WOODLOT TECHNOLOGY
Technical Note TN-99 April 1987

EVALUATION OF THE VIMEK G30 PROCESSOR

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General

Light-weight, farm tractor-mounted processors have been developed in the Nordic countries to delimb and buck pre-felled trees. Designed for smaller diameter stems (max. 30 cm), they can be used on private woodlots mainly for thinning and in some cases for clearcut operations.

Two distinctive types of machines have emerged; those that are equipped with a winch, and those that have a grapple loader. One make of each type is available in Canada: the Swedish Vimek G30 with a winch and the Finnish Nokka 400 with a loader. This report provides an overview and brief evaluation of the Vimek G30.

Figure 1. Vimek G30 processor (photo from Hedman 1986).

Machine Description

The Vimek G30 is designed for a single operator. The unit can be quickly and easily coupled to a farm tractor. When lowered and in working position, the Vimek rests on two manually adjustable legs. A panel of 5 levers, controlling winching, feeding, delimbing, swing and tilt functions is situated behind a protective screen for the operator's safety at the rear of the processor. Winching is the only function which can also be remotely controlled. *All the functions are hydraulically powered except the winch and the feed rollers which are mechanically driven from the PTO.*

Models: There are two models of the Vimek G30 processor available; each is designed for different work loads. The heavy-duty model is not used in Sweden but has been exported to France, Austria, Germany and other countries where trees have thicker, stronger branches. Differences between the two include an additional pressurized feed roller on the heavy-duty model, increased weight and a higher purchase price. One machine of each model has been imported into Canada. Technical specifications of the standard model are presented in Table 1.

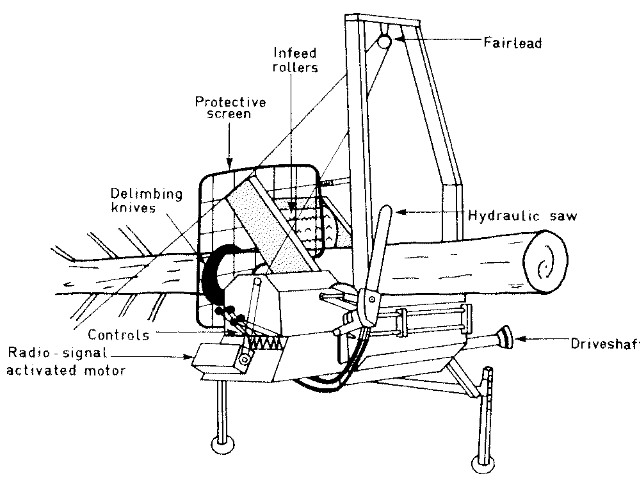

Figure 2. Components of the Vimek G30 processor.

KEY WORDS:

Woodlot logging, processors, farm tractor mounted, winching, delimbing, slashing, small wood, machine evaluation, productivity, costs, Vimek G30 Processor.

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Table 1. Technical Specifications of the Vimek G30 Processor

Table 1

		Standard model	
Tractor	mounting	3-pt hitch (category 2)	
	power requirements	37 kW	(50 hp)
	hydraulic pressure	13000 kPa	(1890 psi)
	hydraulic flow	35 L/min	(8 gal/min)
Processor	max. stem diameter	30 cm	(12 in)
	delimbing device	33 cm	(13 in)
	delimbing knives	2 moving - 1 fixed	
	feed rollers	3 horizontal axis with lugs	
	feed rate	2.5 m/s	(8.2 ft/s)
	swing angle	± 35°	
	tilt angle	± 40°	
	saw	hydraulic chain saw or user's own	
	measuring device	optional digital display, telescopic pole or measuring tape	
	weight	750 kg	(1650 lbs)
Winch	max. tractive force	25 kN	(5,620 lbf)
	length of winch rope	40 m	(130 ft)
Cost	regular model with radio control	$27,400	(Dec., 1986)
	heavy-duty model with radio control	$31,200	(Dec., 1986)

Winching: The weight, balance and stability of the farm tractor and processor limit the amount of allowable winch pull for safe operation. The Vimek's winch can generate a maximum pulling force of 25 kN. However, the winch pull is adjustable and must be matched to each tractor to prevent tractor overturn.

Trees should be directionally felled to reduce resistance to winching and to avoid exceeding safe winch pull capacity. Misaligned stems will result in winching delays which reduces productivity and profit.

The processor's ability to swing ± 35° allows trees felled within a wide radius to be winched directly into the processor without having to move the tractor or set snatch blocks.

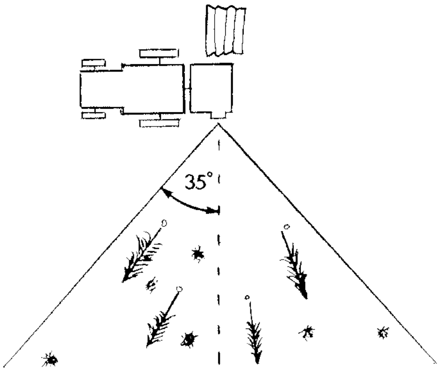


Figure 3. The processor can be swung ± 35° to face incoming winch loads.

The winch cable (maximum length 40 m), must be pulled out to the hook-up site by hand. Its small diameter and the low resistance of the winch in free-spool position make the outhauling task relatively easy. The winch can pull one or two large trees or up to 5 small trees at a time on separate chokers. After the tree(s) have been choked, the radio-controlled winch is activated by pressing a switch on the compact transmitter, worn on a belt around the operator's waist. An antenna, mounted on top of the processor, receives the signal which then activates a small motor controlling the winch lever.

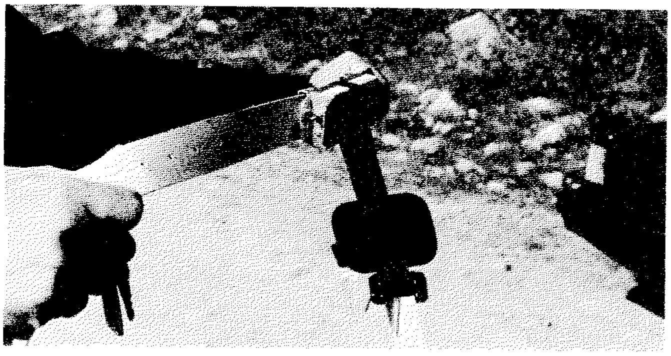


Figure 4. The compact transmitter for the radio-controlled winch can be worn on a belt around the operator's waist.

Figure 5. The antenna mounted on top of the processor receives the radio signal.

The remote control capability ensures increased efficiency in the winching function through reduced delay time. An operator walking in with a load can stop the winch and roll the stems around rocks, etc. avoiding long delays. Safety is ensured through the use of a dead-man switch on the transmitter. Application of pressure on the switch causes the winch to haul in. Once the switch is released, the winch returns to the free-spool position.

A unique choker system enables stems to be winched in to the processor one at a time. Attached at staggered intervals along the cable, stems will remain at the same relative position as they are pulled in, allowing for individual processing.

Loading is fairly simple. With the aid of a high fairlead (about 1 m above processing deck), stems are winched up onto the processor. The winch cable is removed by the operator before the processor is tilted and/or swung such that the stem falls between the open delimbing knives and on to the lower feed rollers.

Delimbing: The operator controls the delimbing functions from behind a protective screen. The machine is equipped with three delimbing knives made of high-strength, tempered boron steel; one is fixed and two are hydraulically controlled. Once a stem is loaded, it is pulled through the knives by 3 or 4 (depending on model) toothed metal feed rollers rotating around a horizontal axis. Knife pressure can be altered independantly with the control lever; it is not automatic, nor is it locked to feed roller pressure. The rollers can be reversed allowing large branches to be run through the delimbing knives several times if needed, or tops to be reversed out and dropped into the slash pile in front of the

processor. Although stems are usually processed butt first, it is possible to process top first. This becomes necessary for trees beyond the limit of the winch line (over 40 m away from the tractor) which are felled towards the tractor and when branch angles and size dictate.
NOTE: Productivity may be reduced when processing stems top first.

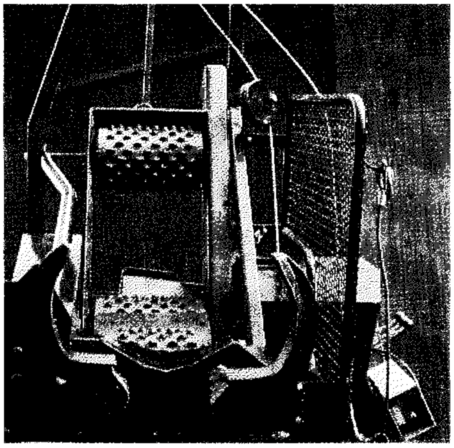


Figure 6. Horizontal feed rollers pull the stems through 3 delimbing knives (photo from Vimek G30 brochure).

Bucking: Bucking is accomplished manually with a hand-held hydraulic or gasoline-powered chain saw placed on a frame. The hydraulic saw is recommended over a conventional chain saw for bucking because a) less maintenance is required and the saw is more reliable, b) response is almost instantaneous; no time is wasted trying to start the saw, c) chain speed is higher and therefore can cut faster. Small diameter stems can be crosscut with a single downwards stroke. To avoid splitting, larger stems (over 20 cm) should be cut on the underside before being cut through from the upper side. The saw can be removed from the frame providing some versatility in cutting although the hydraulic hoses limit the hydraulic saw's use to within a few meters of the processor. Unlike machines with an automatic bucking function, double tops can be bucked individually. This ensures the maximum yield but requires extra time.

Because the feed rollers cannot be programmed to stop at a pre-determined piece length, some type of length measuring device is necessary for most North American applications.

Sorting and Piling: Wide tilt and swing angles aiding loading, sorting and piling are provided through a double-jointed drive. Single-jointed shafts were originally used but did not provide adequate movement for the machine. The processor is designed to tilt 40^{0} on either side. Thus, the machine can be tilted down towards an incoming stem for ease of loading. It can also be tilted the other way to reduce the height from which the processed bolts would fall.

After cross-cutting, the unsupported bolts fall to the ground to form small piles. The piles are often uneven as a result of bolts falling from the processor and bouncing when they land. Sorting can be performed by swinging the processor a few degrees to another position. Thus, several piles per set-up can be formed.

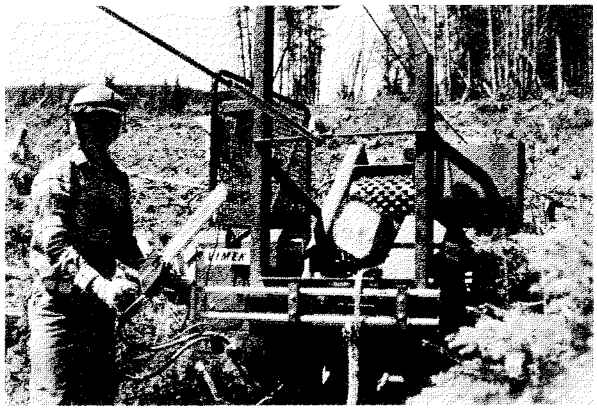


Figure 7. Stems are bucked with a hydraulic chain saw on a frame.

Tractor Requirements

Mounted on the 3-pt hitch of an agricultural tractor, the Vimek G30 processor is powered by the tractor engine through the PTO shaft and by the tractor's hydraulic pump through connecting hoses. The minimum required tractor power is 37 kW (50 hp) but for Canadian conditions a larger tractor is recommended, i.e. 45 kW (60 hp) or more. The user must ensure that the tractor can carry a tonne of additional weight (processor and front weights) and that the 3-pt hitch can lift the 750 kg processor.

A hydraulic pump capable of generating a flow of at least 35 L/min is required on the tractor. If hydraulic flow is too low, the processor will not function properly. If too high, operation of the processor becomes difficult because of a higher response speed than usual. Rather than functioning smoothly, movements can become jerky and hard to control.

Since farm tractors are not designed for forestry purposes, certain modifications are recommended such as the addition of a roll-over-protection structure (ROPS) to protect the operator, guarding over rear and side windows, a belly pan protecting the underside of the tractor, radiator protection, engine side guards, reinforced forestry tires, valve stem protection, a fire extinguisher, and tire chains. Weights on the front end are necessary for counterbalancing the weight of the processor. A blade is often useful and four-wheel drive is advisable.

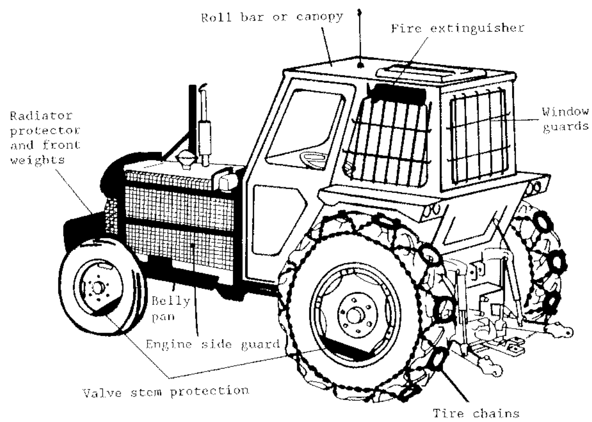


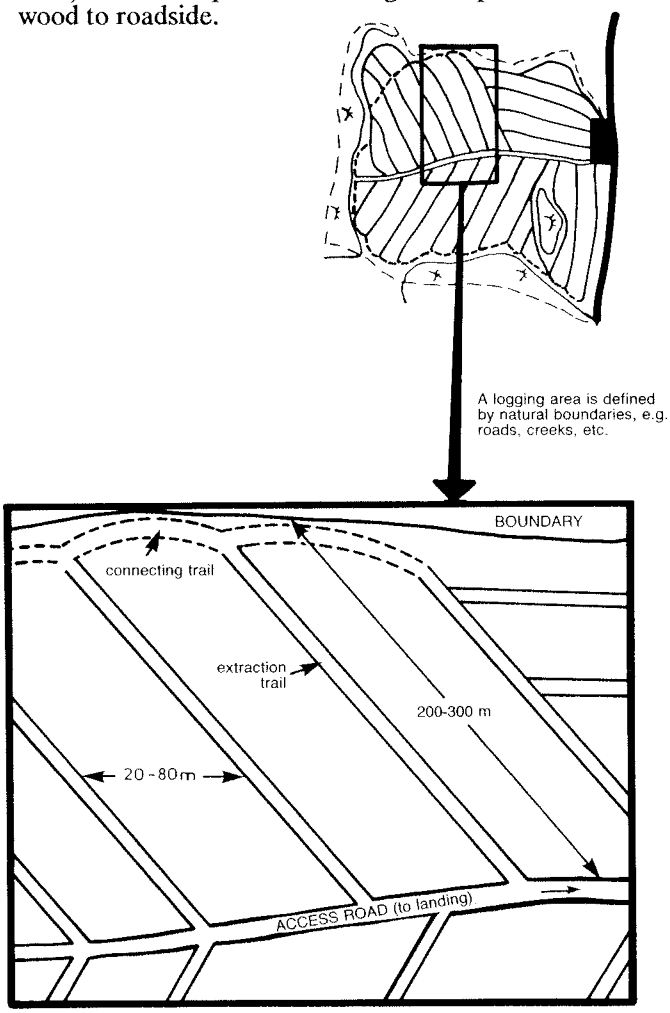
Figure 8. Basic equipment for the forestry-equipped tractor. (Drawing adapted from Nilsson 1982).

Planning the Harvest

Before the start of operations, a logging plan should be drawn up according to stand and operation type (Folkema 1986). A map of the area delineating stands, existing roads, hills, ravines, and other topographical features as well as the property boundaries should be included. From the map, the location of future roads, landings and extraction trails can be planned. Season should be taken into consideration such that soft or wet areas are scheduled for harvest in winter on frozen ground.

The following should be considered for thinning operations where the tractor remains on the trails:

- trails and landings should be marked out on the ground by using flagging tape;
- the distance between extraction trails should be small enough (20 to 80 m), to permit winching from the trails ensuring that the tractor need not circulate in the stump area;
- extraction trails should usually be about 200 m in length, but may be longer;
- trails are best placed straight up and down hills. On side hills, the risk of rolling over and damaging residual trees is increased; and
- extraction trails should be wide enough to accommodate a tractor/trailer or forwader (≈ 3-4 m wide) for subsequent forwarding of the processed wood to roadside.



Suggested layout for thinning in favourable terrain. The winching is done from the extraction trails. If the terrain is difficult with soft, wet areas, ridges, hills and water courses, detailed planning is necessary to minimize costs. The "ideal" layout shown above will not be possible.

Figure 9. Road layout (drawing from Folkema 1986).

Operational Layout

In general, harvesting with a processor can be separated into three distinct operations. First, the trees must be felled. One cannot overemphasize the importance of planning and proper directional felling in this phase. For maximum production, felled trees must be aligned so that they can be pulled straight into the processor, usually butt first.

Secondly, the processor is engaged. Trees are winched in from one side of the unit, delimbed, bucked to length and the bolts are dropped out the other side, forming piles. Owing to the placement of the delimbing knives, slash builds up in front of the processor, occasionally hindering the processing of further trees. In such cases, the slash must be moved manually or the tractor position shifted.

Finally a forwarder or farm tractor/trailer/loader combination is used to transport the bolts to roadside for subsequent trucking to the mill.

Thinning

In Sweden, tractor-mounted processors are used mainly in softwood thinnings. Trees are manually felled at right angles to an extraction trail. In dense stands, felled softwoods often get hung up and their branches intertwined with those of adjacent trees. However, this does not pose a problem with the Vimek. Stems can be pulled in as easily when hung up as when lying on the forest floor.

The tractor/processor starts at one end of the extraction trail and works along, winching in stems situated on one side of the trail only. Processed bolts are piled on the opposite side of the trail simplifying pickup.

Slash is left in the trail providing protection to the ground and increased flotation for the forwarding vehicle.

Swedish users recommend forwarding the processed bolts out before the tractor is turned around and the other side of the extraction trail is harvested. Otherwise, there can be problems with winching around, and with slash buildup on top of the piles of previously processed wood. Another solution is to place extraction trails closer together (max. 40 m apart) so that the entire area between trails can be harvested in one pass from one trail.

Clearcut

The processor can also be used in clearcutting small-diameter trees. Depending on terrain conditions, the tractor either remains on designated tractor trails (in which case the bolts are piled at trail-side) or it travels into the stand and processes where convenient (e.g. on hill tops or valley bottoms).

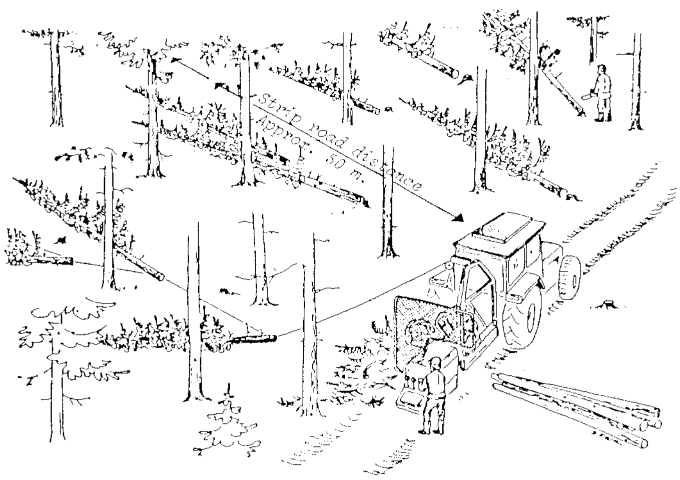


Figure 10. Tractor-mounted processors can be used in thinning operations (drawing from Hedman 1986).

Crew Size

Crews of either one or two are the norm. *In a one-man system*, the worker alternates between felling and operating the processor. By alternating work tasks, physical strain and mental fatigue are reduced; the worker tends to remain stimulated and alert the entire shift. The processor, however, has a high amount of idle time which increases the cost of operation. NOTE: For safety reasons it is best not to work alone. Another person should be within shouting distance or within radio contact.

Where two men work together, one fells the trees and the other operates the processor. The cutter helps with choking and winching when the felling gets far enough ahead. For best possible work results and work environment, the two operators should interchange work tasks during the day. The processor is operated the entire shift with little or no time loss from lack of pre-felled trees. For both safety reasons and higher production possibilities a two-man system is recommended.

Type of Measuring Device

In Scandinavia and Finland, Vimek processors are not sold with a measuring device because variable lengths are acceptable. However, in Canada, bolt lengths must usually conform to a pulpmill standard. The electronic counter available on Canadian-sold models, at a cost of $2,900.00, has a highly visible digital readout accurate to the nearest centimeter. However, there is no automatic stop at a predetermined length. Advancing the stem the proper distance can pose a problem because of high feed rates and the operator often overshoots. Much time can be wasted jockeying the stem back and forth to reach the required length. It is therefore worthwhile to determine from the mill, the range of acceptable bolt lengths.

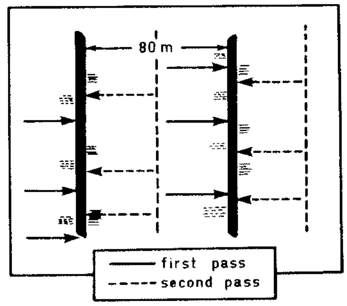


Figure 11. Two-pass system. One side of the trail is processed and forwarded to roadside before the other side is harvested.

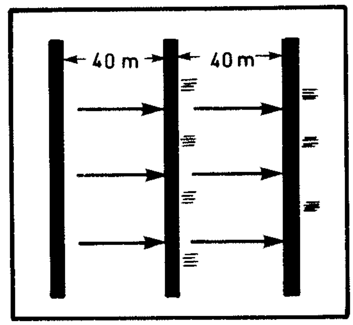
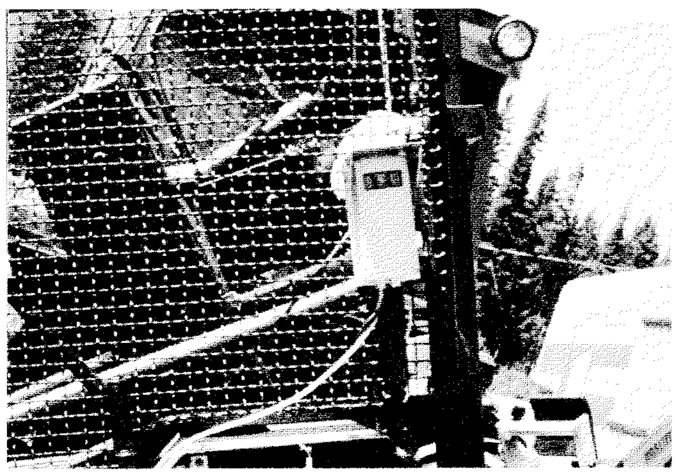


Figure 12. Single-pass system. Trails must be placed closer together.



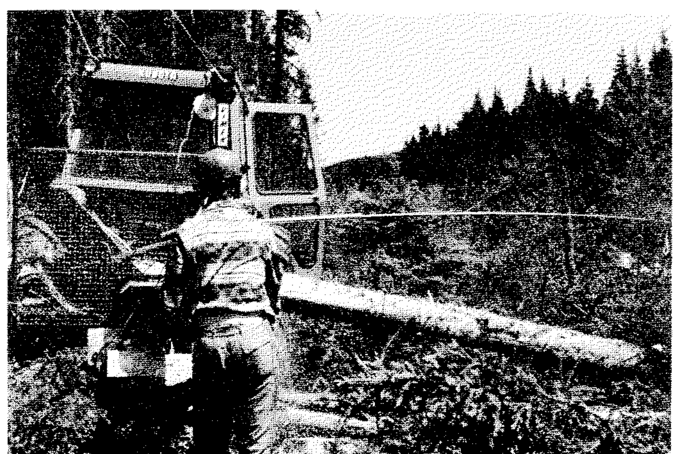


Figure 13 & 14. Two options for measuring lengths are a digital readout counter and a telescopic pole.

A cheaper alternative is to use a 2.6-m (8-ft) retractable measuring pole attached to the end of the processor. Productivity remains unaffected, although slightly lower accuracy can be expected. The measuring pole may be impractical for use when thinning dense stands because it tends to get caught on the residual trees when the processor is swung or tilted. It also is limited to measuring only one length.

Another simple and cheap measuring device is a tape measure with release hook. Lengths can be accurately measured, although productivity may suffer. Attaching and releasing the hook to each piece is somewhat time consuming. As well, advancing the stem the proper distance remains a problem.

Tests and Results

For introduction to Canada, Vimek AB sent a Swedish logging contractor to demonstrate the processor using proper, established techniques. The contractor had owned and operated a Vimek G30 for over a year and was considered to be one of the best operators in Sweden. On two different occasions, FERIC was able to study operations using the standard-model Vimek run by the Swedish operator. On both occasions the machine was being demonstrated to an audience and therefore was not run on a continual basis, nor for very long.

Forêt Montmorency

In June 1986, the Vimek G30 processor was tested in a budworm-damaged, spruce-fir stand in Laval University's forest station, Forêt Montmorency, located 80 km north of Quebec City.

The Vimek was operated on a hillside which was about 30 m long (top to bottom) and had maximum and average slopes of 30% and 15% respectively. The stand was not homogeneous in terms of tree size; trees at the top were of smaller diameter and volume than trees on the bottom. Average diameter at breast height (dbh) for the entire stand including all stems over 6 cm dbh was 16 cm with an average volume of 0.13 m^3 per tree. Thirty-two percent of the standing stems were dead from a spruce budworm infestation and a large portion of the remaining trees were unhealthy.

No extraction trails were planned or followed during this clearcut operation. The tractor was manoeuvered within the stand at the discretion of the operator and piles of bolts were placed haphazardly over the area. The forwarder operator was expected to make his own way to the various piles and take them to roadside.

A total of 3.3 productive machine hours (PMH) of operation was timed. The electronic measuring system was used for one third of the time and the telescopic pole was used for the remainder. Two men worked together for two thirds of the time with the cutter aiding in out-hauling the winch line and choking the stems. For the remaining time the processor operator worked alone on pre-felled trees. Over this short period of time, there was no statistically significant difference in productivity as a function of type of measuring device or crew size.

Average production was 5.36 m^3/PMH at 42 trees/PMH with an average of 11.6 trees per tractor setup. Results are presented in Table 2. The quality of the delimbing was high but there was a large variation in bolt length. Average variation (±) on a 2.6 m bolt was 0.15 m; some exceeded this considerably.

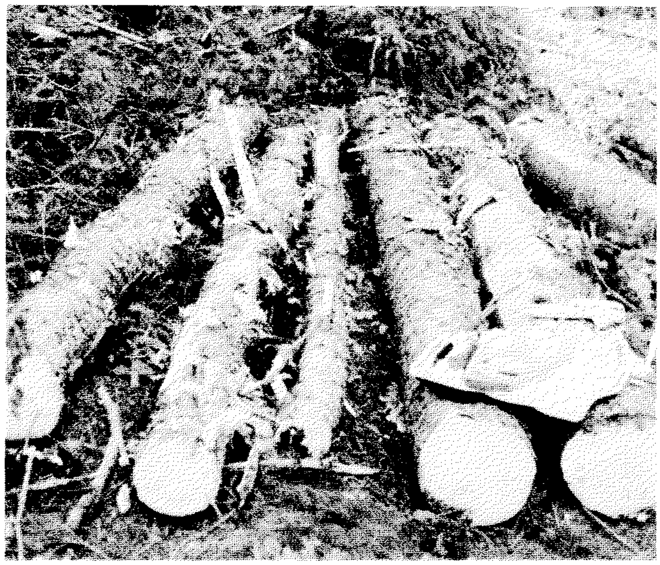


Figure 15. Although in general, delimbing quality was good, stubs remained on some of the jack pine bolts.

U.N.B. Woodlot

Later in June, the machine was demonstrated for a day at the University of New Brunswick's woodlot in Fredericton, New Brunswick. The 51-year-old, mixed pine-spruce stand was situated on fairly flat terrain with well-drained sandy soils and good ground bearing capacity. The plantation had been well tended and was very healthy. This third thinning, removing the suppressed and poorly formed trees (average volume of 0.21 m^3), would be the last before the final cut.

On this operation, only 46 minutes were timed. The telescopic pole was used to measure the length of the bolts. This worked well although, in very dense areas it tended to get caught when the processor was tilted and swung for loading, piling and sorting purposes. In such cases, the operator measured the bolt length by eye.

Conditions on this operation were optimum resulting in a very high average production of 8.66 m^3/PMH. The tractor was moved frequently, averaging 5.2 trees per setup. This is attributable to the type of operation i.e. thinning and to the larger-size trees. Specifics are included in Table 2.

Delimbing quality was, in general, very good. However, a few bolts, mainly pine were left with fairly long stubs. Branches, over 5 cm in diameter, were lopped off by the cutter before the stems were processed. Bolt length had a high variation (2.60 ± 0.15 m) as in the study in Forêt Montmorency.

Total time to process per tree was the same in both studies at 1.43 minutes although the work element breakdown was slightly different. The winching element was the highest time component per cycle in both studies (35% and 40%) and the processing element also accounted for a large proportion of cycle time (29% and 33%).

Table 2. Conditions and Performance (FERIC studies)

	Québec Forêt Montmorency	New Brunswick UNB Woodlot
Study period (PMH)	3.3	0.8
Condition factors		
site classification*	2.2.2.	1.1.1.
type of cut	clearcut	thinning
species	balsam fir	white spruce, jack pine, red pine, white pine
branchiness class**	2-3	1-2
density before operation (trees/ha)	2200	700
density after operation (trees/ha)	0	500
avg. volume per tree removed (m^3/tree)	0.13	0.21
Productivity		
avg. no. stems/tractor setup (standard deviation)	11.6 (5.2)	5.2 (2.6)
avg. no. stems/winch cycle (standard deviation)	1.7 (0.88)	1.2 (0.44)
avg. no. stems/PMH	42	42
avg. no. bolts/stem	2.8	4.0
avg. no. bolts/PMH	117	189
avg. volume/PMH (m^3/PMH)	5.36	8.66

* Based on Mellgren (1980). The numbers represent, in order, ground strength class, ground roughness class and slope class. All classes are graded from an optimum situation (1) to a worst possible situation (5).

** Branchiness class is based on the length of the stem having branches.
1 - up to 1/3 of the tree has branches.
2 - between 1/3 & 2/3 of the tree has branches.
3 - over 2/3 of the tree has branches.

Table 3. Distribution of Work Elements Per Tree (FERIC studies)

	Québec Forêt Montmorency		New Brunswick UNB Woodlot	
Function	time (cmin)*	percent (%)	time (cmin)	percent (%)
winch	50	35.1	58	40.3
load	20	14.0	15	10.2
process	41	28.7	47	32.7
move tractor	15	10.2	17	12.1
remove slash	2	1.1	2	1.6
delay	15	10.9	4	3.1
TOTAL	143	100	143	100

* 1 cmin = 1/100 minutes.

Swedish Studies

Short-term evaluations describe potential productivity under measured but limited operating conditions. Therefore, owing to the very short duration of the studies, the results shown in Tables 2 and 3 are not necessarily representative in all cases. To supplement the FERIC studies, results from three Swedish trials are outlined.

Study N° 1:

In 1984, Lars Hedman (1986) coordinated a project on the Vimek processor with the dual objectives of:

a) comparing one- and two-man crews in pine thinning operations,
b) comparing production in thinning operations using the Vimek versus conventional motor-manual methods.

Conditions and productivity of the study are presented in Table 4. NOTE: Operators were inexperienced and therefore production was lower than expected.

Although not twice as productive, two-men crews could out-produce one-man crews by 72%. Human waiting time, where one man had to wait for another man, accounted for 35% of active work time on a two-man crew whereas one-man crews incurred no human wait time. On the other hand, the processor had higher idle time with single-man crews.

Theoretical studies combined with practical experiences showed that thinning with a Vimek G30 in small diameter stems resulted in a 54-64% increase in productivity as compared to motor-manual cutting, based on one-man crews.

Study N° 2:

Another study was conducted by Konradsson (1985) to determine the suitability of the Vimek G30 as an alternative thinning machine for the Swedish Forest Service. The machine's performance regarding economics, availability, residual tree and ground damage, limiting snow depth, ease and speed of service and repair was analysed over a 6 month period. As well, during the latter weeks of the study, operation in a clearcut was observed.

Conditions and productivity of the mixed thinning operation are presented in Table 4. It was found that snow depth of approximately 30-40 cm reduced production.

The quality of delimbing in spruce and pine was acceptable however, birch and poplar presented some delimbing problems. In terms of both productivity and quality, trees with a high proportion of large limbs were better processed manually.

There was very little damage to the residual stand. Only 3% of the remaining trees sustained wounds and no damage to the ground surface was recorded. Felling and winching of the large poplars accounted for most of the damage that did occur to the residual trees.

The utilization was very low, at only 52% for the trial period. Most of the delay time was not explained in the report. There was very little downtime due to repairs and all repairs were accomplished in less than one hour.

Table 4. Conditions and Performance (Swedish studies)

	Hedman (1986)		Konradsson (1985)		Gårdh and Lidberg (1986)
Study period	not stated 1984	not stated 1984	5 months 1985	3 weeks 1985	6.8 PMH* 1986
Condition factors					
site	flat ground	flat ground	0-60 cm of snow flat ground	0-60 cm of snow flat ground	1.1.2.
type of operation	thinning	thinning	thinning	clear cut	thinning
species	Scots pine	Scots pine	Scots pine, birch, Norway spruce	Norway spruce	Norway spruce
avg. vol./tree (m^3)	0.04	0.04	0.08	0.18	0.07
crew size (n0 men)	1	2	2	2	2
Productivity **					
avg. n0 stems/PMH	not stated	not stated	37	34	40*
avg. vol./PMH (m^3/PMH)	1.54	2.65	2.99	6.28	2.76*

* The original Swedish values were presented without including delay time. A factor of 10% was used for conversion to PMH.
** includes felling, winching, delimbing, bucking and piling to trailside.

Towards the end of the 6-month study, when the operators were more experienced, the Vimek was tested in a clearcut. The stand was comprised of spruce with an average volume per tree of 0.18 m^3. Snow depth reached 60 cm but was then packed by a forwarder to facilitate felling work. Under these conditions, production was 6.28 m^3/PMH or 34 trees/PMH.

Study N° 3:

It was speculated that the Vimek would perform better in spruce stands than in stands of other species in Sweden. Therefore, Gårdh and Lidberg (1986) set up a trial to determine the productivity and cost of a first thinning using a Vimek G30 processor in a young spruce plantation. They also compared the costs to those of manual thinning.

The processor was equipped with a mechanical chain saw which received its power via the tractor's PTO. (This version of the saw is not sold in Canada). Three-metre bolts were produced although the report does not state whether a measuring device was used.

Alternating tasks twice daily, the two-man crew of experienced woods workers removed 51% by stem count and 30% by volume of the stand. Often, the first few felled stems became hung-up. Good planning is vital in such dense stands to ensure that the workers never operate under hung-up stems.

During the felling phase, a high percentage of time was spent clearing, cleaning and limbing the first 1.5 m of the tree (34%) but, because of the winch and good cooperation between the two workers, practically no time was spent manually disengaging and pulling down trees (1%).

The average time to process a tree, excluding the felling phase, equalled 137 cmin/tree excluding delays or 151 cmin/tree when including delays up to 15 minutes as in the Canadian system (productive time).

The cost varied as a function of tree size but, regardless of sizes operation of the Vimek G30 processor was cheaper than motor-manual thinning.

Discussion

Production with the Vimek G30 processor depends on various factors including:

- *Tree size* The most influential factor is tree size. As tree size increases, so does productivity. When winching, it is often possible to bring in several small trees at one time. However, for limbing and bucking, the processor can only handle one tree at a time. Because of this, small trees take almost as long to process as large trees;

  Average tree volumes in all but one of the Swedish studies were much lower than in FERIC's studies as were the corresponding production rates (m^3/PMH). Although other factors may have had some influence, it is clear that the tree volume governs the production rate to a large extent;

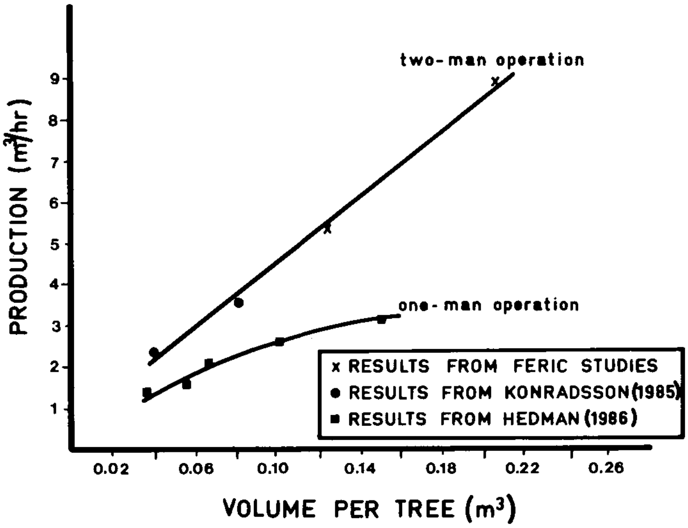


Figure 16. The effect of tree volume on production.

- *Operator skill* Both the manufacturer and two Swedish operators say that it can take up to a year for an inexperienced operator to reach full production potential. Gradually the planning becomes natural, the movements more refined and production increases. Quality is also affected by operator skill;

- *Ground conditions* The terrain must be suitable for a farm tractor. Soft ground should be avoided or logged in winter when frozen. It is possible to winch over small areas of poor ground bearing capacity. Slopes, broken ground, high stumps and heavy undergrowth can also be limiting to the tractor although the winch does provide some flexibility;

- *Snow* According to Konradsson (1985), snow over 30-40 cm starts limiting production. The processor has not been tested in Canadian winter conditions to date;

- *Branch size* Trees with large-diameter branches can slow down production if the oversize branches are not removed manually (i.e. by chain saw or axe) (Konradsson 1985). In such cases, stems must be run through the processor knives several times before the large branches are removed. Even then, the delimbing quality is often poor;

- *Distance between extraction trails* Winching is the most time consuming of all elements in a cycle. Therefore, reducing winching times could significantly reduce cycle times and increase productivity. By placing extraction trails closer together, (approx. 20 m apart) the distance the operator must walk is decreased. He reaches the felled trees faster and once choked, they are winched into the processor more quickly. However, close spacing of trails may not be possible because of terrain configuration. Also, a larger proportion of a stand area is removed from fibre production with a dense network of trails than with a more open network;

- *Crew size* The percent difference in production between crews of different sizes is a function of tree volume as well as waiting time. Nissi (1985), reports that although the percent difference changes, the actual time to process a tree in Finland is 40 cmin lower for two-man crews than for one-man crews regardless of tree volume. Hedman (1986), reported that the two-man crew in his study had 72% higher production than the single man.

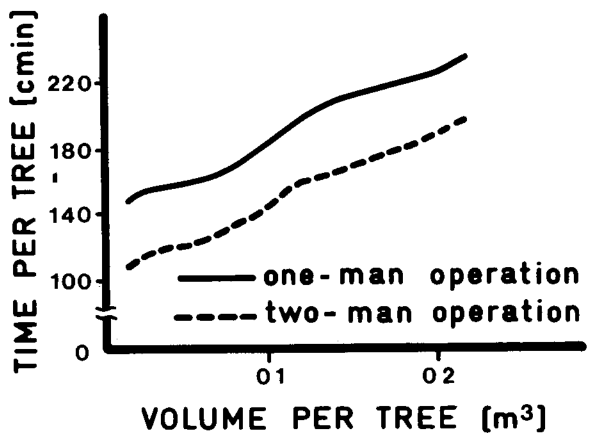


Figure 17. The effect of crew size and tree volume on cycle times (according to Nissi 1985).

The quality of delimbing by Vimek processors is dependant on:

- *Brittleness of branches* Dead branches are more brittle than live ones and therefore tend to shear off more easily. Season also affects brittleness with winter being the best time for delimbing. Spring and early summer conditions are the most difficult since the branches are more supple and can slide under the delimbing knives if not well closed;

- *Size of branches* If branches are large enough, they can resist the shearing force of the delimbing knives. The limiting branch diameter for the processor is not constant and varies depending on species, time of year, and branch distribution. In general, branches under 5 cm in diameter do not pose a problem for the Vimek, unless there are several together. It is a good practice for the feller to remove any larger branches manually, thus eliminating potential time-loss situations for the processor;

- *Distribution of branches* A clump of branches around the stem can have the same resistance to the delimbing force as one large branch. Also, several medium-size branches situated in a row can slow down the feed rate enough to effect delimbing quality;

- *Tree form* Trees with crooks, bends, forking tops or other irregularities can be expected to cause delimbing problems resulting in lower quality delimbing;

- *Tree species* The species usually dictates the size, placement and resistance of the branches. In general, the Vimek's delimbing capabilities are excellent for balsam fir and for small branches on most tree species. Large branches on open-grown spruce tend to remain as long "whips" on the processed bolts. Large jack pine branches are reduced to high stubs whereas white pine, in general, can be cleanly delimbed. The author has not yet seen any hardwoods processed by a Vimek G30 but reports indicate that large branches will cause delimbing problems;

- *Operator experience* An inexperienced operator may have difficulty applying the proper knife pressure to the stem resulting in poor delimbing with high branch stubs.

Machine Reliability: According to the Swedish contractor, who demonstrated the processor in eastern Canada in 1986, the Vimek G30 is very reliable. In his first year of operating the Vimek, only one hour of machine downtime was recorded. Konradsson (1985) reports that the processor is very simple to repair which should result in high mechanical availability. According to Vimek AB, the items most frequently requiring repair are the stabilizer legs which are too weak. The company is working on resolving this problem. In the past, the radio control had proven unreliable but this has since been changed and is now working well. Most problems occur through misuse of the machine by inexperienced operators unfamiliar with the equipment. During the demonstrations viewed by FERIC, there was no repair downtime on the Vimek.

Cost: In 1986, the list price, excluding sales tax, for a regular model Vimek G30 processor with hydraulic saw and radio-controlled winch was $27,400.00 FOB Montréal. The electronic measuring device costs an additional $2,900.00.

A simple cost analysis of a 2-man full-time operation using a tractor coupled with a Vimek to process the stems and a tractor/trailer/loader combination for subsequent forwarding to roadside resulted in a cost at roadside of $12.57/m^3$ or $28.41/cord excluding stumpage and subsidies. Details are provided in Table 5. Part-time operation with a tractor/Vimek processor working 600 SMH/year (3½ months) and a tractor/trailer/loader combination working 420 SMH/year (2½ months) would increase the cost by $1.43/m^3$ to $14.00/m^3$ or $31.62/cord. Lower production than the assumed 6 m^3/PMH would also result in an increased wood cost.

Gårdh and Lidberg (1986), showed that the cost for thinning spruce stands in Sweden was less with a Vimek processor than a manual system. For tree volumes of 0.05, 0.07 and 0.09 m^3, the corresponding cost differences were 24, 29 and 33%.

Hedman (1986), however, concluded that thinning costs of a one-man crew with the Vimek in pine plantations were the same as for motor-manual methods despite productivity being 54-64% higher.

Table 5. Cost Analysis

Assumptions:
a) Full-time operation
b) A two-man operation with a Vimek processor can produce 6 m3/PMH
c) A tractor/trailer/loader combination can extract 8 m3/PMH.
Thus, because it is 33% faster, assume it is used in another operation for 33% of the year.
d) Other assumptions are included below.

Machine Rental Rate Calculation for Operations with a Vimek Processor

	Tractor	Vimek	Saw	Loader	Trailer
Power (KW)	45	0	2	0	0
estimated machine life (years)	5	5	1	5	5
Scheduled machine hours per year	1600	1600	1600	1600	1600
Purchase price ($)	22000	27400	600	8000	6000
Salvage value ($)	0	0	0	0	0
Licence cost ($/yr)	0	0	0	0	0
Insurance ($/yr)	200	300	0	80	60
Interest rate (.%)	12%	12%	12%	12%	12%
Duty Cycle (.%)	50%	50%	50%	50%	50%
Utilization (.%)	70%	70%	65%	70%	70%
Lifetime repair costs ($)	5000	2700	600	8000	2000
Fuel consumption (l/PMH)	10	0	3	0	0
Fuel price ($/l)	0.5	0	0.5	0	0
Oil and Lubrication ($/pmh)	1.00	0.00	0.00	0.00	0.00
Tire Life (hrs)	1600	0	0	0	1600
Tire replacement costs ($)	250	0	0	0	100
Tires per machine	4	0	0	0	4
Operator Wages ($/SMH)	10	0	10	0	0

****

	Tractor	Vimek	Saw	Loader	Trailer
FIXED COSTS					
Annual Capitol Cost	$6,103.01	$7,601.03	$672.00	$2,219.28	$1,664.46
Yearly Other Costs	$200.00	$300.00	$0.00	$80.00	$60.00
Yearly Total	$6,303.01	$7,901.03	$672.00	$2,299.28	$1,724.46
Costs Per PMH	$5.63	$7.05	$0.65	$2.05	$1.54
Costs Per SMH	$3.94	$4.94	$0.42	$1.44	$1.08
VARIABLE COSTS					
Total Tire Cost	$4,000.00	$0.00	$0.00	$0.00	$1,600.00
Yearly Costs	$8,520.00	$540.00	$2,472.00	$1,936.00	$720.00
Costs Per PMH	$7.61	$0.48	$2.08	$1.43	$0.64
Costs Per SMH	$5.33	$0.34	$1.35	$1.00	$0.45
LABOUR COST					
Cost Per Year	$16,000.00	$0.00	$16,000.00	$0.00	$0.00
Costs Per PMH	$14.29	$0.00	$15.38	$0.00	$0.00
Costs Per SMH	$10.00	$0.00	$10.00	$0.00	$0.00
ALL COSTS					
Grand Total Per Year	$30,823.01	$8,441.03	$19,144.00	$4,235.28	$2,444.46
Grand Total Per PMH	$27.52	$7.54	$18.11	$3.48	$2.18
Grand Total Per SMH	$19.26	$5.28	$11.77	$2.44	$1.53

The cost of the entire operation including wages at $10/SMH but excluding stumpage and subsidies is:

tractor + operator	100% of time	$27.52 /PMH	
Vimek processor	100% of time	$7.54 /PMH	processing
chainsaw + operator	100% of time	$18.11 /PMH	
tractor + operator	67% of time	$18.44 /PMH	
loader	67% of time	$2.33 /PMH	extraction
trailer	67% of time	$1.46 /PMH	
		$75.40 /PMH	

Advantages and Disadvantages

The following advantages and disadvantages are associated with operation of the Vimek G30 processor:

Advantages:

Technical, general

- the Vimek G30 is versatile; it is possible to cut and sort different lengths e.g. 3.2-m sawlogs, 2.6-m pulpwood and 1.3-m firewood. Although limited to tree diameters under 30 cm, the processor can be used in both thinnings and clearcuts on trails or in the stump area;
- the potential productivity is high. Production reached 8.66 m^3/PMH on one study conducted by FERIC but other studies showed lower productivities;
- the processor can be mounted on a farm tractor and run off the PTO. Power requirements are not high; the recommended minimum is 45 kW with a minimum hydraulic flow of 35 L/min;
- the processor's small size and light weight (750 kg) allow easy transport from location to location;
- Swedish Vimek units are reported to have high mechanical availability. In Canada, however, that will depend somewhat on operator skills and attitudes as well as on the parts supply and quality of service available. To increase parts availability, all units destined for North American markets are adapted for S.A.E. standard hydraulic hoses and fittings (rather than metric);

Technical, specific

- independant feed roller and delimbing knife pressure as well as roller configuration provide adequate feeding with very little slippage and minimal stem damage;
- the bucking saw can be removed from the frame. This is advantageous in handling double tops and irregular pieces;
- with the winch, stems do not need to be felled to the ground. Thus, much time and effort can be saved, especially in dense stands where trees frequently get hung up;
- the winch also provides versatility in tractor placement. Because of the winch, this system is not limited to flat terrain only, although the extraction trails must be suitable for forwarding;
- the radio-control on the winch ensures higher production capabilities than direct mechanical-control because the operator can start to winch in immediately after hook-up without first walking back to the processor. He can then walk in with the load, stopping and starting the winch as necessary to avoid obstacles. Using a cord to activate the winch from a distance may be a cheaper solution than radio-control but it is less than ideal when working around residual trees or in heavy underbrush;

Working environment and safety

- a good working environment is provided, particularly when alternating between felling trees and operating the processor;
- working with the Vimek is less strenuous than manual limbing and bucking;
- there is less risk of accidents because the limbing function is performed by the machine;
- the safety screen protects the operator from branches during delimbing;

Biological

- during thinning, very little damage is inflicted on the residual trees;
- slash is left on the extraction trails, providing protection to the roots and increased flotation for the forwarding vehicle;
- the slash also remains as a nutrient source in the residual stand.

Disadvantages:

Technical, general

- the high capital cost of purchasing a Vimek may be prohibitive for seasonal operations, however leasing arrangements are available;
- trees over 30 cm in diameter cannot be processed;
- production varies greatly depending on tree size, operator skill, crew size and ground conditions. Studies conducted or reviewed by FERIC had productivities ranging from 1.54 m^3/PMH in a one-man operation in small trees (0.04 m^3/tree) to 8.66 m^3/PMH in a two-man operation in larger wood (0.21 m^3/tree);
- acceptable operator efficiency can take as long as a year to achieve;
- planning is more critical than for motor-manual operations. Trails must be planned in advance, particularly for thinning operations. Only one side of a trail can be harvested at a time, therefore, processing and forwarding must be well coordinated;
- trees must be directionally felled. Poorly felled trees result in winching delays which reduces productivity;
- after felling, the cutter must remove all branches with a diameter greater than 5 cm;

Technical, specific

- bolt lengths are not consistent. Whether using the electronic counter or a simple telescopic measuring pole, variation within bolt lengths were unacceptable by some mill standards. By spending time to measure each bolt more carefully the variation of lengths can be reduced, however, this will result in reduced productivity;
- the last bolt in a stem is often too long but because of saw placement relative to the feed rollers, it is ejected from the machine before it can be cut. The operator must then slide the piece back, remove the saw from the frame and cut the bolt to the proper length.

- the delimbing function does not operate well when encountering crooked stems or large branches. Hardwoods, open-grown conifers and trees with clusters of branches can be expected to cause problems;
- Nissi (1985), reports that in Finland during cold weather, there was an unacceptably long delay when engaging the winch by radio control. However, in case of remote-control failure and when convenient, the winch can be activated by a lever on the control panel;
- counterbalancing weights must be added to the front of the tractor to prevent rearing (both front wheels lifting off the ground). Thus, the tractor must be capable of supporting a total additional weight (processor and weights) of about 1 tonne.

Working environment and safety

- the operator must work outside subject to the elements;
- heavy underbrush, low branches, and/or difficult terrain can slow down or discomfort an operator walking to and from the pre-felled trees. The effect of adverse terrain and stand conditions on productivity is a function of the magnitude of the adversity as well as the average distance walked per unit volume produced;
- snow depths over 30-40 cm render it difficult for the operator to walk out to the felled trees. Snow or ice on pre-felled trees may add weight and reduce the number of trees which can be pulled in by the winch at any one time. Felling should not be far ahead of the processor in winter as pre-felled trees may become frozen fast to the ground or lost under the snow.
- the hydraulic saw has a handguard but no chain brake. The handguard provides adequate protection while the saw remains on the bucking frame but not when used out of the frame. There is a potential for injury from kickback. NOTE: Use extra care when cutting with saw removed from frame.

Conclusion

The Vimek G30 processor has the potential to become a useful tool in eastern Canada for thinning work, stand improvement, and perhaps some clearcutting of smaller diameter stands. The high capital cost and the high skill level demanded excludes usage by occasional woods workers. Therefore, it is best suited for contractors, woodlot owner groups, and large land owners who could use it on a full-time basis.

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Conversion: A m^3 refers to solid wood excluding bark and air spaces. A cord refers to stacked wood and includes both bark and air spaces. The amount of solid wood contained in one cord varies depending on tree diameter, roughness, crookedness, and bark thickness. Normally it is accepted at 2.41 m^3/cord but in smaller wood it can be as low as 1.98 m^3/cord. The conversion used in this report is 2.26 m^3 = 1 cord (80 ft^3 = 1 cord).