The Australian Experience in Assessing the Economics of Road Vehicle Limits

R.A. Pearson[1]

ABSTRACT

Australia has now undertaken two major studies into the economic effects of increasing truck size and weight. These were the Economics of Road Vehicle Limits (ERVL) Study, 1973-1975, and the Review of Road Vehicle Limits (RoRVL) Study 1984-85. Both these studies used a systems approach to the prediction of the effects of regulatory change in size and weight. The paper will discuss both ERVL and RoRVL, briefly outline systems used, compare predicted with actual situations post ERVL, and review Australian experience to date.

INTRODUCTION

Australia has now undertaken two major studies into the economic effects of increasing truck size and weight. These studies were the Economics of Road Vehicle Limits (ERVL) Study, 1973 to 1975, and the Review of Road Vehicle Limits (RoRVL) Study, 1984 to 1985. Both of these studies used a systems approach to the prediction of the effects of regulatory change in vehicle size and weight.

Data collection associated with the RoRVL Study provided a valuable opportunity to assess the effectiveness of the predictive models.

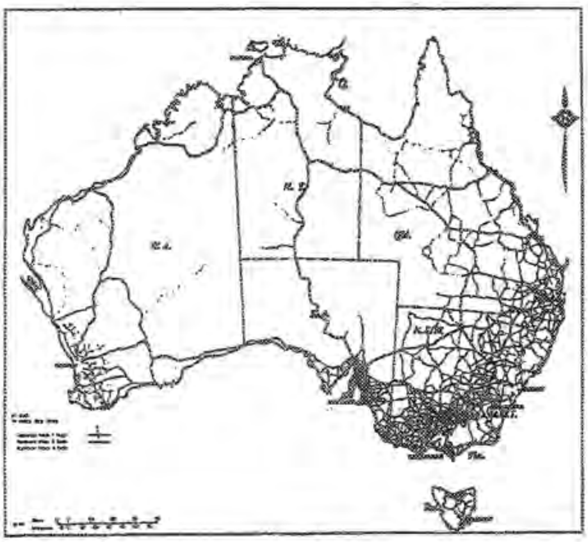
This paper outlines the systems used in both studies and presents some comparative data on the changes arising from a discrete change in road vehicle limits in Australia.

THE AUSTRALIAN ROAD SYSTEM

Australia has an area of approximately 7.7 million square kilometers and a population of approximately 16 million persons located mainly on the south-eastern seaboard (Figure 1), together with the heaviest concentration of major roads. The distribution of Australia's population has been determined mainly by climatic factors, such as the rainfall pattern and, to a lesser extent, by topography. However, not only have these factors influenced the extent of transport activity but they are also important factors affecting the design and construction of roads. The properties of subgrade materials, the design of road pavements, road geometrics and drainage works are all influenced by topographical and climatic conditions.

In this paper, the term Eastern States is used to describe the States of Queensland, New South Wales, Victoria and Tasmania, while the Western States refers to the States of Western Australia, South Australia and the Northern Territory.

Traditionally, the mass limits in the Eastern States have been lower than the Western States. In presenting information in some sections of this paper, a representative Eastern State, Victoria, is illustrated, and information is given for Western Australia as representative of Western States. The use of these States provides a direct comparison



Major rural roads in Australia

FIGURE 1

1 Engineer, Road Vehicle Limits, Road Construction Authority, Victoria, Australia

with changes in vehicle limits, as regulation of this nature is the responsibility of each State.

STUDY ORGANISATION

Both studies were undertaken by a full time Study Team under the direction of a Steering Committee. In ERVL, the Study Team comprised four engineers, economist and support staff and the Steering Committee included a transport industry representative.

The RoRVL Study Team consisted of 3 engineers and support staff, and Steering Committee members comprised five State Road Authority representatives, and representatives from the Australian Road Research Board, the Australian Road Transport Federation (operators), the Federal Department of Transport, the Bureau of Transport Economics and the Transport Workers Union.

GENERAL DESCRIPTION OF STUDY SYSTEMS

The methodology described below was developed for the ERVL Study and used with minor modifications for RoRVL.

A representative system network diagram for both ERVL and RoRVL are presented in Figure 2.

The key elements in the system process are:

- the prediction of the response of the transport industry in adapting to a new set of limits; and
- the response of the road system to this new set of vehicle characteristics.

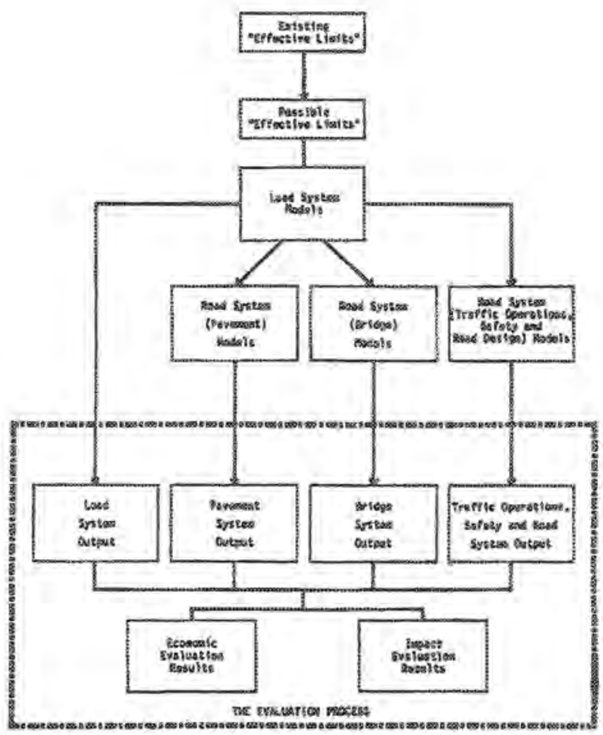
The first step in the process was to collect information on both the existing vehicle fleet and the condition of the road network. Comprehensive surveys of vehicles were carried out throughout Australia covering both classification and details of mass and dimension.

The load system models aimed to reflect the likely responses of truck operators and manufacturers to an alternative set of vehicle mass and dimension limits. This was achieved by examining characteristics of each truck in the data base and generating an alternative set of vehicles which would carry out the transport task in the new limit situation. It was considered, in developing the models, that the degree of utilization of existing limits provided a guide to the potential utilization of alternative higher limits. Within this frame work, the basic premise adopted was that the extent to which alternative limits would be utilized depended upon:

- utilization of the existing limits; and
- relative magnitudes of the alternative and existing limits.

In contrast to the procedures adopted in similar previous studies, the models were applied to individual vehicles in the data base rather than the frequency distribution of any given characteristic. Various constraints must be applied to ensure the real situation is predicted as accurately as possible. The most important of these constraints were:

- the exclusion of certain vehicles from the procedures (e.g. those carrying out collection and delivery functions which are not constrained by mass, and those not designed to utilize the existing limits);



Typical system network diagram

FIGURE 2

- ensuring that the load did not exceed the physical capacity of the vehicle in terms of volume; and

- ensuring that the amount by which the limit on any characteristic is exceeded is no greater under the higher alternative limit than it is in the existing situation.

Figure 3 illustrates an example of the results of this model, presented as cumulative frequency.

The change in loadings predicted by the load system models will result in a change in the rate of deterioration of existing pavements, different strength requirements of new pavements, and a change in the maintenance requirements for pavements and shoulders. Models were developed to predict the extent of these changes.

The major difficulty with pavement systems is the measurement of current pavement condition under an alternative set of limits. Both studies used pavement roughness as this measure. Roughness was used because of the difficulty of assessing structural condition when considering the entire road system and the prediction of performance relating the degree of severity of structural deterioration to various axle loadings. Different models were derived for each of the major road classes and each of the Australian States or Territories.

For bridges the effect of increased loading were considered in terms of the load capacity for each separate vehicle. Load capacity of bridges were assessed by using elastic based working stresses rather than ultimate strength analysis.

Various cost models were developed to determine the costs associated with any new alternative limits for both roads and bridges.

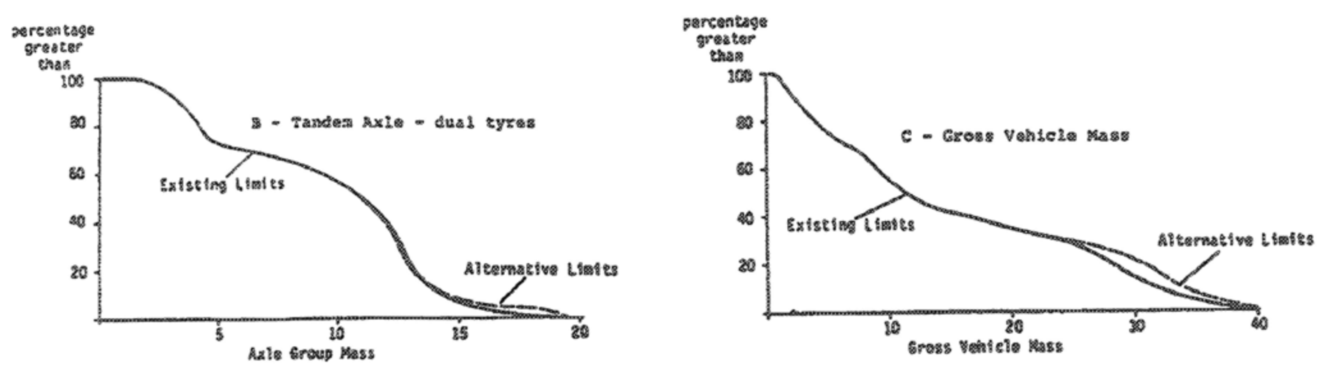
The benefits to the trucking industry were estimated after collection of substantial data on current vehicle operating costs, and the effects any changes would have on those costs.

With respect to the evaluation of alternative limits, an economic evaluation based on cost-benefit analysis was considered most appropriate for those factors which were capable of expression in monetary terms. However non quantifiable measures were also considered.

THE ECONOMICS OF ROAD VEHICLE LIMITS STUDY 1973 - 75

The objective of the ERVL Study was the determination of the most appropriate mass and dimension limits that should apply nationally or in particular regions in Australia. Changes to the mass and dimension limit regulations were considered having regard to the advantages to be gained through savings in transport costs, and the cost and impact on the community.

In arriving at final conclusions from the ERVL Study as to the most appropriate set of limits, recognition was given to the need for greater uniformity in individual State regulation which existed at that time. This was considered to be particularly important in relation to the design and manufacture of heavy commercial vehicles, where differences in individual State regulations were evident in the configurations used. A further measure or constraint was the level of additional



Comparison of output and input of new truck model

FIGURE 3

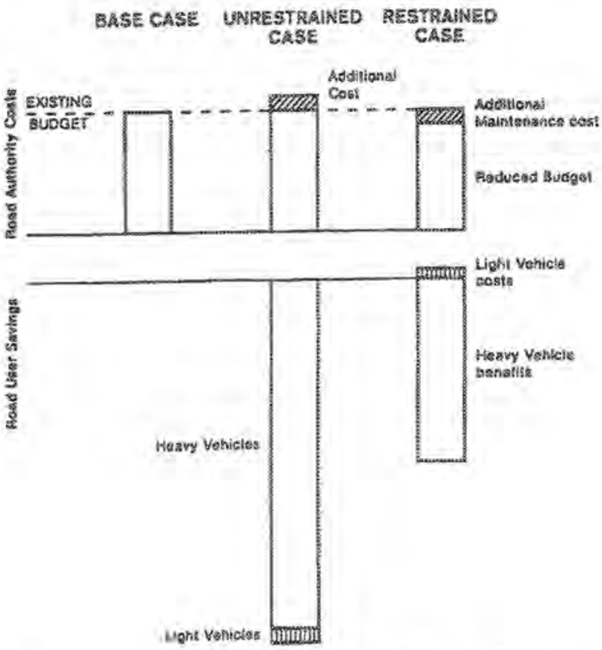
road costs which could be reasonably accepted in considering proposed changes given the current road finance limitations, the significant back log of existing pavement and bridge deficiencies, and short term road budget forecasts.

Following these considerations, a set of mass and dimension limits were recommended by the Study and by mid 1978 were incorporated in virtually all States and Territories. Additional recommendations were made relating to mechanical, operating and enforcement matters.

REVIEW OF ROAD VEHICLE LIMITS (RoRVL) STUDY

Virtually no changes have been made to vehicle mass and dimension limits since the implementation of the ERVL Study. Implementation of that Study resulted in a high degree of uniformity, particularly in the Eastern States.

Over the 10 year since the ERVL Study, improvements had occurred in the national road network and advances had been made in heavy vehicle performance and safety standards. The objective of the RoRVL Study was to recommend appropriate limits and associated regulations with the aim of improving overall efficiency of the road transport industry within the constraints of the road and bridge system and environmental concerns.



Representation of RoRVL budget cases

FIGURE 4

One of the major differences between ERVL and RoRVL was consideration of budgetary conditions as outlined in Figure 4. Two budgetary cases were considered in RoRVL, the unrestrained budget case and the restrained budget case. In the unrestrained budget case, it was assumed that all the costs associated with increased limits would be provided and the road system would be adjusted accordingly. In the restrained budget case the critical management strategy parameter, the rehabilitation roughness level, was adjusted iteratively to yield a minimum change in Road Authority costs for the option under consideration.

Another major change was the considerable emphasis given to the costs on local roads i.e. roads other than arterial roads. The majority of the analysis concentrated on the main freight roads between centres of population. However, local roads account for some 23% of all traffic and consequently vehicle limits have an important impact on local roads. Inventory data was not available for local roads and therefore a very broad methodology had to be adopted. This methodology assumed that all current rehabilitation costs for local roads would be attributed to heavy commercial vehicles, and the increase on local road costs would be by means of a relationship between the revised limit loading and the existing limit loading. This analysis provides only broad estimates of Local Government Authority costs. Lack of data precluded any detailed analysis of the impact of new vehicle limits on Local Government Authority Bridges.

SIGNIFICANT CONSTRAINTS IN ASSESSING THE ECONOMICS OF VEHICLE LIMITS

URBAN OPERATIONS

Much of the urban transport task is constrained by factors other than vehicle mass and dimension limits. With respect to road pavements higher design standards are generally adopted in urban areas as a means of achieving lower probability of failure. It has been concluded that:

- the effects of alternative vehicle limits on transport operations in the urban areas must be assessed in the context of the effects of congestion, terminal problems and other numerous factors effecting operations in urban areas;

- the effect of given changes in traffic loading on pavement costs are smaller in urban areas than for major rural roads due to the importance of non-load factors in design and construction; and

- the higher traffic volumes on major urban roads reduced the effects of increased loading on pavements and bridge costs for given changes in traffic loading.

In both Studies therefore it was concluded that any set of alternative limits identified as being appropriate for major rural roads would also be economically warranted for major urban roads.

DIMENSION LIMITS

The general economic consequences of variations in dimension limits are less easy to identify independently in the same manner as for mass limits. In particular the consequences of road costs tend to be minor for those items which can be quantified in economic analysis, the major effects being on non-quantifiable items. Changes in vehicle dimension limits are generally only direct significant for the carriage of low density freight, and although the average density of freight is reducing, many other factors must be taken into account in evaluating the effect of dimensions. These factors include:

- traffic operations, especially overtaking manoeuvres and safety;

- vehicle turning requirement in relation to geometric road design standards;

- road capacity; and

- vehicle stability.

Such factors cannot be quantified in the economic evaluation.

COMMUNITY ATTITUDES

There is increasing concern with road safety and the effects of large vehicles in the traffic stream. Environmental intrusion, particularly in urban areas, is also of concern. The public perception that large heavy vehicles are intimidating and dangerous cannot be evaluated in economic terms, and must therefore be part of the non-quantifiable assessment.

ENFORCEMENT

The economics of changes in road vehicle limits are very dependent upon the effectiveness and capability of enforcement authorities both before and after any change to limits. Just as increased mass limits can be shown to be economically viable, then overloading is economically advantageous for operators. However, the increased costs to Road authorities must be considered in any change of limits. If a change is expected in the overloading characteristics of vehicles, these changes must be considered in the economic analysis.

MECHANICAL CONDITION OF VEHICLES

Any assessment of changed vehicle limits must consider vehicle performance and mechanical requirements for heavier vehicles. Any changes recommended can be classed as a trade-off, whereby increased vehicle limits are permitted providing that the mechanical performance of heavier vehicles are improved. These changes obviously have an influence on safety and operating costs, but cannot be considered in terms of the overall economic efficiency of changes as very little data is available.

CHANGED VEHICLE TYPES AND NEW TECHNOLOGIES

Large combination vehicles in Australia are amongst the longest and heaviest road vehicles carrying general freight in the world. Up to 50 metres long and with legal mass limits of up to 138 tonnes, they have contributed significantly to economic development in Australia. Due to their size these vehicles operate under permit and are generally restricted to sparsely populated regions and lightly trafficked roads. However, there is now an increasing acceptance for their operation in some more heavily trafficked routes and on the outskirts of some urban areas.

Medium combination vehicles within the range 40 to 70 tonnes have not attracted a great deal of attention until recent years. However the increased quest for transport efficiency has led to the examination of a category of vehicle between the general freight vehicle and the larger combination vehicle or road train. B Double vehicles, based on the Canadian B Train concept, are being permitted on trial in most States of Australia, and there will certainly be an increase in the usage of this type of vehicle in the future. Industry claims increases of up to 20-25% in productivity with such vehicles relative to the general freight 6 axle articulated vehicle. However, with the introduction of such vehicles, careful consideration has to be given to the routes on which these vehicles are to be permitted to operate.

COMPARISONS OF VEHICLE FLEETS 1974 - 1984

GENERAL

The extensive surveys undertaken by the ERVL and RoRVL Studies provide an excellent comparison of vehicle characteristics over the ten year period between the surveys. This period was sufficient for industry to react to the changes which followed the ERVL study.

Table 1 – Approximate mass limits on major axle types and gross mass 1975 and 1985 – Australia

	Eastern States		Western States	
Type of Limit	1975	1985	1975	1985
Single Axle - dual tyres	8.1 - 8.4	8.5	8.2	8.5
Tandem Axle - dual tyres	13.2 - 14	15	16.4	16.5
Triaxle - dual tyres	Approx. 16.5	18 18	Approx. 16.5	18 - 19
Gross Mass	Effectively 33 to 35	38	Approx. 38	42

The traditional differential between mass limits in the Eastern and Western States continued during the period, principally the higher tandem limit. Table 1 illustrates the magnitude of the mass limit changes.

CHANGES IN COMPOSITION OF THE VEHICLE FLEET

The composition of the vehicle fleet has changed reflecting the demand for larger, heavier vehicles. The most dramatic change has been the increase in the number of six-axle articulated vehicles due to the higher comparative load allowed on the tri-axle group.

The ERVL's classification data shows that in 1974 six axle articulated vehicles formed about 3% of heavy commercial traffic on rural arterial roads, while in 1984 they represent about 20%.

Table 2 outlines the changes in composition for vehicle types in Victoria and Western Australia. The most significant change is the increase in articulated vehicles in urban areas in both States, and the increase in truck trailers indicates greater utilization of the rigid trucks.

CHANGES IN OVERALL LENGTH

In addition to becoming progressively heavier, trucks on the average have become longer over the last 10 years. The most frequent overall length for rigid trucks throughout Australia is now 7.5 metres as compared with 7.0 metres in 1974, although there was no change in the allowable length of 11 metres. The most frequent length for articulated vehicles has increased from 14.5 metres to 16.0 metres and for truck trailers from 15.0 metres to 17.0 metres. The allowable length

Table 2 – Proportion of vehicle types 1974 and 1984 – Victoria and Western Australia

	Rural			Urban		
	Rigid	Artic	Truck/ trailer	Rigid	Artic	Truck/ trailer
Victoria						
ERVL 1974	49.8%	48.7%	1.5%	76.4%	22.5%	1.1%
RoRVL 1984	43.2%	51.1%	5.7%	60.8%	31.1%	8.1%
Western Australia						
ERVL 1974	59.7%	38.6%[1]	1.7%	86.7%	13.1%	0.2%
RoRVL 1984	53.2%	34.4%[1]	12.4%	67.6%	26.3%	6.1%

1 Excludes road trains.

for articulated vehicles increased from 15.3 metres to 17 metres and for truck trailers from 16 to 17 metres.

EFFECTS OF INCREASED MASS LIMITS

Increases in axle and gross mass limits resulted in a corresponding increase in the average loads and in the proportion of vehicles utilising the new limits.

Figure 5 illustrates 1974 and 1984 distributions of loads on tandem axles on rural road, aggregated for Australia, and indicates a general upward movement of about 2 tonnes in the most frequent mass of a loaded axle.

The distribution of gross vehicle mass for articulated vehicles is given in Figure 8, which indicates a shift, in the most frequent gross mass, from the mass limit of 32 tonnes in 1974 to the 1984 Eastern States legal limit of 38 tonnes. Similar upward shifts are evident in all vehicle types and axle types on both urban and rural roads.

Examples of more accurate comparisons for Victoria and Western Australia are illustrated in Figures 7 and 8, where single axle loads and tandem axle loads are compared.

In both cases of single axles (Figure 7) the increase from 8.2 tonnes to 8.5 tonnes was accompanied by a significant decrease in frequency of higher masses in rural areas and a limited decrease in urban areas. The explanation for these decreases appears to be the move by operators to tandem axles from heavily laden single axles to improve productivity, particularly from single drive articulated vehicles to tandem drive, but also from two axle rigid to three axle rigid trucks.

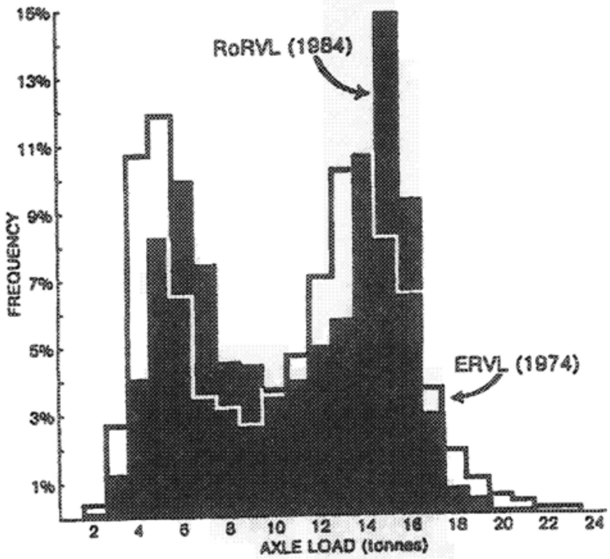
The position with tandem axles is less clear. In Victoria the tandem axle limit increased from 13.3 tonnes to 15 tonnes, a lift reflected in the increases illustrated in Figure 8(a). On the other hand, Western Australian tandem axle limits did not change significantly and rural distributions illustrate a similar change to the single axles.

ERVL PREDICTIONS

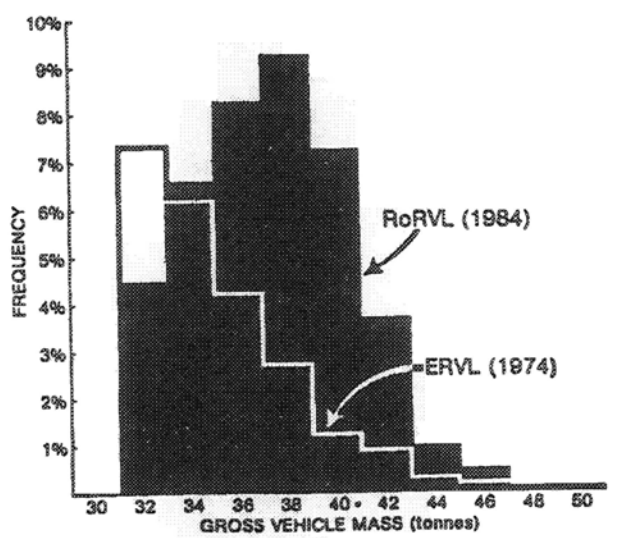
FINANCIAL IMPACT ON ROAD AUTHORITIES

Road funding and expenditure is influenced by political, economic and social factors as well as engineering requirements. It is impossible to reliably assess what influence the costs predicted by the ERVL Study had on road funding.

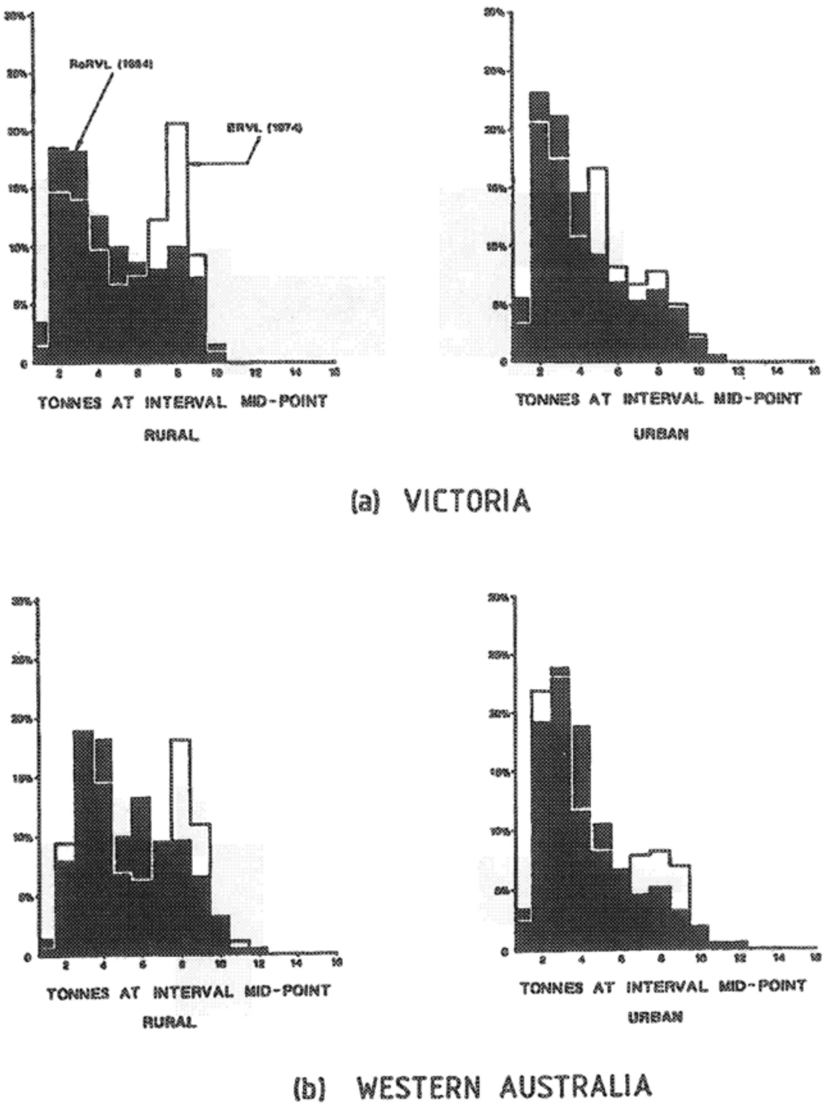
In the post ERVL period, road expenditure on National roads and rural arterial roads remained constant in real terms for about the next 7 years, although total expenditure actually reduced in real terms. Additional costs of the implementation of the ERVL recommendations were estimated to be about 4% over the latter 5 years of that period. Certainly there was general concern with the level



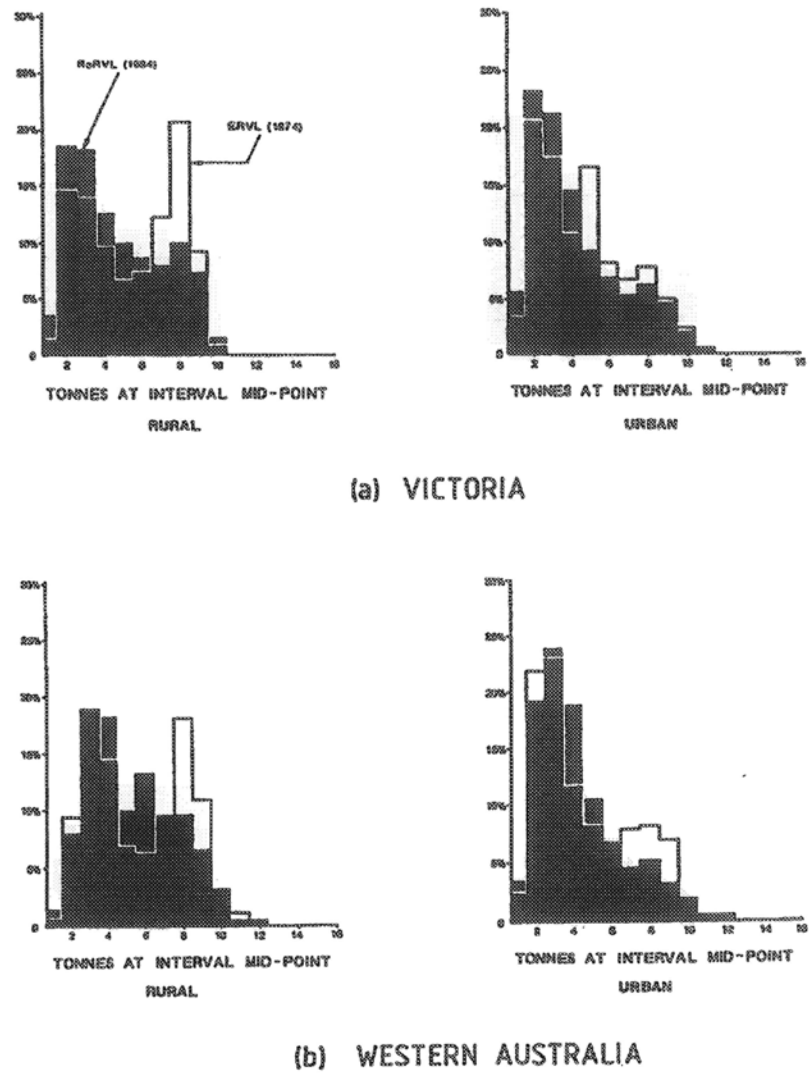
Axle loads, tandem axles
– Australia (Rural)
FIGURE 5



Articulated vehicles over 30 tonne gross mass
– Australia (Rural)
FIGURE 6



A comparison of single axle loads for Victoria and Western Australia
FIGURE 7



A comparison of tandem axle loads for Victoria and Western Australia
FIGURE 8

of funding and the condition of the road network, and it is clear that additional costs were incurred due to higher axle loads utilised by truck operators (see later).

BENEFITS FOR TRUCK OPERATORS

Comparison of the total operating costs of 1974 ERVL predictions and actual 1984 operating costs shows that there was a general tendency of the ERVL predictions to overestimate operating costs. Significant variations occurred in some items, such as wages, and the costs for urban operators (such as tippers) showed reasonable correlation. However, in the line haul vehicle, total ERVL estimated costs were about 15% above actual 1984 survey results.

The financial return to truck operators by way of freight rates has reduced considerably in real terms over the last 10 years, leading to the conclusion that cost savings have been passed onto the community. No accurate information is available on freight rates because of the competitive nature of the road freight industry and the general cost cutting practised.

ROAD IMPACT OF MASS LIMIT INCREASES

The most reliable estimation of the impact of new limits on the road system is the change in damaging power (ESA's) for each vehicle carrying freight.

Table 3 gives the change in ESA's per commercial vehicle over a 10 year period for the State of Victoria, where there was generally a 10% increase in mass limits in 1976.

The change in ESA's is influenced by:

Table 3 – Change in average equivalent standard axles (ESA's) per commercial vehicle 1974 -1984 – State of Victoria

Road type	ERVL (1974)	RoRVL (1984)	% Change
FC1 - intercity highway	1.371	1.719	25% (increase)
FC2 - rural	0.836	1.127	35% (increase)
FC3 - arterials	1.184	1.065	-10% (decrease)
FC6 - urban	0.727	0.851	17% (increase)
FC7 - arterials	0.828	0.765	-7% (decrease)

- the move to the 6 axle articulated vehicle which provides a lower impact expressed as road damage per tonne of payload;
- rate of change in freight movements; and
- the total numbers of vehicles and their configuration.

It is evident that the main rural and urban roads (FC1 and FC2) have had significant increases in freight movements and axle group loads, whereas the less important roads are benefitting from the move to six axle vehicles.

The models for predicting the new truck fleet under alternative limits (described earlier) under-estimated the increases shown to have occurred. Therefore the costs incurred by road authorities are likely to have been higher than predicted.

One measure of the performance of the road network is ride quality determined by roughness. Recent surveys of Victoria's major rural roads have shown the results given in Table 4. Only marginal shifts between categories are apparent.

ECONOMIC ASSESSMENT

The increase in vehicle limits was following the ERVL Study justifiable economically given the substantial benefit cost ratios predicted. The incidence of benefits was predicted to be highest in Victoria and lowest in Western Australia, and there appears no reason to doubt this general thrust given the changes in fleet characteristics and the current condition of the road network.

THE FUTURE

MASS AND DIMENSION LIMITS

The recommendations of the RoRVL Study were released for public review in January 1986. Three

Table 4 – Ride quality on major rural roads measured by road roughness – Victoria

Ride quality	1981/82	1984/85
Good (up to 99 cts per km)	85.6%	84.5%
Fair (100 to 139 cts per km)	11.5%	12.8%
Poor (over 139 cts per km)	2.9%	2.8%

mass limit options were presented as given in Table 5. The only difference in the options relates to the allowable load on tandem axles in the Eastern States, and the overall increase in gross mass which would be possible for 6 axle vehicles. The results of the economic analysis are given in Figure 9.

A full listing of Study Reports is attached to this paper.

In releasing the recommendations for public review, the supporting documentation outlined that, as a matter of principle, increased road costs would be recovered from road user beneficiaries. This decision together with the presentation of options is the major change from the results of ERVL.

At the time of writing, the public review process is still underway, and the final outcome is not yet known.

Debate on the recommendations currently centres on:

- the impact on local roads;
- method of recovering the costs (e.g. registration charges or fuel charges); and
- the introduction of a new configuration of vehicles, B doubles, based on the Canadian B train concept.

Option A has advantages of the greatest benefit cost ratio and the least financial impact on road authorities, but suffers the disadvantage of retaining the load differentials between Eastern and Western States.

Only minimal changes to dimension limits were recommended.

B double vehicles will operate on restricted routes, and decisions on allowable routes will impact heavily on the future composition at the heavy end of the truck fleet.

Decisions on these matters are unlikely before the end of 1986. Nevertheless, it is clear that the quest for transport efficiency will reinforce the trend to larger and heavier trucks.

METHODOLOGY

The use of the same methodology for the ERVL and RoRVL studies arise principally because the time frame given for RoRVL precluded development of new systems. However, in addressing the primary elements used to assess impacts of change

Table 5 – Mass limit options recommended by RoRVL

	Mass limit (tonnes)[1]				
	Option A		Option B		Option C
Axle group	Eastern Sstates[2]	Western states[3]	Eastern states	Western states	All states
Single axle, single tyres	6.0	6.0	6.0	6.0	6.0
Single axle, dual tyres	9.0	9.0	9.0	9.0	9.0
Twin steer, load sharing	11.0	11.0	11.0	11.0	11.0
Twin steer, non-load sharing	10.0	10.0	10.0	10.0	10.0
Tandem axle 4-tyres	11.0	11.0	11.0	11.0	11.0
Tandem axle 6-tyres	13.0	13.0	13.0	13.0	13.0
Tandem axle 8-tyres	15.0	16.5	16.0	16.5	16.5
Triaxle, 12 tyres	20.0	20.0	20.0	20.0	20.0
Triaxle, less than 12 tyres	15.0	15.0	15.0	15.0	15.0
Axle spacing mass schedule	3L + 8	3.6L + 7	3L + 8	3.6L + 7	3L + 8[4]
Gross Mass	41.0	42.5	42.0	42.5	42.5

1 For conforming vehicles only

2 Eastern States refers to new South wales, Victoria, Queensland, Tasmania and the Australiam Capital Territory

3 Western States refers to South Australia, Western Australia and the Northern Territory

4 3.6L + 7 in the western States (L = the distance between extreme axles)

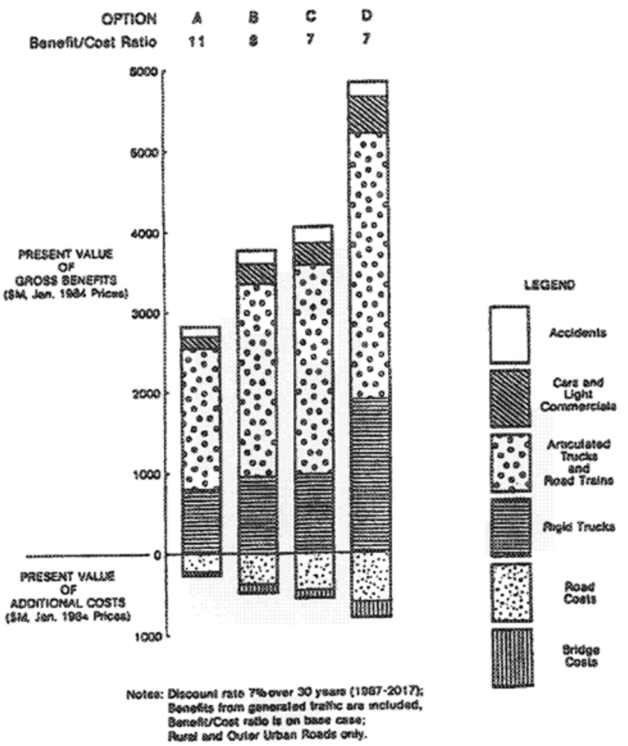
regulatory measures, it is apparent that little substantive change could have been made given the current state of knowledge.

Of primary concern is the measurement of pavement condition and the prediction of changes caused by changed limits. In both studies, roughness was used as the primary indicator of pavement conditions. While measurements of other parameters such as deflection or profile may be more appropriate, significant constraints exist. These constraints include:

- lack of data on the loading history of the road network;
- limited availability of historical network information on alternative parameters.

Recent development in techniques to efficiently measure alternative parameters and loading history are encouraging. Given the life of road pavements it may be some years before alternative assessment models are available.

Historically, inventory data on less important freight roads (local roads) is sparse. The need for improvements in the local road data base appears less compelling than improvements in prediction capability.



Economic analysis of RoRVL options

FIGURE 9

Detailed surveys to determine the mass and dimensions of the fleet are expensive, and evasion of survey sites by overloaded vehicles tends to bias data. However, validation of models to predict fleet changes can only be made if such data is available. The data is also necessary for road planning purposes, and statistically reliable sampling surveys should be undertaken on a regular basis.

CONCLUSIONS

Australian capability to assess the impacts of heavy vehicle regulatory measures has been considerably advanced with the ERVL and RoRVL Studies. Knowledge gained during the RoRVL Study modified by overseas advances, should ensure that the community benefits from efficient freight transport with minimal road, safety and environmental impacts.

ACKNOWLEDGEMENTS

The paper is presented with the kind permission of the Chairman and Managing Director of the RCA, Mr. R.T. Underwood. However, the views expressed are those of the author and not necessarily those of the RCA or any governments.

LIST OF ERVL AND RoRVL REPORTS

ERVL Study
(these reports are now not generally available)

Report no.	Date	Title
R1	July 1974	Concepts and Procedures
R2	February 1976	Evaluation and Conclusions
R3	October 1975	Summary and Recommendations
R4	January 1976	Commercial Vehicle Surveys
T1	February 1976	System Concepts and Programs
T2	February 1976	Transport Operations
T3	February 1976	Bridges
T4	February 1976	Pavements
T5	February 1976	Performance and Operational Characteristics of Commercial Vehicles
T6	February 1976	Structural Implications of the Axle Spacing/Mass Schedule
T7	February 1976	Accident Involvement and Severity Relating to Commercial Vehicles

RoRVL Study
(TS references to Technical Supplement)

Report no.	Date	Title
Main	September 1985	Review of Road Vehicle Limits
TS1	January 1986	Results of Commercial Vehicle Surveys
TS2	January 1986	Consultation and Community Attitudes
TS3	January 1986	Systems and Procedures
TS4	January 1986	Mechanical Requirements for Heavier Trucks
TS5	January 1986	Axle Spacing Mass Schedule Study
TS6	January 1986	Some Effects of Increasing Axle Limits Within Urban Areas
TS7	January 1986	Guidelines for the Operation of Medium Combination Vehicles
TS8	January 1986	Effects of Wide Single Tyres on Pavements
TS9	January 1986	The Effect of Gross Vehicle Mass Variations on Heavy Vehicle Noise Emission
TS10	January 1986	Overseas Practices
TS11	January 1986	Results of Analysis
TS12	January 1986	Heavy Freight Vehicle Operating Costs