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Production and Performance of Mechanical Felling Equipment on Coastal B.C.:

Timbco Feller Buncher with RotoSaw Head

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PREFACE

The author wishes to thank the personnel of Antler Creek Logging Limited of Port Alberni, B.C., and the Manager and Divisional Forester of MacMillan Bloedel Limited, Northwest Bay Division for their assistance during this project. The author is also indebted to FERIC staff member Kristi Francoeur who checked and arranged the manuscript for final publication.

Information in this report is given in metric units. Imperial units may occasionally be shown in parenthesis.

AUTHOR

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SUMMARY

A Timberjack Timbco Model 2518 Hydrobuncher with a RotoSaw felling head was used on Coastal B.C. between June and September of 1984. The machine was contractor-operated and worked for MacMillan Bloedel Limited's Northwest Bay Division on Vancouver Island. The buncher performed as part of a fully-mechanized harvesting operation in a 110-year-old stand of second-growth Douglas-fir, cedar and hemlock.

FERIC monitored the performance of the Timbco/RotoSaw combination for approximately two and a half months. The contractor normally operated two shifts per day and seven days per week, but 52 of the 140 potential shifts were lost because of Divisional holidays and fire-hazard closures. Eleven additional shifts were not scheduled and a further 18 shifts were lost for mechanical reasons and waiting for parts or mechanics.

The remaining 59 shifts were productive. Shift length averaged 8.8 hours, of which 66% was spent in the normal functions of cut, bunch and move. Availability during shifts worked was 70.5 percent. At an average tree volume of 0.58 m^3, productivity per Productive Machine Hour averaged 35.4 m^3 from 61.0 stems. When the buncher worked two full shifts per day, daily production averaged 405 cubic metres.

The RotoSaw performed well during the trial, except for some minor items, and both contractor and company were pleased with the head. However, both head and carrier were returned to the dealer at the end of the study because the contractor considered the Timbco undersized for a Coastal B.C. application. A stick-boom length longer than normal probably influenced downtime on the carrier and boom. Ground conditions also affected the machine's performance. In addition, this machine was the first Timbco to be sold in British Columbia by Timberjack. Both the manufacturer and the user were developing experience with the machine. Overall, it is likely that this unit was incorrectly matched to working conditions. The result was poor machine availability.

A second Coastal Timbco with a shorter stick has operated for two years, apparently with better results. It therefore cannot be concluded from this study that the Timbco feller buncher cannot work on the Coast. Although this particular introduction may have failed, it is FERIC's opinion that it is inconclusive whether Timbco machines can perform successfully on Coastal B.C. However, the Timbco concept of a high degree of cab levelling is both desirable and viable.

SOMMAIRE

Une empileuse Hydrobuncher Timberjack Timbco modèle 2518 avec tête abatteuse RotoSaw fut utilisée sur la côte ouest de la Colombie-Britanique de juin à septembre 1984. La machine était opérée par un entrepreneur oeuvrant pour la Division Northwest Bay de la compagnie MacMillan Bloedel Limited sur l'île de Vancouver. L'empileuse faisait partie d'une opération de coupe entièrement mécanisée dans un peuplement composé de repousses de sapin Douglas, de cèdre et de pruche de 110 ans.

FERIC a mené une étude sur la performance de la combinaison Timbco/RotoSaw pendant environ deux mois et demi. En temps normal, l'entrepreneur travaillait deux quarts par jour et ce, sept jours par semaine, quoique 52 des 140 quarts potentiels furent perdus à cause des congés de la Division et des fermetures dues aux risques d'incendies forestiers. Onze quarts additionnels ne furent pas prévus à l'horaire et 18 autres quarts furent perdus pour des raisons d'ordre mécanique ou d'attentes pour des pièces ou des mécaniciens.

Les 59 quarts restants furent productifs. La durée des quarts était en moyenne de 8.8 heures, dont 66% du temps était consacré aux tâches normales de coupe, d'empilage et de déplacement. La disponibilité durant les quarts travaillés fut de 70.5%. Avec un volume moyen de 0.58 m^3 par arbre, la productivité moyenne par Heure Machine Productive (HMP) était de 35.4 m^3 et ce, avec 61.0 tiges. Lorsque l'empileuse opérait pendant deux quarts complets par jour, la production journalière était en moyenne de 405 m^3.

La tête RotoSaw s'est bien comportée lors des essais, à l'exception de quelques points mineurs, satisfaisant ainsi l'entrepreneur et la compagnie. La tête et le transporteur furent cependant retournés au marchant à la fin de l'étude parce que l'entrepreneur considérait la Timbco de trop faible dimension pour être utilisée sur la côte ouest de la Colombie-Britanique. La flèche, plus longue que la normale, a probablement eu un effet sur le temps mort du transporteur et de la flèche. Les conditions du sol ont également influencé la performance de la machine. De plus, cette machine fut la première Timbco a être vendue en Colombie-Britanique par Timberjack. Le manufacturier ainsi que l'utilisateur étaient au stade d'expérimentation avec la machine. En général, cette unitée fut vraisemblablement mal agencée compte tenu des conditions de travail. Comme résultat, la machine fut peu disponible.

Il semble que de milleurs résultats furent obtenus avec une deuxième Coastal Timbco à flèche plus courte qui opéra pendant deux ans. On ne peut donc conclure suite à cette étude que l'abatteue empileuse Timbco ne peut opérer sur la côte. Quoique cette tentative en particulier peut avoir échouée, il est de l'avis de FERIC qu'on ne peut conclure si les machines Timbco peuvent opérer avec succès sur la côte de la Colombie-Britanique. Cependant, le concept de Timbco d'une cabine à haut degrée d'ajustement de niveau est à la fois souhaitable et viable.

INTRODUCTION

Mechanized felling trials have been conducted on Coastal B.C. since 1977 and by 1982 were no longer considered experiments, principally because of Crown Forest Industries' work in second-growth stands (McMorland, 1982). Excavator-style machines were shown to be able to manoeuvre on these sites. Slopes were usually gentle (5 to 15%, well within the range that could be handled by existing feller-buncher carriers) and, with assistance from a handfaller, the machines were able to work amongst the large old-growth stumps and windfalls.

Since 1982 mechanized felling has expanded on the Coast, leading the trend towards full mechanization of stump-to-landing or stump-to-roadside operations in second-growth stands of smaller timber. Fully or mostly mechanized operations are also planned for some high elevation old-growth stands (usually smaller trees that have lower value than lowland timber) which have been considered uneconomical to harvest using conventional Coastal systems.

Several Coastal contractors have become involved with this trend towards mechanization. One is Antler Creek Logging Limited of Port Alberni, B.C. (central Vancouver Island) who are experienced Coastal loggers. For the past 18 months, they have specialized in contracting mechanical felling operations to MacMillan Bloedel Limited (MB) divisions.

As a specialty contractor, Antler Creek Logging wanted a feller-buncher carrier designed, as much as possible, as a feller buncher rather than a converted excavator. They also wanted a machine that would eventually permit them to extend their range of felling activity to slopes greater than 20 percent. A third major criterion was reliability because the unit would have to operate two shifts per day and seven days per week. Antler Creek also required a non-shear felling head. Many of the stands they would harvest for MB were for overseas markets and shearcut trees are frequently unacceptable.

Antler Creek decided that Timberjack's Timbco Model 2518 Hydrobuncher equipped with a RotoSaw feller-buncher head was the best match of carrier and head suitable for their requirements and available at that time. The unit arrived on site in late spring 1984. FERIC contacted them soon after and arranged to establish a performance monitoring program. Antler Creek agreed to cooperate because they were interested in machine reliability and productivity data.

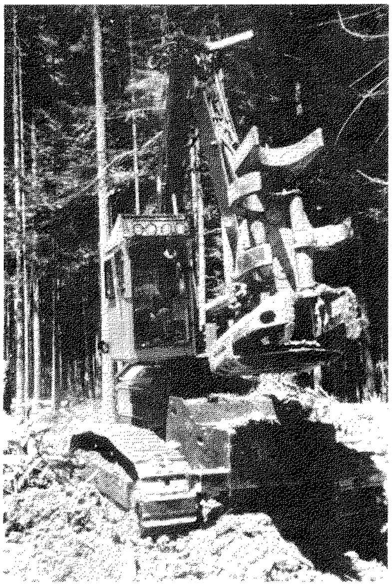
FERIC instrumented the Timbco with a Model DSR Servis Recorder (event recorder with a 2-track monitoring system) to identify carrier and head activity. An automatic tree-count system was installed, set up so that a count was recorded only when certain machine functions occurred in sequence. The operators provided daily recorder charts and shift reports to FERIC, which included details of non-productive time.

Monitoring began in July and ended in September 1984. Data summaries were issued to the contractor, MB and the carrier and felling-head distributors. At the end of the study the Timbco and RotoSaw were returned to Timberjack as the contractor considered the machine undersized for a Coastal application. However, Antler Creek considered the Timbco concept to be applicable to Coastal B.C., and they intended to finance and build for themselves a larger carrier incorporating similar design features.

This report contains the results of the monitoring program. FERIC originally planned to include these results in a publication which also would have contained the study on Antler Creek's larger machine. Unfortunately, the machine is still not functional at the time of writing (April 1985). FERIC decided to issue the Timbco/RotoSaw results at this time, and issue a separate report once the study on the new buncher has been conducted. Completion date for Antler Creek's machine is now expected to be summer 1985.

MACHINE AND OPERATION DESCRIPTION

Figure A shows the Timbco and RotoSaw as used during the monitoring period.



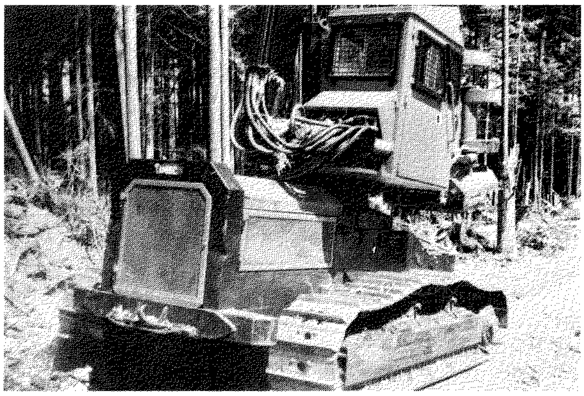


FIGURE A. Timbco Model 2518 Hydrobuncher and RotoSaw Felling Head.

Fuel and hydraulic tanks, and the engine, are located below the turntable.

Timbco

The Timbco is distributed in Canada through Timberjack's distributor network. Many components are manufactured in the United States by the original designer and are then shipped to Timberjack's plant in Woodstock, Ontario where additional fabrication and final assembly takes place.

As shown in Figure A, only the cab and boom are located above the turntable. This gives the machine a low centre of gravity which means a counterweight is not necessary. The Timbco also has a unique 3-way tilting upperworks--cab and boom assemblies can tilt forward 27° and to each side up to 22.5 degrees. (The forward tilt permits the cab to be levelled while the Timbco is on grades up to 51 percent.) Boom geometry is such that a tree in the felling head can be rotated in a 1.83-m (6-ft) radius from machine centre. These combined factors mean that mechanized felling can be extended to ground slopes previously inoperable with excavator-type machines.

Price as of May 1985 was $335 000 for the Timbco and RotoSaw combination, and $270 000 for the Timbco alone, f.o.b. Prince George, B.C.

RotoSaw

The RotoSaw is manufactured by Risley Equipment Limited of Grande Prairie, Alberta. Risley Equipment's policy is to sell directly to the user, although orders can be placed through local equipment dealers. The company can be contacted at:

Risley Equipment Limited
9620 109th Street
Grande Prairie, Alberta
T8V 4E4

Telephone: (403) 532-3282

The RotoSaw is a circular-saw type felling head. Two versions are manufactured. One is a feller-director for front-mounting on bulldozer tractors and the other is the buncher version as used in this trial. The buncher is classed as a 56-cm (22-inch) capacity feller, but the throat tapers from front to rear (Figure B). At approximately 28 cm (11 inches) from the rear of the throat, which corresponds to about half the diameter of a capacity tree, the width inside the frame is approximately 53 cm (21 inches).

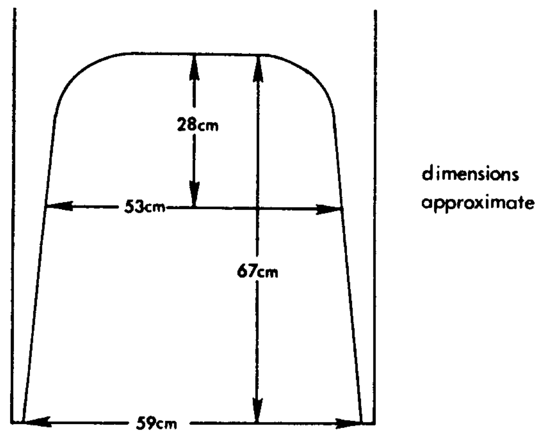


FIGURE B. Throat Dimensions of RotoSaw Buncher Head.

The circular disc is composed of two main parts: a top carrying plate on which the tree butt rests and a lower rotating element. The lower element is attached to the top plate at the centre by a sealed and lubricated bearing. Cutting teeth are cup-shaped and are bolted to mounts welded to the edge of the lower element. When teeth have dulled, the fastening bolt is loosened and the tooth is rotated 90 or 120° to provide a fresh cutting edge; or a new tooth can be installed. The disc is designed to operate as a low-speed (150 rpm), high-torque cutter. Cutting rate is 10 cm (4 inches) per second, provided the saw has 300 L/min (80 gpm) flow at 17 237 kPa (2500 psi). The buncher head can be equipped with optional sidetilt of 20° each way, but this is not provided on heads installed on Timbcos because of that machine's levelling ability. Price as of May 1985 was $65 000, f.o.b. Grande Prairie.

Further details and manufacturers' specifications for the Timbco and RotoSaw are located in Appendix I.

Operation

The study location was part of Tree Farm 19 on the east coast of Vancouver Island near Buckley Bay and was supervised by MB's Northwest Bay Division. Antler Creek Logging acted as a phase contractor and was responsible for all felling activity. Their buncher normally operated two shifts per day and seven days per week, and they also supplied a handfaller for the five weekday day shifts. This crewman felled occasional oversize trees, bucked any windfalls and spent his remaining time doing production felling.

Felled trees were skidded by rubber-tired skidders (line and grapple machines) and one FMC 220 with an ESCO grapple to roadside landings where a Hahn processor delimbed, bucked and topped them. Logs were sorted at the landing by a Barko 250 hydraulic heel boom loader into five sorts: export Douglas-fir; hemlock and fir sawlogs; cedar; fir pulp; and hemlock pulp. Log lengths were loaded onto highway trucks by the Barko 250, with occasional assistance from a Barko 450, for the 60-km trip to the Northwest Bay dryland sortyard. The woods operation was budgeted for, and produced, 15 highway loads per day over the five-day hauling week.

The pulp sorts accounted for about 40% of total volume produced. Pulp loads were weighed and direct-dumped, bypassing the individual log scale-and-grade procedure at the dryland sortyard. Woods sorting and direct dumping are important in connection with Coastal second-growth harvesting. Pulp loads contain between 100 and 200 pieces. This number of stems/truck cannot easily be introduced into the flow of a dryland sort because most yards are limited by the number of stems that can be handled and stick-scaled each day.

MACHINE PERFORMANCE DATA

Area Description

Table 1 describes the timber and terrain on the study area. Block size was calculated at over 80 ha, but part had been completed before the monitoring began. Slope classifications were visually estimated by FERIC. All other information was obtained from company cruise data. The divisional company forester had conducted check cruises and considered the cruise data to be representative of the site.

TABLE 1. Area Descriptive Factors.

No. of cutblocks	1
Merchantable volume/ha, m^3	520.0
Merchantable stems/ha	898.5
Block size, ha	80.8
Type of logging	clearcut
Avg tree size : volume, m^3	0.58
: dbh, cm	30.0
Species distribution : weighted average, % by volume	Douglas fir 61% Western red cedar 20 Western hemlock 19
Slopes - approximate range, % of area of block	50% of area between 0-10% 50% of area between 10-20%

Figure C further illustrates ground and site conditions. The photos show the lower portion of the block, which is generally less than 10% slope. The surface, however, is broken and rough, and ground debris frequently obstructed head placement on trees. The previous stand had completely blown down in 1875 and, while much of the Douglas-fir and hemlock blowdown had rotted, the remains of stems and root systems caused many hummocks. The block's upper portion was steeper, rising to a constant 20% slope, and larger blowdown was more common. The largest cedar windfalls in this area ranged from 1 to 1.5 metres in diameter and required manual bucking.

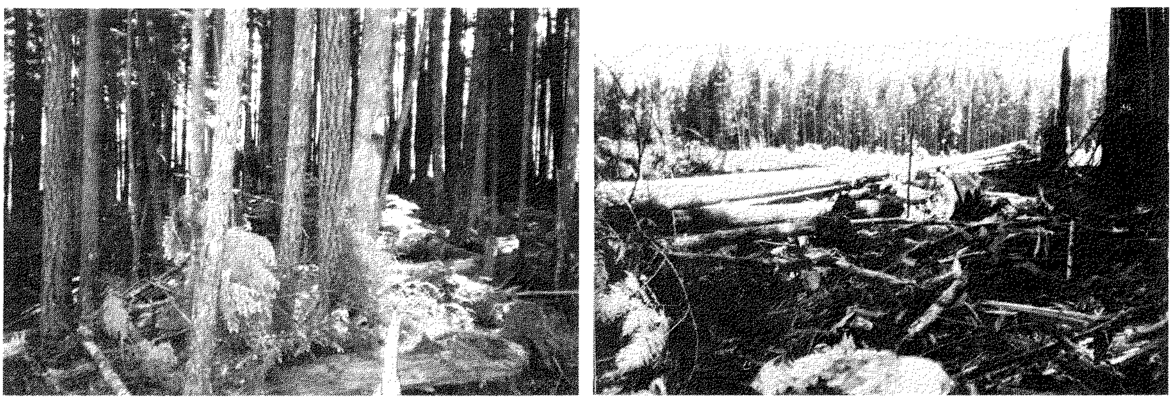


FIGURE C. Lower Portion of Cut Block.

Results

The data presentations in this section utilize a new format that has been used for recent interim reports and monthly machine summaries. Please refer to Appendix II for further explanation of the format and terminology.

Tables 2 through 6 summarize the information collected during the monitoring period.

Table 2 contains the calendar time summary showing the distribution of shift types. Production occurred on only 59 shifts, or 42% of the 140 shifts potentially available during the monitoring period. Non-productive shifts are detailed in the table, and are about equally divided between day and afternoon shifts, both in type and quantity. The exceptions are the 11 "non-scheduled" or unnecessary shifts which occurred when the contractor had adequate production felled in advance of skidding.

TABLE 2. Calendar Time Distribution.

Identification	Day shift		Afternoon shift		Both	
Report period	July 12 to September 19, 1984					
Calendar days in period	70					
	# of shifts	%	# of shifts	%	# of shifts	%
Possible shifts in period	70	100	70	100	140	100
Shifts worked (with production)	36	51	23	33	59	42
Shifts with no production:						
Repair or service shifts	6	9	6	9	12	9
Weekends (# of shifts of no activity)	0	-	0	-	0	-
Legal holidays (# shifts)	0	-	0	-	0	-
Shifts lost for other reasons **	28	40	41	59	69	49
** Reason for lost shifts	# shifts		# shifts		# shifts	
Wait parts	1		2		3	
Wait mechanics	2		1		3	
Divisional holiday closure	10		12		22	
Non-scheduled shifts	-		11		11	
Fire-hazard closure	15		15		30	

Table 3 contains time and production summaries for shifts worked. Total volume was obtained by multiplying the operators' piece counts by the cruise average tree volume. This procedure introduces a small error because oversize trees are included in the average tree volume, but they were felled by the handfaller instead of the buncher. However, the cruise showed 10 stems/ha to be above machine capacity (approximately 1% of the trees) and this error is considered negligible by the company, contractor and FERIC.

Time Distribution

Day shifts were of longer duration than afternoon shifts--9.4 hours versus 7.9 hours average. There were also more day shifts worked than afternoon shifts because of the 11 non-scheduled shifts. This resulted in more hours in all time categories for the day shift.

On a proportionate basis, the afternoon shift was more successful in utilizing total time for productive work. As shown below, nearly 69% of the afternoon shift was productive, compared to 64.2% for the day. This was because repair and service activities were concentrated during the day shift.

TABLE 3. Time and Production Summary for Shifts Worked.

Identification	Day shift		Afternoon shift		Both	
No. of SHIFTS WORKED (with production)	36		23		59	
Usual shift length, hours	9.0		8.0		-	
TIME (hours)	total	avg / shift	total	avg / shift	total	avg / shift
Productive Machine Hours (PMH)						
Cutting	215.8	6.0	123.9	5.4	339.7	5.8
Move in block	1.3	<.1	1.1	<.1	2.4	<.1
subtotal	217.1	6.0	125.0	5.4	342.1	5.8
Non-Productive Time						
A) Mechanical - repair	75.9	2.1	24.8	1.1	100.7	1.7
- service	13.3	.4	6.9	.3	20.2	.3
subtotal	89.2	2.5	31.7	1.4	120.9	2.0
B) Non-mechanical						
Wait parts	9.0	.3	9.9	.4	18.9	.3
Wait mechanics	9.0	.3	4.4	.2	13.4	.2
Landing changes	1.5	<.1	.3	<.1	1.8	<.1
(number of changes)	4		1		5	
Other non-mechanical	12.6	.4	10.2	.4	22.8	.4
subtotal	32.1	.9	24.8	1.1	56.9	1.0
Total	338.4	9.4	181.5	7.9	519.9	8.8
PRODUCTIVE TIME RATIO (Productive hours / Total hours)	64.2 %		68.8 %		65.8 %	
AVAILABILITY (for SHIFTS WORKED only)	68.3 %		74.6 %		70.5 %	
PRODUCTION						
Volume produced, m³	7770.8		4339.6		12110.4	
Tree count	13398		7482		20880	
Average tree size, m³	0.58		0.58		0.58	
Volume per PMH, m³	35.8		34.7		35.4	
Trees per PMH	61.7		59.9		61.0	
Volume per shift worked, m³	215.9		188.7		205.3	
Tree count per shift worked	372		325		354	
Production per 8-hour shift						
m³	183.7		191.0		186.6	
Tree count	317		329		322	

Note: AVAILABILITY for SHIFTS WORKED

$$= \frac{\text{Total hours - sum of (repair + service + wait parts + wait mechanics)}}{\text{Total hours}} \times 100\ \%$$

	Percent of Total Hours Day	Afternoon
Productive	64.2	68.8
Repair and service	26.4	17.4
Non-mechanical	9.5	13.7

Combining data for both shifts shows the average utilization to be 65.8% and the availability during shifts worked to be 70.5%, which is classed as low availability. Further information on mechanical performance is located in Tables 5 and 6.

Production

About two-thirds of total buncher production came from the day shift, again because the shifts were longer and there were more of them. On a Productive Machine Hour (PMH) basis, the day shift did produce slightly more (about 3%) than the afternoon. This could be because of a difference in operators and/or poorer visibility with night lighting. However, ranked on the basis of an 8-hour shift, the afternoon produced about 4% more volume than the day shift.

When the buncher worked both shifts, average daily production was 404.6 cubic metres, or approximately 12 of the required 15 loads per day. If the buncher had worked all 14 intended shifts per week, then it could have produced around 2832 cubic metres. This corresponds to about 17 loads per day per <u>5-day</u> haul week, which is in excess of the operational quota.

Disregarding the closures for fire hazard and divisional holidays, the buncher could have worked the remaining 88 shifts. However, 18 of them (20.5%) were unproductive for mechanical or waiting reasons. Therefore, the buncher produced at only 79.5% of its weekly capacity given the site and shift lengths involved. This translates to approximately 13 loads per day per 5-day week, meaning that either longer machine hours or a handfaller would have to make up the required quota. Considering that windfalls and oversize trees existed, the handfaller was necessary.

Handfalling production was actually greater than required, as the buncher was not scheduled for those 11 shifts. The best estimate, then, is that the handfaller produced about four loads per day and the buncher the remaining 11 loads per day per 5-day week.

Tables 4 to 6 summarize non-productive time. For each, data from both shifts have been combined.

Non-Productive Time

Table 4 summarizes non-productive time resulting from organizational, operational and personnel reasons. Organizational delays refer to in-shift waiting times for parts or mechanics, and interference to the machine from other operations and phases. Operational delays are usually weather-related, moves or activities the operator must perform in order to continue with or carry out his job.

The largest causes of non-productive time in these categories were organizational, specifically waiting parts and mechanics. These two groups accounted for 57% of the time listed in Table 4.

TABLE 4. List of In-Shift Non-Mechanical Delays.

Category	No. of occurrences	Total time	
		hours	%
<u>Organizational</u>			
wait parts : hydraulic components	5	16.9	33
: travel to/from service area (# 1-way trips)	18	2.0	
wait mechanic : transport parts to/from repair facility	9	10.3	
: machine travel to/from repair area (1-way trips)	16	1.8	24
: wait arrival of mechanic	1	1.3	
idle : wait for skidders to finish	1	2.6	5
idle : faller bucking windfalls	11	1.7	3
install study recorder	1	1.4	2
unknown	1	1.3	2
idle : faller cutting oversize trees	8	1.2	2
subtotal	71	40.5	71
<u>Operational</u>			
shutdown or early quit : wind	1	2.6	5
operator bucking windfall	10	1.9	3
landing changes	5	1.8	3
inspection by Workers' Compensation Board	1	.8	1
tree or log stuck in cab	1	.3	1
operator handfalling oversize trees	2	.2	<1
subtotal	20	7.6	13
<u>Personnel</u>			
visitors	13	4.3	8
coffee breaks	30	4.2	7
discussion with FERIC staff	1	.3	<1
subtotal	44	8.8	15
GRAND TOTAL	135	56.9	100

Little could have been done to reduce either the type or duration of recorded delays significantly. The total time in Table 4 accounted for only 11% of total in-shift time; each particular category therefore represents a small portion of daily operating time. Still, increased experience in stocking applicable parts would help to reduce wait time somewhat.

Mechanical downtime is listed in Tables 5 and 6. Table 5 is an overview showing a Mechanical Downtime Ratio (MDR) of 61.7 hours of repair and service per 100 Productive Machine Hours (PMH). Repair and service time both within and outside the operating shifts was included. To place this study's MDR in perspective, an 8-hour shift that had one-half hour of mechanical downtime would give a ratio of 6.7 hours/100 PMH (PMH for the shift is 7.5 hours). If that shift also had a half-hour of non-mechanical downtime (which further lowers PMH to 7 hours for the shift) the ratio would be 7.1 hours/100 PMH. These results are high compared to many other studies FERIC has conducted on harvesting machinery.

TABLE 5. Summary of Active Maintenance.

Identification	both shifts
Active repair and service hours on:	hours
A) shifts with production--in shift	120.9
--after shift	0
B) shifts without production	90.1
Total Repair and Service hours	211.0
Total Productive Machine Hours	342.1
Mechanical Downtime Ratio ([repair + service hours] / 100 PMH)	61.7

Table 6 contains the details of repair and service activities for the Timbco and RotoSaw. Service items like fuelling, adding oils, greasing, etc., were normally carried out at the end of the shift and most of them are already part of the category "daily service period". Occasionally, some occurred during the course of the shift and are therefore listed separately.

As an overview, 211.0 hours of repair and service were recorded, distributed as follows:

Head repair	18%
Boom repair	11%
Carrier repair	62%
Service	10%

TABLE 6. List of Repair and Service Activities.

Category		Problem	No. of occurrences	Total time hours	%
HEAD	Hydraulics	replace or modify hoses	9	8.2	
		repair or replace cylinder (unidentified)	1	5.4	
		tighten or replace fittings	13	5.1	
		repair valve	3	2.8	
		plan re-routing of hoses	1	.5	
		subtotal	27	22.0	10
	Housing/arms	grab arm repair - welding	3	9.9	5
	Cutter	replace or rotate teeth	7	3.9	
		saw jammed - clean debris	6	1.3	
		adjust feed speed/pressure	5	.7	
		subtotal	18	5.9	3
		subtotal : HEAD	48	37.8	18
BOOM	Hydraulics	repair tool cylinder - rod broke	2	11.1	
		replace hoses	4	1.4	
		tighten or replace fittings	1	.1	
		subtotal	7	12.6	6
	Mechanical/ physical	welding on boom or stick : includes 1x check on internal welds	4	8.6	
		examine/diagnose/check cracks	9	1.6	
		subtotal	13	10.2	5
		subtotal : BOOM	20	22.8	11
CARRIER	Frame/ turntable	straighten, weld and reinforce frame	1	64.0	
		replace belly pan	1	5.0	
		subtotal	2	69.0	33
	Hydraulics	repair cab tilt cylinder	3	25.0	
		replace hoses (includes 1x reposition of collector arm valve)	4	12.4	
		repair or replace pump	2	3.4	
		tighten or replace fittings	8	3.3	
		repair main valve bank	1	.8	
		subtotal	18	44.9	21
	Undercarriage	tighten and weld rock guards	1	9.0	4
	Cooling system	clean radiator	7	4.6	2
	Fuel system	plugged fuel line or filter	4	1.0	<1
	Motor	repair or replace throttle cable	1	.8	<1
	Cab/ROPS/ engine housing	repair wire screen	1	.3	
		tighten console mount	1	.1	
		repair seat	1	.1	
		replace broken bolts	1	.1	
		subtotal	4	.6	<1
	Electrical	replace fuse	1	.2	
		repair wire	1	.1	
		subtotal	2	.3	<1
		subtotal : CARRIER	39	130.2	62
TOTAL ALL REPAIRS			107	190.8	90
SERVICE		daily service period (undifferentiated items)	22	8.4	
		machine warm up	33	4.9	
		grease machine or attachment	12	3.1	
		fuel up	8	1.5	
		change oils or filters	2	1.0	
		check for oil leaks	7	.9	
		add hydraulic oil	2	.4	
TOTAL SERVICE			86	20.2	10
GRAND TOTAL			193	211.0	100

Of repair time alone, the RotoSaw accounted for 20% and the Timbco for 80% (boom: 12%; carrier: 68%). The two largest repair categories were carrier frame and carrier hydraulics, accounting in total for 60% of all repair hours.

The recorded types and quantity of downtime is of concern to user, manufacturer and potential user. There are four basic reasons why such levels could occur:

1) operator misuse, abuse or neglect;
2) poor design concept;
3) poor quality parts and/or manufacturing procedures; and
4) inappropriate match of machine to conditions.

FERIC does not consider that operator misuse, abuse or neglect caused these downtime levels. FERIC was on-site on several occasions during the study. No misuse or careless procedures were noted. The crew was also highly attentive to buncher mechanical performance. Their philosophy was that the machine represented their livelihood.

It is also very unlikely that design concept, or parts quality and manufacturing procedures were important negative factors in this trial. Other Timbco machines have been in use longer than this one. FERIC has been involved with some of them and no downtime levels of this order were encountered in a 2-month period. Other users have commented favourably on the design concept. While early repairs have been needed (adjustments, re-solderings or re-weldings, tightenings, etc.) they have been no more serious than what is frequently required on many newly-arrived machines.

It is most likely that this specific machine was incorrectly matched to the working conditions. The Timbco was not designed for a Coastal B.C. application, but for the smaller trees and smoother ground conditions of non-Coastal stands. In view of this, FERIC considers that there are at least three factors which influenced mechanical downtime in this trial: ground conditions; tree height; and stick-boom length.

Ground Conditions. Although a given Coastal cutting block may fall predominantly within a certain slope range (e.g., level; 50-70%) the ground surface is not uniform. It is broken and frequently has old stumps, debris, rock and small windfall. There are many dips and hollows. Freshly cut stumps add to these natural impediments, particularly when a machine must back up.

The Timbco's belly pan and part of the carbody framing failed during the trial. The 1.3-cm (half-inch) thick belly pan was designed to slide out, partly for access for repairs and servicing and partly so that felling debris (needles, branches) could be more-easily removed to reduce fire hazard. Both the belly pan and some of the 0.64-cm (quarter-inch) thick tubing of the carbody had buckled and were out of line. The carbody tubing acted as the support frame to which the belly pan guides were attached.

In order to install a stronger pan of 2.54-cm (1-inch) CHT 100 steel, the frame had to be repaired and reinforced with thicker and higher strength material. Approximately 70 hours were required to perform the repair, but this did not actually detract from productive time because the work was done during the divisional holiday closure.

Tree Height. Second-growth timber on the Coast is taller than the equivalent diameter and species in the Interior. Adamovich (1979) has shown that Interior best-site 40-cm Douglas-fir averaged 26.9 m in height in the wetbelt and 21.3 m in the drybelt. In comparison, the cruise for the study area (high medium-quality site, type code FH-(1875)21) showed the average height for a 40-cm fir to be 30.9 metres, between 15% and 45% taller than an Interior tree. (Best-site Coastal trees would be taller.) The centre of gravity of Coastal fir is therefore higher and the weight is probably greater. Unfortunately, data on full-tree weights of Coastal species does not appear to exist, so further comparisons cannot be drawn with Adamovich's Interior work. Although all species comparisons may not show this range of height difference, Douglas-fir was chosen for this example because the study block was predominantly of that species.

Stick-boom Length. This Timbco was fitted with the 3.96-m (13-ft) stick-boom instead of the smaller 3.35-m (11-ft) stick. The intent was to increase reach to compensate for increased carrier moving difficulty in the rougher Coastal terrain. With hindsight, it has been mutually agreed by Antler Creek and Timberjack that this route should not have been chosen for a Coastal Timbco. Lift capacity is reduced at greater distances from the machine. Capacity-size trees, especially on the Coast, which are severed at or close to maximum reach, are simply more difficult for the machine to handle.

It is probable that the combination of larger trees and longer reach on this Timbco resulted in some of the problems to the hydraulic system and boom, and to a lesser extent with the grab arms. Both repairs to the tool cylinder and all repairs to two of the four cab-tilt cylinders were because the cylinder rods broke near the piston. Breakage seemed to be finally resolved by boring and threading the rod ends and inserting threaded studs of 4340 steel. However, four of the Timbco's seven cylinders had not received this modification during the trial and Antler Creek expected some or all of them to fail if they had retained the machine. Of greater concern to the contractor was the developing problem with the main boom. It kept cracking near the stick-boom cylinder mount. Antler Creek checked the main-boom internal welds on instructions from Timberjack but found no problems. The Timbco worked only four more shifts before the end of the study so it is not known if repair procedures were adequate to solve the problem permanently.

In December of 1984 Timberjack personnel from Prince George reviewed the downtime data. They noted then that they were no longer offering the longer stick-boom in British Columbia, based on the experience with this machine.

The RotoSaw felling head generally performed well. Initial hose breakage, mostly from chafing, was of concern. This was resolved after the hoses were re-routed (classed as part of a hose repair) after which only three of the nine hose repairs occurred. (The contractor informed Risley Equipment of this problem and fabrication practice was altered.) The grab arms, however, cracked three times. Antler Creek has attributed this to the manufacturing process because the welds had been ground down to give a smoother, more finished look. It is also possible that Coastal tree heights and weights contributed to the fractures.

RotoSaw teeth are not sharpened. They are either rotated or replaced. The teeth required attention seven times during the 59 working shifts. The sessions averaged just over half an hour each. Figure D illustrates the procedure for either rotating or replacing the cutters.

USER COMMENTS

Interviews were conducted during and after the study with the contractor and MacMillan Bloedel's Divisional Forester responsible for the operation. Their comments are summarized below.

Antler Creek Logging

FERIC asked the contractor to list and rank the positive and negative features of carrier, head or trial. They indicated they were pleased with:

1) the Timbco's cab-levelling ability;
2) its ease of access for service and repair;
3) Timberjack's willingness in accepting the return of the machine;
4) the Timbco's stability; and
5) the RotoSaw head.

They were unhappy about the following points:

1) the boom lacked adequate power;
2) (several points they considered of equal importance) ground clearance was too little; carrier was underpowered; hoses chafed at the swivel and behind the boom; cab was too narrow; and
3) lack of cab-levelling ability to the rear.

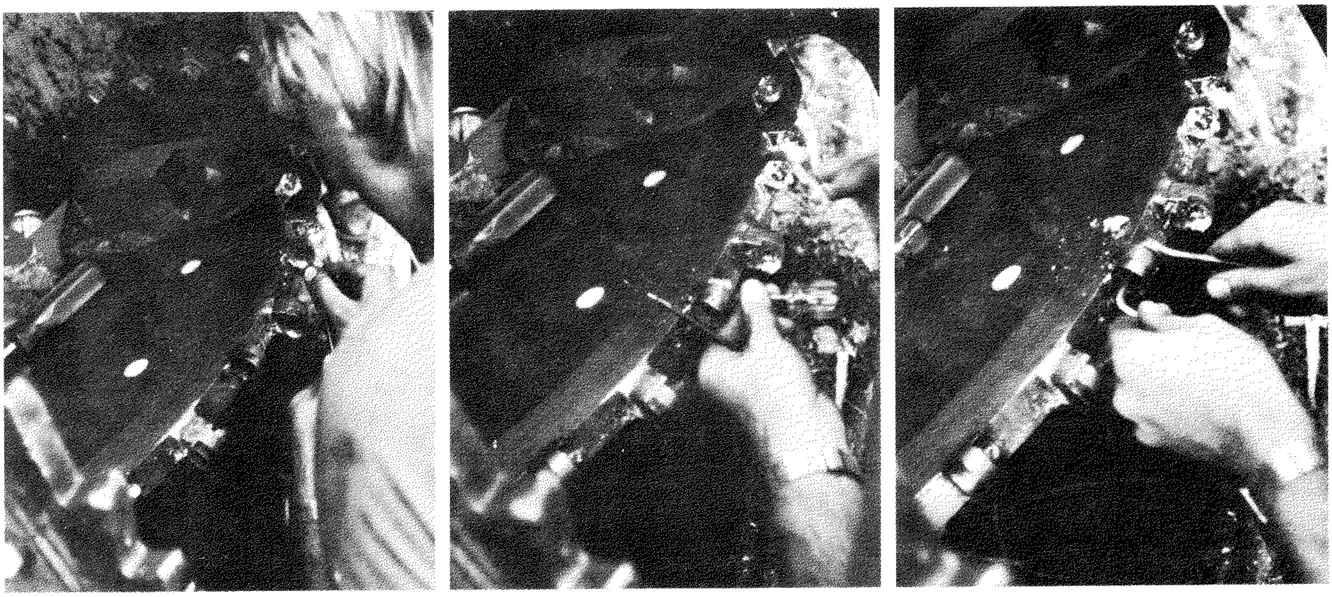


FIGURE D. RotoSaw Tooth Maintenance.

Both the bolt head and nut area must be cleaned (photos 1 and 2) before the bolt can be loosened (photo 3). The circular tooth can be rotated to a new cutting position or a new tooth can be installed if the old one is worn out. The complete procedure takes between 1.5 and 4 minutes per tooth. Not all teeth require attention each time.

MacMillan Bloedel Limited

- From a systems point of view, woods sorting at the landing is necessary for the efficient and economic function of the full system. Smallwood (pulp) is difficult to sort and handle at a dryland sortyard.

- Coastal conditions differ from the Interior. Coastal trees are taller and heavier, and flat ground is not smooth (broken, windfalls, stumps). This places demands on a Coastal buncher. Cab levelling is therefore desirable. A powerful machine is also necessary in order to manoeuvre effectively on rough ground.

- Mechanical felling for most Northwest Bay operations will be on slopes averaging less than 30% but there will be pitches to 35 percent.

- Grapple yarders will be an integral part of Northwest Bay operations. Trials are underway to determine if mechanical felling and bunching can be a cost-effective component of this system.

- The RotoSaw worked very well, but the requirement for non-sheared wood at Northwest Bay may be limited. The export market has recently tapered off, but when it returns, non-shear wood may again be desirable. However, after the Timbco/RotoSaw combination left the area, a Case 1187 with a shear head was used at MB's Cowichan Woodlands Division in a 50-year-old second-growth Douglas-fir stand. The wood was followed through the sawmill. No shear-caused damage was detected by mill personnel. Non-shear heads may not be required, but a contractor can use one if he wishes.

CONCLUSION

This Timbco trial must be considered as an unsuccessful machine introduction to Coastal B.C. second-growth harvesting operations. The Timbco was returned to, and accepted by, the dealer. Although the RotoSaw was also returned as part of the package, the contractor and the company considered the felling head to have been successful. When Antler Creek's own design of feller buncher is completed, they plan to install a larger capacity RotoSaw buncher head.

The Timbco appears to have been inappropriately matched to working conditions. This machine was the first Timbco to be sold in British Columbia by Timberjack. Both user and manufacturer were inexperienced with Timbco applicability to Coastal B.C. Ground debris and projections buckled the belly pan and part of the carbody frame. Larger Coastal trees, combined with a stick-boom length that was probably too long, seem to have caused problems to the hydraulic system and boom, and possibly the head grab arms. The result was low availability (70.5%) during working shifts. Overall mechanical performance (both within and outside working shifts) showed that 62 hours of repair and service were required to keep the machine productive for 100 hours. This degree of mechanical attention is quite high.

While the machine worked, the contractor considered productivity to be acceptable. Day and afternoon shifts combined showed an average of 61 trees/PMH, which corresponded to over 35 m^3 at an average tree volume of 0.58 m^3. The contractor considers the Timbco to have been underpowered for manoeuvring and lifting; a more powerful carrier would therefore tend to increase hourly productivity. (FERIC cannot disagree with the contractor's comments on manoeuvring power. On several occasions we observed the carrier to "power out" under conditions which cannot be classed as extreme.) The RotoSaw performed well except for some minor problems. Both head design and cut quality were considered acceptable by user and company.

This particular trial does not mean that the Timbco concept, or the Timbco machine itself, cannot function on Coastal B.C. Another Timbco has been used on the Coast for two years, and that operation was one of the factors Antler Creek considered before obtaining their Timbco. That first machine is actually smaller than Antler Creek's, but it did not have the longer stick-boom. FERIC met with the other contractor and discussed his operation as well as the downtime problems recorded in this study. That contractor indicated he had not had any major problems with his machine, and his availability has been 90-95% over the two seasons. (Downtime information obtained from monitoring devices, such as the Servis Recorders used in FERIC programs, is invariably more detailed than what can be obtained from operators' time cards. If such a device had been used by that contractor his availability would undoubtedly be lower.) Nonetheless, the contractor was surprised at the types of downtime recorded in this study. Although unfamiliar with many details of the study operation, he noted that extended reach on a Timbco, particularly on the Coast, can result in problems.

Use of feller bunchers on the Coast will increase as more companies face second-growth operations. Bunching of trees, whether for ground skidders or cable yarders, is sensible and logical where tree and ground conditions permit it. Therefore, a feller buncher that can work on 20-40% slopes has an important part to play. The Timbco concept has been proven. Almost all users have been very pleased and equipment dealers are introducing other cab-levelling excavator-style bunchers to B.C. (Tanguay and Caterpillar 227, for example). Antler Creek themselves are building their own cab-levelling machine.

Although this particular machine trial was unsuccessful, another Coastal Timbco has apparently worked longer and with fewer problems. It is therefore FERIC's opinion that it is yet inconclusive whether the Timbco machine is capable of sustained successful performance on the Coast, but the Timbco concept of a high degree of cab levelling is both desirable and viable.

REFERENCES

Adamovich, L.L. Engineering Characteristics of Canadian Trees: Douglas-fir and Western Hemlock in Interior British Columbia. FERIC Technical Note No. TN-27, Vancouver, 1979.

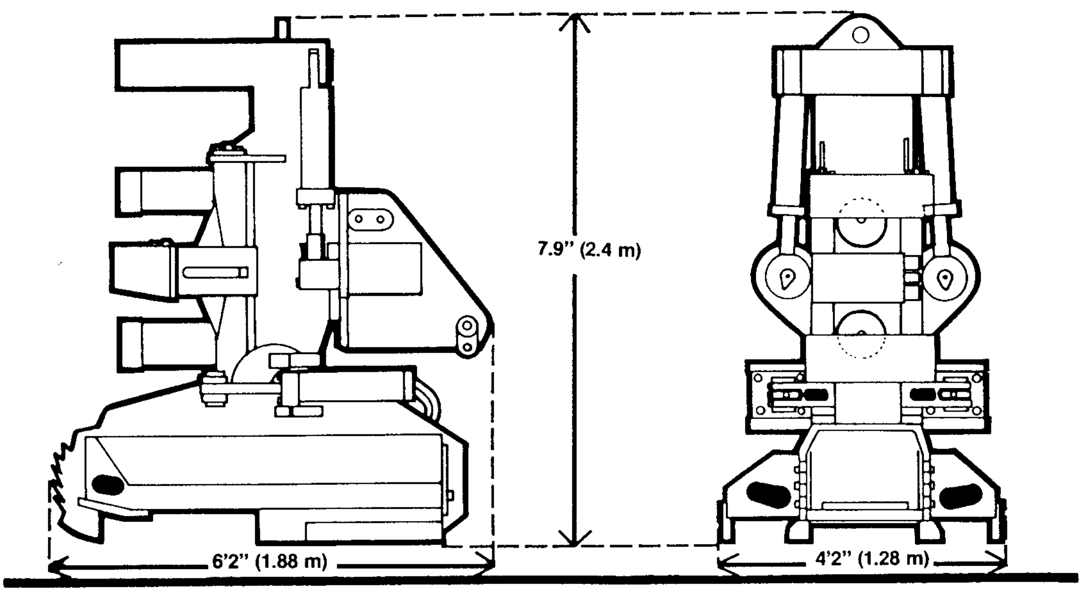
Bérard, J.A., D.H.W. Dibblee, and D.C. Horncastle. Standard Definitions for Machine Availability and Utilization. W.S.I. No. 2428 (B-1), Canadian Pulp and Paper Association, Montreal, 1968.

McMorland, Bruce. Trials of Two Feller-bunchers in Coastal B.C. FERIC Technical Note No. TN-57, Vancouver, 1982.

APPENDIX I

Manufacturers' Specifications

ROTOSAW® DIMENSIONAL DATA,



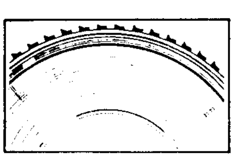
SPECIFICATIONS:

- Weight........................ — 4400 lbs. (2000 kg)
- Hydraulic Requirements......... — 55-80 GPM (200-300 L/min.)
  — 2500 PSI (175 Bar)
- Capacity........................ — 22" Tree (56 cm)
- Blade RPM.................... — 150
- Cycle Time..................... — Variable to tree size and pump flow
  — Optimum — 3-7 sec.
- Side Tilt Angle (Optional)........ — 20° Right/Left

FRAME:

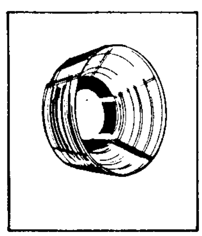
- All load bearing components manufactured from high alloy Grade Steel.
- Welded main frame.
- Pins and eyes all high tensile steel.
- Critical moving parts protected by guarding or enclosing in the frame.
- Serrations provided on front for dozing deadfall and underbrush.
- Torrington ball bushings on arm pivots.
- Fedalloy bolts and nuts utilized throughout.

CUTTING DISC:



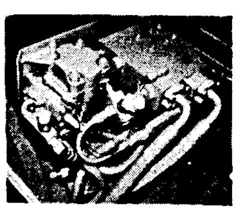
- Manufactured from high alloy spring steel.
- Inner reduction gear drive on ring is sealed, protected, and automatically lubricated.
- Two drive gears to reduce point load and provide constant power to ring for longer life.
- Centre of Disc stationary to support cut off tree.
- All load on cutting edge taken by replaceable nylon and brass inserts.
- Only rotates while in cutting mode.

TEETH:



- Utilizes exclusive **ROTOTOOTH:** Hardened circular insert teeth are self sharpening with up to four times the life of regular teeth as they may be rotated to four different cutting positions before they are replaced.
- Teeth are insert type; therefore they may be replaced individually without changing the complete blade. Tooth inserts are relatively inexpensive and replaceable in minutes with ordinary tools.

HYDRAULICS:



- Compact component package
- 55-80 GPM (260-380L/min) Required hydraulic flow.
- Motor spool control valve required (provided optional for mounting on contractors machine)...
- Single control for both cut and feed of saw.
- Unique roto cut / feed system varies automatically depending on difficulty of cut. Prevents blade stall. If blade hits an obstacle that stops rotation, it will retract momentarily; then return to the cut without operator involvement...
- Denison positive vane motor provides main cutting drive. Hall & Pigget (or Commercial) motor pump combination gives extra power to ring as well as providing power to extend blade.
- Dual cylinders - both operating in compression on (side tilt model)
- Separate arm cylinders for each side arm.
- Caterpillar" Type packings used throughout.

(Specifications and design subject to change without obligation)

2518

Timberjack TIMBCO Feller Buncher

Designed and engineered by loggers for loggers, the TIMBCO 2518 feller-buncher is compact, light, maneuverable, fast:

Unique boom geometry allows exceptional stability with no counterweight, no dead weight.

Cab and boom turntable tilts 27° forward and 22½° to each side for working on slopes up to 60%.

A cut tree can be rotated 600° within a 6 ft. (1 830 mm) radius for thinning and select cutting.

Standard 18" (457 mm) shear capacity, or 15" (380 mm) in dense hardwood.

Vertical reach to 36 ft. (11 m) for delimbing on downstroke using standard top clamp arms.

Optional shear head for accumulation of up to 6 trees before release to pile.

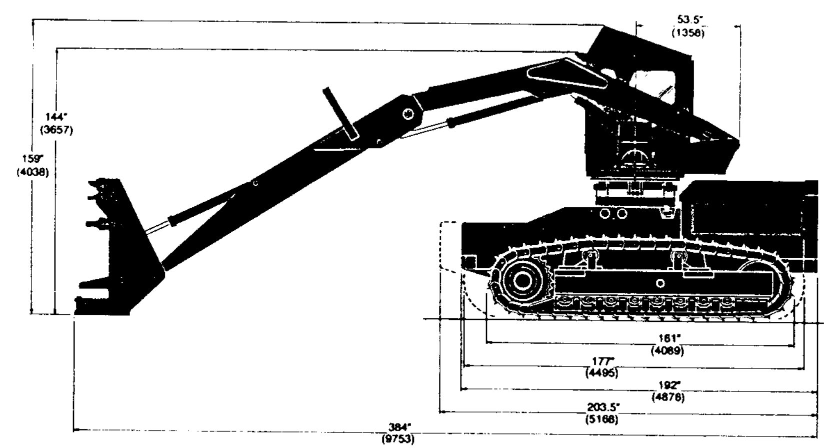
Single-grouser hydrostatic driven tracks for excellent maneuverability and travel speeds of 2.2 to 3.0 mph (3,5 to 4,8 km/h) depending on gear ratios.

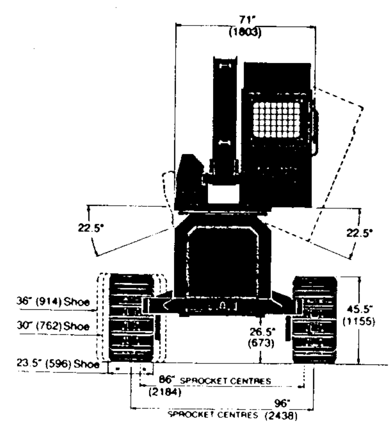
Optional long frame and wider pads for lower ground pressure down to 4.7 psi (32,4 kPa).

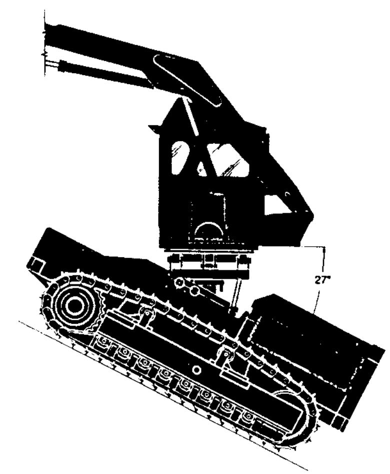
Heavily screened Lexan-enclosed cab meets SAE standards for ROPS, FOPS and OPS.

Pilot-operated joystick controls, naturally positioned.

SPECIFICATIONS







Power Train

Engine	6466T, 177 hp (132 kW) @ 2100 rpm
Drive	Triple pump with 11½" (292 mm) double plate clutch
Pumps	Two (2) hydrostatic 54 Series, one for each track
Operating pressure	5,000 psi (34 475 kPa)
Tracks	B6 excavator with single cleat grousers
Fuel tank	112 U.S. gal. (424 L)
Batteries	Two (2) 12-volt connected in parallel

Hydraulic System

Pumps	Tandem circuit — 44 gpm (167 L/min), 27 gpm (102 L/min) with combined flow
Hydraulic oil tank	135 U.S. gal. (511 L) capacity
Filters	10 micron return filtration with internal sensing for automatic shutdown in case of clogged filters or high viscosity oil. 10 micron suction filtration for hydrostatic drive.
Control valves	D50, pilot-operated, 2,400 psi (16 550 kPa) relief pressure
Hydraulic hoses	4-wire throughout system
Bolt-on-head cylinders	(1) main boom: 7" (178 mm) bore, 42" (1 067 mm) stroke, 3½" (76 mm) rod (1) jib boom: 6" (152 mm) bore, 37" (940 mm) stroke, 3" (76 mm) rod
Bolt-on-head cylinders (cont.)	(1) tool: 5" (127 mm) bore, 36" (914 mm) stroke, 2½" (63 mm) rod (2) tilt — side: 6" (152 mm) bore, 12½" (317 mm) stroke, 3" (76 mm) rod (2) tilt — front: 5" (127 mm) bore, 13" (330 mm) stroke, 3" (76 mm) rod (2) shear: 6" (152 mm) bore, 14" (356 mm) stroke, 3" (76 mm) rod (1) top clamp: 3½" (89 mm) bore, 13" (330 mm) stroke, 2" (51 mm) rod
Cooling	126°F (52°C) ambient engine cooler and 100 U.S. gal. (378 L) capacity oil cooler mounted side by side
Swing motor	6 rpm, planetary drive
Turntable bearing	51" (1 295 mm) outside diameter
Pivot pins	2½" (63 mm) and 2" (51 mm) heat-treated, stress proof, turned, ground and polished with hardened bushings. Tapered hub pin bosses in all critical pin areas.

The manufacturer reserves the right to make changes or add improvements at any time without incurring any obligation to make such changes on machines manufactured previously.

	Short	Long
Overall width —		
23.5" (597 mm) tracks	9'2" (2 794 mm)	10'0" (3 048 mm)
30" (762 mm) tracks	9'9" (2 972 mm)	10'7" (3 226 mm)
36" (914 mm) tracks	—	11'1" (3 378 mm)
Height to top of cab	12'0" (3 658 mm)	12'0" (3 658 mm)
Overall length (less boom)	16'0" (4 876 mm)	16'11½" (5 168 mm)
Weight (less attachment)	48,800 lbs. (22 136 kg)	50,800 lbs. (23 043 kg)

	Short	Long
Ground pressure —		
23.5" (597 mm) tracks	7.7 psi (53 kPa)	7.2 psi (49,6 kPa)
30" (762 mm) tracks	6.1 psi (42 kPa)	5.6 psi (38,6 kPa)
36" (914 mm) tracks	—	4.7 psi (32,4 kPa)
Travel speed range, depending on gear ratios	2.2 to 3.0 mph (3,5 to 4,8 km/h)	2.2 to 3.0 mph (3,5 to 4,8 km/h)

APPENDIX II

Explanation of Data-Presentation Format

The experimental data-presentation style in this report is based on a procedure which accounts for every calendar day in the month (in effect, a calendar time summary). Each day is composed of a number of shifts, and it is that number which is accounted for. On a one-shift-per-day operation, and in a month of 31 days, then 31 shifts would be itemized. If the operation runs 2 or 3 shifts, then 62 or 93 "shifts" must be accounted for.

Under this procedure, it makes no difference to the machine or system WHEN something occurred, only that something did happen and was accounted for. If the machine produces wood on a shift, regardless of quantity, then it is classed as a productive shift, or a SHIFT WORKED. If no wood is produced, the shift is classed under one of five main categories:

Repair;
Service;
Weekends;
Legal Holidays; and
Other.

The category "Other" encompasses all reasons other than the previous four categories. Examples: weather closures, break-up, shutdown for market conditions, personal vacations, sickness or injury, strikes, wait parts or mechanics.

Every operation develops a work pattern of so many days of work followed by so many days off. Usually this corresponds to five working days with Saturday and Sunday as the weekend. Other patterns are possible, but whatever the pattern, the equivalent of "weekends" can be identified. If the crew works on a weekend to produce wood (or do mechanical work) then that shift is called a SHIFT WORKED (or a REPAIR or SERVICE shift). The same applies if the extra time occurred on a legal holiday.

The mechanical performance of the machine is measured in several ways: first, from the calendar time shift distribution; second, from the in-shift Availability figure; and third, from a summary which incorporates the two. This latter item accounts for the grand total of all repair and service times, which is then related to Productive Machine Hours (PMH). The resulting ratio shows how many hours of repair and service were necessary in order for the machine to work for 100 PMH. In addition, a complete list of downtime causes, hours and number of occurrences is provided.