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# **THE INFLUENCE OF TRANSPORT AND BUILDING CYCLES ON URBAN FORM AND THE IMPLICATIONS FOR STRATEGIC PLANNING**

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## **ABSTRACT**

Strategic Regional Planning often has to address the relationship of a large urban area with its surrounds and inevitably focuses on the form of that large urban area. This paper draws first on histories and theories of urban growth, and the resultant urban forms, from the two main perspectives of transport and building cycles. History traces the relatively rapid change, from high-density pedestrian-based cities of the 1850s, to the current sprawling low-density car-based cities, via intermediate stages of urban passenger transport rise and decline. Building cycles are also examined, through their influence on change throughout the city, rather than just at the edge, and their role in locating specific land use types.

Important implications for strategic planning can be drawn from this background.

- The further we look forward into the future the more we need to also look back so as to better understand the influences that caused things to be as they are.
- Cities need to be seen as undergoing continual change, rather than proceeding to any ideal steady state.
- The past is imprinted over the city's urban form, though the causes that induced that form may have long since changed.
- Transport is enabling, and urban form follows transport technology.
- The technology of the dominant urban transport mode has been changing in about fifty year cycles, and the changes to the urban form caused by the transport change are difficult to envision fifty years out.
- The range of modern urban forms exhibited throughout most of the world at this time is essentially only variants of car-based cities, so the range currently demonstrated is much smaller than the potential range possible.

**KEYWORDS:** transport, urban form, urban growth, building cycles

## 1. INTRODUCTION

The ideal of urban areas interacting harmoniously with the adjacent rural land has existed for many years, both in its earlier expressions of the Garden City of Ebenezer Howard and its modern sustainability variant of food miles, eating locally, and farmers' markets. The reality has been markedly different, with the last 150 years being an era of unprecedented urban growth with cities engulfing much of the adjacent farmland through rapid urban population increase coupled with the urban setting being one of decreasing population density. A study of a North American city showing that in the last seventy years, almost all of the urban expansion has been into farmland, rather than wetlands and forested areas, is unsurprising when we consider that the attributes that make land suitable for farming are also the attributes of land suitable for residential settlement.

Strategic regional planning invariably focuses on managing the direction of this movement of the urban area into the surrounding land, either by identifying areas into which to channel growth, or via restrictions to further expansion via policies such as growth boundaries and containment so that growth and densification of the urban area occur. However strategic regional planning as practiced in New Zealand is essentially a combination of vision and management process for changing the use of privately owned land. While there may be some containment of the urban area via green belts and the like, the change is primarily to be effected by the private sector with some public provision of the essential infrastructure.

What is that nature of the ideal urban form and how can change be effected are important questions for strategic regional planning. They are also questions for a research programme "Learning Sustainability", from which this paper is drawn. What is "urban form" and how is it measured are two questions being addressed by the research. Answering the question has been more difficult than expected. First the term, urban form, appears to be applied to many different scales ranging from clusters of a few houses, neighbourhoods, suburbs, right up to metropolitan regions. Second some of the measures in current vogue, such as the sprawl index developed by the USA Smart Growth programme, though highly statistical, are essentially variants of population density and convey little sense of the nature of the city, nor of its progression.

This paper draws from the work of urban morphologists and two in particular, Vance and Whitehand. The urban morphologists view the city as an ongoing entity representing the accretion of past activity and knowledge, which is then modified and added to by the present city occupants then passed on to future generations to be further modified and added to in turn. The urban morphologist's view is that the historical analysis of urban areas moves beyond the specific historical events and uncovers the process and influences that shape urban areas. Vance with a transport focus and Whitehand with a land value and building cycle focus reveal the powerful interplay of transport and economics which shape urban areas - these forces being those which strategic planners hope to influence.

The paper discusses the New Zealand experience from both the transport and building cycle perspective and then concludes by drawing the implications for strategic regional planning.

## 2. TRANSPORT AND URBAN FORM

An extensive literature exists on the relationship between transport and urban form. Typically it is expressed as a particular urban form being favourable to walking or to public transport. Often in this literature it is not the whole city or metropolitan area being considered. For example, walking accessibility studies usually concentrate on the town centre or the neighbourhood level, while Transit Oriented Development generally considers only a neighbourhood-scale centred on a public transport station, albeit that the station is part of the wider city's public transport system.

Vance reverses the way in which this relationship is expressed showing that the urban form arises from a particular transport technology and the nature of the transport network that this technology generates. In his analysis, transport is not the driver of form, (the drivers being often economic, or demographic, or home ownership,) but transport regulates the way that the form of the city changes in response to the form-drivers.

Vance describes how, until approximately 1850, almost all cities of the world were essentially very overcrowded pedestrian precincts, little more than 1.6 kilometres in radius. Where steam-train transport existed, it generated a series of pedestrianised settlements spaced at about 5 kilometre centres linked by the train system. These cities were very crowded and, invariably, unhealthy.

The development of the horse-drawn omnibus (France, 1837), and the horse-drawn tram (United States, 1850), enabled the release of the overcrowded city into one of wider radius, about four to five kilometres, with consequent lower population density. Accompanying changes were from crowded rented multi-unit housing to owned detached cottages, with the wealthiest residents moving to the city perimeter and a wealth gradient back inwards to the old core. The horse-drawn modes of transport made a new more dispersed lifestyle possible while population growth continued the expansion of settlements, with the wealthy continuing to move outwards and the upwardly mobile following behind.

But four to five kilometres is the effective limit of horse-drawn transport. Ongoing population growth therefore resulted in consolidation infill and other densification processes, such as taller multi-level buildings. This consolidation phase was then relieved by the electric tram, with its effective travel range of about ten to twelve kilometres, which was in turn succeeded by wider ranging rapid mass transit systems and finally cars.

Table 1 Mode of transport and enabled settlement area

<b>Mode</b>	<b>Range of travel enabled</b>	<b>Settlement area enabled</b>
Walking	1.6 - 2 kilometres	to 15 square kilometres
Horse-drawn vehicle	4 - 5 kilometres	50 to 80 square kilometres
Electric tram	10 - 12 kilometres	300 to 450 square kilometres
Rapid transit	30 - 40 kilometres	2,500 to 5,000 square kilometres
Cars	About 60 kilometres	to 11,000 square kilometres

Table 1 shows each transport mode, its effective range, and the resultant potential city area. This change in city size via change in transport technology is significant in that, while each change allowed an expansion of the city, it also made the previous transport technology less effective. For example, with the change from walking to horse-drawn tram it became difficult to walk to all parts of a city now about five kilometres in radius. Similarly cars have enabled

large dispersed cities with form that makes it difficult for trams to be effective in the outer regions. It is not just the change in settlement size that is significant. Changes in transport technology also cause the key components of the city to alter their relative locations.

Tram systems allowed for the outward expansion of the population into suburbs, and they also altered the nature of the commercial core. Some industry that was previously centrally located followed the population outwards, the commercial hub moved from near the wharves or railhead to where the tramlines converged, and the heavy foot traffic drawn stimulated the growth of department stores and similar mass retail at this point of convergence. Retail also grew in the suburbs where several separate tramlines converged and at the terminals of the tramlines.

Where the nature of business was such that location within a particular city area was essential, buildings gained in height. Without elevators, a natural height limit was about five storeys. The invention of the elevator, or lift, together with building technology enabled high rise offices of workers or a large amount of retail, to be viable, enabling that distinct urban profile of the high-rise Central Business District.

Cars and trucks have not only allowed industry to move to the periphery of cities, and for people to live anywhere and work anywhere, but the commercial localities have also altered. Retail is now where cars, rather than pedestrians, can readily converge, moving to suburbs. Bulk retail (especially of furnishings, whiteware, hardware, and for gardening) have moved out of the Central Business District area to suburban settings or to regenerating industrial areas.

### **3. LAND VALUE, BUILDING CYCLES, AND URBAN FORM**

Whitehand draws together the work of a very large number of studies and works through these as well as additional empirical evidence to develop his theories of urban processes, particularly over the last 200 years.

Whitehand's central premise is that cities represent the accumulated knowledge and efforts of the previous generations and to understand the city it is necessary to understand the processes by which the present form was derived. He examined the process of urban formation via building cycles, land use, land value, innovation, and planning, then discusses the main parts of the city which he identifies as the fringe belts, the residential areas, and the commercial cores, in relation to the theoretical basis developed.

Whitehand first traces the pace of urban development showing that within western cities, at least, it has never proceeded at an even pace but via a series of cycles of high building activity (of approximately ten to twenty years duration), then periods of low activity. Theories of causes are both at the international level of capital and migration flows between industrialised European countries and developing "New World" countries, and at the national or local level coupled to population growth and economic activity. Whitehand cites Lewis' theory as his preferred theory in which the cycles stem from the interaction of population growth (both natural and migratory increases) with credit availability which is synergised by one of more of other changes that boost real incomes. The resulting building boom tends to bridge the shorter term general economic fluctuations and continues until the credit crises, brought on by the strain of the building boom, together with slowing population growth causes excess building

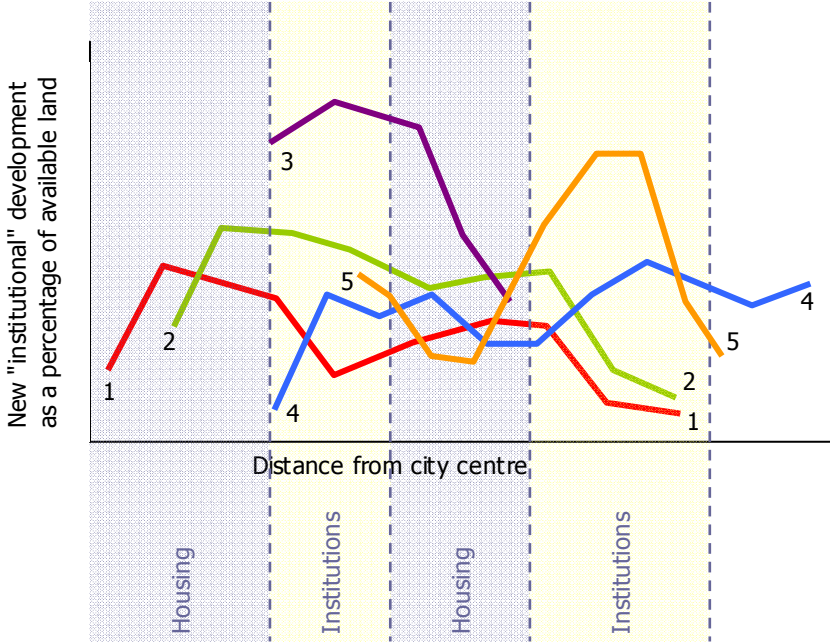
stock to develop which in turn hastens the slowdown with impacts across the economy causing reduced incomes and employment, and encouraging emigration.

However the impact of these building cycles on the urban landscape is accentuated by the different building rates for the different categories of: residential; commercial/industrial; Government and non-building land uses such as parks and golf courses. Residential building is the most cyclical; Government building, parks and sports fields have an almost consistent rate of establishment, with the commercial/industrial rate lying between these two. The result is a city built up of zones of a different composition for different eras. In the United States of America, for example, commercial building activity accounts for only 35 percent of the total activity during building booms, but 70 percent in building slumps.

Land value and land use is an inter-linked relationship with land value determining land use and land use determining land value. While Whitehand agrees with the Thünien view that value increases towards the centre, and that land use reflects the value of substituting "rent" for transport costs from the centre, Whitehand's view is that this needs to be seen as a dynamic relationship over time rather than a static relationship if it is to explain urban processes. He demonstrates that fluctuations in land value correspond to fluctuations in building activity which he sees as not surprising given that buildings are such a large proportion of the urban area.

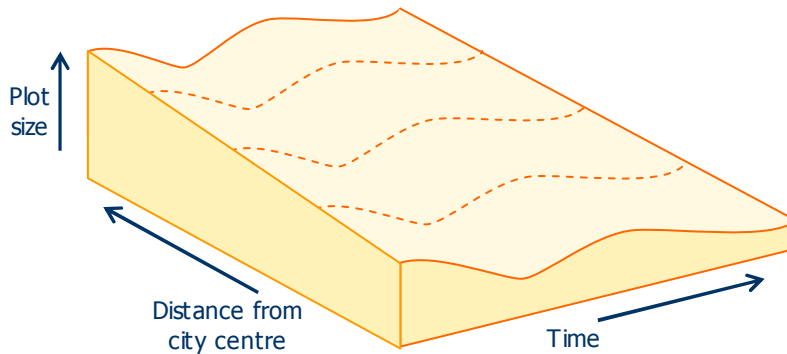
Whitehand advocates a dynamic Thünien theory, where in building booms only the intensive land uses are prepared to pay the high "rents" of the more accessible central sites, which confines those with less capital and those extensive uses for which transport costs are not as critical to the sites on the city fringe. However in building slumps, land value falls and the lower capital users (housing) and more extensive uses can afford to locate anywhere where land is available.

Figure 1 Institutional development as a percentage of available land for five periods superimposed. (Housing development occurs in approximate reciprocal areas.)



This process is significant for both the fringe and throughout the city. In building booms, at the fringe new housing will be closer in and extensive uses (such as institutions, parks, and sports areas) will be located further out. In slumps extensive uses can occupy any of the available land. The results of this process repeated several times are a series of city rings can be formed as shown in Figure 1.

Figure 2 The relationship of plot size to distance from the city centre and time



It also has significance for the existing city as in building booms, already developed lots will be used more intensively (subdivided). Figure 2 illustrates. Plot size increases from the centre to the fringe but plot size is also influenced by the building cycle. The result is that throughout the city, with each successive building cycle, the size of new plot decreases.

Innovation and planning were examined in the categories of construction innovations, functional innovations, transport innovations, and town planning. The construction and transport innovations have already been discussed in connection with Vance. Whitehand does note however that transport improvements reduce the land value gradient between the city centre and fringe, although this trend is overlaid with many other factors. Density controls via two planning strategies that influence land values are minimum lot size and "green belts". Density controls of minimum lot sizes effectively lower the value of the controlled area, with the value shifting to uncontrolled areas. The green belts, whether intended as an amenity area or a more deliberate tool to restrict urban growth, are effective in part. Land values rise within the area bounded by the belt, encouraging a more intensive use, but they also rise beyond the belt as the higher values inside the belt also make the additional transport cost by living outside the belt more acceptable.

Fringe zones are a prominent part of many urban landscapes. These are zones of almost contiguous low-density use that had their origins at the urban rural interface, although the city may have now expanded so as to include them. They are formed in several ways, but usually in a prolonged period of stagnation at the urban-rural boundary. This period usually need to be equivalent to several building cycles. The land uses with low coverage by buildings but which need large land area initially locate in this lower cost fringe, but over the longer period build up a sufficient extent that they act as a barrier to further expansion. The stagnation of the boundary may occur: naturally; or because of a geographical feature; in old cities from fortifications; or by the establishment of town belts or green belts. They are characterised by few roads, and a wide variety of low density uses including parks, recreational areas, large country houses with extensive grounds, hospitals, universities, schools, or defence force bases, and cemeteries. Over time the pressure within the contained urban area causes it to expand beyond the fringe so that the fringe zone is now included within the urban area which expands out until a new fringe becomes established. Once established fringe zones tend to remain as features of the urban landscape, resisting incorporation into residential areas as for

the land uses that originally occupied them it is better to expand on site than to move further out.

## **4. NEW ZEALAND EXPERIENCE**

### **4.1 Transport influences**

The New Zealand experience of transport systems mirrored that described by Vance with respect to the northeast American cities. Though the New Zealand towns in 1860 were much smaller than those of the time in northeast America, they were effectively pedestrian-only centres, in some cases linked by either small railways or water transport. Each of the transport technologies of America were quite quickly introduced into New Zealand with a delay of only about ten years following their first commercial appearance: Horse drawn trams in the early 1860s, an equivalent unsuccessful use of steam trams by the 1870s. Although the electric tram was invented in only 1882 by 1899 the first system was established in Dunedin, and by 1910, eleven settlements had electric tram systems with most established or under construction by 1905.

The impact of these systems on the urban form were quite deliberate, with the intent being to develop the adjacent land as residential suburbs, and to relieve the overcrowding inherent in a pedestrian-only city. The New Zealand city centres though less overcrowded than American and European counterparts were just as unhealthy, in part because basic infrastructure such as effective sanitation was not yet established.

Humphris states that Wellington was similar to other New Zealand and Australian cities with a population density at the time of introducing trams of about 50 people and 10 buildings per acre (125 people and 25 buildings per hectare). In Wellington the city borrowed heavily to establish the tram system which was largely in place as a network by about 1907 and operated as a publicly owned network. The experience in other New Zealand towns, apart from some minor differences, is effectively identical to that of Wellington.

The suburban growth occurred as expected and commercial areas developed at the termini and intersections of these tram lines, and the Central Business District at the central location of the tramlines. Because the lines radiated out from original settlement the developing Central Business Districts and associated warehouses and industry engulfed much of the original settlement with the residue deteriorating into slum housing, which served as a trigger for slum clearance policies from 1930 to 1950.

Figure 3 Annual vehicle registrations (approximate)

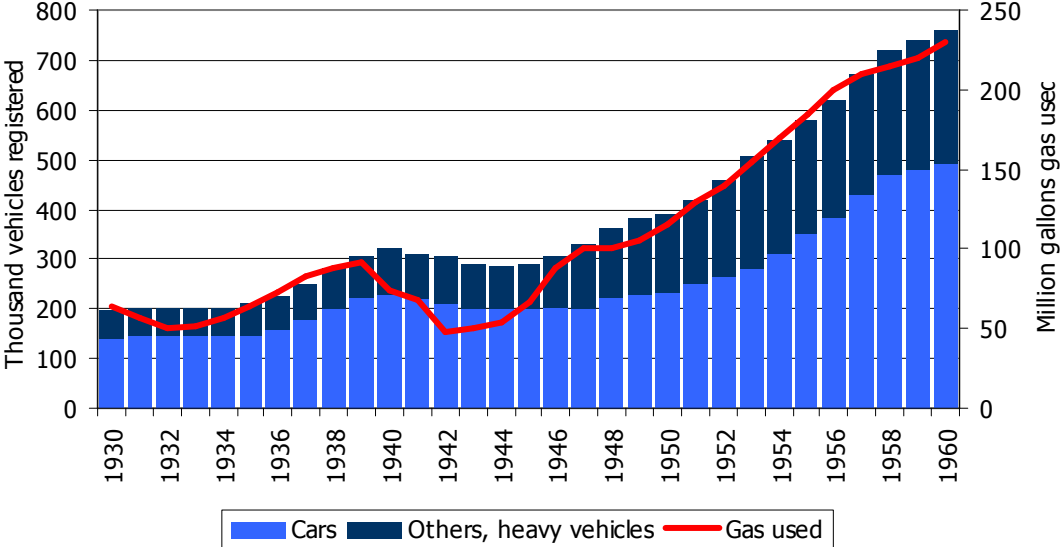
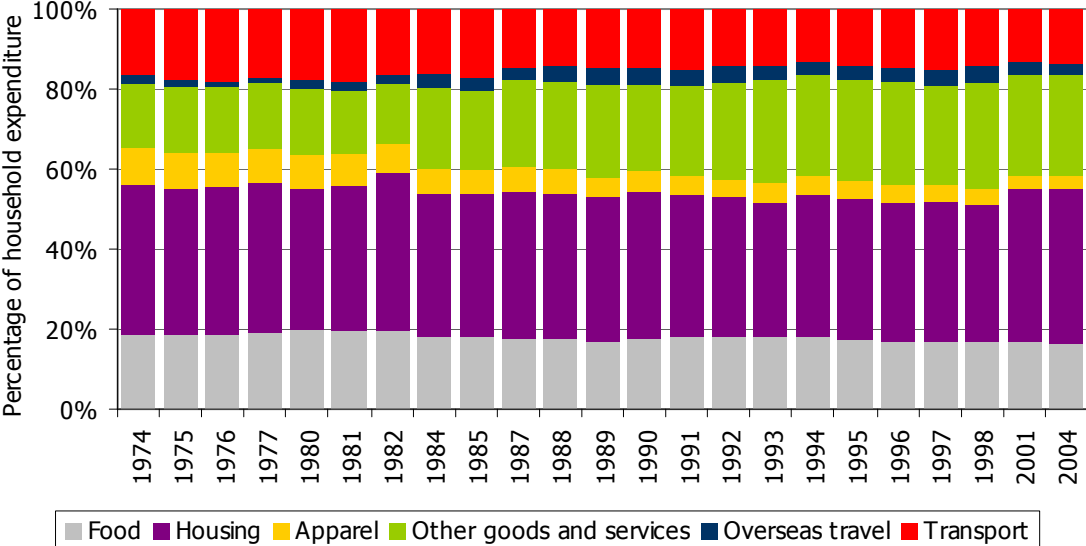


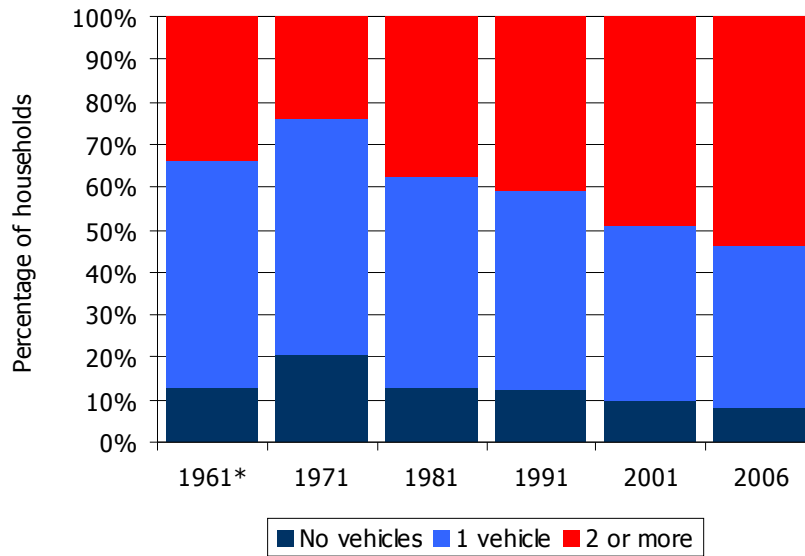
Figure 3 shows the uptake of both cars and heavy vehicles over the period until 1960. The 1930s depression and the fuel restrictions of the early 1940s suppressed car uptake but the post-war period marked the transition from the public transport cities and towns to car-based cities. By then New Zealand was a one car per household, motorway construction into the major cities had commenced, and suburban expansion was via subdivision where little regard was paid to the provision of public transport systems, and heavy vehicle transport, not rail, is the dominant means for freight.

Figure 4 Categories of household expenditure



The market reforms of the 1980s have reinforced the dominance of the car. Policies have lowered vehicle prices by about 30 percent for new cars and 50 percent for used vehicles. As a consequence households now spend substantially less on transport as shown by Figure 4. This is despite an ongoing uptake of cars so that now only 7 percent of households do not have access to at least one vehicle and 50 percent of households have two or more vehicles, as shown by Figure 5. This low cost of transport has facilitated lifestyles spread over two

Figure 5 Household vehicle ownership



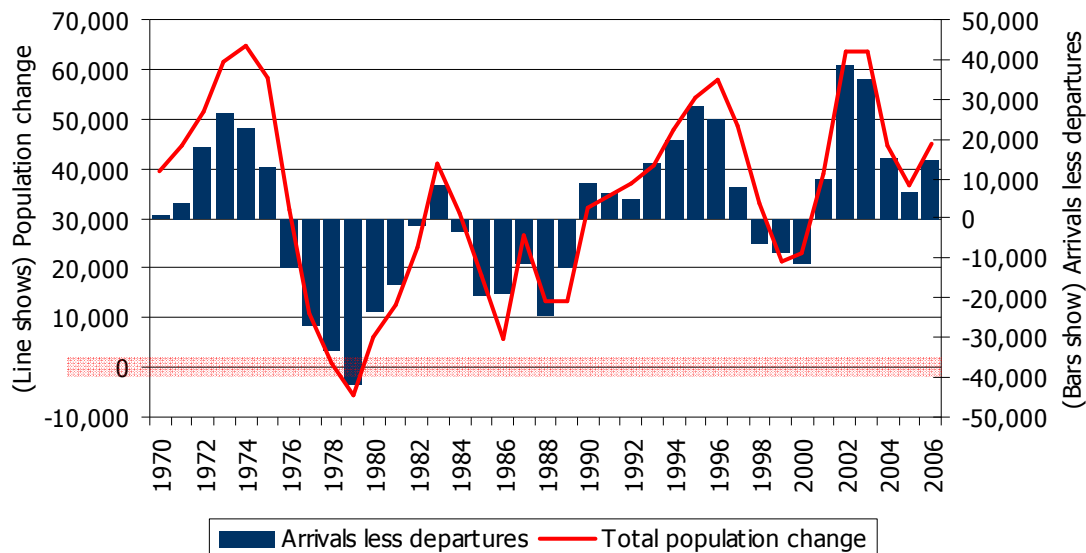
\* The 1961 values are based on Christchurch data only. Other values are from national data.

settlements, the weekday-settlement and the weekend-settlement at the beach, or lake edge, or mountains.

#### 4.2 The New Zealand experience of building activity influences

Whitehand compiled his theories using mainly European data, some from the United States, and occasionally from Australia and New Zealand. He identified cycles of population growth and credit availability as precursors to building cycle activity. The New Zealand experience reinforces this view.

Figure 6 New Zealand population change, with immigration and emigration interactions



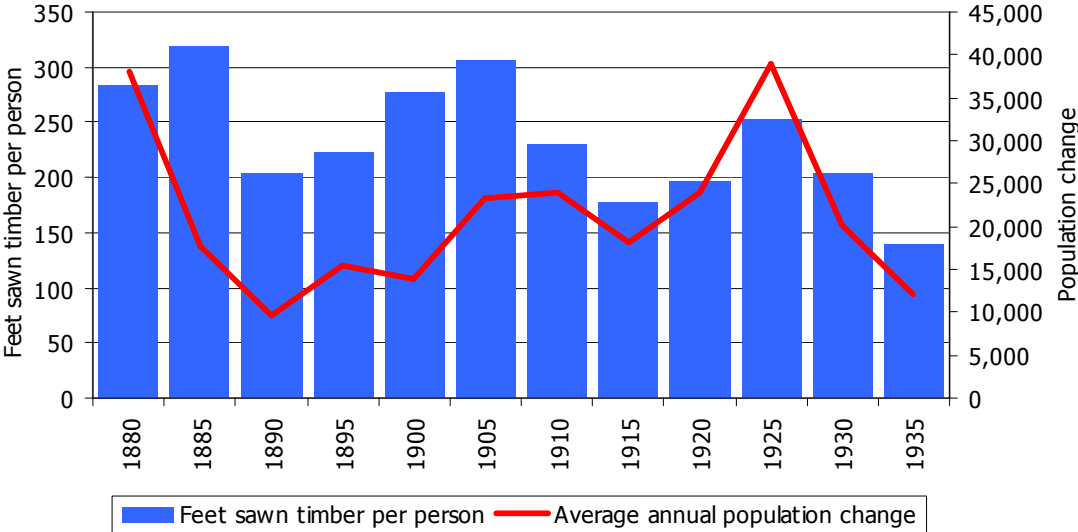
A dominant feature of New Zealand population is that the rate of arrivals and departures, from immigration and emigration, can be approximately equal to the natural rate of increase. The ability of New Zealanders to work long-term in Australia and short-term in the United Kingdom, United States, and European countries means that immigration/emigration flows are dependent on the economic conditions in New Zealand at the time. As a result the

population-change cycles through highs that is twice the natural increase to lows of zero increase, as shown in Figure 6.

Lewis had identified credit availability as another prerequisite of a building boom, and since 1895 there has been ongoing involvement by the New Zealand government in several ways including: making low-cost credit available for people (usually families) to build a house; directly building houses for rental; enabling State house tenants to purchase the property they are renting; or loans to refurbish houses so as to upgrade the housing stock. Examples are: the State Advances Act 1894; the Workers Dwelling Act 1905 (the first State houses); lenient State lending of the 1920s; the State house building programme for rental (1936); the encouragement to buy State houses of the 1950s; building subsidies to reduce house prices in the 1950s; capitalisation of family benefit for deposit (1959); extending assistance for house purchase to existing houses (1980s); and the house improvement programme (CHIPS) of the late 1970s and the 1980s. Generally these interventions were triggered by a perception of a housing shortage, high rentals or poor quality rentals.

Formal records of New Zealand's building construction are not available until approximately 1920, but timber was the most common building material in New Zealand's early development so first indications of New Zealand's urban building cycles are obtained from inspection of the consumption of building timber relative to the size of the population, as shown in Figure 7. From 1921, records of the issuing of building permits have been kept and the annual rate of dwelling permits issued is shown in Figure 8. Figure 7 and Figure 8 also show New Zealand's annual population change.

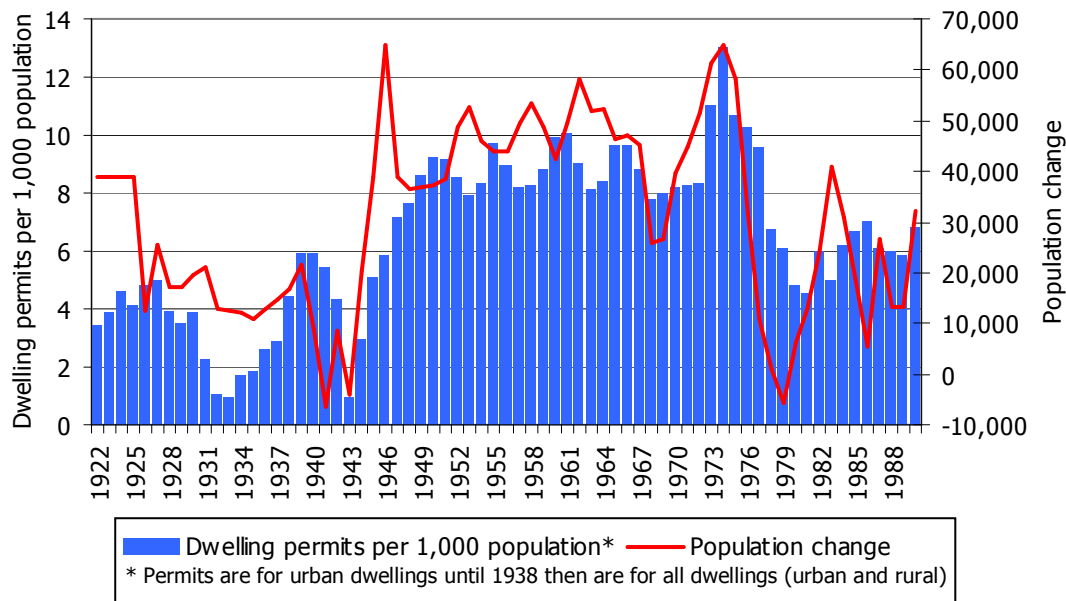
Figure 7 Annual rate of building timber consumption and population change



In both Figure 7 and Figure 8, generally, the line of population change tracks closely to the bars of building activity rates, showing a relationship between building cycles and changes in population size. A few anomalous periods stand out from this trend. High immigration rates, low existent population, and New Zealand's "newness" or "infancy" contribute to the building activity rate being above absolute population change around 1885 to 1905.

The depression of the 1930s also shows a remarkable slump in building activity rates. New Zealand's economic history is marked by other times of depression, including the early 1890s, and 1908-1910. Figure 7 shows how each depression coincides with relative declines in

Figure 8 Annual rate of dwelling permit issue and population change



building activity, identifying an obvious link between business and economic status and building cycles. The First and Second World War had similarly impeding effects.

The swell in building activity of the 1920s, prior to the 1930s depression, is in response to a housing shortage. Renting of dwellings was largely typical at the time but low availability of rental housing was encouraging consideration of home ownership, plus with the lowering standards of any housing stock that was available, a building boom ensued.

Another notable and extended period of building activity followed the Second World War, keeping pace with the general population growth and working with the nation's overall prosperity.

The popular view of the Government promoting solely separate dwellings on separate lots is not correct. Government records identify concerns of "sprawl", the need for urban renewal, and "higher-density housing" issues for New Zealand since the 1930s, and earlier. The 1930s Berhampore flats and the 1950s Dixon Street flats, in Wellington, are examples of Government-funded high-rise development. From around the 1950s, flats and multi-unit housing have been one alternative encouraged by the Government, through the provision of financial assistance for families and companies, and through physical construction.

Government has long recognised the interaction of individual dwellings and community building, and in the predominantly regulated conditions, up to the 1980s, determined to provide new dwellings with a range of amenities nearby. The approaches may now be labelled "mixed-use" or "new urbanism".

Other social and value changes have also influenced the demand for housing. Throughout New Zealand's history, dwelling sizes, house-sharing (with other families or boarders), and occupancy rates have declined. Selection of dwelling type and location varies by personal preference and life-stage, and the attractiveness of "new" subdivisions versus established areas fluctuates, for individuals and with trends.

The trend for Central Business District buildings to first be reused then replaced is evident in a number of New Zealand cities. The Central Business Districts of New Zealand's major cities are now into their third cycle. The original settlement buildings were replaced during the Central Business District growth expansion with the establishment of the tram systems, but many of these buildings have been replaced in turn with both high rise office buildings and high rise apartment buildings. Reuse is shown by factories and warehouses having been converted to apartments or into restaurants.

## **5. IMPLICATIONS FOR STRATEGIC REGIONAL PLANNING**

The literature demonstrates that transport and economics have combined to be a powerful influence on the spread of our cities and also have determined where the composite parts of cities are located. The strength of this transport/economic component is such that most western cities have great similarities, despite the range of management planning processes that may have been applied. At present all our cities are car-based cities. The presence of some densified areas and a slightly more extensive passenger transport system in one city compared to another does not alter the fact that they are only variants of the car-based city-type. To understand what different cities might look like, we need to see cities based on distinctly different transport technologies. History shows us several types: the fully pedestrian city; the pedestrian satellites linked by trains; the lower density passenger transport city; and the sprawling low-density car-based city. Cars, however, are mainly a manifestation of the fuel type, with liquid petroleum being highly portable and suited to independent car-like travel. Coal and steam were best suited to railways with the distinct satellite settlement type but unsuited to use in local public transport. At the time, electric trams were the best way to use electricity within transport. Clearly form followed transport and not vice versa, so that current hopes that building a more dense form will encourage more public transport use may be misplaced.

In fifty years time, it will similarly be the transport technology of the time that determines the shape of our cities. While we at present do not fully know the nature of transport at this future time, we can be fairly sure that it will not be liquid fuel, with fossil fuel being unacceptable for greenhouse gas emissions and biofuels unacceptable for major use because of competition for food. It will most likely be electricity from renewable sources and if history is a guide a collective passenger transport system is the likely form of application.

The urban processes appear to be composed of a range of cycles. Population and building cycles coincide at between five to twenty year timeframes and a further change appears necessary. Urban fringe zones appear to have even longer cycles. Strategic planning appears to range over twenty to fifty year periods. The further that we look forward the more that we should look back so as to understand the processes and cycles that will occur in the planning period.

The past also shows the scale of changes that can occur within a fifty year timeframe. In 1850, in 1900, and in 1950 it would have been difficult for even a futurist to envision the nature of the cities fifty years into the future. This highlights some difficulties in the current practices of strategic management of the concept of community input and buy-in. The democracy is excellent, but it is very difficult for communities to think of a future much different than the present situation.

The history also shows that the shape of the cities was influenced by a wide body of players, including councils, speculators, engineers, surveyors, commerce, and the public. Formalised planning as a separate discipline really only existed from 1956 onwards. A large body of contributors are needed for strategic planning.

Experience is that the most substantial change in cities occurs following strategic action, as opposed to a managerial approach. Examples include the building of the national rail network, the public investment in electric tram based urban transport, the building of the sealed highway network especially motorways, the Government's encouragement of a local vehicle assembly industry and their effective closure of that industry some seventy years later, and the building of the Wellington commuter rail network.

While a number of planning strategies are named "Growth Strategies" the viewpoint provided by the urban morphologists is more one of change rather than growth. Population changes and changes in transport costs not only lead to growth at the urban fringe, but they alter land values throughout the city. Owners then reappraise their land and opt for change from a range which includes subdivision, re-development, or even a new use type. This change is an ongoing process so that the concept that the ideal form, once attained, will become the constant state is a chimera. Strategic planning must recognise therefore that much of what we have will need to be altered by future generations and therefore avoid creating situations that are difficult to modify. History shows that it is these areas that are allowed to deteriorate to a prolonged poor state before they are cleared away completely and development starts afresh.

Although the city changes over time, the past tends to be imprinted on much current use. As expected some of the older building such as early churches and public buildings remain, but the imprint also occurs in less obvious ways. Two examples illustrate. In the electric tram era many suburban commercial areas developed from the foot traffic that occurred where tramlines intersected or at the terminals of the tramlines. These commercial areas remain, even though the tram systems have been long gone. The areas have been modified and are still successful reflecting perhaps their natural location with transport and the developing suburb. In contrast the more artificial shopping centre established as part of suburban development in the 1950s to 1970s are often in decay reflecting perhaps their more arbitrary location by planners rather than evolving over time.

The most permanent imprint is the street pattern, which remains largely unaltered since the time the streets were laid down. In Wellington, it is noticeable that many of the suburbs created during the tram era still have viable, well patronised, public transport while the suburbs of the 1960s onwards tend to have subsidised services provided at a lower level. A comparison of the old suburbs with the rectangular street pattern and alleyway connections with modern suburbs with curvilinear streets and cul-de-sacs shows public transport needs to travel 50 to 100 percent further to access the same number of properties.

The comparative youth of New Zealand cities means that natural fringe areas as discussed by Whitehand have not yet had time to form. However several cities (for example Wellington, Dunedin, Christchurch and Auckland) show these included fringe zones which formed around the town belts that were established during the first survey of the city. These are now included in the city which has expanded beyond them, an expansion that was assisted by the electric tram.

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