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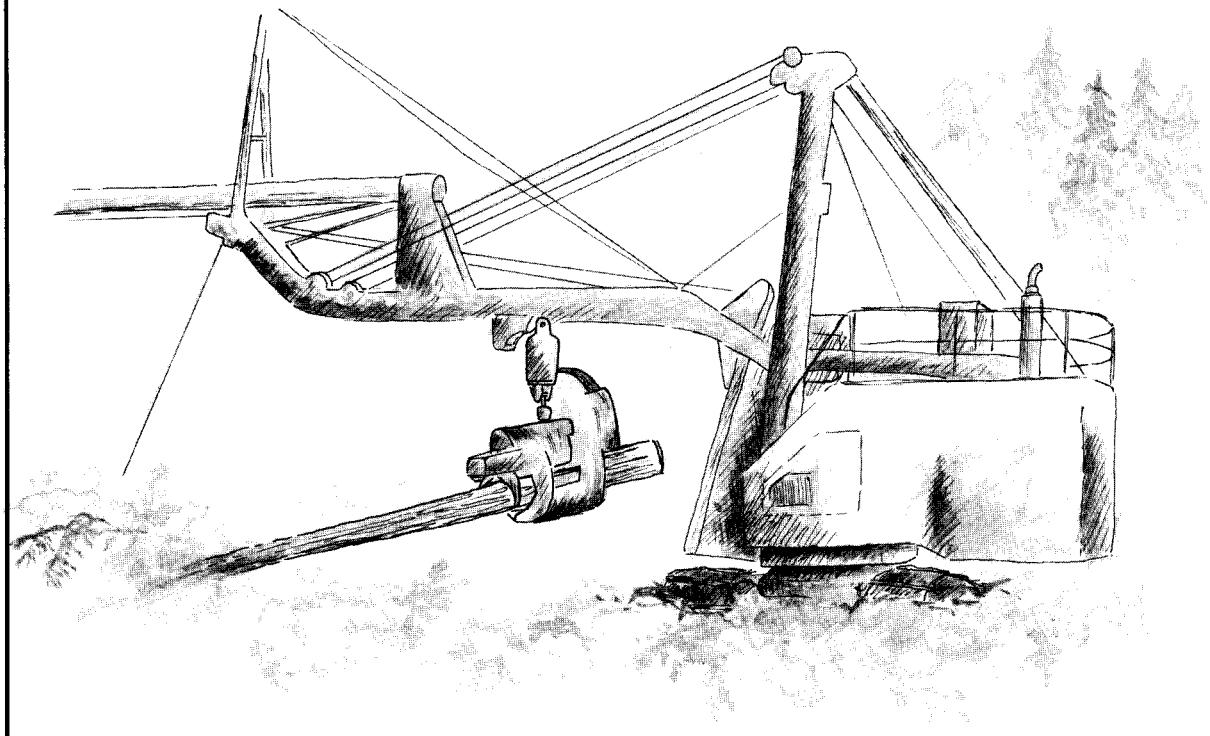
# A REVIEW OF MECHANICAL DELIMBERS IN WESTERN CANADA

A.J. MacDonald

November 1989



Technical Report

TR-93

# A REVIEW OF MECHANICAL DELIMBERS IN WESTERN CANADA

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*KEYWORDS: Delimbing, Mechanical method, Stroke delimbers, Processors, Roadside processing, Product review, Western Canada.*

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# Abstract

In 1988/89, mechanical delimbing equipment in use in western Canada was surveyed in a wide variety of locations and applications. Results from a telephone survey of woodlands managers and field tours of operating equipment are presented. Survey results include specifications for eight types of delimbers, suggested modifications based on comments from equipment owners and operators, and the suitability of the equipment types to various logging systems. Advantages and disadvantages of utilizing mechanical delimbing equipment are discussed. Machine productivities derived from operators' estimates of daily production and short-term detailed timing are also shown.


# Author


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# Acknowledgements


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# Disclaimer

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# Summary

FERIC member companies requested that a survey be conducted to gather information on mechanical delimbing equipment currently available in western Canada. The objective of this report was to fulfill that request by providing information about delimbers in general, as well as information about specific types and brands of delimbers. The survey consisted of telephone interviews as well as field tours to observe the delimbers operating in various locations and applications. The survey was conducted between October 1988 and January 1989.

Interviews with woodlands managers showed that mechanical processing is an important part of many logging operations, especially in the Interior of B.C. and in Alberta. Most woodlands managers also expected the proportion of mechanical processing to increase in the future, and could foresee sustainable timber supplies for the type of equipment currently available.

It was commonly held that mechanical processing was an expensive activity, and that it paid for itself only through the efficiencies it created in other phases such as skidding and loading. The best method of enhancing the productivity for the other phases was to separate them, with inventories between phases to compensate for delays. Roadside logging was the preferred method, but proper machine scheduling could allow phase separation on landings where the terrain prohibited roadside logging.

A delimber is expensive to purchase and operate; it requires that the owner and operator be committed to learning the operating systems so that the machine may be used for the maximum benefit. Many of the mechanical problems about which users commented were relatively minor in nature, but they recurred fairly often, and their cumulative effect decreased machine utilization. The small problems seem to cause more concern with owners and operators than any major deficiencies in machine design. Operator and mechanic training was often mentioned as a concern, especially in relation to electronic devices for measuring log lengths. The technology of log measurement and measurement devices is still evolving and further refinements to system accuracy and reliability are required.

# Sommaire

Les compagnies-membres de FERIC ont exprimé le désir qu'une enquête soit effectuée en vue d'obtenir des renseignements sur l'équipement méchanisé d'ébranchage d'usage courant dans l'ouest du Canada. Le présent rapport vise à répondre à cette demande en fournissant de l'information sur les ébrancheuses en général, ainsi que sur des types et des marques spécifiques d'ébrancheuses. L'enquête qui eut lieu entre octobre 1988 et janvier 1989 comprenait des entrevues par téléphone, de même que des visites sur le terrain pour observer les ébrancheuses à l'oeuvre à divers endroits et dans diverses applications.

Des entrevues avec des directeurs de divisions forestières révélèrent que le façonnage mécanisé tenait une place importante dans plusieurs opérations d'exploitation forestière, particulièrement en Colombie-Britannique intérieure et en Alberta. La plupart des directeurs de divisions s'attendaient en outre à ce que le façonnage mécanisé prenne encore plus d'ampleur à l'avenir, et pouvaient voir un grand nombre de peuplements qui se prêteraient fort bien à l'utilisation des machines de type courant.

D'après l'opinion générale, le façonnage mécanisé était une activité coûteuse et ne faisait ses frais que dans la mesure où il rendait plus efficaces d'autres phases de la récolte, comme le débardage et le chargement. La meilleure méthode de favoriser la productivité des autres phases consistait à exécuter chacune d'elles indépendamment des autres, en accumulant des stocks tampons de bois entre les phases pour éviter les pertes de temps. L'exploitation avec façonnage en bordure de route était la méthode préférée, mais une répartition adéquate des machines pouvait permettre de garder les phases séparées même en travaillant sur les jetées, quand le terrain empêchait l'exploitation par système en bordure de route.

Une ébrancheuse est une machine coûteuse à acheter et à mettre en oeuvre; il est essentiel que le propriétaire et l'opérateur en viennent à maîtriser le fonctionnement des divers systèmes, de façon à ce qu'on puisse retirer de son utilisation le maximum de profit. Les problèmes mécaniques qui ont fait l'objet de commentaires de la part des usagers étaient relativement mineurs en soi, mais ils se reproduisaient assez fréquemment, et leur effet cumulatif diminuait le taux d'utilisation de la machine. Ces petits problèmes semblaient préoccuper davantage les propriétaires et les opérateurs que des déficiences majeures dans la conception des machines. La formation de l'opérateur et du mécanicien a souvent été mentionnée comme une source de préoccupations, particulièrement en ce qui a trait aux dispositifs électroniques de mesure des longueurs. La technologie du mesurage des billes et les dispositifs de mesure sont encore en évolution, et la précision et la fiabilité des systèmes laissent place à de plus amples améliorations.

# INTRODUCTION

Mechanical delimbing equipment first appeared in western Canada in the early 1980s with the introduction of the Denis and Hahn delimbers (McMorland 1984, Powell 1981). Since that time, the choice of delimber models has increased, and FERIC's member companies requested that a survey of mechanical delimbing equipment be conducted. The objective of this project was to fulfill that request by gathering information about mechanical delimbing equipment currently operating in western Canada. This report provides information about delimbers in general, as well as information about specific types and brands of delimbers. Survey results are also presented. The report is not intended to be a detailed study of each machine; the reader is directed to specific FERIC reports for further information. Another FERIC report (Richardson 1988) surveyed processors and harvesters for eastern Canada.

# METHODOLOGY

A telephone survey of woodlands managers was carried out to determine the extent to which mechanical delimbing equipment is used in British Columbia and Alberta. Based on the results of this telephone survey, a series of field trips was undertaken from October 1988 to January 1989. During these field trips, contractors and operators were interviewed, and observations were made on each delimber in operation. It was common to receive contradictory information from different sources because of individual circumstances and experiences, and in such cases, both viewpoints are presented.

Because of the nature of the study, this report is based on subjective information obtained from woodlands managers, contractors, operators, and factory representatives for the various delimbers, rather than from detailed measurements of in-service equipment as is normally done for FERIC reports. Mention of a brand name does not constitute endorsement or recommendation by FERIC. FERIC has evaluated most of the delimbers included in this survey in separate reports, and the reader is directed to these reports for more detailed information.

**Video.** In addition to the results tabluated in this report, a video presentation of the various types of delimbers was produced. Contact FERIC for current availability and price of the video presentation.

# OVERVIEW OF MECHANICAL DELIMBERS

## What is a Mechanical Delimber?

The term "mechanical delimber" includes a wide variety of machines, depending on the definition used and discussed. Mechanical delimbers, as defined for this report, have the ability to remove limbs and to top the stem. "Processors" have this capability plus the ability to manufacture measured logs from the stems. For consistency during the report, the term "delimber" is used whether or not the machine is better described as a "delimber" or a "processor."

Machines not equipped with a topping saw, such as chain-flail delimbers, were excluded from the survey, while machines without bucking saws were included. The ability to measure log lengths was not considered necessary for a machine to be included because many harvesting operations do not require length measurement. Machines which can only cut logs to length, such as mobile slashers, were excluded because of their inability to remove limbs.

## Types of Mechanical Delimbers

Mechanical delimbers can be divided into three major categories: stroke delimbers, boom-mounted delimbers, and self-contained delimbers.

The stroke delimbers generally hold the stem stationary and have travelling delimbing knives, while the boom-mounted delimbers have stationary delimbing knives and move the stem. This distinction becomes clouded with machines such as the Lim-mit LM-2200, which is classified as a stroke delimber, but which contains drive-rollers, and the Tapio, which operates primarily as a boom-mounted delimber, but which also has a stroke boom. The self-contained delimbers vary in their configurations.

Logs processed by stroke delimbers are returned to piles adjacent to the piles of unprocessed stems, so the space required for log decks is minimized. In contrast to stroke delimbers, boom-mounted delimbers move the logs from one location to another during processing, thus, for roadside operations, the stems must be dropped far enough away from the road to leave room for the processed logs to be piled. The area must be reasonably flat and large enough to accommodate the two piles; this amount of space is seldom available in many logging areas.

Stroke delimbers require a higher level of operator training than boom-mounted delimbers because a more coordinated sequence of actions is required to open and close the grab arms while stroking the boom in and out. As well as determining productivity, the higher level of coordination also makes stroke delimbers vulnerable to damage if the stem should move while the chain saws are in use. It is not uncommon for a new operator to bend ten or more chain saw bars during his training period, and one or two per month afterwards. Some owners have made provision to straighten bent chain-saw bars, rather than purchasing new ones.

Some stroke delimbers are equipped with topping knives instead of chain saws, which, according to users, are faster, less expensive, and easier to main-

tain. But, their maximum cutting diameter is smaller. Knives are limited to topping only, while chain saws can be used for topping, bucking, or trimming butts. FERIC observed several delimbers where the butt saw was inoperative and the topping saw was used in its place. If these delimbers had had topping knives, a delay would have resulted while the butt saw was being repaired.

Boom-mounted delimbers must operate off the road surface when roadside logging, in contrast to stroke delimbers which operate on the road surface. The off-road surface provides a less steady working base and contributes to wear on the undercarriage. If the stems are skidded and processed in several passes, debris accumulations can further diminish stability for the delimber because it must work among the tops, branches, and long-butts left from the previous passes. Furthermore, the logs are held by the top, rather than the butt, during piling, and this makes it more difficult to index the butts for loading efficiency. Boom-mounted delimbers are better suited to working in landings where they have a stable working base and sufficient room for log piles, and their higher processing speed can be used to the greatest advantage.

A carrier for a boom-mounted delimber has a relatively easy application because the delimber is relatively light, the motor is not overworked, the delimber supports only part of the stem's weight, and machine movements are smooth. This should result in longer carrier life. However, the delimbers must frequently travel between landings, which results in lower machine utilization and increased undercarriage wear. A high-speed carrier capable of moving quickly between job sites, e.g. mounted on rubber tires, would be an asset. FERIC studied the effect of carrier travel speed in Eastern Canada (Heidersdorf, Gingras, and Golsse 1986).

Self-contained delimbers are manufactured as whole machines, not as attachments for existing carriers. Three very different self-contained delimbers were viewed during the survey. The Hahn delimbers process stems longitudinally through their chassis, which limits their ability to process stems aligned perpendicular to the road. However, the Hahn delimbers work well in landings where auxiliary equipment moves the stems and logs to and from the delimbers. In contrast, stems processed by the Dika Shortwood processor are held perpendicular to its chassis, so it is better able to process stems from roadside piles. The Rottne Rapid delimbers come in two configurations; the Rottne Rapid 860 has a delimbing head attached to the chassis, while the Rottne Rapid EGS-85 is similar to boom-mounted delimbers. They are included in this section because they are sold as complete packages.

## Log-Length & Diameter Measurement

Log-length measurement is critical for some operations and of little concern for others. For example, in the British Columbia Interior where logs can be hauled off-highway, log-length measurement is usually unimportant providing the stem is topped at the correct diameter, or, in regions with small trees, the logs may be short enough for full-length hauling on the highway. However, in operations where the trees are taller and highway hauls are required, the logs must be measured to the correct length to maximize the truck payload and satisfy mill requirements. Log lengths are also usually critical for the higher-valued wood in Coastal operations. Each operation must be evaluated to determine if log length measurement is critical.

Each of the machines surveyed had some capability to measure log lengths, and each manufacturer claimed that the system was accurate and reliable. However, FERIC observed that the most reliable systems were also the slowest. For example, the Denis delimbers with butt-plates and the Hahn Harvester hold the log very securely and measure accurately, but they are slower than the other delimbers. The Steyr KP60 measures log lengths very accurately, but it processes stems more slowly than its counterpart, the Steyr KP40. The challenge is to make reliable log-length measurements at high speed.

Problems in log-length measurement result from two factors: poor reliability of the external electronic systems and log slippage. The electronic sensors, wiring, and connectors are prone to mechanical failure caused by low temperatures, fatigue, and physical damage, and sensors may become blocked with snow or twigs. Log slippage can occur in several ways depending on the machine design. As examples, the Steyr KP40 measures log lengths from its drive-track, which can slip on the stem; the Lako 3T has an idler wheel which can skip over stem defects; and the stroke delimbers are prone to slippage if the operator does not hold the stem securely with the rear grab arms when the boom is moving.

Another area of concern related to log-length measurement is the man-machine interface. The computer must present its information to the operator in an accurate and easy-to-understand fashion, using one of two methods currently available. Some machines simply display the current distance from the butt to the saw for the operator to make the bucking decision. This interface (Figure 1) is used on the Denis, Harricana, and Hahn delimbers. The operator must memorize the preferred log lengths and manually position the saw at the desired cutting position; several minor adjustments are usually required. Some of these displays also include a light to signal the operator when a preset length is reached. The operator must watch the display rather than watch the stem being processed. The second type of man-machine interface uses a programmable computer to store several preferred log lengths from which the operator can choose (Figure 2). The computer controls the delimber, moving the saw into the correct

cutting position without operator intervention. The Steyr KP40 and KP60, and Lako 3T have this type of interface.

Automatic length measurement is less tiring for the operator since he does not have to monitor log lengths constantly as the stems are processed. FERIC observed that it is also somewhat faster than the manual method since the computer can move the saw to the correct length more quickly than can the operator. However, since many trees in any particular stand do not require measurement, the overall speed advantage with automatic length measurement is not as great as indicated by the speed advantage on any individual stem.

Delimbers that automatically stop the feed system at a predetermined minimum top diameter, are advantageous in stands where the bucking position is often determined by minimum top diameter rather than by log length. However, it is also important for the computer to have a manual override for those cases where it is more desirable to select a smaller top diameter, for example when the computer stops the stem slightly short of a preferred length.

Without top-diameter measurement equipment, the operator must rely on visual clues, such as the position of the grab arms, to estimate top diameters. Such systems are subject to operator variation, and must be checked several times each day to ensure accuracy. Some delimbers, such as the Denis D-3000 and the Harricana 1290 50 TP, provide sensors which turn on a light in the processing head to indicate minimum top diameter (Figure 3). Such systems are subject to the same mechanical stresses as other measuring systems, as well as being difficult to see under some lighting conditions. They are most useful at night when it is difficult to see details on the grab arms for visual clues. Also, a light signal indicates when the stem is less than the minimum acceptable top diameter, but it does not indicate by how much. Unless the operator stops the boom precisely when the light comes on, light signals do not provide an accurate indication of top diameter.

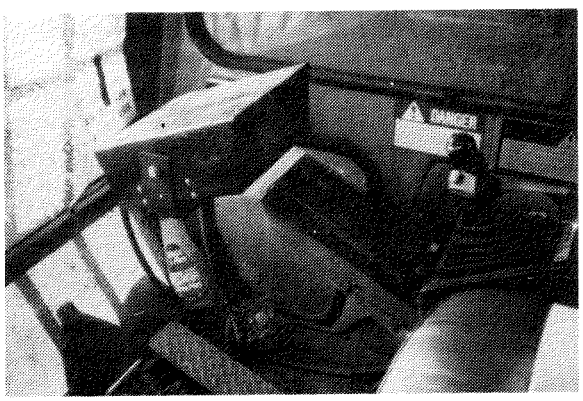

*Figure 1. Denis length-measurement display.*

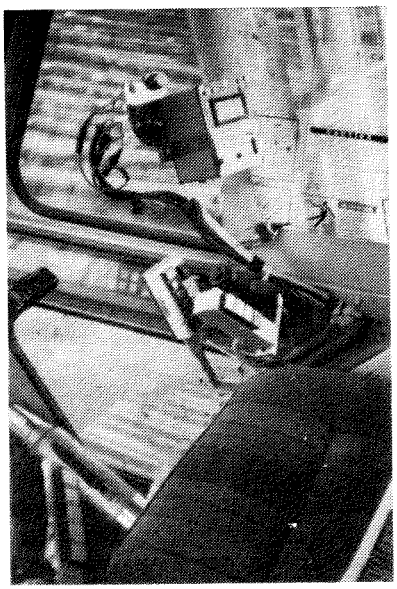

*Figure 2. Log length-measurement display mounted in the cab of the Lako 3T delimber.*

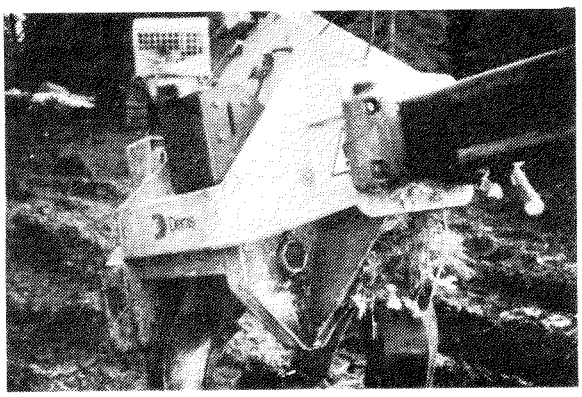

*Figure 3. Top-diameter indicator light on the Denis D-3000 processing head.*

## Operating Techniques

Some stems are small enough to be processed with one stroke of a stroke delimber, and others are large enough that a butt log must be cut first so as not to overload the delimber. However, there are two methods of cutting logs from intermediate-sized stems, i.e. to cut the top log or the butt log first. If the top log is cut first, the bulk of the stem must be stroked through the delimber, then back out. If the butt log is cut first, the delimber must retrieve the top to cut the second log. FERIC conducted only limited comparisons of the two methods. Processing the whole stem first had a slight time advantage, but both methods were workable and the processing time appeared to be influenced more by operator preference than by any great advantage of either method. However, by stroking the entire stem before making any cuts, the total stem length is known and the bucking cut can be made at the optimal location to maximize log value.

The effects of some other operating techniques were more obvious. For example, piling the logs directly in front of the machine, rather than to one side, made it easier to keep the log deck tidy, and less time was spent decking. Delimbing multiple stems was faster than delimbing single stems, but log quality declined; small limbs were left on the stem and top size was inconsistent (Figure 4).

The saw type as well as feed or stroke speed influence the time required to process individual stems, but their effect on total productivity is less clear. For example, circular saws cut more quickly than chain saws. The extra time required for chain saws to top a stem is minimal, however, in stands which require a high percentage of long-butting, the extra bucking time is more significant. Increased feed speed will increase productivity, but not in the same proportion as the change in feed speed; i.e., doubling feed speed will not double productivity.

Delimbers may spend only 40-50% of their productive time actually delimbing and topping stems; productive time is also spent in other activities such as retrieving stems, discharging and decking logs, clearing debris, and moving. It is equally important that these other functions be made as efficient as possible, and the delimber design can be an influence. For example, the Steyr KP40 has narrow grab arms which penetrate easily into the pile to retrieve a stem, while the Lako 3T has roller arms which do not penetrate the pile as easily. The time the Lako 3T loses when retrieving a stem can eliminate the gain made by higher feed speed. As an example for stroke delimbers, the boom on the Lim-mit LM-2200 has a shorter travel than the Denis delimbers, therefore, debris is left closer to the road with the Lim-mit LM-2200 than with the Denis. Some operators have found this makes it more difficult to pile the logs. However, the Lim-mit LM-2200 also discharges the logs more quickly than the Denis delimbers, which can increase its piling speed.

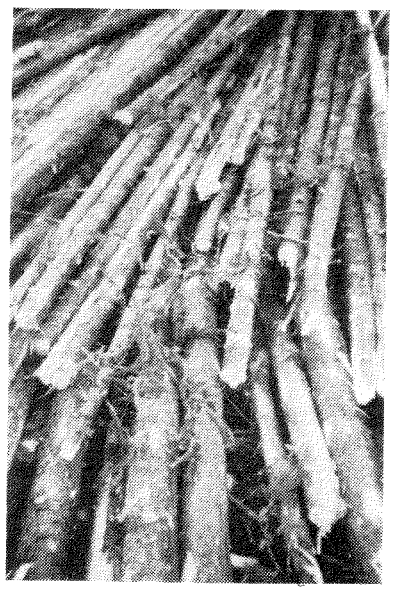

*Figure 4. Poor-quality multiple-stem delimbing.*

The delimber design can also influence other phases such as loading and sawmilling productivity. For example, loading is more efficient when all the log butts are aligned, and the stroke delimbers are more efficient at aligning log butts than the boom-mounted delimbers. Within the category of stroke delimbers, those with butt plates align the butts most efficiently, but they are less efficient at processing long stems unless the butt plate is movable. Finally, the grab arms and delimbing knives on the boom-mounted delimbers automatically follow the stem's taper during processing, which results in maximum delimbing quality. However, the stroke delimbers' grab arms typically do not follow the stem taper and the operator must constantly adjust the grab-arm position as the boom strokes out. If the operator is not careful, branch stubs remain on the logs, resulting in reduced log quality and increased sawmilling costs.

The mechanical reliability of the delimber has a tremendous effect on its productivity. While operators often had tales of major mechanical breakdowns, many of the comments about the delimbers' reliability concerned relatively small items such as hoses, fittings, wirings, and cutting implements. Major mechanical problems were well remembered, but the small items had a cumulative effect that is often forgotten until questioned in a survey such as this. Comments concerning mechanical problems with the delimbers will be made in each of the reviews that follow.

One owner in a Coastal area suggested an interesting secondary use for his stroke delimber: clearing debris from creeks. When site prescriptions specify that all debris be removed from creeks after harvesting, the common practice is to remove it by hand. However, the stroke delimber is able to reach the debris, remove it, and place it above the high-water mark because of its precise control and dexterity.

## Carriers

A wide variety of hydraulic carriers are available for mounting the various delimbers. It is not the purpose of this report to review the carriers, however, Table 1 lists some typical carriers in three different size classes. One delimber sales representative commented that all excavator brands were capable of carrying his attachment and that dealer service and operator training were more important than the brand of carrier chosen.

Note that any attempt at dividing machines into classes will result in overlaps because of different marketing strategies taken by the various manufacturers, therefore, the classes in Table 1 were chosen only to show broad ranges in carrier sizes. The

stroke delimbers usually require a carrier in Class B, although in light timber, some Class A carriers are adequate. Class A carriers are usually sufficient for the boom-mounted delimbers, although in heavier timber, a Class B carrier might be required. The only delimber surveyed which requried a Class C carrier was the Steyr KP60.

*Table 1. Some Typical Carriers Used for Delimbers*

| | Class | | |
|---|---|---|---|
| Make | A | B | C |
| Case | Drott 40 | 1187 | - |
| Caterpillar | 215/EL200 | 225/EL240 | 235/245 |
| John Deere | 590 | 690/790 | 892B |
| Komatsu | PC200 | PC220 | PC300 |

# MACHINE DESCRIPTIONS

## Stroke Delimbers

**Denis.** Équipements Denis Inc. of St. Hyacinthe, Québec manufacturers a complete line of stroke delimbers suitable for a variety of stand types. FERIC has studied the use of Denis delimbers (and the older Roger delimbers) in central B.C. (McMorland 1984) and in eastern Canada (Folkema and Lavoie 1978; Giguere 1981). Denis delimbers have been sold in western Canada since 1981 through local equipment dealers. A branch office was opened in Kamloops, B.C. in 1987 to manage sales of delimbers and parts to equipment dealers, as well as to process special parts orders for retail customers.

The Denis D-3000 (Figure 5), which is the latest model of the Denis delimbers, currently comprises the bulk of Denis sales in western Canada and is the model recommended by the manufacturer for highest productivity. The Denis DM-3000 (the old Roger delimber) is recommended by the manufacturer for customers who have larger trees and need the extra strength afforded by its one-piece boom. The delimbers observed operating in heavy-limbed aspen stands were all DM-3000 or older Roger delimbers. The DM-3000 is available in two boom lengths: 15 m and 18 m.

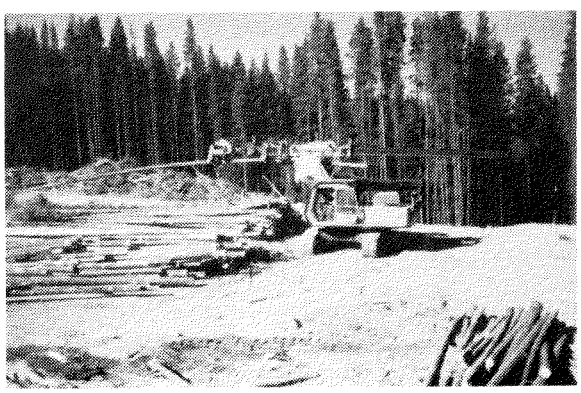

*Figure 5. Denis D-3000 working on a landing.*

The O model is similar to the new D-3000, but its funnel is round instead of octagonal. The models T, K, and KS Denis delimbers are also still available for purchase, but the manufacturer recommends them only for customers who insist on the lowest possible price and will accept lower machine productivity. The actual delimber is the same for each of the three models, but the mounting bases are different. The T model has a fixed butt plate, the K model has a sustaining ring to support the stem, and the KS model has the sustaining ring and a movable butt plate.

Each Denis delimber is also available as a complete unit, mounted on a Timberjack rubber-tired carrier. A FERIC study on roadside logging (MacDonald 1988a) featured two Timberjack 90s, both mounted with Denis KS delimbers. Newer models of the Timberjack processor use Denis D-3000 delimbers. Specifications for the Denis delimbers are shown in Table 2.

The Denis D-3000 and DM-3000 delimbers use the funnel-base design of the old Roger delimber to keep the centre of gravity over the centre of the carrier for better stability and balance. One design for the base, with either 66- or 81-cm-diameter funnels, is used for both delimbers. It contains two grab arms, a movable butt plate, and an optional chain saw for trimming butts. Two cylinders, rather than one on the older models, are used for vertical boom movement. The base has a hydraulic mechanism to lower the delimber and reduce overall height for highway transport.

The head contains two grab arms for holding and delimbing, and topping knives or an optional chain saw for topping. The Denis delimbers viewed in Alberta all had topping knives, while chain saws were used in B.C.

The D-3000 has a single cable to stabilize the head and boom, but a double-cable system is available as optional equipment for increased strength. It is recommended by the manufacturer for most western Canadian operations. The double cable shown in Figure 6 was retrofitted after the owner decided the single cable proved inadequate for his conditions. The DM-3000 is supplied with double cables as standard equipment.

The DM-3000 requires a Class B carrier. Most of the other delimbers observed were also mounted on Class B carriers, although the manufacturer claims Class A carriers are adequate to handle the D-3000. One company in south-central B.C. reported it had purchased a Denis KS delimber mounted on a Caterpillar 215 SA LC carrier (Class A) and subsequently discovered the delimber and carrier were too

*Table 2. Denis Specifications*

| Items | Models | | |
|---|---|---|---|
| | D-3000 | DM-3000 | O, K, T, KS |
| Carrier class | B or A | B - with 18-m boom<br>A - with 15-m boom | B or A |
| Weight (kg) | 6 350 | 6 350 | 4 500 |
| Maximum stem diameter (cm)[a] | 66/81 | 66/81 | 61 |
| Topping | Dual knives or optional chain saw | Dual knives, optional single knife, optional chain saw | Dual knives, optional chain saw |
| Bucking | Optional 56-cm chain saw, optional 76-cm chain saw | Optional 56-cm chain saw, optional 76-cm chain saw | Optional 56-cm chain saw, optional 76-cm chain saw for "O" model only |
| Measuring | Optional digital manual control, optional minimum top-diameter light indicator | Optional digital manual control, optional minimum top-diameter light indicator | Optional digital manual control, optional minimum top-diameter light indicator |
| Current list price, typical configuration | $145 000<br>Includes 2 chain saws, butt plate, measuring systems, double-boom cables, installation | $170 000<br>Includes 2 chain saws, measuring system, installation | $90 000<br>Plus installation |
| Manufacturer | | Denis Équipement Inc.<br>5110 Beaudry Street<br>St. Hyacinthe, PQ<br>J2S 8A2<br>(514) 773-5454 | |

[a] Maximum size which will enter funnel.

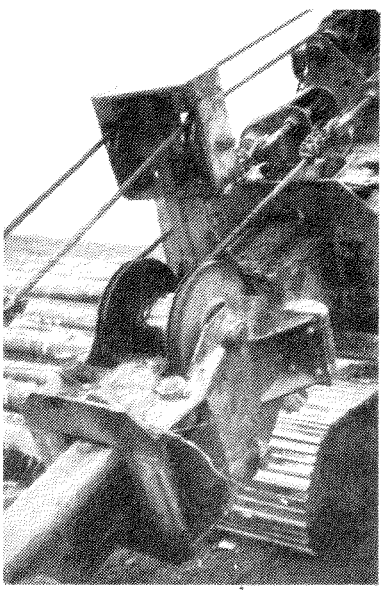

*Figure 6. Double-cable system for Denis telescopic boom.*

light for the local conditions. With the large trees typical of the area, the carrier tended to tip when lifting large stems and could not swing them uphill.

Another company with the same equipment configuration was able to process Coastal second-growth Douglas-fir timber, although it had some concerns about long-term mechanical reliability of the carrier.

To begin processing, a stem is grasped about 3 m from its butt and pulled toward the carrier. The butt is held by the rear grab arms while the boom is extended and the front grab arms cut the limbs. If the stem is longer than the boom's maximum length, the top grab arms are closed while the rear grab arms are opened, the boom is retracted, and the process is repeated. Long stems may require three strokes of the boom. The stroking process is reversed to discharge the stem.

The grab-arms do not automatically follow the taper of the stem; the operator must adjust them constantly during delimbing to ensure adequate delimbing quality.

A computer which displays the distance from the butt to the topping saw is available as optional equipment from Équipements Denis Inc. The distance from the butt to the saw is displayed after the butt passes a photocell mounted near the rear grab arms; the

operator then monitors the saw position as the boom moves in and out. The computer derives its distance information from an encoder on the boom drive motor; the operator must take a few seconds to recalibrate it whenever the boom cables are tightened.

Whether or not the log-length display is changed as the boom moves in and out and the photocells detect the presence of a stem depends on the position of the rear grab arms; it changes when they are closed but not when they are opened. However, if there is insufficient pressure to hold the stem securely when the grab arms are intended to be closed, slippage will occur and the log-length measurement will be incorrect. A light on the console indicates when the grab arm pressure is sufficient to hold the stem securely. If the photocells do not detect the presence of a stem, the length display changes regardless of the grab-arm position.

Most owners and operators felt the Denis was a high-maintenance machine, especially regarding chain saws and bars as mentioned earlier. When the ground is sloped, and depending on operator technique, the boom may slide when cutting with the rear saw, thus bending the bar. However, according to the manufacturer, this should not happen if the rear grab arms are closed tightly while cutting.

Other areas of recurring maintenance were the drive chain, the main hydraulic hoses on the boom, and hydraulic hoses in general. The manufacturer stressed the importance of regular lubrication to prolong chain life. The tensions for the main hoses had to be monitored regularly to prevent excessive wear.

Modifications to the Denis delimbers observed by FERIC were mainly the addition of various teeth and bars to improve log-handling capability, and strengthening around the front and rear grab arms. Several owners added teeth or bars to the rear grab arms to keep the stems from slipping during measuring (Figure 7). One operator who often worked with large-diameter trees found that teeth were required on the front grab arms to keep large stems from dropping (Figure 8). The bumper pads which cushion the boom at its shortest length required strengthening on one machine. Various gusset designs for increasing strength around the head were observed. The manufacturer stressed the importance of good operator technique to minimize structural failures.

However, despite the number of strengthening modifications observed, only a few of the operators and owners had suggestions to improve the Denis delimbers. One owner, who harvested aspen in Alberta, felt that more strength in the boom, base, and head was required to handle the heavy limbs; he owned a DM-3000 which he felt was still too light for the application. It was also suggested that the top-diameter measuring device be made more reliable, and one operator on a Denis model "O" delimber felt

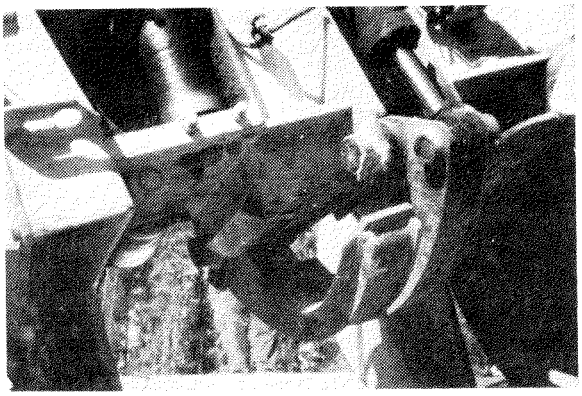

*Figure 7. Traction bars added to rear grab arms.*

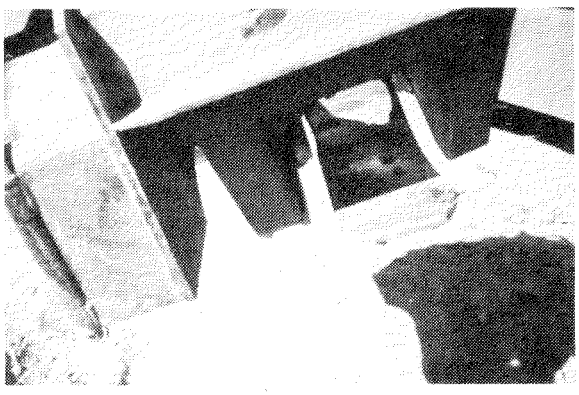

*Figure 8. Teeth added to front grab arms.*

visibility was restricted around the rear grab arms. He felt a mirror would be useful for better visibility during butt-trimming and when the butt entered the funnel. Without seeing the funnel, it was relatively easy to strike the stem against its side, thus causing butt damage.

The Denis delimbers are the most commonly used delimbers in western Canada, especially for roadside processing applications. They are well adapted to roadside processing and, according to the manufacturer, the new models improve on the original machines' capabilities. The D-3000 and DM-3000 have a wider working range for piling higher in windrows, the base is redesigned for better balance and easier transport, and the grab arms have knives on both sides for cleaner delimbing.

The Denis delimbers have been in service for several years, and are supported by many equipment dealers and by the manufacturer through the branch office in Kamloops. The product is constantly evolving and, in FERIC's opinion, will continue to play a large role in delimbing operations in western Canada.

**Lim-mit LM-2200.** The Lim-mit LM-2200 was designed in western Canada for roadside processing in timber stands where conventional stroke delimbers would require two or more strokes per stem. It combines the speed of drive-rollers typically found in

boom-mounted delimbers with the piling ability of stroke delimbers.

Risley Equipment Ltd. of Grande Prairie, Alberta manufactured the first prototype Lim-mit LM-2200 processors in 1986 which FERIC evaluated in 1987 (Peterson 1987). The Lim-mit LM-2200 was introduced in July 1988 (Table 3). Risley Equipment Ltd. plans to distribute the Lim-mit LM-2200 through various heavy equipment dealers, while parts and service will be available through the local dealer or from Risley Equipment Ltd. Figure 9 shows a Lim-mit LM-2200 working at the roadside in central B.C.

*Table 3. Lim-mit LM-2200 Specifications*

| Model | LM-2200 |
|---|---|
| Carrier class | B |
| Weight | 9 100 kg |
| Maximum stem diameter | 73-cm inside tube<br>56-cm delimbing |
| Topping | 102-cm circular saw with 38-cm cutting capacity |
| Bucking | Optional 66-cm chain saw |
| Measuring | Optional digital length measuring with semi-automatic control |
| | Minimum top diameter indicated by grab-arm opening |
| Current list price, typical configuration | $158 000 f.o.b. Grande Prairie<br>Includes bucking saw, hydraulic layover, and installation |
| | Excludes measuring system (price not determined), optional carrier guarding package |
| Manufacturer | Risley Equipment Ltd.<br>9024 - 108 Street<br>Grande Prairie, Alta.<br>T8V 4C8<br>(403) 532-3282 |

The Lim-mit LM-2200 consists of two main components: the base, which is custom-designed for each carrier model, and the delimber, which consists of a sliding boom and a stationary tube. The delimbing head is mounted at the end of the sliding boom; it contains two grab arms, a circular saw for topping, and an optional chain saw for larger diameter butt cuts. The circular saw can also be used for butt trimming and bucking. Two drive-rollers at the front of the tube move the stem through the tube while the grab arms on the delimbing head cut the limbs. Figure 10 shows the delimbing head, feed rollers, and tube opening on a Lim-mit LM-2200. A Class B carrier is required.

According to the manufacturer, the tube has two advantages; its length provides more support and reduces damage to long stems, and it offers an ideal location for the photocell in the length-measuring system. The length-measuring system was still in development when FERIC interviewed the manufacturer, but according to design specifications, it will use console lights to signal three different bucking locations to the operator. It is expected to be operational in 1989.

The basic operating methods remained the same with both the prototype and the Lim-mit LM-2200, but significant changes were made to the drive-roller systems, the saws, the hydraulics, and the carrier mounting. The drive-roller motors are mounted inside the drive-rollers, thus eliminating the gear train used on the prototype model. The boom-cylinder rod extends from both ends of the cylinder and has a smaller diameter than conventional cylinder-rods, thus, it is easier to handle for repairs. The rod is flexible and is always kept in tension, i.e. it acts like a cable. The "double-ended" cylinder design also equalizes hydraulic oil flow on both sides of the piston which allows faster and simpler hydraulic circuits. The circular saw is unpowered except when actually cutting; its momentum and the short burst of power are usually sufficient for topping the stems. However, power must be applied for approximately two seconds to bring the saw up to full speed before cutting larger-diameter stems. The carrier mounting base has

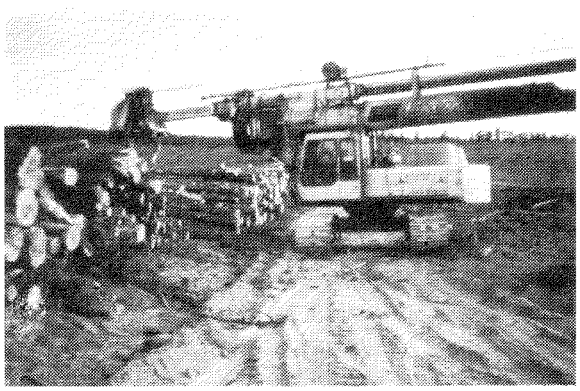

*Figure 9. Lim-mit LM-2200 roll delimber.*

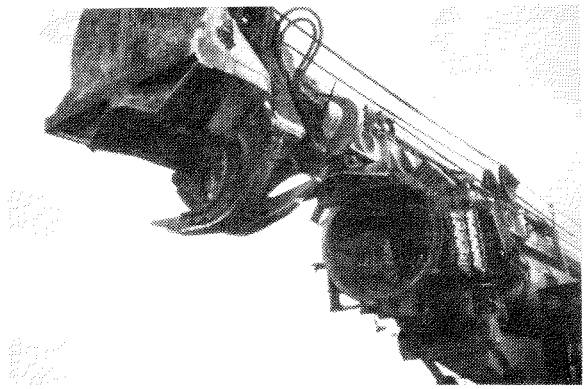

*Figure 10. Delimbing boom and feed rollers.*

an optional hinge mechanism to lay the delimber on its side for public-road transportation.

The Lim-mit LM-2200 begins its processing cycle much like conventional stroke delimbers in that it retrieves a stem and pulls it towards the carrier. Either the circular saw or the chain saw can be used for trimming. Once the butt is inside the tube, the drive-rollers close and begin rotating; the boom stays stationary as the stem moves backwards through the tube. When the stem has moved far enough through the tube for the saw to be over the desired bucking point, the circular saw is engaged and the stem is topped. The drive-rollers are reversed to discharge the stem.

The stroke for the Lim-mit LM-2200 boom is shorter than for conventional stroke delimbers. As a result, the skidder operator must be careful to pile the stems close to the road or they will be out of reach. The shorter boom stroke also helps maintain the centre of gravity close to the machine's centre for increased stability. It should also result in less stress on the boom and carrier. Butt trimming is done when the stem is still near its original position, so less debris accumulates in the ditches than for delimbers that trim the butts adjacent to the road. However, debris accumulations from the Lim-mit LM-2200 may interfere with building the log deck.

The Lim-mit LM-2200 was designed to process larger trees and the manufacturer does not claim that it has any advantage over conventional stroke delimbers for processing small trees. However, where stroke delimbers may require two or three strokes to process a large stem, the Lim-mit LM-2200 can process the entire stem with one motion. The processing motion is very smooth, with little of the jarring motion associated with conventional stroke delimbers. Long-term reliability should be improved.

The grab arms are long and well designed; they easily penetrate the pile to grasp a stem. The grab arms automatically follow the taper of the stem and close to a 10-cm opening to help estimate top diameters; branch stubs are left on undersized tops.

The Lim-mit LM-2200 is still relatively early in its development life, and it is expected that changes will be made over time. For example, when FERIC observed the Lim-mit LM-2200 in 1988 there was still some experimentation with the teeth on the drive-rollers: one machine had conical teeth approximately 30 mm long (Figure 11), while the other had the flat, wavy bars from the factory (Figure 12). Both operators were satisfied with their current configuration, and the deep marks left by the conical teeth were reportedly not a concern at the sawmill.

Both owners surveyed have experimented with the hydraulic pressure on the drive-rollers to find an optimum balance between drive-roller speed and the opening and closing action. The sliders which carry electrical power to the boom cables and head were replaced with sheaves on one machine (Figure 13).

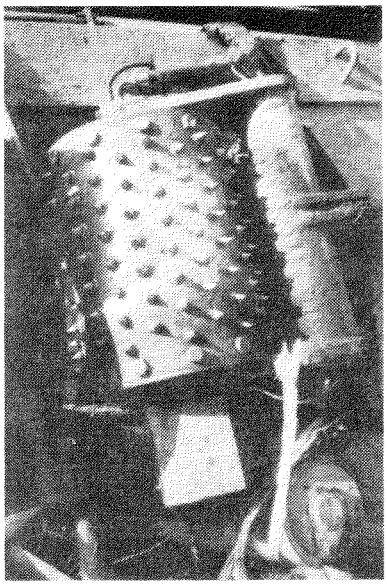

*Figure 11. Conical teeth retro-fitted to a Lim-mit LM-2200.*

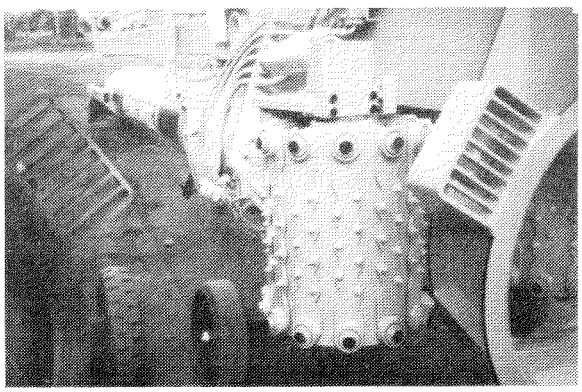

*Figure 12. Factory-supplied teeth and traction bars.*

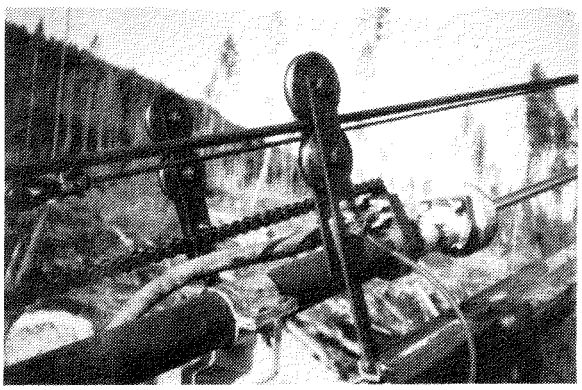

*Figure 13. Hose-tensioning chain and sheaves for electrical power.*

The chain shown in Figure 13 is used to tension the main hydraulic hoses, and it broke several times on one machine. The owner suggested it be replaced with a cable. Trouble with saw-motor seals on one delimber was attributed to a dull saw blade, leading to higher motor loading. With correct saw-blade maintenance, there were no further problems with motor seals. Flying debris from the drive-roller accumulates on the cab window, and may obscure the operator's vision. A mud-flap was installed on one delimber to control the debris, but it reduced visibility of the stem as it entered the tube.

The chain saw on the Lim-mit LM-2200 has a unique mounting; rather than pivoting around the drive sprocket, it is mounted on a column which runs inside another tube (Figure 14). This arrangement keeps the cutting angle constant at all times, and the manufacturer claims it utilizes more of the chain saw's bar. However, the operator of one machine felt that the column guides were inadequate since the column kept binding in its housing and the saw could not be used.

The operator also suggested that the manufacturer should reroute the oil-lubrication line for the chain saw to facilitate access and to prevent possible damage if the chain should break. Other suggestions included putting a catwalk on the tube for easier maintenance, putting a lock on the hose-length equalizer, and installing heavier guarding on the head.

Overall, the owners and operators of both machines were very complimentary toward the Lim-mit LM-2200 and felt it was doing a good job for them. In FERIC's opinion, the Lim-mit LM-2200 has great potential for roadside processing in larger timber. The drive-rollers make operation very fast and smooth, and the machine appears to be well designed, manufactured, and supported by Risley Equipment Ltd.

**Harricana.** The Harricana HM 1290 50 TP is a single-piece boom-stroke delimber manufactured by Harricana Metal Inc. of Amos, Québec (Figure 15) and sold through several equipment dealers in western Canada. A second model, the HM 1290 50 lacks the bucking saw and incorporates topping knives, although a topping saw is optionally available. Specifications for the Harricana delimbers are shown in Table 4. The FERIC evaluations of Harricana delimbers were made early in their development (Folkema and Lavoie 1978, Giguere 1981).

According to the manufacturer, the single-piece boom keeps the design simple and the number of parts to a minimum; common parts are used throughout for ease of maintenance. A Class B carrier is required, and the Harricana is claimed to be easily installed on various carrier brands. Owners generally chose the Harricana brand because they felt it would perform better than competitive delimbers in large timber. Several users reported excellent results when removing heavy limbs.

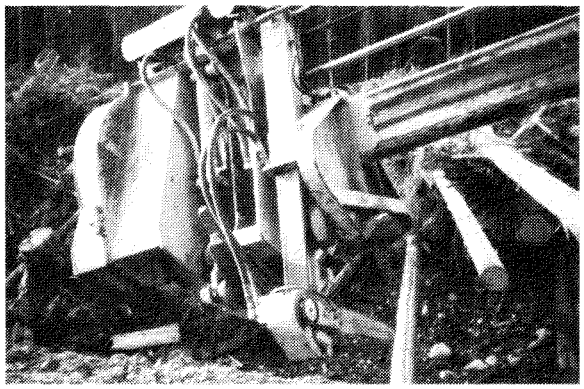

*Figure 14. Lim-mit LM-2200 bucking saw.*

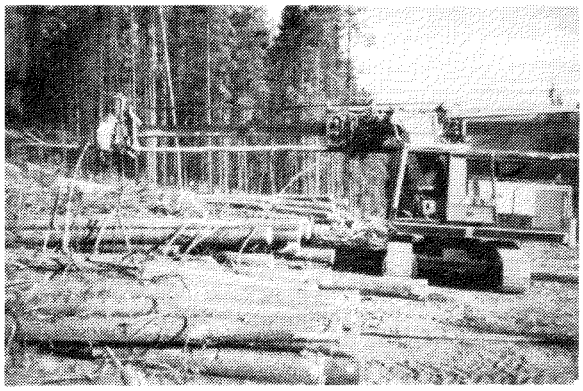

*Figure 15. Harricana delimber.*

A Harricana sales representative is stationed in Delta, B.C. and a service representative resides in Peachland, B.C. A parts depot is located in Kamloops, B.C. for quick delivery of many parts, but the sales representative also recommended that customers keep a good supply of spare parts. Back orders are routed to the factory in Québec, and delays may be incurred for less frequently required parts. Service from the dealer or the factory representatives has been variable, with some users praising the service, and others claiming it was poor. A previous dealer for Harricana remarked on the lack of factory support for western dealers. Telephone consultations with the factory service representative in Peachland, B.C. were highly rated, although he was often difficult to contact.

The Harricana is similar in operation to other single-piece boom-stroke delimbers except that it does not have a sustaining ring or funnel to hold the stems. Therefore, the stems can drop from the rear grab arms when they are opened for stroking, thus increasing processing time.

Preventing stem slippage during log-length measurement is a concern with the Harricana as well as with other stroke delimbers. Two owners commented that the rear grab-arm cylinders were too small to hold the stem securely enough to keep it from slipping. Traction bars (Figure 16) were added to one machine

*Table 4. Harricana Specifications*

| Items | Models | |
|---|---|---|
| | HM 1290 50 TP | HM 1290 50 |
| Carrier class | B | B |
| Weight (kg) | 5 910 | 5 000 |
| Maximum stem diameter | 60-cm holding capacity | 60-cm holding capacity |
| Topping | 40-cm chain saw, optional 50-cm chain saw, optional single or dual knives | Single knife, optional dual knives, optional chain saw |
| Bucking | 60-cm chain saw | N/A |
| Measuring | Digital length measurement<br>Minimum top-diameter light indicator | N/A<br>Optional minimum top-diameter light indicator |
| Current list price, typical configuration | $120 000<br>Includes installation | $104 000<br>Includes topping saw, top-diameter indicator, hydraulic control group, and installation |
| Manufacturer | | Harricana Metal Inc.<br>P.O. Box 550<br>Amos, Que.<br>J9T 3A8<br>(819) 732-8381 |

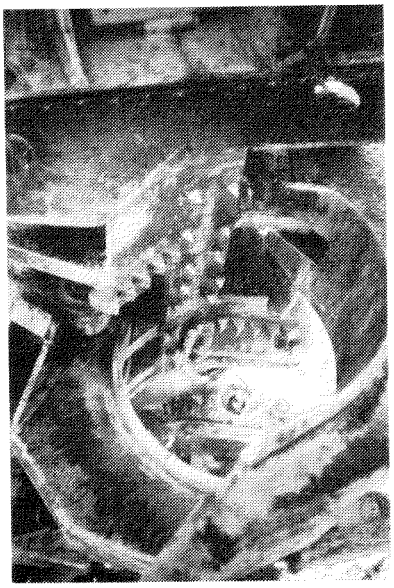

*Figure 16. Teeth and bars for reduced stem slippage.*

to reduce stem slippage. Neither of the machines surveyed had operative measuring systems; one owner commented that it was not worth the trouble to keep the computer operational. He used paint marks on the boom to indicate the preferred log lengths, reportedly with good success.

The same owner, in consultation with Harricana and the local representatives, has made significant changes to the delimber. The original boom-roller was replaced with two wider rollers on a walking-beam assembly to better distribute the load (Figure 17). The rollers were shaped to match the boom's contour; the original roller was straight and caused cracking in the boom. The single cable to support the boom was replaced with a double-cable system for increased strength. The guarding around the track and log-trough were enlarged to further protect the undercarriage and cab (Figure 18). The bolts which hold the delimber to the pedestal were all replaced with larger sizes. The electrical cables inside the boom were all protected inside plastic pipe. He planned to replace the boom drive-chain with a cable because of high maintenance costs.

Another owner commented that the basic design of the delimber was good, but that more work was required to improve the hydraulics and electrics. His mechanical problems were small items, such as broken fittings and short circuits.

The Harricana's single-piece boom makes it well adapted to stands with large trees and heavy limbs; its slower speed makes it less suited for stands with small trees. However, it is not widely used in western Canada, and in FERIC's opinion, dealer service may be a concern for western operators.

## Boom-Mounted Delimbers

**Steyr.** Steyr-Daimler-Puch AG of Vienna, Austria manufacturers two models of boom-mounted delimb-

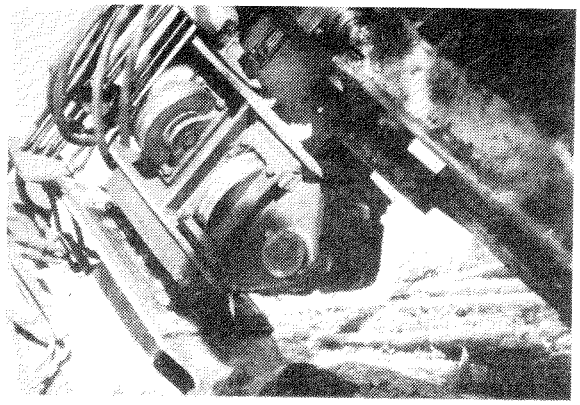

*Figure 17. Modified boom-support rollers on the Harricana.*

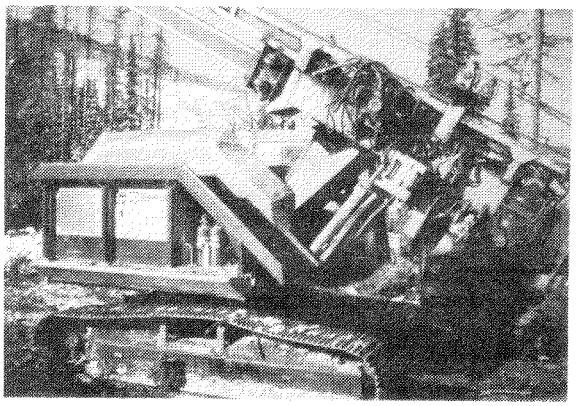

*Figure 18. Enlarged guarding for Harricana track and cab.*

ers used in western Canada, and Deron Forest Technik Ltd. of Prince George, B.C. distributes both machines. The Steyr KP40 (Figure 19) can cut stems up to a 35-cm diameter while the Steyr KP60 can cut stems up to a 56-cm diameter. Both delimbers can handle stems larger than their rated capacities if the butts are clean and do not require delimbing or trimming. The Steyr KP40 requires a carrier in Class A or B, while the Steyr KP60 requires a carrier in the Class C. Specifications for both machines are shown in Table 5.

The Steyr KP40 has been available in western Canada since 1985 when the Series I was introduced; the Steyr KP40 Series II was introduced in late 1986. A FERIC evaluation (MacDonald 1988b) looked primarily at the Steyr KP40 Series I; it was also included in a review of off-road processors for eastern Canada (Richardson 1988). Among the differences between the Series I and Series II models are the grade of steel used for the frame, the drive-track tooth configuration, the wearing pads and oiling system for the drive-track, rotator design, frame and grab-arm reinforcements, and updated computer system.

The Steyr KP60 (Figure 20) was developed for processing Coastal second-growth timber; the first prototype was built in 1985. It can be used in the landing or in roadside operations, with the stems piled on one side of the road and the processed logs on the other side, or in the landing. Ensuring log butts are aligned after processing is not so critical in Coastal operations as in Interior operations since the

*Table 5. Steyr Specifications*

| Items | Models | |
|---|---|---|
| | KP40 | KP60 |
| Carrier class | A or B | C |
| Weight | 995 kg | 3 850 kg |
| Maximum stem diameter | 40 cm delimbing<br>35 cm cutting | 76 cm holding<br>56 cm cutting |
| Topping/ bucking | 90-cm circular saw<br>Optional additional chain saw | 140-cm circular saw<br>Chain saw |
| Measuring | Digital length measurement with automatic or manual control<br>Top-diameter limit switch | Digital length measurement with automatic, semi-automatic, or manual control<br>Digital diameter-measurement with automatic or manual control |
| Current list price, typical configuration | $124 000<br>Includes optional oiler, filters, and installation<br>Excludes optional chain saw | $237 000<br>Includes installation |
| Distributor | Deron Forest Technik Ltd.<br>1204 Pacific Street<br>Prince George, B.C.<br>V2N 2K8<br>(604) 561-0111 | |

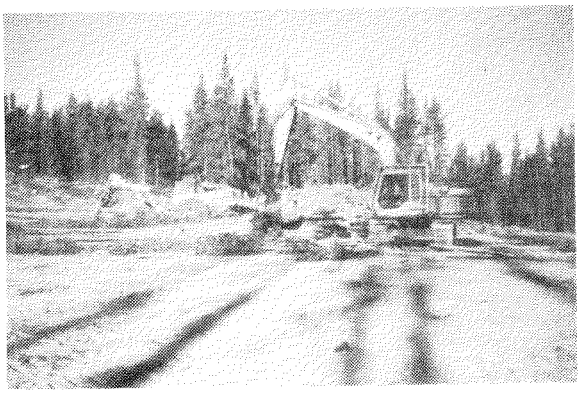

*Figure 19. Steyr KP40 working on a southern B.C. landing.*

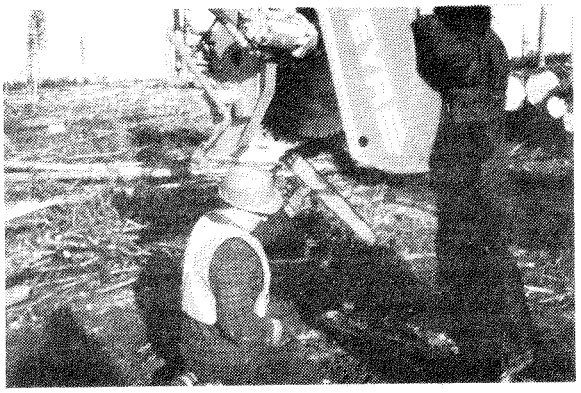

*Figure 21. Optional chain saw on Steyr KP40.*

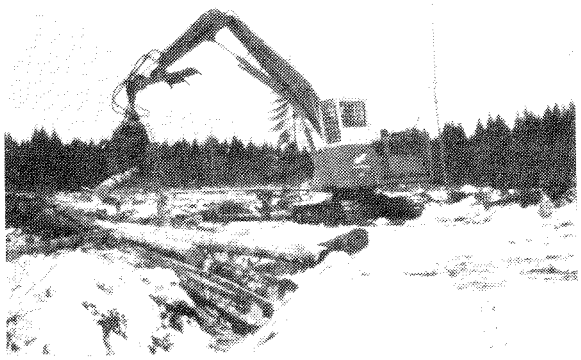

*Figure 20. Steyr KP60 delimber in Coastal application.*

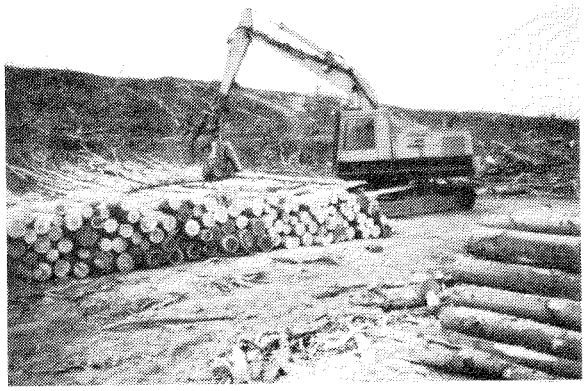

*Figure 22. Steyr KP40 used for bucking aspen bolts.*

larger logs handled by the Steyr KP60 are typically loaded one or two at a time.

To use either delimber, the operator selects a stem from the infeed pile and positions the delimber over it. The narrow-profile grab arms easily penetrate the log pile to grasp a stem. The grab arms hold the stem against the drive-track to move it through the delimber. Knives on the grab arms remove the bottom limbs as the stem moves forward, while smaller top knives cut the top limbs. The saw is used to trim the butt or to cut the stem to length. The Steyr KP60 has a chain saw for trimming larger butts and broken tops; it is optional on the Steyr KP40 (Figure 21).

The Steyr delimbers have computer systems to simplify many of their functions; the operator can automatically delimb, buck, and top the stem by pressing one button. The computer terminal has seven buttons for seven different log lengths, or one length can be programmed for multiple cuttings (Figure 22). The Steyr KP60 computer also allows semi-automatic processing, where the computer stops the stem at the desired length and the operator engages the saw. The Steyr KP40 delimbers have limit-switches which stop the stem at a preselected minimum diameter; the limit-switch can be manually overridden if desired. The Steyr KP60 has a continuous display of stem diameter, and the computer can stop the stem at one of five pre-selected diameters.

Manual operation is also straightforward; the operator needs only to close the grab arms over the stem and engage the forward-travel button to begin processing. The grab arms automatically follow the profile of the stem. The operator stops the drive-track at the desired length and engages the saw to cut the log. The log drops into the outfeed deck and the delimber retains the top in the grab arms for further processing or discarding.

Most operators interviewed felt the Steyr KP40 was a high maintenance machine, requiring constant attention to ensure that small problems do not escalate into major breakdowns. Some areas that require attention are the bolts which hold the drive-track segments to the drive chain, rapid wear on the delimbing knives, and hydraulic hose failures. The diameter-limit switch was relocated to reduce accidental damage. Depending on timber quality, the saw blade may require sharpening up to once a week, and most owners interviewed have switched to third-party suppliers for longer saw-blade life. A FERIC Field Note (MacDonald 1989) describes the IKS CleviSaw replacement saw blade purchased by one owner. Deron Forest Technic Ltd. recommends that a splined saw-motor shaft be used when using the IKS CleviSaw.

The Steyr KP60 was still early in its development when FERIC observed them working, and operators

were experiencing problems, especially with its electronics, chain saw, and grab arms. The photocells for log-length measurement are subject to errors caused by direct sunlight. One operator felt that the chainsaw bar was too light, and should be replaced with a heavier bar. The bar which connects the grab arms together can be easily bent, thus causing the grab arms to go out of alignment. The grab-arm hydraulic pressure must be set carefully; if set too high, the drive-track will lose traction, and if set too low, the Steyr KP60 has difficulty pulling stems from the windrow. Thick bark on Douglas-fir stems often causes drive-track spinouts resulting in lost length references. Steyr is currently testing the use of rollers on the grab arms to allow higher pressures without the drive-track losing traction on the stem. A new system, which increases the grab-arm pressure depending on the work load, has also been developed. Other design mode functions which have been made on later machines include a new photocell design, heavier chain saw, and electronically controlled protection for the chain saw bar.

Troubleshooting via telephone and parts delivery from Deron Forest Technik Ltd. were highly rated. Some owners have installed radio-telephones in their delimbers for the operator to speak directly with the technician from Deron Forest Technik Ltd. for quicker diagnosis of problems. However, many operators located far from Prince George, B.C. also remarked about the difficulty getting dealer representatives to make service calls. In response, Deron Forest Technik Ltd. has opened a service depot in Williams Lake, B.C. Also, owners rated parts as expensive and some have purchased custom-made replacement parts from third-party suppliers.

Some of the delimbers were modified to better suit local conditions. Guarding around the photocell and saw blade were modified on one Steyr KP40 to provide increased protection (Figure 23). Several operators remarked that the saw blade supplied with the Steyr KP40 is too thin and tends to flex due to gyroscopic action when the carrier swings; a modified guard allowed more space for the saw blade to flex without contacting the guard. The distributor noted that this was a result of operator technique, and that saw guides are installed on all Series II machines.

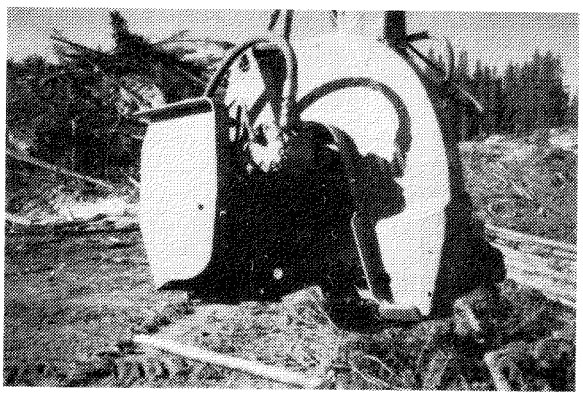

*Figure 23. Extra saw guarding and replacement saw blade.*

Modifications to the Steyr KP60 included more protection to various hoses, added braces between the two front grab arms, and heavier connecting arms between the grab arms. One owner planned to add a keyway to the drive-track motor shaft to facilitate changing motors.

Some suggestions for improvements to the Steyr KP40 were to use rollers instead of pads for the drive-track guides, to use higher quality hydraulic hoses, and to modify the hydraulic hoses leading to the saw motor, eliminating a swivel coupling. Later Series II machines have been changed to address these concerns. One owner remarked that the machine did not need modifications, but that the source of most of his difficulties were a lack of understanding of the machine's systems, and better training at the time of purchase would have reduced his problems.

The Steyr KP40 is the most popular boom-mounted delimber in western Canada. Its success is due largely to the development work done by Deron Forest Technik Ltd. to adapt the Steyr KP40 to western Canadian conditions. In FERIC's opinion, it works very well in its intended application, i.e. delimbing and processing small-diameter logs on landings, but, like other delimbers in its class, is not well adapted in larger-diameter wood or in roadside operations.

The Steyr KP60 has not been as widely accepted as the Steyr KP40 since it is an expensive machine and it requires a large carrier; total cost for the delimber and carrier can exceed $700 000 when using a new carrier. A reliable used carrier may prove more economical. The units now in service are experiencing low mechanical availability, which must be increased before the Steyr KP60 will become widely accepted.

**Lako 3T.** Can-Am Forestry Equipment Inc. of Kamloops, B.C. and Prince George, B.C. have been distributing the Lako 3T Grapple Harvester manufactured by Arctic Forest Machines OY of Finland since early 1988. Can-Am Forestry Equipment Inc. has the exclusive distributorship for Lako equipment in B.C. and Alberta. The Lako 3T (Table 6) is boom-mounted, and requires a carrier from Class B although a smaller carrier may suffice in smaller timber. The Lako 3T was reviewed in a survey of eastern processors (Richardson 1988).

Several changes have taken place since this review was initiated. The manufacturer changed names from Metsatyo Oy to Arctic Forest Machines OY to reflect more accurately their world-wide distribution of forestry equipment. Similarly, Can-Am Forestry Equipment Inc. changed their name from Milso Equipment Ltd. The Lako 3T has been renamed the AFM 60 Lako in reference to its manual 60-cm cutting capacity. This report will use the older designation, the Lako 3T.

*Table 6. Lako Specifications*

| Model | 3T |
|---|---|
| Carrier class | B or A |
| Weight | 910 kg |
| Maximum stem diameter | 55-cm delimbing<br>55-cm bucking |
| Topping/bucking | 63-cm chain saw with 55-cm cutting capacity |
| Measuring | Digital length measurement with automatic or manual control top-diameter limit switch with two auxiliary diameter indicators |
| Current list price, typical configuration | $127 000<br>Includes installation |
| Distributor | Can-Am Forestry Equipment Inc.<br>622 4th Avenue<br>Prince George, B.C.<br>V2L 3H1<br>(604) 562-5561 |

Also, some of the features of the Lako 3T, such as the lack of a photocell and the computer capability, have been changed with the AFM 60 Lako.

The Lako 3T was designed as a harvester and some of its features, though beneficial when used for that application, are detrimental when the machine is used as a delimber. However, although it is often used as a delimber in western Canada, on a worldwide basis, it is generally used as a harvester. Therefore, according to the manufacturer, design changes which might be required for the delimber market in western Canada must also be applicable to the larger, worldwide market.

The delimber (Figure 24) has two grab arms for holding and delimbing, plus two arms with hydraulically drive drive-rollers. The stem is moved by the two drive-rollers and a drive-track mounted between the drive-rollers, such that the stem is engaged on three sides. The manufacturer claims this arrangement of drive-rollers and chain allows higher feed speed and driving force than other boom-mounted delimbers; FERIC's observations confirmed this. A low speed setting is used when jogging to find the correct log length.

FERIC observed one Lako 3T operating in a rough pine stand west of Quesnel, B.C. Most of the stems had limbs over their entire length, and the Lako 3T had little difficulty producing very clean logs from the rough stems. Occasional large limbs caused the delimber to stop, but it was able to remove them with a second try.

The Lako 3T has a hydraulic cylinder to tilt it from horizontal to vertical for falling, however, both machines that FERIC observed were used for processing only. The tilting head is an advantage when discarding tops; they can be held clear of the ground as the delimber swings around to the debris pile. It also improves access for servicing (Figure 25). Falling is more feasible in stands with smaller trees than in the stands where FERIC observed the two machines working; the average stem length here was approximately 25 m and the maximum log lengths were approximately 14 m.

In operation, the delimber is positioned over a stem and the grab arms are closed. The operator reverses the stem until its butt aligns with the chain saw, then he selects either manual or automatic mode for delimbing. The grab arms follow the taper of the stem in either mode. In automatic mode, the operator selects one of the pre-programmed log lengths for the computer to measure and buck. The computer has a tolerance about the correct length in which it stops, then reverses to the selected length; it will have some difficulty finding the correct length if the tolerance is set too small. In manual mode, the operator monitors the log length on a digital display, and engages the saw manually when the desired length is reached.

*Figure 24. Lako 3T delimbing pine stems in Central B.C.*

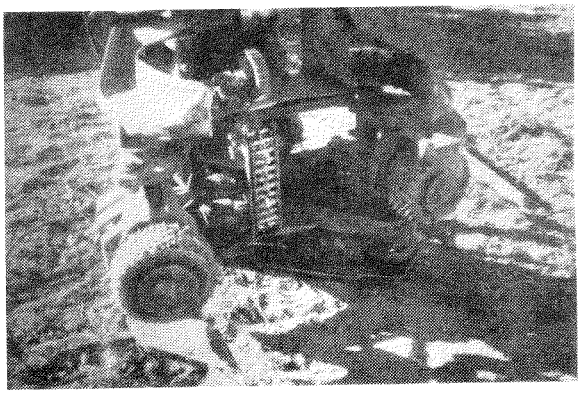

*Figure 25. Tilting capacity of the Lako 3T.*

The Lako 3T has a hydraulically driven chain saw for topping and trimming butts, and it has a computerized bucking system. Log lengths are measured with a spring-mounted idler wheel which is independent of the drive system and subject to less slippage, although one owner suggested that a narrower wheel under higher pressure would reduce slippage even further.

The Lako 3T was designed to engage standing trees and its drive-rollers do not slip easily between the stems in a pile. Therefore, stems are easier to grasp if they protrude from the pile. Also, the processor has difficulty engaging small-diameter stems lying flat on the ground; this is caused by a combination of the relative length of the grab arms to the drive-roller arms, the grab-arm closing sequence, and the angle at which the delimber hangs. The difficulty occurs when the drive-roller arms, rather than the grab arms, engage the stem; the operator must then drop the stem and reposition the delimber to gain a better grasp.

Also, stems can catch on the edge of a drive-roller when the grab arms close (Figure 26), rather than sliding over its face. Again, the stem must be dropped and the delimber repositioned to properly engage the stem. The grab arms for both Lako 3Ts viewed by FERIC were modified to partially remedy the latter problem (Figure 27) and the manufacturer is aware that modifications are necessary.

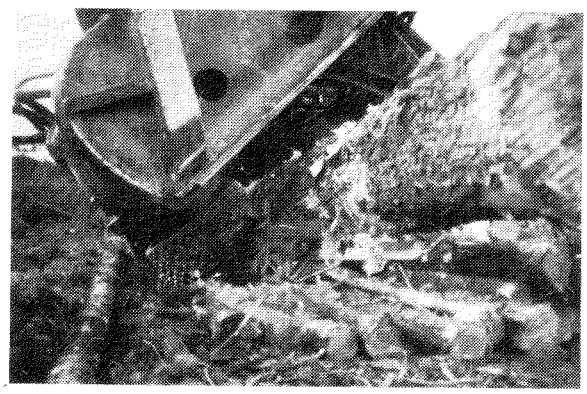

*Figure 26. Position of stem prevents grab arms from closing completely.*

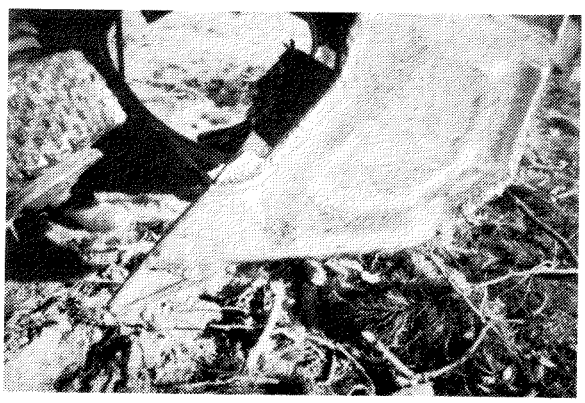

*Figure 27. Modified grab arms help stems slip more easily over the drive-roller face.*

Another problem related to the Lako 3T being designed as a feller-processor is that the method for resetting the length-measuring computer is awkward; the length measurement is reset to zero each time the chain saw is used rather than incorporating a photocell to detect the end of the stem. This is acceptable when falling, but in delimbing applications the chain saw must be momentarily activated at the butt to reset the computer if length measuring is required. According to Can-Am Forestry Equipment Inc., a photocell system will be available shortly.

The Lako 3T has both length-measuring and diameter-measuring systems. The length-measuring systems on both delimbers were inoperative when FERIC was at the site; one was broken and the other was being calibrated by a factory representative. When the calibration was completed, FERIC observations confirmed it was accurate. A new computer system which records up to 12 preferred log lengths will be available shortly. It will also measure log-butt diameters and will record tree species and volume based on average stand taper equations. This system has not yet been proven under local conditions although it has been available in Finland since 1987. The diameter-limit switch cannot be overridden manually once it is activated. If it stops the stem slightly short of a preferred length the delimber must be moved back to the next shorter acceptable length, thus wasting some fibre.

The Lako 3T is an unproven design in western Canada, and its long-term mechanical reliability is unknown at this time. However, observations of the two Lako 3Ts during the survey indicate some components may be too light for local conditions. For example, the grab arms and their connecting rod are of box-beam construction, rather than solid, and showed signs of cracking. Hydraulic hoses are an area of recurring maintenance. FERIC observed that the installation workmanship for both computer systems was poor; wires were left exposed and control-panel mountings had broken off. The Lako 3T is built very compactly, making access to some components difficult. Proper training of operators is an important factor in minimizing downtime; both operators made remarks about their lack of understanding of some of its systems.

However, the owners and operators were mainly complimentary towards the Lako 3T, and had few suggestions for modifications (other than those already mentioned with regard to the grab arms). Like any new product, there will be initial problems, but in FERIC's opinion, Can-Am Forestry Equipment Inc. appears to be committed to adapting the Lako 3T to western Canadian conditions and supporting it with after-sale service.

**Prototypes.** There is a great deal of interest in central B.C. for developing new boom-mounted delimbers. The Industrial Research Assistance Program (IRAP) is a federally funded program to encourage new industrial developments, and the IRAP representative in Prince George B.C. reports that five or six concepts for new boom-mounted delimbers are in various stages of development in his region alone. However, none of these machines is currently ready for the market.

Two delimbers, the Tapio and the FERIC/Johnson, are in prototype-testing stage and are undergoing design modifications.

The **Tapio** is manufactured by Soinin Metalli OY of Finland, and is being tested by its distributor, Forsyth Rentals and Equipment Ltd. of North Vancouver, B.C. It will not be marketed until the manufacturer and distributor are satisfied with its performance under local conditions. This review is based on a video presentation of the Tapio working in a Scandinavian stand and a demonstration of a smaller Tapio model in eastern Canada. The Tapio 400 and Tapio 550R were reviewed by Richardson (1988). Specifications for the Tapio are shown in Table 7.

The Tapio (Figure 28) is a boom-mounted delimber with two feed systems: drive-rollers which engage the side of the stem and a stroke boom. The stroke boom is used if the drive-rollers lose traction on the stem, such as when encountering a large limb. Two grab arms on the stroke boom have knives for delimbing, and two grab arms near the drive-rollers hold the stem when the stroke boom is used. Length-measurement data is obtained from a separate roller mounted near the drive-rollers. The Tapio tilts to vertical for use as a feller; cuts are made with a chain saw mounted at the bottom of the delimber.

Since the Tapio has not been used under actual operating conditions in western Canada, it is too early to comment on its mechanical reliability. As of this writing, the prototype was being recalled to the factory for further modifications.

*Table 7. Tapio Specifications*

| Model | 550R |
|---|---|
| Carrier class | A |
| Weight | 680 kg |
| Max. stem diam. | 45-cm delimbing |
| Topping/bucking | 45-cm chain saw |
| Measuring | Digital length measurement with automatic or manual control |
| Current list price, typical configuration | $125 000<br>Includes installation |
| Distributor | Forsyth Rentals and Equipment Ltd.<br>20 Fell Avenue<br>North Vancouver, B.C.<br>V7P 2J9 (604) 985-8751 |

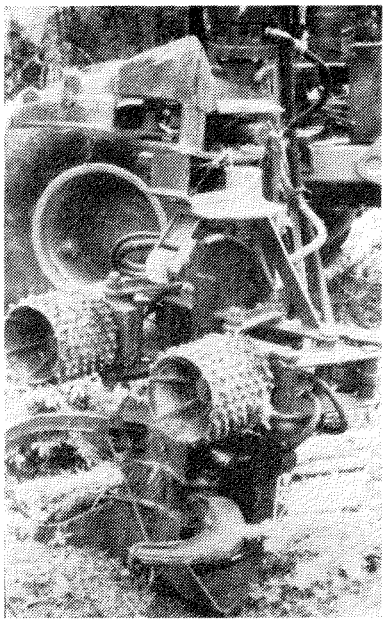

*Figure 28. Tapio processor.*

The **FERIC/Johnson** processor was developed by Johnson Industries Ltd. of Richmond, B.C. and FERIC in cooperation with the Science Council of B.C. specifically for Coastal applications. It mounts on a conventional West Coast cable loader and retains the loader's ability to retrieve stems from large windrows and from over steep road banks. It features a retractable mounting so the machine can also be used for loading. One prototype is currently in operational testing (Figure 29). Table 8 shows the specifications for the FERIC/Johnson processor.

The FERIC/Johnson delimber hangs from a pendulum in the normal heeling area of the loader boom. Two drive chains on mobile arms support the stem during

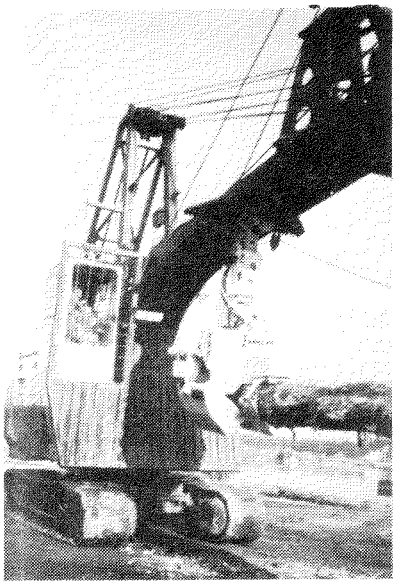

*Figure 29. The FERIC/Johnson processor during testing.*

*Table 8. FERIC/Johnson Specifications*

| Model | Prototype |
|---|---|
| Carrier class | West Coast cable loader |
| Weight | 4 550 kg including pendulum |
| Maximum stem diameter | 60-cm bucking |
| Topping/bucking | 137-cm diameter circular saw |
| Measuring | Digital length measuring with manual control |
| List price | n/a |
| Manufacturer | Johnson Industries Ltd.<br>8500 River Road<br>Richmond, B.C.<br>V6X 1Y4<br>(604) 273-3737 |

processing, and idler rollers ride above the stem. It has delimbing knives mounted on the mobile arms for cutting lower branches, and separate delimbing arms for upper branches. A circular saw trims, bucks, and tops, and it is possible to add a chain saw for cutting broken tops.

In operation, a stem is retrieved with the loader grapple and brought to the delimber. The loader is then angled so the stem passes to either side of the machinery deck. The operator stops the stem travel at the desired length and engages the saw to buck the stem. The top is retained in the delimber for further processing or discarding. Logs can be processed into piles on the road, or the grapple can be used to stack them for later loading.

The prototype FERIC/Johnson delimber derived its power from the loader's engine. A custom-designed drive shaft was attached to the crankshaft to deliver power to a hydraulic pump mounted on the side of the loader. This arrangement was thought to be more economical because only one power source was needed, but several problems emerged. First, the engine did not provide sufficient power for the delimber; second, each future installation must be custom-designed to fit the particular motor and loader; and last, the operator must overcome ingrained work habits to learn new clutching and throttling sequences while processing stems. Future plans include adding a separate engine which would provide constant power to the delimber and be easier to install and operate.

Length-measurement data is derived from one of the drive chains, so any slippage will produce measurement errors. The length is displayed on a digital readout in the operator's cab and control is manual. Future developments will add automatic length-measurement control. There is currently no provision for diameter measurement.

It is too early to comment on the mechanical reliability of the FERIC/Johnson delimber since it is still in the prototype stage. As of this writing, negotiations for further research and development with an industrial cooperator were being undertaken.

## Self-Contained Delimbers

**Hahn.** Hahn Machinery, Inc. of Two Harbours, Minnesota manufactures a line of three delimbers. Each delimber is designed for a particular application; the HSW-110-B shortwood processor and the Pulp/Logger II are designed for shortwood systems such as harvesting aspen. The Pulp/Logger II is larger than the HSW-110-B and is intended for operations which cut 5-8 m sawlogs as well as pulpwood. The HTL300/F tree-length processor is designed for long-log processing. The Harvester II (Super Hahn), with a larger loader than the other three delimbers, was produced in limited quantities, and is no longer available. Table 9 lists the specifications for the three models which are available. The Hahn delimbers have been in use since the early 1980s; FERIC previously evaluated Hahn delimbers in Central and Coastal B.C. (Powell 1981) and eastern Canada (Folkema and Levesque 1982), and other logging systems studied by FERIC have included Hahn delimbers as part of their equipment fleet (Peterson 1986a and 1986b). The distributor in western Canada is General Hydraulics in Nanaimo, B.C.

The three models differ in their specific design, although all share a common operating procedure. Each model has a loader to retrieve stems for processing and clear debris from around the machine. The loader on the shortwood models also stacks the bolts for loading. To start the processing cycle, the loader places one end of the stem into a set of grab arms on the mobile carriage. The carriage pulls the stem through the centre of the delimber and places the butt in a second set of grab arms. These grab arms hold the stem stationary while the carriage retracts to its original position. The HSW-110-B differs slightly in that a shear holds the stem during the delimbing process. Delimbing knives on the carriage grab arms cut the limbs as it returns to its original position. Limbs are usually removed very efficiently with the Hahn delimbers because of their high feed force and secure grip on the stem, but FERIC observed that some very large aspen limbs (approximately 15 cm in diameter) were difficult to remove.

Topping and bucking is usually done by a 1.9-cm-pitch chain saw. Although the chain saw is optional on the HSW-110-B, a hydraulic shear is standard cutting equipment. Log-lengths are measured either by a butt-plate for the shortwood delimbers, or via an electronic counter which derives its measurements from the carriage drive chain. The HTL-300/F has an optional diameter measuring device and log-painting

*Table 9. Hahn Specifications*

| | HSW-110-B | Pulp/Logger II | HTL 300/F |
|---|---|---|---|
| Engine size | 82 kW | 134 kW | 131 kW |
| Maximum stem diameter | 58 cm | 61 cm | 81-cm capacity<br>51-cm delimbing |
| Topping/bucking | Shear<br>Optional chain saw | Chain saw | Chain saw |
| Measuring | Butt plate | Butt plate | Optional digital length measuring<br>Optional digital diameter measurement |
| Design product | Shortwood | Shortwood, logs up to 4.9 m | Logs |
| Current list price, typical configuration | $163 000 f.o.b. factory<br>Includes dual cabs, chain saw, and heel boom | $251 000 f.o.b. factory<br>Includes second butt plate | $274 000 f.o.b. factory<br>Includes dual cabs, length measurement system, and log-painting system<br>Excludes diameter measurement system ($24 300) |
| Manufacturer | | Hahn Machinery, Inc.<br>Box 220<br>Two Harbors, MN 55616<br>USA<br>(218) 834-2156 | |
| Distributor | | General Hydraulics Ltd.<br>2294 McCullough Road<br>Nanaimo, B.C.<br>V9S 4M8<br>(604) 758-0108 | |

manifold to sort and mark logs by size. Processed logs are discharged to either side of the machine with hydraulic kickers. The shortwood models have baskets to catch the bolts to make stacking easier. FERIC observed that the last bolt cut from a stem often turned crosswise on the delimber and was difficult to discharge, thus processing time was increased.

The shortwood delimber FERIC observed during the survey (Figure 30) was equipped with two chain saws; it could simultaneously cut two bolts. However, it had to discharge both bolts before making another cut, and this required two carriage strokes. In FERIC's opinion, productivity could be increased if the hydraulic system was redesigned to allow the delimber to cut one bolt while the carriage was on its backwards stroke.

The standard configuration for the Pulp/Logger II includes cabs for two operators but the second operator's station is optional on the other models. Most customers order the second operator's station (Figure 31). When the delimber is equipped for only one operator, he must control all the machine's functions; therefore, productivity is reduced although labour costs are lower. When equipped with two cabs, one operator handles the actual delimbing section of the machine, while the other operates the loader. Even when equipped with two sets of controls, the Hahn delimbers can be run with one operator; duplicate controls for the loader are retained in the main cab. Coordination and cooperation between the operators is essential for maximum productivity; FERIC observed many instances where the delimber was idled because the loader was busy with other functions and did not have a stem ready for delimbing.

The Hahn delimbers are not well adapted to roadside logging for several reasons. Firstly, they have difficulty extracting stems from high or tangled windrow piles. Their loaders are undersized for this application, and a secondary machine is required to pull the logs from the windrow. One operation which was visited used two Hahn delimbers, but neither machine had the conventional loader; one machine had its loader removed entirely, and a cable loader was used for infeeding the stems; and the second delimber was a Harvester II with its larger loader.

Secondly, the stems must be aligned lengthwise with the delimber for processing, so they must either be turned 90 degrees or the delimber must be parked

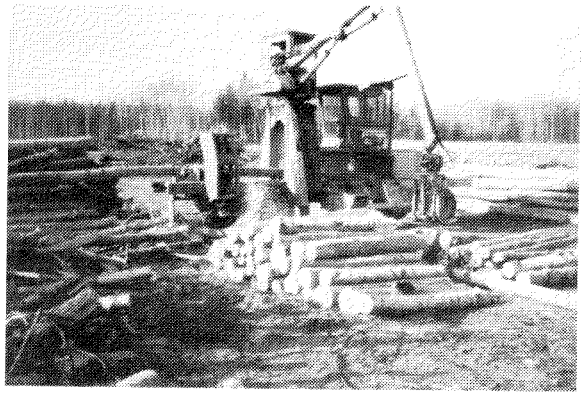

*Figure 30. Hahn delimber cutting aspen bolts.*

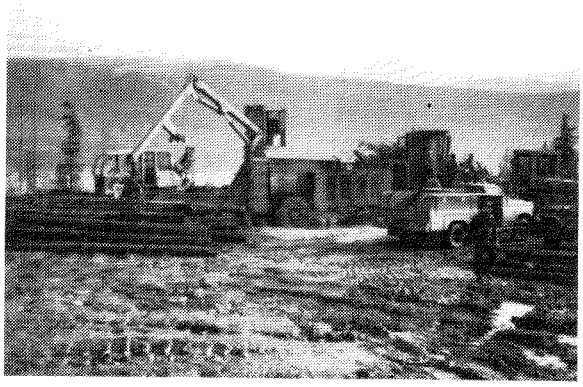

*Figure 31. Hahn delimber showing both operators' cabs.*

perpendicular to the road. This increases either processing time or moving time. Thirdly, processed logs must be removed by another machine to keep the work area clear; they may be loaded immediately onto the truck, or they may be moved to another location for stockpiling. Lastly, the delimbing debris accumulates on the road when processing at the roadside, and disposal can be a problem.

The Hahn delimbers are used to their best advantage in logging systems where stems are brought to the delimber, and processed logs are removed from the working vicinity of the delimber. The manufacturer recommends they are best utilized in a "hot" logging system. Hahn delimbers have been used successfully in central log-processing yards in B.C.

The Hahn delimbers are designed simply and constructed ruggedly for easy maintenance, although the carriage and chain must be replaced periodically. They are better suited to handle large Coastal timber than most other delimbers. They hold the stem very securely during processing, so length-measurement accuracy is not affected by slippage as it is with delimbers which rely on stem contact for measurements. However, one user reported problems with limit switch reliability which affected length-measurement accuracy. Other users have had good results with length-measurement accuracy.

The Hahn delimbers have been successful because they were established early on in the marketplace and they are able to handle the large stems typical of Coastal operations. However, they are not well adapted for roadside logging, and require auxiliary equipment for maximum effectiveness.

**Dika Shortwood Processor.** The Dika shortwood processor is a proof-of-concept prototype for a small, but growing, segment of the forest industry in western Canada, i.e. manufacturing aspen shortwood. It was built for a contractor by Dika Industries Ltd. of Rycroft, Alberta, using an old skidder and a surplus hydraulic log-grapple. As a proof-of-concept prototype, it does not represent the manufacturer's final design for the delimber; his plans are to manufacture a self-contained, single-chassis machine with the operator's cab relocated over the bolt-stacker for maximum visibility. The new model should be ready for testing in early 1989. Preliminary specifications are listed in Table 10.

The current design (Figure 32) consists of a skidder that supplies the power, a log grapple for retrieving stems, a processing head for delimbing and cutting, and an automatic bolt-stacker. The operator's cab is

*Table 10. Dika Specifications*

| Model | Prototype |
|---|---|
| Maximum stem diameter | 51 cm |
| Topping/bucking | Chain saw |
| Measuring | Butt plate with automatic feed control |
| Design product | Shortwood |
| List price | N/A |
| Manufacturer | Dika Industries Ltd.<br>Box 117<br>Rycroft, Alta.<br>T0H 3A0<br>(403) 765-3894 |

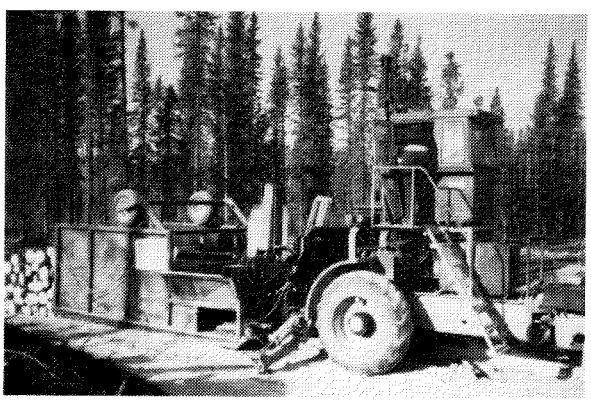

*Figure 32. Dika shortwood processor prototype.*

located above the original winch position on the skidder. It works at the roadside from windrowed piles of stems; they are picked up by the log-grapple and deposited individually between the two drive-rollers. The processing head is hinged, and aligns itself to the stem during processing. One fixed knife and two movable knives cut the limbs as the stem moves through the drive-rollers. A butt plate and hydraulic chain saw are used to measure and cut the bolts. As the bolts roll into a hopper for stacking, they pass a tray which can reject defective pieces by discarding them along the roadside with the limbs and tops. The manufacturer claims this is a unique feature among shortwood processors.

The bolt-stacker is a three-sided box, open at the back, that is pulled by the delimber as it moves between setup positions. Once the bolts roll into the hopper, they are stacked automatically by a continuous-motion hydraulic cylinder. It pushes each bolt into the stacker at the bottom of the pile, forcing the others to roll up and over the new bolt. According to the manufacturer, piling from the bottom of the pile keeps the bolts neatly aligned; this was confirmed by FERIC's observations (Figure 33). Stacking is done without any operator intervention, and only one operator is required to perform both processing and stacking. The maximum height for the bolt-stacker is approximately 1.5-2.0 m, which is less than required to stack all the bolts from a typical cutblock. Therefore, skidding, processing, and loading must be divided into two or more passes for each area. The stack can be made higher when the delimber faces uphill because of the advantage gained by pushing the bolts downhill. The production version of the processor will retain this limitation.

The processor has an automatic control system to activate the feed rollers and chain saw so the operator can retrieve a new stem while another is being processed. However, the control system was not working when FERIC was at the site.

During FERIC's viewing, the processor delimbed and cut approximately 0.8 stems/min, excluding any delays and moving time. The hydraulic chain saw stalled during several cuts and the log grapple was limited to a single function at a time because of a limited hydraulic supply. The Dika shortwood processor has potential for its intended application especially since only one operator is required for processing and stacking. Drawings for the production version indicate that some of the current shortcomings will be remedied.

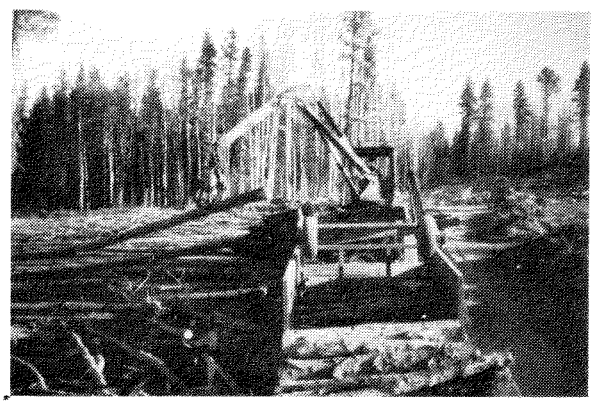

*Figure 33. Aspen bolts stacked automatically by the Dika shortwood processor.*

**Rottne Rapid.** Rottne Industri AB of Sweden manufactures the Rottne Rapid 860 and Rottne Rapid EGS-85 harvesters (Table 11) which are distributed in Western Canada by Rocan West Forestry Ltd. of Whitecourt, Alberta. Harvesters have the ability to fall and process trees with only one machine, although this report is concerned primarily with their processing ability. The Rottne Rapid 860 and EGS-85 were reviewed by Richardson (1988).

The Rottne Rapid 860 is a two-grip harvester, i.e. it requires two separate implements for felling and processing, and the Rottne Rapid EGS-85 is a single-grip harvester which performs felling and delimbing with one implement. The two machines share a common, articulated, rubber-tired carrier. The cab, engine, and transmission for the carrier are mounted

*Table 11. Rottne Rapid Specifications*

| Items | Models | |
|---|---|---|
| | 860 | EGS-85 |
| Engine size | 78 kW | 73 kW |
| Max. limbing diameter | 45 cm | 40 cm |
| Max. cutting diameter | 53 cm | 45 cm |
| Measuring | Idler wheel with photocell | Idler wheel with mechanical limit switch |
| Topping/ bucking | Chain saw shear | Chain saw |
| Drive system | Rubber tire 2.5 or 5.0 m/s | Rubber tire/hydraulic 0-4 m/s |
| List price | $380 000 | $340 000 |
| Manufacturer | Rottne Industri AB<br>S-360 40 Rottne<br>Sweden<br>Telephone: 0470-911 70 | |
| Distributor | Rocan West Forestry Ltd.<br>Box 2009<br>Whitecourt, Alberta<br>T0E 2L0<br>(403) 778-5166 | |

on the tractor unit, while the boom and processing head are mounted on the trailer unit.

The author did not view the Rottne Rapid machines in operation; this review is based on observations made by other FERIC staff who viewed the machines during the course of other work. The review is included to make the reader aware that a unique logging system is operating in western Canada.

Both models were viewed near Whitecourt, Alberta in softwood stands which averaged approximately 0.25 $m^3$ per tree. The Rottne Rapid harvesters produced 4.9-m long sawlogs and pulpwood for subsequent forwarding to the roadside. The rows of logs shown in Figure 34 consist of separate bunches of sawlogs and pulpwood which were sorted during processing. The terrain was gentle, and the wheeled carriers had no difficulty traversing the area.

Rocan West Forestry Ltd. operated the two harvesters with Swedish operators on a contract-logging basis. The operators emphasized the need for proper training and continuous maintenance to minimize mechanical downtime for the machines. The logging company involved with the Rottne Rapids plans to purchase an additional three harvesters to be operated with company employees.

The Rottne Rapid 860 has a delimbing head mounted on a pivoting arm behind the wheels of the trailer unit (Figure 35). It consists of three delimbing knives, a hydraulic chain saw for trimming and bucking, a shear for topping, and two drive wheels for moving the stems past the delimbing knives. The drive wheels are mounted with rubber tires for gripping the stems. The boom may be mounted with a felling head or log grapple, depending on whether the machine is used for harvesting or processing. The tree is severed with the felling head, then placed between the rubber tires for processing. Log-measurement data are obtained from an independent idler wheel, and log lengths can be chosen from three preprogrammed lengths. Once the stems have been delimbed and bucked to the correct length, the logs drop to the ground for subsequent sorting with the felling head or grapple.

The Rottne Rapid EGS-85 has the felling and processing functions combined into one implement mounted at the end of the boom. It consists of a chain saw for felling and bucking, two rubber-tired driving wheels, and three knives for delimbing (Figure 36). The driving wheels can be equipped with chains for improved traction. In operation, the tree is severed with the felling head, then the drive wheels are activated. The drive wheels move the stem through the processing head to cut the limbs. Logs are directed towards the appropriate pile before they are bucked from the stem. The Rottne Rapid EGS-85 has essentially the same length-measuring system as the Rottne Rapid 860, except that its length-measuring computer is reset via a magnetic proximity switch on the chain saw, rather than via a photocell which senses the end of the log. The Rottne Rapid EGS-85 is intended for producing short logs from small-diameter trees in thinning operations or clear cutting.

*Figure 34. Sorted bunches of sawlogs and pulpwood for forwarding to roadside.*

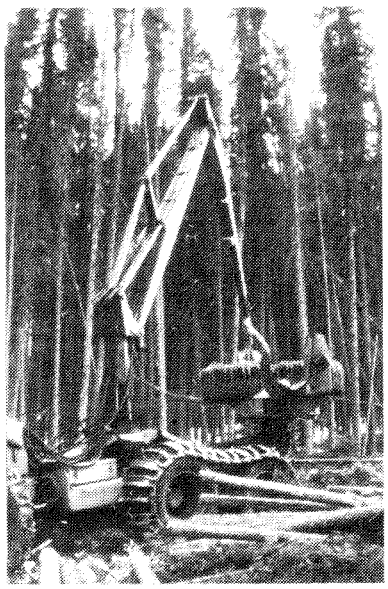

*Figure 35. Processing head on Rottne Rapid 860 double-grip harvester.*

*Figure 36. Processing head on Rottne Rapid EGS-85 single-grip harvester.*

The operators indicated that both models of the Rottne Rapid harvesters produced logs with high-quality delimbing and accurate length measurement. However, the short logs that were produced with the harvester/forwarder system required adjustments at the mill to ensure efficient log flow. The company's plan to purchase more of the harvesters indicates that the Rottne Rapid harvesters are part of a successful logging system for the given terrain and tree size.

# SURVEY DETAILS

## Delimbers Viewed During the Survey

Table 12 shows the manufacturers' figures for the number of delimbers in service in western Canada as of November 1988. Figure 37 shows the location of the approximately 35 logging operations which were contacted during the survey. The operations contacted in these interviews represented approximately 22.5 million $m^3$ of annual cut, of which 40% was processed with approximately 110 delimbers. The volume of mechanically delimbed timber in each division ranged from none to all of the cut. When questioned about the future of mechanical processing in their divisions, respondents said the limiting factor in areas with low delimber usage was steep terrain and average piece size that was too large for current machinery. In areas with high delimber usage, the managers commented that the proportion of processed timber would increase further and that currently available equipment would be suitable for their foreseeable wood supply.

Table 13 shows the distribution of processors surveyed during the interviews and field trips, and the logging systems in which they were used. Roadside

*Table 12. Delimbers in Use in Western Canada, November 1988* [a]

| Brand | All models |
|---|---|
| Denis [b] | 180 |
| Steyr | 81 |
| Harricana | 35 |
| Lim-mit | 14 |
| Hahn | 13 |
| Lako | 3 |
| Dika | 1 |
| Johnson/FERIC | 1 |
| Tapio | 1 |
| Rottne Rapid | 2 |

[a] Source: Manufacturer's estimates.
[b] Includes Roger delimbers.

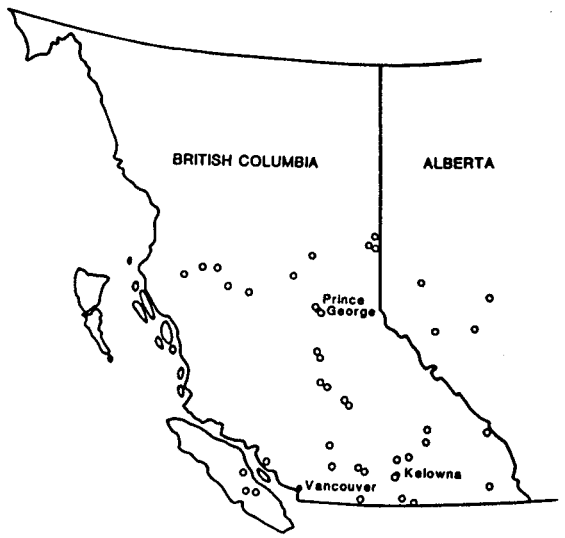


*Figure 37. Logging operations surveyed.*

*Table 13. Summary of Delimber Usage from FERIC Survey*

| Delimber type | Roadside | | Landing | | Total |
|---|---|---|---|---|---|
| | Length measuring | Non-length measuring | Length measuring | Non-length measuring | |
| Stroke delimbers | | | | | |
| Denis | 29 | 19 | 7 | 4 | 59 |
| Lim-mit LM-2200 | 3 | 2 | - | - | 5 |
| Harricana | - | 1 | 2 | 1 | 4 |
| Boom-mounted delimbers | | | | | |
| Steyr KP40 | 7 | 4 | 12 | 5 | 28 |
| Steyr KP60 | 1 | - | 2 | - | 3 |
| Lako | - | - | 2 | - | 2 |
| Self-contained delimbers | | | | | |
| Hahn | 3 | - | 1 | - | 4 |
| Dika | 1 | - | - | - | 1 |
| Rottne Rapid | 2 [a] | - | - | - | 2 |
| Total | 46 | 26 | 26 | 10 | 108 |

[a] Logs forwarded to roadside.

delimbers outnumbered landing applications by approximately two to one, and length-measuring operations outnumbered non-length-measuring delimbers by the same ratio. The stroke delimbers were used more often in roadside applications, and the boom-mounted delimbers were used more often in landings.

Productivity was not measured during this survey, although all operators were questioned about their average daily production and working time. Table 14 shows the results of those operator interviews. Operating hours include all moving and delay times. It must be stressed that these figures were not confirmed by FERIC other than by calculating productivity per hour from the operators' estimates nor were the figures adjusted to account for varying stand conditions.

Table 15 shows processing times per stem, measured from limited samples taken from video tape. These processing times should not be misinterpreted as long-term, sustainable averages because delays and moving times were not included, and the sample size is small. The delimbers were operating under a wide range of conditions during the filming, therefore, the processing times while operating only in pine stands are also presented to account for some of the variation. While there are still other factors such as tree size, branchiness, operator skill, and log-bucking specifications which influence the processing time per tree, the times shown provide a relative indication of the operating speed of each delimber.

*Table 14. Owners' and Operators' Estimated Delimber Productivity*

| Delimber type | $m^3/h$ [a,b] |
|---|---|
| Denis | 18-28 |
| Lim-mit LM-2200 | 26-35 |
| Harricana | 18-35 |
| Steyr KP40 | 24-45 |
| Steyr KP60 | 52-58 |
| Lako | 27-50 |
| Hahn | 20-50 |
| Rottne Rapid | 8-16 |

[a] Based on operators' estimates of average daily production.
[b] Figures were not adjusted to account for varying stand conditions.

*Table 15. Processing Times per Stem from FERIC Video Tape*

| | All stems | | | | Pine stands | |
|---|---|---|---|---|---|---|
| | | Min/stem | | | | |
| Delimber type | No. stems | Min | Avg | Max | No. stems | Avg min/stem |
| Denis | 112 | 0.12 | 0.46 | 1.17 | 68 | 0.39 |
| Lim-mit LM-2200 | 37 | 0.18 | 0.38 | 0.98 | 20 | 0.33 |
| Harricana [a] | 37 | 0.37 | 0.58 | 1.93 | 23 | 0.47 |
| Steyr KP40 | 56 | 0.15 | 0.30 | 0.63 | 52 | 0.28 |
| Steyr KP60 | 16 | 0.20 | 0.49 | 1.35 | - | - |
| Lako | 45 | 0.22 | 0.35 | 0.87 | 45 | 0.35 |
| Hahn | 20 | 0.40 | 1.13 | 4.18 | - | - |

[a] Length-measuring computer was inoperative for one machine; therefore, stems were left untopped. Times should be increased slightly to allow for topping time.

## Advantages and Disadvantages of Purchasing a Mechanical Delimber

Purchasing a delimber requires a substantial capital investment, and should be done only if an economic return can be realized for the particular logging operation. Every person surveyed had his own views of the benefits of delimbing equipment, however, some trends could be seen after reviewing all the results. The following reasons for using a delimber were ranked by FERIC in order of importance after compiling all the reviews:

1. Mechanical delimbers make it possible to separate the logging phases by means of roadside logging or alternate machine scheduling on the landing. By separating the individual logging phases, efficiency for skidding and loading can be improved by reducing interference between all the machines. Thus, the skidders and loaders spend less time in non-productive activities such as spreading, piling, and moving logs, and more time in their intended functions. Several woodlands managers commented that the increased cost for mechanical delimbing was more than compensated by the savings on skidding and loading.

   While phase separation is easier to achieve through roadside logging (Figure 38), many of the same benefits can be obtained by using a delimber on the landing when roadside logging is impractical. Landing-based systems must also be properly planned to ensure that the skidders, delimbers, and loaders have sufficient log inven-

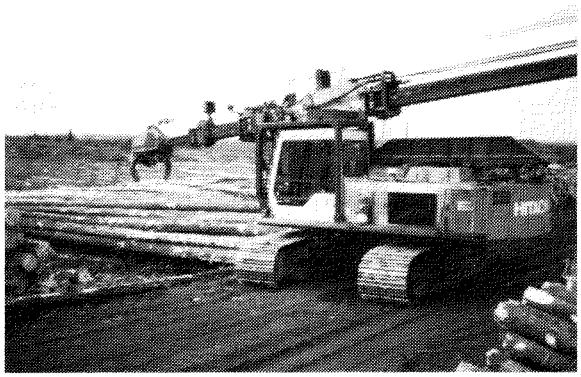

*Figure 38. Roadside processing with a Denis D-3000 delimber.*

tories to allow each phase to operate without delay times.

Roadside processing, which is made possible by the use of mechanical delimbing equipment, has other benefits besides reducing the overall logging cost. For example, site disturbance for roadside systems is reduced in comparison to conventional systems. Woodlands managers generally feel that the extra roads which are built for roadside logging cause less site disturbance than the soil compaction resulting from conventional landings. Also, roadside logging can lengthen the logging season because the phase separation which allows better machine utilization during normal operations also allows the phases to be separated during breakup periods. Therefore, skidding and delimbing can proceed when hauling is curtailed, and hauling can proceed when other operations are curtailed.

2. Worker safety and comfort is enhanced with the use of mechanical delimbing equipment; many managers and contractors commented on the increase in worker safety after changing to a mechanized logging system. Each machine operator is enclosed in a protective cab (Figure 39) and has less risk of being involved in an accident than do ground-based workers in manual systems. Since each operator knows his co-workers are enclosed in protective cabs and are less likely to enter his work area, his stress level is reduced.

   As a further benefit, the space requirements for safe working conditions for manual bucking which would be prohibitive in regions with small-diameter trees are now reduced. Manpower requirements and employee turnover are reduced with mechanized systems, a benefit in regions where there is a shortage of landing buckers.

3. Delimbing quality, topping accuracy, and defect removal is improved by using delimbers, especially in smaller-diameter stems. Figure 40 shows a Lim-mit LM-2200 delimbing a small-diameter pine stem in Central B.C. Mechanical delimbing equipment is well suited to delimbing this type of tree, i.e. as compared to the poor-quality delimbing which often results from motor-manual delimbing.

   Most woodlands managers commented that log quality was improved with delimbers but that strict quality control programs were required to maintain consistent log specifications. Many delimber operators estimated, rather than measured, top-diameters, and had to check their accuracy several times each day to remain within allowable tolerances.

4. Mechanical delimbing permits operations in marginal stands where conventional systems would be uneconomical. Large areas of low-volume timber, especially in Central British Columbia and western Alberta, have been made economical by changes in logging methods brought about by the use of mechanical delimbers.

5. Mechanization permits round-the-clock operations and increased machine utilization. Mechanical delimbing can proceed at any time of the day, whereas safety considerations require that manual operations cease during darkness.

6. Sorting is possible, although generally inefficient, with delimbers. Every log is individually handled, yet most are returned to the same pile without being sorted. When operating in landings, mechanical delimbers can be used to sort logs by species and grade, and some operations have been successful by using delimbers for sorting in roadside operations. Roadside sorting has been used successfully with self-loading trucks which are able to move between small piles of sorted logs.

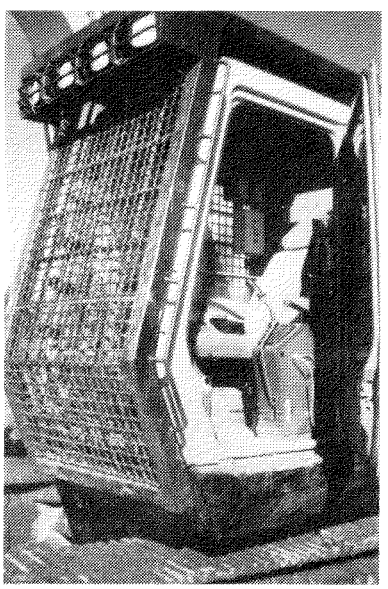

*Figure 39. Protective operator's cab.*

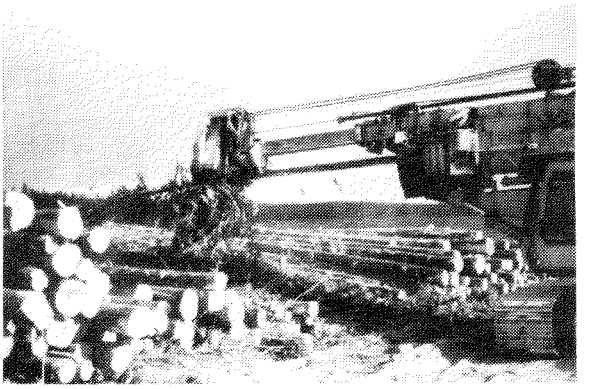

*Figure 40. Lim-mit delimbing small-diameter pine stem.*

Using mechanical delimbing equipment also has certain disadvantages, which are presented in order of descending importance. These rankings were made by FERIC after compiling the results of all interviews:

1. Delimbers are expensive to own and operate. As mentioned previously, delimbers are used to their fullest advantage in roadside logging systems, which require specialized equipment such as butt-and-top loaders, and the cost of such equipment often precludes purchase by smaller operators. The greater annual volume required to generate sufficient cash flow to meet the equipment payments tends to favour larger contractors. One contractor using a mechanized harvesting system may replace several small contractors using conventional methods.

2. Length-measurement accuracy is not sufficient to satisfy most woodlands managers. This is an area of significant concern for many managers and contractors, as was discussed in detail in a previous section of this report.

3. Because fewer machines are required for a fully mechanized logging system, each machine is more critical for maintaining a constant log flow. Therefore, the impact on productivity when one machine breaks down can be greater for a fully mechanized system than for a partially mechanized system. The loader is the most critical machine for either system to maintain a constant flow to the mill, but losing any of the machines can halt production under certain conditions, especially if the inventories between phases are insufficient to provide an adequate buffer. Proper planning must take potential mechanical delays into account when scheduling the machines.

4. Delimbers are high-maintenance machines and may have systems, especially electronic length-measurement systems, which are poorly understood by field mechanics or operators. Many of the delimbers viewed during the survey had inoperative computers because their operators had only a passing knowledge of the computer systems and could not repair them without the aid of a trained mechanic. In contrast, most operators have a working knowledge of mechanical and hydraulic systems, and are able to carry out many repairs without assistance; one owner commented that he and his mechanic learned how to repair the computer, but he could not expect the same from his operators. Eventually, he came to rely on marks painted on the boom to indicate length, rather than using the computer.

   The delimbers sometimes require specialized knowledge to diagnose mechanical problems, and good factory support makes repairs easier. Several users commented on the value of having a skilled factory technician available for telephone consultations, especially when they first purchased the delimber.

5. Certain types of delimbers have a tendency to damage the stem when processing. Delimbers with chain saws may split the butt log if the saw cuts too slowly when long-butting. Also, butts can be split by hitting the log against the sharp edge of a delimbing knife.

6. For some timber types, delimbing costs are higher than those for manual systems, however, this can be offset by proper system planning for a lower total cost, as discussed previously. In general, the industry finds the most advantage for delimbing in small timber and little advantage in larger tree sizes.

7. The current technology does not allow log merchandising, i.e. measuring the whole stem and then cutting based on the greatest end-product value. All the machines have length-measuring systems, and some have preset lengths which the computer will cut automatically, but none can manufacture logs based on their highest calculated value.

# CONCLUSIONS

Interviews with woodlands managers showed that mechanical processing is an important part of many logging operations, especially in the Interior of B.C. and in Alberta. Most woodlands managers also expected the proportion of mechanical processing to increase in the future, and could foresee sustainable timber supplies for the type of equipment currently available.

It was commonly held that mechanical processing was an expensive activity, and that it paid for itself only through the efficiencies it created in other phases such as skidding and loading. The best method of enhancing the productivity for the other phases was to separate them, with inventories between phases to compensate for delays. Roadside logging was the preferred method, but proper machine scheduling could allow phase separation on landings where the terrain prohibited roadside logging.

A delimber is expensive to purchase and operate; it requires that the owner and operator be committed to learning the operating systems so that the machine may be used for maximum benefit. Many of the mechanical problems about which users commented were relatively minor in nature, but they recurred fairly often, and their cumulative effect decreased machine utilization. Many users complained about poor quality hydraulic hoses that required constant attention. Switches and wiring for measuring devices were often prone to failure. FERIC also observed many machines with minor modifications such as

extra teeth on the grab arms or improved guarding around hoses and saws. The small problems seem to cause more concern with owners and operators than any major deficiencies in machine design.

Operator and mechanic training was often mentioned as a concern, especially in relation to electronic devices for measuring log lengths. Telephone trouble-shooting with factory technicians was often used to help diagnose the problem, but every owner seemed to go through a learning phase before feeling comfortable with the new delimber. Also, although most operators could learn to keep mechanical systems running, they were often at a loss to repair the electronic systems. Such failures were often left unrepaired, and other methods of length measurement were substituted. The technology of log measurement and measurement devices is still evolving and further refinements to system accuracy and reliability are required.

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