LOGGING INDUSTRY RESEARCH ASSOCIATION
NEW ZEALAND

PROJECT REPORT

JUBILEE SCHOLARSHIP

A STUDY TOUR TO THE 4TH INTERNATIONAL LOW VOLUME ROADS CONFERENCE AND ROADING FIELD OPERATIONS 1988

D. ROBINSON

Project Report
P.R.36

New Zealand Logging Industry Research Association Inc
P O Box 147
ROTORUA
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SUMMARY

The oportunity to view Roading planning, design, construction and maintenance techniques as practiced in North America has been of value to the logging industry. Also, the oportunity to present a paper at the Fourth International Low Volume Roads Conference was of great personal benefit and contacts made will be of value to the industry for some time.

The key points to note from this report are -

1. New Zealand roading practices in the low volume road area are generally as good as in North America. However in the forestry area, in particular, New Zealand can gain considerable benefit by maintaining links with American and Canadian practitioners and taking advantage of the considerable volume of research which they are undertaking in areas which are of interest and which could produce immediate benefits to the New Zealand industry. These links are of added impotance in getting the best advantage from New Zealands limited roading research budget.

2. We can learn from various North American agencies, the ways and means of handling emotive environmental presure groups.

3. The extent of New Zealands present forest roading program doesn't warrant a major move into computerised road design. We should however, be gradually preparing for the needs of the next few years which may be significantly different from those of the present. The increasing use of personal computers in the roading area is a forgone conclusion and we can gain some benefit by maintaining a close watch on North American developments, particularly in the road management area. More professional engineering input, particularly in the New Zealand forestry education field, will help in avoiding major roading and transportation difficulties in the future.

4. Roading planning in New Zealands forest industry is not as developed or as well carried out as it is in North America. In New Zealand professional involvement in forestry roading is low and this is reflected in the standard of planning, design, contract, construction, maintenance and management. We have been able to get by with this standard in the past because the major timber harvesting has been on easy country where roading and transportation is not a major cost. The scale of many operations is much larger in North America and the lessons they have learned are in many instances directly applicable to New Zealands upcoming conditions provided care and a professional engineering approach is used to account for differences of scale and other factors.

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ACKNOWLEDGEMENTS

I wish to thank New Zealand Forest Products Ltd. for awarding me a JUBILEE SCHOLARSHIP which substantially financed the travel involved in this tour.

I also wish to thank both the Board of the N.Z. Logging Industry Research Association, and the Director and staff for their support and assistance.

While the study tour was of great personal benefit it will also be of benefit to LIRA and the New Zealand Logging Industry. By helping in the more rapid transfer of technology and techniques, able to be used in New Zealand, the industry can benefit from North America's experience.

INTRODUCTION

Objectives of the study tour

Fourth International Low Volume Roads Conference

The objectives in attending this conference were :-

1. To present a paper entitled "Road maintenance costs and research directions - Low volume logging roads in New Zealand".

2. To make contact with overseas practitioners working in a similar field to myself, and in particular, to make contact with US Forest Service Engineers who were expected to be a major force at the conference.

3. To ascertain the type of forest roading research being conducted overseas in order to avoid duplicating effort with New Zealand's limited logging road research budget.

The Pacific North West Area of the U.S.A.

The objectives in this area were to:-

1. View planning and construction techniques for steep unstable ground.

2. Study construction techniques in hard rock.

New Brunswick area of Canada

The objectives in this area were to:-

1. Assess the applicability of geotextile work being undertaken at the University of New Brunswick.

2. View and discuss the Technology Transfer program at U.N.B.

Blacksburg, Virginia area of the U.S.A.

The objectives in this area were to:-

1. Compare practice with the PNW area of the U S A.

2. View roading practice in a plantation environment.

General

Along with the above specific objectives it was my intention to view and discuss:-

1. Road planning, design, and construction in general.

2. The use of personal computers in the roading field.

3. Other techniques which could have a place in forest roading in New Zealand.

FOURTH INTERNATIONAL LOW VOLUME ROADS CONFERENCE

Background to the Conference

The International Low Volume Roads Conference is a quadrennial series of conferences which began in 1975. The conference aim is to examine new technologies and new techniques in the management,

Figure 1 : The beautiful buildings and grounds at Cornell University, Ithaca, New York State.

design, construction and operation of low volume roads. Conducted by the Transportation Research Board and hosted by Cornell University's Local Roads Program on campus at Ithaca,New York, the conference provides a forum for engineers, planners, administrators and economists to exchange views and explore the benefits of recent research dealing with low volume roads. The conference was sponsored by the U S Federal Highway Administration, the U S Forest Service, and the U S Department of Agriculture Office of Transportation.

It will probably come as no surprise to those in the New Zealand forest industry that the USDA Forest Service is responsible for 174 national forests covering about 85 million hectares. This area is served by 550,000 km of roads used for logging, recreation, and tourist traffic.

<u>Particular emphasis at this conference</u>

The Third International Conference identified the following inter-related high priority needs:-

1. More effective methods of correlating and disseminating technical and management information.

2. Program management systems to aid in the designing, constructing, and managing of low-volume roads and to provide information that can be used in justifying appropriate funding levels, and in establishing engineering standards.

3. A greater understanding of the mechanisms of damage to low volume roads.

4. Characterisation of marginal or substandard or unconventional materials, and the documentation of their use in low volume roads.

These concerns were used as the basis for planning the 4th conference.

Three hundred people registered for the conference representing 27 different countries.

The opening Keynote address "Communications, Information and Technology Transfer for Low Volume Roads" was given by John B Metcalf, Deputy Director, Australian Road Research Board. Although a majority of the 77 papers presented at the conference addressed the technical aspects of design construction and maintenance of low volume roads, there was a special session, "Mechanisms, techniques, and assessment of technology transfer", at which invited speakers addressed the topic.

__Areas covered at this conference.__

The papers and discussion at this conference covered the whole spectrum of low volume roading. In order to keep this easily readable I have included full titles of papers in Appendix A. As noted above particular emphasis was placed on Technology Transfer but, the technical session headings of:-

- Administration and management
- Non standard materials
- Heavy hauling and road limits
- Asphalt seals and light pavements
- Pavement and surface course design and management
- Geometric and operational considerations
- Heavy hauling: A challenge for low volume road managers
- Low water crossings
- Development of standards and specifications
- Roadway management
- Vehicle and traffic operations and costs
- Mechanisms, techniques and assessment of technology transfer
- Bridges
- Cold recycling of asphalt pavements
- Maintenance management

give a good indication of the scope and intensity of the conference. Unfortunately, because of the need to have two or three sessions in progress at one time, I was unable to attend some sessions that were of interest, but were not my top priority.

The conference was very well run and organised but I was disappointed at the quality of presentation of some well known and authoritative speakers. Symposiums and Seminars I have attended in New Zealand have been run as well and the general standard of presentation is better. Of course, the technical content of many papers would not be matched, at least in the low volume roads area, within New Zealand.

Registrants were provided with two volumes of proceedings covering the areas mentioned above. These proceedings are held in LIRA's library and are available for loan to members.

__Field visits during the conference.__

A field trip was made to small roading operations during the conference, and in the few days immediately following. When compared to New Zealand practice there are many similarities. The major differences are the harsh winter climate and freeze/thaw problems not generally experienced in New Zealand, and the relatively homogeneous nature of soil condition within any given geographic area. This advantage is seldom seen in New Zealands rugged and changing topography.

__Bridging.__

The standard of construction varied quite markedly from area to area and some practices were noted which would have been quite unacceptable in New Zealand. Environmental restrictions which prohibited the use of Pentachlorophenol pressure treated timber in one bridge did not seem to stop the use of creosote. If the amount of creosote in the stream bed was an indication of

Figure 2 : An unusual covered bridge, Newfield, New York. Built in 1853 and restored in 1972. This bridge has wooden nails and is in daily use on a public road.

the care in its application then I would have preferred pressure treatment and minor leaching rather than the major spills which were observed from the creosote application.

The USA has 580,000 bridges of which about 40% have either a structural or functional deficiency (on the basis of their long term suitability to carry present day traffic and loads). Of this number about 80% carry fewer than 100 vehicles per day in rural areas. These figures show why there is a major thrust to replace bridges and as the existing ones are largely timber there is a trend to use this same material in the replacement program.

The general standard of workmanship in the bridges I saw was mediocre. The design standards varied markedly from area to area and I was left with the impression that our New Zealand bridge and construction standards were superior to those in the US, at least at County Council level. This is due to our small size and centralised roading funding and administration. Perhaps there is a warning here as we decentralise government control.

<u>*Roading.*</u>

The problems in funding roading in rural America are similar to those in New Zealand. Unlike our perception from television, America is not composed entirely of freeways and asphalt roads but has a large mileage of unsealed or chipsealed roadways carrying a relatively small volume of traffic. The chip sealing that I saw was generally not to the standard we expect in New Zealand but again the climate is not comparable and a direct comparison without accounting for this factor is unfair. Bitumen is much cheaper than in New Zealand and from my observations, as the use of chip seals on major roads is not common, the typical New Zealand chip seal roadway is at a higher level of development than in the US.

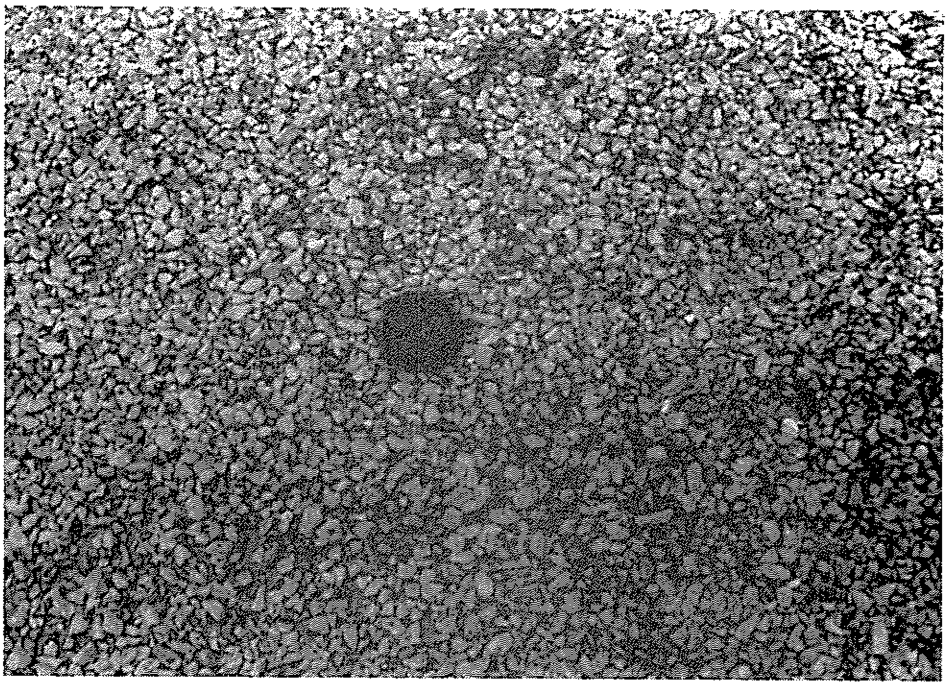

Figure 3 : An example of an American county chip sealing

Traffic.

The traffic behaviour on American roads was a pleasure to observe. Driving habits are much less aggressive and speed limits, road rules and common good manners are observed. A common sight is a four way give-way cross road intersection at which the first car to arrive has right of way. My mind boggles at the ability of some New Zealand drivers to cope with such an affront as having to give way to the first vehicle to arrive at one of these intersections.

Machinery.

Road construction machinery and vehicles seemed similar to those which are used in New Zealand, with the most obvious difference being the need to cope with snow during the winter months.

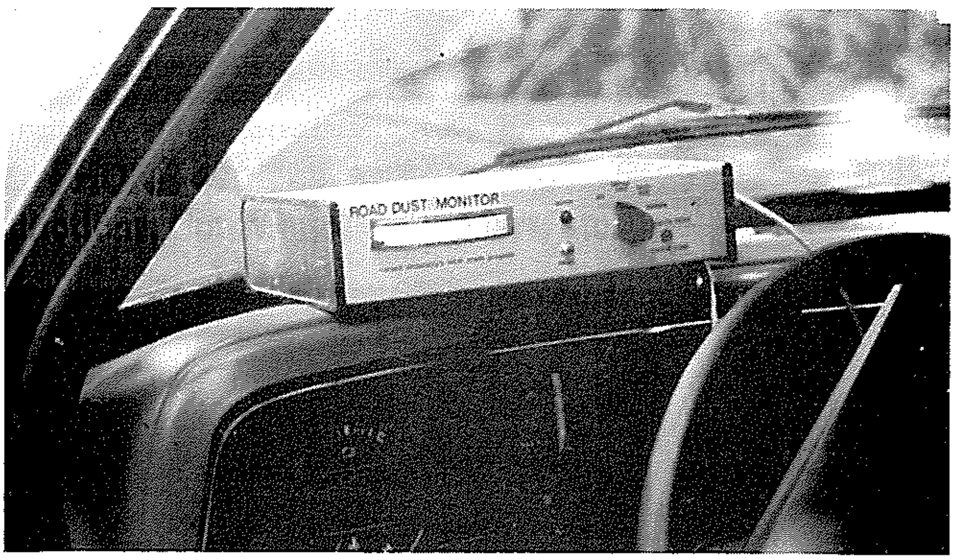

Figure 4 : The road dust monitor readout in a pickup truck cab.

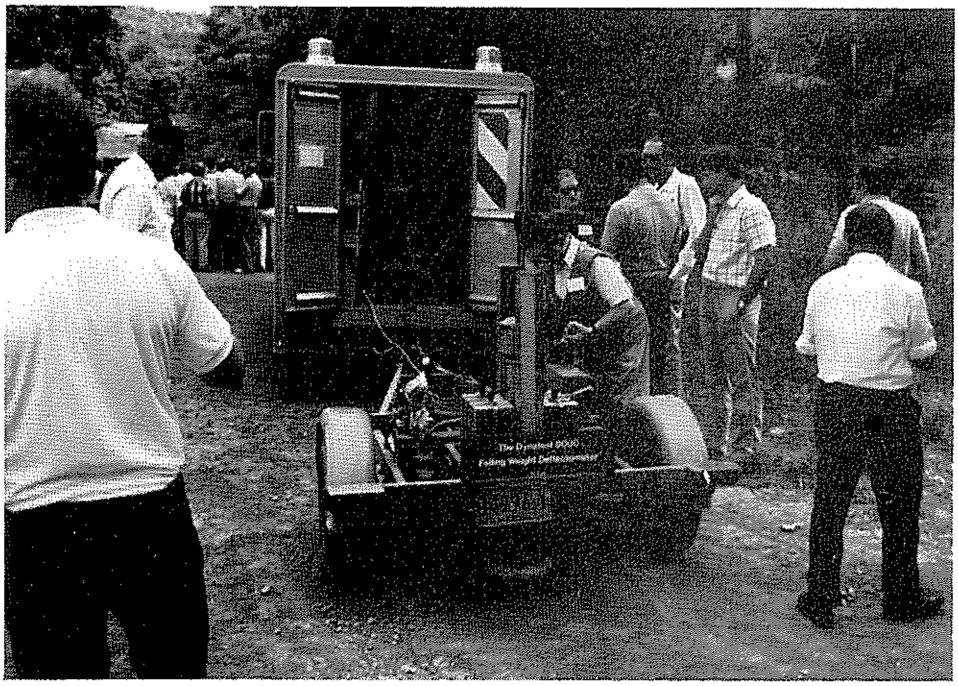

Figure 5 : A falling weight deflectometer in use during the conference field trip. This machine is used to test (measure) pavement strength (or deterioration in strength).

Supervision.

I had insufficient time to observe the levels or competence of typical roading supervisors during the conference field trips.

Conference benefits to the New Zealand logging industry.

Road dustiness measurement

The New Zealand National Roads Board and the Logging Industry Research Association are interested in monitoring road dust. The Baigent unsealed road trial in Nelson is having dust measurements taken and the method being used, while the best that could be devised, is best described as a "pain"! For this reason the Road Dust Monitor on display at this conference was of great interest.

Priced at about US $2000 it is light and easily fitted to standard American 1/2 ton trucks. It is very quick to use, and gives quantitative results on a cab mounted meter readout. The method in current use in New Zealand requires dust collection samples to be analysed in Wellington with delays of many weeks being common. This Road Dust Monitor provides an opportunity to take advantage of the extensive development costs, in both time and money, being borne by a much larger market than New Zealand could provide. Full details of this meter and explanatory notes can be found in Appendix D

Technology transfer

As previously mentioned Technology Transfer (T2) was given some prominence at this Conference. The Federal Highway Administration instigated, and has been active in, the Technology Transfer Program for Local Transportation Agencies, since 1981.

The objectives of the program are to:-

1. Establish or improve the system for transferring technology to local transportation agencies

2. Improve communications regarding transportation technology among Federal, State and Local authorities and universities.

3. Encourage implementation of effective procedures and technology at a local level.

4. Synthesize experiences of T2 centres to serve as models for other states.

The initial program established T2 centres in 10 states at various colleges and universities to provide the following services:-

1. Publish a quarterly newsletter

2. Furnish technology transfer materials

3. Provide technical information

4. Conduct seminars and/or training sessions

An evaluation report published in 1985 shows that:-

1. The centres were achieving or exceeding the minimum requirements.

2. Requests for technical information and materials do not cover the full range of available material.

3. The greatest need was by non professional persons who do not tend toward being members of technical and professional organisations.

4. It is difficult to measure the effectiveness of the T2 program in a quantitative manner.

5. There is still much to be learned about the T2 process.

Training material

During the recesses of the conference considerable training material was demonstrated and a number of publications were obtained outlining the available material. This material is almost exclusively produced by one or other of the technology transfer organisations and a brief listing of the major items is given in Appendix B. This information is kept at LIRA in a Project box.

Automated road design methods.

During the conference recess demonstrations of road design software showed how prevalent this has now become in the US. The three systems on display ranged from simple to moderately complex. They were running (respectively) on a Hewlett Packard HP41c(hand calculator), an XT style Personal Computer or an AT style Personal Computer. As I saw other systems during my study tour I have considered them together under 7.1

ROAD PLANNING

General.

Road planning in the USA and Canada is given much more emphasis than in New Zealand. This could be due to a number of reasons but to me it seemed that the reasons are -

Environmental.

The environmental pressure groups are very active in North America. This pressure ensures that planning is comprehensive. Roading has to be well constructed particularly when public money is being spent and as it is well understood that a well planned road has more chance of being constructed well than a poorly planned one. Environmental pressure groups were conducting a major public relations campaign and information (misinformation) blitz which seemed to be designed to deprive the Forest service of its roading funding. The basis of their argument seemed to be that the USFS roading program was wasteful, irresponsible and environmentally unsound.

Figure 6 : The caption on the rear of this photograph reads:- "U.S.Forest Service bureaucrats want to carve 1,500 miles of new logging roads through Beaverhead National Forest in Montana"

In circumstances such as this logic and common sense seem to be the first casualties, but one positive aspect is that the roading planning seemed to be well executed by competent practitioners.

Economic

In North America there was an awareness of the need for roading to be considered in light of all the factors affecting or affected by it. It is evident in some areas that this awareness is carried to extremes and becomes an end in itself. It is also apparrent in some areas, that considering all factors has had an effect on both road gradients and width, the two major factors affecting costs. There is current research being undertaken on various aspects of steep road design and performance, principally by the US Forest Service.

Climate

Because in general the North American climate in forested areas is much more harsh than that in New Zealand the necessity for good road planning is not only desirable, but essential, if the road is going to be constructed at all in suitable weather conditions.

Unlike the situation in most of New Zealand, roads simply cannot be built if they are not done in the correct weather conditions at the most suitable time of the year. In New Zealand because of the mild climate roads can be built almost all year round, although at a greater cost, and with a greater performance penalty, when constructed in unfavourable weather conditions. This is simply not the case in most areas of the USA and Canada, and road construction is generally performed at optimal timing for both least cost and best road performance.

New Zealand. Although in the manual case it is easy to convert between systems, the use of this system without any other alternatives, in any software package, would make it unusable in this country. Most of the software packages I saw in operation, had provision for the common 360 degree azimuth system used in New Zealand.

2. <u>Distance Measurement.</u>

The use of imperial feet predominates in the USA. The metric system is in use in Canada and the packages I saw allowed for both measuring systems as an option, during the initial program setup stage. The common usage of a station plus increment terminology is different to the NZ way of simply referring to distance but the differences are quite minor and no competent person would find any difficulty in using the American system if need be. (eg. American system to express 4500 meters is 4 + 500)

3. <u>Cross sections.</u>

In this area the American practice seems to be more varied than is the case in New Zealand. They commonly use slope and distance, as well as level and distance. The major difference comes in the regional habits of starting at the outer edge of the section when entering information into some software packages, rather than our method of "centre out" for the leftside and then "centre out" for the right side directions.

Survey instruments.

The use of the Transit is still common. This old style instrument has not seen much favour in New Zealand in recent years. It does have some advantages for simple work in clean conditions and is easy to adjust in the field by those with the requisite knowledge and skill. The new style Total Station theodolite in which the horizontal and vertical angles may be recorded to a memory module, and in which there is also an Electronic distance measuring device, also automatically recording to memory, are readily available and in common use. The use of total station instruments is increasing and the advantages of these when used in conjunction with automatic downloading to personal computers and the reduction of field observations in these computers, can lead to remarkable increases in survey efficiency and a corresponding decrease in cost. As in many cases of improved technology, the anticipated cost reduction by using sophisticated instruments is difficult to achieve because, instead of the reduced time becoming immediately available as a cost saving, it is used to more fully analyse the available options. This trend is also evident in the use of personal computers and many other "time saving" instruments.

Group conflicts

It was interesting to observe while in North America that there is some conflict between Foresters and Engineers, particularly, although not confined to, the USFS.

Road design.

Geometric design.

During this study tour I saw many manuals and publications on the geometrics of road design. The availability of these publications is such that no particular effort was made to collect or order them. They all cover a similar theme of road geometrics such as sight distance, stopping distance and curve geometry which is well understood. In those areas of particular interest to the forest industry such as truck off-tracking on curves, the availability of publications is good. LIRA keeps a close eye on these sorts of publications and they should always be reasonably easily available.

The use of the 3D facilities in some geographic information systems can be used to check road geometry problems and the availability of road alignment draping over a 3D model provides much scope for the reduction of the visual impact of forest roading. The assessment of road geometry and the visual appearance of a road on the landscape at the design stage can have significant benefits for designers. I would expect the use of these sorts of techniques to become common as we come under more and more pressure from groups outside the industry.

There is a definite trend in North America to use steeper grades, as normal practice, on their roads than is the case in New Zealand. In particular steep grades are used to avoid unstable ground, sideslope roading when steeper ridge roads will do, and in other cases when the disadvantages of the steeper grades are outweighed by the advantage to be gained in being more liberal about gradients than many standards recommend. Obviously the use of very steep grades is controlled by legislation as it is in New Zealand, but the attitude toward using these grades is more liberal. The use of steep grades is controlled by the available braking on trucks when travelling downhill, and the available traction when going uphill. Some standards may be required for runouts if steep roads become common.

Structural

There are as many manuals on the structural design of pavements as there are on geometric design. In the forestry area which is characterised by a predominance of high axle loads and low volume and low cost roads the traditional theories do not necessarily work and are likely lead to conservative design in many cases. The nature of road failure, and the risk, or lack of risk, associated with them in the forestry area, is not a subject area handled well by main highway road design methods.

Figure 8 : Loads like this call for sound design methods.
A truck at Millinocket, Maine, USA.

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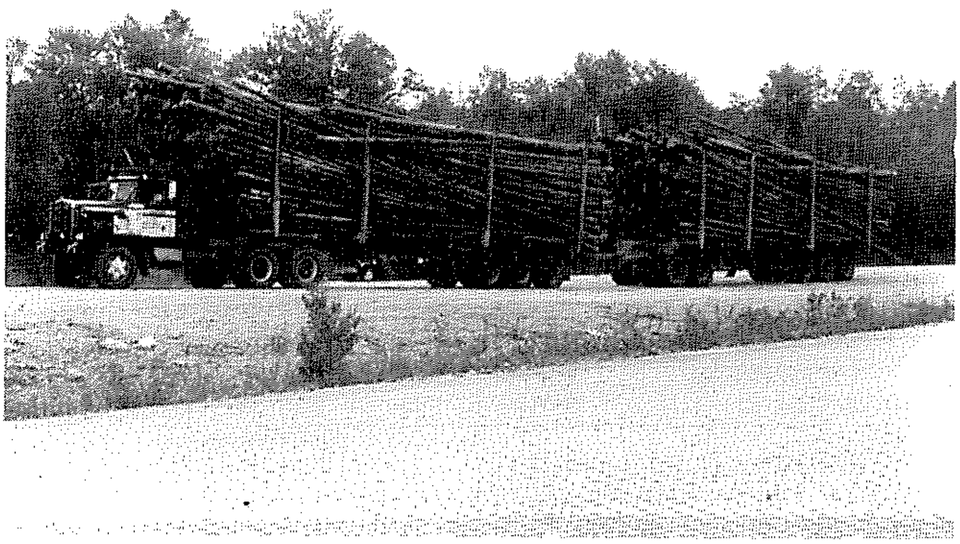

Figure 8 : Loads like this call for sound design methods.
A truck at Millinocket, Maine, USA.

Some new road design methods depend very much on accurate inventory and pavement management criteria and this is an area of major research and development. The easy availability of computer data base systems helps this approach. Some caution in this area is warranted as in one instance that I observed the reliance on specialised systems had caused considerable waste as the inventory process was being carried out for the third time. The use of a well understood and easy file storage system for the information would have prevented this trouble by enabling the data to be transferred as the computer system changed over time. We would do well to head the overseas experience in this area as well as the geographic information system data area. We should ensure that the systems we adopt in New Zealand have easily transportable data that will be useable in the systems of the future. Although no one can predict with certainty the future system configurations, the data style and storage mode can be made easily transportable.

The cost of this transportability may be some reduction in speed in the operation of the present systems but the economic trade offs are easily calculated.

Although there are some rational pavement design methods available, and being used, in forest roading, the final word on the application of the roading aggregate and the depth to which it is applied is in the hands of the field supervisor. It is common in North America, as in New Zealand, for the field supervisor to feel he knows as much about the aggregate depth requirement as the designer and act accordingly. Although this is not a design problem as such it is a problem if the design is not being followed. It was expressed to me on more than one occasion that the design was not being followed in the field because the field supervisor felt he knew best what was required.

Aggregate specification

The trend in thinking amongst experienced unsealed roading practitioners in New Zealand is toward an aggregate specification favouring the inclusion of some fines to bind the road surface and provide some resistance to ravelling. Although there are indications in North America that some consider this a sensible move there is a conflicting requirement to prevent the use of any clay size fines at all in roading aggregate. The reason behind this no clay size fines requirement is that the environmental pressure is so great that any fines at all washed off the road and finding its way into any water course is unacceptable. For this reason some specifications that I saw were definitely sub optimal in the fines area for use on unsealed roads. It is also my view that going to such lengths to prevent fines ingress to water courses has no place in the New Zealand scene. Clay size fines content in roading aggregates need only be in the order of a few percent to be effective and it may well be that the fines content would prohibit the easy movement of fine particles by binding the roading aggregate together and prevent its water borne transport in all but the most extreme conditions.

Inventory and Pavement management systems

In their general form Pavement Management and design systems are a computer based model which uses a large data base of information on the design, performance under traffic and the cost of building and maintaining roads. The analysis of this information enables strategies for maintenance upgrading and reconstruction to be considered before the maintenance or construction takes place. One such program in use on a trial basis by the USFS is SDMS (Surfacing and Design Management System). It is a computer program that calculates and maximises the surfacing design and rehabilitation strategies using information on:-

- construction materials
- expected traffic volume
- vehicle loads
- costs
- required surfacing performance
- materials characteristics

This automated system offers the road designer several advantages over traditional methods. Rather than using complex calculations which tend to become an end in themselves, the designer is free to concentrate on optimum strategies and consider the economic trade offs over a large number of different combinations. Many more factors such as seasonal variations in materials and traffic volume and loadings can be considered in a computer model than can be considered in the manual calculations.

By increasing the ability to predict the performance of a pavement this system provides an invaluable planning and management tool that increases the accuracy of manpower and financial planning.

As is the case with all computer systems the more accurate and comprehensive the information that is put into the computer the more accurate the models are. The more accurate the models, the more successful are the systems that the models support.

As seems to be normal in pavement models, the predictions provided for bituminous pavements seemed to be reasonable. On aggregate roads however the models were inadequate and overly conservative and therefore costly. The USFS has therefore been working on the development of a different model since 1981. The areas in which they felt they needed some "rapid accomplishment" were:-

1. Field measurement of initial and serviceability on earth and aggregate surfaced roads

2. The effect of grading policies on surface performance.

3. The effect of spring thaw on performance.

4. The measurement of logging truck tire pressure.

5. A comparison of specified road surfacing materials and subgrade characteristics with actual present values.

6. Measurement of seasonal traffic distribution as it related to road deterioration and maintenance.

7. A comparison of loaded and unloaded trucks and the effect on the roads.

We can probably expect to see some movement on the more widespread use of this model during 1988. With the contacts I made during the study tour the NZ logging industry can expect to know what progress is being made and when a working model is available.

In some areas a pavement management system is considered to be so important that funding for roading projects is not available unless a system is in place. This is, I believe, already the case in funding some public roads work in New Zealand.

Photogrammetry in Road Planning

General

Photogrammetry has been a widely used tool in forestry and forest roading for many years. It has traditionally used analogue (mechanical) plotting techniques when trying to attain the best available accuracy. The appearance of new analytical photogrammetric techniques, using personal computers, has opened up

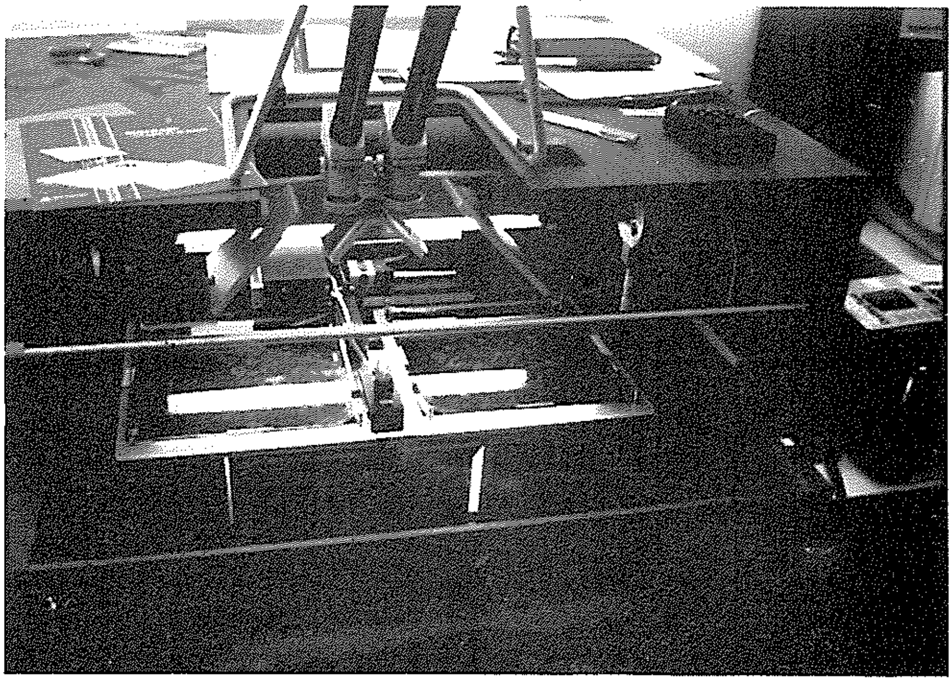

Figure 9 : A Personal Computer based analytical plotter. It fits on to a normal desktop and runs into the computer system shown in Fig 10.

a whole new area in terms of usefulness and increased accuracy, at costs that cannot be matched by analogue equipment in terms of either time or dollars. Photogrammetry is at the dawn of a whole new era in that it can be now applied in a very practical way to many areas that would only have been justifiable as a research project or had some other special reason to justify the required expenditure.

<u>*PC Based Analytical Stereoplotter*</u>

I had the benefit of spending some time in Seattle with the USFS where they are developing forestry applications for a desktop analytical stereoplotter. It was an AP 190 plotter developed by Ward Carson and was demonstrated to me by Steve Reutebach.

Because this stereoplotter is used with an IBM style PC it is inherently user friendly. (This may only reinforce the idea for some how unfriendly analogue stereoplotters are). The plotter in use was developed to be:-

1. User friendly
2. Compatible
3. Accessible and flexible

Uses which were either demonstrated to me or I had the opportunity of trying included:-

Its use as a digitiser.

In this application the plotter is in fact operating on a corrected model of the real topographic features. Because this model is formed from two photographs there is a multitude of detail limited only by the photographic resolution. The model is corrected for photographic and tilt distortions to a high degree of accuracy by simple orientation processes that could be mastered by any competent technician with stereo vision in a very short time. When in use as a digitiser the plotter provides co- ordinate sets as required by the operator and these can be acted upon in the normal fashion by a computer program to provide area information and so on. By simple programming it could also provide average skid distance calculations and other area related processes.

Figure 10 : A Personal Computer in use with a stereoplotter.

Its use in Road location.

This application again is acting on a model of reality represented in correct form from two stereo photographs. Road gradients can be accurately transferred to the model by moving a cursor to any location. If the location is not truly correct then the computer tells where to move the cursor to be on the correct grade. This road line can then be transferred to a map or photograph and used for physical location in the field. Because of the ready availability of both plane and height co-ordinates, alternative routes are easily and quickly tried on the photo model. In this use old tracks, swamps, faults and other features which are difficult if not impossible to see on maps or ground based observation are easily visible.

Its use in viewing a proposed hauler cable clearance.

In this application the hauler cable was made to appear in the model just as it would in real life. Clearances between the cable and the ground could be quickly determined if the visual indicators were not clear or a quantifiable measure was needed. The use of photogrammetric techniques in this way opens up a whole new era of uses by engineers and foresters who are not necessarily photogrammetric specialists. The uses mentioned are only a few of those possible. Uses are limited only by the imagination of the user and the expense or economics of performing the work.

Because an analytic system of this type uses a photographic representation of part of the earth's surface corrected for all distortions involved in the process, the potential accuracy is enhanced over the many step process involved in normal map production. Also, the ready availability of suitable photography for almost the whole of New Zealand make this a very powerful tool in the modern road designers armory. The use of this type of instrument will only increase in New Zealand as the cost is relatively low, the training requirement modest, and we have already a good cheap photo coverage ideal for forestry use.

Personal computers

General

The use of personal computers by both foresters and engineers is very prevalent in North America - to a much greater degree than in New Zealand. Because of the greater use and the larger population of PC's we can learn from their use, and avoid some of the problems which they are facing in some areas.

Compatibility

The general PC being used in the forest industry is the IBM style of MS-DOS computer in all its various forms. It is evident that organisations and areas that had gone to other styles of machine are now having to face the problem of converting their software and records to be compatible with the IBM style PC. For instance the USFS Engineering area have for many years used Hewlett Packard equipment for road design and other engineering uses. These machines are similar to the IBM style of PC but lack compatibility in the Basic Language area in the disk drive area and in the file storage area. While they nominally use the same language there are enough differences to make them non compatible with the predominant standard which is IBM style MS-DOS PC's. The particular examples that I saw of problems in this area were in road design software, where whole programs were being translated into a more transportable language.

The Hewlett Packard machines are very good quality, do a good job as a stand alone unit, but the problems of not speaking the same language and the problems arising from this are so great that the decision to transfer was made. In New Zealand we can learn from this and while it is senseless to not do anything one must keep an open mind on the possible future direction and ensure that the system being used is not leading away from the other users with whom one wishes to be compatible. Size of organisation doesn't seem to affect this necessity to any large extent, at least not if outside input or interchange is desirable. The US Forest Service experience in this area is directly available to us through their computer bulletin board system.

Spreadsheets

The use of spreadsheets for a wide variety of tasks was very evident. As in New Zealand the North Americans are using these programs for a wide variety of tasks. The use in New Zealand is however probably as advanced as I saw although perhaps not as widespread. The standardisation of many organisations on a particular brand is obvious although interchangeability is not the problem in this area that it can be in the hardware area.

Databases

Many of the databases I saw in operation were on mainframe machines rather than on PC's. This is an organisational requirement to have common information in a central database rather than a multitude of small databases in spread locations. But with care in system design, there is no reason why both the requirement for a central database and the need for local access and processing can't be carried out by a Personal Computer.

Upgradeability

This requirement should be kept in mind when purchasing PC equipment. Cheap machines have a limited economic life and with the very rapid advances in technology it is unwise to count on a long equipment life. As an indication of the advances, one engineer I spoke to told me that his recent book on Geotextiles with a half life for the information of 3 years is considered to be a good bet as in the computer area books have an information half life of about 6 months. Similar trends are evident in the computer field.

Networking PC's

The use of networked PC's seems to be growing in North America. In this use of PC's machines are linked together in a similar fashion to that used in terminals from a mainframe computer. To my mind much of this linking is unnecessary and only serves to negate the advantages of PC's as stand alone processing units. There is a place for networking PC's but with the rapid advances made in recent years because of PC's it seems a dangerous step to rush back to the mainframe and terminal system which PC's originally moved away from to allow greater individual processing and computational freedom.

ROAD CONSTRUCTION

Tender

In general the North American tender procedures and overall philosophy of tendering are very much like ours. The specific requirements have their own local differences and requirements. Many of the specific requirements are very much more stringent than in N Z. Special provision is made for minorities such as special ethnic groups and women. From my observation this is obviously abused, leads to many problems in administration, and does not necessarily ensure that the work is done by the best contractor nor in the best manner. In cases where the specification is not being met and the minority contractor is incapable of meeting the requirement there is a tendency to ignore the shortfall as the administrative and political problems are not worth the trouble that insistence on the specification would cause.

I have commented under 4.7.1 on the use of own forces or hourly rate hire in road construction.

Supervision

During my tour I had the opportunity to observe first hand on a number of occasions the supervision of road construction projects of various sizes. The supervision was similar in many ways to that which would be given to similar works in New Zealand. There was a trend, particularly in the USFS, to provide very stringent supervision. The formal qualifications of field supervisors is much higher than in NZ although probably in a much narrower area than would be expected here. From the USFS staff I spoke to, as well as the contractors, it was obvious to me that supervision is overdone and is resented by both parties. In order to understand the reasons one must look at American society and their wont to put any and every argument before a court. The very bureaucratic nature of Government and large private organisations don't help in this regard. Although critical of NZ organisations and bureaucracy I had obviously seen nothing until I looked at the USA where even the rules and regulations are bigger (although definitely not better).

Construction setting-out

Construction set out was always well done in the areas I visited. Some of this was because of the contract nature of the work which even in NZ is better set out than own forces work. Some of it was because of the inherent size and structure of the organisations I visited. The methods used are for all practical purposes the same as in NZ. The use of total station instruments in which the conventional theodolite and chain are replaced by an intelligent memory/calculation module, a theodolite and an Electronic Distance Measurement device, all mounted in a very compact package, taking up little more

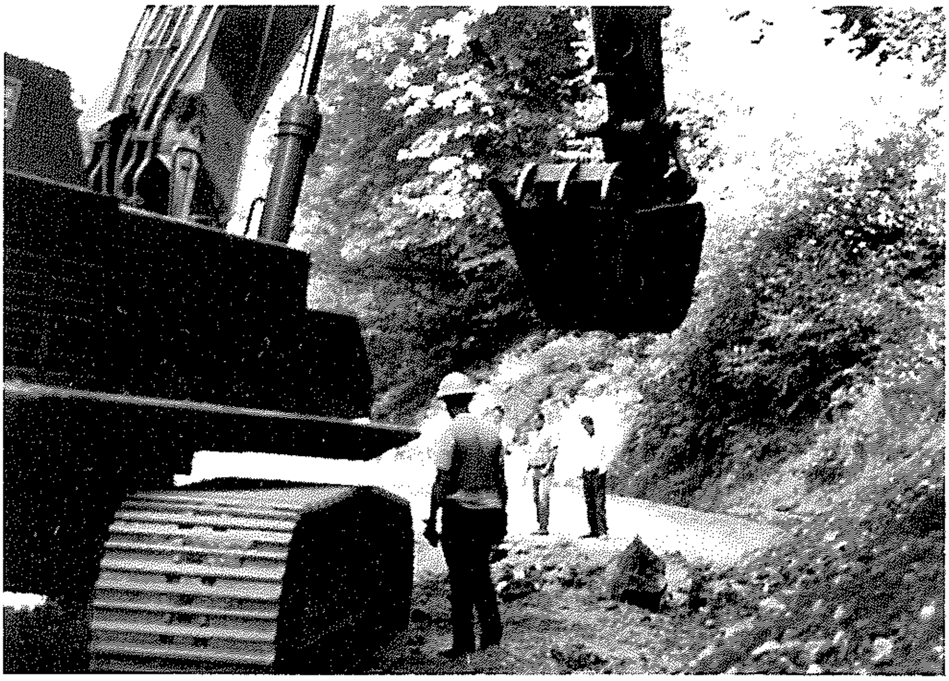

Figure 11 : Supervision!!!

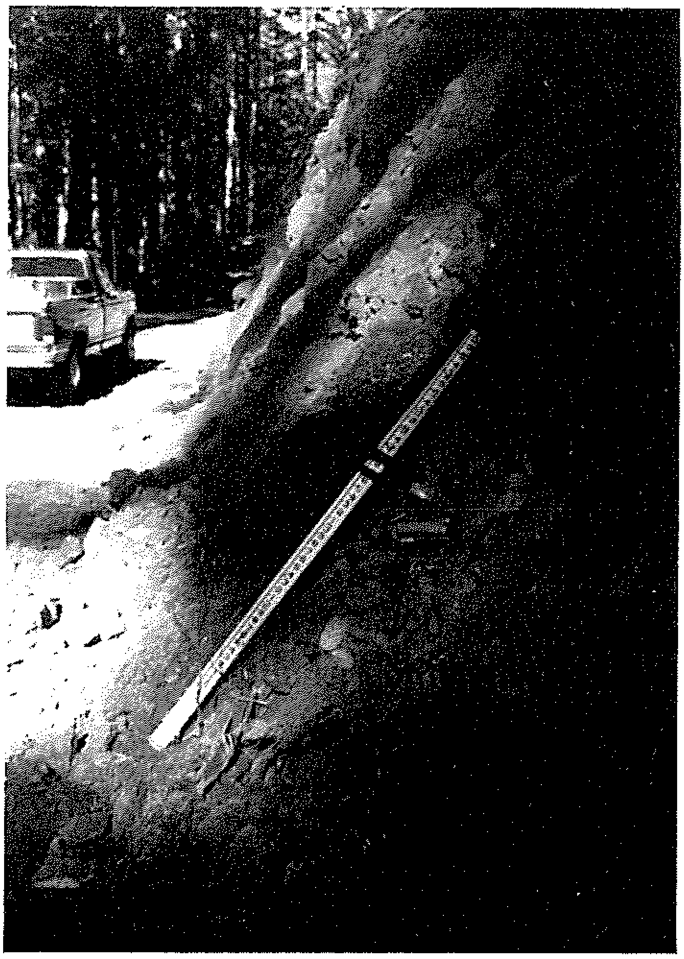

Figure 12 : The use of survey gear was common on all the construction I visited.

room than a conventional theodolite is having a noticeable effect on the way setting out of construction work is done. Many of the traditional construction pegs which would be put in individually from separate set-ups and standard construction dimensions can now be put in from a single set-up as the calculations and distance measuring required for this operation are no longer the time consuming tasks they were under the conventional arrangement. This trend is also becoming apparent in New Zealand although the scale of operations in North America make the high capital cost of this equipment easier to justify.

Construction Machinery

Construction machinery used in the forest industry in North America is again similar to that used in New Zealand. I saw examples of both good and bad equipment use - much as one would expect in any range of operations in New Zealand. The use of excavators in road construction is very common. I was impressed with some quick change fittings for an excavator I

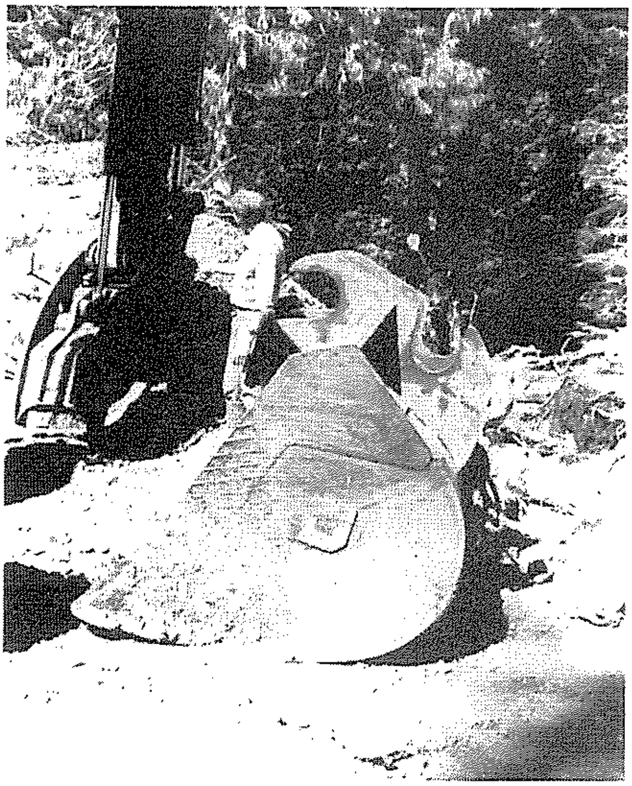

Figure 13 : Excavator bucket showing quick attach fitting.

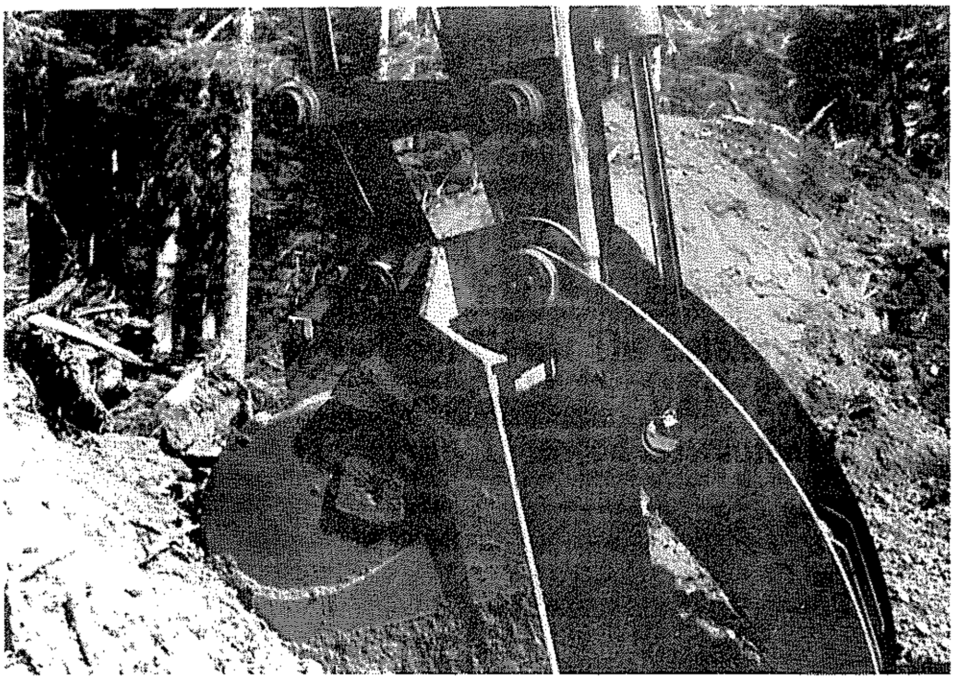

Figure 14 : Attached to the excavator.

Figure 15 : Ripper tooth also in the quick attach mode.

Figure 16 : A DJB type 4wd Civil engineering truck working

saw on a job on Vancouver Island. These fittings were made at the local engineering works and seemed to work very well (Fighre 13). Because of the ezse with which equipment can be obtained, and the cheaper capital cost, there is a definite tendency to use a wider variety of machinery than in NZ. For example where we would use say an excavator and a dozer for a certain roadbuilding job they use both these machines and also have a scraper for the parts that called for it and a grader on site for its specialised tasks. The NZ way in many cases would be to make do with an excavator and dozer and not use scrapers or graders at all. The standard of construction, the cost, and the efficiency of operations within New Zealand often show that planning and construction have occurred without considering fully the consequences of machinery selection.

I saw some DJB type trucks (4WD) operating on a forest roadbuilding job and although they were working well when I saw them, there were stability problems with the 4 wheel variety. I didn't see any of the 6 wheel style all wheel drive trucks operating but from comment it is apparent that they don't suffer the same stability problems and this is consistent with generally held opinion in New Zealand.

Construction Standards

The use of an appropriate range of machinery, the high standard of supervision and the scale of operation all help to make the standard of earthwork construction in North America high.
The standard of other construction work varied from excellent to shoddy. From my observation I believe that generally, New Zealand construction standards are very good and this is probably a reflection of the high general skill level in manual tasks which New Zealand has encouraged in its education system.

In the Housing and general construction area the standards of general workmanship are definitely less than would be accepted in N Z.

Use of Geotexiles

The use of Geotextiles in the forest roading area is as common as in New Zealand. Because of the wider engineering expertise available in the North American industry their use of Geotextiles is a little more rational than it sometimes is in New Zealand although even in North America there is some argument on the relative merits of geotextile design methods. The use of geotextiles falls into 3 categories:-

- Roading.
- Drainage
- Miscellaneous

Roading

In roading Geotextiles are used for a number of purposes but the can best be categorised as:

A SEPARATION LAYER to prevent the mixing of two different materials whose engineering properties would change should the mixing take place. A good example of this use is as a separation layer between a clay subgrade and an aggregate basecourse.

FILL REINFORCEMENT. Where the geotextile is used to impart extra strength to a filling. In this area Geotextiles are sometimes credited with magical properties. The use of Geotextiles in these situations should be treated with caution. A simple engineering analysis of the use will soon show if the material is expected to provide a strength component in a plane which the fabric nature of the material makes it obvious it can have no strength. In some fill reinforcement situations some benefit may well accrue from the Geotextile operating in the separation mode, but this should not be confused with strength or reinforcement properties. The use of geotextiles in both separation and fill reinforcement modes predominates on weak and wet soils. The benefits from its use in these situations is easily apparent and except as a drainage layer it is difficult to envisage significant advantage coming from the use of Geotextiles in soils of any strength. An observation made by one engineer was "if you don't need gumboots you don't need geotextiles". This is a simplification but it highlights the fact that soils need to be very weak to gain easy advantage from geotextiles.

FILTRATION. The use of Geotextiles in this area was very evident. The use was in keeping with NZ practice and I saw nothing which gave me cause to think the NZ standards as set out in National roads Board Specifications are anything other than the best current practice.

FIG 17. The use of Geotextile as a filtration surrounding on a roadside subsoil drain.

MISCELLANEOUS. Uses of geotextiles in this area were mainly evident in the repair or rehabilitation of high quality bituminous pavement and have little direct application to forestry roading practice. I saw no uses of geotextiles as a carrier membrane for bitumen in water proofing applications although there are examples of this type of use as forest fire pond linings, in New Zealand.

Alternate Construction Methods

Own forces work or equipment rental.

In contract construction the contractor is supplied with plans and specifications and paid by measured road construction quantities. In equipment rental (or own forces construction) the construction is directed and supervised and hourly rate hire paid to a contractor (or to another account as the case may be).

It appears strange to us in NZ that this method of construction is worthy of special mention as it has been a normal process in the N Z forest industry for many years. In the USFS, which has operated largely on a contract system, there is an increasing realisation that own forces or equipment rental construction has benefits and can be a real alternative to the traditional contract. The points raised in comparing these types of construction are a timely reminder to us that there are always advantages and disadvantages in any course of action, and that rational analysis is always a tool to be used ahead of following others action or adopting procedures without good and rational reasons.

The advantages the USFS see in this type of construction are the same as we would in NZ.

This type of operation is not entered into lightly and the engineering input seems to ensure that there is a realisation of the likely cost before the work is commenced. I believe that we can learn more from the politics of the environmentalists and by studying their arguments, than we can in the looking at the techniques of end haul construction.

Rock construction practices

Although I only had the opportunity to visit two sites where rock construction was a major part of the work, the impression I gained was that the techniques were standard construction practice.

The scale of operation though has meant that the machinery can be specially adapted and crews are obviously proficient and fast in their work. This is to be expected when it is a major part of their work. The use of large drills for explosive holes is common and an example of a purpose built machine is shown in Figure 20. The use of excavators in rock work is very common and the New Zealand experience that this is a good machine for rock work is confirmed by North American supervisors.

Machinery maintenance

I was most impressed during my visit to Valley Forest Products near Fredericton New Brunswick to see and hear of their experience in machinery maintenance at their timber processing plant. (input tonnage 5250 per day) Two hundred and seventy items of plant and machinery, ranging from Koehring Harvesters downward were being maintained by a team of 18 mechanics who between them worked around the clock 365 days a year. The plant and machinery inventory, running history and maintenance history were kept in a computerised record system and replacement, rebuilding and parts inventory were very closely controlled by a professional engineer. The size of the parts store was very small (see Figure 21) and the incidence of stoppage through mechanical failure was very low.

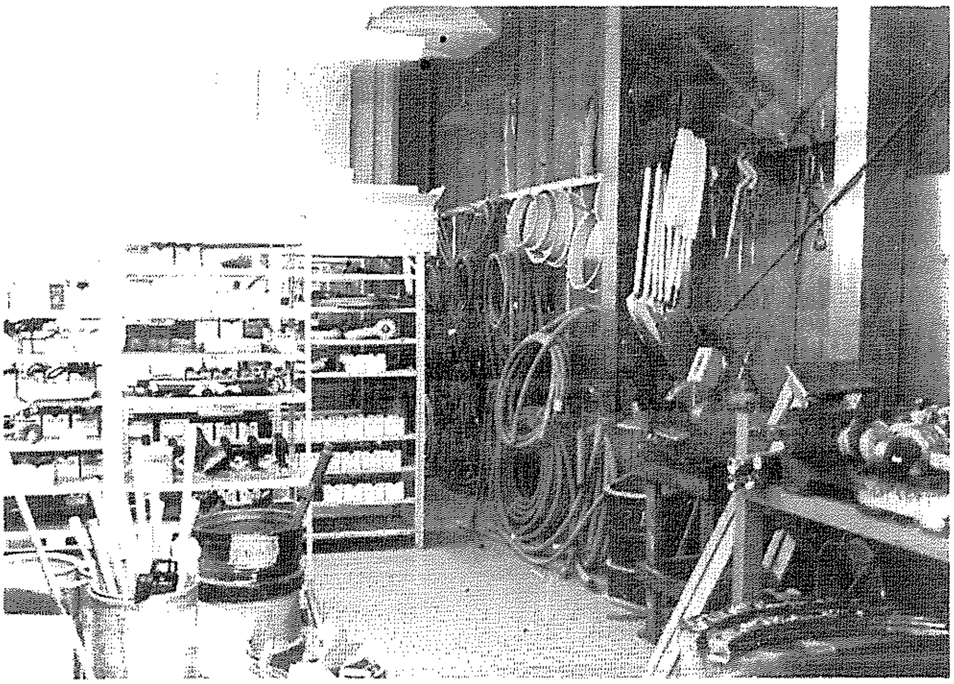

Figure 21 : The small part store. This is about half the total area and all the hydraulic hose spares for 270 items of plant.

From talking with the instigator of the system I learned of his insistence on sensible maintenance procedures - all driven by the criteria of:-

1. Keeping plant working as economically as possible.

2. Repairing or replacing on a strict basis of overall operation economics.

At this plant they also completely rebuild plant items at a very competitive 60% of new cost.

Unstable ground

General

In some areas of the Pacific North West land stability is a real problem. The areas of land instability I visited were mainly in the PNW although some minor areas were visited in the SE of the USA. The problems were of a similar nature and extent to many of those experienced in New Zealand. Because of the pressure from environmental agencies and pressure groups however, the stability problems are given much more emphasis. During this visit some interesting techniques were noted that could be applied to many situations in the New Zealand forest roading area. None of the techniques, with the exception of careful reconnaissance, however can be instituted without the willingness to "have a go", nor without the expenditure of some money. In the case of careful reconnaissance and planning however the potential is that money could be saved - in some cases large amounts. All the techniques I saw are mentioned in the LIRA Project Report no 31 (Hemphill 1987) and there is a wealth of available information in both LIRA's library the MWD library in Wellington.

The techniques I saw were:-

Geotechnical exploration.

The USFS employs considerable number of Geotechnical engineers who specialise in stability problems and their amelioration or cure. These specialists use mapping and land form indicators to pinpoint problem areas during the planning process and they take soil samples and conduct monitoring before and after construction. One noticeable feature of these expert advisors is that they are more often than not employed at a District operational level and are not just visiting experts whose effect can often be limited. The input from these specialists extends through all phases of the project including the economic analysis and construction stages.

Compaction

Compaction on roading projects is widespread although more prevalent in the USFS than in the private areas of the logging industry. Standard highway practice is used although from comments made by my engineering guide on two particular jobs the full field testing which would have been carried out a few years ago has given way to a more tempered approach to the measurement of compaction achievement.

The increasing use of nuclear densitometers has made this task considerably easier and the expense of full compaction testing has made it mandatory only in areas where the cost can be justified. Experienced engineering and supervisory staff are essential when compaction is being performed and this will be the biggest single obstacle to the ready acceptance of this technique in the N Z forest industry.

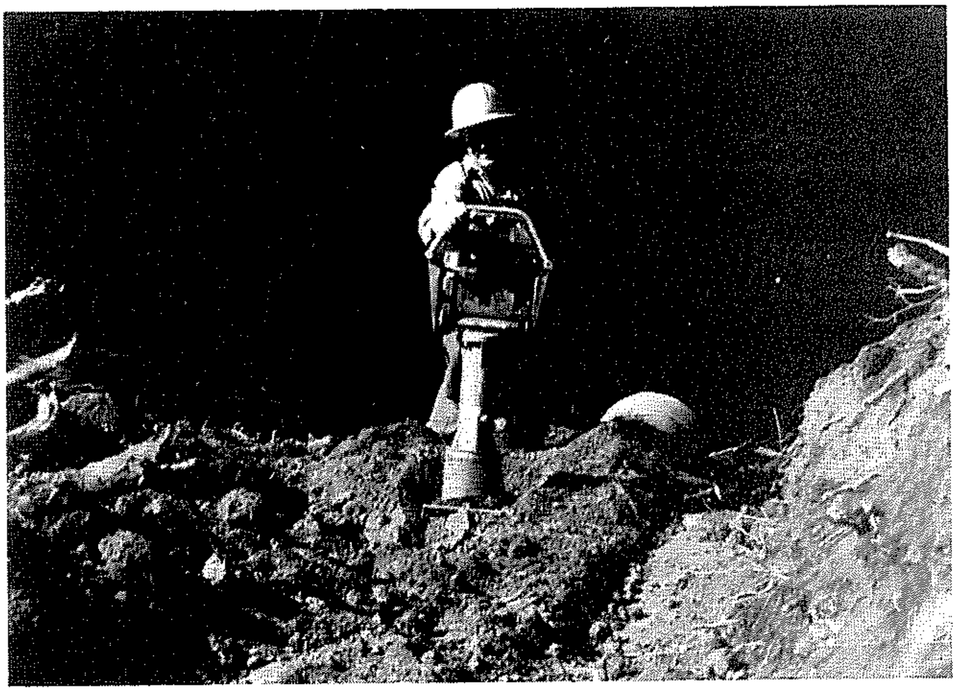

Figure 22 : Compaction with a small rammer. A common sight on earthwork construction in North American forests.

<u>Retaining walls and buttressing.</u>

The use of both these techniques is well known and documented. Use in North America seemed much more prevalent than in NZ. The use of these measures generally requires some engineering input as stability and loading analysis are always required to justify the considerable expense of the construction. The use of buttresses while simple in concept is expensive and suitable rock is often unavailable at an economic cost.

Most conventional retaining walls are used only on main logging roads which can stand the construction cost. One type of retaining wall not seen or used in NZ is the welded wire mesh wall shown being constructed in the following photographs. This particular example has a proprietary brand name "Hilficker" and from my observations it could have a place in New Zealand.

Figure 23 : The use of a small compactor in the construction of a reinforced earth retaining wall.

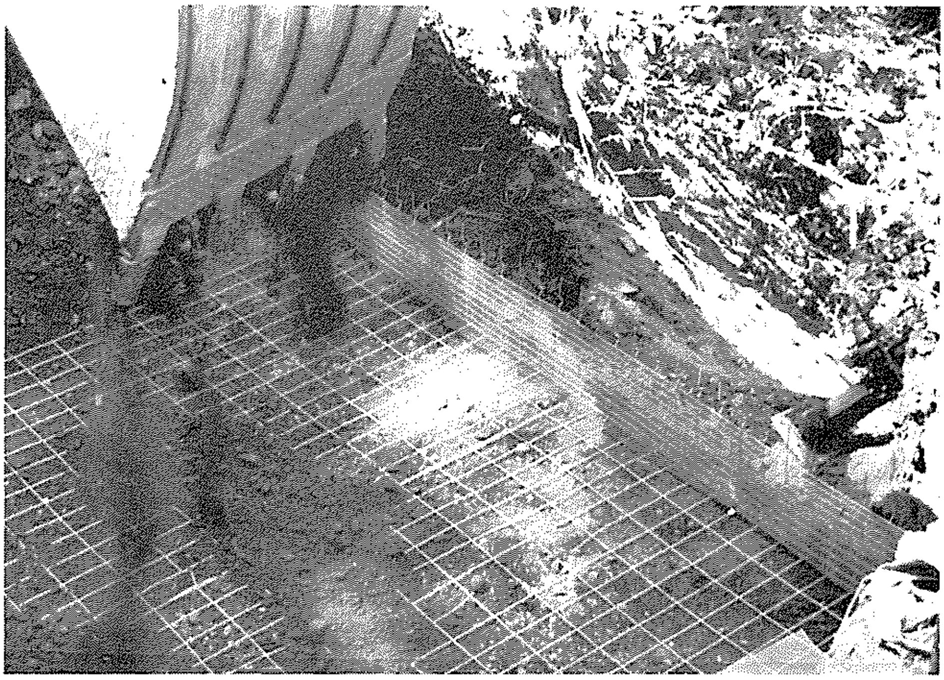

Figure 24 : "Hilficker" welded wire reinforced earth retaining wall.

Decommissioning roads.

This practice is more widespread in North America than in NZ. In decommissioning a road some of the culverts are removed water bars are installed, steep cut slopes are allowed or encouraged to collapse and access bars in the form of earth mounds are place at the entrance to the road. All these measures are done at various places in NZ but the practice is much more widespread in North America.

Figure 25 : A decommissioned road showing typical condition and water bars.

Supervision

Supervision of construction work is recognised in North America as being of the utmost importance. The USFS supervisors have an engineering background and are competent to perform soil and compaction testing. In the private sector the same formal training skills were not evident although roading supervisors are more specialised than is generally the case in NZ.

ROAD MANAGEMENT

Roadway management has several prime objectives. It must help in determining annual budgets and in providing long range planning (2-5 years) information for road improvement projects. The pressure to reduce spending and improve efficiency has brought about the realisation that money spent on roading projects or on annual maintenence must be adequately researched and justified.

On one hand the road inventory information and existing condition must be weighed against the other hand criteria of road significance, priorities, and a deficiency rating. Together these identify specific needs used to forecast annual expenditure and to develope long range improvement plans.

The ready availability of automated information gathering and the ability to analyse this information on personal computers has meant that there has been a rapid increase in North America of the use of various roadway management systems.

Many of the problems of road management are mentioned under section 3.5.

As already mentioned this area is one of growing importance. There is a considerable research effort in how these sytems can be used in a forest roading environment, particularly by the US Forest Service. It is expected that some results of benefit to us in New Zealand will be available later in 1988 or early 1989.

TRAINING

<u>University training in forest roading</u>

The North American universities, in their forestry schools, concentrate much more on engineering aspects of forestry than is the case in NZ. This has benefits in that the graduates are much more aware of good engineering practice and when to call on outside help in solving problems. Although I did not have the time to investigate thoroughly the North American system of training, the tour guides during all of my trip were products of their education and training system and their engineering skills were apparent even though many were designated as Foresters.

<u>Tertiary training in forest roading</u>

It was apparent during my tour that in general the formal educational qualifications of people employed in the forest roading area were high. This was noticeable in all areas from professionals down to field supervisors. As noted in the previous paragraph they do not necessarily have an extensive formal engineering training but the work they produce and the attitude toward roading is more professional than many in New Zealand. In part this difference in attitude may be explained by the dire consequences of road failure in the very harsh freeze thaw conditions not experienced in New Zealand. In the US Forest Service many of the field supervisors were university trained in engineering and professionally qualified. The UNB forestry training school was visited and their one year Ranger certificate engineering content was impressive in its quality. The discipline at this school is very rigid and the work load extremely high. This contributes to the excellent output that the students achieve. It was noticeable that the quality of equipment and tools including computers was extremely high as was the number provided on a per student basis. When I commented on this I was told it was only so in very recent times. I was perhaps justifiably quiet in my reply. Even with what the Canadians feel was a low level of equipment, before the recent purchases, I felt overawed at the amount provided. It was much, much more than is ever provided in New Zealand. Perhaps we should adopt some of their discipline, look for their high standards, and stop our present educational pandering.

International training material

At the 4th International Low Volume Roads conference in New York state there was an abundance of training aids and material on display. Much of this is aimed at third world countries with real training problems but much of it is applicable to NZ and the sources are documented in Appendix B.

Technology transfer

Considerable mention has been made in this area under the 4th International Low Volume Roads conference heading and it is only in the forestry related areas that will be considered here. There is an awareness that technology transfer is an essential part of our system particularly in today's rapidly changing environment. It is an important point to remember that in this area of technology transfer there is no simple "just add water" recipe for skill transfer. It requires an awareness of the system , an acceptance of one's involvement in that system, a willingness to change and the provision of facilities and time to apply the technology that has been transferred and consolidate its use. These requirements of the user must of course be matched by the employer who has a stake in the successful outcome of the technology transfer.

NEW TECHNIQUES

Use of personal computers

Personal computers are used as an everyday tool in all the roading operations that I visited. There is a very high general level of experience in their use and at the practitioner level a high ability to use them where appropriate.

Plotters and Digitisers were commonplace, as was good software. This does not seem to be because of the capital coat as I didn't find too much difference in hardware price levels between America and New Zealand. Software is cheaper. The is a real awareness that these computers are just tools although there is also some admission that this has taken a little achieving. In Appendix E. I have covered the easily available road design software packages.

Wood chip and wood chunk roads

The use of wood chips in roading can best be split into two areas. The use as a light weight fill material - particularly applicable to roading across swamps. In this application the wood chip road trials by the USFS used wood chips over geotextiles and encapsulated with a sand gravel mixture to help prevent drying out and air reaching the wood chips and hastening rotting. The weight advantage in using this type of fill is considerable and savings of about 1.4 tonnes/M3 in the fill material are possible after allowing for moisture content. This saving has real benefits in preventing sinking of the fill material into the swamp. The construction costs were the same but the expected reduction in maintenance costs to rehabilitate a sinking fill is sufficient to justify its use. The source of wood chip needs to be reasonably close to the work site and the viability can be easily determined by a simple engineering economic assessment. In this USFS trial the source of low quality and therefore low cost chip was about 68 km (45 miles) from the job site. The use of chunks instead of wood chips appears to offer some promise as a wider range of particle sizes gives the material more desirable engineering properties. The NZ industry should keep a watch on developments in this area and LIRA will note developments as they come to hand.

Its use as a substitute for roading surfacing or basecourse aggregate. There is little research or development or published material on the use of wood chips as a surfacing material. The previously mentioned trials involved the use as a fill material totally enclosed by earth. During discussions with people involved in the previous trial and in considering it with others the following points need some consideration if wood chips are to be successfully used as an aggregate substitute.

1. The lack of cohesion or binding
2. The lack of weatherability
3. The lack of strength
4. Cost
5. Toxicity of leachates.
6. Maintenance problems.

PAPERS PRESENTED AT THE FOURTH LOW VOLUME ROADS CONFERENCE.

ADMINISTRATION AND MANAGEMENT

Restructuring the Local Rural Road System in the United States

Financing and Maintaining Low Volume Roads in the Midwestern United States

Evaluating Alternative Maintenance Strategies for Low Volume Roads in Sub-Saharan Africa

Low Volume Roadway Network Improvements and accessibility of Public Facilities Located in Rural Areas.

Area Service B Classification: A Legal Approach to Setting Road Maintenance Levels for Little-Used Low Volume Roads

Practical Application of Computer Highway Costing Programs

Equipment Rental-Road Construction

NON-STANDARD MATERIALS

The Use of Wood Chips for Low Volume Road Construction in the Lake States

Use of Phosphate Mining Waste in Secondary Road Construction

Paper Mill Sludge for Stabilization of Sand Roads

Evaluation of Emulsified Asphalt-Treated Sand for Low Volume Roads and Road Bases

Recent Investigations into the Use of Plastic Laterites as Bases for Bituminous-Surfaced Low Volume Roads

Durability Aspects of Lime-Stabilized Weather Basalt used for Low Volume Road Construction in Botswana

Experimental Use of Weathered Basalt Gravels on Roads in Ethiopia

Theory of the Use for Low-Strength Granulated Materials in the Construction of Low Volume Roads in the USSR

HEAVY HAULING AND LOAD LIMITS

Using Site-Specific Truck Traffic to Evaluate the Performance of Surface-Treated Pavements

Consideration of Seasonal Pavement Damage for Timber-Haul Roads

Evaluation of Deflection Data as Criteria for the Timing of Spring Load Limits

Development of a Procedure for Analyzing Load Limits on Low Volume Roads

Structural Evaluation and Load Zoning of Low Volume Roads : A Case Study

Using Central Tire-Inflation Systems on Low Volume Roads

ASPHALT SEALS AND LIGHT PAVEMENTS

Costs Evaluation of Alternatives in Rehabilitating Asphaltic Rural Roads

The Maintenance and Rehabilitation of Sealed Rural Roads

Asphalt Hardening in Sprayed Seals

A Rational Design Approach, Based on the Modified Tray Test, for Single and Double-Surfacing Seals

PAVEMENT AND SURFACE COURSE DESIGN AND MANAGEMENT

A Field Investigation of Some Properties and Requirements for Wearing Course Materials for Unpaved Roads in Relation to their Performance

Determination of Pavement Layer Structural Properties of Aggregate-Surfaced Roads

The Implementation of Appropriate Technology in the Design of Light Pavement Structures

Use of Clegg Impact Tester in Managing and Designing Aggregate-Surfaced Roads

Pavement Design of Low Volume Roads with Consideration of Thick-Packed Snow on Anti-Frost Effects

A Method for the Optimal Design of Rehabilitation for Low Volume Asphaltic Roads

The Maintenance and Design System : A Management Aid for Unpaved Road Networks

GEOMETRIC AND OPERATIONAL CONSIDERATIONS

Identification Deficiencies of Two-Lane Rural Roadways

The Development of Geometric Design Standards for Low Volume Roads

Development of Low Volume Roads in India

Physical and Operational Characteristics of Rail-Highway Grade Crossings on Low Volume Roads

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Durability Aspects of Lime-Stabilized Weather Basalt used for Low Volume Road Construction in Botswana

Experimental Use of Weathered Basalt Gravels on Roads in Ethiopia

Theory of the Use for Low-Strength Granulated Materials in the Construction of Low Volume Roads in the USSR

HEAVY HAULING AND LOAD LIMITS

Using Site-Specific Truck Traffic to Evaluate the Performance of Surface-Treated Pavements

Consideration of Seasonal Pavement Damage for Timber-Haul Roads

Evaluation of Deflection Data as Criteria for the Timing of Spring Load Limits

Development of a Procedure for Analyzing Load Limits on Low Volume Roads

Structural Evaluation and Load Zoning of Low Volume Roads : A Case Study

Using Central Tire-Inflation Systems on Low Volume Roads

ASPHALT SEALS AND LIGHT PAVEMENTS

Costs Evaluation of Alternatives in Rehabilitating Asphaltic Rural Roads

The Maintenance and Rehabilitation of Sealed Rural Roads

Asphalt Hardening in Sprayed Seals

A Rational Design Approach, Based on the Modified Tray Test, for Single and Double-Surfacing Seals

PAVEMENT AND SURFACE COURSE DESIGN AND MANAGEMENT

A Field Investigation of Some Properties and Requirements for Wearing Course Materials for Unpaved Roads in Relation to their Performance

Determination of Pavement Layer Structural Properties of Aggregate-Surfaced Roads

The Implementation of Appropriate Technology in the Design of Light Pavement Structures

Use of Clegg Impact Tester in Managing and Designing Aggregate-Surfaced Roads

Pavement Design of Low Volume Roads with Consideration of Thick-Packed Snow on Anti-Frost Effects

A Method for the Optimal Design of Rehabilitation for Low Volume Asphaltic Roads

The Maintenance and Design System : A Management Aid for Unpaved Road Networks

GEOMETRIC AND OPERATIONAL CONSIDERATIONS

Identification Deficiencies of Two-Lane Rural Roadways

The Development of Geometric Design Standards for Low Volume Roads

Development of Low Volume Roads in India

Physical and Operational Characteristics of Rail-Highway Grade Crossings on Low Volume Roads

MAINTENANCE MANAGEMENT

Development of a Maintenance Management Program

A Periodic Maintenance Management System for Low Volume Roads in Niger

Simplified Procedures for Maintenance Management of Low Volume Roads

Road Maintenance Costs and Research Directions - Low Volume Logging Roads in New Zealand

MATERIAL ON TECHNOLOGY TRANSFER INCLUDING TRAINING AIDS FILMS VIDEOS ETC.

During this study tour I gathered a quantity of material on Technology transfer. Included are some details on training films, training videos, and manuals to assist trainers. All this material is available at LIRA, Rotorua.

The following is a list of the major items although there are many small pamphlets and details that are not included in the listing.

1. Fourth International Conference on Low Volume roads. TRR 1106, Volume 1 and 2. Held in LIRA's Library. This is the collected papers presented at the conference. It is comprehensive and authoritative. A listing of the subject areas is included in this report as Appendix A.

2. University of New Brunswick information folder prepared for DON ROBINSON. Held at LIRA. Section three of this folder contains information on continuing education in Forestry at the University of New Brunswick. It is both philosophical and also covers some detail of UNB's work in this area.

3. University of New Brunswick Department of Forest Engineering Course notes for FE 5761 "Transportation of Forest Products". Held at LIRA. These course notes contain information gathered under one cover to assist students in this particular course. There is an extensive bibliography in the subject area at the back of the notes.

4. RAMPAGES. UNB. Resource Applications Management Newsletter. 8 Pages of interesting information for those using computers in forestry applications. Like "ROADNOTES" this publication may no longer be available.

5. University of North Carolina INSTITUTE FOR TRANSPORTATION RESEARCH AND EDUCATION. Annual report.

6.INTERNATIONAL ROAD FEDERATION VIDEO TRAINING AIDS. A few pages explaining the available training videos with a brief description of contents. Thes are priced at about US $600 per video. A nice feature is that three videos are available specifically dealing with Earth and Gravel Roads.

7. TRANSPORT and ROAD RESEARCH LABORATORY, Great Britain. List of Publications. 1987

8. MINNESOTA DEPARTMENT OF TRANSPORTATION. Research Review.

9. FEDERAL HIGHWAYS ADMINISTRATION. A World of Technology for Sharing. A 64 page publication detailing US aid in the Highway field.

10. FEDERAL HIGHWAYS ADMINISTRATION. Our Nations Highways Selected Facts and Figures.

11. FEDERAL HIGHWAYS ADMINISTRATION. Technology transfer program for Local Transportation Agencies. An Evaluation Report. June 1985.

12. FEDERAL HIGHWAYS ADMINISTRATION. Technology Transfer UPDATE. A small publication whose aim is to pass along information about new ideas etc.

13. US ARMY CORPS OF ENGINEERS. Rating Unsurfaced Roads. A field manual for measuring maintenance problems.

14. Cornell University Local Roads Program. NUGGETS and NIBBLES. A technology transfer, small publication.

15. BETTER ROADS. A small Magazine aimed at Road engineers and officials.

16. A selection of small leaflets etc covering.

Pavement management
Case studies
Microcomputers in Public Works
National Association of County Engineers - order form
American Road and Transportation Builders association - Order form
American Public Works Association - Order form
Technology transfer programs
Rural technical assistance program
Highway research information service
The community roads of Columbia
Transportation Research Information Service
Delft Technical University

COMPUTER BULLETIN BOARD SYSTEM

Computer bulletin boards are used to allow easy interchange of ideas between participants who access the bulletin board using their computer and a telephone modem. The use on normal telephone lines is expensive because of toll call charges but the use through services such as PACNET available from TELECOM makes the cost considerably less. Unfortunately it seems that the example Bulletin Board shown below may close as it has fulfilled the objectives for which it was set up.

The costs to set up a similar system in New Zealand would be:-

1. Computer cost		$ 5000	Lump sum
2. PACNET	connect fee	$ 560	Lump sum
	dedicated line	$ 315	per month
	connect time	$ 432	per month
	usage fees	$ 300	per month (estimate only)
3. System Operator		$???	

This is not a cheap system to setup or operate for small numbers of callers. It may however have a place for special uses where the cost can be justified.

EXAMPLE FROM THE USFS BULLETIN BOARD
****

PACNET 009 010

COM
WELCOME TO RTIPS

R T I P S

A BULLETIN BOARD FOR LOW VOLUME ROAD ENGINEERING

CRITICAL NOTICE - WE HAVE TURNED OFF THE ECHO ON THIS NODE --
This should make it easier for those folks calling in from the DATA GENERAL using the TC processor. However all you folks calling in on TELENET using micros will have to turn a local echo on.

Most MSDOS programs using the ALT-E key to turn the echo on locally. If that includes you - suggest you try turning your echo (half-duplex) on before proceeding. It is tough to type and never see what key you hit. Press [ENTER] to continue?

Please let us know which way most of you want our echo setting - we can easily switch back, but unfortunately we can't make it a user option at this time - although it could be.

PS On this system you must use [CR] NOT newline key.

What is your FIRST name?
Checking Users...
RBBS now echoing what you type
Enter Password (dots echo)? ....

Granted access level 5
Logging DON ROBINSON
RBBS-PC CPC16.1A NODE 1
OPERATING AT 4800 BAUD,E,7,1

* Ctrl-K(^K) / ^X aborts. ^S suspends ^Q resumes *

WELCOME TO Rtips - THE LOW VOLUME ROAD BULLETIN BOARD

Your SYSOP is Brian Lesser FTS 235-8712 or 8635

This bulletin board functions to support the exchange of technical information relative to the Planning, Design, Construction, Maintenance & Operation of Low Volume Roads.

****
========== NOTICE ==========

****
: RTIPS Bulletin Board is tentatively scheduled for shutdown on April 15. We are not seeing as much of a Forest Service-based need to keep this BB running as we used to. All feedback about this proposed action is welcome.
: MORE: [Y],N,NS? Y
: Respond via message placed in the Main Message Center with the <E> command : : from the main menu, or send a message to D.G. address "B.Lesser:W01B".

****
Times on: XX Last was: MM-DD-YY HH:MM

1 NEW BULLETIN(S) since last call: 3
READ ALL new bulletins ([Y],N)? Y

* Ctrl-K(^K) / ^X aborts. ^S suspends ^Q resumes *

BULLETIN £ 3 --
POSTED: MM/DD/YY

SUMMARY NOTES - STAFF MEETING

Director's Office

General Discussion:

MORE: [Y],N,NS? N

* Ctrl-K(^K) / ^X aborts. ^S suspends ^Q resumes *

```
=================== Bulletin Menu =======================
Bulletin
~~~~~~~
  1 - Purpose and origin of this Bulletin Board.
  2 - March     Issue of COMMUNIQUE' (You can download
  3 - Notes from the Director's Staff Meeting
  4 - Using TENSAR & TERRAFIRMA for subgrade stabilization
  5 - Info on running IBM programs on HP 150's.  **** MUST READ
  6 - New Highway Bill & Effect on Forest Highways
  7 - Guide to Management of Roadside Trees
  8 - "Dustaside" dust control emulsion study (Maine DOT)
  9 - Info on Forest Service Photo Laser Videodisc
 10 - Action plan from Regional Engineers Meeting in San Dimas
 11 -  June issue of Region Engineering clip sheets
 12 - Reduce the cost of landscaping along roads with clamshells
 12 - Use of fabrics for subgrade stabilization
 14 - A new road safety guide is available
 15 - Short subjects on roads computer applications
 16 - Review of Expert System shells for the Forest Service
MORE: [Y],N,NS? N


=========================================================

=========================================================
Read what bulletin(s), L)ist, N)ew ([ENTER] continues)? 1

* Ctrl-K(^K) / ^X aborts. ^S suspends ^Q resumes *
```

THIS BULLETIN BOARD

This bulletin board was brought into existence as a result of the National Road Technology Transfer Program. This effort involved the establishment of five teams. Each team was chartered to address a specific topic and these are:

(A) Technology Transfer Improvements
(B) Clearing and Grubbing
(C) Base and Surfacing
(D) Operations and Maintenance
(E) Controlling Road Costs

During the analysis and evaluation of what makes for effective Technology Transfer (TT) it became obvious that person-to-person exchange was the most accepted and effective means of TT for Engineering Personnel in the Forest Service. Thus this board was brought on line -- to put people in contact with people. The board is intended to facilitate INFORMAL exchange on technical topics for roads. If you have any good ideas that you would like to Share -- this board will allow for a national exposure.

Please don't be shy about participating and using this bulletin board. We don't care about missspellled woords or fancy letters. We just want to help ideas and improved ways of getting the job get circulated around.

All bulletins are placed in files in the files section of this BB when removed. Therefore if you haven't been on before or would like another look at one of the old bulletins you need to download the file using the "F" option at the mainmenu. The old bulletins are stored in files starting with B and followed by the date they were posted.

End of Bulletin £1 7-22-85

THE FOREST SERVICE PHOTO LASER VIDEODISC

What is the Forest Service Photo Laser Disc?

The National Agricultural Library, the Forest Service and the University of Maryland cooperated in the development of a 12-inch optical laser disc to provide word searchable access to images and image information. The laser disc contains over 34,000 black and white images in 69 general subject chapters, 500 color slides, 55 botanical illustrations, 175 maps, an award-winning 60 second Smokey Bear fire prevention spot and a brief introduction describing the laser disc production process. The laser disc is accompanied by a menu-driven word-searchable database register.

What is the Purpose of the Project?

- *Improve awareness of and access to the Forest Service Photo Browsing Collection located at the National Agricultural Library.*

- *Provide the photo researcher with quick and efficient image access to major portions of the browsing collection without examining the original photo mounts in this collection.*

- *Provide users in remote locations with an efficient way to preview, identify and order photo reproductions.*

- *Reduce handling of original files and prints contained in the Forest Service Browsing Collection.*

- *Eliminate costly travel and lodging often associated with photo research at the National Agricultural Library.*

- *Demonstrate the benefits of laser disc technology.*

What is the Availability of the System?

The laser videodisc and database register are available to the Forest Service Units and Land-Grant libraries which either have the necessary equipment and software or plan to acquire it in the near future. Only a limited number of free copies are available.

What Equipment is Required?

- *A 12-inch optical laser disc player.*
- *A good quality television monitor.*
- *A microcomputer: MS-DOS compatible with monitor.*
- *A telecommunications board in the computer.*
- *An RS-232C cable to connect computer and player.*
- *Online storage for 20 megabytes of data.*

What Software is Used?

The photo database software currently being used is C-Quest, a picture/image cataloging and retrieval software program for image control and indexing. This is available from Image Concepts, P.O. Box 211, West Boylston, MA 01583 (617) 835-3273.)

For a demonstration or more information, contact:

```
----- MAIL ---------- SYSTEM ---------- UTILITIES -------- ELSEWHERE
    [E]nter a Message [A]nswer Questions [H]elp (or ?)       [D]oors
    [K]ill a Message  [B]ulletins        [J]oin Conferences  [F]iles
    [P]ersonal Mail   [C]omment          [V]iew Conferences  [G]oodbye
    [R]ead Messages   [I]nitial Welcome  [X]pert on/off      [Q]uit
    [S]can Messages   [O]perator Page
    [U]tilities
    [T]opic   of   Msgs      [W]ho   else   is   on       *  = unavailable
[*]Library

    MAIN command <?,A,B,C,D,E,F,H,I,J,K,O,P,Q,R,S,T,U,V,W,X>? F

     64 min left
                RBBS-PC   F I L E   S Y S T E M
    -- TRANSFER ------ INFORMATION --- UTILITIES --- ELSEWHERE -

    [D]ownload file   [L]ist files    [H]elp (or ?)    [G]oodbye
    [P]ersonal dwnld  [N]ew files     [X]pert on/off   [Q]uit
    [U]pload file     [S]earch files
     * = unavailable  [V]iew ARCs

    FILE command <?,D,G,H,L,N,P,Q,S,U,V,X>? S
    Search for string (Press [ENTER] to quit)?
```

```
*****************************************************
          MASTER DIRECTORY
*****************************************************
```

For your convenience the files available for downloading to your computer have been placed in individual directories which are topic oriented.

You can download the file BIG.DIR to get a complete listing of all files on this bulletin board, or we will send a file by Data General or hardcopy by mail if you will leave appropriate information.

Directory	Topic	Directory	Topic
1	BASICA & TURBO PASCAL	10	WORD PROCESSING
2	DATA BASE MANAGEMENT	11	GRAPHICS
3	DESK HELPERS	12	MISC TEXT FILES instructions & general
4	DISK & FILE MANAGEMENT		
5	FINANCIAL, ECONOMIC & STATISTIC	13	MENU programs and DOS

```
6a HIGHWAY ENGINEERING
6b Structures, Hydraulic Analysis
6c Survey
6d Project Management
6e Mechanical & Electrical
7  SPREADSHEETS - PC-CALC etal
8  TELECOMMUNICATIONS
9  UTILITY PROGRAMS
14  LIBRARY programs ARC,
15  Printer controls
16  File format conversions
17  IBM/COMPATIBLE hardware
18  Programs from PC mag
CTIP  Files for the CTIP
99  USER UPLOADS

To find files in the above directories input L;XX;XX where XX =
directory £ ex. L;2;6  will list all files in DATA BASE MGMT. &
HIGHWAY ENGINEERING
 L;ALL  will list file names of all files available -- except the
user uploads.

Please note files with ARC suffix are LIBRARY files & require
PKX35A35.EXE to extract individual files.
What directories (U)pload,A)ll,L)ist [ENTER] quits)?


 56 min left

Now: MM-DD-YYYY at HH:MM:SS
You have been on for XX minutes, XX seconds
MM min left for next call today
DON, Thanks and please call again!
```

****

NOTE: Some editing has been performed on this print out to enable it to fit the page format of the report. It does not alter the ideas or example being demonstrated in any major way.

ROAD DUST MEASUREMENT

GENERAL

The tolerable level of dust on a road depends on the type of use of both the road and its surroundings. As pressure of use on the land bordering roads increases one can expect that pressure will come to bear to reduce the dust levels to what is considered an acceptable level by those affected. In New Zealand this is likely to be pressure from both environmental lobby groups and horticulturalists. To date one of the major problems in this area has been to determine what is acceptable and how to satisfactorily replicate measurements which show the level of acceptability.

The USFS have developed a quantitative instrument for measuring road dust levels which may have application in New Zealand.

BRIEF DESCRIPTION OF THE USFS DEVICE

The USFS have developed a road dust monitor which attaches to the rear of a standard American pickup vehicle. It consists of a galvanised sheet metal duct, an infrared transducer mounted in the duct and an instrument package with an indicating meter mounted in the pickup cab.

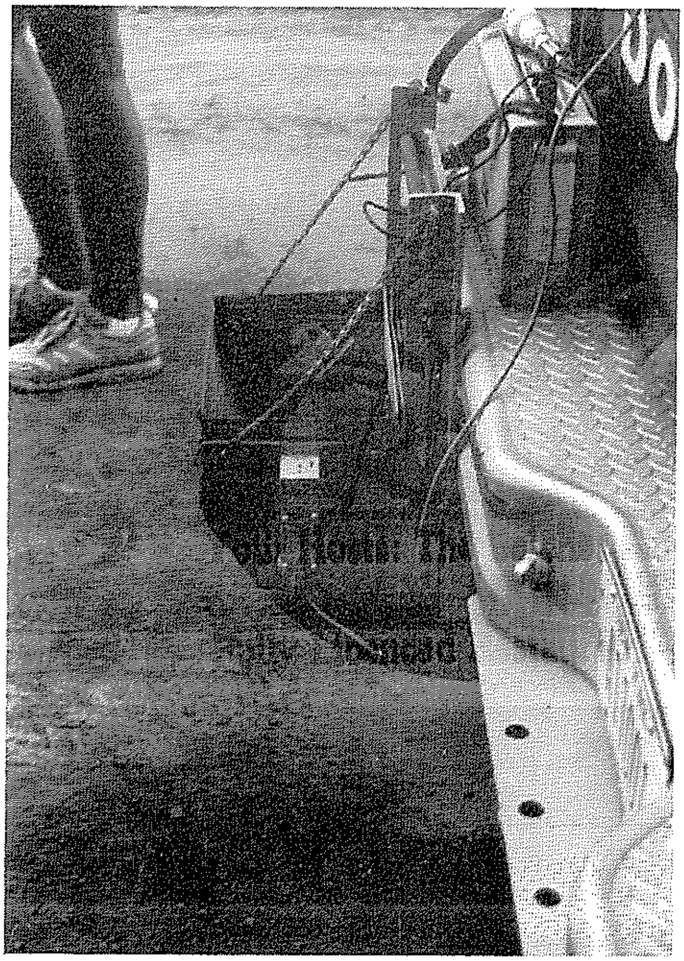

FIG 26. A close up of the dust monitor fitted to the rear of a pickup truck.

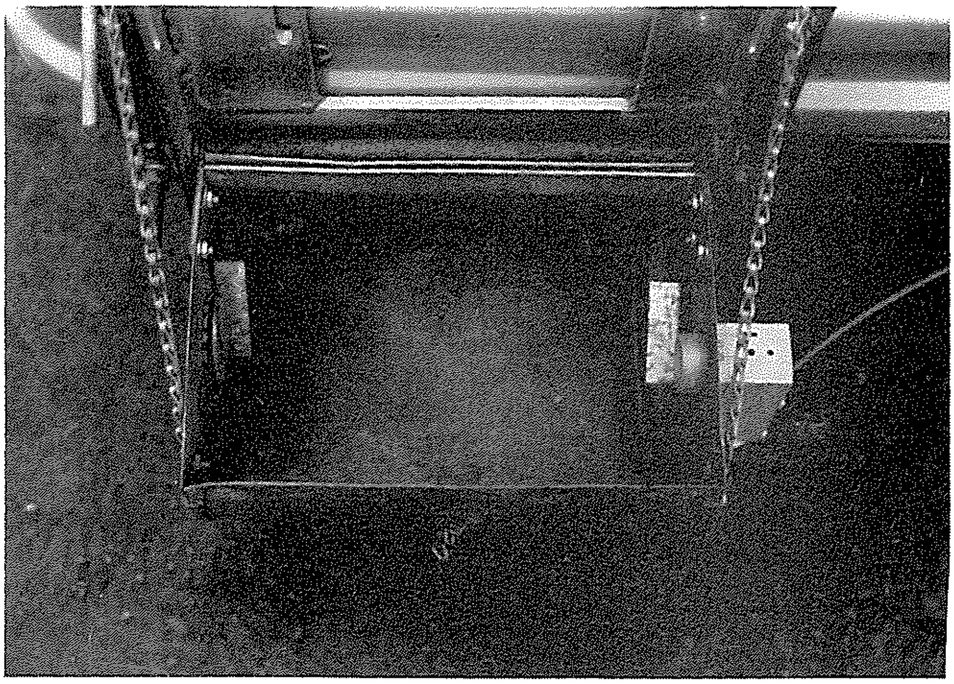

FIG 27. A top view of the device. Reflector is on the left and the transducer is on the right.

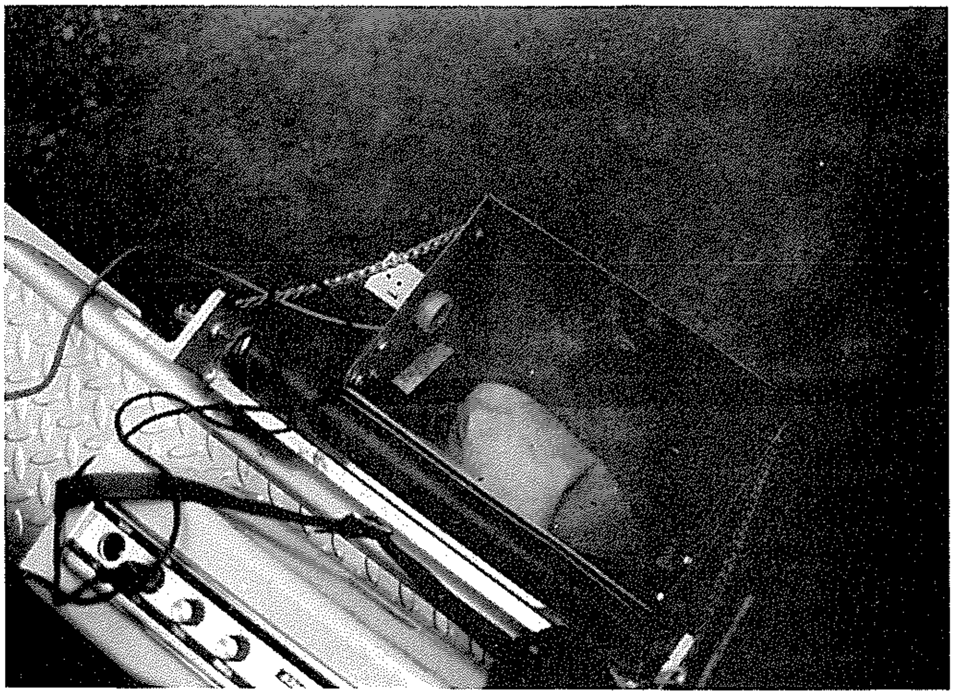

FIG 28. Another top view of the dust monitor.

The duct and transducer are positioned behind the pickup rear wheel. As the vehicle tyre generates dust the dust passes through the duct. The infrared transducer containing a modulated light source shines onto a reflector on the opposite side of the duct and the reflected light is detected by the sensor. The modulation of the light beam makes the device insensitive to changes in ambient light levels. Dust passing through the duct scatters the light beam and reduces the amount of light reflected back to the sensor. The light that is not absorbed in the scattering process is measured by the sensor and converted to a voltage which displays on the meter in the pickup cab.

OPERATION

In operation the readings are affected, as would be expected, by factors such as soil or road moisture. Wind also has an effect on dust readings taken in two directions transverse to the wind direction. Road gradient also has an effect on a two direction test. No other significant problems are evident in the trial operations to date.

ROAD DUST LEVEL

The decision as to whether or not the level of road dust is acceptable or not is very subjective. This device does not alleviate the subjectivity of this determination. What this device does do however is to provide a means of measuring the road dustiness. The decision as to measures to be taken in controlling dust or alleviating it are still required and much overseas experience in this area may be translated to New Zealand conditions with a modest amount of research work. The use of the monitor will make the research work much easier and will also allow quantifiable results from tests to be taken quickly and easily. The standard method used in New Zealand at the present time is to take samples by a filter method and send the resulting samples to Wellington for analysis.

This device is likely to be available commercially in the USA by the time this report is published. The NZ National Roads Board have shown an interest in the device and are investigating the use of the production model or its close equivalent in New Zealand.

AVAILABLE LITERATURE

The literature which I was able to obtain while in North America is all held at LIRA's library.

The most comprehensive document is:-

Taylor, Deborah Jean, Irwin, Lynn H., Aneshansley, Daniel J., A Device To Measure Road Dustiness On Aggregate Surfaced Roads. US Department of Agriculture, Forest Service. EM 7170-8 JUNE 1987 72 pages

This publication covers :-

- *Introduction*
- *Literature review*
- *Instrument design*
- *Instrument characterisation*
- *Tolerable dust levels*
- *Definition of opacity index*
- *Implementation of the instrument*
- *Summary and conclusions*

COMPUTER ROAD DESIGN PACKAGES

41ENS ELECTRONIC NOTEBOOK SYSTEM

INTRODUCTION: The HP41 Electronic Notebook System, is a program which allows the Hewlett Packard 41CV or CX hand-held computer to be used to record survey data in the field. It also allows these calculators to be used as remote terminals for data entry into various computers.

Applicability of the method has been demonstrated in the National Forests of the Pacific Northwest.

PROGRAM DEVELOPMENT: The HP41 Electronic Notebook System (41ENS) was designed to catch common errors made in gathering and reducing field data. By utilizing logical checks, the 41ENS reduces the chance for error in recording the data in the field.

The programs are designed to gather data and transfer it to various programs including the Forest Level Road Design System (FLRDS).

The 41ENS uses a default writing module to tell the program what type of survey will be recorded. The following options are available:

1. *The program can use either section numbers or stations to identify survey points. The program will calculate and display section numbers or allow the user to key them in.*

2. *Traverse angles can be entered as Bearings, Azimuth, deflection or external.*

3. *Traverse distances can be entered as Horizontal or Slope (percent, degree, or zenith).*

4. *Cross section data can be entered as Percent Slope and Slope Distance, degree Slope and Slope Distance, or Horizontal and Vertical Distance.*

5. *Data for "T" lines used to describe junctions or drainage crossings the traverse can be recorded with the survey data.*

HARDWARE AND SOFTWARE REQUIREMENTS: The program requires: HP-41CV calculator with 1 extended function module or an HP-41CX calculator; two (2) extended memory modules or one (1) dual extended memory module (available from Firmware Specialists, Corvallis, OR 97330, USA); one (1) HP-IL interface module to connect the peripherals; one (1) digital cassette drive to store data; mini data cassettes (only one project can be stored on a cassette); one (1) thermal printer for printouts of data entered; one (1) HPIL-HPIB module to transfer data to a computer such as the HP-9020; and one (1)

.5 METER HPIL cable to use as a jumper cable from the HPIL-HP module to the cassette drive.

WHERE PROGRAM CAN BE OBTAINED: The 41ENS Electronic Notebook System and 41ENS Module are available:

USDA Forest Service
Pacific Northwest Regional Office
Director of Engineering
Attention:Clyde E Hally
PO Box 3623
Portland, Oregon 97208 U S A

(503) 221-2089

COST-ESTIMATING OF LOW-VOLUME ROADS USING HP-41CV

INTRODUCTION: Road cost-estimating for low-volume roads needs an efficient, quick method for estimating construction cost. This method asks the estimator questions relating to design standards and terrain. The system allows flexibility in the choice of design parameters, including construction slope ratios, and amount of turnouts and number of cross drainage structures.

The applicability of the method has been demonstrated in the National Forests of the Pacific Northwest and the country of Grenada. Results of these studies were compared with estimates made by traditional methods and with the final actual quantities and costs as computed in the design.

INPUTS:	*OUTPUTS:*
Road Number and Section	*Calculate*
Construction or Reconstruction	*Ditch*
Programs you Want	*Turnout*
Travelled Way Width	*Number of Turnouts*
Length of Road or Section	*Rock*
Distance-Clearing at Cutslope	*Rock Volume*
Distance-Clearing at Fill	*Rock Cost*
Clearing Cost-Acre	*Haul Cost*
Grubbing Cost-Acre	*Excavation*
Embankment or Cut-Fill	*Excavation Quantity*
Cutslope Ratio	*Excavation Cost*
Fill Slope Ratio	*Clearing Cost*
Percent Ground Slope	*Acres*
Compaction Factor	*Clearing Cost*
Widen for Slough	*Grubbing Acres*
Cost Excavation-C Y	*Grubbing*
Cost Ditch Depth	*Seed*
Slope Ditch from Travelled Way	*Seeding Acres*
Turnout Width	*Seeding Cost*
Length Turnout	*Culvert*
Length Transition	*Number of Culverts*
Turnout Space-Feet	*Culvert Cost*
Rock Depth-Inches	*Downspout Cost*

Rock Edge Slope
Rock Cost per C Y
Haul Cost-Average Mile
Haul Cost
Seed Cost per Acre
Cost Culvert per Foot
Culvert Space-Average -Feet
Cost of Downspout

Total Cost of Segment

Cost per mile

HARDWARE AND SOFTWARE REQUIREMENTS: The program requires a HP-41CV calculator, Card Reader, X Function Module, two (2) X Memory Modules, Thermal Printer and HP-IL Module. The program requires Road Estimate and Calculation programs in prime calculator. The program requires storage of the following sub-routines in Storage Modules which can be retrieved on automatic demand. Space used by the program in storage modules is:

data for 134 registers
clearing for 115 registers
excavation for 112 registers
ditch for 6 registers
turnouts for 26 registers
rock for 56 registers
seeding for 42 registers
culverts for 71 registers

OPPORTUNITIES: A transportation planner and/or designer may use this estimation method to examine various alternatives and identify the most cost-effective low-volume road design. With input options and recalculation flexibility, the user may test the sensitivity of each factor and formulate various project alternatives. The hardware and software is completely mobile and usable in extreme environmental conditions.

WHERE PROGRAM CAN BE OBTAINED: The Low-volume Road Cost-estimating Program on HP-41CV and User's Guide are available from:

USDA Forest Service
Pacific Northwest Regional Office
Director of Engineering
Attention: Clyde E Hally
PO Box 3623 Portland,
Oregon 97208
USA

(503) 221-2089

HANS_ON_ROAD DESIGN

This package has developed from a USFS package called LVRDS. Marty Hanson who has left the USFS has developed this package to the stage where it is a very attractive and useful one and would be adaptable to New Zealand use without much trouble.

It is specifically aimed at Forest roading design and also at those with engineering training. No road design package is able to substitute for on the ground experience.

The package runs on an IBM style AT machine with a maths Co-Processor and an EGA video card. These factors alone may limit it use in New Zealand as these are not normally found in locations where road design should be done.

A sample package is available at LIRA for evaluation although as mentioned some special hardware is required.

Cost is about US $600

INTERACTIVE COMPUTER ASSISTED HIGHWAY DESIGN

PROPER Engineering Inc.

The program will function on an IBM or compatible style of personal computer with an EGA video card and screen.

In general the program will do all the activities associated with road design in sufficient detail for forestry use. The program does not plot topographic detail or plan views.

Full details including example print outs are held by LIRA.

Cost is about US $2000

LUMBERJACK

ALTERNATECH

This program is similar to the others in its requirements. From the viewings I had of this program I could not recommend it although as with any road design package considerable time is needed to perform a full evaluation and I did not have that time available when the program was on display.

Its cost is about US $1000.

ROAD SURVEY PACKAGE

Digital Resource Systems, Naniamo, BC, CANADA

This system also is similar to the others and has similar requirements.

It may have some advantages in that Digital Resource Systems may have some association with FRI and this company also has a Geographic Information System which integrates with an Analytical stereo plotter.