UPDATE ON OFF HIGHWAY VEHICLES

Sheldon Drummond
Juken Nissho Ltd
East Coast

INTRODUCTION

Specialist off highway trucking, has often been notioned as one probable solution for harvesting of difficult logging terrain areas. Several operations in New Zealand and offshore have tried various forms of this transport option.

Have they been successful, what were the trial conditions, are there opportunities to cut overall costs or improve environmental results with specialist trucking systems?

This paper takes a snapshot at off highway trucking operations to date and the likely applications for the future.

PURPOSE

Off highway trucks have three possible benefits to a logging industry working difficult terrain:

1. The possibility of using roads which are steeper, and of a generally lower cost. Roads can be kept to ridge tops thus avoiding the need to sidecut over unstable or wet side slopes. Conventional trucking relies on straight road for adverse grades and cornering on the near level whereas off highway rigs can provide far superior climbing ability. Off highway trucks can be used for sustained periods in soft wet riverbeds whereas conventional trucks will be expensive and unreliable in riverbeds unless the conditions are reliably dry and hard.

2. When in difficult terrain graders may be located in more optimum yarding position, rather than having to make do with the point where conventional trucks can navigate from. Thus, yarder production and environmental results may be enhanced.

3. Depending upon the truck type used, payload may be much greater than for "highway legal" trucking systems. While trials to date have concentrated on smaller trucks the option for large loads is available with possible cost benefits.

Unless the market point is within the forest (for the NZ case) off highway trucking relies on the use of transfer or central processing yards. Processing yards have their own peculiarities and set of costs which will be dealt with later in this seminar. A key factor to note when dealing with <u>off highway trucking</u> is that it <u>effects the whole logging system</u> and must therefore be evaluated as such.

EXPERIENCE TO DATE

In 1986 the Logging Industry Research Association's (LIRA, now LIRO) annual seminar included a paper entitled "The Concept of Using DJB Carriers For In Forest Transportation on Low Quality Roads". Prior to that date little work had been done on off highway trucking in NZ other than the off highway heavy load "roadtrain" concept practiced widely in the Bay of Plenty forests.

A long time ago NZ's indigenous logging industry did practice off highway trucking using 6x6 GMC and 4x4 RL Bedford rigs.

In 1986 Caterpillar Australia, who had considerable offshore experience in "non-rigid frame truck" log cartage, visited forest areas on the East Coast and worked on suitable truck designs together with the NZ Forest Service.

Major companies in the NZ Forest Industry sent representatives to three separate workshops in the East Coast area each making recommendations on different facets of logging in that area. Those workshops all identified the need to avoid cross slope roading, to yard as much as practicable uphill and to minimise the general disturbance caused by logging roads.

Using these workshop recommendations as a base, NZ Timberlands, together with the Forest Research Institute (HPG), equipment manufacturers and LIRA, all assisted in building a conceptual logging /trucking plan for the Mangatu, Tokomaru, Ruatoria area.

Early in that study period it was recognised that any off highway trucking would be expensive and should be kept to the essential areas rather than being the norm.

As study progressed it was evident that the 6x6 off highway rigs such as DJB, Moxy, Bell, etc, would have the ability to climb up and down gradients of 1 in 3, given suitable traction surfaces, with loads of up to 35 tonne. In doing so the ability of a logging system to cope with limited roading options, adverse soils, low quality gravel and generally steep country, became very favourable.

RESEARCH AND TRIALS

Given the technical practicality (on paper) of such a system and in showing reasonable indicative costings NZ Timberlands undertook a series of more definitive research projects in their East Coast forests.

These included the following:

a) Truck/tire analysis: Linked to the required gradeability, tyre sizes and tread configurations were assessed to provide ground pressure and consequential road pavement design and costings.

b) Offshore operations were contacted and although very little experience was available worldwide there were important tips received from several South East Asian operators who had tried the system.

c) Numerous construction sites in NZ where all terrain dumpers were in use, were studied. These "dumpers" form the base of the envisaged log trucks so their operating costs, gradeability, road design, etc, were all relevant. Here dumpers were typically contracted for $100/hr, moving 20 cubic metres per trip and travelling on grades of up to 1 in 2.

d) Likely road design parameters were investigated for the soft soiled East Coast forests, indicative costings followed and a number of final variables were left unsolved.

e) These variables were more particularly related to the log truck design which at that point had not been finalised. Specialist research was commissioned from FRI to produce computer based road/truck interaction models. The models compared rigid to non-rigid frame trucks in terms of their gradeability on various surfaces and their braking capacity on declines. Road strength (pavement design) was compared to the variables of payload and setting volume. Together these factors were evaluated for typical soil strengths found in the East Coast area. The computer models were built for Moxy, Bell and Caterpillar DJB truck specifications.

f) With the assistance of LIRA a series of traction co-efficient and rolling resistance tests were conducted using a Moxy dumper (6x6). Surfaces such as crushed limestone, mudstone and ash were evaluated. The results of these tests were used to support the computer models.

g) Having reached the end of the paper research a Moxy dumper was trialed at Mangatu Forest (mid winter 1988). Mangatu was due to commence logging in 2 yrs time. Here the unit was used to haul rock down soft riverbeds and to traverse a freshly formed roadway built to the computer models design strength. Cycle times for various routes were collected, from which a range of likely economic log haul distances could be assumed.

The various parameters in the computer road design model were checked against hard data and the model appeared to be valid.

h) NZ Moxy agents together with contractor L J Reedy who had assisted with research to date designed and had built a new 6x6 log unit with pole trailer (2 axle). The unit was trialed at Wharerata Forest in an existing logging operation mainly through the winter months of 1989. The unit was used to validate the previously researched concepts, over 7 month period, more particularly over the conditions for which least certain predictions could be made by the computer models.

At the Wharerata trials some interesting results arose.

RESULTS OF THE EAST COAST STUDY

One of the all terrain vehicles claim to fame has always been its gradeability. While the computer models predicted amazing gradeability on good surfaces, in practice it was found that the standard ZF transmissions would stall out with a 25 tonne payload on one in 4 grades (soft surface). These transmissions suffer severe damage if stalled for more than a moment so the payload had to be lightened and surface hardened (lower rolling resistance) for steeper grades.

Where surfaces were hard and grades adverse, the 260 HP off highway truck was found to be much slower than the conventional 350 - 450 HP highway rig. The HP of the vehicles trialed (standard 20 tonne Moxy, Bell type) showed lower productions on anything but near flat or favourable grades.

Road surfaces particularly in

sharper corners deteriorated more rapidly than under conventional trucking but the off highway rig was able to continue pulling through amazingly poor conditions. Deep mud ruts in many cases would not stop the vehicle from carting but once the road began to deteriorate it rapidly lost strength.

In short, other than for temporary summer operations, road surfaces must be kept in good order and road maintenance costs are at least equal to that required for conventional trucking.

Tyres on both the 6x6 truck and the trailer wore out in 2/3 the time normally expected. This can be attributed to the overall weight of the unit, the long pole trailers side pulling forces and the windy roads used for the trial.

Offshore experience suggested that the units were top heavy and subject to frequent tipping. This was not our experience, in fact the unit proved to be very stable. Perhaps this is a result of the standard of roading used at the East Coast trials.

During periods where roads were in poor conditions access for workers diesel etc to the yarder were difficult. However, as explained earlier, it was soon evident that road surfaces needed to be kept in good order to avoid high maintenance costs or eventual production stoppages.

When using the specialist off highway system reliability is reliant upon at least two extra machines. That is, the off highway truck and the transfer loader. When designing a system it is desirable to have sufficient volume to warrant at least two of each machine. With only one of each machine, reliability during the trial was limited, yarder productivity marketing, etc, were therefore at risk.

Economic gains in the off highway trucking system are certainly not obvious. The Wharerata trial work identified numerous operational and economic details which can be applied to the more difficult host country stretching north from Gisborne. To specify costs above or below the conventional roading/trucking style is impractical as every lead, road type, and indeed the whole system has its own peculiarities.

The following recommendations / results however are clear for planning purposes.

a) Breakeven analysis is required to determine the optimum haul distance by off highway rigs for any given forest area. Gravel costs and gradients are the key considerations. Provided the gradients are near flat or favourable the off highway rigs will cart at least as fast as the conventional trucks.

b) The operating cost for the off highway rigs trialed is at least 25% higher than conventional trucks, average payload is similar depending upon gradients.

c) While the trucking costs are more expensive (25%) the road gravel costs were definitely lower. How much

lower is entirely dependent upon the soil CBR volume to be carried along the route and gravel costs. Typically for a forest like Mangatu, average haul (non arterial) road costs would be 60-70% of the norm.

d) The East Coast trials showed that for a properly designed road base, maintenance costs were in the order of 150% of what was typically expected for highway trucking. This may be improved with trailer (jinker) design but the inherent artic 6x6 nature of the tractor unit is tough on road surfaces.

e) The 25 tonne payload trucks are not suited to long uphill leads. As a rule of thumb, uphill gradients of 1 in 4.5 are okay for a distance of up to 200 m. A higher horse powered truck with similar payload would be more economic on uphill leads. Gradients of 1 in 10 or more slow the off highway rigs to a speed where they no longer compete with conventional more powerful trucks.

f) The possible roadline locations available to off highway rigs are undoubtedly a major benefit to the environment. Yarders can be positioned where more deflection will protect topsoils, roads can be kept away from side slopes, less soil needs to be moved overall. Road alignment (rather than gradient) must still be designed to cater for the yarder travel within the forests. Shorter roads are therefore possible, using the steeper gradients over short distances, for the off highway rigs.

In areas where side slope roading is at risk of slipping, maintenance costs of the steeper ridgetop roads will be far less. The costs of earthflow disturbance through side slope roading can not be under estimated. In pine forests, unstable type lands are at their highest risk of slippage (be it surface or deep seated) from years 1.5 to 5 (from clearfell date). At 1.5 years from clearfell most of the stump root strength is gone, at 5 years from clearfell the new trees have both significant rooting and canopy closure to reprotect the soils. If conventional roading techniques and poor yarder location lead to unsatisfactory soil damage in the longer term this type of country may become subject to unwarranted environmental pressures or even exclusion from harvest in the more sensitive areas.

FUTURE SYSTEM USE IN NZ

As well as the trials designed to investigate suitability in the unstable East Coast soils, other trials with 6x6 Bell dump trucks (modified to haul short logs) were carried out in the sands at Woodhill and granites of NW Nelson.

The two factors presenting a need for off highway all terrain type log carriers are soils (environmental) and gravel costs. Experience to date shows that savings in road costs alone do not pay for the additional costs of operating this system.

For the off highway trucking system to operate well it

should be limited to areas where the environment dictates a less disturbing result than conventional roading will provide.

Transfer yards or log manufacturing yards are an integral part of the off highway trucking system described. An off highway rig that can travel at speed on highway would be of advantage.

Experience at Wharerata Forest (1989/90) showed that given proper road design conventional trucks can climb from the landing on gradients of 1 in 5.5. Offshore experience (Oregon USA) of one operator in particular has demonstrated the attributes of Central Tyre Inflation (CTI) for savings in road gravel and greater gradeability.

It is unlikely that off highway rigs will find a place in the high yield per hectare pine forest industry excepting those areas where the environment dictates a better roading system. Greater effort in road design and CIT will meet some of the performances offered by off highway trucking as trialed to date with lower costs and a less complicated overall system.