SOME INTERESTING OLD TRANSPORT DATA AND WHERE TO FIND IT

Vince Dravitzki, Tiffany Lester
Opus International Consultants, Central Laboratories, Lower Hutt, New Zealand

ABSTRACT

There was a world before Google; but it is a world of hard copy, of tables and of hand drawn graphs, and of thick transport reports. For those studying transport, urban form, or travel behaviours, it is often useful to understand why transport and our cities are their current forms and the patterns of change in transport; but this pre Google world can appear inaccessible.

This paper is in two parts. The first part outlines a number of the historic transport data sources and the information contained in them, as well as a number of key reports which shaped New Zealand's transportation system and consequently urban form. The second part of the paper presents some of the interesting extracts from the data, such as public transport usage, energy used per passenger, expenditures on travel over time, "natural distances" of different modes, as well as discussing some of the key reports that still shape current transport behaviours

1. INTRODUCTION

Much of the current discussion in transportation is anchored around the current paradigm that we are a hugely car dependent society, that we "have a love affair with our cars" and that we far rather drive than take more healthy options such as walking, walking in conjunction with public transport use, or cycling. Viewed without a context of how the current situation has arisen can lead to views that people are uncaring or lazy. A number of initiatives to change behaviours appear to take this view and are constructed around a belief that if people could just be shown how much fun the alternative was (such as "Bike to Work Day") then people would embrace such alternatives.

Central Laboratories has recently completed two major research programmes. The first identified attitudes and motivations underlying current high private vehicle use, the second programme identified the importance of urban form in the social, environmental, and economic performance of cities. A key subset of the second programme was developing the understanding of how transport had shaped the form of our cities. As part of this work we wished to understand why our transport was of its current form and the pathway of its development. While we initially wished to look at trends over the last thirty years we found that to understand that starting point of thirty years ago it was necessary to go back further again, so beginning in the late 1800s at the transition from the highly crowded compact cities where walking was the dominant mode to cities of the tram-based era. Vance described the evolution of urban form in terms of transportation, and tracks several eras each with their own distinctive form: walking and compact cities of about 2 kilometres radius; to more spacious tram-based cities of about 5 kilometre radius; rapid rail transit cities of about 20 to 30 kilometre radius; and finally low density car-based cities of up to 40 to 50 kilometre radius. While Vance's discussion focussed primarily on North American

cities, Australian and New Zealand cities have followed the same transport-dominated development. This paper is not intended as a history of transport in New Zealand nor as a record of the many reports and statistics that are, or have been, collected on transport in New Zealand. Instead we identify a selection of the reports and data that are available that help give an understanding of the development of the form of our cities, of the factors that have helped our transport system develop into its current form, and to point out some issues that will be relevant as we consider our future transport.

2. THE 1960S TRANSPORT STUDIES

Although our study covered 120 years of New Zealand urban development, rather than a strictly chronological approach to understanding current transport behaviours an appropriate starting point is the 1960s transport studies of Auckland, Wellington, Christchurch, and Dunedin. This period represents the start of the era in which our current transport infrastructure is anchored. The 1960s is the point at which cars had become the dominant form of transport at almost one car per household in 1960, public transport was in abrupt decline, streets of the central business district were heavily congested, and access into the central business district was poor.

The first study of significance was a United Kingdom study, "Traffic in Towns" 1959 (also known as The Buchanan Report). This study investigated the impact of motor vehicles on urban life in cities of the United Kingdom and developed recommendations of how to modify existing cities to accommodate the new dominant transport, and new forms for newly developing urban areas.

While it is uncertain whether the Buchanan Report was a motivator for the Christchurch study (1959) it appears to have at least inspired the title of the book describing the study: Traffic in a New Zealand City.

This study of Christchurch was undertaken to deal not just with immediate problems of the time, of growing inner city congestion, but as part of developing a strategic transportation plan for Christchurch as part of its growth and change, using 1986 as a forecast year. This study was a full transport study, as we currently know them; incorporating household travel surveys, intercept surveys at inner and outer cordons, parking surveys, zonal analysis, land use and transportation forecasting. It is claimed that the study was New Zealand's first to use the "American approach" and using computers to undertake the traffic analysis and forecasting. The report is highly readable because the Christchurch Regional Planning Authority was sufficiently proud of their study that a proper write-up was undertaken on their behalf by the University of Canterbury's Geography Department, to "both inform Christchurch residents of the basis of their transportation plan and assist other cities confronted with the same problem."

"Traffic in a New Zealand City" contains a wealth of data on transport, land use, and growth forecasts for Christchurch. Notably, Christchurch's current problem of the strength of suburban retail threatening the viability of the central business district, was already well predicted fifty years ago. A further item of interest is data on the balance between different modes of transport with distance travelled.

Christchurch is a flat and radially based city with the central business district in almost the geographic centre. Modes such as walking and cycling are easy. Figure 1 shows the mode by which people arrived at a central business district cordon related to the distance they have travelled. The figure illustrates what can be described as the "natural distances" of walking (1.5 kilometres) and cycling (5 kilometres) before these modes shift to bus. It also illustrates that bus journeys of 1.5 kilometres or less are not appealing and finally that, just as now, cars are used for both very short and medium distances.

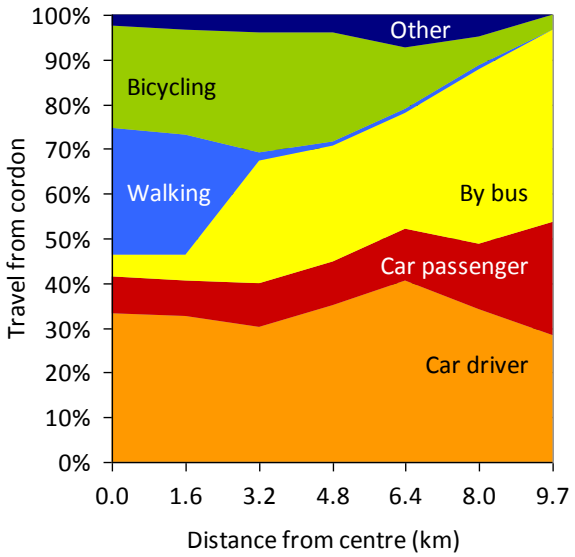

Figure 1 Journey mode versus distance for arrivals at Christchurch central business district in 1959 (adapted from "Traffic in a New Zealand City")

The reports for Wellington (1963 and 1966), Dunedin (1964) and Auckland (1965) are titled as comprehensive transportation plans but are more commonly referred to as the De Leuw Cather Reports – De Leuw Cather being a consulting firm based in San Francisco. As for the Christchurch study, these are detailed studies of transport in the respective metropolitan regions using household surveys, cordon surveys, observational counts, and land use planning to identify current and future needs; and these reports again use 1986 as the forecast year. Both the Auckland and Wellington studies had a stronger emphasis on a rail-based commuting component compared with those studies for Christchurch and Dunedin, reflecting the differing travel distances involved or the existing and needed rail infrastructure of these two cities. Although this set of De Leuw Cather reports have been described as "perpetrating the American Heresy on New Zealand", this is probably unfair as New Zealand had proceeded to more than one car per household and motorways were already under construction by the time of these studies. In Auckland's case, the motorway framework was laid down in the Master Transportation Plan for Metropolitan Auckland (1955), although some short sections of motorway had already been completed by then. This master plan had recommended a motorway system in preference to an underground railway system.

These 1960s reports appear to have several functions which include: forecasting transport needs for the metropolitan areas with 1986 as the forecast year, tying the developing motorway systems into the central business district's street network, and confirming where appropriate already existing transport plans. These master plans

have been reviewed (Auckland in 1976 and 1988) and the regional household travel surveys repeated (Wellington in 1988 and 2002, Christchurch in 2006).

What is clear is that our current transport infrastructure plans are a continuation of those plans laid down more than sixty years ago in very different circumstances around optimism about private car use and before peak oil or human induced climate change had any consideration by other than lone experts. The future will be a different era and we need a more considered approach than "finishing the system" as is so often still advocated.

Our continuation of these 1960s plans is somewhat selective, with the roading component being advanced but the rail component stalling. These 1960s reports did not neglect rail-based public transport. In Wellington they highlighted the shortcoming of the rail network in terminating at the northern end of the central business district and recommended an extension under the central business district, about one kilometre beyond its southern end. Though not built various alternatives continue to be put forward periodically some fifty years later. Interestingly private bus operators travelling north of the city now start their routes at the southern end of the central business district, capturing these potential rail passengers before they can make the 1 to 2 kilometre trip to the station. Several routes start even further south at either the airport or the hospital.

The 1960s reports for Auckland strongly recommend a rapid transit system be established to the west and the south as part of the transport solution, otherwise the motorway system would need to be enlarged over those recommended. The regional council's dilemma was that for this to be viable, they needed to control the bus system so as to deliver passengers to the rapid transit system until such time as urban growth concentrated development around this network and increased its viability, but they noted that the fractured governance around public transport in Auckland made this control very difficult to attain. Only recently with the formation of the Auckland Regional Transport Authority (ARTA) is this fractured governance being addressed.

These 1960s reports, as for the Christchurch report, are interesting for both the accuracy and inaccuracies of their predictions. They predicted by 1986 widespread congestion if motorways were not developed and rail networks in conjunction were not built. The reason that this did not happen in 1986 was that their predictions of population growth did not anticipate the slowing of the birth rate from the 1970s onwards and periods of heavy migrant outflows. However by about 2000, populations in these centres reached their 1986 forecasts and the anticipated transport problems have occurred.

The ART (Auckland Rapid Transit) report (1976) provides a marked contrast with current reports on transport infrastructure where the engineering is taken as an achievable given, and the emphasis is on the environmental impacts and their mitigation and the public consultation input and how this input has been included. The ART report barely mentions environmental impacts and "knows" what is needed for the project to enjoy public support. The report is far more about engineering, about what is needed, how to engineer it, the engineering difficulties, and how these will be overcome.

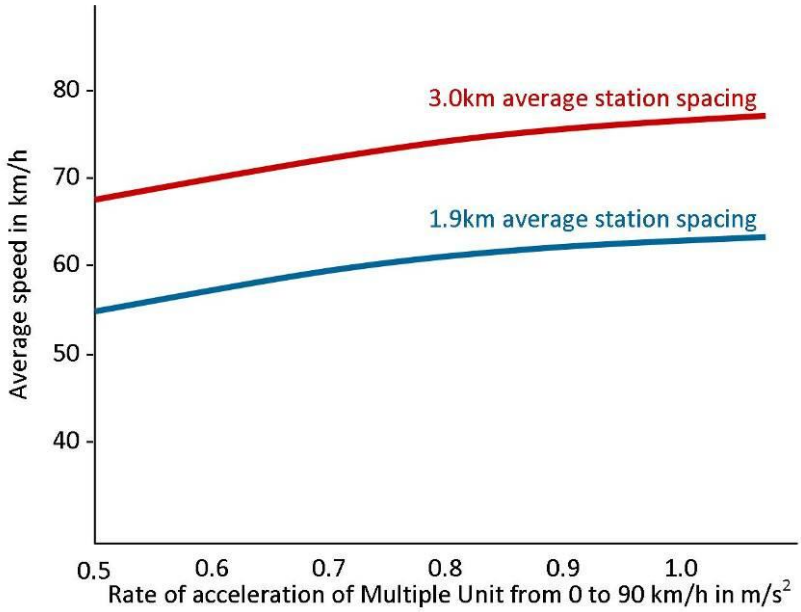

Figure 2 Average train journey speeds achievable with different station spacings (adapted from the ART report)

Figure 2 from the ART report showing average travel speeds with station spacing highlights the importance of speed for the success of the rail system and significant differences between the Wellington rail system and the rapid transit system envisioned for Auckland. The Wellington system is based on a walk-up system with station spacing at 1.0 to 1.5 kilometres. Average travel speed is only 40 to 50 kilometres per hour. Travel time is only comparatively acceptable so long as there is significant congestion on the motorway system. The regional transport plan is to support this congestion by maintaining two main choke points: Ngauranga and the Terrace Tunnel on the motorway network. In contrast the designers of the Auckland system considered the service needed to be fast to provide users with an adequate travel speed over an integrated bus/train journey. Station spacing was set at 5 kilometres and access to the stations was to be by feeder buses, not primarily by walking.

Figure 3 shows the South Auckland area with the calculated combined journey times, which are about one and a half to two times that of the current system. The designers believed this system would deliver a forecast 44 million passengers per year on the southern line (that currently delivers about 4 million).

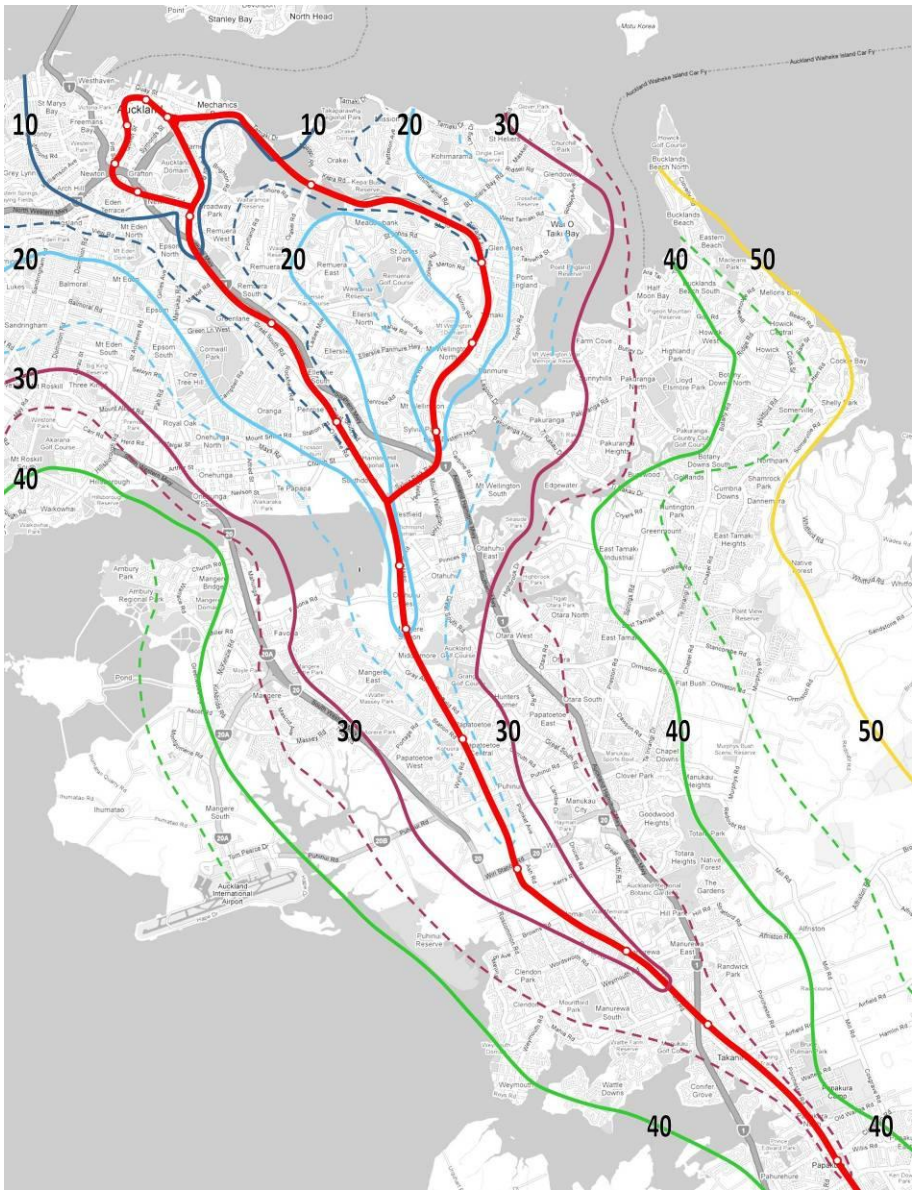

Figure 3 Travel isochrones centred on the central downtown Auckland Railway Station (adapted from the ART report)

3. EARLY DATA (1860S TO 1960S)

When the former Prime Minister Geoffrey Palmer described government being the business of reports, reports on reports, and even reports on reports of reports he was describing not just his current era but previous eras also. While many of these reports on transport from the 1880s to 1950s still exist, most are now archived. In 1922 the Main Highways Act established the Main Highways Board and a national highway network became a national responsibility, rather than a regional responsibility. Reports of the board, and its successor boards, such as the National Roads Board, and its engineering agent, the Ministry of Works and Development are lodged with National Archives. City and regional transport reports, especially those that predate the boards, are lodged with their respective city archives. A short cut to the laborious process of assembling this archived material is use of theses that have been submitted usually for Masters degrees especially in geography. For example,

Humphris draws heavily on the Wellington archives in describing the establishment of the Wellington tramway system in 1900 and the Kilbirnie line in particular, together with analysis of the growth and economic impacts of this line.

Lane in his near 300 page PhD thesis describes in depth the planning establishment and growth of Porirua City from the late 1940s to the early 1960s together with future forecasts of its growth and provides an interesting contrast of a central government planned and built city compared to our current framework.

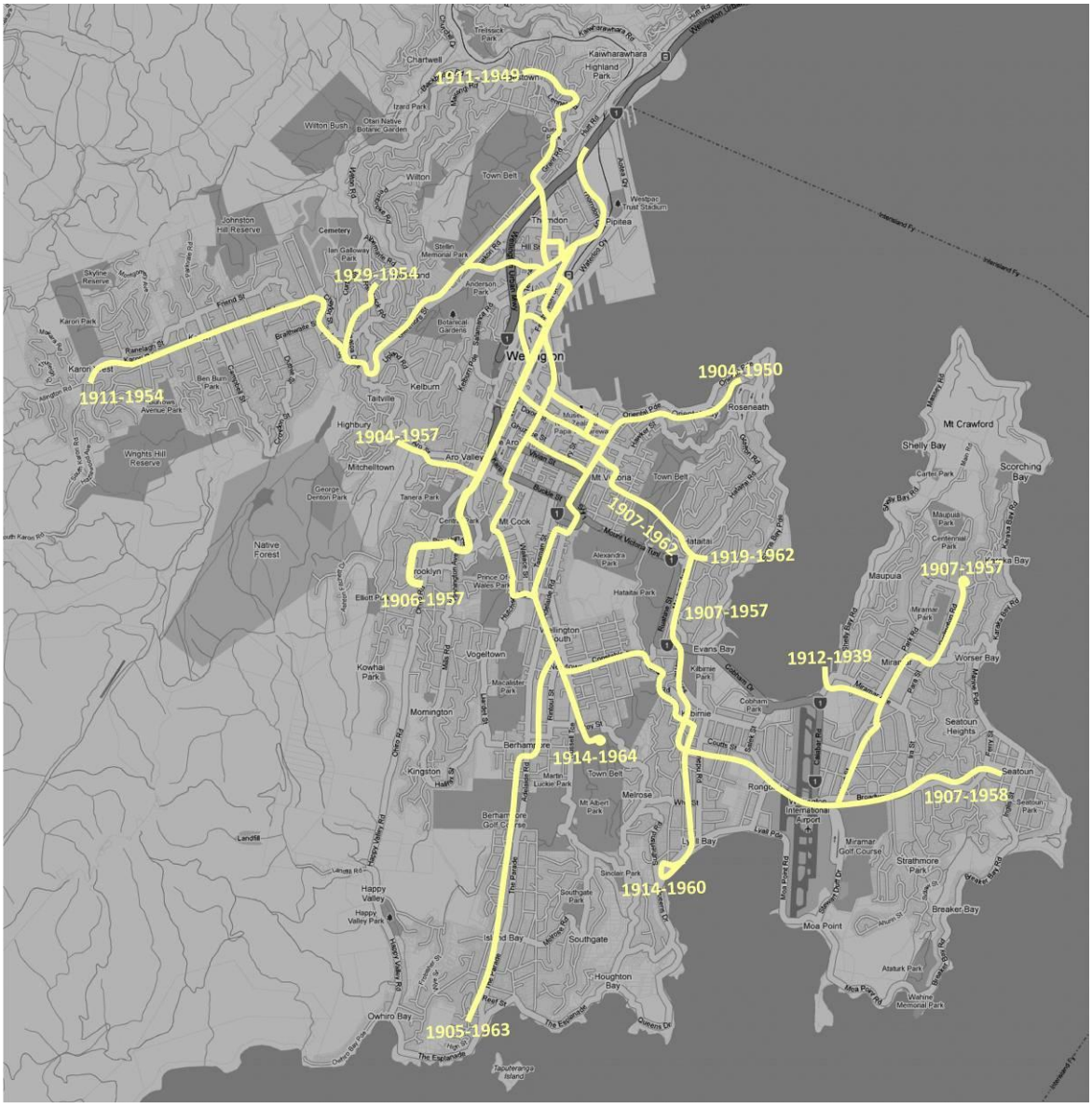

Figure 4 Wellington's tram network overlaid on the current settlement layout

Figure 4 is taken from the New Zealand Railway and Tramway Atlas, a publication showing maps of the tram networks and rail lines of New Zealand together with notes on the time they were established or upgraded, for example by electrification, or perhaps closed.

Figure 4 contrasts with our current expectations around the establishment of transport networks. While we currently expect this to take decades, Figure 4 shows

that from inception of a tram network in approximately 1900 that by 1905 to 1907 the network extends well beyond what was then the existing city to the natural geographical limits (sea or high hills) of Wellington. This is an infrastructure-led development with the public transport route established into greenfields and settlement developing around them. These routes are still Wellington's most viable bus routes. This development contrasts with the suburbs of the 1960s onwards when a road-based network was established of a style not well suited to public transport, and which has consequently meant public transport has always struggled to be viable in these suburbs.

If government is the business of reports, then it also appears that once some activity is regulated or licensed then it must be counted and recorded. Even private data can be available in forums such as a Commission of Inquiry into a transport issue. Figure 5 shows the public transport usage in Auckland from 1925 onwards, highlighting that current usage and targets are, in real terms, well below the actual usage that was achieved when Auckland had a population about only one fifth the current population.

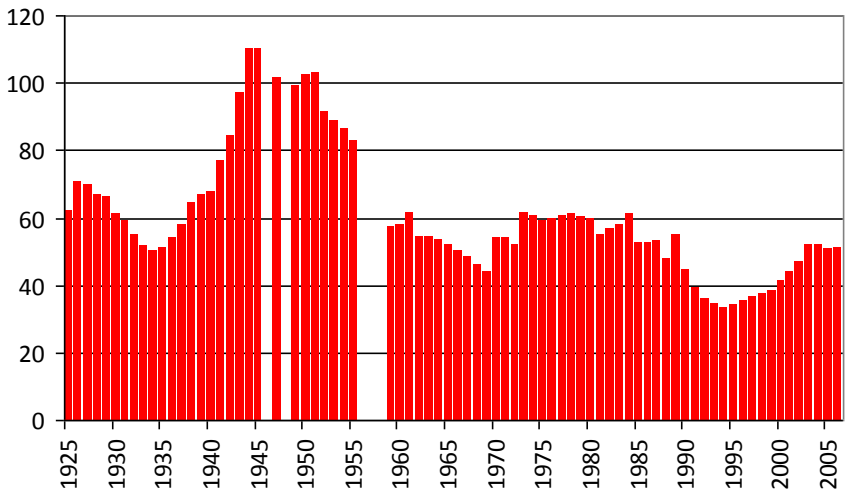

Figure 5 Patronage (in millions of passengers per year) of Auckland's public transport services – trams, trains, ferries, buses

The data has been obtained from a number of sources. The New Zealand Yearbook (Statistics NZ) has contained a separate transport section since 1928 which included in particular details of the tram networks nationally retrospective to 1910 and then from 1928 onwards for each city. As would be expected, the yearbook reflects what was considered important at the time and the level of detail that can be sensibly incorporated. For example, when trams were the dominant form of public transport the data for each city is included in detail. In the 1950s there are attempts to record separate statistics for trolley buses and buses, but this was soon abandoned and the data consolidated and shortened because there was then a need to include other emerging modes such as air travel. The yearbooks contain some commentary which can remain unchanged for several years, but is valuable for the insights it gives into the thinking of the time rather than with historic perspectives. The 1928 commentary expresses the concerns about declining public transport patronage and competition from bicycles, automobiles, and private buses (often operated by World War I

veterans) "necessitating" a transport Act to protect the public system from private competition in 1926.

This protection of the public transport delays the decline although it cannot offset the reduced activity of the 1930s Depression, and the very marked upsurge in public transport use in the early and mid 1940's was caused by wartime petrol and tyre rationing rather than a renewed appeal of public transport. Figure 6, which shows vehicle numbers and fuel use over this period, shows how this rationing reduced fuel by 50 percent yet the hydroelectric power public transport system helped ensure that society functions at a reasonable level.

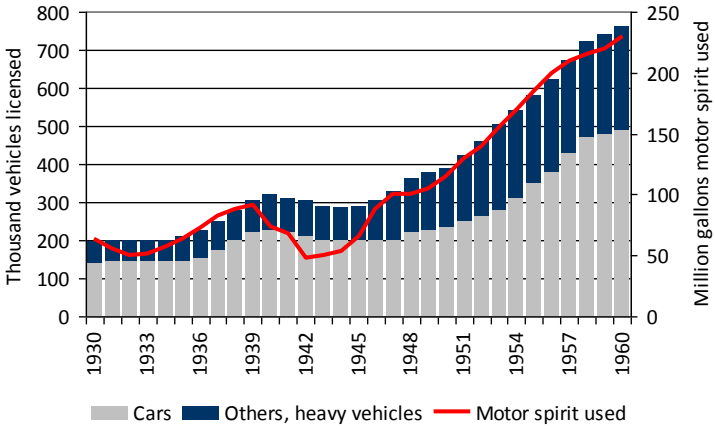

Figure 6 Motor spirit usage versus licensed vehicles, showing the near 50 percent reduction in motor spirit usage during wartime rationing

Archives of historic photographs are a further valuable information source to give perspectives of past transport systems. Many are accessible via the internet. The Alexander Turnbull Library of the National Library of New Zealand has a collection of New Zealand and Pacific images. Street scenes, even as late as the 1970s, are notable for the number of people in the street rather than relegated to the road edge or pavement. Photographs of tram systems at peak periods show that congestion is not unique to today but existed also with these public transport systems. Photographs also give a good sense of the urban form in which the public transport was viable.

Figure 7 shows a Wellington suburb, Lyall Bay, at the height of the tram era. The form of this suburb is not greatly changed other than to become a bit more dense with infill housing, showing that this same form should support viable public transport services in the future with the challenge being to have the population use them.

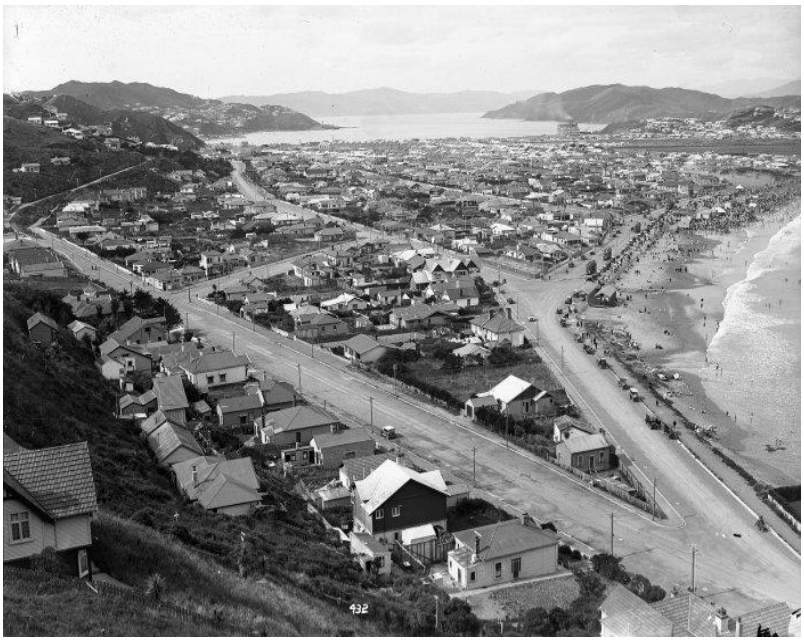

Figure 7 The form and density of Wellington's Lyall Bay circa 1930s is little changed today

The ferry data of Figure 8, that is also a component of Figure 5, was obtained from the 1946 Royal Commission on the proposal for an Auckland Harbour Bridge. This five volume report contains a wealth of data on transport and urban development in and around Auckland over the period 1930 to 1950 and reinforces the then view that car travel was synonymous with development. The bridge by facilitating car and truck travel to the North Shore and Northland region would be a major tool of economic development. The report also discusses the viability of many bridges internationally that were constructed across major rivers and harbours previously serviced by ferries in what could be described as a 30 year bridge era from about 1910 to 1940. The report discusses the acceptability of tolls with these bridges and the acceptability of the urban growth that had eventuated from these bridges.

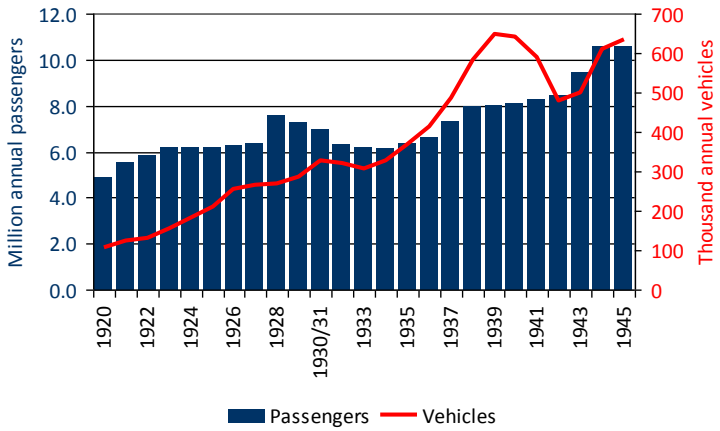

Figure 8 Passengers and vehicles carried on ferries across the Auckland harbour prior to opening of the Auckland Harbour Bridge

Data presented to this Commission on delays caused to private motorcars and trucks provides the explanation to the bridge era of which the Auckland Harbour Bridge is a

delayed part. Although several hundred passengers could easily be accommodated on even modest-sized ferries, few cars could. For the growing number of car owners the ferries then became a major impediment to their journeys, with peak time delays of 15 to 30 minutes and being unable to board two to three fully-laden departures common. Since they were already paying for the ferry, the acceptability of a similar toll for an unimpeded bridge-journey had an obvious appeal.

4. TRANSPORT TRENDS FROM 1970S ONWARDS

From about the 1970s onwards, a more cohesive grouping of datasets helps to develop understandings of how transport is changing and the data provides opportunity to understand this at both the micro and macro level. These datasets include household expenditure surveys; household time use surveys; Census information on demographics, vehicle ownership, and mode of travel to work; and national travel surveys.

The Household Expenditure Survey is conducted by Statistics NZ approximately every three years and traces expenditure across major categories and subcategories within these main categories. Transport is measured as vehicles: operational costs, vehicles capital costs, and public transport. Analysis is by the tem income deciles and also by household occupier-type. Figure 9 shows the expenditure over the last 35 years with transport costs falling from about 18 percent to about 13 percent of total household expenditure. The percentage expenditure is about the same across each income decile, both in total and for the transport subcategories, even for overseas travel. About one percent of household expenditure is spent on public transport, again evenly across the decile groups. An apparent very high usage of high incomes on public transport becomes more understandable once it is realised that domestic air travel is classed as public transport.

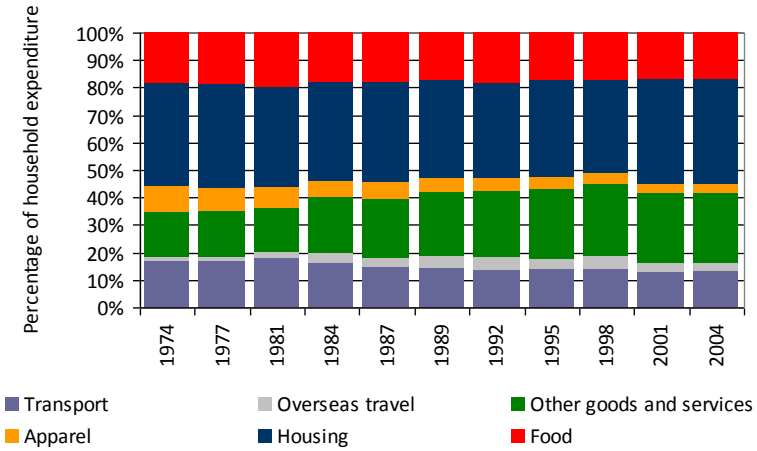

Figure 9 Average national household expenditure across six categories from 1974 to 2004

The falling cost of transport occurs against a background trend of a strong growth in vehicle ownership, but reforms in the mid 1980s have reduced new car costs by about 30 percent in real terms and used cars by about 50 percent, and this coincides with the closure of all local vehicle assembly. These recent reductions contrast with the situation in the early 1920s where local assembly reduced vehicle prices by half.

There will be other expenditure surveys. We sourced two others, one in 1911, the second in 1919. Both mirrored an Australian survey and the surveys expected households to maintain expenditure diaries over a full year so consequently the response rate was poor, at about 4 percent. It appears that then only about 2 to 3 percent of expenditure was on tram or train fares. Compared to now, food was a much greater component of expenditure at 30 to 35 percent, with housing a little cheaper at about 20 to 25 percent.

The five-yearly Censuses have contained, since 1971, questions on vehicles owned by the household and questions of the dominant mode to work. Figure 10 shows the vehicles per household for the Census periods so that now only 8 percent of households do not have a vehicle and more than 50 percent have two or more vehicles. Analysis of persons per household over the corresponding period shows that the percentage of households with only one or two persons has increased from approximately 30 percent in 1961 to about 55 percent now. Compared to 1961 we now need an extra 20 percent more households to house these smaller households than we would have needed just to house the increased population and household size had remained unchanged. This has increased even further the numbers of cars on New Zealand roads.

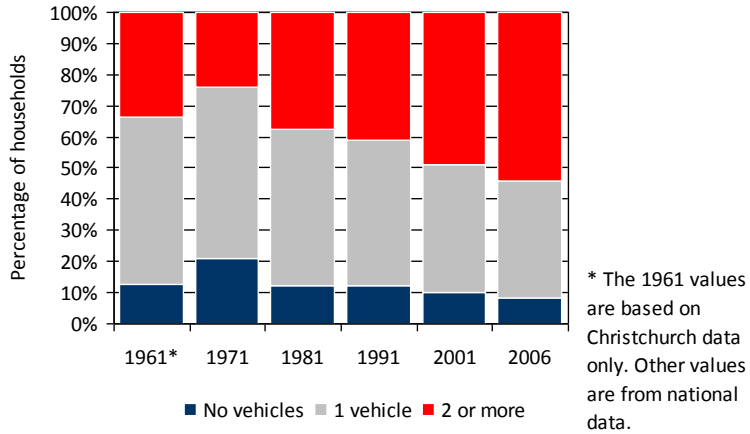

Figure 10 Average number of vehicles per household

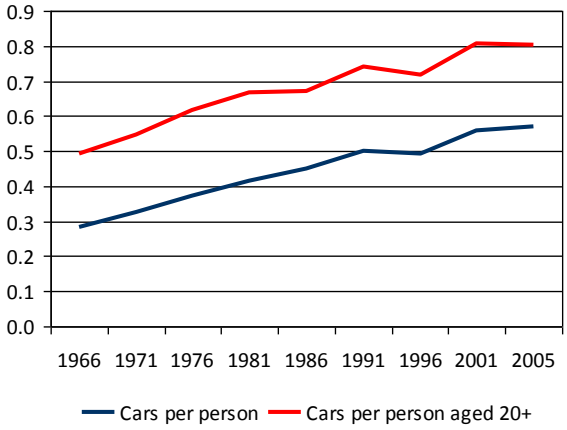

Figure 11 Average number of private motor vehicles per person of the New Zealand population and per person aged 20 and over

Figure 11 first plots the more common cars per person showing that New Zealand is close to having 600 cars per 1000 population. The second part of Figure 11 has taken the Census demographic data, which shows that the total numbers of people under 20 years old has remained almost static over the last 40 years, and plotted the ratio of cars to people over 20 years old. At 0.8 cars per adult we are approaching the stage where almost every able-bodied adult has a car.

The Census numbers for mode of travel to work are shown for each Census period in Figure 12. This "travel to work" trip is the one most likely to use modes other than as a car driver, but even for this trip the consistent trend is for travel as a car driver to increase to being the completely dominant mode.

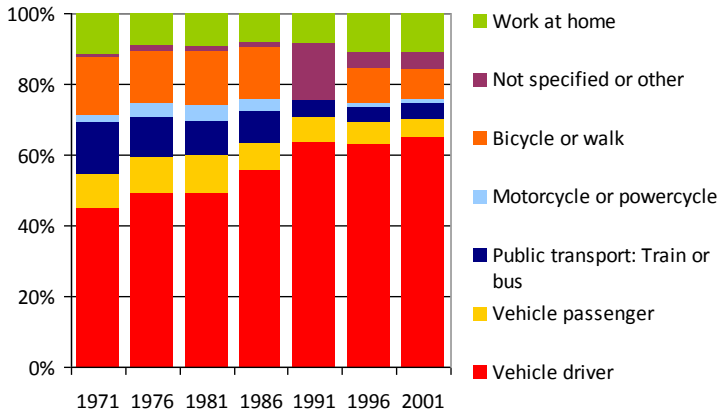

Figure 12 Dominant mode of transport for the "travel to work"

5. NATIONAL TRAVEL SURVEYS

The national travel surveys of 1989, 1997, and the equivalent continuous survey that started 2002 are well known to most practitioners involved in transport and transport research. Processed data is published regularly on travel modes, journey lengths, vehicles types and sizes, at both national and regional levels. Data for all three surveys is electronically available. Less well known is the first survey in this series, the 1976 Driver Exposure Survey. The data for this is electronically stored but apparently irretrievable but reports on processed data are available.

The primary purpose of all four surveys originated not so much to be informed of transport at a national level but as an essential component of road safety in calculating road user exposure to crashes and injury. As a repeated survey of about identical methodology across 35 years a robust series of trends is able to be established.

There are some slight differences between surveys and the 1976 survey classified journeys as "urban" or "rural" depending on whether the speed limit for the road driven on the trip was under 70 kilometres per hour or over 70 kilometres per hour. In contrast the division now is between centres with population more than 10,000 and centres with population less than 10,000. In reviewing the 1976data we gained

insights into the choice of car size with longer rural travel and the role of social recreational travel as a major component of vehicle kilometres travelled.

Table 1 Vehicle kilometres travelled for fleet (calculated from 1976 Driver Exposure Survey)

Engine capacity, cc	Total million vehicle kilometres travelled		
	Rural	Urban	% rural
Up to 1,000	347	515	40.2
1,000 to 1,350	1,749	1,617	51.9
1,351 to 2,000	2,767	2,273	54.6
2,001 to 3,500	2,059	1,451	58.6
Over 3,500	1,149	515	69.0

Table 1 which shows engine size against vehicle kilometres travelled is subdivided into rural or urban driving. Table 1 indicates a process of rational compromise by car drivers/owners. If they make mainly urban journeys, a smaller car is acceptable; if they make many rural journeys a larger car is preferable; and if driving involves approximately equal rural-urban driving then an intermediate sized car appears to be the main choice.

Table 2 shows average trip distance for the three main purposes of commuting to work, services and shopping, and social and recreational trips. For each trip purpose the urban trips are essentially a constant length independent of car engine size. Compared to urban "work commute" trips, urban "services and shops" trips are slightly shorter (0.5 – 1.0km) and urban "social and recreational" trips are slightly longer (about 0.5km). Compared to rural "work commute" trips, rural "services and shops" trips are about 50% longer, and rural "social and recreational" trips are about 2 to 3 times longer. The longest average rural trip is for social and recreational purposes. It is much longer (three to six times) than most urban "social and recreational" average trip lengths.

Table 2 Average trip distance (calculated from 1976 Driver Exposure Survey)

Engine capacity, cc	Average trip distance, km					
	Work commute		Services and shops		Social and recreational	
	Rural	Urban	Rural	Urban	Rural	Urban
Up to 1,000	7.4	4.5	10.1	4.5	19.2	5.3
1,000 to 1,350	10.0	5.4	16.3	4.2	29.6	5.8
1,351 to 2,000	14.9	5.2	14.4	4.7	28.2	5.7
2,001 to 3,500	10.5	6.4	18.6	3.9	21.1	6.5
Over 3,500	17.2	5.2	21.2	4.2	39.9	6.1

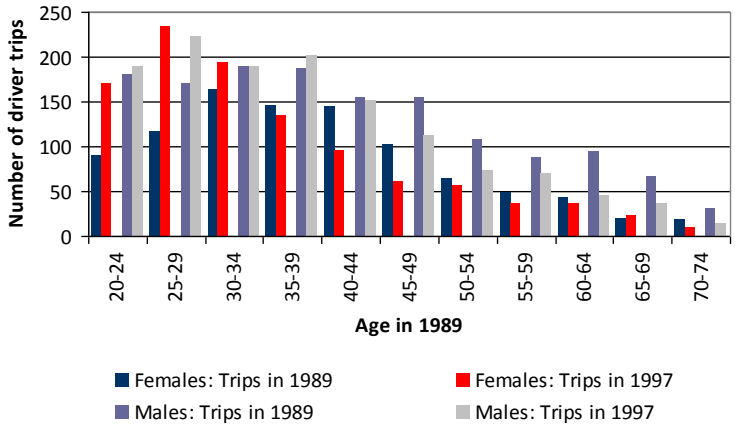

Figure 13 Driver trips made by the same cohorts of females and males eight years apart

Figure 13 compares travel behaviours as number of driver trips across two national surveys, the first in 1989 and the second in 1997. The comparison here is by cohorts so that the 20 to 24 year old age group in 1989 is taken as the 30 to 34 age group in the 1997. The cohorts are subdivided into males and females. The figure shows that in comparison to all other cohorts, the 20 to 30 year old females in 1989 showed a very large increase in driver travel over the next ten years of their lives. It is an ongoing pattern from the 1976 survey to the present one that the former marked difference in travel between male and female has almost gone. The number of trips thedistance travelled and the size of vehicle used are now very similar whereas in 1976 ther were marked differences.

6. TRANSPORT ENERGY PER PERSON

While separate tram systems were operating in different centres of New Zealand, the Yearbook provided statistics of the energy per tram car mile and the persons carried per tram car mile. Energy is quoted in units of electricity without specifying exactly what units, but kilowatt hours are assumed so that the energy per person carried can be calculated.

Table 3

	Energy used per tramcar kilometre (MJ/km			Energy used per person per tramcar kilometre (MJ/km)		
	1928	1938	1947	1928	1938	1947
Auckland	7.29	7.13	7.60	0.69	0.86	0.60
New Plymouth	3.26	5.60	4.99	0.59	0.95	0.46
Wanganui	4.38	5.70	6.19	0.73	1.34	0.92
Wellington	5.36	5.63	6.17	0.49	0.55	0.46
Christchurch	4.72	6.30	5.94	0.66	0.95	0.77
Dunedin	4.67	6.44	5.21	0.37	0.58	0.41
Invercargill	3.73	3.66	3.62	0.35	0.55	0.47

Table 3 shows the energy per tram car kilometre and the energy per person kilometre, both shown as MJ/km, over the period 1928 to 1947, with 1928 being about the point of maximum tram usage after twenty years operation, 1938 showing

some decline post-Depression, and 1947 still showing residual effects of increased public transport use because of wartime fuel and tyre restrictions for private vehicles. Energy per tramcar kilometre is influenced by factors such as the size and nature of the tram network. Extra track would have been added and removed over this twenty year period. Energy per person kilometre is influenced by passenger loadings. Wanganui, New Plymouth, Invercargill, and Christchurch had the lowest loading rates; and Wellington, Dunedin, and Auckland had the highest. Energy per passenger is typically about 0.4 to 0.7 MJ/km and shows the public transport based cities as low energy societies especially for the 1900 to 1928 period when they were almost the only form of vehicle transport in cities.

Data in the 1977 Energy in Transport Study Report 27 of the New Zealand Energy Research and Development Committee cited data from Europe and the United States showing electric transport with an energy intensity of 0.6 MJ/person km and for petrol and diesel public transport typically of 0.8 to 1.3 MJ/km.

The energy intensity of cars is also influenced by average occupancy. A calculation based on data from Report 27 gives an energy intensity of New Zealand car use at that time of 2.1 MJ/person km. The March 1997 Science Monthly notes that the energy intensity of car use has increased from 2.0 to 2.3 MJ/person km/ The energy intensity of urban driving only will be greater and again Report 27 cites a 50 to 100 percent increase in energy use of inner city driving compared to motorway driving.

As a comparison then, the 1920s society operated on about 20 to 30 percent of the transport energy compared to the present time.

7. OTHER DATA

There will be numerous other reports of which we have sourced but a few. The Transport Policy Study (1974) is an extensive study of the national transport system and contains extensive data especially of freight. The 1970s also had a strong focus on transport energy and means to reduce use of transport energy. There are several reports produced specific to transport energy by the New Zealand Energy Research and Development Committee and we have already referred to report No 27 in section 3.

With the creation of the Urban Passenger Transport Council in the early 1970s to help support public transport systems, a small fund to support research was established.. A 1975 report by Heylen Research Centre on attitudes to public transport had similar findings to current studies. That is that many are not so much dissatisfied with public transport as seeing that it does not offer the speed and flexibility of private cars. Those who are dependant on public transport complained about it not serving a number of their desired destinations (a result consistent with form changing under the different transport modes)

A study by Chivers on the provision of public transport in the new (1960's and 1970's) suburbs demonstrated the further links between transport mode and form. The street configuration and how the development was made was unfavourable to buses and public transport was only ever offered at essentially a skeleton service as

the expectation was that most in the suburbs would be living with cars. The way the suburbs were developed and the delays in providing public transport tended to entrench the necessity to have at least one car for the household.

8. CONCLUSIONS

We examined this historic transport data to gain an understanding of why our transport systems are of their current form and to also understand the role of transport in New Zealand's urban development.

Overall the investigation confirms that New Zealand cities have developed much as those of the North American and Australian cities in particular, where successive new modes of transport have enabled the rapid outward expansion of the cities with a wave of expansion coinciding with each new mode becoming dominant. Transport has been fundamental to urban form with each dominant mode of transport establishing the size of cities and location of its dominant components. There is the dynamic relationship between form and transport which results in cities being progressively added to or existing areas modified to new uses as an ongoing process.

Current transport behaviours are in the main the logical outcomes of a public responding to the economics and other real settings of the transport. Often these real settings contradict the urgings for different behaviours. Many behaviours are locked in by our urban form. We found that for most of our metropolitan cities that life by public transport alone is difficult, as journey times are often very long and at times not even possible.

There have been a series of transport eras, each with a dominant mode. At present our transport infrastructure plans are still primarily those laid down in the very different circumstances of the early 1960s. It is difficult to see these as appropriate for the low carbon era that is emerging.

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