INVITED PAPER

FUTURE PERSPECTIVES ON ROADS AND TRANSPORT

by

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ABSTRACT

The future is largely a child of the present. The major factors currently affecting the physical transport system and the user behaviour which determine the travel demands will not necessarily be the same in a few years. Vehicles, work, shopping and leisure changes, traveller and freight movement requirements are all examined, and the influence on the road and road transport system is considered. The alterations in the patterns of work, time use and location that are already visible are considered, as are both the factors causing the changes and the actual nature of effects. The planning horizons for many aspects of the road system already extend into the next century. There are already a number of current technical and behavioural influences and events which make it necessary to reconsider some of these unquestioned expectations, and several would suggest a review of some actions already committed to. The key factors considered are the social expectations, the economic influences on location and behaviour, the influence of more centralised and faster monitoring and control of the road systems and its users - and the nature of the vehicles and the tasks that they will be called upon to perform.

INTRODUCTION

1. The future is the province of everyone. We are all 'experts' in prediction, and we all do it uniformly well or badly. Well, if it is our memory that is relied upon; badly if it is someone else's: few survive an independent audit of the events. The danger of committing one's predictions to paper are that the paper stays around - often until after the dates of the events predicted. The way out of this problem is to project rather than to predict.

2. A few years ago, ARRB held a symposium on the occasion of its 25th anniversary to consider the likely trends for the future in roads and transport research, and the types of work that would have to be addressed to meet these foreseeable requirements (Metcalf 1985). The papers in this symposium, including one by the present author, examine these issues in a manner that requires little updating now, only three years later. Consequently, the arguments presented and recounted on that occasion will not generally be repeated here. The flavour of the future and the transport aspects of it will be the central theme in the present document, and the manner in which predictions, projections and forecasts can be formed and judged.

3. Projection is the process by which present trends are assumed to continue into the future. This specifically begs the question that the future is about events that cannot (or have not) been foreseen. The really significant changes in history have tended to be of the latter type, with steady movement on one line up to a point, and a sudden change in direction afterwards.

4. Predicting the future of transport, roads and road transport is about predicting the future of urban location - predicting the nature of economic growth (or otherwise); rural location - predicting the likely sites where massive extractive industry sites will be initiated; technological changes - predicting those that directly or indirectly affect the demand and nature of travel; social changes - predicting the social and personal attitudes that determine where, when, how and what journeys are made; and, the greatest imponderable, the possible wild card events which can change the whole direction of a country or a society.

5. The freight movement patterns in Australia are dominated by the choices made by the large mining companies as to where they will develop next. This makes the projection task much easier, as the life of such projects is up to a decade or two, except for the difficulties in determining where the companies themselves plan to move next, and the world economic demand levels and commodity needs - neither of which have proved to be more than very roughly anticipated.

6. Many of the aspects of transport, roads and road systems can be confidently predicted, on the basis that the external factors required to change the medium-term life of
roads (for example) would have to be very significant
indeed to disturb the present trends. On the other hand,
the effects of comparatively likely political and social
reactions to alterations in the relative price and availability of oil-
based fuels can equally confidently be expected to have a
major influence on the likely travel patterns and travel
demand levels that result from such (not particularly
unlikely) events.

7. The biggest unknown is the overall reaction of people to
changes in their economic and social environment, where
the locational and social behaviour can be redirected and
vehicle purchases and use patterns can change
substantially.

8. Freight movements are less volatile in their locational
distribution; grain will still move during grain harvest
times; factories will still need raw materials (even if they
are of a different type); mining plants will still take a long
time to start up, and will be active and inactive frequently
as economies demand - but, once established, the actual
locations of the cuts and mines will not change as quickly;
urban areas will still demand deliveries to shops, homes
and factories; refuse will still be created and need
collecting; and people will still wish to meet others
physically - however many alternatives might develop for
activities at a distance.

9. Attitudes on mobility, on safety and on admissible
behaviour will all have long term effects - and many can be
estimated from the nascent trends now appearing. The
difficult task is the identification of which of the current
movements are going to grow into strong trends (and
which of the current major trends will falter and die).

10. Unfortunately, the prediction of the future solely on
projections based on the past has always been a safe short
term measure - and an erroneous long term (and sometimes
even medium term) process to follow major changes which
vastly alter the entire pattern of social environments,
expectations, and capabilities. This has been true for a
considerable time, and technological innovations have
classically been underrated in terms of their likely impact.
The case of the airline industry is a good example. The
virtual disappearance of the ocean liner and the rise in the
trade of all types.

11. The rate of takeup of technological innovations has
become considerably faster, and this rate is likely to speed
up further. The reasons why the rate of takeup has risen
over the last half a century include the emergence of a
new set of technologies and the equipment to
use, location and travel behaviour typical now only of
the young people of both sexes now almost all obtain
education and jobs. The expectations towards vehicle access and
use, location and travel behaviour typical now only of
crime, licence holders, can be expected to apply to almost
the entire population in time.

12. The current competitive pressures to take up
innovations in transport are a direct result of this global
competition. The vehicle industry has responded to this,
and there has been a steady
movement of the location of the major vehicle producing
countries in the world. In fifty years there has been a shift
from the US to Europe, one from Europe to Japan, and
now the rise of Korea, Brazil and other similar nations
close behind in this next wave.

13. The pressures of innovation are now turning more to
operational capabilities; the design and management of
traffic systems, of planning tools, and of the equipment to
enable more effective usage to be made of resources
stuck up in road construction, maintenance and vehicle
operation.

14. There are some key stable factors in the future: people
will continue to be born, age and die - and at the same ages
of rates. Consequently the cohorts of a given age now will
move steadily forward through time, carrying many of their
present attitudes and behaviours with them into their old
age. Those coming in at the lower age groups tend to have
progressively different attitudes and behaviours, some of
which will carry through to modify their travel patterns as
parents when they reach the equivalent ages.

15. One of the most important of these is the holding of
crime licences, where the low levels of licence holding by
women generally and the elderly in particular have been
rising steadily. This trend can be expected to continue, as
the people of both sexes now almost all obtain
crime, and will in the main continue to hold them
once gained. The expectations towards vehicle access and
use, location and travel behaviour typical now only of
crime licence holders, can be expected to apply to almost
the entire population in time.

16. There are few other such solid bases for future transport
projections available, but other regularities in behaviour
may be drawn upon with a greater or lesser degree of
confidence.

HISTORY AND THE PROJECTION OF
DIFFERENT FORMS OF MOVEMENT

17. Projecting road and transport futures may be done by
extending the trends already implicit in the present, or by
specifying where we wish to be in a few years. If the latter
course is chosen, then it is necessary to work out the
intimate set of interdependent shifts and changes that are
implied by that goal, and the methods available to achieve
them.

18. If this is done after deciding on a possible future
situation it is termed a 'scenario' method of forecasting, but
if the technique is carried out by executive bodies wishing
to determine how to reach a given pattern of goals by
positive action. This is very hard to project - it is more
strategic planning. The French five year plans draw
strongly from the latter tradition, but have not been as
successful in other countries. The general flavour of
this approach has led to the French/English term of
dirigisme.

The construction of self-fulfilling projections of this type
requires a level of commitment, coordination and
centralisation which is not always found in other
countries, and is probably not a likely future for Australia
due to the dependence of Australia on other forces external
to the country and its (small) economy.

19. The first step is to recognise that these two different
approaches to forecasting need not give the same outcome.
The normative approach is based on bending the factors
under public sector control towards the desired (projected)
outcome, and the too's for this task include the publishing
of strategy plans, designation of growth centres and a
string of reinforcing political and fiscal moves all designed
to tip the balance towards a new set of land use and activity
outcomes rather than another. Here the very existence of
the projection is a factor in the likely outcomes - and
intentionally so.

20. The other stream is to take the past, dissect it, and use
the components to build a future set of behaviours which
accumulate to predict the situation as it is likely to be in the
future. This approach relies on the mechanisms extracted
from the analysis of the past remaining applicable to the
future. This is not a bad guide in some fields, and, used
judiciously (and preferably with the clarity and precision
of uncommitted hindsight), can be quite effective for human
behaviour and choices in the mass. Transport has achieved
a fair measure of success by this procedure of systematic
analysis and subsequent piecemeal projection.
21. These two approaches are quite different in their appeal to different groups within the community, and lead to very different responses from the various parties in society when they emerge in debate. It has been tempting for some to confuse - perhaps intentionally? - the objective basis of much of the transport and traffic forecasting undertaken, with the political associations of the normative approach, where the action to be proposed is assumed by political opponents to cause the problem which the measure is designed to address.

23. This may lead to reactions against the 'fixed future' put forward as the possible consequence of a systematic planning process, in an attempt to change the explicit or implicit decisions and priorities inherent in the production of a final (or even a discussion) document. This is the 'political' response to the normative projection and plan; the other is to question the assumptions on which the forecasts have (necessarily) been built as the basis for avoiding taking the projection as support for one decision or course of action or another.

24. It is not surprising that the two types of projection are confused, as the public responses and debates but rarely distinguish between them. One firm prediction is that the information given to the public and the processes of consultation will need to be continuously improved if the individual elements and stages of a long term policy are to be successfully agreed. This is a conservative prediction, as other countries have already found it necessary to follow this path.

25. Australia shares much, but not all, of the historical development of the transport and road planning processes that developed after the second world war in the US and Europe. The general tendency has been for transport to be slightly in advance of most of the other spending areas of the public sector in the numerate planning and economic evaluations carried out. Recently other sectors have caught up, and the pressure for more consistently applied and widely used methods for monitoring, evaluation and management response, have raised the level of much of the debate.

26. Unfortunately, this has been matched by steadily strengthening trends in both the politicisation of public service administration, and an effective reversal of many of the moves to make more public and accountable both government processes and the information on which they are based. While public administration may have become more responsive to political requirements, this combination of trends has a real, if as yet unrealised, potential to neutralise many of the improvements in analytic and economic assessment in such complex areas as transport, which are both politically visible and also require long term strategies for their infrastructure management (Wigan and Ogden, 1986).

27. The 1960s and early 1970s saw a great deal of the 'applied trend' projective planning approach, where the trends of land use and vehicle traffic, and both were aligned to the forecast land uses of the plan, with the quite predictable outcome that large-scale capital works would be required to maintain the levels of service, access and spread that seemed to be reflected by the standards aspirated to at the time. These projections were a combination of strategic (normative) planning and projection of the apparently key demand elements in the system. By the end of this period some recognition of the need to balance existing capacity constraints against the demand that had filtered through, and a small number of equilibrium (capacity constrained and responsive) traffic models had been applied in operational studies outside research laboratories.

28. It had also become clear that the use of Treasury defined and mandated growth rates could produce nonsense such as predictions which had a sharp kink (up or down as the case might be) at the exact date where the implied trend growth rate projections terminated and the mandated values were turned to. This uneasy mismatch between normative and trend projective planning and projection did little good to the credibility of the process.

29. The mid and late 1970s saw the emergence of a perception that time, too, was a constrained resource, and that travel was not the only activity that travellers undertook in the day. It was also recognised that the effects of a household structure would constrain the activities and the timing of them still further. This activity and time budget appreciation took some time to take hold, but by the early 1980s had been appreciated as being of immediate and practical value for small-scale policy changes where transport had a significant role to play in altering these constraints and thus the response of people to the new services or demands created.

30. At the same time the need to gain a quantitative measure of the choices made by people on perceived factors became important, and the multinomial logit models of econometrics became a key part of transport analysis and projection procedures. They also placed a major tool in the hands of those wishing to evaluate the consequences of transport investment or operational changes. The main emphasis of the 1970s was the realisation that systematic traffic engineering and management measures comprised at least the basis for one viable form of transport planning policy.

31. It was probably this stage that paved the way for widespread appreciation of the constraint and activity analyses that were being tentatively explored at that time.

32. The 1980s saw a strong shift towards a better appreciation of people and their tastes, capacities to pay, and demands for locational and housing opportunities which overcome a number of the strategic planning dirigeisme, and the capital shortfalls for infrastructure began to have an effect that was subsequently amplified (in Australia) with a hiatus in economic growth and health. This has (in 1988) now persisted long enough to introduce some changes the attitudes of the community towards the future, and has probably already had a substantial effect on the achievable goals that the community is now prepared to set.

33. Even before this phenomenon (which had become well established academically by 1985), research workers were addressing the next crucial question in transport planning and analysis: the longitudinal patterns and determinants of travel behaviour and of vehicle ownership. One of the most significant of these efforts in Australia has been run by Henfes at Macquarie University, with support from the Australian Road Research Board (ARRB), the National Energy Research and Demonstration and Development Committee (NERDDC) and other sponsors. This type of work focuses at last on the basic elements of travel and road transport demand - the people themselves. As households, individuals and groups reach particular stages they change their vehicle ownership patterns and their travel patterns: this type of work addresses when, why and how much.

34. The use of population cohort models then becomes a matter of practical importance, as the behaviour of an age group tends to carry through as that age group moves into the next age group as time goes by. Perhaps the best and most obvious example is that of the driver licence holding by women, which drops off quite markedly with age. The available sets of data from several countries show higher
levels at all ages for men than for women - but the youngest age groups now show uniformly high levels of licence holding. As they grow older this will fill out the coverage by age.

35. This is but one obvious example which is of a basic committed mechanism whose effects are moving through the population, and the decisions to buy or sell a car or other vehicle are also associated with different stages in the lifecycles of these people. The longitudinal travel survey is one tool that allows us to reduce the uncertainties of projection most effectively.

36. This steady movement to place people at the centre of the analysis and response production effort has now reached a stage where a reversal of the emphasis is probably needed, as land use changes themselves are now vulnerable to change over the same spans of extended time periods - and are perhaps rather less well monitored or analytically understood. The few models that exist and find some application draw strongly from the ideas and academic culture of the early 1970s, and are still founded on the application of microeconomic housing models and land use development models with a location mechanism dependent on the locational settlement choices made by people and the consequential developments of activities to service these people.

SOCIAL DETERMINANTS
SOCIAL DETERMINANTS - BEHAVIOURAL

37. The social value system currently applied to travel is a complex matter. It discriminates strongly between age groups, vehicle types and locations and shows distinct shifts between socioeconomic groups.

38. At one level the revealed behaviour of travellers (and of course non-travellers) points the way to these differences, but at another does not identify the underlying attitudes that give rise to that behaviour. For that to change it is necessary to disentangle the changes in attitude and behaviour over time of the same individuals, while most past survey instruments have aimed more at a cross-sectional view of activity, and not gone to any great lengths to gain a longitudinal view of the behaviour of individuals surveyed.

39. This has begun to change. Continuing survey instruments, such as the Kontiv surveys in West Germany and Austria, have become more widely used and are now the subject of the kind of widespread academic attention which will ensure improved accuracy and understanding from this type of work.

40. These attitudes reveal themselves in various ways in enforcement, in information provision, regulation, consultation and co-road behaviour.

41. There are longer term trends that particularly hard to forecast. Two modes of transport have been subject to wide fluctuations in popularity and usage, and the short term trend forecasting worked only on the upsweeping and downsweeping of these social trends. These modes are powered (moped, motorcycle) and unpowered (bicycle) single track vehicles. Currently motorcycles and mopeds are on a rapidly declining curve, while bicycles are on an upsweep. A decade or so ago the reverse was the case.

42. It is tempting to suggest that these two modes of transport are intrinsically less pleasant than the car, and that people will stop using them as soon as their income permits. This model of long term social behaviour worked fairly well for some years after the second world war, when real incomes were climbing again and personal motor transport was becoming woven into our city fabric as a pre-supposition of planning calculations. Yet, in the early 1960s the Japanese completely recreated the motorcycle industry ("You meet the nicest people on a Honda...") was one of the great social attitude engineering and marketing campaigns of the century, and the momentum generated failed only in the 1980s.

43. The perceived lack of mobility requirement for such vehicles associated them now with recreation and freedom, and the packaged product was presented as new consumer disposable toy which required little mechanical attention or knowledge. The enthusiast markets alone for any type of vehicle have always been unable to provide more than thin pickings for a major manufacturer.

44. In practice, the highest levels of adult motorcycle ownership in Australia are still in the households without cars - but is is equally true that the best predictor of the number of motorcycles in a household in the number of cars (and are almost exactly equal to the number of cars in a household of a given income, divided by ten).

45. Bicycle usage began its climb with the health, fitness and recreation trend associated with the 'environmental' and 'green' movements. The momentum of the growth of bicycle usage still continues, but for how long?

46. In both cases the arguments for short term linear projections are strong, but the longer view shows that wide changes in social trends can be induced and alter the short term view of the world substantially - and for a decade or more.

47. A narrow interpretation of 'travel behaviour' as the choice behaviour displayed in mode choice - or even in vehicle purchase patterns as a family lifecycle progresses - is clearly insufficient. A broader view of 'social behaviour' as a determinant of travel demand must be maintained if the accumulated short term trend forecasts are not to sweep one over the cliff of changes in social direction.

48. The two examples (single track vehicles) are particularly sensitive to political and social attitudes towards safety, fitness, regulatory restrictions on access and environmental attitudes. This is due in part to the demographic characteristics (and the consequential political and social position) of their primary users (young males for motorcycles, school children - incidentally, largely males again - for bicycles).

49. The social atmosphere of a country is significantly influenced by the demographics, and the rapid ageing of the Australian population will have a distinct and pervasive influence within a very few years. The elderly travel less, at different times, and yet have wide access to mobility - and have well established views that tend towards the conservative.

50. It is difficult to avoid concluding that greater attention to the demography and sociology of transport mode and vehicle choice may be necessary if one is to be able to understand the forces at work, and predict the usage patterns of the future.

SOCIAL DETERMINANTS - ECONOMIC

51. The economic trends in expendatures show distinct distortions between travel demands and other expenditure headings. Communications, entertainment, food and energy provide a range of interacting variables which, when combined with fluctuations in discretionary spending have grave implications for personal transport.
52. The economic rents for oil and oil substitutes will continue to rise in the 1990s, but the transport, vehicle and travel responses will show up more as a distributional cost and overall pressure on terms of trade rather than as a panic measure. The dislocation vulnerability of Australia will rise markedly, and the distribution of LNG and LPG into remote areas may well be seen as markedly raising the risk levels on the roads, whatever the evidence might show. These are examples of the unexpected side effects of economic changes in the environment which need to be accounted for when viewing transport in context.

53. There have been rising trends in the home orientation of non-work activities in OECD countries, although leisure and recreational activities requiring travel have also climbed in importance and frequency. The choice of location for non-work activities has increased markedly over the last two decades, and now the ability to choose from a wider range of work locations, styles and timings has been added. These greater freedoms will only be translated into altered travel patterns if people respond to them, and the social environment will have a major influence on this.

54. There has been a steady rise in the level of licence holding by both young and old, and the differences between the two sexes have been rapidly diminishing. Female drivers are beginning to display some of the same types of accident behaviour as males, and there is a general trend towards more similar patterns of travel involvement amongst the younger groups when employed. The lower workforce participation of females shows up in lack of women in the early morning travel peak, but this may now be corrected to some degree over the next decade.

55. In some respects the attitudes towards expenditures on personal travel by motor vehicles have been fairly stable for many years. At all income levels the balance between fixed cost and variable expenditures on vehicles have been roughly equal for at least 15 years, and the substantial changes in the transport and economic climate that have passed by in that time have apparently not disturbed this parity. This may be used to suggest how people will react to greater economic pressures upon them, and to the first order it is likely that this parity of fixed and variable expenditure will continue.

56. One of the interesting pointers towards changing attitudes and responses in vehicle expenditures is the change in the elasticities for this expenditure category. The expenditures on vehicles and travel are now inelastic once again, and are therefore, by the economic definition, no longer regarded as a luxury good.

57. The economics of personal transport are important to most households. Up to 20% of household expenditure goes on transport (Fig. 1), which is second only to food for most age groups. Communications expenditures (telephone etc) are rising steadily, and the next ten years will see the many new small scale services which complement transport growing to substitute for it in some cases - if only due to economic pressures imposed by rising real fuel prices, and wider access to services offered through telecommunications as an intermediary.

SOCIAL DETERMINANTS - POPULATION

58. The age structure of a society has major implications for travel accessibility, demand, economic stability and success. The steady movement of age cohorts through time will take with it the edge of conservatism and the edge of innovations. The age balance towards the older age groups will raise the 'safety' and 'restrict youth mobility' aspects in an attitudinal sense, and the road and transport usage and behaviour patterns can be expected to follow to at least some extent.

59. It would be nice be more confident that the population forecasts have faith in their predictions, but the vexed issues of female fecundity and participation in the workplace make this an increasingly difficult task. The numbers of children produced per female has been dropping for some time.

Fig. 1 - Family expenditure data from 1985-6
60. There are strong indications that this is related both to rising economic standards of living and to greater participation rates of females in the workforce: these two trends are not strictly additive as delayed age of childbearing is a third and common factor between these two indicators. Nevertheless, the projection of population and age structure is one of the firmer planks on which to project and predict the future in terms of the personal and public transport markets.

61. Of equal importance, the trends in household formation and size of family are continuing to create a greater number of smaller families. The rise in the percentage of the elderly will be matched by the decline induced by the reduced amount of travel that they undertake once retired.

62. In the many years that transport analysts have been examining travel behaviour through large household-based sample surveys, most of the effort has been spent on forecasting vehicle flows: the last decade has seen a strong movement to looking at very small numbers of households as a unit, and examining all the different forms of activity - including travel - that they engage in.

63. Few studies have focussed on the personal travel aspects of the rich household interview data sources. This is rather surprising, as people tend to be the basic common factor in travel demand and its realisation, while vehicle movements are at least one remove from this, and can therefore be expected to be less stable, even when stratified carefully. The author has carried out such a study of the personal travel characteristics of Australian households, and used the large sample sizes to examine subdivisions between the people in the household, rather than to pick up geographical differences.

64. Consequently the work reported in Wigan (1987,1988) largely ignores geography, but provides a broad spectrum of perspectives on people of different type, ages and household lifecycle characteristics instead. For a similar approach to the expenditures of households on transport, see Morris and Wigan (1979). The factors identified in that report have remained considerably more stable than the km/p.a., of vehicles or many other factors which attempt to project transport demand's solely from a vehicle standpoint.

65. As suggested in Wigan (1987), this approach provides a better degree of understanding of the factors already at work that will affect the future of transport through the behaviour of individuals as they move along the age and household lifecycle scales.

66. Figs. 2, 3 and 4 (all drawn from Wigan, 1987) help to illustrate the interactions between population age distribution, individual age and working roles which can help in travel projections. Fig. 2 shows the time expenditures in Brisbane for personal business travel in 1978. Once the two stages of identifying the people who are actually doing any such travel at all, and the subsequent assessment of the amount of time that these people then spend have been taken, the stability of the time commitment of the active people over all age groups is clear.

67. Fig. 3 shows the Sydney 1981 travel time usage profiles over the entire day for those of 60-64 years of age, the age group where females are formally over retiring age but males are not.

68. The absence of women from the morning and evening peaks are as expected - but the variation with age in terms of those participating in travel to work shows that effective retirement ages were already spread over a much wider range. Both this spread, and the formal ages of retirement can be expected to vary in the future: the retirement age could be dropped, in line with recent trends, or even rise as age discrimination acts begin to appear, or shortages of skills in the workforce place greater priority on retaining older people in the workforce. Even the simple realignment of retirement ages would cause a significant change in travel patterns for the elderly, although until they form a larger part of the population this would not necessarily be a large shift in the peak hour capacity requirements in cities.

69. The amounts of time that are likely to be spent within the home is an important parameter for projecting transport needs. Fig. 4 shows these values, derived from a mid1970s survey of noise nuisance and exposure, carried out in many cities across Australia.

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Fig. 2 - Time per person and time per active person in 'personal business' in Brisbane in 1978, by age
70. The inclusion of cohort models of different age groups is an important tool for anticipating the underlying consequences of a steadily changing age structure in the population, and permits the other possible effects to be anticipated in a consistent manner: such is the valuable role of trend projection methods of planning for the future.

SOCIAL DETERMINANTS - INDIVIDUAL EXPECTATIONS
71. The expectations of each generation shift, and the essentials of one generation are often the luxuries of the last. Private transport is an area that has moved from the luxury to the essential - and might even be moving back again to the luxury good. The income elasticities of demand for vehicle ownership moved from being considerably below unity in the 1960s to rather above unity in the 1970s - and under some estimates could once again be on the decline.

72. The ownership of vehicles in elderly households is far higher than the income levels would suggest, and are almost exactly balanced by the lower levels of expenditure on maintenance and running of these vehicles. The rising numbers of elderly, and the rising levels of motorisation of this age group, leads to greater expectations of personal mobility on their part (and thus a more widespread locations for homes), and also to a greater concern for the maintenance of this mobility through the retention of driving licences.

73. This trend to to higher levels of driving licence holding - in particular amongst women - has been growing in recent decades, and the cohorts of both sexes retiring in the next 10-20 years will almost all have obtained a licence to drive (see Fig. 3).

74. This will cause possible conflicts between a possible social expectation that aged individuals will be more responsible for their own fiscal and physical sustenance, and be able to use essential services accessible only by driving, and between road safety interests concerned about the higher incidence (per km covered) of accidents involving the aged.
PLANNING INFLUENCES

75. The expectations of the community as a whole have a strong influence on the allocation of funds, and can stem a tide of irreconcilable economic pressures for a considerable time (at a real cost, however, that is not always made apparent at the time). In some areas these community priorities tend to move in cycles. The attention paid to the environment, and particularly to traffic noise, has recently followed this pattern. The high level of attention paid to environmental and amenity questions in the early 1970s cooled under economic and other concerns for about a decade, and a mild resurgence of this concern has begun once again in some countries.

76. Road construction itself is subject to similar cyclic swings, and it is difficult to ignore the historical evidence that the pendulum swings from enthusiasm (and funds) for construction to community rejection of this particular aspect of infrastructure in the community list of visible priorities.

77. The new factors that must be accounted for in the near future are the rapid rise in maintenance as a prime function, rather than new road construction, and the steady move towards more revenue raising from movements along the roads.

78. These have two largely contradictory effects. The increase in maintenance will mean that there will be more pressure for such expenditures at a local level (new road urban, and sometime rural, construction is not an unloved blessing to local areas close to the construction sites). Local response and central responsiveness can be expected to increase, and the rise of pavement information and management systems will become a matter of lively concern to local authorities.

79. On the other side of the ledger, the installation of toll roads and tolled facilities will tend to reduce access levels along the routes served, and the need to service the debts, will press for operational concentrations which are unlikely to be in the hands of local authorities: they are far more likely to be in private than in government hands at any level by the turn of the century.

80. The degree of mobility of labour and of work will increasingly affect transport and planning. The centralist approaches may not win out, as planning has classically limited behind events to a great extent, and the rates of change now outpace planning. This could work the other way however, as the rates of change of demand and for particular locations for tourism development have considerable potential to change the entire environment and transport needs of a large number of currently little-developed locations in Australia.

DATA AS GRIST TO THE MILL

81. Social expectations and sensitivities to privacy will continue to complicate the task of obtaining and using the detailed personal and other sensitive information required for effective and continuing land use and personal behaviour monitoring and for land use and transport systems planning at one level, and for detailed enforcement and control of traffic movements at the other.

82. Australia has yet to move to follow the lead of many other OECD countries on data registration and privacy protection. This may be regrettable when viewed from some quarters. The present situation is one of minimal effective privacy regulation and few practical constraints on the use of information gained for one purpose being passed on or used for another by another party. If this largely uncontrolled laissez faire free market in sensitive information continues, then monitoring methods for both vehicle and personal behaviour could quickly become widespread and easily linked to different official sources of information to give an excellent and economic basis for long term and short term planning and review in both traffic and transport fields.

83. Changes of this type require little or no technical advances. Consequently, they have the potential to come into effect on the ground at a rate that could easily outpace user expectations, or even tolerance.

84. At the vehicle level, data needs have in the past been limited largely to the numbers, weight, types and speeds of passing vehicles at given locations. As the pressure for capacity utilisation continues to rise, and the economics of automatic regulatory enforcement become even more attractive, the trend to combine monitoring with enforcement automation will probably prove to be irresistible.

85. It would be difficult not to use an active vehicle navigation system as a means of locating emergency vehicles, but the next stage is to use the same transponders for locating offenders who had contravened an automatic speed detector station; and a little later for other enforcement parties to log the movement patterns and locations visited and the timing of these - just as telephone...
tapping is used for investigations and surveillance now. These concerns are no more than a reflection of a number of the concerns that surfaced in Hong Kong when the electronic road pricing trials were undertaken.

86. With the additional instrument of owner onus, the capability already exists to tap the massive revenue generating capacity of a simple speed camera by harnessing the owner's responsibility, registration file addresses, communication links and automatic identification and notice issuing databases and computer systems.

87. Truck drivers and owners are not (and perhaps should not) be immune to similar measures. The tachograph has a formal place in the EEC, and is no longer always seen as 'the spy in the cab' for its role in logging the entire journey in detail, as the evidence has been of value to protect drivers from employer and other pressures. Such detailed electronic data gathering measures can therefore become socially acceptable with the appropriate legal and political treatment of their introduction and use.

88. A natural next step is the introduction of an automatic wheel force transducer fitted to truck trailers to make load balancing and weigh: limit compliance easier for drivers. The addition of a short range transponder would make it possible for enforcement of axle load limits to be done automatically, using the same information that would then be available to the driver himself on a continuing basis.

89. Many more examples of equipment and systems such as this are ready - or nearly ready - today, and the types and variety will proliferate over the next ten years: generally with one or more of the core functions of monitoring, detection, recording and communications. The legal, administrative and social factors will determine the extent to which this group of issues will or will not become of widespread importance.

90. Whilst the automatic collection of high quality information will become easier, limited only by social and legal constraints, the same issue (of privacy) will have the reverse effect on the availability and quality of home interview-based personal information, still the key data required for most of the planning for transport. Answers to the question: what people will choose to do will become much harder to obtain on an interview basis: a trend already evident in many countries. Fewer administrative and social factors will determine the extent to which this group of issues will or will not become of widespread importance.

91. Existing stable sources of high quality stratified sample frame information such as the Census and the Voting Rolls are not exempt from fundamental change over even a short horizon. One example is the proposed reintroduction of a poll tax (a requirement for all people living in a district to pay taxes to the council, rather than just the owners of property in that locality) in the UK. Even the promise of the possible introduction of this tax has already begun to reduce the value of the Voting Rolls as sample frames as non-property owners are already beginning to neglect to register for the Rolls and thus will not appear on either the Rolls - or in any samples based on these lists.

92. A local example is the result of the continuing pressure in Australia to reduce the amount of information collected in the Census. This must be reviewed regularly, and it is the task of the Bureau of Statistics to ensure that the core of the Census (required by the Australian Constitution), not be prejudiced by undue growth in the range, coverage controversy and intrusiveness of the body of the census enquiry form. While this regular review of the contents of the census must be applied to all parts of the form, the transport sector has a special concern that the value of the census as an anchor for sample survey reference not be weakened. Transport demand is increasingly serviced by small and closely focussed enquiries, but the larger scale coverage of the overall movement patterns and changes in the large cities is now tied closely to Census dates and to the use of the census data for sample frame expansion.

93. The need to monitor, understand and respond to the travel demands and needs of different groups of people will continue to be one that cannot safely be ignored. The ability to extract reliable analyses from fairly small samples of the population still relies upon the sampling frame for its application at large.

94. On the other hand, the steady development of land and geographic information systems at the local, State and Central Government levels will progressively fill the void that currently exists in many areas of land use monitoring. The fundamental tasks of planning and management of the transport system may thus be given more basis from the planning side through this route. Non-traditional measures of travel demand and needs will continue to emerge, and the range of different travel and activity behaviour measurement monitoring and analysis tools will need to be expanded as the demands to monitor and justify expenditures.

95. Achieving the analysts Holy Grail - having all of the information available with which to do a forecast - may overshadow a further fundamental problem inherent in the use of excellent data about the present as the basis for forecasting the future.

96. As a practical example, freight vehicles are extremely important in the prediction of environmental disturbance as they contribute to heavily to noise pollution in particular. A freight vehicle movement model was fitted to accurately reproduce a good data set describing freight vehicle movements in the present, and then the 'best' model available for predicting the future freight vehicle movement patterns was used to forecast the future flows. The environmental noise and other impacts were deduced from the differences between these two 'best' models available - but when the limited model used for the forecasting was fitted to the 'present' situation (thereby giving up much of the extra data available for tuning the 'present' model) the results made a great deal more sense. The common sense test of matching like with like had been overlooked in the drive to do the best possible job on both present and future models (Wigan 1976), and a major systematic error had been introduced that substantially distorted the conclusions that would otherwise have been drawn.

97. This is an example of the problems of having too good a data set for the present, and not enough understanding to be able to forecast in a useful manner. The move to monitoring and continuous policy adjustment may obscure the fact that this style of operation can run into the sand if a little vision is not retained, and attention paid to the fundamentals. A paper on the future by a research analyst is expected to offer the conclusion that more research is required. I merely ask the readers to note that: to maintain judgement, a second informed voice is increasingly necessary. Involvement in research can develop and maintain such a third view, within or without operating organisations.

SURPRISE FREE PROJECTIONS

98. There will be more travel. People will feel more inclined to choose between different locations and types of shopping and other activities as there will continue to be
more options in terms of activities and places to choose from. The range of locations that they will wish to get to will increase, and become even less centrally oriented. They will continue to need transport for this purpose, which will be much harder to provide by public transit systems due to the spread of non-centrally oriented travel patterns - certainly until the arrival of the driverless vehicle. The congestion levels of the road system will also continue to even out over the day, and over locations and directions of movement.

99. Fuel will (probably) rise in real price, and thus help to amplify the specialisation in the types of transport used, for different purposes. The greater levels of specialisation of recreational vehicles, and the larger and still rising numbers of vehicles/household make this outcome a reasonable projection of what is already happening. Mobility limitations will be eased by automation, but a heightened consciousness of safety will come with the ageing of the population, and may be translated into a wider portion of the population favouring safety measures against mobility needs as this retired age group becomes more important.

INDIVIDUAL TIME Usage

100. People will choose when they do things with a greater degree of freedom. This is an obvious result of the freeing of space and time constraints for interactions between people, enterprises and contracts of all types - informal and formal. The delivery of goods directly from integrated Manufacture and Computer Assisted Manufacture (PDM) have led to two apparently divergent trends, manufacturing to order as an intrinsic part of the same warehouse to home is about to be supplanted by the remote integration of selection, order, storage, production and delivery that will further diffuse manufacturing and 'white collar' locations.

101. It is an open question if the greater freedom from working time and working time constraints offered by the alterations in the patterns and nature of work involvement already established will cause greater or lesser quantities of travel. The evidence from time use studies (another resource largely neglected by transport and social analysts) is that it is the higher socio-economic groups that use non working time to engage in hobbies and outdoor activities (Wigan 1987) - television (and its close substitute, the video recorder) take up far more of the time of the more remote integration of selection, order, storage, production and delivery that will further diffuse manufacturing and 'white collar' locations.

102. The basic trend which will have the greatest influence is the trend for women to bear fewer children, and have them later in their life. The has influenced on (and is influenced by) female workforce participation rates, and the massive time and expenditure shifts that arise when children enter a household has been well documented for most types of cultures: for example in the international time use study reported by, Szalai (1972), and other results reported in Wigan and Morris (1980).

CHANGES IN MANUFACTURING

103. Continuing reductions in the labour levels in manufacturing plants, and the greater economics and better quality control potential of CIM/CAM (Computer Integrated Manufacture and Computer Assisted Manufacture) have led to two apparently divergent trends, each of which have major transport consequences.

(a) Complete assembly and manufacture of larger and more complex goods at a single location is becoming less common as the larger - and particularly automotive - industries move to a global level of integration.

(b) The greater use of robotic control and transfer machinery has made mixed products on a single line a normal event for those companies that have invested in this area.

104. In the first case transport of components or partially finished goods will continue to rise, both locally on the road and rail systems, and internationally to ports and onwards by sea. These styles of manufacture tend to be amongst those that can best withstand the design and production plants are in suitable locations, and can sustain the levels and predictability of freight movement that allow the railway system work at its best.

105. In the second case, the tight control of the JIT (Just In Time) mode of manufacture places a high degree of reliance on the monitoring of the entire production process and the requirement to maintain throughout, with minimal stock holding and work in progress investment, places considerable importance on flexibility and timing of goods required for production, in progress, and removing after manufacture. Servicing this type of operation is a finely tuned balance between the best features of all modes of freight transport and road transport (see for example, Blumenfeld et al 1984) - and gained a major and singular role to play which leads to fairly frequent (and critically timed) road freight movements on a continuing basis.

106. These two trends will therefore not necessarily see the end of the trend to increased movements by road, nor the requirement for both small and large freight vehicles in a more steady flow to manufacturing plants, and to and from warehousing locations (someone has to hold buffer stocks in a country with a major level of component imports and the long and industrial vulnerable supply lines of Australia). In practice, the second mechanism is normally the highest developed in the very companies most involved in large scale global integration: a car engine is a component of cars, but also a complex and complete manufacture in its own right.

107. The delivery and retail side of the freight task is also under pressure to better integration of the stockholding and delivery frequencies from similar economic mechanisms. The pressures for continuous deliveries are not as great, as the display requirements of retail outlets require a certain buffer stock to be held, and thus the control of the timings of deliveries and their frequencies is capable of being handled by without such a coordination and at lower levels of frequency relative to the sizes of the outlets.

108. The common factor between the retail and the industrial trends is the higher level of integration of the freight and transport system into the production process: Physical Distribution Management is more and more the appropriate term to use, rather than simply the Transport department. One of the first organisations to take up this point at a central corporate level was the central laboratory of General Motors in the USA. The transportation research department moved into the PDM aspects of transport within the GM environment as a research exercise some years ago (see for example, Blumenfeld et al 1984) - and gained strong positive results and user involvement. As result of tapping this central emergent theme of operational management, these issues are now far more widely recognized, and it is necessary for more of the groups involved in road transport and road management to appreciate the implications, as this is a trend that one can fairly confidently project will continue for quite some years.
109. The wider diffusion of tertiary growth centres within cities - a formal policy of the Victorian Department of Planning, and a visible trend in Sydney and elsewhere - has as a side effect of success a steady trend to a more uniform level of congestion over the day and over the whole metropolitan area, and on arc routes as well as radial. The freight distribution (as distinct from intercity line haul) implications are not yet clear - other than the increased cost of freight movements in terms of time, timing and efficiency. Special steps may need to be taken to give freight delivery and distribution (although quite probably not the larger line haul) vehicles better service levels than the rest of the traffic stream if this pattern of events continues to develop.

110. Redevelopment of city centres and recycled land in the middle regions may not be taken up as freight distribution centres or warehousing, as the added value of these land uses do not necessarily yield high enough returns in competition with commercial or integrated residential/commercial complexes. The evidence is a number of Australian cities is that freight distribution centres have adequate land in their present locations to expand if they wish. How long this will remain true is nasty in practice, but any general rise in congestion levels will tend to have a uniform pressure in terms of higher delivery, collection and movement costs until depot relocation becomes a more important issue to these operators.

ENVIRONMENTAL ATTITUDE CHANGES

111. The speed at which such changes take place is not fast, but over as little as ten years can show a drastically altered urban activity mix. The environmental disturbance levels now the province of the few will become the concern of the many. The widespread concern, and the congestion band will influence reverse commuters and off-peak travellers as much as peak time movements - and the traffic will cause this wider spread of annoyance and intrusion. Noise and air pollution will move steadily up the list of city priorities, and the 'environmental' lobby will gain a far wider political base as a result.

112. Who knows: maybe the period from midnight to 6am will actually be taken into account again for traffic noise planning? Community noise standards may be applied more rigidly to traffic, and the greatest offenders being trucks and (modified) motorcycles, the freight industry will have to respond to the demonstrable requirement that they should use quieter vehicles and operate them more sensitively.

ENFORCEMENT, SURVEILLANCE AND REGULATORY IMPACTS

113. Traffic enforcement is currently expensive and uses up a great deal of manpower. There are continuing pressures to simplify the system, improve its effectiveness (in terms of behaviour modification), and raise the revenues involved. The rapid rise in the electronic content of vehicles will be matched by the automation of the roadside, and the level of electronic dataveillance (data monitoring and collection for surveillance purposes) will probably have to increase if these goals are to be met.

114. The automatic detection and tracing of offending vehicles will become more widespread, and possibly even become less covert, and thus more acceptable to a community more acclimatised to higher levels of enforcement of laws and regulations that were envisaged when the regulations were drafted. This leads to a marked increase in the effective severity of the penalties currently in place (Wigan 1986), and some rebalancing between the penalties for traffic and other types of offence will probably have to be undertaken within the next 5-10 years.

115. This alone will influence traffic law, and roads and traffic will no longer be pacemakers in the levels of severity for victimless (and victimised) offences, and a greater degree of concordance between regulatory and penalty treatment, and between criminal, civil and traffic offences will emerge. This will materially assist the police in the execution of their duties, but may also require a compensating reduction in their regular use of automatic dataveillance techniques on the population at large.

116. The steady automation of the highway will take place faster overseas than in Australia, due to the sheer physical scale and low population densities of this country. Cities on the eastern seaboard are the most likely to follow US and European trends at an earlier date, but the more comprehensive route advice, capacity control and detailed electronic management systems will at any given time be economically justified by fewer locations in Australia than in most of the densely populated developed countries.

117. Due to the highly urbanised and concentrated population centres of Sydney and Melbourne, some of the imminent innovations could well be taken up very swiftly such as the automation and guidance technology. The use of automated traffic generation and near-cybernetic freeways may still be a long time coming, as such high density traffic corridors will not be numerous enough to justify the capital investment in the highways for the off-vehicle options, and the mileage of suitable road will for a long time be insufficient to sustain any special equipment required for the vehicles themselves for the on-vehicle approach. Indeed, lower cost piloting using existing technology fairly soon, but the widespread application of these two approaches will probably have to wait for another generation or two of vehicle designs and automation integration. This is, however, simply a matter of 5-10 years and can hardly be regarded as a long term issue when road systems are designed for 25-40 year lives!

118. These trends will not be strongly out of line with other countries, but just enough to show lags in uptake and penetration into the world vehicle fleets.

119. If the real wealth of Australians were to continue to decline in relative (and perhaps real) terms, one effect would be to lengthen the replacement cycle, lower the levels of optional equipment fitted, and to reduce the penetration of the Australian market by the more highly optioned variants of imported cars (the ones most likely to be equipped for the automated highway environments of more crowded countries): there are signs of this in effect, but, at the same time, locally manufactured vehicles are moving up the scale in terms of the optional equipment offered.

120. No doubt export markets will help to keep the Australian vehicle fleets in line with the rest of the world in terms of the fraction of the value of the car which is devoted to electronic and additional equipment.

121. The state of penetration of electronics into vehicles is following the trends forecast some years ago by the industry-based Delphi studies at the University of Michigan (Cole 1983). The electronic equipment component in the value of cars will probably reach 50% for many models by the turn of the century. The more complex environments and closer headways (and tighter operating controls) that will follow and instead push forward these types of smarter vehicle will be less pressing in all but a few areas of Australia: Sydney is likely to be the first to see significant
Roads and transport are a major concern, as they have a direct impact on the economy and the daily lives of people. The decision to create a user fee, based on the actual stresses placed on the road surfaces by individual vehicles, is a necessary step to ensure the sustainability of road infrastructure. The economic benefits of such developments are impressive, as evidenced by the trend towards unified identity-location data systems, which will influence behavior on a large scale.

The onus need not be just on the roads and the road operators; the rising intelligence of vehicles can also be tapped. Just as cars can now record all the key events likely to contribute to a record service and control, so can the owners of a need for an early service, the use of wheel transducers in trucks could be linked to the trip and time recorders now used so often for the legal protection of drivers in the EEC (quite a change from the 'spy in the cab' views of yesteryear). Perhaps the same could occur for road pricing? Perhaps trip loggers and recorders will be requested by private car owners as their sole defence to an automated enforcement system bent on revenue raising at minimum cost via automated owner fines levied by direct debit on bank accounts; an interesting further twist to the established trend towards unified identity location data systems of all types. This will become a major social issue in all sorts of currently disconnected areas of social activity as the century draws to a close.

The behavior of people changes both swiftly and frequently unpredictably. Analysts of perceived and subjective choice variables will become considerably more important, as the constraints on expenditure, location and movement and timing of activities are progressively relaxed. Location decisions move at a slower pace than travel movements choices. The most rapid changes arise in route choices within a single journey on a single day, while the slower changes occur as a result of steady shifts in habits and patterns of behavior and expenditure.

Other social aspects of change include a steady rise in the incidence of lawsuits for travel-related issues; this trend has been well established in the USA. The partial disenfranchisement of road accident victims of the Victorian and NSW governments is unlikely to head this off indefinitely even in the narrow area of third party claims.

Road providers and road maintainers will have to look even more closely at their responsibilities to the users if this growth of liability becomes significant and endures by the courts. As a wider application of this type of approach exacerbates the established problems of extended government by regulation under enabling legislation, and the erosion of individual rights to fair compensation in many transactions. As regulatory bodies move to widen the bridgehead established by capped compensation and the abrogation of common law rights, the pressures will appear at different points in the chain of adjudged responsibility; a trend that has already become solidly entrenched in the U.S.

**EFFECTS OF EDUCATIONAL CHANGES**

Distance education is perhaps the most obvious trend which will influence behavior on a large scale. The effectiveness of the Darling Downs Institute of Advanced Education, RMIT, Deakin University and the University of New England and other major organisations in spreading their teaching and participation to the widespread community has added an increased level of participation in learning and re-learning, and will gain pace over the next decade. Professional Institutions are already moving to require continuing in-service education for their members.
and managers as the trend to career-long regular retraining finally becomes recognised and acted upon. The long honeymoon of Australian organisations - public and private - to simply import skills in short supply has really passed, and the need to invest in staff on a continuing basis will rapidly be taken up or imposed by the market (or governments) upon them through training boards and levies and greater flexibility and assistance to individuals.

134. If the patterns of participation in education move to favour the older members of the work force, the timing of such courses will reduce yet more the peaking demand currently encountered as scarce facilities are used for less limited and temporally circumscribed times and timings, and will also extend the times that activities generate traffic at educational locations. Social measures to levy higher charges on students will also tend to push educational activities over a wider span of space and time. Although the levels of participation might also be affected in the short term, the expected growth in self-education as a near-recreational activity will no doubt pick up any slack, and will tend to spread the timings of educational travel still more widely.

135. This is but a single example of the many different ways pushing to make greater use over longer spans of time of public facilities and buildings, and every move in this direction further spreads the travel demand peaks. The burning lights and active libraries of Stanford University that I have observed at midnight signal the effects of pressures - public and private - for such greater utilisation levels, and illustrate the alterations to travel demands that may occur.

136. The trend to less fixed timings of other activities will also continue. Recreational demands will begin to become the inflexible ones to meet, with their need for coordinated timings for mass movements. The patronage of such locations will be biased towards those with transit access, and the radial movements will be accentuated by them. This has interesting implications for parking policies, and the real conflict between usage and access will become the more acute as the 'out of business hours' aspects of the sites conflict with the peaking/penalty rate aspects of transit.

We are in for interesting times.

VEHICLES AND THE ROAD ENVIRONMENT

177. Transport as an industry is usually assumed to be private freight transport and mass public personal transport. This is not entirely correct, as private expenditures on transport are typically 15-30% of the entire household budget, and the whole mechanism of roads, ports, airports and the construction, maintenance and management of roads and other transport facilities is one of the major public expenditure headings. The main public ownership of this huge infrastructure disguises the sheer size of the activities it comprises, and the all-pervading nature of transport, roads and access provision lends a special edge to the phrase 'public responsibility'.

178. The infrastructure and the vehicles and their scheduling are largely under public control. They are one way or another in the public transport and railway areas, far less so in airports and barely at all in shipping and roads. The private railways of the mining companies, that not as extended conveyors and pipelines for the primary industry, are a major exception.

139. It is in roads that the main problems of access, quality of service, ride and environmental disturbance are likely to be felt in future as roads are strictly and legally speaking rights of way, rather than simply roads, and the range of utilities and access rights involved are wide-ranging across many spheres of activity, public and private.

140. The vehicles that use these rights of way gain the benefits from the system, and the maintenance and construction of the rights of way do not in general fall to those who reap the benefits - or indeed the revenues. One long standing method of extracting dues was to place a toll at a point where the right of way was privately operated, not a currently popular mode of operation of roads in Australia, but one now being gradually reintroduced to provide additional rights of way funded by the tolls. It would be a different matter if these were to be tolled versions of the sole right of way and of access for the resident of the frontages of the tolled roads, and to date the physical access and charging problems have made the provision of tolls on the sole means of access impractical. Some of the electronic developments could overcome this, and once again the electronic road pricing issue re-emerges in a different guise.

141. The other common unspoken assumption is that a car must have a driver. This is at present a reasonable assumption. However, the ability of several military development vehicles to drive themselves over rough terrain at 24 km/h while avoiding obstacles and approaching and recognising a goal suggests that the next decade will see the full of this assumption as well. The implications are quite important.

142. Roads are now under construction (and many more in the planning stage for construction up to decade ahead) with a design life of 30 years. By the time that many of these roads are barely in operation, and certainly by the end of their lives, the vehicles using them may not need to be manually controlled. This would vastly alter design criteria for sight lines, road furniture, road width and many other factors, all of which assure that the vehicle is the driver (when decisions are to be made). The technology to achieve this type of vehicle could be drawn from a wide range of possibilities. These include entirely autonomous vehicles such as those now in experimental use for military purposes in the US, using image processing and robotic techniques - or a simpler method as tackling embedded wires in the road with a much lower level of on-board intelligence. The fact that several different methods can be anticipated today makes it more likely that such vehicles could be technically possible within 30 years - the decision to deploy them in quite another manner.

143. Limited access highways with automatic control over-rides are already a reality and practical option for the near future, and the ability to send a car back home after dropping one off at an exact destination has fundamental implications in terms of the mobility levels of the young, old and impaired - also to the economics of parking as well.

144. This illustration is one which has been given to press home the issue that we are already designing and building roads that may need to be totally transformed in their operational characteristics within their life; but that the right of way is the one constant - albeit assuming a continuation of the presently held social expectations and legislation.

145. The freight system is also responding with alacrity - as it usually does - to the locational aspects of the new technologies of communication and control, and for the next ten years the top of the line long haul and local operational freight vehicles will make the running in terms of the full take-up of the new options for movement/communications and activity servicing fields - and due to the expense of such vehicles will be well able to
afford the costs of buying into this real operational area earlier than the private car can be expected to do for other than prestige reasons.

146. At the other end of the scale, bicycles and pedestrians are also valid road users, and the progressive integration of their needs into the planning and operation of roads has taken many years, and is still moving comparatively slowly. The alterations in the age profile will make such modes less important, as both are predominantly used by the young but the elderly are involved in accidents by these modes of travel.

147. Road structures themselves are also amenable to a cohort approach to forecasting, and the periods of time involved permit this to be done rather better than for people (who have a habit of changing their behaviour under unpredictable stimuli); roads are structures that have a life of the order of tens of years, like people, and the manner in which they give of their substance in the service of the users in dependent both on the quality of their initial construction (and subsequent maintenance) and on the levels and types of usage that they incur. This enables us to look at roads from the standpoint of the probability that they will remain in a given condition category for a given length of time, and the effects of reconstruction on this likelihood.

148. The most basic method for projection is to look at an age distribution for roads, and project these into the future. The interactions between standards at which roads are to be reconstructed and the ages at which the combination of traffic and climatic deterioration will reach this condition.

149. Markov chains have been used in various ways to exploit this characteristic, and semi-Markov approaches permit an estimate of the length of time a road will remain in a given state (poor, degraded, fair, average, good, etc) all depending on the states and their descriptions, if nothing is done to it. Modifying this to reflect the effects of reconstruction, improved maintenance, or modified patterns of traffic is the policy sensitive aspect of this view of roads.

150. Even the limited data required to make these comparatively simple projection models workable has proved to be surprisingly difficult to find: see, for example, Roscovitz et al. (1985). Pavement management systems will soon be altering this chronicle state of uncertainty about the present, and provide the basis for projections for the future from a richer view of the present and past - and will need to do so to improve the management aspects of FMS systems.

151. Every one of the above methods were designed to work with poor data, but even one fall down due to the sheer lack of the basic commodity - information. Predictions of traffic conditions and vehicle types and a further layer of uncertainty which current overall road information and monitoring systems are clearly still ill prepared to respond to.

TRYING TO FORECAST: LIMITS AND SENSIBLE GOALS

152. The major problems in transport are the replacement and maintenance of roads, and the public transport funding shortfalls that must be made good from general revenue. The arguments about cost recovery on the road system seem to fall short of the holistic integration of the public transport funding base, unless the debate is conducted or initiated by the railways - when the debate tends to be muddled (rather unfairly) as lobbyists or sectarian in scope.

153. The resources in a society are not unbounded, and as the knowledge of these interactions and interdependencies grows, so too does the requirement to take a practical and reasonably consistent technical assessment line - the politics will continue regardless (see Wigan and Ogden 1987), but at least the debate will take place on the more fertile soil.

154. The process of forecasting and of projection has a fine line down the middle. The honesty of those who state that their forecasts are projections is not always matched by the underlying documents on which they depend.

155. For example, the Adelaide forecasting process for the 1980-2000 period issued by the South Australian Director General of Transport (1987) assiduously covered all of these grounds - but still had to resort to generally unavailable, and unpublished, documents about employment forecast in order to drive the projections at the most fundamental level.

156. This style of governmental information censorship (of key bases for forward projections) is no longer a question of isolated examples as such interactions are becoming more widespread as forward planning becomes increasingly necessary to maintain policies and programs. This alone is a fair set of grounds for Freedom Of Information legislation of wider scope simply to allow the many parties outside government who now need to know in detail about the assumptions underlying their normative projections - on which many have to base both decisions and investments.

157. Transport is once again vulnerable to this type of burying of premises, and the example is far from unique.

158. Prediction of vehicle types is one more area where the uncertainties can be reduced by a careful projection approach.

159. The 'life' of most types of vehicles registered for use on road follows a fairly consistent pattern, and the majority of the vehicle fleet registered for use in 2000 is probably either on the road now or is being produced in factories around the world in the next few months. The shifts in these patterns for private vehicles have not been huge (see, for example, Thompson and Wigan (1987)). However, freight vehicles are quite a different matter. It is comparatively easy to define a 'freight' vehicle, and even a four wheel drive LandCruiser or RangeRover are within these 'normal' bounds, and share most of the same characteristics. Once the word 'freight' is used this stops being the case, and a light delivery van and a multi-trailer prime mover become loosely lumped together. The range of prices for the 'freight' vehicle range over a huge set of values, and the difference is that the utilisation of the largest vehicles is far, far higher than that of the middle sized or smaller trucks and vans. The speed with which the large articulated vehicles cover the miles and the levels on tonne/km/year show that it is here that the real freight issues are being addressed (Fig. 6), and the economic life of vehicles used in this way is a matter of a (very) few years.

160. Consequently the speed with which the on-road fleet of heavy vehicles can change is very rapid, and it would be reasonable to see the equivalent of the European quiet heavy vehicle spread across the entire heavy vehicle fleet in a few years, if introduced in Australia.
161. While the prime movers will continue in the hands of lower level operators, and the tonne/km are swept up increasingly by the new purchasers, who can afford to keep updating as the vehicles deliver their most efficient miles to them. This lends new hope to those entrenched upon by the current fleet of noisy massive trucks which, while so important to the economy, certainly extract their Danegeld from the people living near the routes that they traverse.

162. Even if the introduction of freight vehicles of the current European levels of quietness and comfort is not brought into use for some years, this will still have caused a virtual complete changeover to this style of vehicle before the year 2000. It is the private car that looks comparatively conservative, with its mean life on register of 12–18 years. Any changes in private vehicle size will, however, be amplified in the same way (although not to the same extent) by the tendency of younger vehicles to travel further - as long as these smaller vehicles are not treated as the 'second car', when the incremental mileage is far less. Changes of various types will occur steadily in the private car fleet - but the largest changes can be expected to occur and sweep through to near universal use most quickly.

163. More and more analyses that mix together road traffic user behaviour, physical characteristics, and transport demands will be needed as the interactions that bind the country together are treated on a more and more holistic manner. This will occur as information becomes cheaper, and the ability to manage large systems by overall objectives requiring continuous monitoring grows.

164. The emergence of stronger links and interactions between different elements of the transport system has already begun to make an impact on traffic engineering (Wigan 1986). Some of the interactions are traced (in the next section) in terms of a number of common comments, some of which are myths and some not.

165. The future of road transport is not only about roads and transport, but about the ways in which people think about them both. The idea of the right of way was crucial for many centuries, and roads provided them. The emphasis has now moved to the data highways, where the common carrier fights between the operations and the owners of the communications network are still largely the same people, and the communications equivalent of the right to carry goods over an infrastructure of (data) highways has not yet been resolved.

166. This idea is a replay of the roads and transport movement developments of history, but little has been contributed from the transport area barring some powerful ideas. Marchand's work on marginal cost pricing ranges in the 1960s equally over communication networks (telephones) and road usage marginal pricing. While road pricing is currently stalled in the transport sphere (at least, under the specific label of road pricing), similar debates have been won, lost and still run hot on the data highways.

167. Any such shifts - in location, frequency or time - have a direct effect on travel. The debate is only about how much. In the past the extent of such impacts have been overestimated in the general effect (although generally quite realistic on the small and closely focussed populations able to take full advantage of the possibilities for a particular industry or activity with participants spread over a wide area, this is unlikely to influence the road transport field as the debates are regarded as virtually disconnected although they are patently not! Once common carrier services over privately owned and operated networks gain more ground, the express document market, the documentation of freight, and the transaction and carriage marks of both commerce and shopping will all influence the travel demands, timings, locations and patterns of operation of businesses and manufacturing and people as individuals, both in terms of greater freedom of choice in the location of desired and mandatory activities.
168. Tourism both by Australians and by overseas visitors - has a growing importance in non-urban areas of the continent, and has a value which is not always easily reconciled with the usual urban traffic forecasting and evaluation methodologies. The investment in transport facilities as an aid to economic development has often been overstated, but the value of transport investments to improve the effectiveness of an overall developmental plan for a rural area has been entirely appropriately endorsed.

169. Tourism and weekend and recreational travel lead to rather different patterns of demand. The categorization of highways into recreational routes and others can be done on the basis on nth highest hour analyses of AADT with a high degree of accuracy, but the more pragmatic evidence of certain roads suffering their peak demands at weekends and holiday periods provides a more persuasive type of evidence that all can enjoy.

170. The economics of investment in improving the levels of service of such roads to service such non-business peak period peaks is not easily reconciled with other road investments with far larger freight and economic efficiency components, and the valuation of leisure time by individuals may well not match the normative values used for road investment appraisals. As many of these 'recreational peak' roads are personally encountered by most people only at such peak times, their view of the adequacy and efficiency of the road system as a whole is likely to become increasingly influenced by such conditions.

171. There is little information on the frequency with which people make trips outside their city of residence, the last being the BTE National Travel Survey in 1978-9: there is as yet little more available to tell us the frequency with which people travel into a city centre if they live at different distances away from it. The overall patterns of movements that can be deduced from the regular ABS Census Journey to Work surveys provide one of the very few measures of changing transport conditions and demands consistent over time, but do not tell us about this question, which has major planning commercial and perceptual importance.

172. If the range of movement of individuals continues to move outward to their suburban local region, and if long distance journeys continue to be rare events, then the public perception of road transport conditions will become more and more influenced by the growing congestion in our city areas as cross trips continue to follow the US pattern in causing a steady spread of suburban congestion. The moves to urban road investment can then be expected to run into several different mechanisms already evident in the US: (1) demand for better roads in these areas (2) pressures to slow or reverse the location of new traffic generators in these areas and (3) greater concern for local streets treatments in terms of speed limitation and other environmental protection measures.

173. In Australia the changes to residential planning controls to increase development densities in the middle suburbs in particular have arisen as a result of better understanding and concern to reduce the overall burden on the community resulting from present trends in residential location. The marginal cost of the community servicing new land at the periphery of a city is far higher than for supporting higher densities of development closer in - and at present the middle suburbs are paying for the subsidies to the out areas, not only in terms of rate income and reduced local expenditures, but also in the actual loss of facilities due to the population shifts to the out areas so that they pay more to get lower quality of service and subsidise the new facilities in the expensive to service subsidised outer districts. This is not solely a planning problem or a housing problem: the transport requirements can be clearly seen from the demographics involved: more younger people move outwards to the cheaper (and subsidised) land and facilities, and then require transport services in these lower density regions as well as the sewerage, roads, educational and other services.

174. The present trends will have to be reversed in many Australian cities, simply because much of the infrastructure (roads, sewage, water etc) is beginning to require urgent, major and prompt attention to maintain the central and middle regions, this will affect the public transport provision though fiscal constraints, although the locational distribution will remain a matter of political balance. It is inevitable that a greater degree of reliance on personal transport will ensue for the outer suburban areas.

**SOME CONVENTIONAL WISDOM ABOUT THE FUTURE OF ROAD TRANSPORT**

Or: Myths I have Known.

It is instructive to consider a few of these:

**Cars will go on much as they are indefinitely**

175. The shells of cars are indeed likely to continue to change very slowly, as the key parameters are the size of box required to contain people in some comfort and with crash protection is fixed, the wheels and suspension require an irreducible minimum of space and the space required for motive power has already been reduced markedly and motors and fuel storage volumes are already to be found almost anywhere in a vehicle. Just what kind of fuel is held in those tanks, and just what motive power plant is fitted is no longer an issue which is likely to be very visible (other than in the cost, range and the safety provisions).

**Cars will change radically - but not just yet**

176. The changes that will occur will be driven by the fuel availability, safety legislation, and economic health of the community. And the overall physical shape will change as slowly as public taste will require - and the present convergence of external shapes - already marked - will continue. The radical changes will arise from the level of intelligence built into the vehicle.

177. The present generation of innovations include antilock braking systems, automatic maintenance interval monitoring, car telephones, Compact Disc players and spoken warnings and hazard alerts. The next generation will include automatic and driver aided navigation, limited headway control, vehicle and driver behaviour monitoring and active transponders for information systems.

178. The generation after that will be potentially capable of automatic headway control and positive or autonomous control by the roadside traffic control system. The determinants of this latter generation arriving on our roads will once again be public taste, and the economic environment. While the cars may be manufactured on a worldwide integrated basis by then, and thus be capable of delivering a very high order of autonomous intelligence and control, the capital costs of the roadside environment will differ from country to country, and city to rural region, and so will the purchasing power of the population. As this generation of vehicles will depend on the capital expended on the road side of the system, it might be long in coming...
to countries like Australia - who will respond to the next generation again: the autonomous vehicle. At this point cars will stop being the same types of entity that people currently think of them as.

The vehicle I now own will last me ten years.

179. The evidence is that a great many of the current vehicles on the road will last ten years. The larger trucks will not, as they use up their economic life at a massive rate in a very few years of intensive utilization - a trend likely to continue, and not to be reversed: in fact the multilane truck may soon come to be seen as an essentially minority vehicle within a decade, as the economics of the large units force the mid-sized units into their most suitable market niches. The lightest trucks will continue to fulfill the local tasks that continue to proliferate in a service-based economy, as we move slowly towards one.

Public transport cannot go on losing money like this

180. Another myth: it certainly can. The collection of 50% of the operating costs from the fare box is still a measure of a reasonable level of cost recovery for urban transit systems. Only the decline in the public transport usage due to population changes can limit this - and the town planning measures seem set to magnify the costs of serving the needs of the further-out new suburban dwellers for the next ten years.

181. Only reductions in both the service levels and the expectations of public transport can be expected to have a major influence over and above the effects of demographics as the younger people all begin to hold driving licenses.

182. Public transport can be set up to be more effective (the case of the London Underground with increasing patronage in a stable city is a case in point), but the user cost levels are generally at a level where the existence of a more viable market requires a fairly large and concentrated city, the improvements in information technology will add to the efficiency of the public as well as the private modes of transport, but it will be the characteristics of the existing and developing urban form that will have the greatest influence over the next few decades.

183. The expectation that people be able to travel to work, to meet government administrative requirements, and to school, medicine and education must be matched by provision of transport for those who are outside walking range, and are too young or to old to drive. The safety policies of the last few decades have left the impression that driving is a privilege rather than a (limited, right - yet the social structure of building and administration continues to act as if it were a limited right if not even a normal expectation.

The roads are in bad condition

184. 'Bad' is an interesting statement. Bad usually means 'worse than I think they should be'. Both vehicles and roads have changed in their ability to separate the riders impressions of a road and its physical surface condition. The appearance of at least some roads will probably ulcerate as more consistent and widespread applications of review processes are applied (and also overall, if funding levels for the overall task were to drop substantially below present levels); it is an open question if the subjective comfort will not keep pace with this decline, so obly projected in the various roads studies in the last few years.

They will have to slow down the traffic

185. The demands for movement in all directions has grown as the centralist journey patterns in cities have declined in their absolute and relative importance. This is creating a slower travel environment over very much wider areas, and so this will undoubtedly occur - but it is probably not the area in which such views would have been expected to have been applied. Local streets are the battleground in this mushy spread of traffic grid. Access is the concept which will have to be set against environmental quantity. Grid-lock will produce its own local constituency to alter planning approvals for new traffic generators. As Australia tends to follow certain US trends at a few years remove, it is not unlikely that this will become one of the trends already apparent in the US which could also appear here in turn.

Take their licences away to protect the community

186. The access to the multidirectional movement pattern is now becoming sufficiently important that the high basic age of driver licensing will need careful re-examination, as the combined effects of fiscal drains due to extending public transport into the growing and thinly populated long routes of the outer suburbs combine with the need to ensure that people can access the major facilities. Pledges rather than punitive measures may be needed for a decade or two, until the autonomous vehicle makes most of these questions quite irrelevant.

I will always need a car(s)

187. If we continue to plan our cities, our workplaces, and our administrative arrangements to require movement than we will indeed consider that we will 'always need a car'. If however, we find that our working, recreational and administrative arrangements begin to become more footloose and less tied to the points of service we have become used to in the past, then the choice of a residential location may not need to be so much attention to the personal transport and servicing requirements. If we do not stop to think about this we will certainly build in to the future as essential what has been in the past effectively closer to a luxury.

SUMMARY

189. The forecasting of transport and road requirements is made up of two major components: the first being the technical projection of the infrastructure, its life, usage, and nature: the second being the reason for the whole business: where and when will people wish to carry out their activities, and how will goods that have to be moved be moved.

190. The technical aspects are easier (but not straightforward) to project into the future: the demand aspects are not, and depend on many more factors that can change very swiftly and for fewer that remain stable. The trip generation and other techniques that have worked fairly well for some decades generally produce a similar pattern of activities will apply - and this is exactly what is under threat of change from technical and social changes in the next 20 years.

191. These technical changes will affect the vehicles, the roads, and the traffic enforcement as well as the opportunities and locations for people to go and goods to move to, and the prediction of the transport and road futures will now require a better understanding of all three elements - travel demand and technical road provision standards will not be enough. Road management will soon come to combine similar elements in road maintenance
management, traffic management and enforcement of operations and regulations. Fiscal competition for similar goals will be highlighted. Changing overlaps between organisations in each of these areas will follow these shifts.

192. The process of forecasting requires the different elements of the future situation to be worked out consistently, and it is in this discipline that the combination of projection and more effective and cheaper monitoring capabilities will determine the manner in which roads and transport services will be demanded and provided in the next 20 years.

REFERENCES


