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# SELF-LOADING TRUCK EVALUATION

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*Figure 1 - Trailer Unloading Procedure*


## ABSTRACT

*This Report is an evaluation of a self-loading logging truck incorporating an attachable/detachable crane. The advantages and disadvantages of the system are described and factors affecting loading performance are identified. Recommendations for grapple size and stack presentation are made.*

*Loading times for both chip logs and sawlogs were recorded and the results analysed. This analysis revealed that the crane was working at between 30% and 35% below its rated capacity.*

*The truck, which was licensed to operate at 44 tonnes GVW, was able to carry a legal payload slightly in excess of 30 tonnes on highway when the crane was detached.*


## INTRODUCTION

Since their introduction to New Zealand approximately twenty years ago, self-loading trucks have helped to make small woodlot logging operations and some commercial thinning operations economically feasible. Some contract logging operators working in scattered, low volume settings cannot fully utilise a mobile loader due to their low daily production and long travel distances between blocks. Equally, some farmers and private landowners often have enough equipment to harvest their own trees and skid them to a landing, but few are equipped to load logging trucks. It is the long distance mobility and low initial cost that makes the self-loader attractive in these situations.

The truck, which incorporated a Jonsered Ek M1070 attachable/detachable crane, was able to piggyback its trailer and unload it using the crane. The unloading procedure involved firstly slewing the back of the trailer on to the ground, then picking up the front and slewing the whole trailer around to the rear of the truck where the drawbar was connected ready for travel (Figure 1).

The objectives of this study were to document the performance of this self-loading truck, emphasising the crane attaching and detaching procedure.

*ACKNOWLEDGEMENT*

*LIRA wishes to acknowledge the assistance of McCarthy & Wilshier Transport, Rangiora who supplied the truck for this study.*

## CRANE ATTACHMENT/ DETACHMENT PROCEDURE

To attach the crane, the truck is backed up to the crane on the ground so that the mounting pockets on the truck and the crane's supporting brackets roughly line up and are close enough so the hydraulic connection can be made. The hydraulic hoses are connected between the truck and the crane via four "quick connect" couplings (Figure 2). By controlling both stabiliser feet and the boom, the crane can be manoeuvred on to the truck and locked into position with two high-tensile pins. The whole detaching/attaching procedure usually takes less than four minutes to complete and can be accomplished without difficulty on soft ground.

The ability to detach the crane provides some significant on-highway payload advantages.

## STUDY AREA AND METHOD

The self-loading truck was loading and transporting logs from scattered woodlot logging operations throughout North Canterbury. The unit was studied loading and transporting both chip logs for Carter Holt Harvey's medium density fibreboard plant at Ashley and sawlogs for McAlpines Sawmill in Rangiora.

A production study of the crane was undertaken in which a total of 16 truck loading cycles were recorded.

The productivity of the crane was defined as total tonnes of wood transferred from the stack to the truck. By measuring the number of swings, the number of logs per swing and the payload, the following variables can be calculated and their influence on the loading rate measured:

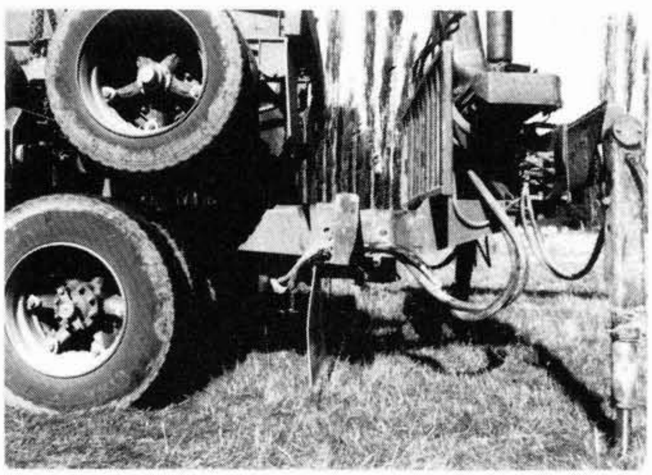

*Figure 2 - Crane Attaching/Detaching Procedure*

(i) Grapple load size
(ii) Piece weight
(iii) Number of pieces per grapple load
(iv) Loader lift capacity
(v) Stack presentation

The self-loader studied was operated competently and efficiently by an operator who had many years of experience with self-loading trucks and cranes.

**RESULTS AND DISCUSSION**

Results of the crane loading study are presented in Table 1.

**Loader Productivity**

The results show that the average grapple load for sawlogs was approximately 15% greater than that for chip logs. The assumption that heavier logs are slower to load than small logs is reasonable since the loader system had a constant power source supplying a constant force (according to laws of physics an increase in mass will result in a corresponding decrease in acceleration). Analysis of the gross loading times however showed that sawlogs were approximately 17% faster to load than chip logs. This result is similar to that of a previous study of a hydraulic knuckleboom loader loading pulp and saw logs (Williams, 1989). The reasons for this improved productivity are:

- Less time required to accumulate a grapple load.
- Less time required to position logs on the truck/trailer.
- Less logs required to make up a truck load.
- Fewer truck repositions required when loading sawlogs.

*Table 1 - Summary of Results*

| | | *Radiata chip logs (n = 8)* | | *Radiata sawlogs (n = 8)* | |
|---|---|---|---|---|---|
| | | *Mean* | *± 95% CL** | *Mean* | *± 95% CL** |
| *Piece size* | *($m^3$)* | *.17* | *.03* | *.30* | *.04* |
| *Grapple Load* | *(kg)* | *590.0* | *99.0* | *632.0* | *38.0* |
| *No. of Pieces per Grapple* | | *3.5* | *1.2* | *2.2* | *0.9* |
| *Payload* | *(tonnes)* | *26.6* | *2.4* | *27.3* | *0.4* |
| *Truck Set-up Time* | *(min)* | *5.58* | *1.29* | *6.12* | *.98* |
| *Truck Reposition Time* | *(min)* | *2.13* | *.46* | *.19* | *.032* |
| *Net Loading Time* | *(min)* | *33.5* | *6.4* | *27.7* | *1.5* |
| *Gross Loading Time* | *(min)* | *41.2* | | *34.0* | |
| *Net Loading Productivity* | | | | | |
| *Tonnes per hour* | | *47.7* | | *59.2* | |
| *Mins per tonne* | | *1.25* | | *1.01* | |
| *Total Loading Productivity* | | | | | |
| *Tonnes per hour* | | *38.8* | | *48.2* | |
| *Mins per tonne* | | *1.54* | | *1.24* | |

**95% Confidence Limits - an indication of the variability of data around the mean.*

Crane lift capacity and productivity can be enhanced by adjusting the governor setting and increasing the pump oil flow. Exceeding the manufacturer's flow specifications however will ultimately cause excessive heat buildup, premature oil contamination, 'O' ring failure and other associated hydraulic problems.

It should be noted that daily maintenance is very important on a self-loading truck. The crane requires constant attention to ensure that cracks and particularly oil leaks do not become major causes of downtime, oil contamination and lost productivity.

## Grapple Load Size

Inspection of the crane specifications showed that at its full reach of 7.3m the crane has a lifting capacity of 1.3 tonnes.
In this study, it was estimated that the average working reach (the average distance from the base of the loader to where the grapple was accumulating logs in the stack) was between 4.5m and 5.5m. At a reach of 5m the crane has a lifting capacity of 2.0 tonnes.

From the results (Table 1) where the average grapple load for chip logs was .59 tonnes and for sawlogs was .63 tonnes, the crane was working at 30% and 35% respectively, below its rated capacity.

This result indicates that a larger grapple could be employed to improve productivity. Two factors to be considered when adding a larger grapple are:

- A larger grapple will reduce the lifting capacity of the crane.
- A larger grapple will substantially improve productivity when loading sawlogs. However, it will be more difficult to accumulate a full grapple in smaller piece size wood. This difficulty is magnified when stack presentation is poor.

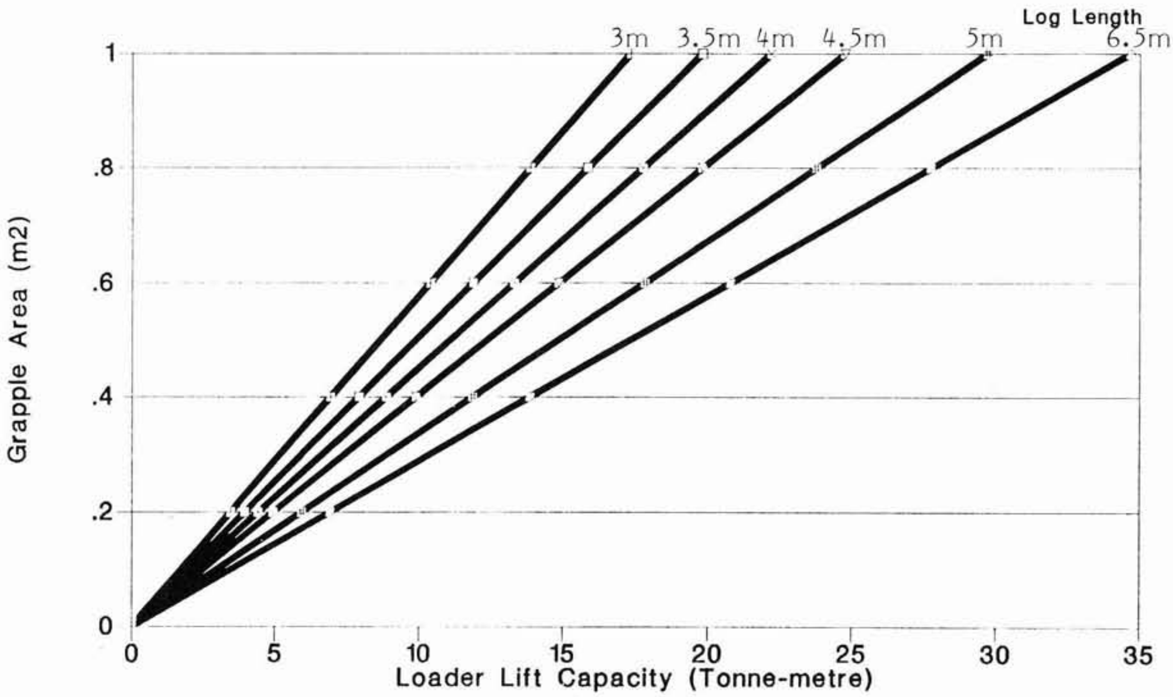


*Figure 3 - Optimum Grapple Size*

Figure 3 shows the relationship between optimum grapple size, tree length and loader lifting capacity. In calculating the values for this graph, the average distance between the crane and the stack was estimated to be 5m and the wood conversion factor used was 1.01 $m^3$/tonne. This graph could be used to determine the optimum grapple size for a given length of log hauled and crane capacity.

**Grapple Volume**

Assuming log lengths remained relatively constant for both sawlogs and chip logs, then the relationship between grapple load and grapple volume is linear. Therefore operators tended to fill the grapple to the same degree, whether loading sawlogs or chip logs each time a grab was accumulated. The measured increase in average piece size from chip logs to sawlog was approximately 42% whereas the percentage change in grapple load from chip logs to sawlogs was approximately 7%. This indicated more time spent accumulating a full grapple when loading chip logs.

**Stack Presentation**

The presentation and accessibility of the wood is critical to the success of a self loading truck operation.

Stack presentation was generally poor. The logs were both butt and head pulled to a landing where they were cut into lengths ranging from 4.2m to 8m depending on log quality. These logs were pushed into stacks using the blade of the extraction machine.

The landings utilised ranged from confined hillside landings to open paddocks. While the stacks on hillside landing were not well presented, the wood was confined to a small area enabling the truck to manoeuvre close to the stack and load without having to reposition. Where the landing is very confined or the ground conditions unsatisfactory it is possible to position the trailer off the landing and double handle the wood from the stack to the truck and from the truck to the trailer.

Where the wood had been pulled to an open paddock, the truck had to reposition at least once before loading was complete. In some cases repositioning the truck took 12% of the total loading time.

Stack presentation influences loader productivity to a greater degree for chip logs than for sawlogs.

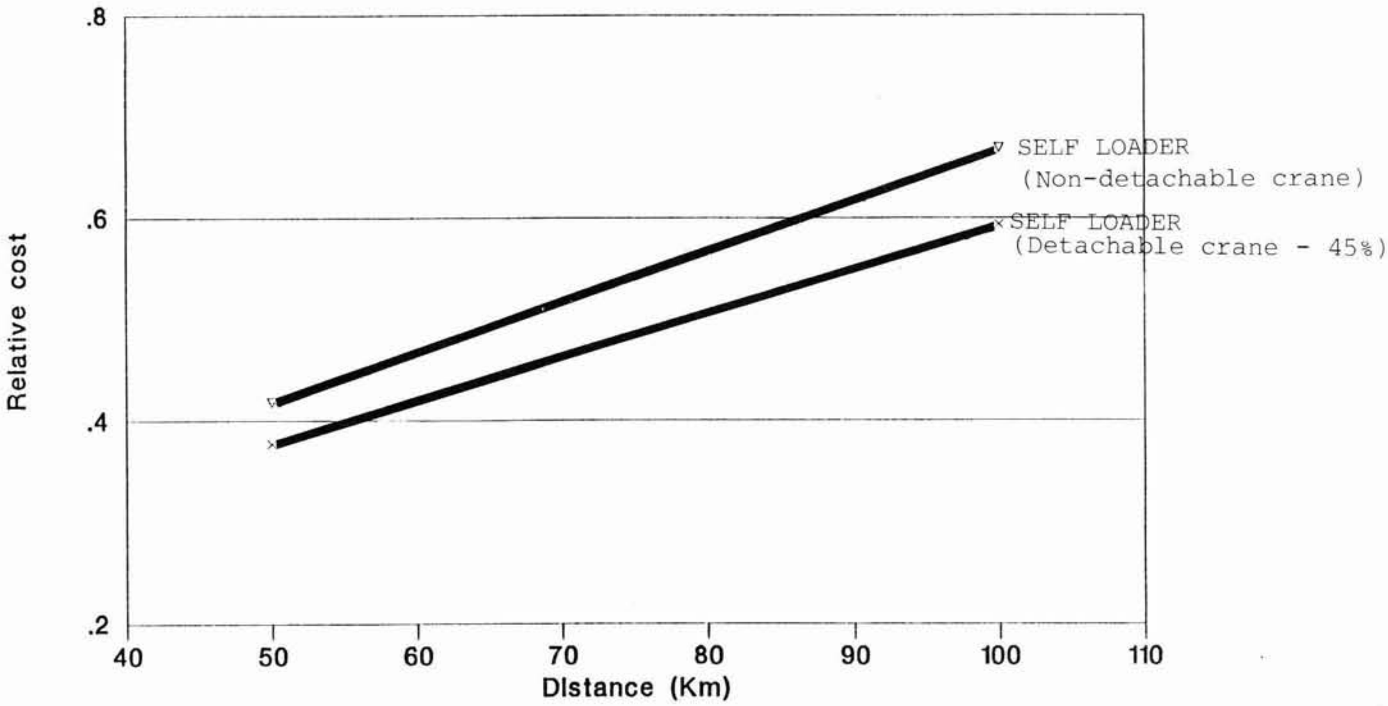


*Figure 4 - Load/Transport System Comparison*

The logs were not heeled when loaded. They could be easily rotated in the grapple while swinging from the stack to the truck. In all cases, the truck was positioned parallel to the stack and the logs were swung through $90^{\circ}$ to the truck or trailer depending on log length. Slewing angle and grapple rotation speed are more critical when loading long logs with a self-loading truck.

## COSTING COMPARISON

A loading and transport rate has been calculated using "TCOST" and compared in Figure 4.

- a self-loading truck with a detachable crane
- a self-loading truck with the crane permanently attached.

The rates calculated are based on loading and transporting logs which are approximately 6m long and approximately $0.2m^3$ in piece size. In each case the truck is an 8 x 4 and 3-axle trailer and has a total tare weight of approximately 14 tonnes without the crane. The self-loading truck with the non-detachable crane is the only unit that is not able to piggyback it's trailer. This rate comparison also assumes that the self loading truck with the detachable crane operates on highway without the crane for 45% of the time only. Repairs and maintenance, road user charges, payloads and operating costs have been calculated according to each particular system.

## CONCLUSION

The crane productivity results in this report indicate that the crane was under-utilised and working below its capacity. While it is recognised that a larger grapple would reduce the lifting capacity of the crane, this modification would significantly improve productivity particularly when loading sawlogs and to a lesser extent when loading chip logs. For maximum efficiency when loading chip logs with a large grapple, the emphasis shifts very firmly to stack presentation.

Due to its simplicity and speed, the crane detaching/attaching procedure has little to no effect on the daily productivity of the truck. This modification, which costs approximately $5,000, allows the truck to carry an extra 2.5 tonnes in payload and results in a 40% increase in transport profit over a four year period, assuming the crane is detached from the truck for approximately 45% of the on-highway time.

## REFERENCES

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