LOGGING ROADS STANDARDS PROJECT

REVIEW PHASE OVERVIEW

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SUMMARY

This paper introduces the LOGGING ROADS STANDARDS PROJECT Review Phase report

The New Zealand forest industry is becoming increasingly aware of the extent to which costs will increase as harvesting expands into forests established on difficult terrain.

The greater proportion of the current harvesting roading network is established on the pumice plateau lands of the Bay of Plenty. The future harvesting operations will centre on forests established over the last 25 years on relatively steep terrain, often on unstable, erodable soils. For these forests, road construction and maintenance costs and enviromental constraints will have a significant impact on harvesting costs.

There are already indications that the combined costs of harvesting, roading and transportation, based on current costs and conventional logging/transportation systems, threaten to render some forests economically worthless. The economic significance of expenditure required to upgrade and extend initial road networks to harvesting standards in particular, is such as to necessitate not only re-evaluation of current forest road standards and construction practices, but also the broader issues which can influence the development of optimum logging road standards.

In early 1984 LIRA, in consultation with industry, defined a need to review the standards used for logging roads in New Zealand. The review was to describe the current "state of the art" and identify areas that needed research work.

The following paper, in particular notes the criteria on which current logging road standards are based, identifies areas of contention and highlights significant factors that surfaced during the review. In conclusion, reference is made to the research needs as indicated by industry personnel during the course of the review.

ACKNOWLEDGEMENTS

I would like to acknowledge the co-operation and assistance I received from all sectors of the industry during the course of the review, in particular of the time and data freely given by the many industry personnel.

In addition, I would like to thank :

The Director General of Forests for the approving of my secondment from the N.Z. Forest Service to LIRA to carry out the review phase of the project.

The LOGGING ROADS STANDARDS PROJECT industry working group for their assistance, support and input into the project.

The Director and staff of LIRA for the valuable support and assistance afforded me during my period of secondment to LIRA.

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PREAMBLE

As this Workshop objective is -

"To define the industry's future directions for research work in both the roading and road/truck interaction areas"

I intend to highlight the significant findings that surfaced during the course of the review, and to which emphasis was given in the review report.

In my view, if the workshop objective is to be achieved, then consideration will need to be given to these findings during your group deliberations.

At a Workshop held in Idaho in 1975 into "Low Volume Roads" (another term for forest roads), it was stated that questions that required definitive, technically sound answers were:

"What are the economic constraints for forest roads? Is building a road always the answer?

When should a road be single lane? double lane? earth surfaced? aggregate-surfaced? surface-treated? asphalt concrete?

What is the proper thickness design procedure for an aggregate-surfaced or surface treated road?

What is surface failure on an aggregate-surfaced road?

What is the cost of time and its significance on forest roads?
Is it important for 10 vpd and 32 km/hr speed? 50 vpd and 32 km/hr? 100 vpd and 50 km/hr? or whatever?

How much dust is tolerable?

On small, ungauged streams, how do we estimate drainage requirements for 5, 10, 25, 50 or 100 year storms?

How much damage does a logging truck do to an earth-surfaced, aggregate-surfaced, surface-treated, or asphalt treated road?
Is it the same as a passenger vehicle? 10 times more? 100 times more? 1000 times more?

Should a forest road have shoulders? If so, how wide should they be?

What is the appropriate sight distance for logging traffic? What should the turnout frequency be?"

It was stressed that these were merely a few examples of the scores of questions regarding forest roads.

I put it to you, has the New Zealand forest industry addressed these questions, even with reference to harvesting forests on easy terrain? let alone those established on difficult terrain.

I found little little evidence of it during the review.

REPORT LIMITATIONS

From the outset, I would emphasise that the review report does not in general encompass, nor would the observations and comments contained in it necessarily, and I would stress "necessarily" apply to logging roads associated with :

- those forests having a production area of less than 500 hectares.
- those major forests established on the pumice lands of the Bay of Plenty in general, and in particular the N.Z. Forest Products Limited forests of Tokoroa.

As current major harvesting operations, outside the Bay of Plenty, are predomimately in State Forests - the main exceptions being Baigents in Nelson, Carter-Holt's in Hawkes Bay, Dunedin City Council in Otago and Henderson and Pollard in North Auckland - the review had to in the main focus upon current State harvesting operations. The report has, to a degree, been influenced by this fact.

I would, however, qualify that last statement - during the review I found little evidence that would lead me to believe that when harvesting commences in similar private sector forests the findings will be any different.

The review highlighted the fact that the private sector has about five to ten years breathing space in which to fully comprehend the problems, constraints and probable costs of roading associated with harvesting that the State is currently facing in forests such as Patanamu, Te Wera, Tairua, Glenbervie, Pomahaka and so on.

REVIEW OBJECTIVE

The objective of the Review Phase of the Project was to meet a need to review the current standards used for logging roads in New Zealand, as set out below :

(1) REVIEW CURRENT LOGGING ROAD STANDARDS BEING ADOPTED BY THE INDUSTRY

(2) IDENTIFY THE CRITERIA ON WHICH CURRENT STANDARDS ARE BASED :
e.g. COSTS
VOLUMES OF PRODUCTION
SPEED/LOAD
MAINTENANCE
ENVIROMENTAL FACTORS

(3) REVIEW COSTS AND EQUIPMENT USED

(4) IDENTIFY AREAS NEEDING RESEARCH
e.g. COMPACTION
PAVEMENTS
BATTER STABILISATION, etc.

In broad terms, the review was to describe the current "state of the art" and reveal areas that needed future research work.

REVIEW REPORT FORMAT AND FINDINGS

The format of the review report, contents and significant findings are :

Summary

Summarises the main findings of the review (refer Appendix)

1.0 Foreword

Notes that the New Zealand forest industry roading environment differs from that reported in literature from America, Canada and Europe and that this difference has influenced New Zealand forest roading philosophies, practices and development of specialist technical staffing.

2.0 Background

Outlines the reasons for the project, the scope, the manner in which it would be monitored and the objectives of the review phase.

3.0 Introduction

Details the concern of the industry as harvesting moves into those forests established on difficult terrain and comments that any road transportation system is a compromise between the objectives of minimising road construction and maintenance costs, whilst at the same time providing efficient and safe operation of heavy transport vehicles. In the forest industry high logging costs will put increasing pressure on this compromise.

It also notes that a high proportion of existing low standard internal forest roading, and County roading systems serving the forests, will require extensive upgrading and extending to meet harvesting requirements.

4.0 Industry Personnel contacted during Review

Identifies all the industry personnel contacted during the review and the location of all forests visited.

5.0 Scope of Review

Outlines the scope of the review and comments that emphasis was given to those forests, outside the major forests of the pumice plateau, having a production area greater than 500 hectares.

	50 - 500 HECTARES	500 - 1000 HECTARES	1000 - 5000 HECTARES	5000 HECTARES
STATE	29	17	52	32 *
PRIVATE	660	69	64	15 **
TOTAL	689	86	116	47

CONSERVANCY :

*	5	Auckland (2 Sand)
	10	Rotorua (4 East C.)
	6	Wellington
	5	Nelson
	3	Canterbury
	3	Southland
**	3	North Auckland
	12	Rotorua

SOURCES : N.Z.F.S. Annual Report 1984
PRIFO 1984

6.0 Current Logging Road Standards

6.1 Definitions

The wide variation in terminology used to distinquish between roading *classifications, categories, and standards* became apparent from the outset of the review. Not only is there a wide variation in the format of formally defined roading standards, but also in interpretations as to what infact constitute roading standards.

As stated by the Forest Engineering Research Institute of Canada in their technical report "Standard Classification for Forest Roads" a good classification system should :

(a) *PERMIT DIALOUGUE WITHOUT CONFUSION OVER TERMINOLOGY*

(b) *PROVIDE A BASIS FOR THE DESIGN OF ANY NEW ROADS*

(c) *PROVIDE A BASIS FOR THE EVALUATION OF EXISTING ROADS*

It is clearly apparent that many current formally defined New Zealand industry roading standards would fail to meet the above criteria.

You will note that the Canadian's use the term *road classifications*, why not, *roading standards*?

Is there any difference between *road classification* and *roading standard*?

In fact, what is meant in the NZ industry when terms such as roading *classifications, categories, standards and specifications* are used?

As I could find no general concensus in common definitions for these terms, I gave each my definition and adhered to them throughout the report.

CLASSIFICATION	- Functional description
CATEGORY	- Notation given to a particular road standard
STANDARD	- Describes road geometry
SPECIFICATION	- Construction, workmanship, materials, and design detail descriptions

On adopting these definitions, it then became apparent I would need to go further, even common engineering terms are either mis-understood or incorrectly interpretated. For example, at one forest I visited I used the term *pavement* to a roading supervisor and after a period of time, and confusion, it transpired that his interpretation of what constitutes a *pavement* was quite different to mine.

This is not suprising, as later I noted in an industry publication entitled "Glossary of Engineering Terms" that pavement was defined as *a hard regular surface*, whereas the common technical definition is *the sub-base and surface courses placed singly, or in combination on the subgrade.*

This confusion over terminology is widespread throughout the industry. Terms such as *"super", camber, crossfall, shoulders, formation width, extra-widening, invert, CBR, alignment"* and so on are often not understood in the real technical context. To overcome this problem, two diagrams are included in the report to illustrate the correct application, of common engineering terms/definitions.

6.2 Range of Standards

Adopting the definitions I give for *"classification", "category", "standard" and "specifications"*, what currently exists in the industry in terms of formal road classifications/categories?:

	CATEGORIES
1. N.Z. Forest Service	D E G I
2. N.Z. Forest Products Limited	Arterial Secondary Spur Planting
3. Baigent's	Arterial Secondary Spur Planting
4. Carter Holt	Class 1 Class 2 Class 3 Class 4
5. Henderson & Pollard	Use N.Z.F.S. standards
6. Olsen	Class I Class II Class III Class IV
7. Tasman (Murupara)	Arterial Spur
8. Tasman (Kawerau)	Arterial Secondary Spur
9. Dunedin City Council	No specific standards

In addition to the above are common terms such as *"establishment, shunt, stab, spur, snig, skid, haul"* to describe road/access *classifications*. There is certainly no common acceptance or application of these terms within the industry.

Of the various *classification/category* nomenclatures, I consider the one defining *categories* in terms of *"arterial - secondary - spur - planting"* to be the most appropriate, as they are functional descriptions having meaning.

Defining road *categories* by alphabetical notation, as in the N.Z.Forest Service, has not only caused confusion over the years but also means little to people outside the Forest Service. How can a cartage contractor for instance realistically tender for a State cartage contract based on say a Class G road, without knowing the technical criteria (in terms of geometrics, grade, speed, pavement loading, etc.) on which Class G is based.

Using numerical *category* notations linked to "Class", e.g. Class 2 or Class II, as in the case of Carter-Holt and Olsen, can also create confusion. As in common civil engineering terminology they can be interpreted as indicating pavement strength/loading capability, not road geometric/speed criteria.

Although there is a diverse range of *category* nomenclature, there is nevertheless a degree of functional commonality within the various *category* groupings, relative to road usage/function criteria :

	MAJOR LOGGING ROADS (Maximum traffic/ loading)	LOGGING ROADS (Medium traffic/ loading)	SPUR/SHUNT LOGGING ROADS (Low traffic/ loading)	ESTABLISH-MENT/ MANAGEMENT ROADS
1.	D	E G	G I	G I
2.	Arterial (2 lanes, sealed)	Secondary (2 lanes)	Spur	Planting
3.	Arterial	Secondary	Spur	Planting
4.	Class 1	Class 2/3	Class 3	Class 3/4
6.		Class I	Class II	Class III + IV
7.	Arterial	Arterial	Spur	
8.	Arterial	Secondary	Spur	

6.3 Basis of Standards

In attempting to ascertain the basis on which current roading standards have been determined, it became apparent that there are two distinct groupings. They are :

(1) Standards which have been developed/ modified over the years to meet the transportation requirements of the high production forests of the Bay of Plenty, and to a lesser degree, the major production forests of the Nelson region.

It was evident that logging road standards have been developed for some major forests in these areas that are based on technically sound data resulting from detailed monitoring of actual operating costs. From this data, appropriate logging road standards have evolved to meet the fundamental criteria of optimising the combined costs of roading and transportation.

(2) Standards which have evolved over the years to meet the requirements for forest establishment and management operations and have been extended, it would appear often haphazardly, to meet harvesting operations.

Although the Forest Service is involved in relatively major logging operations outside the Bay of Plenty and their current roading standards are presumed to be based on traffic density/volume criteria, in conjunction with a range of topographical descriptions, the validity or technical soundness of these standards have never been seriously tested or researched during the 20 years they have been in existence.

It is pertinent to note that Forest Service standards have generally been adopted, or used as a basis, for the formulation of many of the current roading standards throughout the private sector.

Of particular significance during the review was the number of times the comment was made that alternative transportation options warrant urgent evaluation, the costs to construct spur roads appropriate to conventional trucking systems could be economically prohibitive.

As yet there are few private forests outside the Bay of Plenty where large scale harvesting has reached a level where the formulation of logging road standards, based on sound technical and economic criteria becomes a critical consideration. This will not remain the case for much longer.

6.4 Appropriateness of current road standards

Apart from those road standards developed for the major forests of the Bay of Plenty, there was little sound technical or economic data available to substantiate the appropriateness of current logging road *standards*, or in fact many current road construction practices.

It needs to be recognised that the formulation of logging road *standards* cannot be done in isolation, development of optimum road *standards* must interact with :

(a) LOGGING SYSTEMS OPTIONS

(b) INTERNAL FOREST TRANSPORTATION OPTIONS

(c) ENVIRONMENTAL CONSTRAINTS

(d) PUBLIC ROADING STANDARDS

(e) VOLUMES OF PRODUCTION

(f) PRODUCT TYPE

(g) SEASONAL SCHEDULING OF OPERATIONS

These elements dictate the appropriate road *classification/category* and influence, or control, the location, timing and the construction *standard* of the logging road.

To develop integrated roading *specifications* requires subsequent evaluation of road usage/ function criteria, in terms of :

- VEHICLE TYPE
- SPEED
- SAFETY
- AXLE LOAD
- TRAFFIC DENSITY
- ROAD LIFE/MAINTENANCE
- SEASONAL REQUIREMENTS
- DIRECTIONAL FLOW OF TRAFFIC

combined with assessment of :

- TERRAIN
- EXISTING FOREST ROAD NETWORKS
- TECHNICAL MANPOWER RESOURCES
- CONSTRUCTION PLANT AVAILABILITY
- CONSTRUCTION OPTIONS
- ECONOMIC EVALUATIONS

It will be seen from the above that where it would be feasible to have a common road *classification/category* system, it is not feasible for a common road *standard/specification* system, the latter evolve from specific road usage/function considerations.

It is interesting to speculate whether, if roading *standards* had been developed taking into account the above factors at the forest establishment stage, the industry would in fact have the extent of forests established on difficult terrain that it currently has today.

One of the most significant findings that surfaced during the review was that few sectors of the industry have sound cost data to enable realistic evaluation of the cost relationships between :

(a) ROAD CONSTRUCTION AND ROAD MAINTENANCE

(b) ROAD CONSTRUCTION STANDARDS AND TRUCKING PERFORMANCE

(c) THE EFFECT OF VARYING ROAD MAINTENACE STANDARDS ON TRUCKING COSTS

(d) THE EFFECT ON PAVEMENTS OF TRAFFIC LOADING

(e) THE SEASONAL EFFECT OF TRAFFIC LOADING ON PAVEMENTS

(f) THE EFFECT OF VARYING ROAD SURFACE TYPES ON TRUCKING PERFORMANCE

In my view, research into the relationships between all these factors must receive high priority in attempting to rationalise the current roading concerns, rather than the narrow specialised approach that is often evident to date.

A number of roading *classifications* are deficient due to a lack of explicit criteria to indicate which *category* is appropriate, in terms of road usage/function considerations. Due mainly to this ambiguity, it is evident there is a high incidence of over or under design of many logging roads, the latter appearing to be far more prevalent.

It is also particularly noticeable when comparing the various roading *standards* that there is considerable variability in the translation of "*standards*"into "*specifications*". It appears that the extent to which *specifications* are defined/developed, and implemented is largely reliant on the specialist technical staffing levels within a company.

Significant omissions in many roading *standards* are :

- PAVEMENT DESIGN SPECIFICATIONS
- DATA TO DETERMINE OPTIMUM PAVEMENT THICKNESSES RELATIVE TO SOIL CONDITIONS/TYPES
- TYPICAL ROAD CROSS-SECTIONAL DETAILS
- SUPER-ELEVATION AND EXTRA WIDENING SPECIFICATIONS
- BASIC ROAD METAL SPECIFICATIONS
- SIGHT DISTANCE CRITERIA
- DRAINAGE AND CULVERTING CRITERIA
- ROAD MAINTENANCE CONSIDERATIONS
- EARTHWORKS CONSIDERATIONS
- SOIL/PAVEMENT/MATERIAL TESTING PROCEDURES

I would strongly recommend that consideration be given to the merits of a standard road *classification/category* system being adopted throughout the industry.

6.5 Construction Standards, Practices and Costs

To illustrate the widely differing road construction standards noted during the review, and the road usage/function criteria that influenced, or dictated the construction standards, four examples are highlighted in the report :

(1) The main arterial road through Kaingaroa State Forest to the rail head at Murupara that has to accommodate triple rig logging units having a gross vehicle weight of 120 tonnes.

(2) The internal forest roads of the Wellington Regional Council forests. These forests are often served by low standard public roads with bridges having load restrictions, as a consequence logging contractors have adapted trucking systems to suit. The internal forest roads are constructed to standards that reflect these constraints.

(3) The Nelson Pine Forests beech logging operations involve constructing roads over private land to give access, from high standard public roads, to limited beech resources. The roads are generally temporary, short in length, have relatively low volumes carted over them and often revert to general farm access. The construction standards reflect the low volume of traffic, short period of use and the fact that there is no ongoing commitment to maintenance.

As the fourth case is more typical of what will be encountered in the future with forests to be harvested on difficult terrain, I will set it out as it is in the report :

(4) Harvesting operations in many forests established on the East Coast of the North Island, for example Nuhaka, Mangatu, Wharerata, will require development of roading standards and construction specifications that will reflect :

- the adverse soil types
- the high cost for road metal, currently \$36 m^3 in some areas
- the erosion prone terrain

- the severe environmental constraints
- the probable use of non-conventional logging/transportation systems

As a consequence, roading standards and construction specifications will require to be developed with emphasis being given to these factors, having regard to :

- optimum drainage and culverting
- mechanical compaction of both subgrade and pavement
- programming of construction during the summer season
- use of road fabrics and soil stabilisation agents
- soil/material/pavement testing procedures
- seasonal logging operations

What are currently commonly referred to as *roading standards* are in fact *road classifications/ categories,* broadly defining function and general descriptions of road geometry, pavement strength and pavement surface type. The wide variation in construction standards noted during the review confirm that *road classifications/ categories* should be seen as *"guidelines for the basis of design"*. The result of design is the development of construction *standards* and detailed *specifications* appropriate to road usage/function criteria.

The extent to which formal engineering design will be economically justified depends on the scope and technical complexity of the particular roading operation.

I would stress that the wide variation in road construction standards noted during the review confirms the current practice in many sectors of the industry is to construct roads to predetermined costs, derived from broad road usage/function criteria. It is evident that while initial construction cost may be the criteria virtually no effort is made to assess the <u>combined</u> costs of construction, maintenance and vehicle operation and set standards to achieve <u>minimum total costs.</u>

Construction practices - Many current road construction practices have evolved as a consequence of almost total reliance on bulldozers for road construction. This is particularly evident where construction has been carried out with "own forces" type operations.

As the prime function of forest establishment and management was basically one of gaining access, generally for light duty vehicles, the formalities of design, survey, supervised construction and adherence to formally defined roading standards were not critical functions. Neither were the need to achieve optimum road construction standards critical considerations.

As a consequence, the common road construction practice has been contour sidling roading, with excavated material being sidecast. Pavement construction practice has commonly been the over-laying of, generally bulldozer-graded, formation with sufficient metal to achieve traction for establishment vehicles. As a consequence, the capability of the subgrade of many existing roads to sustain axle loads of even establishment/management traffic is limited, as was evidenced by the high incidence of pavement failure noted during the review.

I consider it justified to make the following comment. Many civil engineering practices which have evolved over the years in regard to public road design are often, to a greater or lesser extent, pertinent to many logging road construction operations. I would suggest that adoption of those practices which are appropriate may/would result in minimising the industry's road construction and maintenance costs; ignoring them will have the opposite effect.

The requirement to construct logging roads to standards that will achieve the criteria of *"minimum combined cost for truck hauling and road construction and maintenance"* will necessitate re-evaluation of many current forest road design and construction practices.

Costs - Due to the wide variation in road construction standards and site conditions, there is a correspondingly wide variation in construction costs. It is quite evident, however, that pavement metalling is generally the major cost component. With the exception of forests having a ready source of rippable or river gravel, pavement metalling rarely constitutes less than 40 percent, averages about 50 percent and can be as high as 70 percent of total current road construction costs.

I am therefore of the opinion that a priority for research should focus on pavement design and pavement construction practices, for example :

- subgrade/pavement compaction techniques
- soil/road metal/pavement testing procedures
- road fabric and road stabilisation agents
- pavement maintenance practices
- pavement drainage criteria

The review indicated that the range of construction costs for various road categories would be :

MAJOR LOGGING ROADS (2 lane sealed) approximating main highway standards	$60,000 to $120,000/km
MAJOR LOGGING ROADS (2 lane unsealed) approximating rural County road standards	$30,000 to $80,000/km
LOGGING ROADS (1 lane metalled) approximating rural County road standards	$15,000 to $40,000/km
SPUR/SHUNT (LOGGING) ROADS	$10,000 to $20,000/km

I consider that it is probably because of the above costs that there is widespread concern within the industry at the high cost estimates often put forward by many local authorities for upgrading of public roads to meet the industry's transportation needs. It is therefore difficult to avoid the conclusion that either :

- the industry's current road construction standards and/or construction practices lead to lower costs, through under-design, and there was evidence to support this view, or
- that many public authorities, who operate largely with Government subsidies for roading, are reluctant to adapt their current road design criteria to achieve standards more appropriate, certainly in terms of economics, to the forest industry's transportation requirements.

Should the latter in fact be the case, then this reluctance could well be reflected back to Consulting Engineers, and be a major reason why they have difficulty in recognising the critical financial constraints associated with roading operations within the forest industry.

Maintenance

It was apparent during the review that in many sectors of the industry roading maintenance has become the "catch all" category in roading budgets. I would defy anyone to come up with realistic probable, or typical costs for roading maintenance within the industry. I know in the State sector it ranges from $200 per kilometer per annum to well in excess of $2500 per kilometer per annum.

If road maintenance is defined as "work required to keep a road at its present standard or restore it to its original standard" then a very high proportion of expenditure being identified as roading maintenance would be more technically described as road upgrading or reconstruction. I am concious of the fact that in the private sector there could well be taxation considerations in this regard.

It must be recognised that the design criteria and construction practices adopted for establishment and management roads were chosen to achieve the primary function of gaining access, and pavement loading was not a critical consideration. As a consequence, what is often being accounted for as roading maintenance is in fact re-construction or upgrading of roads that have failed, due to being subjected to loads and vehicles for which they were never designed or intended.

The limitations of much of the current forest roading will not become apparent until increased loads are placed on the roads by production thinning and clearfelling operations.

There appears to be an almost total lack of appreciation within many sectors of the industry of the extent of these limitations and of the probable expenditures that will be necessary to upgrade existing pavements to sustain logging transportation loads.

The fact that road maintenance costs are generally difficult to identify hinders realistic evaluation of the trade-off between initial road design standards and construction practices relative to maintenance costs, and particularly to total expenditure over the life of the road.

7. Factors highlighted during the Review

In the report are a number of concerns that warrant specific mention. In my view, they have an impact on the possible future direction THE LOGGING ROADS STANDARDS PROJECT should take. Of the thirteen stated in the report, I will comment on seven :

- Minimal research has been attempted within the industry to evaluate the inter-relationships between road standards, roading costs, roading density, production volumes and production costs. As a consequence, they are poorly defined in many instances.
- In a large number of forests the internal forest haulage distance will be minor in relation to the haulage distance from forest to mill. As a consequence, the haulage distance on, and the standard of, county roads and State highways may be more significant, in terms of total haulage costs, than the internal forest road networks.
- Although the industry considers that current roading costs are higher than necessary they have little hard cost data to support this view.
- Currently, initial construction costs appear to be the major determinant in setting road construction standards. It is evident that many logging roads are constructed to monetary estimates/budgets and not to defined road standards based on sound economic analysis.
- There appears to be a lack of sophistication evident in many sectors of the industry when making decisions between road construction by contractors or "own forces". It is often not recognised that the use of contractors not only offers a basis for valid cost comparisons but can also ensure access to specialised skills and construction plant.
- There is almost a complete lack of application and understanding of compaction techniques which could be used to minimise the major cost of providing pavement strength.
- Due to the almost complete reliance on bulldozers to form roads little emphasis or consideration has been given to forming roads on a cut and fill basis, thus greatly restricting the ability to achieve optimum standards of alignment, particularly in forests on difficult topography.

8.0 Technical staffing

8.1 Functions

Road planning, design and construction requires a fusion of a variety of disciplines and skills. It is the function of logging planners to give clear definitions of the use expected of a road (e.g. vehicle type, speed, axle loads, traffic density, road life, seasonal requirements, timber volumes and directions, etc.), the operational impacts of changes in road location or standards, the tolerable level of maintenance costs and to define their needs in terms which will permit engineering staff to develop appropriate road standards.

The specialist engineering function is to ensure that roads are designed to meet the logging planners' criteria, not only efficiently and economically but also to minimise environmental impacts and land loss. The outcome of engineering input must be a clear definition of road location, road design criteria, estimated costs and appropriate road standards/specifications that can be interpreted by construction supervisors.

The function of construction supervisors is to closely supervise and manage construction works, apply proven construction techniques and monitor plant/labour performance to ensure roads are not only constructed to design standard but also on time and within budgeted costs.

A significant factor to emerge during the review was the lack of formal structures allowing for this type of planning and the apparent shortage of qualified/experienced personnel to make it effective. Perhaps the most critical element to emerge in this regard was the minimal number of personnel holding tertiary or technical qualifications in civil and/or forest engineering to execute the location, technical evaluations, design and construction activities associated with roading.

8.2 Current staffing levels

The spread of civil engineering personnel in roading throughout the industry is :

	Registered Engineers	*Civil Eng. Graduates*	*Technical Officers**	*Construction Supervisors*
N.Z.F.S.	*5*	*1*	*20*	*7*
N.Z.F.P.	*1*	*2*	*5*	*17*
Tasman (Murupara)	*0*	*0*	*1*	-
Tasman (Kawerau)	*0*	*0*	*2*	-
Baigents	*0*	*0*	*1*	*2*
Consultants	*0*	*0*	*0*	-
Others	*0*	*0*	-	-

- *unknown*

* *Formal qualification : N.Z. Certificate in Engineering (Civil)*

Note :

Definition : Construction Supervisor:

- a person having had substantial experience in the operation and maintenance of a wide range of road construction plant and/or quarry plant plus formal training in basic civil engineering and management skills applicable to road construction works, or quarry operations. Would be competent in management of plant and labour and application of sound construction techniques. Formal qualification would be "Civil Engineering Works Supervisors' Certificate".

8.3 Ramifications of current staffing levels

- The extent to which current roading standards and specifications are effective is by and large dependent on whether staff given the responsibility to implement them have the technical training/expertise to interpret them.

- The number of staff responsible for roading operations who lack even a basic understanding of fundamental civil engineering principles and sound construction practices should be of concern to the industry.

- The current technical demands placed on the few qualified engineering staff within the industry is high with the result that few are able to attempt practical research, detailed evaluation of construction options or implement materials/pavement testing procedures as a means of reducing roading costs.

- It is evident that many sectors of the industry fail to appreciate the skills and expertise required of staff given the responsibility for supervision of road construction works.

- The effects of these specialist staff shortages will become increasingly apparent as harvesting operations expand and additional roading is required to be constructed/upgraded to logging standards.

8.4 General Comments

If logging roads are to be designed and constructed on the premise of "minimum combined cost for truck hauling and road construction", engineering design of roads will be essential as will engineering survey and proficient supervision of construction works to ensure adherence to design criteria and cost estimates.

Although considerable literature is available in New Zealand describing research carried out overseas into forest roading and transportation, the limited number of technical staff within the industry available to analyse and evaluate this data is a block to gaining the benefits from this research.

POSSIBLE RESEARCH DIRECTIONS

I put forward a number of research suggestions you may wish to give consideration to in your group deliberations :

(1) Whether industry should consider adopting a a standard road classification system.

(2) Whether the industry is hooked into conventional transportation systems and is unaware of other options available.

(3) Whether the existing training programmes relating to roading and transportation are appropriate for future harvesting operations.

(4) How the industry can develop training programmes to integrate the specialist functions of logging, roading and transportation.

(5) How to ensure the industry benefits from the considerable research carried out overseas into forest roading and transportation.

(6) How the industry is going to access the specialist engineering skills that will be vital to ensure future harvesting, in those forests on difficult terrain, will be economically viable.

(7) How those factors that should be the basis of road construction standards are researched and evaluated.

(8) Whether the industry give emphasis to collating all the present knowledge and the "state of the art" experiences relating to roading throughout the industry and compile a detailed forest roading manual.

CONCLUSION

I commenced this paper by quoting a number of questions, pertinent to forest roads, as needing definitive, technically sound answers, that were identified by the U.S. Forest Service at a Idaho roading workshop in 1975.

The fact that the New Zealand industry is now addressing these questions, a decade later, at a similar type forum underlines the significance of the LIRA Logging Roads Standards Project.

In conclusion, I would quote a statement from the Chairman's opening address to the Idaho workshop:

> *"I HAVE ALWAYS FELT THAT IN MANY RESPECTS IT IS EASIER TO DESIGN A HIGH TYPE (STANDARD) OF ROAD FOR SEVERAL REASONS.*
>
> *ON THE LOW-VOLUME ROAD, FOR EXAMPLE, WE ARE CONTINUALLY STRIVING FOR LOW COST, WHICH MAKES OUR DESIGN EXTREMELY SENSITIVE FROM THE STANDPOINT OF THICKNESS, QUALITY OF PAVING (OR SURFACING) MATERIALS, GEOMETRIC DESIGN, AND MANY OTHER FACTORS."*

In my view, this comment has particular relevance to the New Zealand forest industry, certainly in relation to those forests established on difficult terrain.

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APPENDIX I

SUMMARY SECTION FROM THE LOGGING ROADS STANDARDS PROJECT INTERIM REPORT

Summary

(i) Future harvesting operations will centre on forests having a wide range of terrain, in terms of steepness and difficult/unstable soils. The review has given emphasis to forests outside the Bay of Plenty, having an initial annual production of at least 10,000 cubic metres. The report does not specifically apply to forests having a production area of less than 500 hectares.

The industry already has an extensive roading network of at least 26,000 km, this will be substantially increased over the next two decades.

(ii) Current roading standards fall into two distinct categories, they are:-

(a) Standards which have been developed/modified over the years to meet the transportation requirements of the high-production forests of the Bay of Plenty, and to a lesser degree, the major production forests of the Nelson region.

The long experience, high volumes transported and accumulation of sound cost data has enabled appropriate standards to be developed, although they may not be formally defined.

(b) Standards which have evolved over the years to meet the requirements for forest establishment and management and have been extended, it would appear haphazardly, to meet the harvesting operations.

It is difficult to identify the criteria on which these standards are based. The fact that few of the private sector forests have reached the stage of large scale harvesting has meant that the appropriateness of current standards has not become a critical issue.

Some organisations have written road classifications and standards of intent but these are rarely reflected in practice. NZFS standards fall into this category, it is unfortunate that some private organisations appear to adopt these standards at face value.

(iii) There is no consistency in terminology within the industry in defining road standards, classifications or categories, although there is a degree of commonality in functional descriptions.

The extent to which specifications are developed appears to hinge on the capability of personnel to interpret them.

Consideration should be given as to the merits of a standard road classification system for the industry.

(iv) There are significant omissions in many roading standards of specifications defining construction details, e.g. pavement thickness according to soil types, road profile details, superelevation/extra widening detail etc.

There is as a consequence wide variations between the defined standards and the standards to which roads are actually constructed. This is particularly evident in the poor standards of drainage, pavement and alignment of many current forest road systems.

(v) Currently within the industry there are 9 civil engineers, 29 civil engineering technicians and approximately 26 construction supervisors (having formal qualification or training). They are spread unevenly through the industry as two organisations account for over 90% of them.

The benefits that can accrue through applying sound supervision to road construction works by experienced construction supervisors would not appear to be generally appreciated in many sectors of the industry. The crucial function and importance of the construction supervisor is daily on-site supervision of plant and labour. The application of correct construction techniques to achieve maximum efficiency will determine the final outcome of works in terms of costs, effectiveness and adherence to design criteria. It should be of concern that so little attention has been given to ensure that adequate skills are available at this level.

The number of staff responsible for roading operations who lack even a basic understanding of fundamental civil engineering principles and practices should be of concern.

(vi) It is evident that conventional civil engineering training does not adequately prepare its graduates, professional or technical, to be immediately effective within the Industry. Serious consideration should be given to broader forest engineering training, to encompass both civil and harvesting operations.

The current technical demands placed on the few qualified civil engineering staff is high with the result that few have time to attempt practical research, detailed evaluation of construction options or implement materials/pavement testing procedures as a means of reducing roading costs.

If logging roads are to be designed and constructed on the premise of "minimum combined cost for truck hauling and road construction" engineering design of roads will be essential as also will engineering survey and proficient supervision of construction works to ensure adherence to design criteria and cost estimates.

The functions of specialist civil engineering staff - whether they be engineers, graduates, technicians or construction supervisors - and their roles relative to foresters and forest management staff is ill defined within the Industry.

(vii) The wide variation in construction standards would confirm that current practice in many sectors of the industry is to construct roads to pre-determined costs, derived from broad road usage/function criteria. It is evident that while initial construction costs may be the criteria virtually no effort is made to assess combined costs of construction, maintenance and vehicle operation or to set standards to achieve minimum total costs.

Although industry considers that current roading costs are higher than necessary they have little hard cost data to substantiate this view. Although it is acknowledged that there is a direct relationship between road costs - maintenance costs - haulage costs scant consideration is given to it as evidenced by the absence of accurate cost data.

Until sound cost data is available the appropriateness of many current roading standards is doubtful.

(viii) There is a very wide range of construction standards. As road usage/function criteria varies greatly this is to be expected, adherence to formal roading standards would be inappropriate in many instances.

The required standards of construction vary widely, from the 2 lane sealed roads through Kaingaroa to take triple rig logging units to the temporary access roads to gain access to limited beech resources in Nelson. It is apparent that existing logging road construction standards (as opposed to the organisation's formal written classifications and standards) generally reflect road function in terms of vehicle type, design speed, axle load, traffic density, road life criteria.

The wide variation in construction standards confirm that roading classifications are only guidelines for the basis of design. The extent to which formal engineering design is economically justified depends on the scope and technical complexity of the particular roading operations.

(ix) There is almost a total reliance on bulldozers for road construction and as a consequence the common road construction practice has been contour sidling roading with excavated material being sidecast. Pavement construction practice has generally been the over-laying of, bulldozer graded, formation with sufficient metal to achieve traction. As a consequence the capability of many subgrades of existing non logging roads to sustain even medium axle loads is limited.

There is an almost complete lack of application of compaction techniques to minimise the major cost of providing pavement strength. This appears to be mainly due to a lack of understanding of compaction principles, and insufficient planning lead-time to achieve optimum moisture content.

The use of specialised items of plant (e.g. motor-scrapers, hydraulic excavators, construction graders, compaction plant, etc.) within many sectors of the industry has been minimal with the result that road construction based on a cut and fill method has not been developed.

To achieve the road standards necessary for future harvesting operations a better balance of construction equipment will be required, use of specialised plant will improve options for optimum alignment, drainage, pavements etc.

Current construction practices have restricted the ability to achieve optimum road construction standards in terms of alignment and gradient.

(x) Road metalling is a major cost and rarely constitutes less than 40%, averages about 50%, and can be as high as 70%, of total current road construction costs.

There is a critical trade-off between initial formation construction practice (in terms of road profile, drainage, compaction, location etc) and road metal requirments. This is clearly an important area for research and the development of guidelines.

FERIC* have given emphasis to this aspect in their current research programme.

(xi) There is wide interpretation throughout the industry in definitions of what roading maintenance encompasses. A high proportion of roading maintenance could be more technically described as road upgrading/reconstruction. This may be as a consequence of existing taxation requirements. As a consequence initial construction standards are resulting in the apparent high road maintenance costs.

It is evident that pavements fail due to being subjected to logging loads for which they were never designed or intended.

There appears to be an almost total lack of appreciation within the industry of (the extent of) these pavement limitations and of the probable expenditures that will be necessary to upgrade them to sustain logging transportation loads.

The fact that road maintenance costs are difficult to determine hinders realistic evaluation of the trade-off between road standards and construction practices relative to maintenance costs, and particularly the relationships to total expenditure over the life of the road.

(xii) In a very large number of forests the internal forest haulage distance will be minor in relation to the haulage distance from forest to mill, as a consequence the haulage distance on, and the standard of, County roads and State highways may be more significant than the internal forest roads.

(xiii) The participation of private civil engineering consultants in roading operations within the industry is minimal. The reason must in part result from a lack of appreciation within the industry of the financial benefits which can flow from skilled technical input.

However, it is also apparent major reasons inhibiting greater use would be due to consultants:

- often demonstrating a lack of understanding of the financial imperatives that underlie forest operations, and/or

- being unable to accept that much of the technical design criteria, and construction practices, applicable to public roading systems are often not relevant to forest roading operations.

In this regard industry will have to evaluate whether to substantially increase the numbers of specialist personnel within the industry or use engineering consultants to a greater extent than at present.

* Forest Engineering Research Institute of Canada.

(xiv) The standards for spur/shunt/stab roads giving access to hauler/skid sites from arterial secondary roads needs to be resolved. The majority of these roads are relatively short in length, temporary in nature and generally have very limited volumes passing over them.

It is evident that alternative transportation options, e.g. forwarders, off-road trucks, cable roads etc warrant urgent evaluation. The cost of constructing conventional roads in a number of situations, relative to production volumes and road life, could be prohibitive.

(xv) By far the most significant finding to emerge from the review was an awareness of the extensive research carried out overseas into forest roading operations and the appropriateness that much of this research would have to the New Zealand industry.

It is evident that before the industry tackles areas of new research, emphasis should be given to reviewing the application of the knowledge and findings already available.

From a 1975 US Workshop on "Low-Volume Roads" (i.e. forest roads) the Chairman stated in his opening address, that

> "I have always felt that in many respects it is easier to design a high type (standard) of road for several reasons. On the low-volume road, for example, we are continually striving for low cost, which makes our design extremely sensitive from the standpoint of thickness, quality of paving (or surfacing) materials, geometric design, and many other factors."

(xvi) Many of the report findings are not solely as a result of the review, clearly the report has been influenced by the author's involvement over the last 20 years with roading operations with the State sector.

The review confirmed, however, that the many areas of concern that are currently surfacing in the State sector as harvesting expands into forests established on difficult terrain (e.g. Te Wera, Patunamu, Pomahaka, Tairua etc.) are, or will become evident, in many private sector operations.

(xvii) Many within the industry, with purely a civil engineering background, stated during the review that they were concerned at not only the lack of sound technical and economic data on which to base engineering judgements, but also the frequent inability, for one reason or another, to apply sound engineering practices.