Session 4
Paper (a)

LOADER SELECTION

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MAIN TYPES OF LOADING MACHINE

The main types of log loader in use today in New Zealand are the self-loader, the front-end loader, and the grapple loader.

Self-Loader

The self-loader is mounted on, and powered by, the log truck that hauls the logs. It is therefore a low-capital option. On the other hand, it is limited in lift capacity (usually 6 to 13 tonne-metres in New Zealand) and reach (typically 6-8 m). Also, its weight must be subtracted from the net payload of the truck.

It is used where daily logging production is too low to justify a separate loading machine, and where logs can be decked within 4-6 m of the road edge.

Front-End Loader

The front-end loader is familiar to New Zealand loggers, and is therefore not described in detail here. Most are rubber-tyred. The undercarriage of the tracked type is expensive to maintain, and in turning it tears up the landing. On the other hand, it has more flotation and is therefore preferred over rubber-tyred front-end loaders for soft soils.

Front-end loaders have an advantage of lower capital cost compared to grapple loaders. However they generally have a shorter working life, and most importantly, they require a large, smooth landing.

Grapple Loader

Grapple loaders fall into two basic categories: line and hydraulic. The grappling and lifting of logs is done by wire ropes in the line type, and with hydraulic cylinders in the hydraulic type. Most often, they have been cranes, excavators, or draglines custom converted for log loading.

Line Loader

The simplest line loader is a 2-line machine with tongs. The "lifting" or "hoisting" line is for lifting the load, and the other "boom hoist" or "luffing" line is used to raise and lower the boom. The tongs are simple to operate but require an extra person to set them on the log. They also are not capable of loading multiple logs, and therefore are not productive in small wood. The tongs can be accurately tossed up to 50 m by a skilled operator.

Most tongs have been replaced by grapples. As well as the hoist lines, there are two additional drums on the loader. The grapple is powered open by a separate opening line (it is closed by the lifting line). The "tag" line is used to swing the grapple back and

forth to spot it on the log. The grapple may be tossed up to 20 m from the machine.

There are two important styles of boom in use. The most common in New Zealand is the straight or dragline boom, often of the familiar lattice construction. Overseas, the heel boom, using a bent boom, is common.

The straight boom is used for "balance" loading, in which the log is grappled near its centre of gravity, or "drag" loaded where it is grappled off-centre. Ideally, the loader should be located alongside the truck.

The heel boom works differently. The log is grappled off-centre, with the short end closest to the loader. The short end is tucked under the heel, which then holds it in position. This gives more positive control of the log than with the straight boom, and means that logs are best loaded over the rear of the truck. A landing is operated with the logs decked in a more or less radial pattern about the loader, without a need to construct any landing beyond the small area occupied by the loader. Because there is more leverage exerted on the loader, a larger loader is required than with a straight boom.

A variation on the heel boom is the snorkel. The snorkel is a wood or steel pole extending out from the heel a further 8-10 m. On the end is hung a block, through which runs the tag line. This line is used to pull the grapple out to the end of the snorkel, enabling the grapple to be accurately spotted over 20 m from the centreline of the loader. The snorkel is widely used in large timber for logging roadsides, or as a primary logging system on easy terrain where roads are built at a 40-45 m spacing. It does not find favour where there are many sorts.

Line loaders are used with two main types of undercarriage: tracked and rubber tyred. The tracked machine is stable, requiring no outriggers, and therefore it can move about on the landing. The rubber tyred type, mounted either on a custom undercarriage or on a truck, requires outriggers in use, so that it is not practical to use where movement on the landing is desired. On the other hand, it has much higher travel speeds than tracked machines and has a definite advantage for loading out scattered decks of logs.

Hydraulic Loader

Hydraulic loaders are very positive in their action, and easy to learn to operate. They come on both tracked and rubber tyred undercarriages, that have the same advantages and disadvantages as with line loaders. They are ideally suited to handling small logs in multiples of perhaps ten or more. Because the grapple is fixed to the boom, they do not have the reach of the line machines.

There are several logging fronts in use. They mostly feature two common boom segments: the "boom" attached to the machine platform; and attached to it, the "stick". The important differences between the various logging fronts revolve around the configuration of attachment of the grapple to the boom.

The most common type in New Zealand is the knuckleboom, which has the grapple hung at the end of the stick. As with the straight boom line loader, logs are usually grappled at or near the centre of gravity, which means balance or drag loading with the loader alongside the truck.

The heel boom type has an additional boom segment, the heeling rack, on the end of the stick (Figure 1). The rack has the heel on the rear end against which logs are pivoted, and the grapple on the front end. As with the cable-operated boom loaders, logs are normally loaded over the rear of the truck, and logs are decked radially about the loader with

Figure 1

Typical heel boom, showing, from right to left, main boom, stick, and rack. This rack has a double heel to provide a larger target area.

minimal constructed landing space required. Again, because of the greater leverage exerted by the logs, a larger loader is required than with the knuckleboom type.

Some models have two heels on the rack - a short heel and a long heel - to give a larger target area for heeling and therefore faster action.

NEW ZEALAND HYDRAULIC GRAPPLE LOADER APPLICATIONS

The knuckleboom loader is suited to tree-length logging on large landings, since it can be positioned alongside tree lengths and trucks. A relatively small loader, by positioning itself alongside the tree lengths, can handle the material.

For restricted landings, a heel boom is better, since it can operate from one end of the tree length. However, it is then essential that the tree be cut into logs within reach of an area accessible to the loader - usually the road. In tree-length logging, it is also essential that all trees arrive at the landing butt-first. Also, because of the leverage exerted by the tree length, a larger loader is required for heeling. American experience is that a 25 t loader can heel a tree up to about 2.2 t, and a 31-35 t loader, a 3-4 t tree (Figure 2). This compares with the 18-20 t class of machine most common in New Zealand for non-heel operation (Langsford, 1985).

Potential loader applications in New Zealand include more than just loading logs. Shovel logging is one obvious application for which many log loaders could be adapted. It would be advantageous to fit other loaders with auxiliary skidding winches.

Figure 2

This logger uses a 35-t Prentice 810 to heel tree lengths up to 4 t. Larger trees than this have a log cut off the butt at the stump.

FEATURES OF HYDRAULIC GRAPPLE LOADERS

As with any machinery, the logger will be considering the quality of the construction, grade of steel used, parts standardisation and availability, cab and controls ergonomics, service availability, manufacturer's and dealer's reputation, and price. Specific to log loaders, the best performance is obtained from high-pressure machines built since about 1983. The following features should be considered.

Sizing

The size of machine selected will depend on the application: the size of wood, whether it has to handle tree lengths or log lengths, the reach required, and whether or not it has to heel. As a minimum on most logging shows, it must be able to offload a trailer. New Zealand trailers generally weigh 3-5 t.

The lifting capacities quoted by manufacturers must be interpreted with caution. Lifting capacities are limited by both the hydraulic capacity of the machine, and by tipping of the machine on its tracks. They also often exclude the weight of the grapple. Lifting capacities are quoted at various percentages of hydraulic and tipping limits, and sometimes only one of these. Furthermore, they are generally quoted for a machine in new condition, on a firm, level surface. For logging applications, it is recommended to assume an actual lifting capacity 2/3 of the theoretical (100%) maximum, using the lesser of the hydraulic and tipping limits. Tipping limits need to be calculated over the side, where there is generally less stability than fore-and-aft.

Guarding and Upper Modifications

Depending on the model of loader, reinforcing or guarding is likely to be required for the engine house, catwalks, the front of the machine, the operator's cab, hydraulic hoses and fittings, and track motors. An elevated cab is preferred for improved visibility, and a heavier counterweight may be required than on stock excavator models. Some models feature a tilting cab to facilitate highway moves.

Guarding is especially important on shovel loggers. It is common to add 19 mm plate, with 50 x 100 mm bars outside, under the carbody, and 8 mm plate on the underside of the upperworks.

Boom Type

Some excavator conversions retain the earthmoving boom. Custom logging booms have better reach, lift, and flexibility, but are not as suitable for earthmoving if this is desired as a part-time utilisation of the machine. Logging booms should have wide hinge joints and sufficient width to withstand torquing by off-centre loads. Large pin sizes are also desired.

Top vs bottom-mounted stick and rack cylinders

The stick and rack cylinders may be mounted either above or below the boom. The latter has become more common in recent years.

Mounting above has the advantage of protecting the cylinder from the log. (However on a tower landing it is exposed to wire ropes). Mounting above also suits the machine for building high-decks in the mill yard, for which purpose this configuration is now most commonly used. Also, mounting above permits the load to be brought closer to the machine for greater lift capacity.

The problem with mounting above is that lifting is achieved with a pull stroke, requiring a larger cylinder and therefore having a slower speed than a pushing

cylinder. Furthermore, if a cylinder should break, the log may come down on the operator.

For these reasons, it is more common for log loaders to be supplied with stick and rack cylinders mounted below.

Hydraulics

Hydraulics power the following functions in a modern log loader: swing, travel, boom hoist, stick, rack, grapple opening and closing, and grapple rotation. This may be accomplished with a greater or lesser number of pumps, depending on the sophistry of the controls. Some models feature advanced computer control of the oil flow between functions, permitting the machine to operate with as few as two pumps. A different approach is to have more pumps - 4 or 5 - in order to reduce the complexity of control.

Hydraulic circuitry is specific to each brand and model. Simpson (1985) gives a description of the plumbing employed on one New Zealand excavator-to-loader conversion.

Undercarriage

Especially for shovel logging, a log loader should have increased ground clearance - almost double - compared to an excavator. For log loading, 75 cm of clearance is desired (Figure 3). A widened track gauge is also advantageous, for sideways stability.

Most modern loaders are mounted on a tractor-type lower typically capable of travel speeds of 5 km/h. The older flat-pad machines have slower travel speeds and poor off-road capability. Simultaneous swing-and-travel capability is especially useful where many sorts are made on the landing, requiring frequent machine movements. The ability to counter-rotate the tracks adds to machine manoevrability.

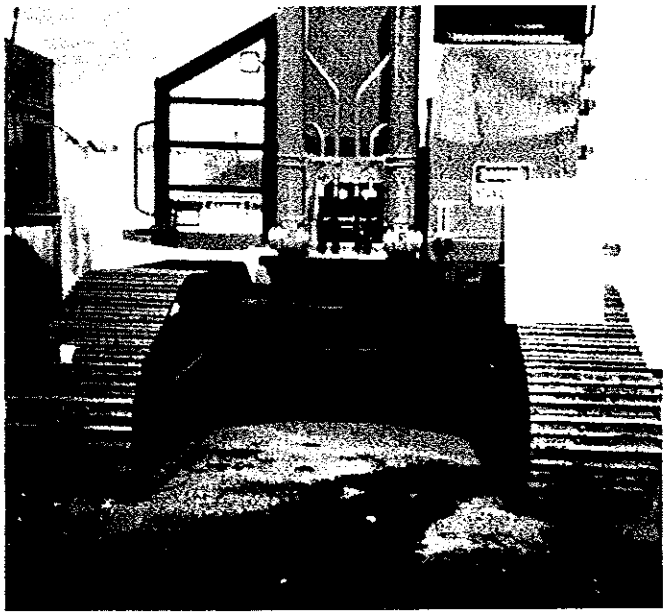

Figure 3

The carbody on this excavator customised for logging has been raised to give 75 cm clearance. Additional guarding is provided on both the upper and lower works. Some conversions also feature an increased or even a variable track gauge.

The most stable log loaders are those with the greatest undercarriage length and width. There must of course be a tradeoff with the problems of highway moves for overwidth machines. Some models feature a variable track gauge.

Ruggedness is a primary attribute to be sought in undercarriages. Apart from guarding, the logger should seek a loader with large-dimension undercarriage components, and should also check the number of rollers.

Grapple Design

The main types of grapple in use in New Zealand are described by Langsford (1985) - the grab, pulpwood, and 3-tine types. The latter is the most useful for modern hydraulic log loaders in the most common New Zealand applications. There are several variations, however, on the concept.

The grapple may be either fixed or power-rotating, and the latter is recommended for efficient log handling.

Without a heel, the 3-tine type is less efficient than the pulpwood grapple for handling multiple small logs. However, the 3-tine type is highly efficient if used with a heel, and good operators frequently grapple 10 or more small logs in a pass with this configuration.

Some variations on the heeling concept have been developed for handling small tree length wood, permitting the loader to alternate tops and butts on the load. In one class of tree length grapple popular in eastern parts of North America, the entire heeling rack is power-rotated. Some models feature two hydraulic stabilisers, which act as small heels both behind and in front of the grapple (Figure 4). Another type has one large heel instead of two small ones (Figure 5).

Among the non-rotating-heel small-log variations, one type features an enlarged heel, with wide horns

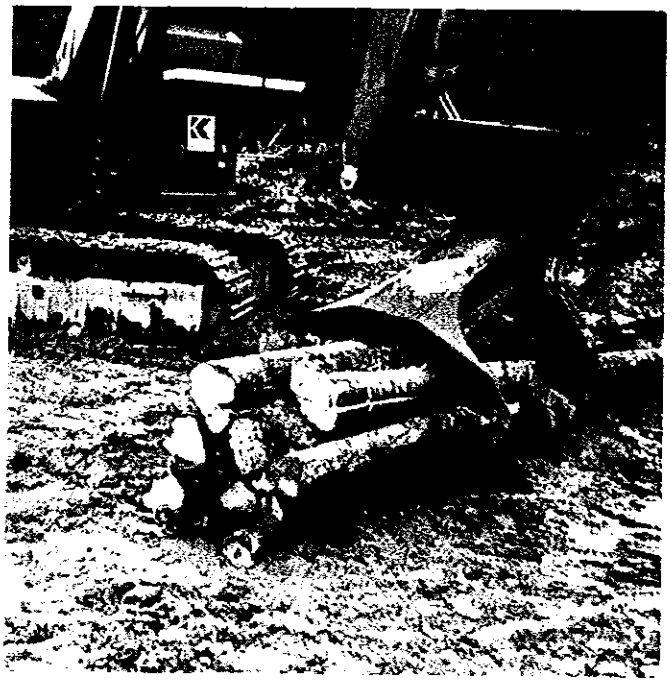

Figure 4

Koehring tree length grapple for small wood.

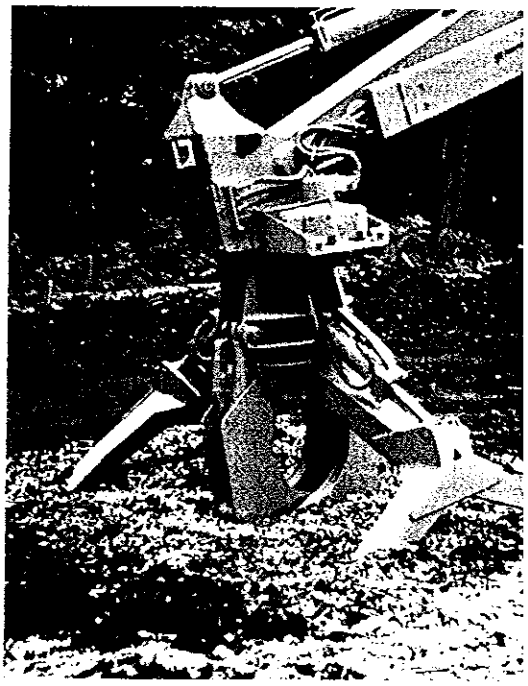

Figure 5

Weldco tree length grapple loader to alternate tops butts on the load.

that catch and contain l before they spread. Anothe "butt-'n'-top" grapple, second grapple on the r place of the heel, suiting small logs of mixed top orientation.

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