

## THE CHANGING NEEDS OF A DEVELOPING ROAD SYSTEM

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**ABSTRACT:** *Australia's road system is seen as largely complete. The network of sealed, two lane rural arterials typically caters to traffic volumes of a few hundred vehicles per day but has the capacity for several thousand. In urban areas it has become clear that the provision of ever more road capacity (besides being prohibitively expensive) does not address the complex issues of social dynamics which underlie the congestion problems.*

*An increasing proportion of road funds is required simply to 'maintain the asset'. The age distribution of rural arterials suggests that current reconstruction rates will have to be doubled if present standards are to be maintained.*

*Road construction authorities need to take stock of the new situation. Their institutions and procedures, developed during the growth phase of the road system, are based predominantly on technical considerations and on an earlier underlying consensus on the need for more and better roads. With the maturing of the road system, road needs have become relatively less urgent in relation to other social needs. As a consequence, the decreasing component of discretionary expenditure will have to be more fully justified in economic and, increasingly, political terms than has been necessary in the past.*

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### INTRODUCTION

The provision of a road system is one of the largest single investments which a nation is required to make. Whether an investment spread over several decades is correctly described as single is, perhaps, open to discussion, but the consideration of a nation's road system as a single entity does help to focus attention on the various stages of its development and, in particular, on when or whether the system is complete. This paper is concerned with the way Australia has, implicitly, come to view its road system as largely complete and with the way this perception is expressed. It also examines the requirements of the mature, as opposed to the developing, road system.

It must be emphasised that the various stages of road system development and the corresponding funding levels which are discussed, are identified with the benefit of hindsight and are to be understood as the result of an interplay of political forces, social expectations and resource limitations. Only in the loosest sense should they be thought of as the stages of a long term plan.

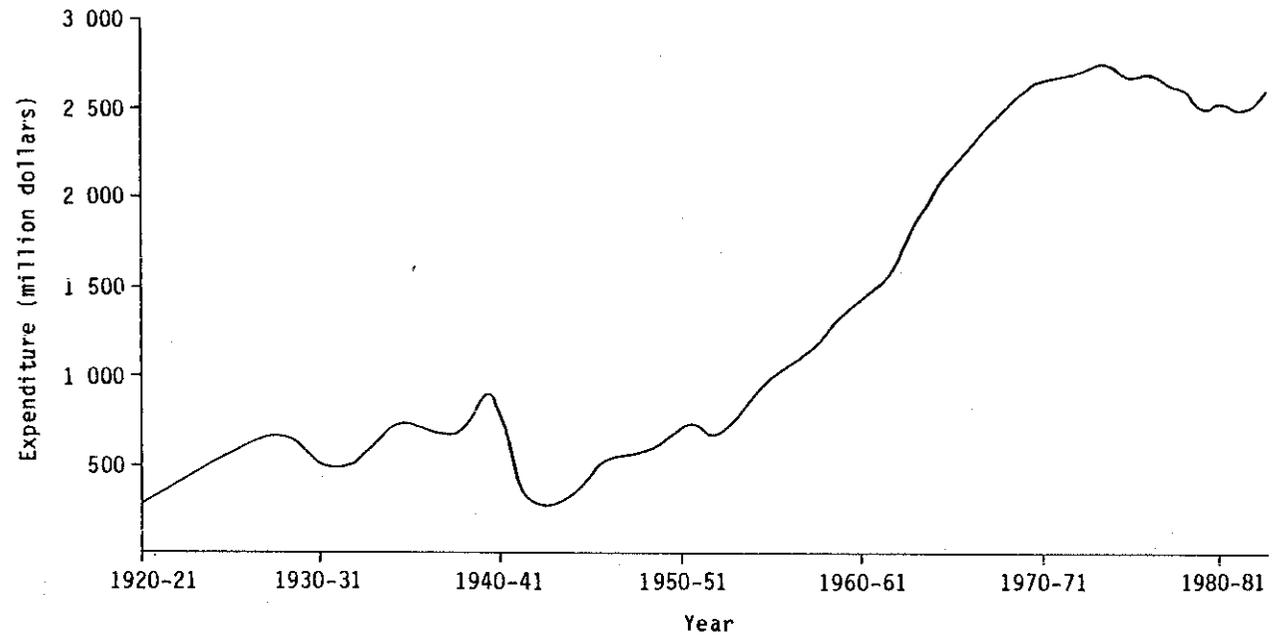
Two features distinguish the Australian situation. Most countries entered the twentieth century with a fairly extensive network of roads which, while they were not adequate for the increased speeds and loads of motor vehicles, at least provided for basic access and communications. In Australia, a virtual absence of roads over much of the continent meant that the provision of a basic network, at however rudimentary a standard, was a priority which occupied much of the period between the wars. Only subsequently could funds be applied to bringing the quality of service up to desired levels.

The other main feature of the Australian situation is a consequence of the sparseness of the population and its concentration in a relatively small number of independent urban centres. Except on a few roads radiating from the State capitals traffic volumes on rural roads are extremely low, typically a few hundred vehicles per day. However, the minimum expected road standard for long distance travel is the sealed, two lane highway, which can cater for traffic volumes of several thousand vehicles per day. Thus, once the basic arterial network of sealed two lane roads is in place, it provides a very considerable buffer of capacity to handle future traffic growth.

### DEVELOPMENT OF THE AUSTRALIAN ROAD SYSTEM

Figure 1 shows the annual expenditure on roads since 1920 and provides the framework for a consideration of the development of the Australian road system. 1920 is an appropriate starting point as it coincides with the period of rising demand (delayed by the First World War) for improved roads to meet the needs of motor vehicles. This is also the period of the establishment of the State Road Authorities and of the first Federal grants for road works to the States.

The stages of development of the road system are loosely reflected in the pattern of expenditure which shows three distinct phases.



Source BTE (1984) *Assessment of the Australian Road System: 1984*, Report 56, AGPS, Canberra.

Figure 1 Total annual expenditure on roads in Australia, 1920-21 to 1983-84 (constant 1981-82 values)

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### 1920-1950

During this period the basic network of (unsealed) roads was being laid down against a background of strongly fluctuating road expenditure. On the whole, the economic climate was not favourable to major investments. Only during the early and mid 1920s was there a steady growth in road funds, made possible by the rapid growth in vehicle ownership and the registration revenues which were a major source of those funds. This growth was reversed by the depression of the early 1930s. A decade later, following a recovery, the Second World War cut road spending by more than half as well as diverting the drastically reduced funds available to strategically important routes, to the detriment of roads generally. In the years immediately after the war funding returned to pre-war levels, but was largely absorbed in making good the neglect of the war years.

Despite the recurrent difficulties in obtaining funds, the need to justify road expenditure does not seem to have posed a problem at any time during this period. A basic road system to link widely separated centres of population and to 'open up' the vast continent to development seems to have been implicitly recognised as a necessity by both population and politicians. War or economic crisis might delay its achievement, but they did nothing to detract from the basic 'need'. Indeed, the funding difficulties may have imparted a sense of urgency as new forms of low cost road construction were developed to allow the greatest possible lengths of road to be established. By the early 1950s the road network was largely complete, at least in the sense that it had reached its present total length of 800,000 kilometres and that few new links have been established since that time.

### 1950-1970

In contrast to the earlier period, during which the establishment of the basic network was the primary objective, the period since 1950 has been devoted to upgrading the existing system. Constraints on road funding appear to have been relaxed until 1970 by which time annual expenditure in 1981-82 prices had grown five fold, to about \$2500M. Certainly, this expansion was part of the post-war economic boom, and coincided with a 50 per cent increase in population but, with a growth rate of over 8 per cent per annum, there was clearly a considerable readiness to invest in roads.

It is possible to see the pressures at work during the period 1950-1970 as a repetition, in more favourable circumstances, of those acting during the earlier period. Once again, the desire was for what were considered to be basic essentials. In the more optimistic climate, however, with rising community expectations, concern focussed on the quality of service provided by the roads. Minimum expectations were now that sealed roads be provided for urban roads and the rural arterial network and indeed, for a significant fraction of rural access roads.

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Sealing of existing arterial roads was, therefore, the principal activity during at least the first part of this period. Today the rural arterial system has a total length of about 90,000 kilometres of which about 70,000 have been sealed. Much of this had been achieved by 1970.

While the more dramatic events were, for many years, associated with rural roads, urban roads had also been developing but, in the absence of special problems or challenges, did not attract much attention. From the start, Australian cities had been laid out with what were, by European standards, generous road reserves and, as early urban roads occupied only the centres of the reserves, it was, for many years, easy to expand capacity to meet the demands of increasing traffic. By the early 1960s much of the scope for easy road widening had been used up and congestion emerged for the first time as a serious problem. The initial response was the natural one, conditioned by forty years of technical success in meeting the road needs of a growing nation - provide more and better roads.

The period from 1950 to 1970 resembled the earlier period in that the broad consensus about roads still held. There was general support for the view that road system upgrading and the resolution of road problems could safely be left to the experts and, for twenty years, the strongly growing economy provided the necessary resources.

### 1970-1985

A sharp change in the pattern of road expenditure occurred about 1970. Growth stopped abruptly and, with some fluctuation, has remained at about \$2500 million per year since then. The change and its suddenness can be attributed partly to causes unconnected with roads or road construction. Throughout the world, post-war economic growth and the confidence which had accompanied it, were declining. Inflation was increasing and was soon to become a major economic problem, exacerbated by the first of a series of oil shocks which, as well as having serious macro-economic effects, were to call into question some of the basic assumptions about the viability of road transport itself.

There were, however, developments in the perception of the road system which, even without the more general changes, would probably have led to a stabilisation of road expenditures. In broad terms, the view appeared to be emerging that the goal of the previous half century was within sight. Certainly, much remained to be done. The sealed rural arterial network was still not complete, and on urban roads congestion had been an increasing problem since the early 1960s. Nevertheless decisions were taken which would cause the program of rural road upgrading to proceed at a reduced pace, while some of the solutions proposed for urban congestion problems themselves suggested the need for a review of basic assumptions.

The urban congestion problems which had emerged in the early 1960s led to a series of major transportation studies based on methodology which

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epitomised the technically oriented approach to road issues. For the most part, the studies concluded that the solution to the congestion problems lay in the provision of increased road capacity. As capacity expansion within the existing road reserves was precluded, the proposals called for the construction of extensive networks of urban freeways at truly enormous expense. Only a small fraction of the proposed freeway projects was ever built, and even these absorbed a substantial proportion of road funds, particularly in the early 1970s. Moreover, it soon became clear that the expectation that freeways would eliminate congestion problems was misplaced. Traffic volumes quickly expanded to fill the additional capacity, and land uses changed to take advantage of, and eliminate, areas of reduced congestion. On the whole, the studies suggested a decision process committed to the provision of ever more roads with insufficient regard for the complexities and uncertainties of urban social dynamics. By overreaching themselves these studies sowed the seeds for a developing scepticism about road funding proposals based primarily on technical considerations.

While these developments all tended to limit road expenditures, the maintenance requirements of the road system were increasing. Recent estimates indicate that approximately half of all road expenditure is already devoted to maintenance. It is argued below that this proportion is likely to increase considerably.

### THE 'MATURE' ROAD SYSTEM

The view that the road system is approaching maturity may seem surprising when there is no lack of calls for increases in the allocation of resources for road upgrading. There is, in fact, no contradiction. For the most part, the calls for additional road funding relate to perfectly genuine problem areas, for the solutions to which funds will, in due course, have to be found. These particular cases, however, are to be contrasted with the overall situation in which the more pressing needs have been met and the more tractable problems resolved. Those remaining are, by definition, less urgent or less tractable, and it is natural that proposals for work in these areas should be subject to increased scrutiny. At the project level, detailed economic benefit-cost analyses may be required but, increasingly the case for road funding will have to be argued in the political arena.

This is as it should be. Economic analyses inevitably focus on the readily quantifiable aspects of a case, the capital cost of the road and the savings in user costs. Even here, sweeping assumptions are required about, for example, the value of time, or the value of life - to mention two items, routinely included in the analyses, but for which the underlying rationales carry less than complete conviction. Other issues, such as the value of the 'amenity' in residential streets, are generally acknowledged to be unquantifiable.

Moreover, even if all the uncertainties in the economic analyses of road projects were resolved, funding for roads would still have to be

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obtained in competition with the other needs of society whose costs and benefits may be even less quantifiable than those of roads. The resolution of these issues, not to mention questions of equity and the macro-demands of the economy as a whole is quite properly left to the political process.

The constraints on economic analysis as an input to policy making are very severe. On the one hand it is dealing with very complex issues, treatment of which may require the development of new and sophisticated techniques. On the other hand, to carry weight in the political arena, the results must be intelligible and the arguments clear and uncontroversial. These requirements are contradictory and impose on the purveyors of advice the difficult task of combining the insights they gain from analysis with a realistic assessment of political feasibility.

The new 'rules of the game' have not been universally welcomed. For more than half a century there was a general, if rarely articulated, consensus that a great task was before the nation, to provide the roads for a continent. At the start, and for many years thereafter, the task would have seemed never-ending, and the question "How much is enough?" an irrelevance. During this period the institutions for the accomplishment of the task were built up and their procedures refined. Quite properly, technical considerations dominated decision making and engineers and the technical staff who presided over the road construction authorities were relied upon to identify the 'needs' and 'deficiencies' to be tackled next. Steady progress was made towards the distant goal.

It is not in the nature of institutions to reflect upon their own *raison d'etre*. A considerable momentum of road building had been established and the roads institutions had little cause to question the need for more and better roads. By the 1970s, however, the nation and the economy had moved on. Many of the most pressing needs for roads had been met and other social and economic problems had come to overshadow the remaining deficiencies. Road expenditures could no longer be based on purely technical grounds but, increasingly, required economic justification and, more particularly, they had to fit in with the wider political programs of the funding authorities.

An early manifestation of the new situation was the setting up, in the late 1960s, of the Commonwealth Bureau of Roads in response to federal funding levels proposed to meet road 'needs' as identified in a study by the National Association of Australian State Road Authorities. The Bureau was intended to provide the Commonwealth Government with independent advice and to pioneer new approaches to road assessment. To a degree, it was successful in that it inaugurated formal economic analysis of road projects on a nationwide scale, but its analyses embodied traditional road standards and its recommendations differed little from those of the established institutions. They still failed, in particular, to take account of the constraints imposed by the political context within which road funding decisions are made.

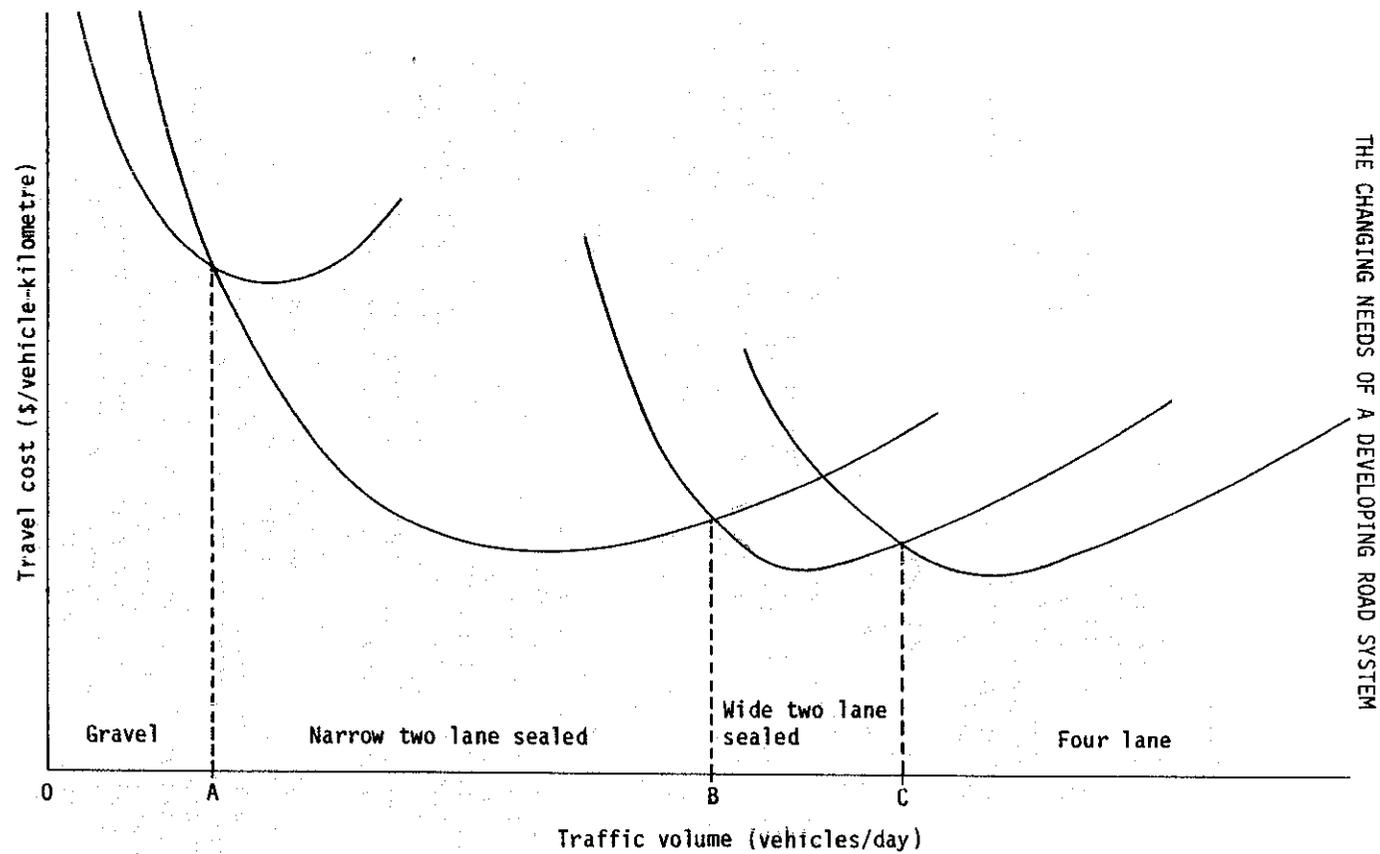


Figure 2 Travel cost as a function of traffic volume (schematic)

It is easy, with hindsight, to say that the roads institutions were slow to adapt to the new circumstances. Probably they showed no more than normal organisational inertia. In any event, it must be acknowledged that an awareness of the new circumstances is now evident in a number of road authorities which have been reorganised to present their cases with greater political sophistication. In a break with tradition some chief executives have been appointed whose backgrounds are not in the road construction profession.

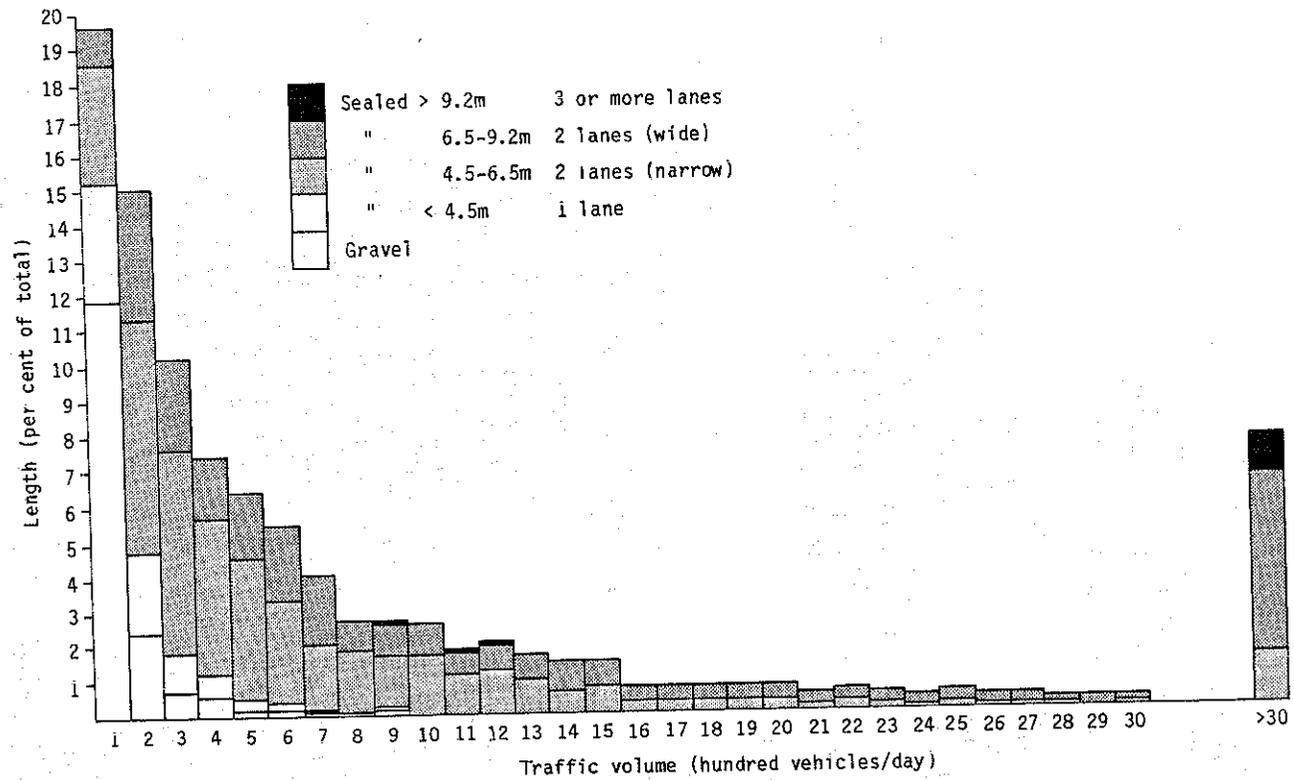
#### THE MAINTENANCE OF A MATURE ROAD SYSTEM

It is important not to be confused by the special meaning given to the term maintenance in road engineering circles. There, the term refers to a variety of relatively minor routine tasks. In the present wider context, maintenance covers everything which needs to be done to preserve the road system and the quality of service it provides. This obviously includes the minor routine tasks covered by the specialised meaning, but it also includes periodic major reconstruction necessary to make good the damage to pavements caused by heavy loads and, in order to preserve the quality of service, it includes any upgrading necessary to cater for increasing traffic.

#### Coping With Growth

It is useful to start by clarifying some of the ideas which underlie the choice of road type to cater for a particular traffic volume. Figure 2 is a schematic representation of the total, long term average costs of travel on different types of rural road as functions of the traffic volume. The costs include all road construction and maintenance costs distributed among the users as well as vehicle operating costs and the costs of depreciation, accidents and travel time. Each road is associated with a U-shaped curve which falls initially as the road costs are spread over increasing numbers of users, but which eventually rises as congestion costs come to dominate. The appropriate road to cater for each traffic volume is that which gives the lowest travel costs and, correspondingly, for each road there is a range of traffic volumes for which it is the most appropriate. In the figure, the gravel road covers the traffic range OA, the narrow, two lane, sealed road covers the range AB, and so on. It is important to note that these ranges are determined by economic cost criteria and that their upper ends, in particular, are not, in any physical sense, the capacities of the roads. The Bureau of Transport Economics is examining the dependence of the range limits on the assumptions of the underlying economic analysis. What is of interest in the present context, is that the traffic range for which the narrow, two lane, sealed road provides the lowest cost travel is a very wide one.

Typically, the range (AB in Figure 2) between the gravel road and the justification for a wider road, is from about 100 to 2000 vehicles per day - a twenty fold variation. For comparison, the wide two lane road might normally cover the range 2000 to 8000 vehicles per day - a variation by a factor of four. While these figures are approximate,



Source: NAASRA data bank 1984 and BTE projections.

Figure 3. Distribution of length (per cent of total) by traffic volume and road type-Rural Arterials and National Highways combined

the qualitative result is robust over a very wide range of assumptions. The implication, in the current context, is that, if the traffic levels on a network of two lane sealed roads are predominantly in the low hundreds of vehicles per day, a very considerable buffer is provided against the need to upgrade the network to cope with traffic growth.

Figure 3 shows, for the combined Rural Arterial and National Highway network, the distribution of length by traffic volume and road type. Median traffic is about 400 vehicles per day. Twenty per cent of the network carries fewer than 100 vehicles per day and only 12 per cent carries more than 2000 vehicles per day.

If the traffic volumes on this network grew uniformly at 5 per cent per year (somewhat above recent rates) about 16 per cent of the network would need upgrading within the next 20 years, an average of 0.8 per cent or about 800 kilometres per year. For comparison, the current rate of reconstruction for all purposes is about 1400 kilometres per year but, as is argued below, there is considerable pressure for this rate to be increased. It is apparent, therefore, that the contribution of traffic growth to the need for reconstruction is comparatively modest, and that this situation is unlikely to change for at least 20 years.

#### The Age of the Roads

Recent estimates suggest that a little over half of current road expenditures is devoted to maintenance. In the long run, of course, if ever a final road system were to be in place, maintenance would absorb the whole of the budget, and this sets a lower bound to road expenditure. Unfortunately, the data which would allow this budget to be estimated for the whole system do not exist, but some insight can be obtained by considering the rural arterial roads about which more is known.

Old roads are not necessarily bad roads but, as a general rule, roads do deteriorate with time and eventually require reconstruction. In order to maintain minimum conditions there is, therefore, a continuous requirement to reconstruct the older roads and, in the steady state, the scale of this task is directly related to the life of the road. The age distribution of the Australian rural arterials is, of course, nowhere near a steady state. Much of the network was sealed for the first time during the 1960s and only a small proportion has yet required reconstruction. The current rate of reconstruction is about 1.4 per cent per year which, if maintained, would correspond to a road life of over 70 years and an average network age of 35 years. On the other hand, the current average age of the network is about 17 years, with very few sealed roads over 40 years old. While little is known about the relationship between age and condition on a network wide basis, a gross objective might be to maintain the average age of the network. In the long term, this would require a doubling of the reconstruction rate to almost 3 per cent per year. In the short term, the requirement might be even more severe as there is a substantial

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grouping of roads in the age range 25 to 30 years which will shortly be in need of reconstruction.

### CONCLUSION

With only a slight oversimplification, one might contrast the traditional bottom-up approach to estimates of road funding needs with the top-down approach required by present circumstances. During the growth phase of the road system it was appropriate, or at least acceptable, to determine the total road budget from the bottom-up by summing the costs of projects needed to achieve technically specified standards. However, as the road system approaches maturity, it loses its special status and has to compete for funds with other needs of society. Road funds are then determined largely by outside constraints and road programs need to be designed from the top-down to fit within a limited budget. Maintenance of the existing road system absorbs an increasing share of the budget and the case for the decreasing component of discretionary expenditure is more and more determined by political considerations.

The important lesson for the analyst or technical advisor is that technically determined unique solutions to road planning and budgetary problems may not be appropriate. They may even be counterproductive if they conflict with strong political pressures and are not amenable to adjustment and iteration to take account of these pressures.