FERIC FOREST ENGINEERING RESEARCH INSTITUTE OF CANADA
INSTITUT CANADIEN DE RECHERCHES EN GÉNIE FORESTIER

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Evaluation of the Timberjack 30 Delimber-Slasher

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FOREWORD

This report summarizes the results of a brief study of the Timberjack 30 Delimber-Slasher, a machine developed and sold by a Timberjack Inc. dealer in Québec.

Since the time studies were based on samples that represent a limited range of operating factors, the reader is advised that the results refer to "cases", presented as indicators of machine potential, and should be applied to other situations with caution.

Grateful appreciation is extended to N. Baird and W. Brown of C.I.P. Inc., Maniwaki, Québec, to Y. Gauthier of Grand-Rémous, Québec, to R. Ménard of Timberjack Inc., Pointe Claire, Québec, and to T. White and K. Kelly of Timberjack Inc., Woodstock, Ontario.

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SUMMARY

The Timberjack 30 Delimber-Slasher is a machine that delimbs, tops and slashes to a standard length in one operation, using a single operator. It was developed and sold by a Timberjack sub-dealer in southwestern Québec during 1981. Three similar units were built; one of these units was studied by FERIC during the summer of 1981.

The Timberjack 30 Delimber-Slasher incorporates into one logging machine all, or parts of, several existing machines; i.e. a Husky XL 220 Heel-Boom Loader with a Rotobec grapple; a modified Timberjack 230 Skidder; and a Timberjack 30 Delimber, equipped with circular cut-off saw.

The machine studied by FERIC was a rental/purchase unit operated by two partners, logging contractors for C.I.P. Inc. at a location about 140 kilometres north of Maniwaki, Québec. The unit was operated on a two 9-hour shift-per-day basis, 5 days per week, delimbing and slashing 3.8-m lengths from softwood full trees piled at roadside by skidders. No sawlogs were produced. Two studies were carried out by FERIC, the first when the operator had 1 month of experience; the second study when he had 3 months.

The results of FERIC's studies are shown in the table below:

Table S-1. Summary of Productivity

	Study I		Study II	
Volume per tree, m^3 (ft^3)	.14	(5.1)	.17	(6.0)
Loading cycles per PMH	50		49	
Delimbing cycles per PMH	38		39	
Trees processed per PMH	53		60	
Trees processed per delimbing cycle, % of total				
1 tree	91		73	
2 trees	9		21	
3 trees	-		6	
Production per PMH m^3/PMH (ct/PMH)	7.6	(2.7)	10.2	(3.6)

Loading full trees required 56% of the total time on both studies; it was time consuming for the following reasons:

a) the operator frequently had trouble extracting only one tree from the full tree pile;
b) each full tree was swung through a 90° arc;
c) the Husky XL 220 loader is a large capacity loader with relatively slow boom extension and turntable rotation speeds;
d) due to the small size of the butt grapple at the base of the delimber rail it was often difficult to place more than one tree at a time onto it.

The Delimber-Slasher's maximum travel speed was 3.0 km per hour. The mobility of the unit was judged to be good due to the 4-wheel hydraulic drive, no-slip differential, plus the articulation provided by the skidder frame. The unit was never stuck during the first three months.

Some mechanical problems were encountered during the first three months of use. These included problems with the cables jumping off the pulleys on the end of the delimber rail; this problem has been rectified. Problems with the failure of sealed bearings on the delimbing carriage may be rectified by the current changeover to greasable bearings. Other problems, such as premature failure of the bearing on the circular saw are still under study.

By combining delimbing and slashing functions on one machine the Timberjack 30 Delimber-Slasher can reduce the number of times that wood is handled. Other benefits such as reduced manpower required, improved safety conditions and lower wood scaling costs may also result. However, due to the limited productivity of this unit, there was no apparent savings as compared to other existing methods for delimbing and slashing. This may change if further improvements are made to the unit, or to other delimber/slashers, using similar operating principles.

INTRODUCTION

The Timberjack 30 Delimber-Slasher is a new machine that incorporates all, or parts of, several existing machines (i.e. the Husky XL 220 Heel-Boom Loader; the Timberjack 230 Skidder, and the Timberjack 30 Delimber with a large, circular cut-off saw) into one logging machine. The idea for this combination originated from J.Y. Piché, Timberjack sub-dealer, Ferme Neuve, Québec. He recognized the possibility of delimbing and slashing on one machine, thereby reducing the amount of wood handling, and thus possibly reducing the total cost of delimbing and slashing.

To supply the power required for loading, delimbing, slashing and moving, a single engine with a large hydraulic capacity was required. The Husky XL 220 Loader, equipped in the factory with a large engine (93 kW), three @ 230 L/min pumps and a large hydraulic cooling system was selected for this purpose.

The Timberjack 30 Delimber-Slasher was built at the Pointe Claire, Québec branch of Timberjack Inc. with the exception of the circular saw which was installed at the Ferme Neuve Québec, Timberjack sub-dealer. Personnel from Timberjack Inc. (Woodstock, Ont.) were not directly involved with this project.

Three units were built during the first half of 1981, all for logging contractors of C.I.P. Inc., Maniwaki, Québec. The first unit started production in February; two more units began production in May and June, 1981. FERIC's study was conducted during June and August, 1981 on the second unit built.

In October 1981, the price of the complete Timberjack Delimber-Slasher was C$175,000 f.o.b. Pointe Claire, Québec. Approximate prices for the various components were: delimber unit, $50,000; loader unit, $85,000; modified skidder carrier, $20,000; hydraulic hook-ups, valves, circular saw, $20,000.

TECHNICAL INFORMATION

The Timberjack 30 Delimber-Slasher is comprised of several major components (see Fig. 1):

Husky 220 XL Loader

- Detroit Diesel 4-53 motor, 93 Kw (125 hp) @ 2200 rpm
- Lift capacity 10,861 kg @ 2.4 m
  6,089 kg @ 4.6 m
  4,445 kg @ 6.7 m
- Hydraulic operating pressure 13,790 kPa
- Three (3) hydraulic pumps, each with a 230 L/min capacity
- Extra hydraulic cooling capacity
- Two (2) sets of stabilizers
- Heel-boom attachment
- Gresen valves
- Lever controls plus two (2) joy sticks
- Rotobec 878-44 pulp grapple

Timberjack 230 (modified) Skidder Frame

- A used (10 year old) TJ 230 skidder frame, with the back end lengthened and the front end widened, was used to carry the Husky loader.
- Power was supplied to all 4 wheels using a hydraulic drive motor driven from a pump on the loader's engine.
- Tires were 20.5 x 25 20-ply Keflar.
- Both axles had "no-slip" differentials.
- Travel speed maximum 3.0 km/hour
  (The unit studied by FERIC had ring-type tire chains on the front skidder axle).

Timberjack 30 Delimber (with Slasher Saw)

This is a towed unit that is hydraulically powered, using "quick disconnect" couplings from the engine on the Husky loader.

- Designed for small trees; the rated limb diameter is 4 cm; maximum butt diameter is 35 cm; maximum delimbing knife opening is 52 cm.
- Maximum delimbing stroke - with the retractable end section fully extended is 12.8 m.

The slasher unit consists of a 132-cm, hydraulically-driven circular saw mounted in a protective steel cage on the side of the delimber bunk. Additional support arms were added to the delimber bunk to accomodate short tree sections.

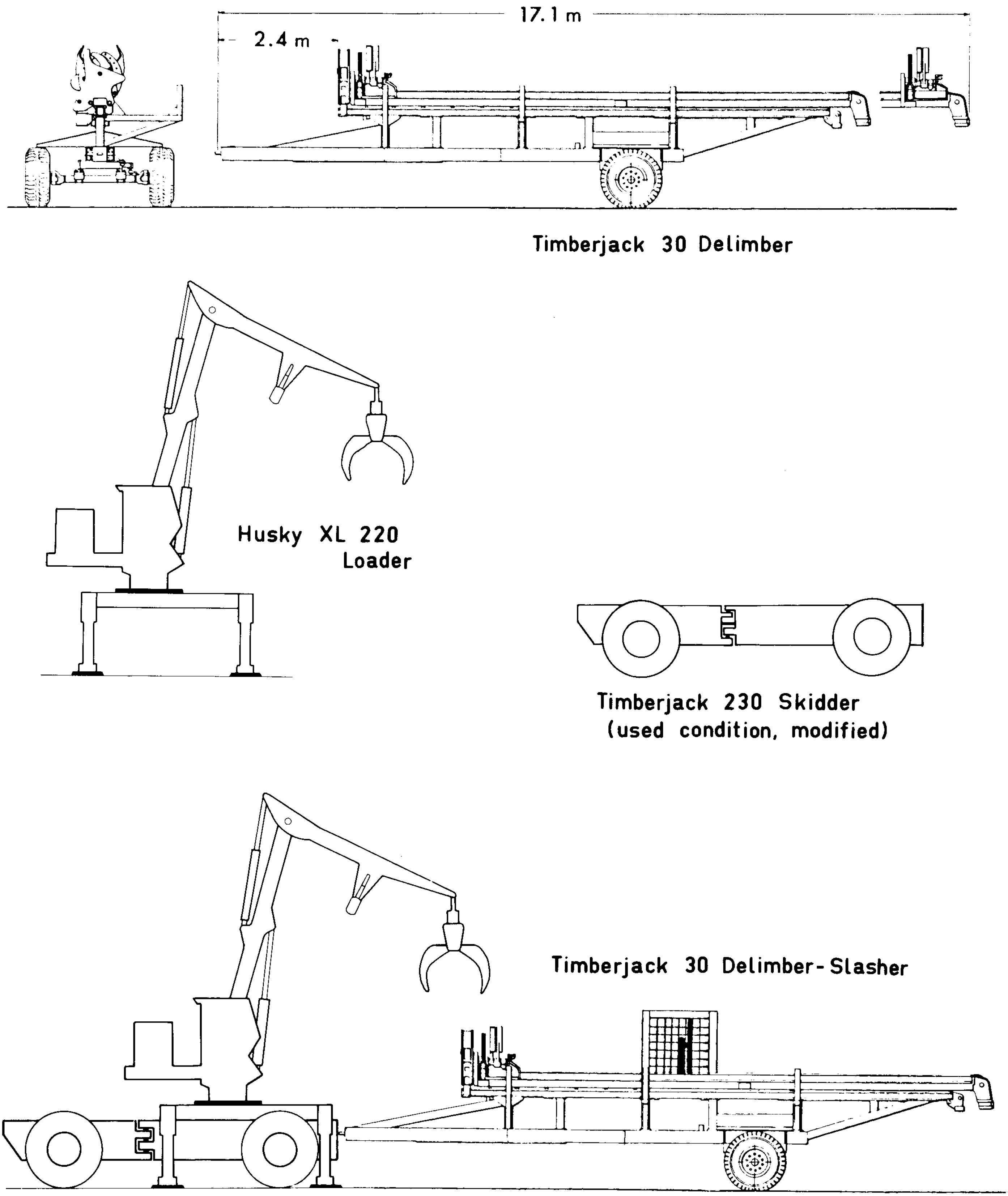

Fig. 1. Timberjack 30 Delimber - Slasher; major components are shown.

THE OPERATION

The Timberjack 30 Delimber-Slasher studied by FERIC was a rental/purchase unit owned and operated by Y. Gauthier and M. Rivest, logging contractors for CIP Inc. at Camp Pensive, located approximately 140 kilometres north of Maniwaki, Québec.

The unit was operated on a two 9-hour shift-per-day basis, 5 days per week, delimbing and slashing full trees piled at roadside by skidders. This machine was equipped to produce 3.8-m lengths; no sawlogs were produced.

The main species harvested on this clearcut operation were black spruce and balsam fir. Most of the trees ranged from 9.1 to 10.7 m merchantable length; however, some trees (approx. 10-15%) were longer, up to 14 m merchantable length. Although the area was clearcut for black spruce and balsam fir about 50% of the stand, i.e. all hardwoods plus softwoods such as hemlock and eastern larch, remained standing. The terrain was gently rolling and was classified as 2.2.2.*. Road conditions were excellent during the study.

Y. Gauthier, one of the two owner/operators, operated the machine during the two time studies conducted by FERIC, in June and August 1981. At the time of the first study, he had only 1 month of experience on the Timberjack 30 Delimber-Slasher; on the second test, he had 3 months. Previously he had approximately 5 years experience operating log loaders and 3-man mobile slashers. All repairs and service were carried out by the owner/operators. Assistance with major repairs and modifications was obtained from the Timberjack sub-dealer in Ferme Neuve, Québec, about 100 km away.

OPERATING SEQUENCE

<u>Moving</u> - Normally, the Timberjack 30 Delimber-Slasher was positioned on the road at right angles to the full tree pile (see Fig. 2). When the pile was finished or when the operator could no longer reach the trees, the machine was moved.

<u>Delimbing & Topping</u> - Using the heel-boom loader, the operator picked the tree(s) out of the pile, placed it on the delimbing rail and closed the butt clamp, thereby securing the tree while the delimbing carriage travelled up the rail. The operator stopped the carriage at the proper diameter for topping and activates the topping knives. The butt clamp was then opened and the tree-length slid down into the bunk.

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* Mellgren, P.G. Terrain Classification for Canadian Forestry, Can. Pulp & Paper Assoc., Dec. 1980.

NOTE: - For trees longer than 12.8 m in merchantable length a special procedure was required for delimbing and topping. The tree was first delimbed but not topped. The butt clamp was then opened allowing the bottom part of the tree to fall into the bunk and a 3.8-m log was removed. The delimbing carriage was pulled away from the operator and then towards him re-aligning the tree in the butt clamp. The loader grapple was also used to pull the tree fully forward. The rest of the tree was delimbed and topped in the normal manner. NOTE: - The above procedure added an average of 56 cmin (1 cmin = 1/100 min) to each cycle time (see Table 2).

Slashing & Piling - When enough trees were collected in the bunk (5 to 10 trees, depending on size) the operator closed the grapple around them, activated the circular saw, and piled the 3.8-m lengths. He then grappled the remaining sections of trees, pulled them forward to the butt plate, cut them and piled them, repeating this procedure again, if required. During Study I, the full trees and 3.8-m lengths were piled on opposite sides of the road; in Study II on the same side.

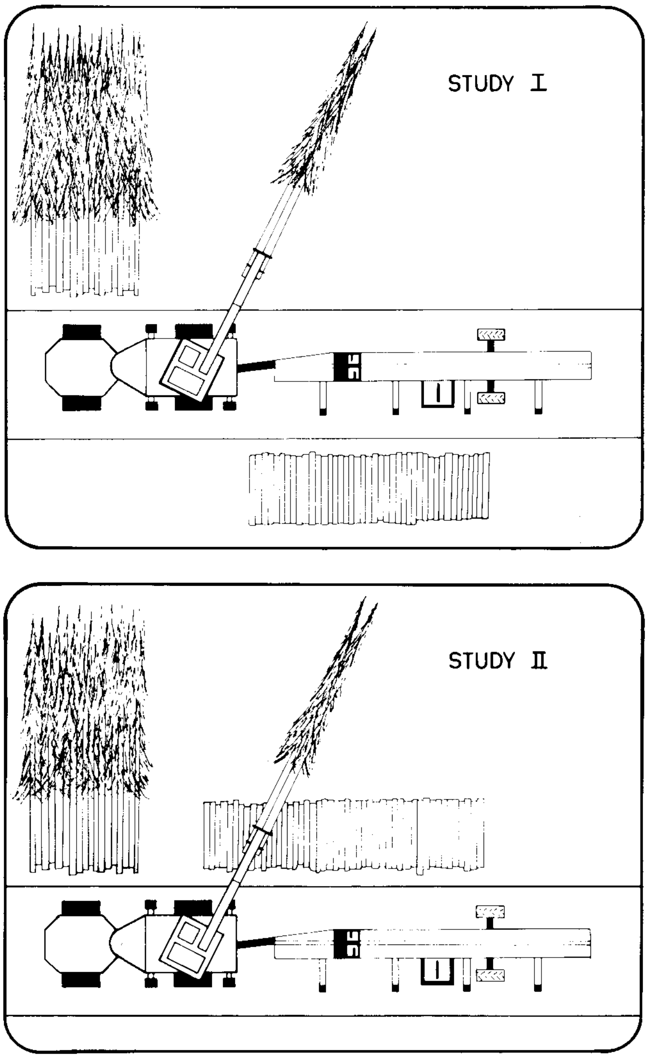

Fig. 2. Operating Sequence.

RESULTS & DISCUSSION

FERIC's time study was conducted in two parts, in June and August, 1981. The results of FERIC's studies are shown in Tables 1 and 2.

Table 1. Average Condition Factors at Roadside

FACTOR	STUDY I	STUDY II
Date of study	June 1981	August 1981
Operator experience, months	1	3
Study duration*, hrs	4.26	3.59
Volume per tree, m^3 (ft^3)	.14 (5.1)	.17 (6.0)
Species**, approx. %		
balsam fir	70	60
black spruce	30	40
Branchiness class ***		
- Class 1	40	50
- Class 2	60	50
- Class 3	-	-
Trees processed per <u>delimbing</u> cycle, % of sample		
1 tree	91	73
2 trees	9	21
3 trees	-	6
Volume per <u>delimbing</u> cycle, m^3 (ft^3)	.16 (5.6)	.22 (8.0)

* This includes operational delays, mechanical breakdowns and personal delays. Delays were treated in different ways depending on their duration.
0-5 cmin were included in the time elements during which they occurred (Table 2).
5 cmin - 10 min. were recorded as "delays"; also shown in Table 2.
> 10 min. were not considered as part of productive time (PMH) and were therefore excluded.

** Due to spruce budworm mortality - some trees did not require delimbing by the Delimber-Slasher.

*** Branchiness class, % = $\frac{\text{Merchantable length with live branches}}{\text{Total merchantable length}}$

Class 1: 0 - 33%
Class 2: 34 - 66%
Class 3: 67 - 100%

Table 2. Productivity Summary

	STUDY I				STUDY II			
	Frequency	Average time required (cmin)[1]	% of total time		Frequency	Average time required (cmin)[1]	% of total time	
Extricate & load "full" tree(s)								
- onto delimber rail	163	67	42.9	55.4	140	73	47.6	56.5
- onto delimber rail plus topping[2]	11	64	2.5		-	-	-	
- into wood bunk[2] or if consisting of a piece <4m directly onto shortwood pile	38	65	10.0		35	55	8.9	
Delimb								
- normal length tree(s)	134	22	11.8	20.6	142(3)	22	14.6	15.1
- over-length tree[4]	29	78	8.8		1	99	.5	
Slash & pile on ground								
- 1st pass	34	54	7.1	19.7	32	49	7.3	24.1
- 2nd pass	34	68	9.0		32	63	9.4	
- 3rd pass	13	68	3.6		26	61	7.4	
Moving time	3	188	2.2	2.2	3	255	3.5	3.5
Delays	6	86	2.1	2.1	2	81	.8	.8
Total	-	-		100.0	-	-		100.0
Volume per tree, m^3 (ft^3)	.14		(5.1)		.17		(6.0)	
Loading full trees* cyles per PMH		50				49		
Delimbing cycles* per PMH		38				39		
Trees processed per PMH		53				60		
Production per PMH, m^3/PMH (ct/PMH)	7.6		(2.7)		10.2		(3.6)	

[1] cmin = 1/100 minute
[2] branches previously broken off - no delimbing required
[3] several multiple trees were loaded together but delimbed singly
[4] over-length trees = merchantable length >13 m
* see above; not all trees were delimbed

Productivity

The productivity of the Timberjack Delimber-Slasher is summarized in Table 2.

Table 2 indicates that the total number of loading cycles per PMH was similar for both studies; 50 for Study I and 49 for Study II. The number of delimbing cycles per PMH, at 38 and 39 respectively, was also similar.

Study I was conducted when the operator had only 1 month of experience on the TJ Delimber-Slasher; Study II when he had 3 months of experience. The lack of significant difference between the cycle times of the two studies indicates that the operator had reached his normal production level on the TJ Delimber-Slasher after only a few weeks experience. His prior operating experience on other machines probably helped him to learn quickly. He was considered by FERIC to be a good, well-motivated operator, in spite of his limited experience on the TJ Delimber-Slasher.

Although the number of delimbing and loading cycles per PMH were similar for both studies, the productivity was not. For Study I, the productivity was 7.6 m^3 per PMH; for Study II, 10.2 m^3 per PMH. The difference in productivity was mainly due to three factors; average tree size, the number of trees delimbed at one time and the degree of concern for delimbing quality.

The average tree size on Study II was .17 m^3 compared to .14 m^3 for Study I. For Study II, the operator was able to delimb 2 or 3 trees at a time more frequently, in spite of the larger tree size. This was attributed mainly to increased operator skills.

A third reason why the operator had higher productivity during Study II was that he appeared to be more production-oriented and had less concern for good limbing quality; e.g. he would only make a single pass with the delimber knives, even if a second pass was required to get good results; or, for long trees he seldom cut off a 3.8-m butt log prior to delimbing, preferring instead to cut off a large top (this was faster).

The number of trees collected in the bunk prior to slashing, ranged from 5 to 10 and averaged 6.7 for Study I; for Study II it ranged from 4 to 12 and averaged 7.0.

The large circular saw slashed the tree-lengths to 3.8-metre lengths on both studies. Left-over 'nubs' under 2 metres in length fell between the bunks. Table 2 indicates that on both studies, due to the relatively small tree size, that often only two cuts were required. Sometimes however, there were several long pieces left in the bunk after two cuts were made; these remaining pieces were simply slashed along with the next bunch. This practice helped to improve productivity.

Loading

The time required to load full trees onto the delimber rail was similar for both studies; it required about 56% of the total time (see Table 2). It was a very time-consuming operation for several reasons:

1. Extraction of full trees from roadside piles requires much more lift capability than for tree lengths, due to interlacing of branches in full tree piles. The operator often had difficulty extracting a single tree from the full tree pile. Usually he grappled 2 to 4 trees, pulled on them to loosen them from the pile, dropped them, then re-grappled only one of them for delimbing; a time-consuming process (see also Delimbing, point 1).

2. The Husky 220 XL is a large-lift capacity loader (6089 kg @ 4.6 metres). It could easily handle any tree that required delimbing. However, (similar to most other loaders of the same capacity) it was also relatively slow when the boom had to be extended or retracted. This was due to the greater oil flow required for the large boom cylinders. The relatively long length of the Rotobec grapple was also a factor, since the boom had to be fully extended to reach the treelength sections behind the saw. A shorter grapple would have been slightly faster.

3. Each full tree was swung through an arc of 90^{o} to be placed onto the delimber rail; this is time consuming.

   NOTE:
   The Husky 200 XL loader is normally powered by a GM 3-53 motor. However, due to the extra hydraulic power required by the delimber, a GM 4-53 motor with three @ 230-L/min. pumps, and extra cooling capacity to allow simultaneous operation of both the loader and the delimber unit, was installed.

Delimbing

The delimbing unit, which is similar to the one used on the Timberjack TJ-30 Harvester was originally designed to delimb only one (small) tree at a time. The delimbing unit (shown in Fig. 3) had several limitations which are discussed below:

1. Due to the small size (35 cm max. opening) of the butt clamp, (located at the base of the delimber rail) the operator frequently had trouble loading more than one small tree into it. FERIC observations on other delimbers have indicated that multi-stem capability is essential for maintaining good productivity when delimbing small trees. NOTE - This will vary somewhat depending on the capital and operating cost of a delimber.

2. The delimbing rail was too short (12.8 m) for many of the trees. Table 1 shows that for Study I, 29 of the 163 complete delimbing cycles observed were over-length trees - that required 56 cmin per tree extra, above the normal processing time. NOTE: A delimbing capability several metres longer would have been much more suitable.

3. The Rotobec grapple on the loader did not close tightly around the trees. This caused a problem when a second tree needed to be held in place during delimbing (since the butt clamp on the delimber often would not hold two trees). Since the second tree would be pulled out of the Rotobec grapple, the operator had to push down on the second tree with the empty, closed grapple to hold it in place. The above problem could be rectified by minor re-design of the grapple or by substituting a Cranab SG-6 grapple.

4. The delimbing carriage travel speed was not fast. It was measured by FERIC to be 1.8 m/sec.

5. The topping knives also are not fast. A "whistle-type" topper at a pre-set diameter such as used on the JD 743 Tree Harvester would be faster and would reduce the hydraulics required on the carriage. A disadvantage is that tree multiples could not be properly topped. However, since topping can be done by the slasher saw on the Delimber-Slasher, this is not really a problem.

6. During FERIC's study no large limbs (>6 cm in diam.) were present; no delimbing problems were observed. The manufacturer recommends the delimber for trees with branches less than 4 cm in diameter.

Speed, Mobility & Flotation

According to the operator there were no mechanical problems with the skidder frame or with its hydraulic 4-wheel drive during the first four months of use.

The maximum travel speed in high range on a flat firm road surface, as estimated by FERIC, was only 3.0 km per hour; for a rubber-tired machine, this was considered very slow. The maximum travel speed in low range was measured by FERIC to be 1.15 km per hour on a flat, firm road surface. The slow travel speed was not considered to be a major shortcoming of the Delimber-Slasher on the operation studied, since the amount of travel was usually quite limited. However, on operations where mobility is important, the slow travel speed can be detrimental.

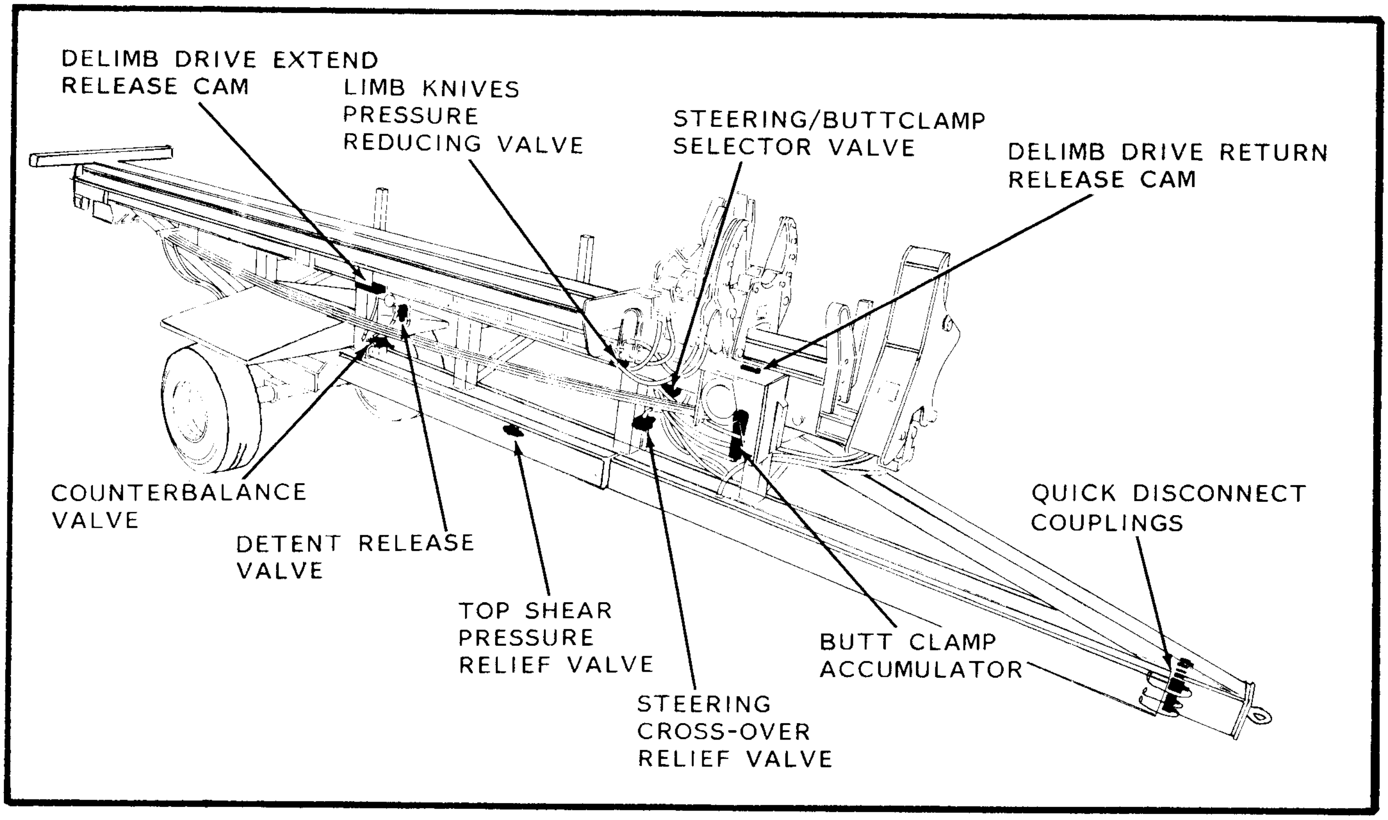

Figure 3. Location of adjustable components on the TJ 30 Delimber.
Note: Slasher unit is not shown.

The on-road (and sometimes off-road) mobility of the TJ Delimber-Slasher was judged to be good due primarily to the 4-wheel hydraulic drive, the no-slip differential, and the articulation provided by the skidder frame. According to the operator the TJ Delimber-Slasher was never stuck during the first 3 months that it worked, even though the unit was sometimes positioned off the road.

The weight distribution on the skidder axles however was not ideal; the rear axle of the skidder (under the loader) carried about 80% of the weight (loader (8200 kg) plus the skidder frame and tires (4500 kg)) resulting in a ground bearing pressure of 128 kiloPascals (18 psi) on the front axle and only 33 kiloPascals (5 psi) on the rear axle. When going uphill in reverse (pulling the delimber) the front axle of the skidder sometimes rose off the ground. Tire chains were required on the front axle to increase the traction (see Fig. 4). When moving, the Delimber-Slasher's knuckle-boom loader was placed in a holder on the front axle. This shifted extra weight onto that axle and improved the traction.

Circular Saw

When the saw cuts through 6 to 8 trees at once the saw motor hydraulic pressure input must increase from 2100 kPa (idling) to 17 500 kPa. This momentary load, plus deflection due to the "dish shape" of the saw at certain RPM's, was most likely the reason for several problems that occurred during the first 2 months of use. The changing shape of the saw had caused it to deflect and hit its cover; also premature failure of the saw bearings occurred. The solution, according to a Timberjack representative, was to slash fewer trees at a time; however this would have a negative effect on productivity. NOTE - a re-designed saw motor, bearing and saw may be required to effectively solve this problem.

NOTE: Although it did not occur during the first three months of operation, it is theoretically possible for the operator to strike the grapple from the loader against the rotating saw when reaching out to grab the treelength sections behind the saw.

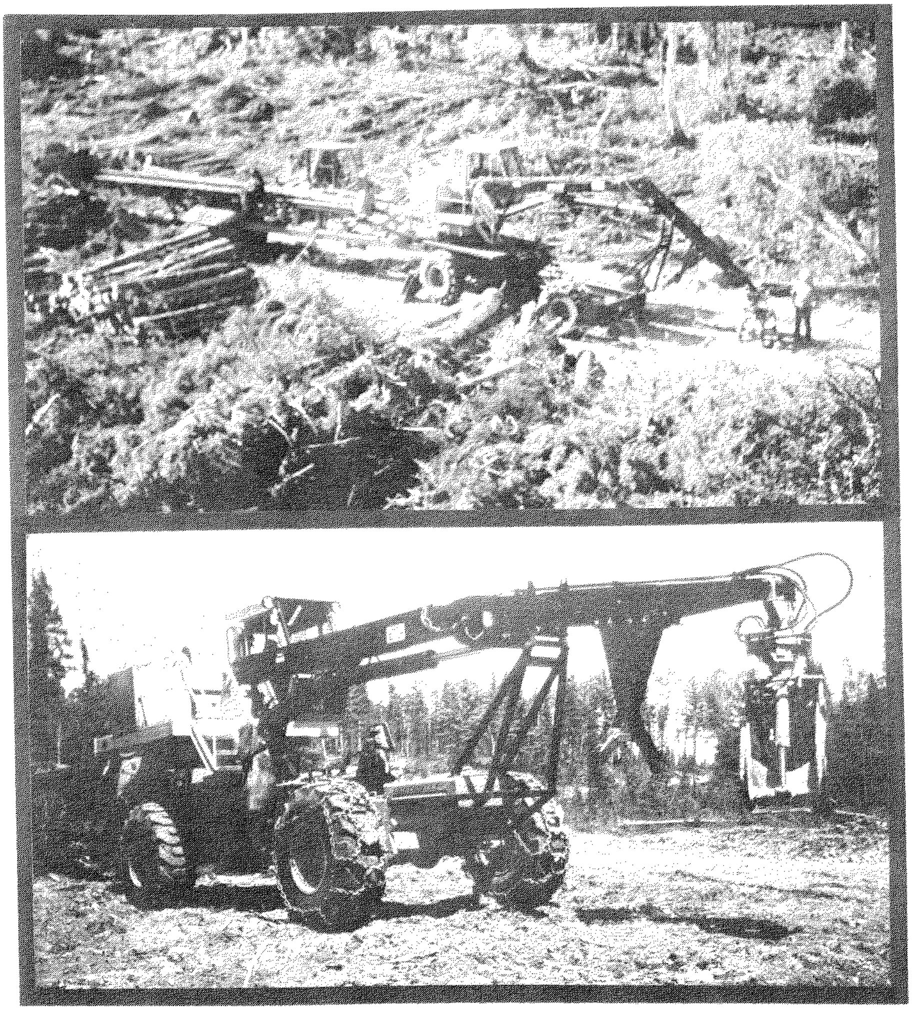

Figure 4. The Timberjack 30 Delimber-Slasher.
Note the tire chains on the front axle of the skidder frame.

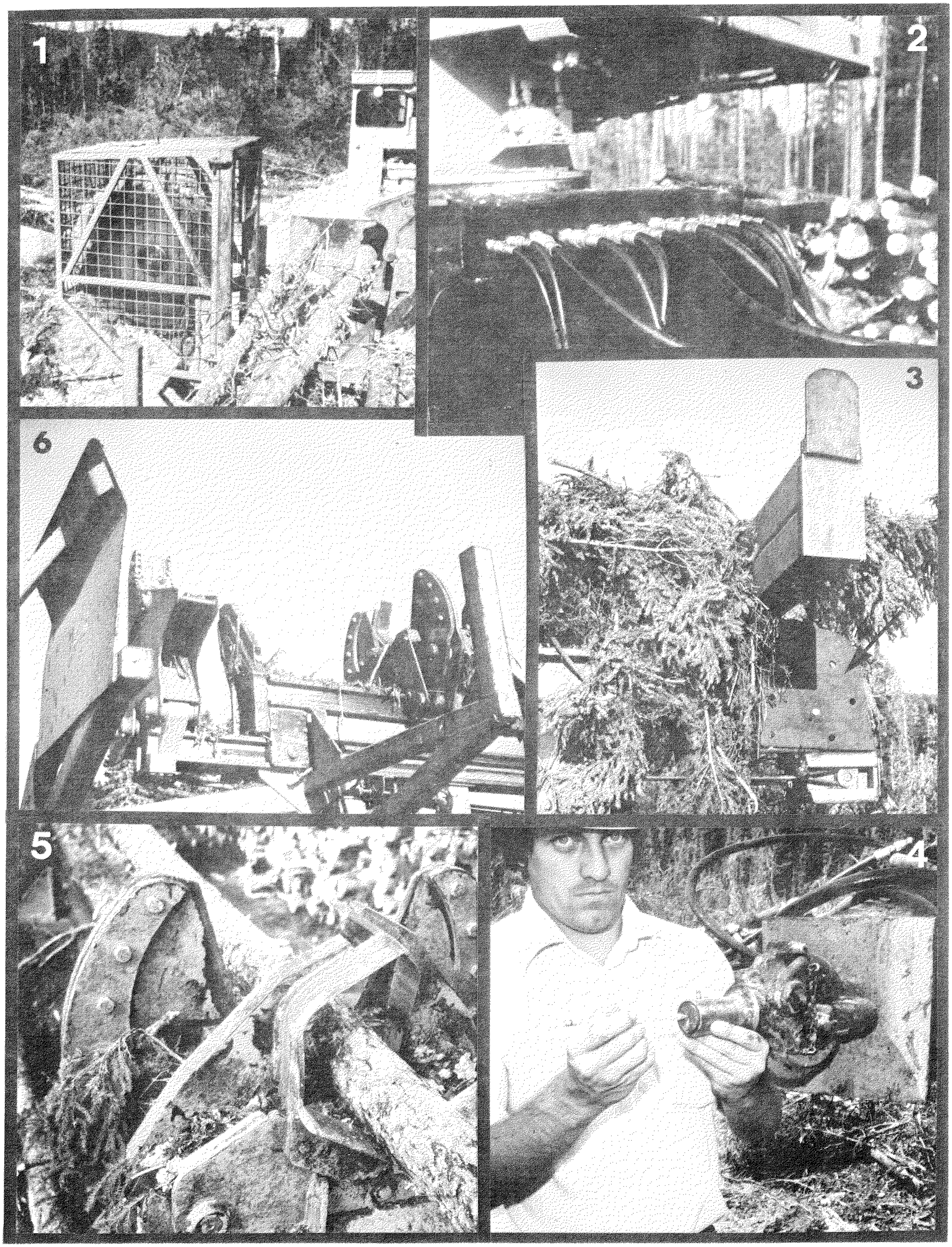

Fig. 5. Timberjack 30 Delimber-Slasher, 1: circular saw with cover and protective cage, 2: quick-disconnect couplings from delimber-slasher unit, 3: protective plate (see arrow) installed to protect cables and pulleys from debris, 4: broken pintle hook on delimber tow unit which occurred during FERIC's study, 5: delimbing knives and topping shears, 6: delimbing carriage, also butt clamp and butt plate.

Noise

For normal operation, the GM 4-53 diesel motor (93 kW) was required to operate at 2200-2300 rpm. Due to the extremely noisy nature of this engine, plus the proximity of the operator's cab to the engine, the noise level in the cab, as measured by FERIC, greatly exceeded the acceptable limit (adopted by the U.S. Dept. of Labour in 1969), for prolonged operator exposure. The noise level ranged from 93 to 95 decibels (on the A scale) with the cab door closed and from 98 to 99.5 decibels with the door open. To protect his hearing, the operator wore protective ear covers at all times.

Fuel Consumption

Although not measured by FERIC, the owner/operator reported the fuel consumption to be approximately 20.2 L per meter hour.

The capacity of the fuel tank (220 L) was not considered adequate. It needed to be refilled during nearly every shift (this was a 2-shift per day operation).

Mechanical Availability

Due to the brief duration of FERIC's study very few mechanical problems were observed. The owner/operator of the TJ Delimber-Slasher noted the following problem areas:

1. The cable sometimes came off the pulleys on the far end of the delimber rail due to debris getting between the pulley and the cable.
   NOTE: The local Timberjack sub-dealer has since installed a cover plate that should solve this problem (see Fig. 5).

2. All the sealed bearings on the rollers for the delimbing carriage failed prematurely (apparently due to debris becoming lodged in the bearings).
   NOTE: 1) Other TJ delimber owners have experienced similar problems.
   2) Greasable bearings are now also available.

3. The pintle hook bolt (rated at 30 tons) connecting the delimber unit to the loader unit broke in two. Prior to breaking, the fastening nuts on the connection frequently came loose and required tightening.
   NOTE: The bolt broke during FERIC's study when the machine was almost stopped - thus the hydraulic hoses were not damaged. The break of the pintle hook was attributed by Timberjack Inc. to "a poor casting".

4. The steer cylinder on the axle of the delimber unit is exposed and requires better protection. The steering axle can be locked for transport.

5. The circular saw required several repairs. The saw cover required welding repairs and the bearings for the saw had to be replaced.

Although the loader performed well during FERIC's study, it is necessary to note that many hydraulic hoses (for the delimber, grapple saw and the skidder frame hydraulic drive) had to be funnelled through the centre opening of the turntable. These hoses are subject to twisting, when the loader turns and can be expected to be a high maintenance area. In comparison, on a trackmounted sliding-boom delimber, only the hoses for the hydraulic drive are fed through this centre point, thereby reducing the risk of mechanical downtime.

The chassis of the TJ Delimber-Slasher was composed of a used TJ 230 skidder that had been extensively modified to accommodate the loader, presumably to reduce initial capital costs. Although extensively modified (by the Timberjack sub-dealer) this used frame was not considered by FERIC to be as good as a new skidder frame.

Constraints on Logging System

The TJ Delimber-Slasher usually takes full trees from one side of the road and piles shortwood on the other side. However, if the full tree piles are not too high (i.e. <2m), shortwood can also be piled on the same side of the road as the full trees. This permits full trees to be piled on both sides of the road (see Fig. 2). NOTE: If working on a large landing or a flat area beside the road a variety of full tree and processed product arrangements are possible.

Debris from delimbing/topping accumulates on the road; this will cause problems for other vehicles using the road and to some extent for the delimber itself. One way to minimize disruptions is to commence working at the far end of a road, if possible. Periodic clearing of the road may require a crawler tractor since the brush may be too interlaced for removal with a skidder blade. If shortwood and/or full tree piles are continous on both sides of the road, debris disposal may pose a problem. In addition, piles of debris at roadside may be objectionable for other reasons such as aesthetics or fire hazard.

On many secondary logging roads the TJ Delimber-Slasher will block the road to other traffic. The machine can be moved to allow other traffic to go by, but this delay will have a negative effect on production.

These factors indicate that careful planning is required to minimize the detrimental effects and maximize the positive effects of the TJ Delimber-Slasher on the rest of the logging operation.

Expected Operating Costs

The expected operating costs for the Timberjack 30 Delimber-Slasher are shown in Table 3, below. The operating costs are based on the production level (60 trees/PMH) shown in Table 2. Since it is a small tree delimber, an average tree size of .15 m^3 (approx. 5.5 ft^3) is assumed. The operating costs also assume a machine utilization of 80%, repair costs at 120% of depreciation, operators wages of $13.00 per scheduled hour (including fringe benefits), an operating period of 190 days per year, two-shift per day operation, a machine life of 6 years and an 18% interest rate.

Also shown in Table 3 are expected operating costs for a two machine system for delimbing and slashing, using a sliding-boom delimber (e.g. Denis, Roger, Harricana) plus a mobile slasher (e.g. Hood) at roadside. Expected operating costs are based on the same criteria as for the Timberjack 30 Delimber-Slasher. Table 3 indicates that for trees averaging .15 m^3 that the two machine system is cheaper.

Table 3. Cost Comparison*

	Timberjack 30 Delimber-Slasher	Sliding-Boom Delimber	Mobile Slasher (mounted on used 10-wheel tandem axle truck)
Machine list price	$175,00	$220,000	$78,000
Operating Cost/PMH	$60.00	$69.00	$40.00
Trees per PMH	60	145	110
Productivity, m^3 (ct) per PMH	9.3 (3.3)	22.7 (8.0)	19.8 (7.0)
Cost per m^3 (ct)	$6.41 ($18.14)	$3.02 ($8.55)	$2.04 ($5.77)

* Direct logging costs only - includes all fixed, operating, maintenance and repair costs, but with no allowance for engineering, roads, supervison, overhead or profit.

GENERAL COMMENTS

The Timberjack 30 Delimber-Slasher was originally designed to combine delimbing and slashing on one machine reducing the amount of wood handling and thereby lowering the total cost.

Although this concept is basically sound the TJ 30 Delimber-Slasher has not reduced this total cost (on a m^3 basis) compared to the costs of the existing two machine system (e.g. sliding-boom delimber plus a mobile slasher) that is now commonly used in the same area where the TJ unit was studied. The main reason for this is the low productivity of the TJ Delimber-Slasher (50-60 trees/PMH).

In the future no extra production can be expected from increased operator experience; the operator studied by FERIC was considered to be a good, highly-motivated operator. Some increase in productivity could be achieved from a larger butt clamp on the delimber rail, since this would permit more frequent multi-stem delimbing.

Other improvements such as an improved loader grapple design and conversion to a "whistle-type" topper could also help to increase productivity. To use the machine only for larger trees would probably be counter-productive, since the maximum delimbing stroke is 12.8 m. Larger, longer trees would require a much longer cycle time since the butt logs would have to be cut off before delimbing could start.

The machine also has limited usefulness for multi-product operations. Due to the swing room required for the Husky loader upper structure it is difficult to have a second butt plate for 5.0 m sawlogs. To summarize; unless considerable improvements are made on the Timberjack 30 Delimber-Slasher, the prospects for increased use of this machine do not appear bright.

APPENDIX I

CONVERSION TABLE

1 cm	1 centimetre	: 0.39 inch
1 m	1 metre	: 3.28 feet
1 km	1 kilometre	: 0.62 mile
1 m^3	1 cubic metre	: 0.353 cunit
1 L	1 litre	: 0.22 Imperial gallon : 0.26 American gallon
1 L/s	1 litre per second	: 13.20 Imperial gallons per minute : 15.85 American gallons per minute
1 kg	1 kilogram	: 2.20 pounds
1 kW	1 kilowatt	: 1.34 horse-power : 3,425 BTU
1 kPa	1 kilopascal	: 0.145 pounds per square inch
1 lx	1 lux	: 0.093 foot-candle : 0.093 lumen per square foot
^oC	degree Celsius	: $\frac{5}{9}$ (^oF-32)