Session 4
Paper (d)

FRAME GROUP

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COMPUTER AIDED ROAD DESIGN

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1. HISTORY

To begin this lecture I thought that I might show a photograph of early New Zealand settlers hauling a 3 metre diameter Kauri log with oxen along an evenly graded track or wooden railway and tell you that they were the first logging road designers in New Zealand.

However I thought a little more and recalled we are told that Captain Cook and /or Abel Tasman used New Zealand timber as replacement spars on their sailing vessels. They certainly must have known some thing about the carriage of tree length logs to their point of export!

But delving even further back the Maori was a renowned military engineer well before European contact and evidence of their construction of trenches, tunnels and palisades abounds. To construct these palisades the early Maori logging engineers must have devised methods of felling the trees and transporting them uphill to the construction site. Easy answer you may say the palisades were constructed of very small logs.

On the other hand when it was decided that a new canoe was required a large tree was taken from the forest and transported to the waters edge.

These early logging engineers must have had some concept of roadway curves and grades to determine the shortest or easiest route to where their logs were used.

2. Why Design Logging Roads.

All logging roads are designed. The design may be carried out in a formal manner with plans drawn and calculations made, or perhaps someone has taken a few abney shots. Even when the dozer operator is pointed in the right direction and told to carry on some concept of what the final result will be rests in somebody's mind.

These types of design techniques certainly each have their place and will likely be used for many years to come.

However with the advent of the Resource Management Act and the growing knowledge, sophistication and power of those granting Resource Consents the design which exists in the operators mind is becoming or has already become unacceptable.

Many and probably all Resource Consent applications require a statement detailing the amount of soil that will be shifted in a logging roading operation. In most District Schemes the movement of more than one hundred cubic metres of soil requires a consent.

Those people granting consents need to know where excess fill, if any, is to be disposed of and where borrowed material will come from.

To be able to answer these queries and to maintain a reputation as an environmentally concerned corporation, company, owner or manager, more formal design of logging roads will be necessary in the future.

Another reason for designing forestry roads and determining the volume of material to be shifted relates to the common use of hiring plant on an hourly basis for road construction. Whether this is the most economical method of construction is difficult to determine. Up to the present it has been costly and taken too long to calculate volumes of spoil to be shifted with any variations in the design requiring a disproportionate amount of time and effort to recalculate the volumes. A computer package can do in a matter of minutes work that would take a draughtsman or designer days or weeks. Thus, as with most computer programmes, a greater amount of information is available much more readily.

The design provides information for cost estimates, project scheduling and equipment requirements.

3. Design Procedure

Good road design begins with good data acquisition.

Data is collected from sources such as field surveys, Forest maps, Topographical Maps and Geographic Information Systems. Some of these, although appearing otherwise, may not have sufficient accuracy to enable a satisfactory design to be carried out. The traditional 1:10,000 forest map may well be one of these. GIS may provide good data in an easily manipulated form but once again the accuracy of the original information installed must be determined.

Field surveys can be carried out by the simple abney, tape and compass method through to modern methods using hand held laser rangefinders complete with data logging systems.

The choice of survey method is directly related to the required accuracy of the final plans. Road design systems whether by computer or drawing and calculation cannot be more accurate than the original data supplied.

4. Features of Computer Aided Forest Road Design Packages

- It is desirable and almost essential that a Computer aided forest road design package run on existing computer hardware. Most forest offices have IBM™ compatible equipment operating Microsoft DOS™.

- Systems that operate in the WINDOWS™ environment provide ease

of operation and rapid skill acquisition.

- Compatibility with a wide range of plotters, dot matrix and laser printers and digitisers is worthwhile so that extra equipment does not have to be obtained to run the system.

- Some systems are available with Tutorials, Training and telephone or on site support. Obviously these are preferable to a system that has none of these.

- A wide user base and regular upgrading and development with the addition of new features.

- Ability to receive information from data loggers.

5. What the System Does Not Need.

For use in forest roading some of the products directed to the highway authority and the local authority market include features that are superfluous to the forestry requirements. Typical of these features are kerb and channel design, underground water and electricity services.

There is no profitability in purchasing features which are rarely or never used.

6. Systems Available

I have been investigating computer based road design packages suitable for use in the forest industry for a number of years and have identified several that are worth investigation by a prospective purchaser.

Of these only three have been written especially for the forest environment.

One of these is a New Zealand Product developed several years ago and has been outclassed by more modern products.

Another comes from the USA and has many good points but is yet to be metricated.

The third was developed in Canada and is now used by over 150 forestry organisations around the world with 5 copies being used in New Zealand, two of these by major forest companies. This product is **ROADENG**™ developed by SOFTREE Technical Systems Limited of Vancouver,Canada.

7. ROADENG FEATURES

ROADENG was designed after consultation with forest managers and engineers to determine their requirements.

To make the software easy to use it operates in Microsoft Windows™ on an IBM386 or 486 compatible system.

It requires 4 Megabytes of RAM and a hard drive.

ROADENG is compatible with most printers and plotters including dot matrix and laser printers and supports a variety of digitisers.

The system consists of five modules which include field note entry, map generation, digitising, terrain modelling, contouring, road design and cable logging analysis.

The **Survey Notes** module simulates the field note book and block boundaries, roads, ground profiles ad other survey features can be entered and saved. Once entered traverses can be displayed and analysed for a variety of purposes. For example, contour maps can be generated, yarding profiles can be analysed or detailed road design can be carried out.

The **Map View** module allows the creation an display of a network of traverses. It is commonly used to plot setting or location maps. The user creates a map by specifying a list of traverses.

The **Terrain** module provides facilities for assembling and manipulating topographic and other map features. Information can be entered from a paper map using a digitising tablet, from the Survey Notes module, or imported from an external co-ordinate file. Examples of the use of this information include generation of contours from field notes, digitising yarding profiles and creation of road profiles with side slopes from total station surveys.

The **Cable Analysis** module provides functions for analysing cable harvesting systems and was designed to simulate most common logging systems. Different types of equipment and rigging configurations can be rapidly evaluated for a series of profiles. Options allow the designer to analyse clearance, line tensions and payload.

The **Location Design** module allows the user to interactively design a road. Cross sections grades, vertical and horizontal curves, slope stakes and earthwork quantities can be calculated instantly and after any desired changes recalculated again just as quickly. This enables optimum designs with balanced volumes to be determined. Data for setting out can be selected and printed out in the report form most suitable to the users requirements.

7. FUTURE DEVELOPMENTS

Version two of ROADENG has been announced and will be released later this year. Enhancements include ;

- Entry of side shots from centreline out or point to point
- Increased number of side shots
- Cross section display in Survey Notes
- Interfaces to various handheld data collectors
- Print previews

- Automatic output of cross sections

8. CONCLUSION .

Computer Aided road design systems allow rapid calculations and drawings to be produced and allow many more options to be considered.

The optimal design of forest roads is best achieved by experienced technologists who can incorporate many years of field experience into a design.

Computer systems will not replace this expertise, but they can assist both experienced and novice designers improve their design work . The computer should be considered a "tool" in the efficient design of forest roads.