Session 5
Paper (a)

SHOVEL LOGGING

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Introduction

The use of excavators to bunch or shovel wood in clearfell is gaining in popularity in New Zealand and Australia. Bunching consists of swinging felled trees from the stump into a bunch ready for an extraction machine. Shovel logging occurs when stems are repeatedly swung from that first bunch. Previous studies of bunching operations in New Zealand have focussed on production thinning operations. Nicolls (1981), Gleason and Stulen (1984) showed that skidder productivity increased through decreased cycle times and increased payloads. In clearfell, Hill and Evanson (1992) found that load accumulation for a grapple skidder was up to 40% faster in bunched wood.

Excavator Versatility

Shovel logging seems particularly useful in the woodlot logging area because of the versatility of excavators. In New Zealand they are used for harvesting in these applications:

- roadlining and road forming,
- fleeting logs and loading trucks,
- felling trees with a feller director head attached (such as the Hultdins F850),
- pulling trees through a static delimber,
- as a carrier for single grip harvesters or stroke boom delimbers and
- cable logging, when large winches are fitted.

Following logging, excavators are used extensively in site preparation in the following applications:

- windrowing,
- roller crushing, where a machine is fitted with winches,
- spot rip, spot rip and mound,
- Scrub muncher or Slash buster - both disc slash breakers,
- Rotree and VH Mulcher which cultivate a spot and break slash at the same time,
- dismantling of birds nests around hauler landings,
- landing rehabilitation by ripping, fertilising and spreading slash and
- extraction track rehabilitation.

In the woodlot logging area then, it is feasible to use an excavator for road and landing formation, logging, fleeting, loading, clean up, site rehabilitation and site preparation. This versatility may lower capital requirements and transport costs for contractors and enable profitable use for logging machinery during times when no contracts or markets are available.

Shovel logging

The North American experience suggests two different retrieval patterns for shovel logging operations (McNeel and Anderson, 1993) with little difference in efficiency between them. These are illustrated below and are the Up-and-back system (Figure 1) where

the loader moves at right angles to the road and the Serpentine system (Figure 2), where the loader moves parallel to the road. Two operations seen on the 1993 LIRO study tour (Riddle 1994)

the roadside when trucks appeared. Shovelling distance was up to 150m from the road and production was reputed to be up to five 90 tonne trucks per day. The other operation was a Cat 330LL which only shovel logged.

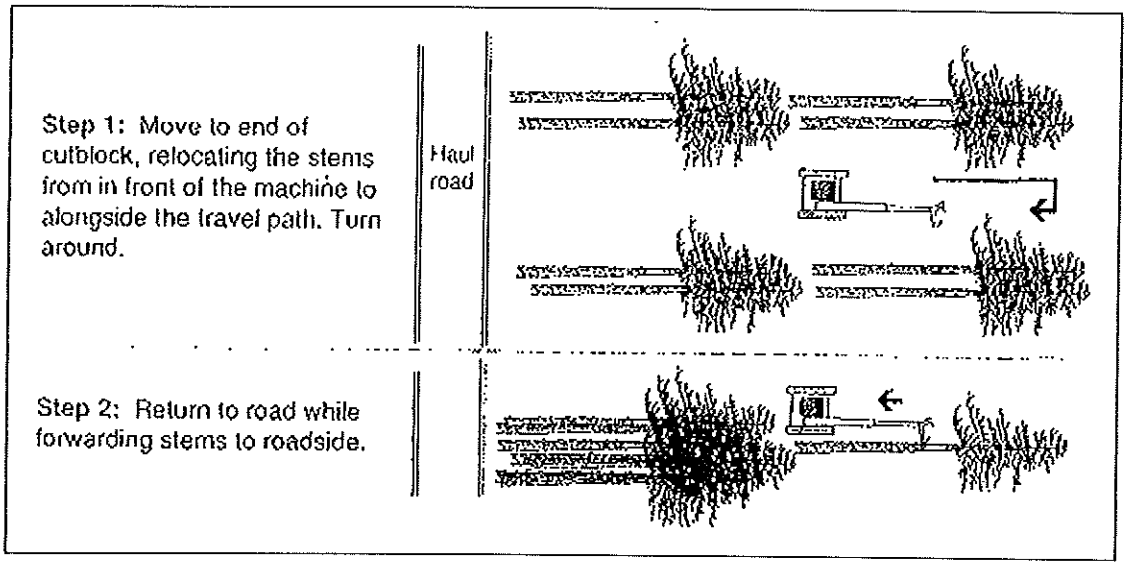

Figure 1 Up-and-back working pattern of shovel logging. (McNeel and Andersson. 1993)

on Vancouver Island demonstrated both systems. One operation used a Thunderbird 1148 to shovel and load using the Serpentine system at 45^0 to the road so there was always wood at

Maximum yarding distance was up to 250m and average production in $2m^3$ tree size was reputed to be $500m^3$ per 6.5 machine hours.

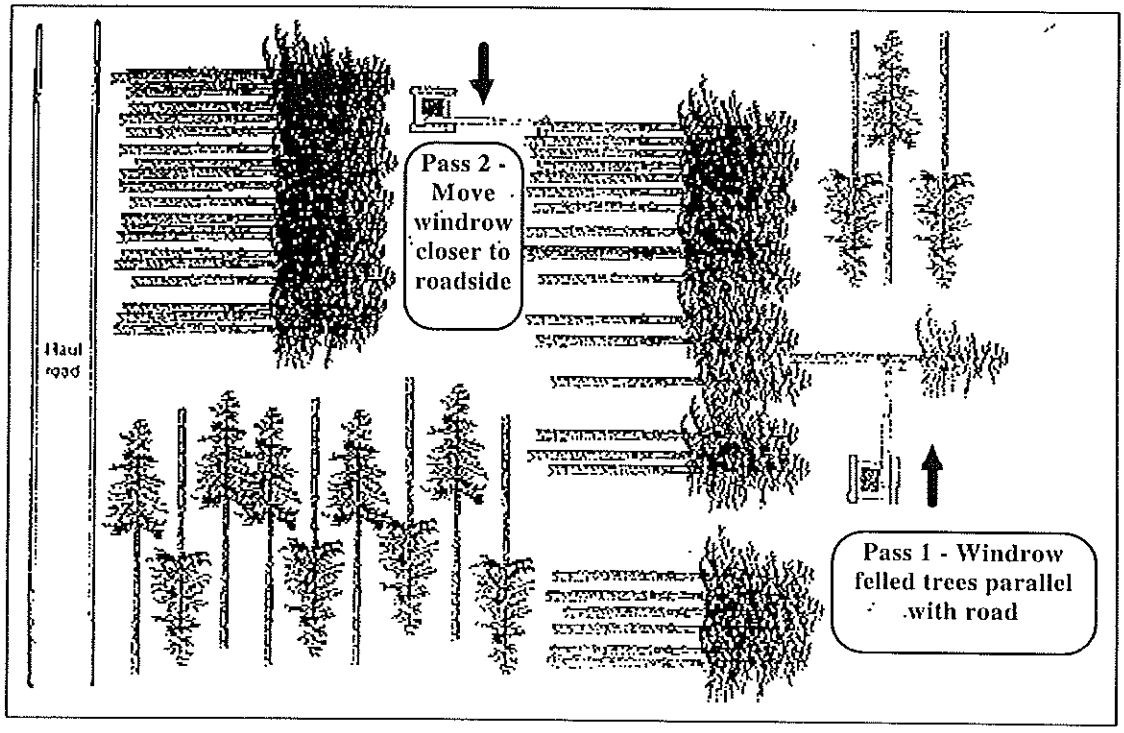

Figure 2 Serpentine working pattern of shovel logging.(McNeel and Andersson. 1993)

A New Zealand trial with loader logging in New Zealand (Moore 1990) used a 30 tonne Sumitomo in three trials. In 0.4 m^3 piece size in windthrow, 50m from road, 140 m^3/day was achieved. In 3.8m^3 'old crop' on 18 degree slopes and up to 100m from road, 373 m^3/day was achieved and in 2.1m^3 radiata on 13 degree slopes and up to 125m max, 195 m^3/day was achieved. These results were reasonable when the inexperience of the operator working at shovel logging on the cutover was taken into account.

Another New Zealand example of shovel logging on a sensitive site was in removing exotic species to allow native regeneration in a national park (Jayne 1994). The site had problems with 2m rainfall per year and a high water table with soft ash soils containing large old native stumps over a pan. The maximum haul was 250m. A 20t and a 30t excavator managed 60t/day each.

Skidder/excavator combination crews

During the last twelve months LIRO researchers have visited or gathered information on a number of shovel logging operations which illustrate the technique. The most recent formal study investigated the effects of bunching wood on system productivity, worker safety and environmental performance by studying three excavator-skidder logging operations (Brown, McMahon and Evanson 1996). Each operation was working on terrain with both short steep slopes and some near-flat areas. Major findings are summarised in Table 1.

Operation 1

A Cat EL 240 excavator and a Cat 518 skidder were used to bunch and extract. Trees were delimbed and cut to length at the landing with a Hahn Harvester which required stems to be presented butt-first.

Trees were manually felled. On flat terrain, the excavator would bunch the stems by the butts. On slopes, trees were felled downhill and pulled down tip-first, then grabbed near the butt and bunched. In some cases the heel was used to lift the stems onto the bunch.

The excavator spent spare time making drag-sized bunches for the skidder. This included positioning bearers for bunches and attempting to remove branches by rubbing stems together. All bunches were elevated at the butt end with logging debris for a quicker hook up. No shovelling was carried out. The excavator was also used on the landing to fleet and shift stems closer to the Hahn Harvester.

The Cat 518 skidder operated a single long strop. Drags were butt-pulled to two positions on either side of a single landing, and bladed into a stack.

	Mean extracted stem volume (m^3)	Excavator productivity (m^3/PMH[1])	Skidder productivity (m^3/PMH)	Mean haul distance (m)
Operation 1	1.3	59	49	145
Operation 2	4.0	112	94	173
Operation 3	1.6	58	44	182

[1] Productive Machine Hours

Table 1 - Summary of operational data for the three excavator bunching operations (Brown, McMahon and Evanson 1996)

Operation 2

A Cat EL 300 and a Cat 518 skidder were used to bunch and extract. Trees were manually felled and delimbed. In this operation, the excavator was used to remove all timber off the slopes. In many cases this meant shovel logging stems distances of up to 70 m from the stump to the bunch. Broken top pieces were also handled during the operation, being placed in separate bunches.

Stems were extracted either butt or tip-first by a Cat 518 skidder fitted with three or four chain strops. There was no need for the skidder to work on any adverse slopes. The operation used five landings to dephase extraction, log making, fleeting and truck loading.

Operation 3

A Thunderbird 738 excavator-loader was sub-contracted by the principal logging contractor, who owned a Cat 518 skidder and also managed felling and processing. The excavator operator had only three months experience on the machine. Despite this, the excavator was still able to keep ahead of the skidder.

Bunches were formed using a variety of methods. Trees felled down-slope were tip-pulled, grappled near the butt and pushed closer to the landing. On flatter terrain, the excavator was building bunches or stacks with a maximum of 35 stems. Shovel logging was used in some cases. Extraction by butt or tip was carried out with a Cat 518 skidder with four or five chain strops. Bunches were extracted until the closest landing was full, at which point the skidder would extract from a different bunch to another of the five landings used.

During the study, a number of points became obvious:

Skidder productivity was higher than in standard operations because the skidders were working from bunches and did not have to travel on the steeper parts of the settings.

In each case, the excavator was able to bunch stems faster than the skidder could extract them. The excavator did not move across the block as frequently as the skidder, which moved to a new area when the landing was full. Often two or three bunches would be formed in an area before the excavator would move.

The difference in productivity between the excavator and skidder allowed the excavator to do other work, such as fleeting and assisting with the felling of leaning trees. This extra excavator capacity could also be used to increase production by:

- shovel logging the wood closer to the landing (this was done in two of the operations)
- extracting wood directly to the landing
- decreasing hook up times by more careful presentation of stems

All three operations demonstrated the ability to more safely extract wood off slopes. Many of the steeper slopes could have been skidder logged, but would have posed a greater risk to operator safety.

Operation 1 demonstrated an ability to tip-pull wood off a maximum 26° slope while sitting on flat ground at the base of the slope. Unlike the other excavators, this machine was not fitted with appropriate guarding to allow operation on slopes. The Operation 2

excavator would climb the slope and position itself on a small flat excavated platform to increase the volume of wood that could be reached. This allowed stems to be extracted approximately 70 m on 25° slopes. The alternative method would have been pulling winch rope uphill or climbing slopes with a skidder.

Large branches were trimmed manually in the cutover in Operation 3 to reduce the hindrance to tip-first extraction. In the other operations, fallers were only required to head off stems, thereby increasing the number of trees that could be felled in a day. The multiple handling of stems by the excavator appeared to cause the majority of branches to be broken off prior to extraction. Often the excavator operation would aim to remove branching by repeatedly sliding the stems over each other. This did not totally eliminate the need for manual delimbing on the landing, but reputedly resulted in less trimming.

An obvious benefit to the site from excavator bunching was the reduction in soil disturbance on slopes. Minor disturbance on the slopes comprised surface soil mixing, with occasional subsoil exposure. The excavator in Operation 2 utilised short sections of stub track from which the excavator could work. However, these were generally less than 10m in length.

The incidental delimbing during handling by the excavator meant that less branch material was removed from the cutover. This is likely to have positive benefits for long term site productivity as it may help maintain site nutrition. Additionally, where delimbing occurred at the bunch sites there was potential for the excavator to redistribute the slash material rather than leave it in piles.

When working in bunched wood, the skidder travelled repeatedly over the same tracks. Although this is likely to reduce the total area of compaction within a setting, the trade-off is increased compaction of these tracks. This issue will need to be addressed in the future to ascertain the long term effects on site productivity.

Excavator logging study tour and workshop.

A recent excavator logging study tour in Victoria and Tasmania looked at the Australian experience to date.

The early part of this tour demonstrated two schools of thought in both countries. The first machine seen bunching and shovel logging radiata was a Cat 325LL belonging to Gary Leeson and demonstrated the "buy big and it will last" school of thought.

The local Caterpillar man, Lynton Perry, talked about this purpose built shovel logger sourced from the USA factory. The Cat 325LL has a heavier frame from the ground up with wider and higher track fame and a 1.2m cab riser. Its weight is 36 tonnes, with 5.2t lift at max reach of 11.5m. A standard Cat 325L costs A$200 000 in Australia - the 325LL is A$400 000.

There was some discussion about using a standard excavator for shovel logging. The Cat dealers thought you should add a logging boom and strengthen cylinder mounts.

The opposing view came from loggers who were shovel logging using standard excavators. They felt that large machines cost too much and that

shovelling wasn't hard on excavators because those machines did not move around the cutover carrying loads. They had no problems with standard excavators and further, if something did crack, they just reinforced and welded it up.

A visit to Barry Kingston in Tasmania reinforced this second view. He was working in E. regnans clearfell on a very wet site at high altitude. One excavator with a crab grab was loading trucks, taking a little bark off and fleeting at the landing. Following manual felling two excavators shovel logged to the skid. Barry had input to the harvest plan but it was ignored at roading time and he had ended up with one skid at the edge of the setting for 40ha, a maximum distance of 400m with a quota of 200t per day. Two excavators (Cat 220 and 225) worked together with one picking up trees from a pile and moving them one tree length to the next which did the same. They aimed to get to the landing 2 to 3 times per day, each time with 70 to 100 tonnes. Most bark is removed after 3 to 4 swings. Just short of the landing they log make with the saws on the grapples to maximise good peelers and sawlogs (all random length). There were no men on the ground at the landing. The setting was noticeable for the lack of mud with no drainage work needed on completion. The soils are wet and fragile. In the first 3 days on the setting they had 150mm of rain, worked through it and still did not cause any mud or disturbance. The machines work on a mat of bark and branches and only move wood when they are standing still.

One machine had a Hultdins grapple with a saw on it but the preferred head was a Thunderbird shovel logging head with a Hultdins cut-off saw attached. The cut off saws were very useful and did not get in the way.

Barry's experience with the repairs and maintenance on machines shovel logging is that there is very little stress on machines because they don't carry wood. A floppy grapple head works best. He felt that the machine was only running on slash so there was no stress on track pins and bushes - he suggested that tracks would last the life of the machine (6 - 7000 hours in the cutover, then put it on the landing) but emphasised the need for short track frame machines to reduce stress on the tracks when turning on cutover.

A short workshop back at the hotel described more shovel logging systems in use in Australia.

Denis Smith from Coffs Harbour, NSW, has a shortwood system with Waratah HTH230, 20t forwarder and another excavator with a Unicon II head which is capable of felling and bunching or shovelling trees. Ten loads a day were produced with 3 of these needing 250 logs to a truck (40 to 60% is small log and the rest is pulp). The key to this productivity was the Unicon II felling, bunching and shovelling all wood on slopes down to the Waratah for processing. The forwarder is very efficient when it does not need to look for its load but gets a full load from one spot.

Wayne Poke from NW Tasmania harvests mature blackwood from swamps. Ground based extraction is only possible for a few weeks each year when the water table drops far enough to use his TD20 with grapple and JD 648 and grapple. He now uses an EL240 excavator with Hultdins grapple with saw to top, bunch and shovel to set up for skidders. The

excavator can start doing this well before conditions are right for skidding and ensure very high skidder production during the short season. This is another indication of the ability of a shovel logging operation to extract wood when ground conditions prevent traditional logging machinery to operate.

Frank Brunt from Orbost produces 10,000t/month of Eucalyptus pulp in very small timber. He has three operations - one based around a grapple skidder, one around a tractor and one using a Cat 322 excavator with crab grab and cut off saw. This excavator pushes material over, cuts root balls off (and if a large diameter tree leaves a hole in the ground they put the stump back in the hole), debarks, cuts to length and bunches. It then grabs a blade in the crab grab and forms a rough dirt road to enable the truck to come to the wood. After the first month of doing this he found that the production from this one man and machine matched his other crews.

Examples of multiple uses of one excavator

With shovel logging accepted as a legitimate extraction method, the concept of using one machine for a multitude of uses becomes more feasible. Two examples which could enable an excavator be used in this way are the Hultdins F850 head teamed with a static delimber and the Unicon heads which are manufactured in Australia.

Hudson Lusty

Hudson Lusty in Northland has a Hultdins F850 head mounted on a Cat 325 excavator by an attachment system which enables a quick changeover to a standard grapple. He normally fells with the Hultdins head and then pulls stems through a George static delimber and bunches for a skidder. If the tree size is not too large the Hultdins head can be used for the delimbing operation. This system could be versatile enough to use in the woodlot arena.

Unicon

Timberjack this year demonstrated an Australian designed Unicon II head on a Timberjack 2628 base in Tasmania. Contractor Denis Smith and engineer Warren Mitchell designed the head and have given manufacturing and marketing to Timberjack. This head can fell, trim some large branches, shovel, cut to (random) length and load, and weighs two tonnes. It looks a promising concept and is well engineered.

A Unicon III head, which has been undergoing field testing, will probably be released in 1997. It has 4 feed rollers and delimbing and length measuring abilities, and weighs about three tonnes. Denis has done several jobs of one or two hectares where the one machine has done a complete job - fell, shovel, process and load. This concept may also be useful as the New Zealand woodlot resource comes on stream.

Conclusions

In New Zealand there are more contractors using the shovel logging concept both in woodlots and in corporate forest operations. Advantages offered by shovel logging include:

- the concept adds to the versatility of the excavator and makes the "one

machine" logging operation possible.

- less impact on soils, giving an ability to work in more adverse conditions than skidders
- because many branches are knocked off during shovel logging, less trimming is required on the skid or in the bush which improves worker safety and productivity
- if working with a skidder, increases skidder productivity
- less soil disturbance through reduced earthworks or tracking on slopes,
- retention of slash on the cutover
- increased safety due to the elimination of skidder travel on steeper slopes
- the skidder/ excavator combination is more productive than the more traditional skidder / tractor combination.

Maximum skidding distances up to 200m can be shovel logged efficiently. Purpose built shovel logging excavators are available but many contractors are getting by with standard machines. Cut-off saws are a useful addition and do not get in the way of shovelling operations.

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