USING TWO STAGE LOGGING TO IMPROVE LOGGING SYSTEM PERFORMANCE

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INTRODUCTION

Two stage logging can be described as a system where there is an intermediate means of moving the logs from where the extraction machine drops them to where they are loaded onto trucks or barges for long distance transport. Processing of the logs can take place either before or after (or partial processing before and after) they are transported by the "second stage" machine.

At the LIRA Seminar "Cable Logging" held in Nelson in 1989, Terry Burrows presented the paper "The Viability of Two Stage Hauling in Cable Operations". Three examples of two stage hauling in hauler operations in Kaingaroa Forest were described (two using a skidder and one using a tractor) and the following advantages were explained:

- The hauler can be placed in a position on the landing that favours extraction rather than a compromise which allows areas for processing, storage and loading.
- Interference to the hauler by landing activities can be greatly reduced.
- The work environment at the processing area can be greatly improved, promoting safety, more efficient use of labour and better value recovery.
- Where appropriate, production may be maintained or boosted using the tractor or skidder as the extraction machine (especially during hauler downtime).
- It is possible for the hauler to work along a road (particularly a swing yarder) rather than needing specific landing locations.
- Existing roads and landings may be utilised better.
- Savings can be made in road and landing construction costs.
- Soil disturbance can be reduced.
- If delimbing is done at the processing landing away from the hauler, "bird's-nests" at the edge of the hauler landing are avoided.

For the operations in Kaingaroa used as examples, it was recommended that the maximum distance from the hauler landing to the processing / storage landing should be 200 metres.

Since 1989 two stage logging has become more common as more logging has occurred on steep terrain. Much of this has been in first rotation crop where there were no landings and most of the roads needed to be upgraded or constructed. There are also large volumes to be harvested from relatively small woodlots with poor or no existing access. The advent of the Resource Management Act (1991) has resulted in increased concern regarding disturbance of soil and waterways in many areas. The Health and Safety in Employment Act (1992) has resulted in both contractors and forest owners attempting to reduce hazards in log extraction and processing operations; in particular cable logging is now used on much terrain that would previously have been logged with ground based equipment. Many of the haulers currently in use in New Zealand are track mounted and can travel over much rougher and steeper

terrain than large truck or trailer mounted machines. The number of log types to be cut by most logging operations has also increased, leading to increased concern about value recovery and requiring more space for log storage.

As a result of these changes there has been an increase in the number of two stage logging operations and a wide variety of equipment used for the second stage extraction.

This paper uses examples of particular operations to illustrate how two stage logging systems can work effectively. Most of these examples use a cable hauler as the primary extraction machine but a two stage system may sometimes be applicable to operations using ground based extraction machinery.

OBJECTIVES OF HARVEST PLANNING

The main objective of a harvest plan is to maximise the net return from the crop and any subsequent crops. Figure 1 shows that total logging costs are the sum of operational costs, environmental costs and planning costs. Using this definition, the main objective can be expressed as "to minimise total logging costs while receiving maximum income for the crop".

While trying to achieve this main economic objective, other objectives which must be given consideration are those which relate to production, environmental effects and the health and safety of the workers. Factors which have a beneficial effect on one of these objectives may have a detrimental effect on one or more of the others. It is important to ensure that minimum acceptable levels are achieved in relation to these sub-objectives, but that the main economic objective must always take precedence.

Some examples of these objectives are listed below.

Production Objectives:
- to achieve the maximum possible production from the extraction machine (This could include minimising interference from the processing operation).
- to maximise value recovery
- to maintain woodflow in all weather conditions
- to utilise skidworkers' time as fully as possible
- to employ an operation which is able to produce during periods of hauler downtime.

Environmental Objectives:
- to minimise unnecessary loss of productive land (or reduction in site productivity)
- to keep sediment runoff within acceptable limits
- to keep visual effects within acceptable limits

Health and Safety Objectives:
- to keep skidworkers well away from moving ropes and machines

HOW TWO STAGE LOGGING CAN HELP TO ACHIEVE THE HARVEST PLANNING OBJECTIVES

The factors which change depending on whether a conventional or a two stage logging system is used, are listed on the left hand side of Figure 1. The effect of these factors on the total logging costs is explained below:

Extraction Costs
- Greater deflection near the landing can be obtained by locating the hauler closer to the edge of the landing hence payloads can be larger.

Figure 1 - Factors To Consider when Evaluating Two Stage Logging Systems

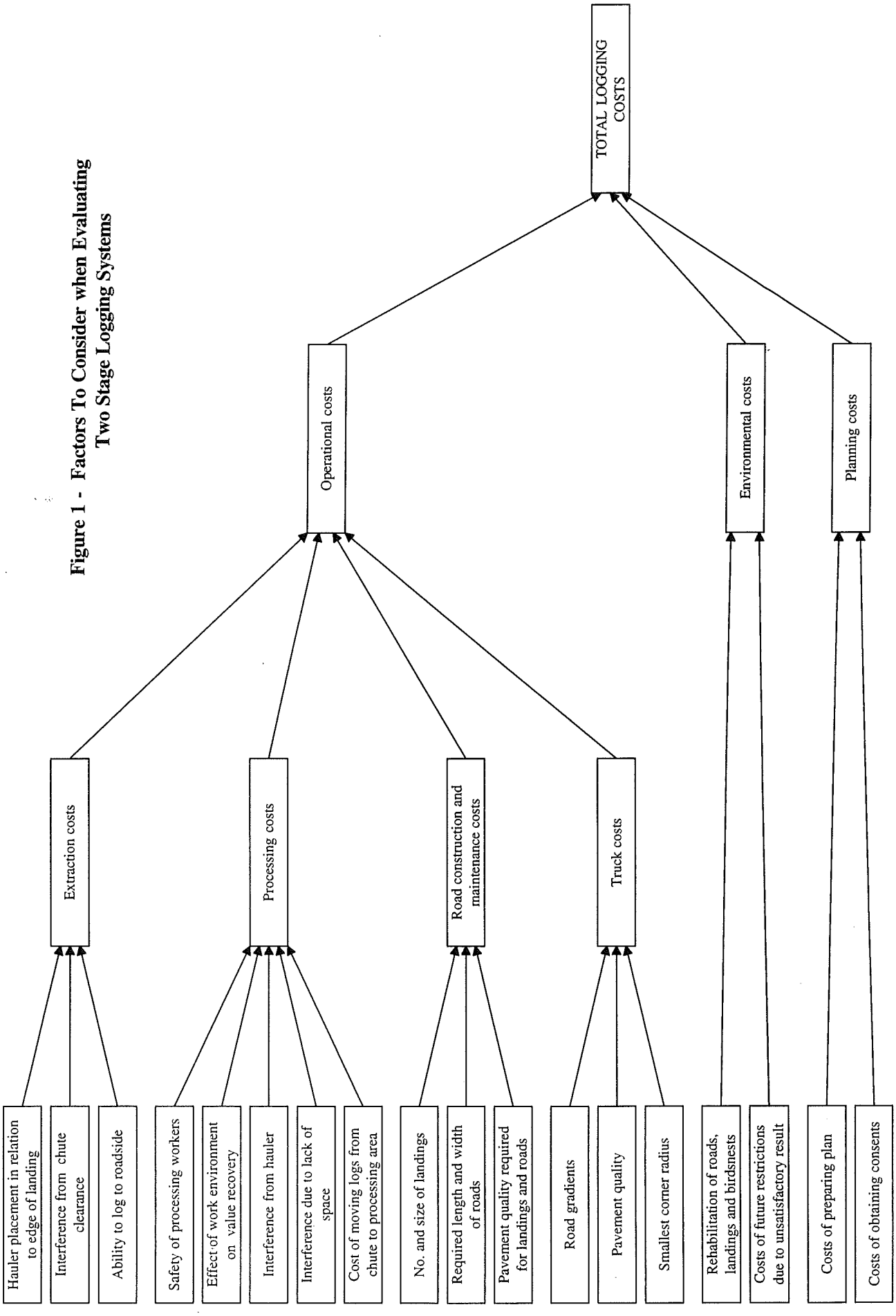

Table 1 - Performance of Two Stage Logging Operations

	Second Stage Extraction machine	Primary Extraction Machine	Location	Haul Distance (typical) second stage [m]	Daily Production (typical) [m^3/day]	Load Volume (typical) [m^3]	Time to load / hook on (typical) [mins]	Time to unload / unhook (typical) [mins]	Travel speed, loaded (typical) [km/h]	Travel speed, unloaded (typical) [km/h]
1	Cat 528 cable skidder	Thunderbird TSY 255 (swing yarder)	Omataroa Forest (B.O.P)	369	300	6.0	4	1	7.8	9.8
2	Mercedes 6 × 4 with Bailey Bridge	Thunderbird TMY 70 (hauler)	Glenbervie Forest (Northland)	1100	200	30 to 40	14	10	-	-
3	John Deere 640E skidder with tandem axle trailer	Madill 071 (hauler)	Glenbervie Forest (Northland)	140	170	12	5 to 8	3 to 5	6.8	4.9 (in reverse)
4	MAN 8 × 8 truck	2 × ground based operations	Moerewa Station (Northland)	3800	200	11 to 17	8 to 12	8 to 12	14 (downhill)	21 (uphill)
5	Bellis BE 70 Hauler	Thunderbird TTY 45 (hauler)	Marahau Forest (Nelson)	380 (hor.) 130 (vert.)	150	-	-	-	-	-
6	Clark Ranger 666F cable skidder	Madill 171	Kaingaroa Forest	100	260	3.0 to 6.0	-	-	-	-
7	Gantner long reach skyline	Washington 88	Marlborough Sounds	650 (hor.) 135 (vert.)	95	2.5	-	-	-	-
8	Forwarder (typical, 12 tonne payload)		Forestry Commission Output Guide	200	200	12	8	8	15	15

Table 2 - Operation Descriptions

	Second Stage Extraction machine	Situation	Operational Procedures	System Matching
1	Cat 528 cable skidder	Small hauler landings were used to minimise earthworks on a visually exposed ridge. A single processing landing was used for 3 hauler landings.	A Waratah 234 cleared the hauler chute, delimbed, removed heads and slovens and presented full tree lengths for the skidder. Logmaking was done manually.	Skidder could produce at 90% of hauler rate. Waratah is able to stockpile surges and keep chute clear. Skidder could work during smoko to catch up.
2	Mercedes 6 × 4 with Bailey Bridge	The hauler location only a small landing could be constructed so even though there was truck access. A separate processing landing was used.	Full tree lengths with branches were loaded by Cat 950A. and unloaded by Kawasaki 85Z2. At the processing landing a Bell/Trinder static delimber was used with manual logmaking.	The truck had to wait at the hauler for about 20 minutes for a full load to accumulate.
3	John Deere 640E skidder with tandem axle trailer	The hauler landing was of sufficient size to allow processing but not log storage. The skidder was chosen because it wasn't being used elsewhere during winter.	Logmaking was done at hauler landing then logs are loaded onto trailer for transport to storage area. The crew prefers to do the processing away from the hauler.	The capacity of the skidder easily exceeded that of the hauler. When the Skidder returned to the hauler, the driver assisted the skiddies until there was a complete load.
4	MAN 8 × 8 truck	Logs from two or more ground based operations were taken downhill along unmetalled tracks in silty-clay soils.	Each ground based operation had a processing landing where the MAN was loaded using a Bell Ultralogger. A Clark 45C was used to unload the MAN and load on-highway trucks.	The MAN truck easily transported the 200 tonnes produced by the ground based operations.
5	Bellis BE 70 Hauler	Relatively small areas of unlogged forest remained out of reach of the roadside landing. The TTY45 was driven down a ridgetop firebreak, assisted by a D6 tractor.	At the intermediate landing a Komatsu PC200 excavator type loader moved the logs from the chute of the TTY45 to a "hooking on" area for the BE70.	At about 150 tonnes per day the BE70 had to wait for a full drag to accumulate in each cycle.
6	Clark Ranger 666F cable skidder	To move the processing operations away from the hauler, two processing landings were used, one adjacent to the hauler and one approx 150m away.	The landings were used alternately; while one was being filled by the skidder, logs on the other were being processed. A Volvo L90 loader serviced both landings.	The production of the skidder exceeded that of the hauler when taking logs to the closer landing, although a stockpile could accumulate when haul distance was further.
7	Gantner long reach skyline	Extracted logs needed to be transported 650m over some steep (over 30°) terrain down to near a barge landing. The aerial system avoided the need for tracking.	Trees were manually processed into log lengths at the upper processing deck. The logs were taken to a barge from the lower landing by a Cat 936 wheeled loader.	Two skyline systems were used side by side. Two skylines were used only during surges in production from the swing yarder.
8	Forwarder (typical, 12 tonne payload)	Sample data from "Extraction of Sawlogs and Small Roundwood by Medium Class Forwarder" - Forestry Commission Work Study Branch, Output Guide 7	Forwarder self loading and unloading pieces of volume 0.3m³ to 0.4m³, travelling 200m.	The hypothetical forwarder will transport 200m³/day in these conditions.

- Production can be maintained during periods that the hauler is not working by using the second stage machine (where it is a skidder or tractor) as an extraction machine where the terrain is suitable.
- Small areas which may be very time consuming to set the hauler up for may be logged in less time using the second stage machine if the terrain is suitable.
- Delays to the hauler because of interference by processing activities and moving logs can be greatly reduced.
- The extraction operation can become completely separate from the processing operation, even to the extent of having separate parties contracted for each function. This would allow owners of expensive haulers to concentrate on maximum utilisation of the hauler which is probably their highest value asset.
- Swing yarders can work their way along a road without the processing operation needing to follow them. If the hauler moves each time the tailhold is moved, adjacent extraction corridors can be parallel, resulting in more wood being extracted from each corridor. (This will be most beneficial when a mobile tailhold and/or a mobile guyline anchor are used).

Processing Costs

- The interference and hazards from moving ropes and incoming logs are removed.
- There are fewer machine movements to be aware of. (If multiple processing landings are used, there may need to be no machines on the landing while the skidworkers are there).
- The processing landing can be located away from a ridgetop where there is more flat land available, so the landing can be larger.
- There are no guylines to get in the way of log stacks, loaders and trucks.
- Because of the quieter conditions and fewer distractions, logmakers are able to concentrate better on their job, enhancing value recovery.
- As there is less moving heavy machinery on the landing, there is less chance of electronic calipers being damaged.

Road Construction and Maintenance Costs

- Smaller hauler landings can be constructed, and one processing and storage landing can be used for several hauler settings therefore the total area of landings can be reduced.
- Truck grade roads need only be constructed to gain access to the processing landing - not each hauler landing. (The track for the second stage machine can be steeper, softer, narrower, more slippery, and have tighter corner radii than a truck grade road, depending on the second stage machine used). Earthworks requirements may be considerably reduced (and therefore less cut and fill areas) and less metal required to construct a second stage track.

Truck Costs

- Processing landings to which trucks need access can be located so that the trucks can avoid difficult adverse or favourable grades, therefore increasing travel speeds.
- As a higher volume of wood may be taken from a processing landing than a single hauler landing, a higher quality of pavement can be justified, which can result in higher travel speeds and better accessibility in wet weather.

Environmental Costs

- With a smaller total area of roads and landings, the loss of fully productive land can be reduced. Costs of

rehabilitating the roads and landings will also be reduced.
- With smaller hauler landings, the fill slopes sitting above steep slopes will be smaller, reducing the risk of the fill sliding down the hill.
- If delimbing takes place away from the hauler landing, there will be no bird's-nests there. (Bird's-nests can slide down slopes, taking some of the landing fill with them, collecting more debris along their path and come to rest in a gully or streambed).
- If using a two stage system results in environmental effects which are acceptable as defined by the resource consent, it should be straightforward to obtain future consents for similar operations in the future. If a system is used which has a higher risk of unacceptable effects, there may be a cost in terms of obtaining future consents.

Planning Costs
- Because of the environmental reasons listed above, it should be easier to demonstrate to local authorities that a two stage system will meet environmental requirements, so less time and effort should be required to obtain a resource consent.

SELECTING A TWO STAGE LOGGING SYSTEM

There are many types of machine that can be considered as second stage machines, and combined with the possible arrangements of landings and processing sequences, there are too many possible combinations to list.In designing a two stage logging system, selecting a second stage extraction machine should be done when the form of the track on which it will operate is decided. All of the cost factors mentioned previously should be considered while the system is being designed. As so many things need to be evaluated simultaneously, the selection process is not a simple series of steps. The best method is to consider how operations have worked in similar situations elsewhere.

For a hauler operation, it is important that the overall production of the operation is not limited by the second stage machine. (As the hauler is usually the highest value machine, it is important that its utilisation is as high as possible).
When the probable load type, production required, second stage haul distance, and slope and surface qualities of the track have been estimated, the possible types of machine can be identified. The process will usually be simplified by having only a limited range of machinery available.

Tables 1 and 2 describe particular two stage hauling situations, compiled as a guide to how some two staging operations have worked in eight different situations with seven different machines. Numbers 1 to 7 are situations which have been observed by LIRO. Number 8 has been derived from which lists loading and unloading times and travel times for a range of forwarders. Unless stated otherwise, the examples in tables 1 and 2 refer to an approximately flat second stage route.

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