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A Future Beyond the Car?

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Contents

Editorial Introduction	3
A Future Beyond the Car?	
Steve Melia	
Abstracts & Keywords	7
Three Views on Peak Car	8
Phil Goodwin	
The Implications of Climate Change for the Future of the Car	18
Mayer Hillman	
Jan Gehl and New Visions for Walkable Australian Cities	30
Anne Matan and Peter Newman	
The Future of Carfree Development in York, UK	42
Randall Ghent	
The Delivery of Freight in Carfree Cities	54
Joel Crawford	

A Future Beyond the Car? Editorial Introduction
Steve Melia

How to mitigate, counteract or eliminate the problems created by cars and traffic is the challenge at the heart of most transport research and many past articles published in this journal. This special edition turns this focus towards the future. The suggestion of a future beyond the car may seem extreme or utopian in a discipline and a world preoccupied with the present. But as Goodwin suggests in the next article, the assumption that trends observable today will continue indefinitely will often seem short-sighted from some point in the future. How many of those involved in the rail and bus industries would have predicted the rapid transition from growth to decline in rail and bus use after World War 1 and World War 2 respectively?

Whether such a turning point has already occurred in the use of the car is the issue of uncertainty at the heart of that article. One implication of this uncertainty, Goodwin suggests, is that policies which are "robust under any of the uncertain futures are to be preferred." In the context of 'peak car' this statement applies in the short-term: with the benefit of greater hindsight the causes of the recent fall in car use and the direction of future trends will become clearer. In the meantime, according to Goodwin, commitments to "frozen infrastructure" should be avoided.

Over the longer-term, uncertainties about behaviour change are overshadowed by the issue of climate change. Following the failure of the Copenhagen conference to agree binding global targets, the scientific consensus would suggest that disruptive – probably catastrophic – climate change is becoming progressively more likely.

In the third article in this edition, Hillman provides a sobering assessment of the seriousness of the situation, the inadequacy of

current attempts to address it and the fallacious assumptions underpinning public policy across the developed world. The only effective solution, he argues, is 'contraction and convergence' a concept first proposed by the Global Commons Institute in 1995. Amongst other fundamental changes to western lifestyles, this would imply a dramatic fall in car ownership and use.

Attempting a rational discussion of policy options in such circumstances may seem faintly absurd, like a debate in a burning building whose occupants persist in spraying the air with petrol. With no political solution in prospect it may be useful nonetheless to draw a distinction between areas of certainty and uncertainty in climate science and their implications for transport policy.

The areas of certainty include the physical properties of greenhouse gases and their rising concentrations in the atmosphere. The longer this process continues, the greater the ultimate impact on the global climate. The existence of positive (and negative) feedback mechanisms, where rising temperatures release further greenhouse gases are likewise well-established. The nature, timing and regional variations in climate change are all subject to greater uncertainty. The IPCC reports express outcomes in terms of probabilities, mainly based on quantitative modelling. These probabilities are themselves subject to further uncertainties, to factors as yet undiscovered by the modellers. The consequences may be more or less serious, the timing sooner or later, the changes more or less rapid than current scientific knowledge suggests. The future trajectory of global emissions adds a further element of uncertainty.

To devise a comprehensive set of policies robust under all the scenarios this suggests would be impossible but as with peak car, uncertainty has

policy implications. The position of some American opponents of action on climate change has been characterised as follows:

"If we [the US] clean up our environmental act and the Chinese don't we all die anyway and their economy will outperform ours while we live. If we don't clean up our act, we still all die, but at least we have a stronger economy until then."

(Clemons and Schimmelbusch 2007 cited in: Crompton, 2010)

The UK's Chancellor of the Exchequer expressed this argument in a European context in a recent speech to the Conservative Party conference (Osborne, 2011). A similar underlying logic can be detected in some discussion on transport and climate change, particularly in pronouncements from the aviation industry (although the consequences are rarely articulated in this way - see for example: Cheapflights Media, 2011). Threats from climate change cannot be solved by changes in the transport system alone, so why disadvantage one country, or group of countries, and why incur voter hostility or additional costs when 'we all die' anyway? As accumulating evidence weakens the climate sceptic case, variations of this argument are likely to become more common.

Apart from the obvious moral issues this raises, it implies a certainty and a finality which the evidence does not support. Some humans (and other species) have survived catastrophic climate change in previous eras - although people, settlements and civilisations have perished along the way. Even if 'tipping points' are breached, accelerating changes in the climate, our past and future actions will continue to influence the concentration of greenhouse gases in the atmosphere with consequences which cannot be quantifiably predicted with any certainty. This, and the moral imperative (if we are 'all going to die', how would I want to behave?) are two reasons why combating climate change should remain the principal focus of those of us seeking to influence transport

policy, even if, as seems likely, the collective global response is too little, too late.

The largest proportion of transport emissions in most developed countries is caused by private cars, which brings us back to the point where this article began, but with greater urgency and a need to look beyond the policies and practices of the present. Those governments which are committed, legally or rhetorically, to climate change mitigation tend to emphasise technological solutions and to downplay systemic and behavioural changes.

In 2008 the UK became the first country in the world to enact legislation committing the Government to emissions targets based on scientific advice. This Act created a Climate Change Committee (CCC) to advise the Government on progress towards those targets and appropriate policy responses. The current target based on that advice aims for an 80% reduction in CO₂ equivalent emissions by 2050. The transport-related reports and chapters from the CCC illustrate this tendency, with graphs showing smooth and rapid reductions flowing from their policy recommendations. The Government is invited to assume the outcomes of these policies will occur in a timely way regardless of vested interests, unforeseen factors or unintended consequences. Thus politically difficult choices concerning car use and particularly aviation can be minimised or avoided altogether (see: Committee on Climate Change, 2009).

Their medium abatement scenario assumes a 44% reduction in emissions from road transport by 2030, mainly through a rapid switchover to electric cars accompanied by a 90% 'decarbonisation' of electricity generation over the same period (Committee on Climate Change, 2010). The carbon budgets recommended in this report were accepted by the Government, and their current approach is broadly in line with these policy recommendations. Though less specific, the recent E.U. White Paper on Transport recommends a similar approach across the European Union (European Commission, 2011). Bent Flyvberg, the leading

authority on optimism bias in transport planning has written guidance for the UK's Department for Transport on how to deal with such bias in respect of infrastructure projects (Flyvbjerg, 2004). A similar analysis is clearly needed for the advice of the CCC and the climate change policies of governments in the UK and elsewhere.

One of the few transport issues of which we can be relatively certain over the longer-term is that walking will remain an important and sustainable mode. Under several possible scenarios it may become the principal, or only, mode available to most people. In the decades following World War 2, cities in many developed countries, particularly in North America and Australia, began to sprawl, with design features reducing their 'walkability' at the same time as rising car ownership was contributing to a modal shift from walking to driving. Newman and Kenworthy (1989) was an important milestone in the reaction against those trends, which has influenced planners and governments to varying extents across the world. One of the first cities to embrace pedestrian-focussed transport planning was Copenhagen, influenced by the work of Danish architect and urban designer, Jan Gehl. In the fourth article of this issue Matan and Newman describe how Gehl's work has helped to improve the pedestrian environment in several major Australian cities.

A growing body of literature has sought to measure the multiple benefits of increasing walkability and to make the case for investment in it (e.g. Sinnett *et al*, 2011). The evidence is compelling based on the short-term benefits of principal interest to governments but the strongest arguments for such changes relate to the probability that walking will remain essential to the functioning of cities which survive the ravages of climate change and the threats to movement by other modes.

An article in a previous edition of WTPP (Melia *et al*, 2010) described the range of carfree residential and mixed-use developments around Europe. The significance of these relatively few examples of good practice may likewise become

more apparent in the longer-term, in providing models for how cities can begin to move beyond the age of the car.

The article by Ghent in this edition explores the potential demand for carfree developments in the English city of York, chosen for its compactness and culture of walking and cycling. He finds considerable evidence of potential demand, particularly amongst 'Carfree Choosers' – people who currently live without a car by choice.

Carfree developments built so far all involve some degree of compromise with vehicular access, partly because a small minority of their residents continue to own cars, but more importantly for deliveries of various kinds. Small-scale urban carfree areas will be served by the logistics system of the city as a whole. To go further towards an urban environment free from motor traffic would require a completely different system, only feasible over much larger areas. In *Carfree Cities* Crawford (2000) outlined a vision of how new cities could be designed entirely without cars. In the final article of this edition, he addresses this key issue for the design of carfree cities: how to organise deliveries of freight and removal of waste. He assesses the experience of existing carfree areas, and proposes a system based on light rail deliveries of containers for the carfree cities of the future.

The UK Climate Change Act requires annual reporting to parliament of national performance against the carbon budgets. Whilst the recession has kept emissions below the first budget cap, in its latest report the CCC notes:

"the underlying trend is one of broadly flat emissions. ..an acceleration in the pace of emissions reduction will be needed if future carbon budgets are to be achieved."

(Committee on Climate Change, 2011)

Thus the UK will become a test-bed for the view that technological change could occur rapidly

enough to avert catastrophic climate change. If that view proves over-optimistic, more radical options such as carfree cities may begin to seem less fanciful than they currently appear to governments and the mainstream transport community today.

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Three Views on Peak Car

Phil Goodwin

Three current views are that trends in car ownership and use in developed economies (a) are still in long-term growth with only temporary interruptions due to economic circumstances; (b) have reached their peak and will show little or no further growth; or (c) have passed a turning point and are now in long-term decline. The evidence is not yet conclusive, but is amenable to properly designed research. The author judges the third view to be a viable possibility with useful policy implications.

Keywords: Peak car, decoupling, traffic saturation, plateau, reduction

The Implications of Climate Change for the Future of the Car

Mayer Hillman

The spreading and intensifying addiction to fossil fuel-dependent lifestyles around the world, not least in the car-based transport sector, will inevitably add to the likelihood of ecological catastrophe from climate change. The longer we procrastinate in responding sufficiently to this prospect, the greater the chaos. This paper sets out key fallacious assumptions on which current policy is founded and outlines the only strategy that can achieve a relatively smooth and speedy transition to sufficiently sustainable practices and patterns of development that will assuredly deliver the essential very low-carbon footprints to prevent it.¹

Keywords: ecological catastrophe, future generations, fallacious assumptions, low-carbon strategy, carbon rationing

Jan Gehl and New Visions for Walkable Australian Cities

Anne Matan and Peter Newman

The work of Jan Gehl aims to revitalise cities through more walkable urban design. His Public Spaces Public Life (PSPL) surveys

provide momentum and support for a larger movement towards sustainable transport modes and have been conducted in over 40 global cities. Central to Gehl's PSPL is pedestrian-based transport planning and urban design that is explicitly pro-urban, showing how car-based planning destroys city centres. He has had a profound and growing impact on Australian cities.

Keywords: non-motorised transport, urban design, pedestrian, cycling, transport planning, sustainability, Australia

The Future of Carfree Development in York, UK

Randall H. Ghent, MSc

This paper investigates the market potential for carfree development in York, UK, as a means of increasing the city's social and environmental sustainability and improving quality of life. A survey was conducted using purposive sampling, focusing mainly on 'progressive' groups within the York population. Positive attitudes towards the concept of carfree development were found, among 'Carfree Choosers' as well as other 'household car behaviour' categories.

Keywords: Carfree, car-free, car free, development, York

The Delivery of Freight in Carfree Cities

J. H. Crawford

A proposal to use a dedicated, automated system to deliver standard ISO shipping containers inside carfree areas is presented. Included are methods to deliver smaller, lighter shipments to areas not directly served by the dedicated system. Alternative measures for smaller carfree projects are considered.

Keywords: carfree city, sustainable cities, freight delivery, ISO shipping container, automated freight handling

THREE VIEWS ON 'PEAK CAR'

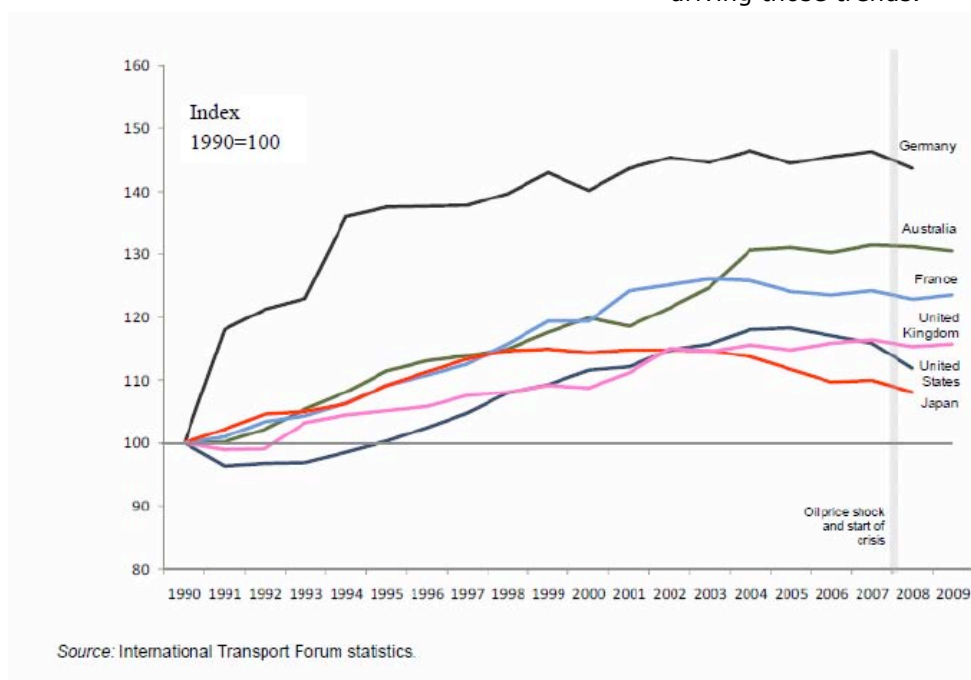
Phil Goodwin

Introduction

The 2011 annual overview report of the International Transport Forum (the OECD agency formerly known as the European Conference of Ministers of Transport) (ITF 2011) is a thoughtful and problematic discussion, drawing attention to the huge scope there is for increases in private car travel in developing countries. The summary states 'The world's population will reach 9 billion by 2050...global passenger mobility and global freight transport volumes may triple'.

The core of their argument is that this growth will largely be dominated by growth outside the developed countries in the OECD group – the developing countries seeing up to a 5-fold increase in passenger kilometres by car. The report concludes that this "would be reached only if mobility aspirations in emerging economies mimic those of advanced economies and if prices and policies accommodate these aspirations".

Figure 1 Private Automobile Use 1990-2009

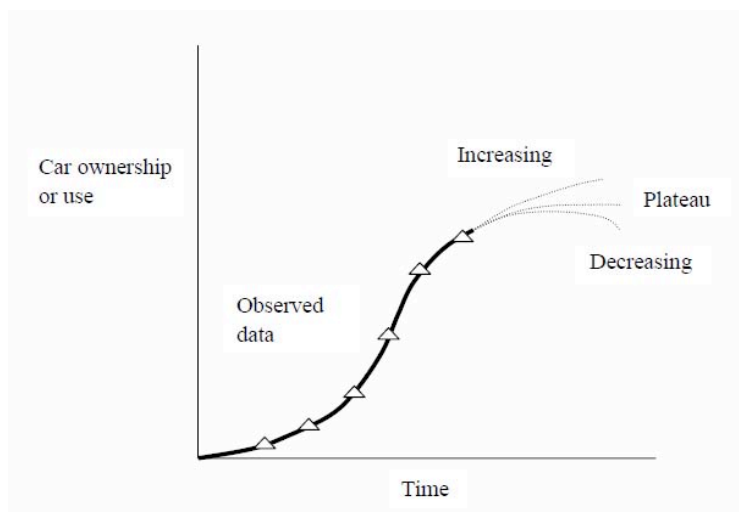


Concerning the developed countries themselves, Figure 1 shows its analysis of six advanced economies, Germany, Australia, France, UK, USA and Japan. The figures include mileage by 'light trucks' (roughly equivalent to the UK 'cars and vans'). It is immediately apparent that there is little sign of any growth in the 2000s, and some signs of falls. The report comments that this appears both before and after recessionary crises.

None of these three views claims to start from axioms of either desirability or undesirability: this is overtly a different argument from the disagreements about whether increased car use provides dynamic economies and improved standards of living, or economic inefficiency and social and environmental damage. The three views are about what has actually been happening – for whatever good or bad reason – to the choices people make about the cars they buy and use. They rely on their interpretation of statistical evidence about time series trends and the relative strength of different factors driving those trends.

The reason why such apparently different views can be defended simultaneously is partly due to the fact that all three outcomes can be consistent with the same historic pattern of roughly S-shaped traffic growth, as may be seen diagrammatically in Figure 2. All such outcomes, following a long period of growth, may be seen in real world natural and social phenomena.

Figure 2. Simplified form of the three views



The purpose of this paper is to summarise these different views about the current trends and where they are heading. There is a brief discussion about the consequential policy issues and the research necessary to resolve them, but the broader question about the nature of the social and transport consequences of each is discussed by other papers in this issue, and elsewhere.

Future Continued Growth

Forecasts of continued growth in car ownership and use (and consequently of total traffic volumes, of which cars are by far the greatest proportion) has been the official position of the UK Government (and many other Government agencies), and continues to be so albeit at rates less than at some periods in the past. Table 1, from the UK Department of Transport (DfT) (2010) shows their observation that growth rates have been declining, and Figure 3 their forecast that traffic growth will nevertheless continue.

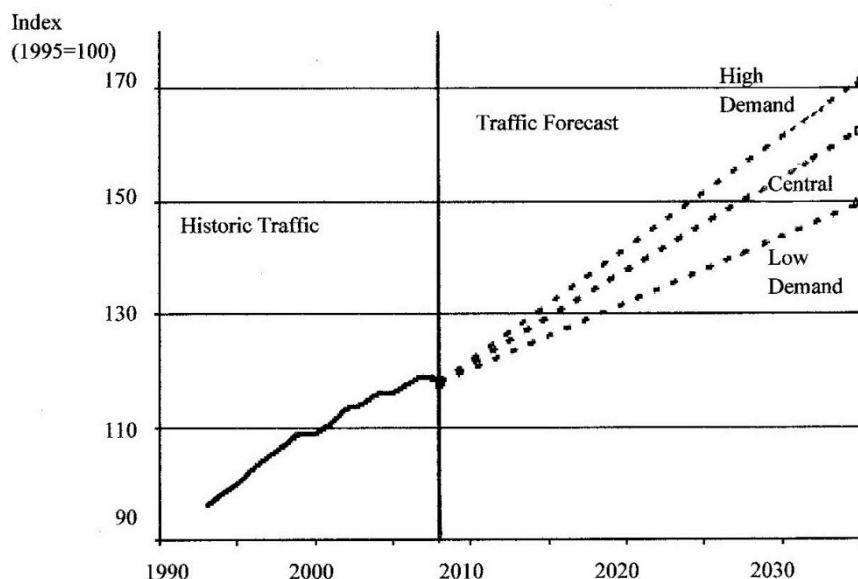
Table 1. DfT Analysis of Declining Rates of Growth of Traffic

Decade	Traffic Average Annual Growth
1950s	8.4%
1960s	6.3%
1970s	2.9%
1980s	4.7%
1990s	1.4%
2000-2007	1.2%

The forecasts envisage that even under a combination of low economic growth, high fuel prices, and little improvement in fuel economy (all of which would be expected to depress demand), traffic would grow by 31% from 2003 to 2035, and by up to 50% under more favourable economic assumptions. Under the central scenario, traffic would grow by 43%: this is sufficient to lead to a forecast of congestion (measured as time lost per kilometre) increasing by 54%, and journey time per kilometre increasing by 9%.

There have been a few voices suggesting that even a reduction in the rate of growth is unlikely in the long run – for example Glaister (2011), has argued that “total traffic has grown in a quite remarkable way since the 1950s, I would suggest, more or less a straight line, with deviations from a straight line depending on the current economic circumstances... In the last two or three years, total traffic has indeed fallen a bit. It's what you would expect to happen in view of the history and the fact we have quite a severe economic recession.... What that says to me is that you must expect that, when the economy recovers, the demand for the road network will recover as well”.

Figure 3: DfT Central, High and Low 2035 Traffic Forecasts, England



Source: adapted from DfT (2010)

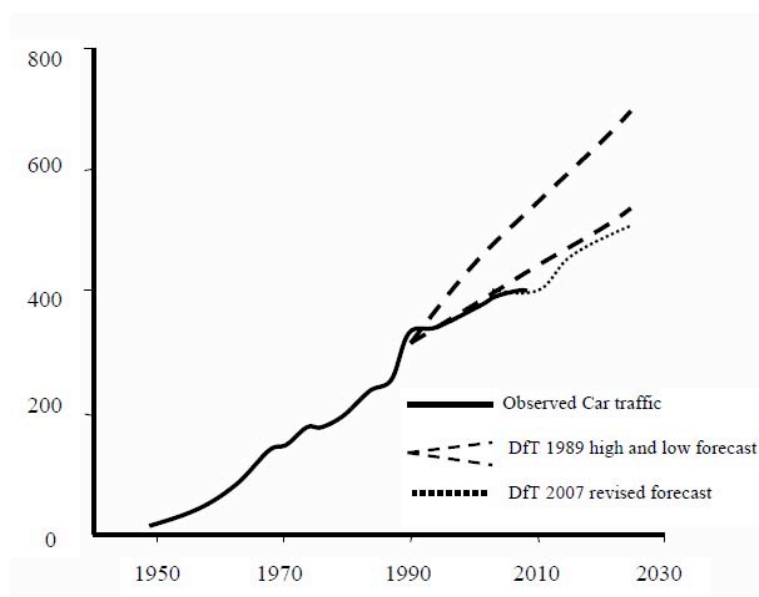
This view does not seem to be a carefully considered one, and indeed it is obvious from Table 1 that traffic has not grown 'more or less in a straight line'. Nevertheless the phrase 'when the economy recovers' is a crucial element also of the DfT approach, suggesting essentially that any reduced growth or reduced traffic is due mainly to temporary unfavourable circumstances.

The problem about this approach has been that it has performed rather consistently badly for at least 20 years. This may be seen by looking at two earlier sets of DfT forecasts, those made in 1989 and revised ones in 2007. These are shown in Figure 4.

Thus even by 2007 the successively revised forecasts have since 1989 consistently overpredicted traffic growth, and have needed to be 're-based'. That has continued to be true subsequently, as discussed below.

Nearly 25 years is rather a long time to be described as temporary, unfavourable circumstances.

Figure 4. Tendency for Official Overestimates of Traffic since 1989

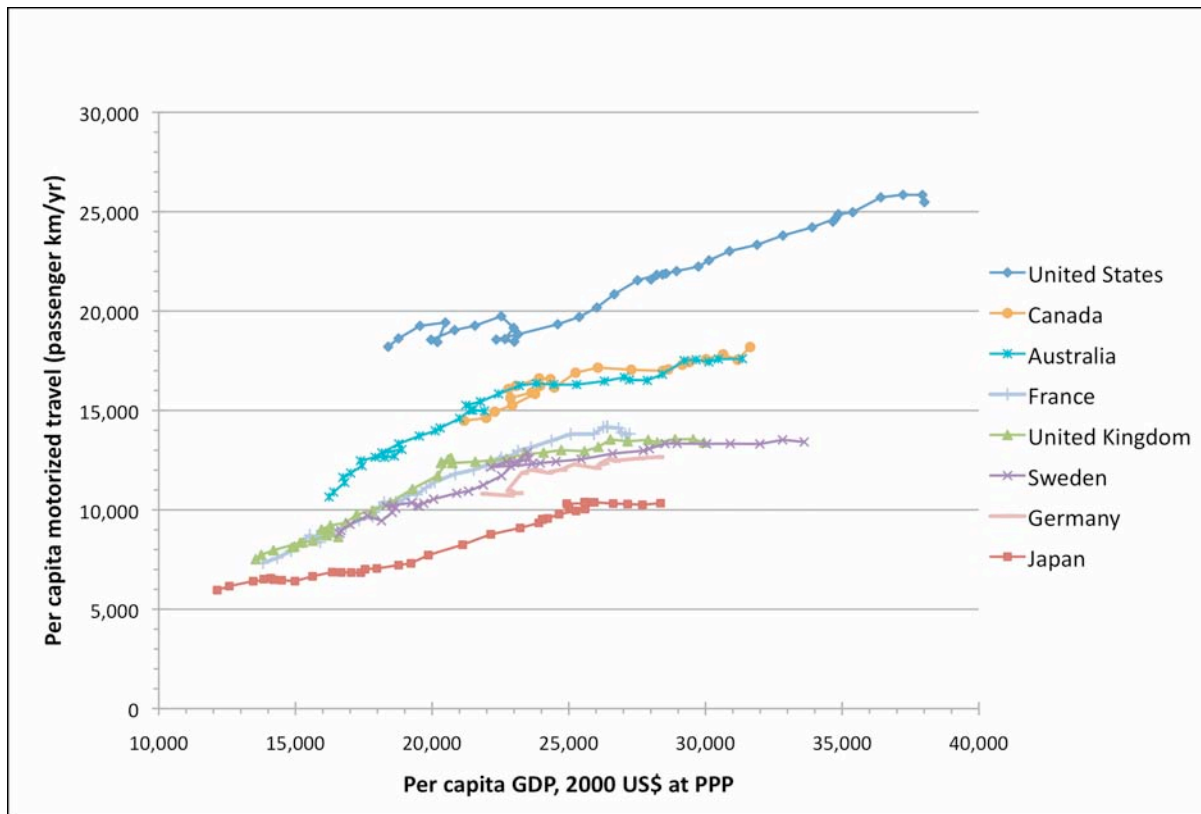


'Plateau' or 'Saturation'

An increasing dissatisfaction with the 'continual growth' analysis led to an alternative reading of the trends, with notable advocates being Schipper and his colleagues in the USA, and Metz in the UK. The first in his prolific series of published technical analyses of multi-national data was by Schipper et al (1993), and his last, before

his untimely death last month, were by Miller-Ball and Schipper (2010) and Schipper (2011). Figure 5 shows his analysis of the flattening relationship between automobile use and income (income being the main driver of traffic growth in the DfT forecasts).

Figure 5 Schipper's Analysis showing reduced effect of income on motorised travel



His commentary on this is as follows:

"In short, with talk of "peak oil", why not the possibility of "peak travel" when a clear plateau has been reached? This paper provides some qualitative evidence to support these ideas of saturation. It finds that since 2003, motorized travel demand by all modes has levelled out or even declined in most of the countries studied, and that travel in private vehicles has declined. Car ownership has continued to rise in most instances, but at a slower rate and these cars are being driven less."

Note that Schipper's use of 'peak' here is of an upper limit which, when reached, stays

there. This is discussed further below. The explanations he offers for the trend changes are tentative and various, but as the influence of income declines, tend to focus on demand sensitivities to other economic factors notably fuel price elasticities on which he has done much empirical analysis.

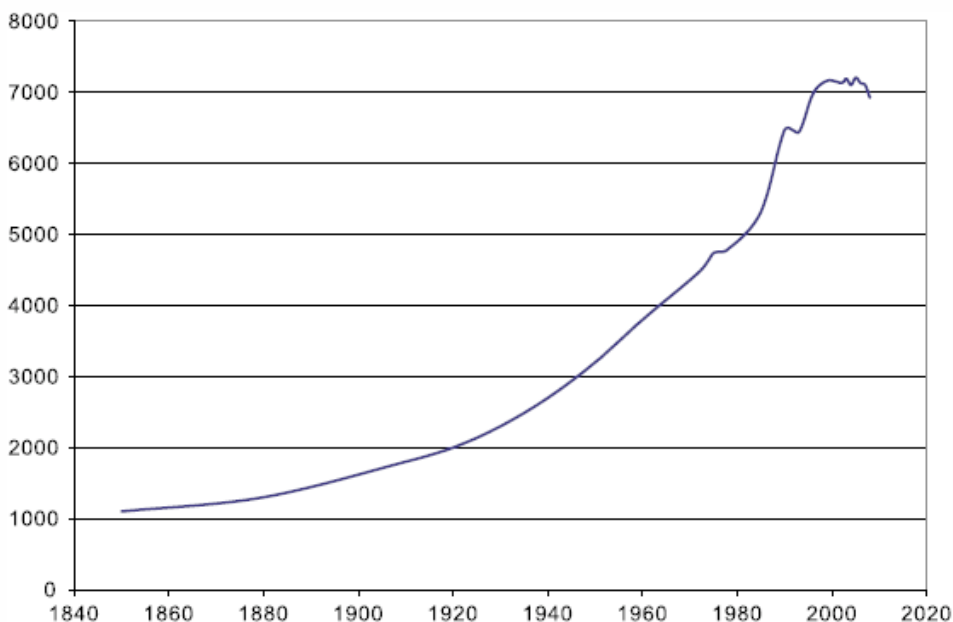
Metz, former chief scientist at the DfT, has made a series of published criticisms of its forecasting assumptions: like Schipper, he sees the future as a plateau rather than further increases. Although acknowledging the impact of fuel price, his main suggested explanation lies more in stable characteristics of travel behaviour embedded in the natural laws of geometry. Thus in Metz (2010) he argues:

"Data from successive national travel surveys show that important characteristics of personal daily travel behaviour in Britain are comparatively stable. Over a 35-year period, there has been little change in

average travel time, journey frequency, purposes of journeys, and proportion of household income devoted to travel. The one factor that has changed significantly is distance travelled, as people have taken advantage of growing incomes to travel faster, thus gaining access to a greater choice of destinations. However, this growth in distance travelled has now ceased - an outcome which is helpful in relation to concerns about sustainability and the environmental impact of the transport system. The explanation proposed for this cessation of growth is that mobility-based access and choice increase with the square of the speed of travel, whereas the value of additional choice is characterized by diminishing marginal utility. Hence, a saturation of the demand for daily travel is to be expected: a novel conclusion."

Metz also calculates a proposed long-term trend for total mobility, calculated as miles per person per year by all modes, as shown in Figure 6.

Figure 6. Metz's suggestion of saturation of mobility



He gives a speculative interpretation;

"... our need for routine access and choice has largely been met. The curve in figure [6] would be an example of a logistic or sigmoid curve, representing market penetration and eventual saturation of demand for a ... series of technologies contributing to personal mobility. Saturation of demand arises when full advantage has been taken of the benefits of these technologies"

It is interesting to observe that Metz implicitly treats the apparent recent downturn in the 'total mobility' curve he has calculated as a 'blip', or perhaps overshooting, around his stable saturated maximum, not as a new phenomenon.

The peak considered as a turning point to decline

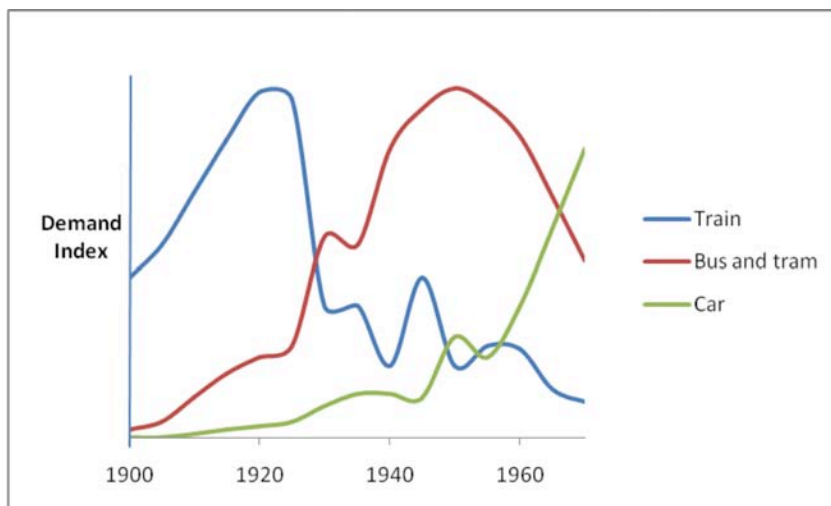
The author has suggested a different interpretation of the phrase 'peak car', in a series of short articles (Goodwin 2010-11) in the magazine *Local Transport Today*. The analogy with 'peak oil' is that, after some point, the availability or economic feasibility

of oil extraction peaks and then turns down: it is a turning point in historical terms, when a long term increase turns into a long term decline, not the achievement of a stable, continuing, maximum level. Logically the concept must be valid since oil is a finite resource, therefore the question is whether the turning point is imminent or in a discountable distant future: the shape and timing of the turning point in those circumstances may be determined by technological, supply or

political imperatives as much as market tastes.

But even where there are no binding constraints, growth trends do turn to decline trends. Figure 7 shows the well known history of growth and decline of, in turn, rail and road public transport, with car ownership showing – up to the first three quarters of the 20th century – no signs of a similar turn.

Figure 7. Growth and Decline for Rail and Road Public Transport, Growth for Car, 1900-1970



But when closer examination is given to the period since 1970, a different picture emerges, as shown in Figures 8 and 9.

Figure 8. Changing Trends in Trips by Car and other Modes (Source: NTS)

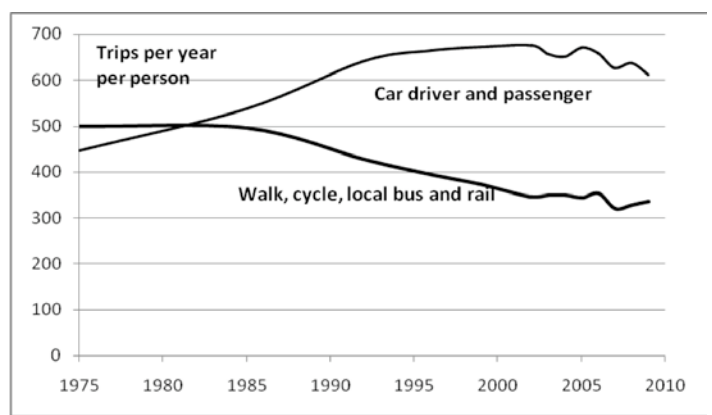
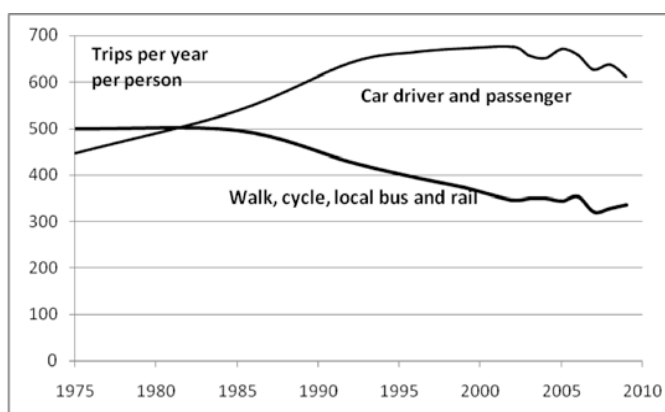


Figure 9. Changing Trends in Miles Travelled by Car and other Modes (Source: NTS)

Analysis of a series of National Travel Survey results since 1975 shows signs of a substantial shift in the shape of the trend for car use, whether measured by distance travelled or trips made, over a period which is substantially longer than can be explained by conditions of economic difficulty since 2008. Also, the very long downward trend in walk, cycle and public transport use has bottomed

out, and just started to increase, though the turn was later, and smaller, than the reversal in the car trend. From 1999 to 2009 the miles travelled by car per person reduced by 500 miles a year, while the miles travelled by walk, cycle, local bus and rail only increased by 133 miles a year, suggesting that a little over a quarter of the decline in car use could have been accounted for by a like-for-like mode transfer of journeys, the rest being accounted by a shortening of journey distance and the abandonment of some car trips altogether. So people were changing their destination choice and propensity to make car trips, not only their modes of travel.

We must assume that the very latest figures are influenced by recession and therefore

may have exaggerated the trend. But most of the results above definitely precede the recession, with a turning point in the trend appearing to be at about 1992-4.

Policy Implications

The prevailing orthodoxy for many years, of powerful factors leading to a long term rise of car ownership and use, was always cited in support of a number of quite different, indeed contradictory, policies: in favour of the construction of large scale increases in road capacity (to provide for inevitable traffic growth); or in favour of road pricing (to moderate that traffic growth to what is economically justified); or in favour of traffic restraint (to reduce the environmental and other undesirable side-effects of traffic growth); or in favour of a range of investment and psychological initiatives (intended to alter or soften the trends themselves). There has been a strong tendency by all parties to describe any of these policies as 'challenging', 'difficult', or 'in conflict with public acceptability'. The expected pressure for increased car ownership and use also influenced the author's own contribution to the policy debate (sometimes called the 'New Realism', Goodwin et al 1991), which was constructed around the conflict between the trends in car ownership and use, and the restricted capacity of the road network to accommodate it: demand management was a necessary core of transport policy because 'predict-and-provide' led only to a progressive deterioration in traffic conditions.

The question is whether the discussion on peak car leads to different policy conclusions. Uncertainty itself has a policy implication. When there is uncertainty about even the direction of future trends, policies which would be robust under any of the uncertain futures are to be preferred. That suggests a strong preference for policy implications which are flexible and which do

not commit very large amounts of 'frozen' infrastructure investment which would only be worthwhile under one of the disputed outcomes. It is an argument for 'revenue' rather than 'capital' expenditure in terms of local authority finances, or for demand management rather than infrastructure investment.

But what would follow if the peak-and-decline car profile actually does emerge as the future trajectory? It may be predicted with confidence that traditional policy arguments will not go away: if car use declines, it can be argued that road investment then becomes more useful in that it can make travel conditions better rather than just slowing down the pace at which they get worse. On the other hand, it is less necessary and worthwhile to do so – the trends themselves soften the worst of the negative effects, and one can get benefits without having to work so hard. There is a version of this which says 'if car use has saturated there won't be any induced traffic so we can build more roads again'. This as it stands is technically illiterate – a confusion between induced traffic, which is the additional traffic due to a scheme, and the base trends due to all the other factors. But the germ of truth is that when traffic is going down there are opportunities for improvements in quality and efficiency that simply do not exist when it is going up. One example of this would be the potential for priority to certain classes of freight traffic, which has little political attractiveness when congestion is higher and increasing, but becomes more feasible when there is elbow room on the network.

Some implications are more straightforward – it becomes easier to reach carbon targets, and to contribute a greater proportion from the transport sector with less pain than is sometimes feared now. And some are more complex – if traffic goes down speeds are likely to go up, and there will be safety

issues that need careful management. And there are as yet unresolved issues of whether 'virtuous circles' would be set up: the theory of habit dynamics suggests that it is easier for policy to give a boost to habits which are already moving in a desired direction than to reverse those that are moving in an unfavourable direction, due to asymmetries which are ignored in most transport modelling.

Underlying all this is a great and as yet unanswered question: to what extent has the shift in trends been due to policies which have already been carried out, and to what extent is it the result of extraneous pressures, social changes, or constraints which are beyond our control, or at any rate beyond the scope of transport policy? If it is the product of policies, then behaviour must be significantly more sensitive to policy than is currently assumed, which is important, as it affects the confidence and care with which future policies can be taken forward.

Thus the idea of 'peak car' does not of itself lead to a specific policy approach, but it does widen the set of feasible policy outcomes, especially those intended to encourage less car-dependent lifestyles for reasons of health, economic efficiency, or environmental improvement.

Research Issues

In this discussion the core issue is to identify a potential change in historic trends, a 'trend-break' or discontinuity, while it is still happening. This has quite different and very demanding requirements for data and analytical methods. Methods which are rooted in extrapolating dominant historic experience cannot, by definition, answer this question.

The sort of evidence which can realistically be sought may be considered by a mind-experiment: suppose the peak car hypothesis is true, what results in the

observable world would it first cause which are different from those of car saturation? This leads to an interesting insight. If the national, aggregate trend is flat, then peak car implies that there should already be some places, or some groups of people, for whom the peak is already passed, so that for them the trend is already on the way down. Car use saturation on the other hand suggests that at the disaggregate level the differences will be that some places or people show an earlier or swifter approach to stability.

Thus the difference between the second and third school of thought discussed above lies not in ever more subtle analyses of the overall trend, but in the observable variations around that trend. We should look to see whether there are pockets of everybody's future evident in the leading places already. This means we need to judge what is 'leading', or in other words who are the trend-setters. For example, we might focus on the young (because they are the future), the old (because they are the largest growing sector), the rich (because they are less constrained by money) and the thoughtful (because they may see things more swiftly). If we observe car use reduction among declining, impoverished communities, this would have a quite different significance than if we observe it among rich, growing communities. An initial review of evidence by Goodwin (2011) considers work carried out by other researchers (notably Cairns, Chatterjee, Dargay, Dudley, Hass-Klau, Madre, Melia, Satterthwaite, Sloman). Preliminary themes in the evidence suggests that car use may have passed its peak and be on the way down in some particular contexts. These include young people at about the age when getting a license and first car has been common; also in some towns, including London and those smaller towns with the most enlightened smart choices policies, or those improving public transport most

dramatically, or both. Trends in the housing market show increased popularity of central and inner cities especially in developments providing little opportunities for, or good alternatives to, car use. Finally there is manifest growth in the use of Internet and smart phones which in some circumstances (though not all) can replace vehicle travel, or provide a different focus for those who love the latest technology. These are not negative messages for the future.

There is another meaning to 'leading indicators' often used in economics, when there are lags or inertia between causes and effects, for example in the response of travel behaviour to changes in income, prices, household and age structure, and according to some theories, attitudes. In that case, we can seek insight about the future pattern of car use from the present pattern (and trends, some of which we will know) of these variables. An important caveat is that this would only be helpful if the analytical methods used are capable of handling discontinuity and non-reversibility. Therefore for this research, only dynamic models need apply.

Similarly, we will need disaggregate longitudinal analysis, with repeated observations on the same place, class, household or individual over time, rather than comparison of repeated representative cross sections, because we need to know who has changed, not just how big the changes have been. The qualitative and quantitative methodologies here are well established and explored, though for various reasons less common in transport.

Conclusion

It seems to me that evidence for the full version of the peak car hypothesis – we have now passed peak car use and are on a new, firmly established, downward trend – is not yet definite. But the evidence for its full rebuttal – we are still on a long-term trend

of increase with only temporary interruptions due to recession – is even less persuasive. The key element of the discussion in the last year has been that there are changing features of car use, which clearly precede the recession, and simply do not fit the traditional forecasts.

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The implications of climate change for the future of the car

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Introduction

The world now faces a dire predicament. Carbon dioxide emissions in the atmosphere have reached a dangerous level of concentration, and yet are predicted to go on rising considerably into the foreseeable future. Sea level and temperature increases and changes in weather patterns are leading to a shrinking habitable land mass on which a burgeoning future population, forecast to be between a third and a half higher than it is now, will have to live. One of the most eminent US climate scientists, James Hansen, warns of the hazards of the concentration exceeding 350ppmv (parts per million by volume): at present, it exceeds 390ppmv and is *accelerating* beyond an irreversible tipping point. Temperatures around the world fairly recently were calculated to be totally unsafe if the average global temperature were to exceed a rise of 2°C above the pre-industrial revolution level but more recently predicted to rise 4°C or higher later this century. The consequences are already apparent in the recent melting of glaciers in the Himalayas and ice in the Arctic and Antarctic; growing desertification in Africa and China; flooding in Bangladesh; heat waves in Australia; methane release from tundra regions in Siberia; and losses of vast areas of rainforest and peat lands in the Tropics.

Addiction to fossil fuel-based lifestyles around the world is spreading and intensifying. Even a major reversal of current policies, not least in the transport sector and therefore affecting car use, will be unable to prevent ecological catastrophe on such a scale as to gravely prejudice the quality of life in the future. This is not surprising given that current transport policy in most countries is aimed at enabling more

people and goods to move further and faster, and more cheaply and 'seamlessly'. Minimising consequential adverse social and environmental impacts is seen to be a secondary objective.

Catering for the seemingly never-ending growth in demand for the energy-intensive transport activities, especially car and air travel, has led to investment in more road building, airport expansion and improved rail transport and for evermore ingenious ways of financing it. Indications of the success of this policy can be seen in more and more distant destinations becoming accessible. All modes have risen spectacularly: UK passenger mileages by road, rail and air in the last 20 years have risen by 25, 65 and 160 per cent respectively², and are forecast to rise even more spectacularly over the next two decades^{3,4}. Carbon dioxide emissions from transport sources in the UK alone now account for a quarter of their total.

Prospects for future generations

No other aggregation of human behaviour in recorded history can begin to match the appalling legacy we are in the process of bequeathing to future generations by our near-total failure to face up to the implications of climate change^{1,5}. It would be difficult to refute the prediction that most, if not all, the following outcomes will prove correct in due course:

- regions of the world becoming uninhabitable at an accelerating rate leading in due course to hundreds of millions of ecological migrants having to seek refuge elsewhere;
- extensive water and food shortages in many countries;

- catastrophic loss of life and likely wars of survival;
- widespread decrease of species diversity and genetic variability;
- little of the planet's key finite mineral reserves left for the generations succeeding us;
- horrific risk of nuclear war owing to the proliferation of weapons-applicable technology;
- the imposition on thousands of future generations the absolute requirement to guard against the radioactive waste from nuclear-based electricity leaking from its repositories;
- repayment of huge financial debt owing to this generation's inability to live within its means;
- a world in which news on the consequences of our failure to meet the challenge of climate change getting progressively and inescapably grimmer.

The response from all sectors of society

We do not seem prepared to reverse the process that has brought about this lamentable prospect for our children. We are loath even to *contemplate* the changes that must be made, especially those entailing a massive reduction in our use of fossil fuels. Encouraging statements are made by some politicians, professional institutions, and religious leaders to give the impression that they are aware of the gravity of the situation and that we must act as current stewards of the planet committed to furthering the cause of social justice, working towards achieving worldwide low-carbon economies and, whenever possible, adopting sustainable strategies.

However, when attempts are made to translate these worthy objectives into practice, the statements made in proposing them seem unlikely to be realized: authoritative predictions for the future

indicate that global energy consumption will rise faster than ever, with more than a 50 per cent increase by 2035⁶. They could be interpreted as little more than empty rhetoric. Those questioning the sufficiency of current efforts being made are dismissed as theoreticians incapable of understanding human nature and political reality or as 'holier than thou' kill-joys - probably with a hidden political agenda.

Hope of light at the tunnel's end is being cast into doubt, first, by the absence of any indication that even affluent population's demand for high energy-based activities such as those in the transport sector, is by any means satiated; second, by the sharply rising third world population's understandable aspirations to follow the West's lead in adopting high energy lifestyles; third, by the gross inadequacy of governments' carbon reduction targets and, finally, by reasonable doubts that even these will be met⁷.

From this perspective, a re-appraisal of the relevance of climate change to future planning has to be undertaken as a matter of urgency. The implications are far more significant than may be initially apparent. Every domain of policy that is directly or indirectly related to the extent of the energy-intensiveness of our lifestyles must be considered against this background. Such a re-appraisal would factor in the contribution each will make in terms of adding carbon emissions to the planet's remaining capacity to safely absorb them. That will demonstrate why a *massive* reduction must be achieved, focusing in particular on every area of fossil-fuel dependent activity which cannot be categorised as absolutely essential.

It is almost as if, in planning decisions in our cities over the last 50 years, there has been a conspiracy to achieve the reverse! The physical outcome of policy can no longer be

allowed to be largely antithetical to the process of restructuring our existing urban area and other patterns of settlement if they are to promote the progressive aims of self-sufficiency, sustainability, conviviality, the quality of life especially in the local community, and, most particularly, very low carbon lifestyles.

Misleading judgments informing public policy

Many widely endorsed assumptions underpin public policy at present yet they have not been seriously challenged. As a consequence, the transition to decreasingly car-dependent lifestyles has been rendered more difficult to be achieved in the shortening number of years available to do so owing to carbon dioxide concentrations in the atmosphere accumulating towards an irreversible level and by the fact that planners have assumed that one of the major functions of Government is to cater for as much public demand for personal and freight transport as possible.

Current efforts to enable the car to continue to be the mainstay of personal travel can be seen in the attention paid in recent years to better performance in the form of more energy-efficient vehicles enabling less fuel to be needed; to encouraging car sharing and car clubs; economical ways of driving; and research on alternative fuels such as electricity generated from shale gas and bioenergy. Whilst achieving some reduction below the level that they would otherwise have reached, carbon emissions from the transport sector overall are still rising alarmingly.

This outcome can be laid at the door of the many questionable beliefs – close to tenets of faith – that are standing in the way of making a speedy transfer to lifestyles, practices and patterns of development that will deliver very low-carbon footprints. Sadly, they have wide support as they seem

to hold out hope that the need for urgent adoption of a strategy to deliver such footprints will prove unnecessary. These beliefs include a near-absolute confidence that:

- The primary way of improving the public's welfare and quality of life is through the medium of economic growth and, to escape from the damaging effects of the current worldwide recession, every effort must be made to return to it.

It is as if the limit on the degree to which the powerful link between GDP and greenhouse gas emissions can be sufficiently de-coupled because there is good evidence of some easily adopted de-coupling. No doubt for that reason, at their 2011 annual conferences, all three of the main political parties in the UK affirmed their belief that the primary aim of government must be to return speedily to economic growth.

- It is seen as unnecessary for the sectoral components of growth to be differentiated according to their contribution to climate change and as a consequence an adequate response to climate change does not have, nor must be allowed, to limit it.

The implication of this is that a stratagem will be found, without any supporting evidence, for making compatible the goals of ever-rising economic growth and protection of the global environment from irreversible climate change - and into the foreseeable future.

- Modest reductions in greenhouse gas emissions on the principle that 'every little bit counts' are welcomed as indicative of a process that can eventually lead to *sufficient* reductions. It is also implied that, in a democratic society, only an atmospheric concentration of carbon dioxide can be chosen that is acceptable to a majority of

the electorate. Associated with this is the inference that there is both sufficient time left for this expectation to be realised and that the necessary funds will be afforded for its delivery.

However, the safe level of concentration cannot be negotiated as it ignores the fact that that safe level to which we must adapt is finite. Moreover, time is regrettably unavailable: the deteriorating condition of the planet is far too advanced for a 'business-as-usual' strategy.

- The public has been led to believe that it has a right to ever-rising improvements in its material standards and life choices. Statements of all the main political parties give a strong impression that such a future is possible without the need for the major behavioural changes that the public would strongly prefer not to make. People are seen to have an inalienable right well into the future to engage in environmentally-damaging activities, such as driving between home and place of work, education, shopping, leisure activities and so on, if there are no alternative means of making the same journey, and they are prepared to pay the price for doing so, under the 'polluter pays' principle.

A major explanation for the disastrous outcome of these lines of thinking is that it is judged perfectly reasonable to decide where and how to travel entirely from a self-interest perspective and with little regard to the effects on other people's quality of life, on community health and on the physical environment, not least, on accelerating climate change. And, of course, the effects are worse where decisions lead to more carbon-intensive journeys over longer distances and at higher speeds. No longer should the most relevant institutions and the media continue to be allowed to fail to alert the public to the largely inescapable links of

these patterns of activity with climate change.

- Taxation can be deployed to ensure that the polluter pays principle is applied sufficiently effectively thereby enabling a realistic price to be set to cover all the costs of releasing a tonne of carbon dioxide into the atmosphere. This price, it is argued, then frees the market to work in the most effective way.

However, this requires attaching a realistic monetary value that adequately compensates for the emissions' impacts over the 100-years that they remain in the atmosphere. At present, no value is given to cover some unquantifiable but nevertheless huge short and long-term adverse effects, such as the rise in food prices following a switch from agricultural land being used for biofuels rather than food crops, and the mass migration and re-settlement of ecological refugees fleeing their homes from the effects of climate change.

- Public policy to limit damage from climate change is aimed at identifying the most effective policies and practices that encourage individuals and industry to switch to lower carbon lifestyles.

However, the essential behavioural changes that must be made can easily take several decades to bring about and, moreover, even a public properly informed of their desirability is not necessarily prepared to do so. Although public opinion polls, at least in Europe, indicate that climate change is a real cause for concern – one greater than the economic recession⁸ – governments in a democracy are expected to 'get in step with public opinion'⁹. Yet, there is little evidence that that public even in the European Community is prepared to act other than to take modest steps to that end¹⁰.

- Against a background of the numerous opportunities for doing so, it is presumed

that science and technology can be relied upon to make major contributions to finding hugely cost-effective ways of ensuring that environmental problems following in the wake of continuing economic growth will prove adequate by:

- researching into clean means of continuing to use coal by burying carbon dioxide underground;
- developing renewable sources of energy and more advanced techniques based on less carbon-intensive electricity generation for instance in electric cars;
- identifying relatively low-carbon alternative fuels, such as shale gas and tar sands; and renewable sources of energy such as, solar, wind and wave power and bioenergy;
- using fuel more efficiently.

Implicit in this approach too is the view, based on sparse evidence, that, in time, these practices will lead to a sufficient reduction of emissions and that the public, industry and commerce can be motivated to deliver it voluntarily, encouraged by better information, offers of grants, exhortation and the government setting higher standards.

However, many of these developments aimed at making a marked contribution to reducing dependence on fossil fuels are being re-appraised in the light of recent outcomes of R&D. They include carbon capture and storage owing to the fact that, as yet, it has not been proven technically or commercially viable¹¹; shale gas, owing to dangers of methane leakage¹², oil from tar sands proving too carbon-intensive and unacceptable on environmental grounds¹³; biomass as being too land-intensive¹⁴; and, in the case of nuclear-based electricity, too risky¹⁵. Not surprisingly, many of these installations are seen as far too expensive¹⁶

especially in a time of economic recession, and some are being abandoned¹⁷.

- It is thought that the world's population is better-off if more fossil fuel reserves are found to feed its increasingly energy-dependent lifestyles as the rising demand for them can then be more readily met.

This comforting thought overlooks the fact that the more reserves that are found, the more will be burned thereby adding to the concentration of greenhouse gases into an already dangerously overloaded global atmosphere. Allied to this is the concern, increasingly expressed, that we are using the planet's reserves of oil at such a rate that there will be little left within 40 years or so. It is clear from this perspective that the 'we' relates to the availability of oil solely for our generation. What about the claims of future generations? They may well have more essential applications for it when compared with the frivolous way in which we are using it now (long distance car commuting, a stag party in Prague, for skiing in the Rockies, a beach holiday in Muscat, a cruise to the Antarctic Peninsula). Insofar as presumably decision-makers wish that life on earth should continue to be enjoyed for hundreds if not thousands of years into the future, surely our children's and their children's claims should be factored into the calculations of what is to be left for them?

- A future can be reasonably anticipated in which most people, once adequately educated about climate change and the processes exacerbating it, will be prepared to voluntarily escape their addictions and forego their high fossil fuel-based lifestyles.

But it is totally unrealistic to expect many individuals, communities or indeed countries to act unilaterally when others are not doing so. Nor is it realistic to expect a significant proportion of individuals or businesses to

impose a self-denying ordinance of personal rationing on themselves.

- Rail transport is seen as a relatively low-carbon emitter and this therefore, with all-political party support, is cited to justify the case for heavily subsidising rail fares and, for instance, providing vast sums of public money for the construction of a high speed rail system from London to Birmingham and, later further north. Indeed, in support for its case, the UK Coalition government has stated that it will aid the competitiveness of the UK economy and thereby 'help to fulfill our ambitions for economic growth and a low carbon economy'. Allied to this is exaggeration of public transport's role as the way out of the impasse created by growing car use.

The fact is overlooked that most current car mileage was not previously made by public transport. This error then results in chasing an ephemeral objective - the belief that the situation can be reversed by sufficiently high investment in public transport. Such a view ignores the fact that the energy efficiency of cars has improved in the last three decades to such an extent that fuel consumption per person kilometre is already often lower by car than by train. This is especially true if the fuel used on a journey to and from a station at either end of the rail journey is factored into the calculation. Moreover, there is every indication that these improvements in the car's fuel consumption are set to continue in future. In addition, not only is rail travel associated with long distance journeys (nearly three times as long, on average, as car journeys - a factor all too frequently excluded from inter-modal comparisons - but it also needs to be borne in mind that a train travelling at say, 400kph, requires 4 times as much energy as one travelling at 200 kph and 16 times as much as one travelling at 100kph.

The time is over for engaging in these distorting lines of reasoning and wishful thinking. They have led to massive public investment in so-called 'improvements' of transport systems that almost exclusively cater for lifestyles with rising rather than sharply declining dependence on fossil fuels. Those with their own form of transport are able to choose more distant locations. And the providers of retailing, hospitals and leisure activities have exploited the benefits of economies of scale by increasing the size of outlets whilst reducing their number, in the knowledge that an increasing proportion of their customers or clients have access to a car, and they can largely ignore the personal and public costs of their use. To enable access to and from ever more distant destinations, changes in land use and the built environment, particularly in suburban, urban fringe and rural locations, have resulted in patterns of activity which cannot realistically and sustainably be served without a car and in which only a small minority of journeys is possible by non-motorised means¹⁸.

Indeed, it is almost as if, in decisions over the last few decades, there has been a conspiracy to lower the quality of life of those without a car. Concern for the future in this domain of public policy would appear to be wholly justified by changes taking place in countries such as India where the annual growth rate of car ownership has reached 9 per cent. Yet the factors that appear to account for the political failure to face reality and institute measures which will ensure the speedy adoption of very low-carbon lifestyles inevitably point to the need for a much diminished role for the car.

The exponential growth of towns and cities has only been made possible by exploiting, with seemingly gay abandon, the planet's finite reserves of fossil fuels. Just consider: at a time when it is widely agreed that carbon emissions have to be drastically

reduced, in the transport sector, rail travel is heavily subsidised as is, indirectly, both car travel and flying because the ecological damage they cause is hardly if at all covered in the calculation.

The only strategy with any prospect of success

What are the implications of this depressing diagnosis of our predicament and is there a way out? It is often argued that every available measure will have to be drafted in to achieve the desired outcome. However, there is a complementary approach which will *assuredly* - not just hopefully - deliver success and provide the essential framework within which the contribution of each of these measures can be evaluated. This must reflect the fact that it is not possible to respond sufficiently effectively to climate change in the absence of a world agreement. Based on the principles of precaution and equity set out in the United Nations Framework Convention on Climate Change, this is the Global Commons Institute's (GCI) proposal first put forward in 1995¹⁹ and, since then, fast gaining support internationally²⁰ - *Contraction & Convergence (C&C)*²¹.

It requires the imposition of a global cap on greenhouse gases and, given the finite capacity of the planet to safely absorb further gases and share them on an equal *per capita* basis between the world's populations, surely the only politically practical and therefore realistic course of action to take. The fact that no one has a right to more than that fair share means that this will ensure that everyone's personal responsibility to limit their use of fossil fuels is not just an aspiration but an imperative within which to live.

However, only governments have the authority and power to take the necessary steps at the level of individual and corporate decision-making to set this process in train

by taking immediate steps to reach an international agreement on the massive switch to very low-carbon lifestyles. Therefore, C&C's national manifestation will be in the form of a *Personal Carbon Allowance (PCA)*, that is an equal *per capita* 'ration' allocated by each government, with an annual phased reduction to a scientifically-determined extent down to the agreed level of global carbon emissions.

Since publication of the text of the book first setting down this concept¹, a number of related studies have been undertaken and proposals put forward, ranging from the development of research at the Institute of Public Policy Research, the Lean Economy Institute, the Environmental Change Institute at Oxford University, the Centre for Sustainable Energy at Bristol University, the Royal Society of Arts, and relevant Government departments²². Many of these have been reported and reviewed in a special issue of an academic journal focused comprehensively on authors discussing various aspects of personal carbon trading²³.

However, a study commissioned by the then Government to explore the feasibility of per capita carbon rationing concluded that it should not be pursued at present for two reasons. First, it was judged to be 'ahead of its time' and would not be accepted by the general public and, second, in practice, its costs of administration would be prohibitive. These could be seen as remarkable assertions, given that the government and its advisers in the policy area of climate change have repeatedly stressed the grave consequences of climate change and therefore the need for urgent action, and that, when it was judged by government at the beginning of World War 2 that a serious food shortage was in prospect, rationing was immediately introduced - without the 'smart' technological advances available now for an initiative in a time of equivalent global crisis.

The allowances will act as a parallel currency to real money, as well as creating an ecologically-virtuous circle. A key feature will be buying and selling: a 'conserver gains' principle will replace the conventional 'polluter pays' principle. Those who lead less energy-intensive lives and those who invest in energy efficiency and energy renewables are unlikely to use all their allowance. They will then not only spend less on fuel but also have the added incentive of increasing their incomes by selling their surplus units. But the cost of buying these units will rise annually in line with the reduction of the allowance as it will be determined by the availability of the surplus set against the demand for it. The process will act in a way that encourages individuals to adopt green practices far more effectively than they would through regulation, pricing, exhortation or appeals to conscience. Simple means are already available to enable individuals to work out how they wish to manage their allowance.

Not only does C&C offer the only prospect of ensuring that the worst effects of climate change are avoided, but a range of other highly desirable outcomes will follow in its wake. Public health will benefit as people recognise that more cycling and walking not only enables them to live more easily within their carbon allowance but also delivers improvement in their physical fitness²⁴. Lowered demand on the NHS is very likely to follow. Policy on social justice will be enormously advanced and personal and national budgets will be driven by *economy*. As the ration is reduced, demand for fossil fuel-dependent products and activities will fall away, easing considerably the problems associated with energy scarcity and security of its supply. Moreover, as the sharing of the global gases that can be safely emitted into the atmosphere will be made according to their populations in the year of C&C's adoption. If any country's population rises thereafter, its share will fall, and vice-versa.

In this way, it will be able to have a significant demographic function in population control.

The populations of the developing world will be the main beneficiaries as they will become the recipients of transfer payments at the level of the individual far more equitably and justifiably, and on a far larger scale, than from technology transfer or charitable aid from affluent countries. These beneficiaries will almost certainly use the revenue from this source to improve the quality of their lives to ensure that this part of their income is maintained.

There can be no denying that managing the transition to very low-carbon lifestyles in the developed world will not be easy. Most aspects of life and nearly all sectors of the economy will be profoundly affected. The outcome of the introduction of an annual carbon ration down to the very low level that must be achieved is unpredictable. No one can realistically pre-determine to what extent it will be used for transport purposes, such as car travel, in the face of the competing claims on it for heating, hot water, lighting, power and so on. However, it can be stated emphatically that the future of the car can only realistically be predicted by considering how individuals will respond to the inevitable introduction of the annual sharply declining carbon allowance for all of their fossil fuel-dependent activities.

Consider the consequences for future transport demand: at present, the average individual's annual emissions in the UK just for car and public transport are about *three times* the amount that can be allowed for the total of an individual's fossil fuel uses for a year (roughly equivalent to one round flight from London to New York!). Against this background, it is inevitable that activities entailing long distance travel by any means other than perhaps sailing, will fall dramatically, and therefore that all transport policy, practice and high cost

transport infrastructure projects already sanctioned to meet the largely unconstrained growth in demand, will need to be critically reviewed²⁵.

It is very likely that most forms of motorised travel, especially those such as rail which are associated with relatively long distance journeys will decline sharply rather than continue to rise. Bus may be the exception owing to the fact that it only caters for short distance trips, and is generally very economical in fuel used per passenger kilometre. The same holds true, though to a lesser extent, for the coach in spite of the fact that, in the main, it caters for longer trips. Provision for the inevitable huge growth in demand for zero and low carbon (and incidentally very low-cost) green travel – cycling, walking and bus – for local, short distance journeys will replace it²⁶. Changes in land use and transport planning infrastructure in favour of compact developments will logically follow.

What can we do?

How is our current failure as individuals to make the changes from our energy-extravagant lifestyles to be reversed? What is needed is a widespread programme of public education on the links between carbon emissions and our energy-profligate lifestyles so that it becomes obvious that there is no alternative to carbon rationing. We must learn very quickly to come to terms with the implications of the unpalatable evidence of ecological decline and therefore the significant behavioural changes that must be made to limit its rate²⁷.

At the personal level, it is self-evident that we will be far more motivated if we are aware of the extent of our personal contribution to the problem. To do so simply requires the completion of a carbon dioxide emissions self-audit^{28,29} and then comparison with the annual total with the world's current annual per capita emissions

of just over 4 tonnes, the average of the UK population of about 12 tonnes (of which the average household car accounts for over a quarter), and the average of well under one tonne – similar to that of much of the populations of India, Africa and Bangladesh now – that we must get down to as speedily as possible!

Among the numerous logical consequences of applications to a local authority for planning permission will be the inclusion of a carbon footprint calculation covering both the constructional process and annual emissions from the development. At the same time and for the same reason, there will be increasing pressure to reject applications for low density developments given their association with higher levels of car ownership and car mileage.

There can be no escape from four unarguable truths and the logical reaction to them in behavioural terms that can be drawn from stopping to deny both their existence and their relevance to policy, such as the future of the car. First, insofar as we know that our own patterns of fossil fuel-dependent activities are making matters worse, we are all complicit to varying degrees. Second, 'doing something' can only be interpreted as representing meaningful progress if it will result in an essential target being met on time for, otherwise, it can easily delay and make more difficult our coming to terms with the inadequacy of the steps being taken. For instance, the EU target of providing 15 per cent of its member states energy requirements from renewables by 2020 implies that the majority will still be coming from burning fossil fuels, thereby still adding to the concentration of greenhouse gas emissions in the years beyond that date. Third, unfortunately, there is much in the pipeline stemming from our past patterns of activity which cannot be avoided. Finally, all of us, without exception, have a responsibility to

make the necessary changes to limit the damage through changes in our personal and working lives. In particular, professions such as that of transport planning, have a critical part to play.

Conclusions

Given the urgency of the situation, the implications of failure to limit individual carbon emissions to a fair share dictated by the planet's finite capacity to absorb the emissions safely are dire. We cannot continue passing the buck between individuals, industry and government. We must stop pretending or implying through our decisions that the harm that we are causing is unavoidable or only marginal. The carbon dioxide emissions that we are now adding to the atmosphere will affect the climate for well over 100 years and it is wishful thinking to believe that the essential much lower overall level of emissions can be achieved on a voluntary basis. Everyone must be subject to a mandatory requirement to contribute their fair share. The only strategy with any prospect of success is the one based on C&C and PCAs. It is very difficult to predict how people will use their allowance. However, given all the claims on it, it is very likely that cars will be used far less than they are today and that car ownership will fall dramatically to be replaced by car clubs catering for the relatively rare use within the annual allowance.

Responding to climate change is ultimately a moral choice. We can no longer proceed as if we have a right to turn a blind eye to the damage we are causing. What will we do in the decades ahead when justifiably challenged by our children and grandchildren on our woeful failure to have acted in time? The accumulation of evidence on climate change will make it progressively unacceptable for us to attempt to excuse ourselves either by claiming that 'we did not know' the consequences of our actions or, in

many respects even more reprehensibly, by just pleading guilty – and joking about it.

It is incumbent on us all to be involved now by coming to terms with the fact that the role of the car in future must be heavily reduced. We must not bequeath a dying planet to the next generation; but we are heading inexorably in that direction.

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Jan Gehl and new visions for walkable Australian cities

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Introduction

Globally there is a growing cultural shift to more sustainable urban lifestyles (Newman and Kenworthy, 2011). The negative effects of sprawl and automobile dependence are now widely accepted, with current trends illustrating that limits, both environmentally and socially, are being reached in cities around the world and that citizens and planners are seeking alternatives to problems of urban form and transport. Vehicle use is decreasing in developed cities (Brookings Institution Metropolitan Program, 2008; Newman and Kenworthy, 2011). Citizens are seeking other alternatives to transport, including a cultural shift to more urban locations, particularly creative, vibrant cities, and locations that enable less car-dependent lifestyles (Newman & Newman, 2006). These shifts have profound impacts on how cities and transportation infrastructure has to be planned and designed. To be economically, socially and environmentally viable, cities have ultimately to reduce their inefficiencies and consumption of finite resources. This means increasing the use of non-motorised travel modes and emphasises the need to examine and envisage what we want our current cities to be, working within context-specific solutions.

Australian cities are part of this transition. Danish academic, architect and urban designer Jan Gehl and his firm Gehl Architects have been working in many Australian cities to help create more sustainable and vibrant city centres. Gehl is one of the most internationally recognised urban designers with substantial contributions in over 40 cities around the world. He has continued and expanded on the humanistic, organic urban design

developed, researched and practiced during the 1960s, 1970s and early 1980s in Copenhagen (Gehl and Gemzøe, 1996). Beginning in Australia he has been discovered globally and is now working in the world's main cities including London, New York, San Francisco and increasingly in Chinese and Indian cities. His work is a reaction to Modernism and its expression in car-based planning. His approach is to use a technique, *Public Spaces Public Life* (PSPL) survey, focused on bringing people's use of streets and city spaces to the forefront of urban concerns. The PSPL surveys provide the support for a city centred on ideas of pedestrian-based transport planning and urban design (Gehl, 2010).

Gehl's urban design theory is a reaction to how cities have been designed for vehicular movement and function, rather than for people who are inherently pedestrians, especially in city centres. The economic potency and vibrancy of walkable city centres is now well recognised (Glaeser, 2011). Yet, the ideas of car-based planning are still prevalent in most city planning and design departments today through the manuals used by traffic engineers and are embedded in town planning schemes. Gehl attempts to replace the ideas and the practices with explicitly humanist rather than car-based design, and to provide a quantitative base that can allow cities to compare themselves in how well they perform on this set of walkability criteria. Jan Gehl and his firm, Gehl Architects, work to create not only positive assistance to pedestrians and cyclists in the form of better infrastructure for them, but to make city spaces walkable and inviting for people to

want to stay and enjoy the life of the city that they help to create.

Gehl has developed an urban design practice, the PSPL surveys, that provide a quick, efficient, universal and effective evaluation technique for assessing pedestrian needs and use in city centres based on observations and follow-up surveys. Their work has a clear policy-relevant analysis, in reports that highlight the imbalance caused by automobile-oriented city design and how to move towards a more walkable city. Gehl and Gehl Architects have worked in many major Australian cities, including Melbourne (1994, 2004) and Melbourne Docklands (2011), Perth (2004 and 2009a), Adelaide (2002, 2011),¹ Sydney (2007), Brisbane (2009b), Hobart (2010) and Launceston (2011).² This paper will focus on Melbourne and Perth, and then briefly report on the surveys in Sydney, Brisbane, Hobart and Adelaide.

PSPL Surveys

Jan Gehl is widely acknowledged for his use of social science research methods to study human-built environment interactions that provide statistical analysis (the 'numbers'), while also explaining in detail how spaces are being used—and by whom. In his urban design practice, he is one of very few designers who rely heavily on empirical research. At the heart of Gehl's method is continuous and systematic observation of how people use public space. In effect, the method revolves around examining existing issues, implementing improvements and then re-examining the area as an iterative process. A core component of his research is a grouping of surveys collectively referred to as *Public Spaces Public Life* (PSPL) surveys. The PSPL surveys are part data-logs about cities, part examinations, part commentaries on public life and part urban design

recommendations. Gehl pioneered the PSPL method in Copenhagen in the 1960s (with his first major survey in 1968) and has since conducted these surveys in cities internationally. The PSPL surveys enable cities to collect data and information on public life, to see how people currently use city spaces, to track the results of design changes, to modify these as necessary, and to envisage solutions to enable better functioning of cities and spaces.

Gehl's PSPL method involves both qualitative and quantitative surveys of city centres primarily using observational techniques centred on quantitative pedestrian and activity counts. The surveys are principally concerned with levels of activity in and use of the city centre spaces, the existing quality, rhythms and characteristics of the centre's public spaces. The PSPL surveys involve three parts:

1. *Public space analysis*: focus on the quality of the public space.
2. *Public life analysis*: focus on use of public space. This provides a baseline for further studies and enables analysis of changes, along with benchmarking against other cities.
3. *Summary and strategic recommendations*: based on the analysis, including suggestions of pilot projects to increase public life.

The surveys are focused on the walkability and urban design of the pedestrian realm and are adapted to fit the distinctive requirements, conditions and needs of individual cities. The surveys provide a 'big picture', a story, of how people are treated in the city, comparing them to other cities where the PSPL surveys have been conducted. The reports establish the current conditions of the public space and public life in order to develop holistic planning and transport decisions regarding public spaces

¹ The PSPL report for Adelaide 2011 has not yet been released.

² The PSPL report for Launceston 2011 has not yet been released.

and infrastructure, to implement and monitor changes and adapt responses as necessary.

Results of the PSPL surveys

Gehl's and Gehl Architects' PSPL surveys have all shown cities what they can do to help pedestrians; many cities have implemented enough of these recommendations to make them go back and evaluate their success by conducting a further PSPL survey. These reveal that planning for pedestrians can influence walkability levels, either increasing the use of public spaces (as in many of the cities) or the opposite: enabling the spreading out of use in areas that are overcrowded (Gehl, 2010; Gehl Architects, 2002; Gehl & Gemzøe, 1996). Gehl has demonstrated, particularly within the Australian context, through the changes in Melbourne and also in Perth, that with each improvement to the pedestrian environment comes an increase in the level of activity in the city spaces. These results are outlined below.

The PSPL surveys also help to facilitate positive changes in cities and in planning and design policy. Of particular notice is the cost saving to cities of increasing the mode share of walking and cycling. In Copenhagen the City determined that every kilometre conducted by bicycle in Copenhagen effectively gives the City of Copenhagen US25 cents in health and road maintenance savings, whereas every kilometre driven costs the City of Copenhagen US16 cents (American Society of Landscape Architects, 2011).

These changes have occurred in cities with governments and communities of all political persuasions and reflect what could be called a 'universality' of his approach. This is particularly evident within the Australian cities in which he worked. The surveys have been able to be reproduced by others outside of Gehl Architects and have been adaptable to varying scales and contexts, including non-western cities.

There is, however, a limit to what a survey alone can achieve. The surveys place a high demand on human resources, which can result in errors and subjective judgements, opening them up to different results, observations, and other human errors such as miscounts. Researchers can overcome some of the subjective results and possible human errors by combining different surveys to provide a broader snapshot of city life. Gehl Architects are very aware of this issue and have tried to address the shortcomings of their surveys.

The remainder of this paper provides an overview of the PSPL surveys conducted in Melbourne and Perth, concluding with a brief report of the results of the surveys in Sydney, Brisbane, Hobart and Adelaide. Melbourne and Perth were chosen because they provide a good case study of the PSPL work and changes because they have had follow-up surveys (Adelaide's 2011 survey report is not yet released).

Melbourne, 1994 and 2004

The changes within the City of Melbourne show perhaps the most dramatic results of all the Australian cities, illustrating how positive changes to the public realm can result in increases in walking and life within a city. In 1993-94, Gehl, along with the City of Melbourne, conducted a PSPL survey of Melbourne's city centre. A follow-up survey was conducted in 2004 enabling a decade of work to be evaluated (Gehl Architects, 2004). The PSPL surveys and the recommendations ensuing from them served as a guide for actions and policies, particularly providing a benchmark from which the city could judge its progress (Beatley & Newman, 2009). The combination of the two surveys enables the City of Melbourne to measure and monitor the success, or otherwise, of changes and to claim on the basis of its clear success to be one of the world's most liveable and attractive cities (Adams, 2005).

Some of the major changes in the Melbourne city centre between the two surveys (1994 and 2004) include the following:

- A dramatic growth in the number of city centre residents—from 1008 in 1992 to approximately 9,375 in 2002;
- An increase in pedestrian traffic: the number of pedestrians in the city centre on weekdays in the evening has increased 98 percent (from 45,868 in 1993 to 90,690 in 2004), and daytime traffic has increased by 39 percent (from 190,772 in 1993 to 265,428 in 2004);
- The number of people spending time in the city increased dramatically in many locations;
- An increase in public space by 71 percent via creation of new squares, promenades and parks (From 42,260 m² in 1994 to 72,200m² plus Birrarung Marr Park's 69,200m² in 2004);
- More places to sit and pause, with an increase in cafés and restaurants (from 95 in 1994 to 356 in 2004), a threefold increase in café seats (from 1,940 in 1993 to 5,380 in 2004) and an integrated street furniture collection; and
- Improved streets for public life, including the revitalization of a network of lanes and arcades (Gehl Architects, 2004).

In addition, the City of Melbourne has taken a number of steps to restore and strengthen the city's traditional grid pattern, including activating mid-block alleys as pedestrian spaces. The City of Melbourne has placed a 40-metre height limit on its core, ensuring that the city's public spaces receive adequate sunlight and has established policies to encourage mixed use development, especially small business uses, outdoor cafés and restaurants, and to encourage buildings to appropriately and openly connect with

public spaces. The City of Melbourne has actively encouraged residential development, including developing their own residential demonstration projects, as well as implementing greening and public art strategies. The City of Melbourne also placed considerable emphasis on redesigning footpaths, including planting 500 street trees annually.

The Melbourne example dramatically demonstrates the effects of the surveys and a city introducing a public space strategy. Beatley and Newman contend that Melbourne has emerged as "a remarkable case study in an emerging pedestrian city, having shown some dramatic, positive change in its pedestrian character and public sphere in the relatively short span of twenty years" (2009, p.134).

Not all places that have had a PSPL survey demonstrate such dramatic results. However, most illustrate an increased awareness about creating a friendly and inviting public realm. Melbourne has been successful because of its focus on intimate spaces, on street details and what people experience in the streets, rather than on 'amazing architecture', or the 'Bilbao effect'. From all the public space changes Melbourne has become a 'brand'. It is consistently named in the top great cities of the world but not many people can say why it is famous. Now it is famous for the experience of place and celebration of urban culture. Gehl, in a StreetFilm in 2008, asserts that the "overriding lesson" from Melbourne is "that even if you are a city in the new world with wide streets, with a car culture, the whole thing geared for rushing from A to B, if you are willing to give people the space they need, give the bicycles the space they need, then you can have a complete change of behaviour" (Eckerson Jr, 2008).

The next step for Melbourne is to continue to improve the city, including increasing

residential capacity (Adams, 2011). As the 2004 report points out, although Melbourne has improved dramatically in terms of street life, there is always more work to do (Gehl Architect, 2004b). Melbourne now has a formal research programme for public space and public life.

Perth, 1994 and 2009

Gehl and colleagues conducted the first PSPL survey in Perth in 1994 followed by a new survey in 2009. The primary surveys conducted in both were pedestrian counts, stationary activity counts, street frontages assessments, and test walks.

The 1994 survey determined that there was “no invitation for walking, and certainly no great invitation to walk for the pleasure of walking—to promenade through the city” particularly as “waiting times in front of traffic lights will account for 35-40 percent of the total trip time” (Gehl, 1994, p.9). At the time, they determined that “the city heart of Perth is tiny...probably the smallest for a city of its size. It has the character of an oversized department store” (Gehl, 1994, p.v). The survey revealed that the mall system used in Perth (and other Australian cities) was “conceived not as walking routes but as isolated pedestrian places in a car traffic dominated city centre”. The malls were essentially “conceived as concentrated shopping malls”, rather than pedestrian networks, with the malls not really connecting important destinations (Gehl, 1994, p.9).

As a result of these surveys and analysis a series of recommendations were made to enable the city centre to be transformed. Fifteen years later the follow up survey findings reflected the result of many changes within the city and revealed the following changes from the 1994 survey to the 2009 survey:

- Improved conditions to walk and spend time in the city, resulting in 13

percent more daytime pedestrian traffic (from 132,650 in 1993 to 150,100 in 2009);

- 57 percent more stationary activities during the day, with 37 percent more in the evenings;
- 15 percent more bench seats (from 1,725 bench seats in 1993 to 1,988 bench seats in 2008);
- 190 percent more outdoor cafés (from 48 in 1993 to 140 in 2008) and 74 percent more café seats (from 1,940 seats in 1993 to 3,390 seats in 2008);
- 1576 more street trees; and
- 34 percent more people traveling to work by public transport than in 1994 (Gehl Architects, 2009a).

The survey also highlighted areas that needed improvement and established a baseline figure against which changes could be measured. Amongst other issues, the Perth surveys highlighted the absence of people walking and spending time in the city at night and on weekends. The Saturday pedestrian count was only 62 percent of the weekday pedestrian count and the night-time pedestrian numbers had only increased by 3 percent in the fifteen years between the surveys, even though the numbers of residents had increased. The report acknowledged that the city’s streets generally perform well in terms of accessibility for people with mobility impairments. However, the city lacked appropriate spaces for children, youth and older people, particularly in regards to spaces for ‘play’ and in social places for older people. The surveys identified a need to invite more residents and students into the city through the provision of amenities to enable the creation of a ‘24-hour’ city (Gehl Architects, 2009).

In addition, the surveys highlighted that the Perth city centre still retained the *shopping centre* concept that it had in 1994 and that this needed to be replaced with a *people*

centre concept. Many of the existing functions and the corresponding built form could be anywhere and many of the unique aspects of Perth (topographical, environmental and architectural) were ignored, particularly the river, the foreshore and historic buildings within the city centre. In addition, the Modernist ideology and land use patterns of separation of uses were still prevalent, with what Gehl described as “beer here, culture here, shopping here and government here” (Gehl Architects, 2009). The report concluded that the existing land use divisions within the city had altered only slightly in the prevailing fifteen years.

In addition, the report highlighted that although the City had done much to invite pedestrians and cyclists into the city through the provision of cycle lanes and widening of many footpaths, more still needed to be done, particularly with the creation of complete pedestrian and bicycle networks that connect to the wider region.

The work of Gehl has been in the city centre but others have used his techniques and applied them to smaller, suburban centres in Perth, including Fremantle and Midland (Matan, 2007; Roberts Day Pty Ltd., 2010).

Other Australian city surveys

Sydney, 2007

The PSPL survey from the City of Sydney (2007) illustrates a city dominated by cars and congestion. The surveys highlight a lack of balance between the transport modes and disconnected public spaces (Gehl Architects, 2007). As part of turning this around, Gehl Architects continue to advise the City of Sydney to create a more people-friendly city (Gehl et al, 2011). The influence of Gehl is particularly noticeable in the refurbishment of the central city’s Pitt St Mall (a pedestrian, car-free area), the creation of a pedestrian priority network connecting major areas throughout the city and the implementation of a 200 kilometre bike network by 2016, all

as part of the ‘Sustainable Sydney 2030’ plan (City of Sydney, 2011).

Brisbane, 2008

Gehl Architects conducted a PSPL survey of Brisbane City Centre in 2008. The survey here along with pedestrian counts had a focus on cycling. The survey determined that Brisbane had a focus on car-dependency, a lack of attractive pedestrian and bicycle facilities and a lack of diversity in age groups using the city. The surveys provided a base-line figure for numerous pilot projects focused on increasing walking and bicycling within areas of the city. Some of the recommendations provided by Gehl Architects include: increasing density and reducing car dependency, reducing driving, providing a more people-oriented, safe and inclusive city; improving connectivity; improving conditions for walking; introducing cycling on a city-wide scale; amongst others. The PSPL report informs the development of the ‘River City Blueprint’ aimed at increasing the sustainability, liveability and activity of the city, along with guiding the Queensland Government on other major planning initiatives (Brisbane City Council, 2011).

Hobart, 2010

The Hobart PSPL survey praises the natural setting and gentle built form of Hobart, however recommends a “broom and a steady hand” is needed to enable users of the city to be able to celebrate these unique features. The task of the PSPL survey in Hobart is to provide a vision for the city of a vibrant people-first city with a 21st Century transportation system. The PSPL provides the base-line pedestrian figures from which any future changes can be measured (Gehl Architects, 2010).

Adelaide, 2002 (2011 yet to be released)

Gehl Architects conducted a survey in Adelaide in 2002 and are currently undertaking a follow up survey as part of the

Government of South Australia's community dialogue program. The focus in Adelaide is working on creating a better balance between the modes, especially increasing the bike riding of all inclusive users, so that it is not just men but also women, children and elderly. In addition, the follow up survey reveals that the city has disjointed footpaths and long pedestrian waits at intersections, with many minor pedestrian interruptions. Furthermore, the City has 41,000 car parking spaces, with the generosity of car-parking creating lots of traffic and much of the car parking being underutilised. The 2011 report provides a vision, aimed at freeing up the city centre from car parking, moving some of it to the extremities, and using the resulting space for other uses. In addition the report aims at supporting an inclusive transport system (Henriette Vamberg, as cited in Government of South Australia, 2011).

Conclusion

Gehl's work resonates with a sense of responsibility and optimism aimed at creating a more walkable and vibrant city centre. Local government architects and planners have a responsibility to create and enable sustainable lifestyles and this underlies each of the PSPL surveys described providing practical policy options for them to implement. The work and theories of Gehl returns to the very core of urban design and sustainable transport planning as the design of cities to maximise the diversity of exchange, while minimising travel needs, continually bringing people to the forefront. This explicitly humanist, pro-urban and pro-people emphasis in city design and transport planning has had a profound and growing impact on Australian cities.

The work of Gehl has focussed on city centres and by showing how walkability increases economic, social and environmental benefits in the heart of the city, the surrounding suburbs are challenged

to reduce their car dependence. However, the challenge for creating a city beyond the car will be to build such walkable centres throughout the suburbs.

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Is my area walkable?

Some questions to help you assess the walkability of a locality and how it can be improved.

Use/Network

What is the volume of pedestrian traffic on this street? (pedestrian counts)

Who are the people using this street? Do they have special walking needs given their age or disability?

What is the pedestrian density of particular footpaths (numbers of pedestrians per metre width of footpath per minute)?

What are the main pedestrian routes in the area (day time and night time)?

What types of pedestrian facilities are in the area (dirt paths, paved footpaths/sidewalks, shared streets, pedestrian only streets, plazas, squares)?

What is the length and area of these pedestrian facilities?

What are the main arrival and exit points to the area? Are they connected via walkways?

How easy is it to walk through the area? (Do test walks to establish this.)

How adequate are footpaths/sidewalks in the area? (Some possible problems: no footpaths, discontinuous, too narrow)

What proportion of streets have footpaths/sidewalks?

Are the footpaths/sidewalks complete on both sides of streets?

Is the footpath/sidewalk provision satisfactory in both major and smaller streets?

Are footpaths wide enough to cater for the number of people who walk on them?

What are the footpaths/sidewalks made from? (asphalt, concrete, paving bricks, flagstones, dirt, gravel, etc.)

Are the footpaths/sidewalks well-maintained? (free from cracks, holes, rubbish, etc.)

Are the block lengths short? (If they are long there may need to be walkways through the block.)

Does the pedestrian network connect major areas/destinations in the city?

Does the pedestrian network connect to primary destinations such as schools, hospitals, transit stations?

Is the pedestrian network itself well-connected (with, for example, few pedestrian cul-desacs)?

Barriers

Is the area accessible to those with disabilities? Are there ramps instead of steps where possible?

Are there obstacles on the footpaths (for example, street trade, shanty dwellings, piles of rubbish, parked cars, animals, road or building construction materials, or a large number of poles and signs)?

Are there buffers between the road and the footpath, such as fences, bollards, trees, hedges, parked cars and landscaping? (Buffers have advantages and disadvantages, but they can screen walkways from traffic and prevent parking on the walkways.)

Are there many small interruptions to the pedestrian networks (e.g., minor road crossings, parking lot crossings, driveway crossings)?

Are there other major barriers to walking in the area (major roads, train tracks, rivers, hills, gated land uses, etc.)?

Does the slope of the area make it hard to walk?

Intersections

How convenient is it to cross the street? Where are the pedestrian crossings?

What type of traffic intersections are used?

Are pedestrians given priority at intersections?

What are the crossing aides used at traffic intersections (pavement markings, different road

surface or paving, signs, traffic lights, median traffic islands, curb bulb-outs, underpasses, overpasses, etc.)?
Is crossing made easier either by curb cuts or road raising?
How safe is it to cross the street (at designated pedestrian crossings)?
Do drivers obey road laws and traffic signals?
Are pedestrian crossings clearly marked?
Do traffic signals indicate how long you need to wait before crossing, and how much remaining time you have to complete the crossing?
Do you need to press a button for a pedestrian signal to permit you to cross?
Are there any mid-block crossings? Are these adequate?
Public Transport connection
Is the area connected to public transport? Where are the public transport nodes?
Are the public transport waiting areas of high-quality (weather protection, information, signage, seating, waste receptacles, etc.)?
Land use
What are the primary land uses of the area? (This will suggest the numbers of pedestrians at different times of the day.)
What are the primary destinations (industrial, commercial, governmental, recreational, community) in the area?
What is the population of residents and workers in the area?
Enjoyment
What are the main public areas (square, parks, plazas, etc.)? Are they public (open to everyone) or private (limited access, controlled use)?
What is the quality of the public spaces (comfort, appearance, maintenance, possibilities for use)?
How many people are using these spaces? How are they using this space? (can be assessed through stationary activity counts or behavioural mapping)
Are there any spaces for children/elderly/youth within the city?
Does the area allow for physical activity, play, interaction and/or entertainment?
Are there any identifying features in the area (monuments, land marks, neighbourhood character)?
Is there any indication that one is entering a special district or area? (It's good to have the neighbourhood character indicated in some way along the walkway.)
Are the walking areas interesting?
Are there interesting views?
Are there temporary activities in the area (markets, festivals, buskers, street performers, etc.)?
Does the area allow for resting, for meeting others, for social interaction?
Is there adequate greening in the area (plants, trees, etc.)?
Is the area of a high visual quality (pavements, facades, art, etc.)?
Streetscapes
Where buildings meet the street, is it clear what is private and what is public space?
Are the dimensions of the buildings lining the footpaths at human scale?
Are the facades of the buildings lining the street transparent/active (i.e., do the buildings have many doors and windows opening onto the street, 'soft edges', with many niches, detailed facades)? (see Gehl, 2010 below)
Infrastructure
What is the amount of seating available?
Is the seating in the right place (with regard to views, comfort and protection from climatic conditions, located at the edge of spaces)? Does the seating maximise the natural

advantages of the area?
Are the seating arrangements appropriate (can you talk to friends)?
What is the quality of the seating?
Are there places to stand? To lean against? Attractive edges?
Are waiting areas adequate, providing comfort and protection to pedestrians waiting for transit or to cross the street?
Are there enough rubbish bins?
Is there any public art?
Are there water fountains?
Are there wayfinding devices?
Are there public toilets?
Comfort
Is there adequate protection from the sun, rain and wind?
Is there adequate protection from negative aspects of vehicle traffic (pollution, noise etc.)?
Are the ambient noise levels low and comfortable?
Do the sightlines allow you to see where you are going?
Is the area well maintained (footpaths, buildings lining the footpaths, etc.)?
Is the area clean (free from rubbish, broken glass, inappropriate graffiti)?
Safety
Is the area lively and active?
Is there street life?
Is there passive surveillance of the area? In other words, are there people around to watch out for each other? (This is especially important when it comes to night-time usage.)
Is the area safe? (both perceived and real)
Is the lighting from street lights and buildings adequate at night time?
Are there signs of other people at night time?
Are there night time uses of the area?
Is there a mix of land uses in the area?
Are there many small land uses?
Are the facades of buildings 'closed' at night?
Is there adequate visibility between modes of transport?
Is there protection from vehicle traffic?
Vehicle traffic
What is the traffic volume of the street? Does it make it hard/unpleasant for walking?
Is there street parking (on/off street)
What is the speed limit of the street? Does this make it hard/unpleasant for walking?
Are there any traffic calming or traffic control devices in the area?
How many lanes of traffic are there?
What are the traffic control devices used (traffic lights, stop signs, roundabouts, speed bumps, etc.)?
Perception of the area
Is the area perceived as safe?
Is the area perceived as pleasant?

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Robert Salter, Subash Dhar and Peter Newman (2011), *Technologies for Climate Change Mitigation:*

Transport Sector, Risø Centre on Energy, Climate and Sustainable Development, United Nations Environmental Program (www.uneprisoe.org); at http://techaction.org/Guidebooks/TNAhandbook_Transport.pdf. (pp. 228-231) [This version was specifically tailored for this publication so is altered from the one here].

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THE FUTURE OF CARFREE DEVELOPMENT IN YORK, UK

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Introduction

Carfree development is a relatively uncommon instrument that can address a wide range of well-known and lesser-known social and environmental problems. These include air and noise pollution, traffic danger and casualties, health and obesity, climate change and oil dependency, social isolation, lack of community cohesion, and the visual and physical intrusion caused by motor vehicles when both driven and parked.

Whilst each development has its own unique character, the distinguishing features are a traffic-free environment within the site and measures to encourage walking, cycling and public transport over private car use. Car club vehicles are often incorporated into the site. Parking is limited and relegated to the site periphery, and sometimes charged for as a separate cost from the housing – in line with the ‘polluter pays’ principle. This stands in contrast to conventional developments where typically the cost of road construction and parking infrastructure is included within the housing cost and absorbed by all residents, regardless of whether they own a car.

Confusingly, the original concept of carfree development – as described above and as defined in previous research (Melia, 2010) – must be distinguished from what is sometimes called ‘car free’ development or housing in the UK. The latter is a narrow definition and simply means that the development has no on-site parking (perhaps with exceptions for disabled residents), or the residents have no right to a residents’ parking permit. The quality of life advantages of a traffic-free environment are usually absent. The residential buildings may even be located on a busy road. It is easy to see why that type of development can be seen as the worst of both worlds – no

benefits of carfree living, no benefits of car ownership and use, and full exposure to the ‘negative externalities’ of other people’s car use. This can render the concept undesirable to developers and would-be residents alike. As about one-third of car owners would like to reduce their car dependence (Stradling et al., 2000), it is very important to get the concept right in order to attract these people.

In contrast, following the original concept with a traffic-free environment, successful carfree developments have been built in several European countries, including large-scale schemes in Germany and The Netherlands. Discovery Bay in Hong Kong, with a population of over 16,000, was probably the world’s first carfree development, although it does not appear to have influenced the European examples. In Abu Dhabi, Masdar City is being built as a carfree city for an eventual population of 40,000 (Alameri, 2011). Yet to date in the UK, the largest carfree development aside from student accommodation is the 120-unit Slateford Green in Edinburgh. There is evidence from these examples that carfree development has not only improved life for non-car owning households, but led to major behavioural change among car-owning households in favour of walking, cycling and public transport (Scheurer, 2001; Nobis, 2003; Melia, 2010).

For this reason, carfree development has a strong potential for ‘building in’ sustainability to new development, countering the historic and continuing trend towards in-built car dependency in new development. However, carfree development relies on the necessary level of political will to replicate best practice on a much larger scale. It is an open question whether this can be achieved in the context of a society with a high level of car

ownership. Another possibility is that carfree development will be mainly built *in response* to a future decline in car ownership and use.

Based on experience elsewhere, carfree developments are less likely to come from a commercial developer than from a not-for-profit developer, a housing association, a forward-thinking landowner, or a group of committed would-be residents. In fact, almost all of the existing examples of carfree development have been led by one of those four groups.

A recent PhD thesis titled 'Potential for Carfree Development in the UK' (Melia, 2010) identified substantial demand for carfree development in the two areas surveyed: Camden in inner-city London and the seaside town of Poole in Dorset. However, there has been no known research of this kind in the North of England. This thesis investigates the same topic on the scale of one Northern city – York.

Why York?

York was chosen for several reasons, including its compactness and the viability of walking and cycling there. There is a precedent for carfree development in York, in the case of both of York's universities and the associated student accommodation. University of York adopted all three key characteristics of carfree development in its original 1962 Masterplan (University of York, undated), pre-dating the European concept of residential carfree development by three decades and Discovery Bay by two decades. Planning documents for some of York's major development sites also suggest 'car free' development – in the narrow sense of no parking provision – as a future possibility.

York's per capita income and level of car ownership are close to the England and Wales average, although car ownership is high for an urban area; 72.7% of households in York owned a car or van in 2001 (ONS,

2001). This may indicate that, if carfree development proves viable in York, it may be even more viable in the UK's larger urban centres, at least in certain respects.

York New City Beautiful, a detailed 30-year strategy document commissioned by City of York Council and Yorkshire Forward, proposes a largely carfree future for York (Simpson, 2010). This has been incorporated into the city's overall 'renaissance' vision and the 'evidence base' for York's Local Development Framework.

Simpson writes: "Streets and spaces can never provide the capacity for all the people and all our vehicles all of the time. We cannot provide high-quality places for civic and community life in attractive, beautiful environments as well as satisfying all the functional demands of private vehicle use. The critical need is in the quality and character of city streets, places and spaces. York has the makings of such conditions." (Simpson, 2010 p35).

Sampling Strategy

The original thesis investigated the potential for new carfree development in York from three angles: market potential, technical feasibility and political feasibility. This paper is however limited to the question of market potential.

The broad research question of this paper is "What is the market potential for new carfree development in York?" This can also be phrased as an objective: "Determine the level of interest in, and likelihood of, moving to a carfree development within the next five years, among potential residents who currently live in York." This in turn corresponds to a research hypothesis: "There is enough latent demand for new carfree development in York for a strong business case to be built."

Previous research (Melia, 2010) identified demographic categories that are more likely

to live in, or consider living in, carfree development. These include 'Carfree Choosers' (those who do not own a car by choice) and 'Carfree Possibles' (those who currently own one or more cars but would be willing to forego car ownership under certain circumstances and have done so in the past). In addition, 'Car Limiters' is a term used by Melia to describe people willing to reduce their car use on moving to a carfree or low-car environment (Melia, 2010). However, in the context of this paper, 'Car Limiters' are those who will continue to own one or more cars but use it/them sparingly – as we are looking at people who have not yet moved to a carfree development. Car Limiters are also expected to demonstrate interest in carfree development, as long as car ownership for less frequent use is accommodated.

Discussions with real estate agents suggested that 'hard evidence' concerning sale prices of carfree developments would be needed to convince commercial developers of their viability (George Grace, personal correspondence, 1 December 2010). However, in the context of York, no such comparison of hard evidence can be made. No carfree development other than student accommodation has yet been built.

While data based on hypothetical questioning is in some ways less satisfactory than hard sales data, the former can provide initial indications of market potential, to be followed up with further research in the case of compelling results.

It was decided to use purposive sampling, targeting groups within the York population expected to contain high concentrations of 'Carfree Choosers', 'Carfree Possibles' and 'Car Limiters'. These groups included members of environmental and cycling organisations, parents of an 'alternative' school and members of City Car Club.

For comparison, a more mainstream sample of York residents was sought. Lacking the resources to post the survey to a randomised sample of York residential addresses, the researcher decided to recruit respondents in a public place in the city centre, Library Square. An additional 'mainstream' sample was chosen: readers of the local newspaper, *The Press*. In both cases there was no presumption of the sample being representative of the wider York population.

Market Survey Design

For practical reasons, it was decided to use an online survey tool rather than a paper-based survey. This had the negative effect of eliminating some willing respondents who did not have access to email. However, on the positive side, respondents approached in person only needed to provide their email addresses, and were not subject to a significant delay or the potential need to rush their responses. After being emailed the link to the online survey, respondents could complete the survey at their convenience at home. This probably contributed to more thoughtful, detailed responses to the essay-type questions, providing high quality qualitative data.

The survey included 35 questions, expected to take ten minutes to complete. As most respondents were expected to be unfamiliar with the concept of carfree development, the survey began with a 230-word description of carfree development, designed to present an objective summary of the concept:

Car-free development is defined as residential or mixed-use development which:

- (a) provides a traffic-free immediate environment, incorporating public shared space
- (b) is designed around movement by non-car means

(c) offers no parking or limited parking separated from the residential environment, and

(d) usually separates the cost of parking from the cost of the housing.

The idea is to offer a greener, more peaceful living environment, away from the noise, air pollution and danger of car traffic. Children are given safer places to play, compared to a roadside environment. Walking and cycling routes, as well as secure bicycle parking, are provided. Non-car owners have the advantage of not having to pay for car parking infrastructure. Only those who own a car will pay these costs, often in the form of a substantial ownership payment for a parking space, which the owner can then sell on at any time. A pay-per-use car club is often incorporated into a car-free development, so that non-car owners have a convenient option for occasional car use.

The overall effect of car-free development is to encourage walking, cycling and public transport primarily through urban design improvements, whilst providing disincentives to car ownership and use, without stigmatising motorists. The pedestrian-based urban design and the shared values of the residents may also foster a sense of community. Shopping and other amenities are usually located nearby for ease of access.

Respondents were then asked for their attitude towards the concept, and related questions using a Likert-type scale of responses from from 1 ("very positive") to 7 ("very negative"). These were followed by a request to list positives, negatives, and questions about the concept. This served to check for understanding of the concept, gain

a qualitative insight behind respondents' thoughts and feelings, and flag up practical issues with carfree development that would need to be addressed in any successful scheme.

Other key questions included the likelihood of respondents to choose to live in a carfree development, their likelihood of moving within York in the next five years, their 'household car behaviour' category, and where or through which organisation they became survey respondents.

Research Results

Although based on a hypothetical description of carfree development, the overall results were quite striking. Out of the 151 respondents, 82% had positive attitudes towards carfree development. 60% were likely to move to a carfree development, if in the position of looking for a new place to live in York and "if one were built with suitable housing within [their] budget"; 26% were 'very likely'.

On the qualitative side, there were many high-quality essay-type responses, both positive and critical towards the concept. Interestingly, only one respondent pointed out that carfree development "provides a choice for people who wish to be car free". In a society where personal choice is highly valued, one might have expected more respondents to express that carfree development might be a good option *for some people*, to allow them to gain the full benefits of being carfree, whilst benefiting the larger community in terms of a minimal contribution to road traffic.

Despite having read the above description of carfree development, in some cases respondents showed a lack of understanding of the concept, highlighted by the essay-type responses. There was clearly a balance to be made between providing a concise

description of carfree development and predicting and addressing potential concerns. The relatively short description of carfree development appears to have elicited respondents' main concerns, which was extremely valuable. However, the researcher believes even stronger support would have been achieved if the description of carfree development had provided further details – for example on disabled and visitor access, deliveries and heavy goods transport, parking security, preventing parking 'overspill' to surrounding areas, and the likely range of walking distances from the housing to the car park. The survey purposely didn't mention existing schemes, but some respondents wondered whether examples of successful carfree development existed, or if it was just an untested theoretical concept.

Table 1 summarises the survey results according to the original samples.

only those who selected '1'. The same pattern is followed for 'Very Likely'.

Here we see that City Car Club respondents were the most likely sample to move to a carfree development, while York Cycle Campaign respondents had the most positive attitudes towards the concept. Library Square and York Cycle Show respondents had very similar results in four of the six measures listed in Table 1. This is perhaps surprising, as the Library Square sample was a 'mainstream' control group. In both cases over half of the respondents were likely to move to a carfree development. The researcher does not believe that *The Press* sample is representative of readers of that publication, as some of the respondents appear to have been motivated to complete the survey by their strong opinions on the issue.

Table 1: Summary survey results by sample

Sample	Sample Size	Attitude Towards Carfree Devel.		Likelihood of Move to Carfree Devel.		Likelihood of Move in Next Five Years	
		Positive	Very Positive	Likely	Very Likely	Likely	Very Likely
City Car Club	12	92%	75%	83%	50%	33%	17%
York Cycle Campaign	19	100%	84%	74%	37%	16%	11%
Environmental Groups	21	81%	48%	62%	29%	48%	10%
York Steiner School	39	90%	49%	67%	23%	38%	26%
Library Square	28	75%	21%	54%	21%	25%	14%
York Cycle Show	19	84%	47%	53%	21%	26%	16%
The Press	13	38%	23%	15%	8%	38%	15%
ALL RESPONDENTS	151	82%	48%	60%	26%	32%	17%

Table 1 requires some explanation. The 'Positive' and 'Likely' columns aggregate the totals of respondents who indicated 1, 2 or 3 on a seven-level Likert-type scale. A response of '4' is neutral, and 5, 6 and 7 are negative. The 'Very Positive' column is a sub-set of the 'Positive' Column, including

While the survey results according to the original samples are of considerable interest, the researcher's intention was to focus on the variable of 'household car behaviour', as shown in Table 2. 'Household car behaviour' appears to be the single most important

variable, in line with previous findings (Melia, 2010).

all major life decisions on the basis of not owning a car, including raising 3 children, who participated in activities and social events usual to childhood.

Table 2: Summary Survey Results by 'Household Car Behaviour'

Household Behaviour' Category	Car Sample Size	Attitude Towards Carfree Devel.		Likelihood of Move to Carfree Devel.		Likelihood of Move in Next Five Years	
		Positive	Very Positive	Likely	Very Likely	Likely	Very Likely
Carfree Choosers	41	98%	81%	90%	59%	34%	20%
Carfree NonChoosers	5	100%	40%	80%	40%	60%	20%
Other	11	91%	55%	55%	36%	18%	18%
Carfree Possibles	18	94%	56%	72%	22%	28%	6%
Car Limiters	59	80%	34%	47%	9%	27%	14%
Car Dependents	17	29%	6%	12%	0%	47%	29%
ALL RESPONDENTS	151	82%	48%	60%	26%	32%	17%

The general explanation of Table 2 is the same as for Table 1.

Carfree Choosers. As shown in Table 2, all but one (98%) of the 'Carfree Choosers' – the 41 respondents in households that "[do] not own a car by choice" – indicated positive attitudes towards the concept of carfree development, with 81% 'very positive'. If in the position of looking for a new place to live in York, 90% of Carfree Choosers were likely to move to a carfree development, "if one were built with suitable housing within [their] budget"; 59% were 'very likely'. However, a lower percentage of Carfree Choosers (37%) were likely to move within York in the next five years, with 20% 'very likely'. The only 'Carfree Chooser' who had a negative attitude towards carfree development wrote some responses that strongly suggested he or she was not actually a Carfree Chooser.

Qualitatively, Carfree Choosers exhibited views such as the following: "We have made

While none of them live at home, we manage to get to and from their houses, and look after the grandchildren, still enjoying a car-free existence."

Table 3: Carfree Choosers by Sample

Sample	Count	Percent of Sample
City Car Club	9	75%
Environmental Groups	9	43%
York Cycle Campaign	6	32%
York Cycle Show	4	21%
York Steiner School	7	18%
The Press	2	15%
Library Square	4	14%
TOTAL CARFREE CHOOSERS	41	

In Table 3, City Car Club, perhaps predictably, stands out in particular. At the other end of the scale, two of the groups deemed 'progressive' did not differ greatly from the two 'mainstream' control group samples. It cannot be inferred that Carfree

Choosers represent about 15% of the York population. The researcher can only hypothesise that the true figure lies in the region of 5 to 10%, and considerably higher for those interested in moving to developments in or near the city centre.

Carfree NonChoosers (Table 4). Those who “[do] not own a car by necessity (financial, health, ability, etc.)” – are more common than Carfree Choosers in the broader population. However, given the purposive sampling strategy, the reverse was the case here. There were five Carfree NonChooser households in this survey, who were surprisingly supportive of carfree development. It is likely that a larger and more general sample of Carfree NonChoosers would have had different results.

Table 4: Carfree NonChoosers by Sample

Sample	Count	Percent of Sample
Library Square	3	11%
City Car Club	1	8%
York Steiner School	1	3%
Environmental Groups	0	0%
York Cycle Show	0	0%
York Cycle Campaign	0	0%
The Press	0	0%
TOTAL CF NONCHOOSERS	5	

It may be of some interest that Library Square, the larger of the two ‘mainstream’ samples, contained three of the five Carfree NonChoosers. The relatively affluent ‘progressive’ samples contained only two Carfree NonChoosers out of 110 respondents.

Other (Table 5). This classification was selected by the ten respondents who, we can assume, did not feel that the other choices adequately described their situation. In Table 2, ‘Other’ also includes one respondent in a household that is currently carfree but plans

to buy a car in the near future. Three of the other households were carfree; five households owned one car, and two households owned two cars. Judging from the responses, these cars are generally owned primarily for specific, necessary uses – such as for health reasons, rural work location, visiting relatives or holidays. Some of the ‘Other’ respondents could actually be described as ‘Car Limiters’ (see below). In any case, they were highly favourable towards carfree development, with 36% ‘very likely’ to move to one.

Carfree Possibles (Table 6). These are the 18 respondents in car-owning households that “would be willing to not own a car under certain circumstances”. These circumstances appear to relate to public transport quality, work location, car club cost and convenience, the cost of local food shopping, and other

factors. Note that respondents were not asked whether they had actually given up car ownership in the past – as was done by Melia (2010) – as this would exclude households that are relatively new to car ownership. All but one (or 94%) indicated positive attitudes towards carfree development, with 56% ‘very positive’. If in the position of looking for a new place to live in York, over 72% (13 of the 18) were likely to move to a carfree development, “if one were built with suitable housing within [their] budget”, with 22% ‘very likely’. However, a lower percentage of Carfree Possibles (28%) were likely to move within York in the next five years, with only one respondent (6%) ‘very likely’.

As a qualitative example of a Carfree Possible respondent, one wrote: “Am seriously considering not replacing current car when it gets too unreliable and depending on cycling for a while.” Another wrote: “[I] had to use a car for my job and no option with local authority for pool car.

Bought a car after a year as no chance of changing my job at that time.” A third respondent wrote: “Proximity is the most important circumstance to support car free living - closeness to places I want to be.”

Table 5: ‘Other’ Respondents by Sample

Sample	Count	Percent of Sample
York Cycle Show	3	16%
York Cycle Campaign	2	11%
The Press	1	8%
Library Square	2	7%
York Steiner School	2	5%
Environmental Groups	1	5%
City Car Club	0	0%
TOTAL ‘OTHER’	11	

likely to move within York in the next five years, with 14% ‘very likely’.

In terms of the qualitative data from Car Limiters, one passage stands out as particularly thoughtful: “We prefer not to use the car – certainly on trips within the city.

We are committed cyclists, and for long-distance trips wherever possible prefer to go by train. We simply loathe sitting in traffic. However, I would hate to be without one. The car gives such a lot of freedom when used sparingly. It is the only practicable way of accessing the countryside. It also is so much easier to have as an option of transporting children to different destinations. We thought about being car-free at one point, but the thought makes me feel claustrophobic – the idea of not being able to escape place and people.”

Table 6: Carfree Possibles by Sample

Sample	Count	Percent of Sample
Environmental Groups	4	19%
York Steiner School	7	18%
Library Square	3	11%
York Cycle Show	2	11%
The Press	1	8%
York Cycle Campaign	1	5%
City Car Club	0	0%
TOTAL CARFREE POSSIBLES	18	

Another Car Limiter also questioned “[t]he implication [of carfree development] that everyone who uses a car has a choice not to”. That response, however, presumes that carfree development would prohibit car use and ownership, and that it is designed to be ‘something for everyone’.

Car Limiters (Table 7). This term describes the 59 respondents in households that “will continue to own one or more cars, but intentionally limits the use of the car(s)”. Of the Car Limiters, 80% indicated positive attitudes towards the concept of carfree development, with 34% ‘very positive’. If in the position of looking for a new place to live in York, 47% of Car Limiters were likely to move to a carfree development, “if one were built with suitable housing within [their] budget”; 9% were ‘very likely’. However, a lower percentage of Car Limiters (27%) were

Table 7: Car Limiters by Sample

Sample	Count	Percent of Sample
York Cycle Show	10	53%
York Cycle Campaign	9	47%
Library Square	12	43%
York Steiner School	16	41%
The Press	4	31%
Environmental Groups	6	29%
City Car Club	2	17%
TOTAL CAR LIMITERS	59	

Car Dependents (Table 8). This term describes the 17 respondents in households

that “will continue to own one or more cars and use it/them frequently”. Unsurprisingly, this group was the least favourable towards carfree development. Nonetheless, 29% indicated positive attitudes towards the concept of carfree development, with 6% ‘very positive’.

One Car Dependent respondent wrote: “I can see the advantages of having small areas of car free zones for residential areas. [...] Those people who are employed and need a car or van to travel would not be able to live in this area unless secure parking was to be provided. I could see the advantage of having the green space overland and underground car parking.” Another wondered: “Where would the car parking spaces actually be? If they were close, car-free development would be brilliant. If not then I would say it won't catch on.” A third wrote: “Motorists are already penalised enough. We already pay for the privilege of parking outside our home. Not all employment can be found locally. A better solution is to improve cars rather than imagine we can live without them.”

Table 8: Car Dependents by Sample

Sample	Count	Percent of Sample
The Press	5	39%
York Steiner School	6	15%
Library Square	4	14%
Environmental Groups	1	5%
York Cycle Campaign	1	5%
City Car Club	0	0%
York Cycle Show	0	0%
TOTAL CAR DEPENDENTS	17	

Other Variables. It was judged worthwhile to analyse the data according to two other factors: age and whether one or more children were living in the home. No information on gender was collected, as it was assumed that many of the households would contain both genders.

In Table 9, it can be noted that attitudes towards carfree development differed substantially according to age. The figures were less dramatic on the question of likelihood to move to a carfree development. Respondents aged 37-48 were the most likely to move to a carfree development, followed by those aged 49-64. However, the differences in the ‘very likely’ column were more subtle. In terms of likelihood of moving in general, the two youngest age groups were more than twice as likely to move in the next five years as the respondents aged 49-64.

Table 10 addresses the potential impact of the presence of children (up to age 17) living in the household. A two-tailed ‘t’ test showed no statistically significant difference in the proportions of people with and without children positive towards carfree development ($p=0.448$) or likely to move to a carfree development ($p=0.638$). In fact, the percent ‘very likely’ to move to a carfree development was 26% for both groups.

This is interesting because having children is often cited as a reason for buying or continuing to own a car.

seeking to move within York, 60% were likely to move to a carfree development, “if one were built with suitable housing within [their] budget”; 26% were ‘very likely’.

When classifying respondents according to ‘household car behaviour’, the ‘Carfree

Table 9: Summary Survey Results by Age

Age	Sample Size	Attitude Towards Carfree Devel.		Likelihood of Move to Carfree Devel.		Likelihood of Move in Next Five Years	
		Positive	Very Positive	Likely	Very Likely	Likely	Very Likely
18-24	4	50%	25%	50%	25%	50%	25%
25-36	38	76%	42%	53%	24%	50%	29%
37-48	50	92%	56%	66%	28%	30%	10%
49-64	42	83%	50%	64%	26%	21%	12%
65+	17	71%	35%	47%	24%	24%	18%
ALL RESPONDENTS	151	82%	48%	60%	26%	32%	17%

Table 10: Summary Survey Results by Presence of Children in Household

Children Living at Home?	Sample Size	Attitude Towards Carfree Devel.		Likelihood of Move to Carfree Devel.		Likelihood of Move in Next Five Years	
		Positive	Very Positive	Likely	Very Likely	Likely	Very Likely
Yes	66	85%	50%	62%	26%	24%	15%
No	84	80%	46%	58%	26%	39%	18%
ALL RESPONDENTS	151	82%	48%	60%	26%	32%	17%

Conclusions

The thesis offers strong initial indications that carfree development may be a viable proposition in York. Hypothetical questioning is subject to great uncertainty in terms of how such data might differ from individuals’ concrete actions. With that caveat in mind, the market potential appears to be very strong among the targeted samples: of the 151 respondents, 82% indicated positive attitudes towards carfree development, with 48% ‘very positive’. If in the position of

Choosers’ were the most receptive to carfree development (98% positive, 81% ‘very positive’). If in the position of seeking to move within York, 90% of Carfree Choosers were likely to choose a carfree development, “if one were built with suitable housing within [their] budget”; 59% were ‘very likely’. Support was also strong among those classified as ‘Carfree NonChoosers’, ‘Carfree Possibles’ and ‘Car Limiters’.

This evidence supports the research hypothesis – though as it is based on hypothetical questions, it cannot be considered proven.

It is predicted that the level of interest would further increase in the case of an actual development proposal, where potential residents' uncertainties are allayed through knowledge of the specific plan. If the concerns cited by survey respondents could be addressed by any such plans without detracting from the benefits, this could further strengthen the business case.

The research methods, results and conclusions of this thesis are particularly relevant to the 115 (mostly urban) UK local authorities where the percentage of carfree households is greater than or equal to York's 27.3% (ONS, 2001). The reason for this is not simply to attract people who are already carfree to live in carfree developments, but to locate carfree developments where they have the most promise for reducing household car ownership.

Government can encourage carfree development through strengthened national guidance to local authorities on transport and housing. Local authorities in turn can encourage carfree development through their Local Development Frameworks, Planning Briefs and Area Action Plans. Perhaps most importantly, local authorities can set a strong example by building high-quality carfree development on Council-owned development sites.

Suggestions for further references research

The results highlighted in this paper, although based on hypothetical questioning, are sufficiently strong to warrant follow-up research of a more concrete nature. Any opportunities for comparison of hard sales data from carfree vs. conventional housing should not be missed. This could follow the

research question "What is the effect of a traffic-free residential environment on property values?" and "What are residents' views towards a traffic-free environment and the various scenarios for parking provision that can be associated with it?"

More broadly speaking, it would also be of interest to study the effectiveness of various measures intended to discourage car use and car ownership in new residential development. Forge Bank Co-housing Project, under construction near Lancaster, would be particularly worthy of future study, given the unprecedented scope and depth of its plans (Lancaster Cohousing 2010). The views of students who live in campus accommodation that prohibits car ownership may also be of interest. In terms of a specific proposal for a carfree development at a specific site, it would be useful to conduct focus groups to gauge reactions and seek input on various options and plans.

Returning to the hypothetical, a postal survey to a random sample of residents would be worthwhile – in York and elsewhere that market research is sought – to provide a more accurate sense of the percentage of Carfree Choosers and other 'household car behaviour' groups within the general population, and within specific areas of the city.

The wisdom of *using the term* 'carfree development' – when seeking political support as well as in marketing – is also worthy of exploration.

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The Delivery of Freight in Carfree Cities

By J.H. Crawford

Introduction

It seems unlikely that urban car usage can continue at the levels common in developed nations in the face of concerns about energy supply and climate change. This poses the question of what level of car usage, if any, is optimum in a sustainable city. Given that the removal of cars from urban areas also yields a large improvement in the quality of life, it seemed useful to explore the feasibility of large carfree cities.

In *Carfree Cities* (Crawford, 2000), a "Reference Design" for carfree cities was presented in detail, beginning with the topological arrangement of the entire inhabited area, continuing on to the district scale (approximately 12,000 inhabitants), and on down to the level of blocks and buildings. Detailed proposals were also made for both passenger and freight transport (Crawford, 2000, Part II). Passenger transport systems employ standard metro or low-floor Light Rail Vehicle (LRV) technology to keep worst-case door-to-door travel times under 40 minutes in a city of one million people. Freight was a more challenging problem and required the proposal of some extensions to existing technology for handling standard shipping containers.

In *Carfree Design Manual* (Crawford, 2009), the Reference Design was taken as a foundation, and the book explored, starting from first principles, how a highly functional and beautiful carfree city might best be designed. The book assumed the construction of a new city on an empty site, a condition that occurs with some regularity

in the developing world. The principles laid out in both books will require substantive adjustment when applied to the conversion of existing cities to the carfree model.

Moving freight remains the greatest challenge in the development of workable carfree cities. The problems are greatly affected by project scale – solutions for isolated carfree districts diverge widely from a city-wide implementation.

Freight falls into two main classes, heavy and light. Heavy freight is sea-container-sized shipments destined to a single address. Light freight can be carried by a light-duty delivery van and comprises the large majority of shipments but a far smaller percentage of global ton-miles. Shipments with local origins and destinations comprise most light freight, and many shipments are very small.

Freight in a carfree city breaks down into three distinct categories, each with its own requirements. Freight moves 1) externally, between city districts and the rest of the world, 2) internally, between districts within the city, and 3) locally, within a single district. All three categories must of course be managed. Most local shipments can be handled by simple means, but longer-distance deliveries that today rely on trucks require another solution. In a city of a million people, only a dedicated freight system can reasonably be expected to provide 24-hour-a-day freight service without hindering passenger service or clogging the streets with trucks. A dedicated system is expensive

to construct but is cheap to operate and imposes minimal externalized costs.

Carfree Cities proposed "metro-freight," an automated, rail-based system using standard shipping containers (ISO containers) to move nearly all heavy freight, thereby holding street traffic to an absolute minimum (Crawford 2000 pp 195-220). However, a full-scale metro-freight implementation requires a large project to support it. Smaller projects may have to accept truck deliveries, although these projects can be designed to permit later implementation of metro-freight. A freight route through the project should be identified and protected, and this route permits truck deliveries while encouraging major freight customers to locate along the route. This supports the later installation of a metro-freight system.

The provision of "utility areas" avoids the need for much freight ever to enter the inhabited areas of the city. They avoid the need to site such functions as heavy industry, warehousing, and freight handling in the city proper and provide a location for storage of passenger and freight rail cars. The Reference Design was premised on a significant continuing level of car usage outside the city, so parking garages were also proposed for the utility areas (Crawford 2000 pp 215-220).

Localization of economies has been widely proposed, and increasing fuel prices may force a retreat from globalization. However, the freight requirements of a carfree city are not greatly affected by this trend, as approximately the same volume and mass of goods must enter and leave a city regardless of the distance they may be traveling.

Each region develops its own distribution patterns, which are affected by tradition, geography, economics, national borders, local laws, international treaties, and local transport modes.

Eventually, we may see a return to older patterns of retail distribution, with goods being brought to small stores close to customers. However, early carfree developments will be too small to affect regional distribution patterns and so must adapt to the prevailing regional arrangements.

What of freight delivery requirements in existing cities and towns undergoing carfree conversions? The Reference Design implies some approaches, but it seems clear that the implementation of a full metro-freight system, as proposed below, will be essentially impossible in existing cities that have any significant underground works (i.e., essentially all of them). Overhead installations are in theory possible but so damaging to the tissue of an urban area that their use deserves no further consideration. However, in the case of large, new extension to existing cities, the metro-freight approach can be applied to the extension.

In existing urban areas large enough to support tram service (whether new or existing), freight trams, as discussed in Alternatives to Metro-Freight, can provide quite good service. Tram service is already being re-established in most European cities of any size, and the night-time surplus capacity of these systems can be employed to deliver freight. (Some daytime service is possible if the system is not heavily loaded.) The operational costs are appreciable, as transshipment of freight is required, but capital costs are relatively low. Freight trams must be purchased and loading/unloading facilities established. Little or no new right-of-way is required.

In large cities, dedicated freight tram networks are a plausible alternative to metro-freight, and indeed this was proposed for Manhattan (Crawford, 2000, pp 272-273). One advantage of this approach is that new trackage can be arranged with sufficient clearances to permit the hauling and delivery

of standard ISO containers, which is usually not supported by existing tram networks. The costs are moderate, especially if self-propelled freight trams using batteries or other energy storage systems can be developed, as the cost of the overhead power supply is saved.

Towns not large enough to support tram service are probably condemned to indefinite truck service for external freight. Most internal freight, given the short distances involved, can simply be handled by freight bicycle or hand cart, substantially reducing today's volume of track traffic. Various financial inducements can be imposed to encourage the use of non-motorized delivery modes, but that is the most that can be expected.

Containerized Shipping

Standardized shipping containers were first developed in the USA during the 1950s and have played a steadily more important role in freight transport, especially sea freight (Cudahy, Levinson). They are the subject of ISO standards that control every important aspect of their design and construction (ISO). Standardized containers are dimensioned in feet and come in a fairly small variety of sizes, mainly 8 feet wide and 8.5 or 9.5 feet high. Principal lengths are 10, 20, 40, 45, and 53 feet, but other sizes exist. Oversize containers 8.5 feet wide give rise to some compatibility problems (Katims). Huge investments have been made on the basis of these standards, so we can base freight transport in carfree cities on ISO containers without fear that the system may become obsolete.

Specialized containers for liquids, powders, grains, and refrigerated cargoes already exist. Containers are tough and inexpensive, being fabricated in large numbers from cheap steel components. They are fitted with universal hoisting and securing points on all eight corners. These fittings allow rapid,

automated attachment of a crane's lifting beam and also permit quick, rigid securing of containers to the deck of a ship, the bed of a rail car or truck chassis, and to other containers. Fully automated handling is possible when the containers are always situated at controlled locations, which can be achieved with rail-based systems. (The author was employed for several years by TAK Automation, one of the pioneers in automated container handling.

Repeatable precision of just a few millimeters can be achieved with rail-mounted systems, which is considerably better than required for reliable automated picking and spotting of containers. Auto-steering and positioning of rubber-tired vehicles is in some cases possible but is less robust.)

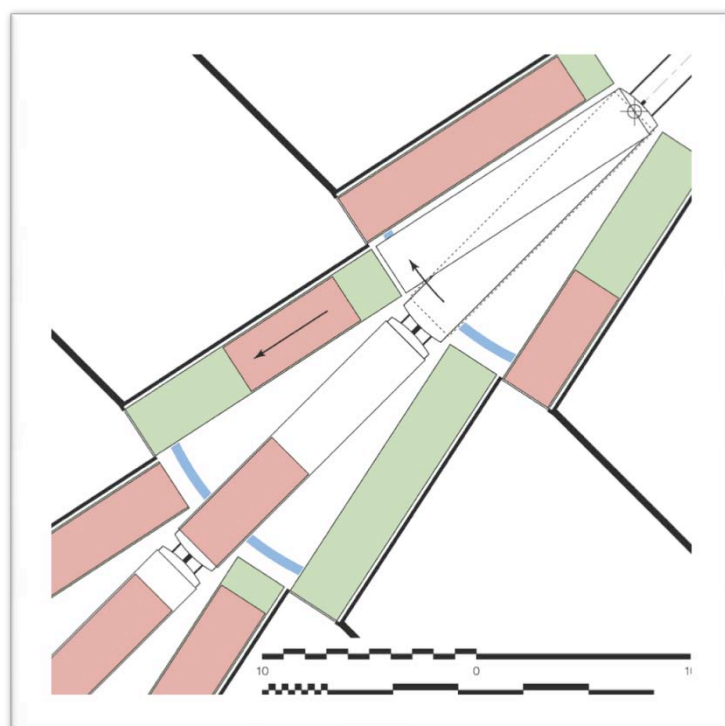
Following the overwhelming success of seaborne containerized freight, the method was also adopted for overland transport. Loaded containers are moved by road to the nearest intermodal facility, where they are set onto special rail cars for fast, cheap long-haul transport to another intermodal facility where final delivery by road is arranged. An intervening sea voyage is easily accommodated as needed.

Metro-Freight

The metro-freight proposal is central to the provision of good freight service in large, new carfree areas. Alternatives exist, and some are mentioned below, but none achieves all the benefits of metro-freight. The system is based on ISO containers and is capable of fully-automated operation. Chicago is the precedent for dedicated freight delivery systems that do not impinge on city streets (Perkins). Downtown Chicago is still honeycombed with narrow-gauge tracks far underground that once delivered much of that city's freight.

metro-freight line, where they are unloaded onto the docks. As the name implies, metro-freighters are adapted from standard metro vehicles already in wide use. The self-propelled metro-freight cars draw power from a third rail and need travel no faster than 70 km/h. Depending on capacity requirements, much lower speeds may be sufficient.

Fig. 1. Metro-freighters and container docks



Metro-freight rail lines run in an open cut, separated from the passenger rail system by about 20m. This arrangement permits the location of larger stores along the main street, with its high public exposure. The system delivers ISO containers onto loading docks adjoining the basements of all buildings abutting the metro-freight tracks. Heavy freight users would have a strong incentive to choose a location with direct metro-freight service, as it would be the fastest and cheapest way to ship and receive freight.

Specialised rail cars, "metro-freighters," deliver containers to loading docks along the

Every container entering the metro-freight system is first set onto a "roller frame" in one of the utility areas. These roller frames are the same size as the base of the container and about a meter high. They are latched onto the bottom of the container using the standard attachment points. Roller frames are fitted with pneumatic tires, small motors, batteries, and control equipment. They are self-propelled at walking speeds and can be controlled by one of two means. The principal means of control is automated equipment aboard a metro-freighter that controls the loading and unloading of a roller frame from that metro-freighter. Alternatively, a tow arm can be inserted into either end of the roller frame, allowing an operator to move it through the streets of the city by manipulating hand controls on the tow arm.

Containers with attached roller frames are then loaded onto metro-freighters in the utility areas. When a metro-freighter reaches the designated loading dock, it is stopped in precise alignment with the dock. The pivoting carriage on which the loaded roller frame rests is then swung out and aligned with the loading dock. The loaded roller frame hauls its container onto the loading dock, a simple structure with a smooth, flat surface the length of the longest container in use. The container doors (always found on the end of ISO containers) open into the basement of the building to which the

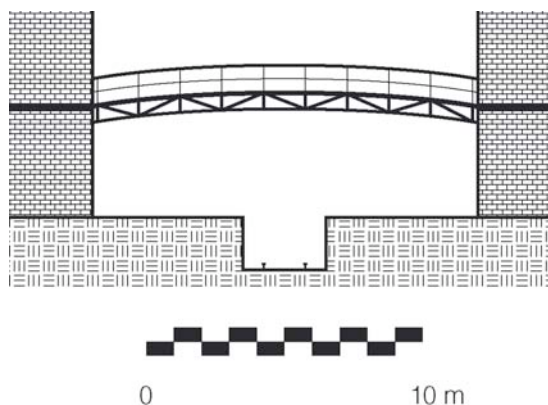
delivery is made, permitting direct unloading into the basement. The container floor and basement floor are at the same height.

Delivery by metro-freight confers several advantages compared to conventional trucking, including 1) low operating costs, 2) energy-efficient operation, 3) modest land requirements, 4) direct compatibility with ISO containers, and 5) low externalized costs such as noise and air pollution. The ultimate capacity of the proposed system is enormous, but this has scant effect on the basic system design: the construction of the right-of-way is the largest cost, and the anticipated volume of freight does not affect this cost. Bringing the system up to its ultimate capacity requires only the expansion of the intermodal facilities, the construction of additional loading docks, and the acquisition of more rolling stock.

When a container must be delivered to a location that lacks direct metro-freight access, it is first delivered to a district depot (see below), where a tow arm is inserted into its roller frame. An operator then pilots the container up a long ramp that passes through the district depot, onto the street, and to the consignee. The speed is limited to a fast walk, but the distances are no more than a few hundred meters, so speed is not important. However, most businesses with significant freight needs will locate along the metro-freight line, and delivery by roller frame should be rather infrequent.

Metro-freighters run in one direction only if the track can be arranged as a closed loop. Otherwise, the system reverses direction every few hours. This saves the large additional cost of a two-track system and allows a single track to serve buildings on either side of it.

Fig. 2. Metro-freight right-of-way cross section



The metro-freighters operate in a cut 14 meters wide (including the angled loading docks on both sides of the track). The cut is deep enough to permit loaded metro-freighters to pass beneath street-level bridges. This requires a cut 5 meters deep, less if low-floor metro-freight vehicles can be developed. Each loading dock occupies 14 linear meters of space on one side of the freight line. The system must not be accessible to passersby because of the third-rail power supply.

In small projects that may eventually see major expansion, we can establish the right-of way for a future metro-freight line and use it initially as a truck corridor. Because the metro-freight line runs in a cut, trucks moving along it impinge on the public only by their air pollution and noise.

Alternatives to Metro-Freight

A surface tram system could use excess capacity to move freight aboard specialized trams. In Porto, Portugal, around 1900, freight trams carried coal and fish over the same tracks used for passenger service (Museu do Carro Eléctrico). The practice has recently been revived in Dresden, Germany (Crawford, 2009 p 174). Passenger and freight service can probably be mixed except during the peak hour, when passengers may need full system capacity. This approach suffers from two drawbacks. First, unless the freight service runs only at night, it is likely to delay passenger service while the freight trams unload. This can be resolved by

providing sidings for freight tram unloading. Second, direct delivery to the recipient can only be arranged for some customers. All other locations require additional handling between arrival in the district and final delivery to the consignee, which would be accomplished using various arrangements for local handling of light freight as described below.

Fig. 3. Dresden freight tram



A significant barrier to adopting freight trams is the close spacing of tram tracks on most older systems--ISO containers are too wide to pass one another. Without extensive rebuilding, container service would be impossible.

In smaller carfree areas, the admission of trucks, usually during morning hours only, is routine today. Conventional trucks will often be used in early carfree projects. It may be feasible to arrange the district so that stores have a freight alley behind them, with the trucks following a route that does not

impinge too seriously on the otherwise carfree nature of the area.

Fig. 4. Truck on carfree street in Basel, Switzerland



Trucks are obtrusive, noisy, odiferous, and dangerous, and the number of trucks entering a carfree area should be kept as low as possible. Urban Consolidation Centers (UCC) have been built on the outskirts of a number of cities, such as Groningen, The Netherlands. At a UCC, trucks with partial loads deliver their cargoes, and full truckloads destined to the center city are then assembled, reducing the number of trucks entering the city (Browne et al).

In the 1920s in the USA, battery-powered delivery trucks were widely used, and this practice continues on a small scale in Europe today. Little stands in the way of extensive use of battery-powered local delivery trucks, especially given recent improvements in battery technology. These vehicles are simple if their required radius of action is short and top speeds are held to 50 km/h or less. Deliveries from load consolidation centers could readily be accomplished with such vehicles. If trucks are to be allowed in a carfree area at all, speed-limiting governors should be installed, set to 20 km/h.

Utility Areas

Utility areas are required to provide a location for activities that do not mix well with residences. As already mentioned, heavy industry, warehouses, freight handling facilities, and parking garages are relegated to utility areas. Wholesale food markets and distribution facilities are also located in the utility areas, where they have quick connections to both the global freight network and the metro-freight system. The utility areas need to be served by the passenger transport system, as many people will need access to them routinely.

Fig. 5. Utility area with battery-powered mini-trucks, Brig, Switzerland



The city of Brig, Switzerland, established a utility area on the north edge of the town, and no car or truck traffic is permitted beyond that point. Incoming cars park there (or in lots even farther away that are served by the train), and freight of all kinds is warehoused there. Distribution in Brig is accomplished by battery-powered vehicles that serve a number of functions depending on their configuration. Delivery truck and taxi are chief among them.

In a similar manner, the Reference Design calls for ISO containers to be transferred between rail, road, and water and the metro-freight system at intermodal terminals. Quite a number of containers reaching the utility

area will not need to enter the inhabited areas of the city at all, as their contents are destined for businesses located in the utility area itself.

Container service also demands a storage yard where containers can be stacked, large cranes that serve the entire yard, and direct access to all relevant freight modes. These same cranes load the metro-freight trains that deliver containers throughout the city. Bulk cargoes require containerization prior to delivery inside the city.

Arrangements for Local Delivery

Excepting full containers destined for a single consignee, all freight must be sorted and consolidated in the utility areas prior to delivery within a carfree city. Most of this freight is refrigerator-sized or smaller, so it is easy to handle. Several times a day, all the packages destined for a particular district are loaded into a container and shipped by metro-freight to a local freight depot, one of which is located on the metro-freight line near the center of each district. The district depot arranges local delivery of all freight other than containerized shipments delivered directly by metro-freight.

The mainstay of local delivery worldwide is some form of bicycle, often a rickshaw, or a handcart. There is some debate about the upper limit of loads for pedal-powered delivery vehicles, but 200 kg is practical. Above this, some form of battery power makes economic sense, owing to the increased productivity of the drivers. Modern freight bikes are lightweight, have flexible gearing, a low load platform, and high capacity. These bikes are comparatively expensive to purchase but cost hardly anything to use.

Fig. 6. Lightweight postal cart, Brig, Switzerland



simple devices, like this battery-powered postal vehicle in Brig, Switzerland, are adequate. It is equipped with a small motor and two ordinary car batteries. The postman controls direction with the tow arm, which also has simple controls for starting and stopping. No suspension beyond the pneumatic tires is provided. Battery-powered pallet movers, already in wide use, can move a tonne over the streets, provided the paving is smooth.

Freight logistics are simplified by the establishment of local concierge services that help nearby residents. Each concierge serves one or two blocks and operates from early morning until late evening. Several hundred households would support the service, so the cost per family can be held to moderate levels.

The concierge service functions in some ways as a local utility area, where bikes are stored, packages and mail sent and received, and groceries refrigerated until customer pickup. The concierge would rent ladders, tools, and specialized carts and bicycles. Short- and long-term storage would be offered.

People often need to take small- and medium-sized goods with them, and cars have made this task simple. In a carfree city, provisions must be made for people to move suitcase-sized objects, and preferably considerably larger items. The simplest solutions are the use of freight bikes and hand carts. In Venice, larger grocery purchases are usually hauled in lightweight, collapsible carts that require little storage space. The carts are large enough to haul a week's groceries for a small family.

Large items such as furniture are delivered via local stores located on the metro-freight line. A variety of handcarts, some possibly with battery assistance, is required to accommodate these deliveries. Light-weight handcarts can accommodate moderately bulky loads and are easy to push because they are equipped with good bearings and large-diameter wheels. Individuals can rent freight bikes or carts if they wish to perform final delivery themselves, or the district depot can arrange to deliver any goods residents who do not wish to handle themselves.

Fig. 7. Battery-powered package cart, Brig, Switzerland



Local freight that is too heavy or bulky for transport by freight bicycle will require some form of battery-assisted delivery. Quite

Fig. 8. Folding grocery carts, Venice



People need a means to move light freight and baggage from their home or office to vehicles parked in utility areas. If the freight in question fits onto a small hand cart, the owner can simply roll it aboard a metro or tram and ride with it to the utility area. In the case of larger quantities, the local freight depot collects the baggage and delivers it to a temporary storage area in the utility area. When the driver is ready, he drives to a loading zone where the goods are loaded into the car. This is perhaps the largest inconvenience that must be accepted in a carfree city.

Internal Freight

Freight must also move internally, within a carfree city. Some of this freight moves between one district and another, and some of it moves locally, within the same district. When moving freight between districts, the metro-freight system generally offers the best means, but other methods may occasionally be expedient, particularly when the two districts are in close proximity.

When a large shipment is moved between districts, the standard metro-freight system is used. If either or both the shipper and the consignee are located off the metro-freight system, a number of options arise. The freight can, of course, simply be loaded into a container atop a roller frame, towed to the district depot, shipped by metro-freight to

pot in the consignee's district, and moved to the consignee's doorstep. In involving large volumes of freight, this is probably the best approach. If the districts are close together, a loaded container can be towed from one district to the other, although this is slow, cumbersome, and adds to street traffic.

Freight bikes often provide the cheapest and most efficient means to move smaller shipments on flat terrain. When long distances are involved or hills intervene, the freight depot's package delivery service may offer a better solution. In this case, freight bikes move the shipment to and from the freight depots, and the package delivery system moves the shipment between the depots.

Special Cases

Trash collection is always a troublesome point, and one of two basic approaches can be adopted. Residents could bring their trash to a collection facility integrated into the district depot. Alternatively, wastes can be separated into bins at the concierge service, from whence it would be delivered to the depot for consolidation and transfer to processing facilities. Battery-powered trash trucks are already a common sight in Amsterdam, and such trucks could collect trash and deliver it to the district depot. Whatever means is chosen for collection, wastes are consolidated at the district depot into specialized containers for transport to disposal and recycling facilities.

The delivery of building materials is difficult. The last few decades have seen the extensive deployment of specialized, self-unloading trucks for bulky and heavy materials such as gypsum board, brick, and lumber. If each new district were built from the center out, then the blocks under construction would always lie on the outside edge of the district, permitting direct access by delivery trucks. These trucks could use the low-capacity road network (needed in any case for emergency vehicles and bicycle

travel between districts) to deliver materials directly to the construction site, which they would approach without travelling through inhabited parts of the district. After the initial round of construction, materials for renovation would be loaded into standard containers and delivered by metro-freight.

A family moving into a carfree city simply packs their belongings into a shipping container. The loaded container is delivered by rail or road to a utility area in the carfree city and thence by the usual metro-freight service. Local moves could be handled in the same way or by freight bike, a practice still common in Amsterdam.

Some types of street traffic may have to be tolerated (possibly only on the major streets). This includes moving vans, cranes, construction equipment, ready-mix concrete trucks, maintenance vehicles, emergency service vehicles, and local deliveries from the freight depot. The admission of these vehicles to city streets should be stringently regulated, and drivers specially licensed. Alternatives should be explored for each case. Speeds must be kept very low and battery-powered tugs used whenever possible. Ideally, these vehicles would travel as far as possible on the network of slow, narrow roads just outside the city before actually entering it.

Many tradesmen require immediate access to a heavier assortment of tools and parts than can readily be moved by human power alone, so cart-sized battery-powered vehicles must be permitted where their use is essential. The technology has existed for years: these vehicles are just modified electric golf carts. However, the convenience offered by these vehicles would exert a constant pressure to bring ever more of them onto the streets, and, despite their limited size and speed, they still impose a burden on other street users. Their use can be minimized by taxing them heavily, on the basis of length, width,

and annual mileage driven. Height needs to be restricted to about 1.4 meters, so that pedestrians can see over them. Speed must be limited to 15 km/h to ensure the safety of pedestrians and cyclists and to assure the continued livability of the carfree city.

Conclusion

It will be seen that arrangements for freight delivery in a carfree project will depend upon the project's size and that more ad hoc arrangements may be required in small projects. In large projects, specialized, dedicated freight systems can perform the brunt of the work, with carts and bicycles being used for the remainder. Standard ISO containers can be handled and indeed form the backbone of the system. A carfree city would thus be fully compatible with global containerization methods now widely used for all but bulk cargoes. Arrangements for freight handling can be made without significant adverse effects on the carfree nature of the area.

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