

STUDY METHOD

A total of 70 cycles were recorded on a continuous time study basis. A ground profile was run to get indicative hauling distances and this is shown in Figure 3. Scaled log volumes from the truck loadout were used to derive an average piece size for the study. The loader and chaser were activity sampled concurrently with the hauler cycles and these have been reported separately (Prebble, 1989).

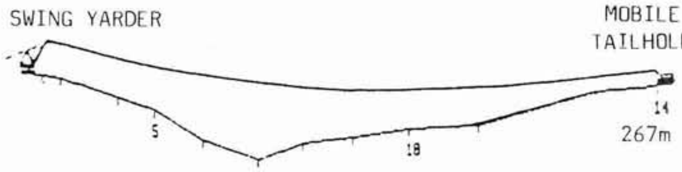

Figure 3 : Ground profile for 122 Madill study

RESULTS

Average cycle times from the study data are shown in Table 1. Four breaker-outs were hooking on for over 75% of the cycles.

Using a scab skyline system, the Madill 122 was producing around 38m^3 per available machine hour which is high compared to a similar study of a Washington 88 log length operation in New Zealand (Prebble, 1988). While the 88's cycle times were slightly faster, average piece size was only .50 and the resultant smaller drag size meant productivity was much lower than the 122.

The outhaul speeds of 312m/min in the 122 study were considerably slower than specification and more inconsistent than would be expected from a machine of this capability (r^2 value of only .49). Frequent wrapping of the unloaded tailrope caused by a single block at the tailhold, meant that the operator had to outhaul slowly until the rope unwrapped. The problem was not evident during inhaul.

Table 1 : 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 (5.77 pcs)
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	.71
Ave drag size	4.09
Production/hour	$38m^3$ (53 pcs)

(1) Position includes untangling strops and lowering rigging in the bush.

SD = Standard Deviation

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

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

Considering the relatively small $.71m^3$ piece size, average drag size was realistic with 5.8 pieces being hooked onto four strops each cycle. The largest drag was 11 pieces. Hook on was actually quicker with three breaking-out, but fewer logs were attached per drag. There was no significant difference in hauler productivity between three and four breaker-outs.

Three lineshifts were observed during the study and these averaged less than five minutes per shift. The D7 mobile tailhold helped keep rigging time per cycle low. One 10 minute re-positioning of the swing yarder was recorded and this involved moving the machine along the road (approximately 5m) and changing guyline locations.

Assuming an availability of 95% for a swing yarder (derived from Prebble 1988, MacDonald 1987) productivity would have been around $290m^3$ per eight hour shift. The particular crew studied normally worked a nine hour shift and their productivity would have been closer to $325m^3$. Machine utilisation was very high at 82%.

COSTS

Based on LIRA's costing format (Wells, 1981) a logger would need around $4200 per day for a new Madill 122, a 30 tonne loader and ten men (see Table 2). At $290m^3$/day the unit cost would be approximately $\$14.30/m^3$. By increasing working time to nine hours the cost would reduce to about $13.35/m^3$.

DISCUSSION

The Madill 122 was capable of high production in the relatively small piece size of $.71m^3$. While cycle times were not as fast as they could have been (due to tailrope wrapping problems) they were regular and the average drag size of $4m^3$ was enough to return good hourly production.

Lineshift times averaging less than 5 minutes were possible with the mobile tailhold. Generally delay times were low at less than one minute per cycle. As a consequence, utilisation of 82% was recorded. Lower utilisation would be expected over a longer term.

Table 2 : 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 cost per m^3 can be significantly reduced by working an extra hour per day. This crew worked a nine hour shift and that reduced the unit cost by seven percent. Extended hours per shift or double shifting will be necessary for high cost machines like the 122 to be viable in New Zealand. Loggers will need to use the most efficient systems possible to offset the high costs of swing yarders and this may include adding extra capital to mechanise some parts of the operation.

The 122 has basically been designed for grapple yarding and as such it has limited line capacity with 22mm ropes (less than 900m on the tailrope drum). S. Madill Ltd now manufacture a 123 model which has 715m of mainrope and slackpuller capacity and 1350m of tailrope capacity. This new machine is more expensive at US$595,000 but it will be better suited to MSP operation with the capacity to work over longer distances.

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The costs stated in this Report have been derived using the procedure shown in the LIRA Costing Handbook for Logging Contractors. They are only an estimate and do not necessarily represent the actual costs for this operation.

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