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Contents

This is an unusual and important issue of the journal. We are delighted to carry an article by Bruce Appleyard in the United Sates which is his introduction to a new edition of Livable Streets. Livable Streets by Donald Appleyard was published by the University of California Press in 1981 and is one of the most important transport texts to be published in the last 40 years. It immediately identifies the street as an important social milieu and an asset of the greatest importance for sociability, neighbourliness, friendliness and community life. Donald Appleyard made a huge leap forward leaving the tawdry world of transport economics, cost-benefit analysis, highway construction and foolish notions about higher car based mobility feeding higher quality of life well behind. It establishes a new paradigm and to the shame of most transport professionals and politicians making decisions on transport choices its message is diluted, misunderstood and ignored.

Donald Appleyard's book opens with the sentence: "Nearly everyone in the world lives on a street". He goes on to say that the book has two objectives:

- To explore what it is like to live on streets with different kinds of traffic
- To search for ways in which more streets can be made safe and livable

These two objectives capture a great deal of the spirit and purpose of World Transport Policy and Practice and the revised edition of Livable Streets will be warmly welcomed by everyone who lives on a street and would like to see life made better by celebrating the quality of those spaces rather than treating them as sewers for the rapid movement of lumps of metal.

This article is followed by a UK application of the Donald Appleyard methodology. Joshua Hart and Graham Parkhurst report on an original empirical application of "Livable Street" in Bristol and confirm the original findings about the negative impacts of traffic on sociability and conviviality and the need to assert a new transport paradigm that puts streets and human life at the top of the priority list and not somewhere below the level of a car driver speeding through a residential area to visit a gymnasium in order to keep fit.

Finally we have another major contribution from Peter Newman and Jeff Kenworthy. In this article they identify the concept of "peak car use" and speculate that "we may now be witnessing the demise of automobile dependence in cities". The authors identify the scale in decline of car use and discuss 6 possible reasons for the decline and its significance for the future of planning, engineering, urban design and financing. If this phenomenon is well established and can be relied on to continue through the next 30-40 years then we can confidently look forward to Donald Appleyard's human centred desires becoming a global reality and that will be something to celebrate.

Street Conflict, Power and Promise: *Livable Streets*: Humanising the Auto-Mobility Paradigm
A New Foreword for the Second Edition of Livable Streets
Bruce S. Appleyard, PhD

Donald Appleyard's seminal book "Livable Streets" was published in 1981 and in this article his son, Bruce Appleyard, has written an introduction to a new edition to be published by Longman in 2011. The introduction to the new edition is reproduced in full and puts into context the importance of the original work, the untimely death of Donald at the hands of a drunk driver in Athens and the stronger than ever relevance of the clarity and purpose of this celebration of the street and how to go about restoring streets to human beings.

Key Words: Appleyard, Livable Streets

Driven To Excess:
Impacts of Motor Vehicles on the Quality of Life of Residents of Three Streets in Bristol UK
Joshua Hart and Prof. Graham Parkhurst

This article reports an original empirical study carried out in Bristol (UK) modelled on Donald Appleyard's study published in the book "Livable Streets". The results confirm the findings of the original work by Donald Appleyard. Higher levels of motor vehicle traffic were found to have considerable negative impacts on the social and physical environment whilst residents identify numerous impacts on the psychological and practical aspects of quality of life. The authors go beyond the findings of negative impact and identify policies, measures and interventions that are capable of restoring streets to people. These include reduced numbers of parking spaces, modal shift in the direction of walking and cycling, "shared space" and 20mph/30kph speed limits in urban area

Key Words: Appleyard, Livable Streets, Bristol, street design, shared space, parking, walking and cycling

'Peak Car Use': Understanding the Demise of Automobile Dependence
Peter Newman and Jeff Kenworthy

This article identifies and discusses the concept of "peak car use". Car use is declining in the USA, UK, Australia and a range of other relatively wealthy counties. Data are presented and discussed, the decline in car use confirmed and six potential causes identified. The causes include growth in public transport use, hitting the Marchetti wall, reversal of urban sprawl, ageing of cities, growth in the culture of urbanism and a rise in fuel prices. The article concludes with a discussion of the implications of a decline in car use for traffic engineers, planners, urban financiers and urban economist and confidently asserts "the demise of automobile dependence".

Key Words: Peak car use, decline in vehicle kilometres of car use, urban sprawl, Marchetti, urbanism, fuel prices, traffic engineers, planners, financiers, urban economists, demise of automobile dependence

Street Conflict, Power and Promise:
Livable Streets: Humanising the Auto-Mobility Paradigm

A New Foreword for the Second Edition of Livable Streets

Bruce S. Appleyard, PhD

February 8, 2011

Foreword

On September 23, 1982, Donald Appleyard was killed by a speeding drunk driver in Athens, Greece. He was in the final phases of completing his book on environmental symbolism, urban identity, power and place. It remains unpublished. A year earlier, in 1981, the first edition of *Livable Streets* was published, a groundbreaking and seminal work, the product of more than a decade of rigorous research and exceptionally thoughtful analysis. My father's untimely death at 54 was not only extremely painful for me and my family—I was seventeen at the time—It was also a devastating loss for those concerned with the design, planning and engineering of our streets, as well as the "thousands of people who may not have known him but whose environments and lives are more joyful and satisfying because he helped plan them – humanely."[1]

The tragic irony of Donald Appleyard's death by an automobile and the reckless actions of its driver (the only one to survive the crash) underscores central questions raised in *Livable Streets*—Had the drive to accommodate cars and trucks on city streets gone too far? Had the objective been overshot, allowing automobiles to take over neighbourhood streets with menacingly lethal indifference?

Now, as then, automobile encroachment of neighbourhood streets is skyrocketing around the world, especially in our most populous countries (e.g., China, India, and Indonesia). Thus the questions raised by *Livable Streets* are as relevant today, if not more so, as when they were first published in 1981.

Although struck down by an automobile, my father, in a remarkable stroke of phoenix-like prescience, left us with a guidebook to find our way back: to recapture our streets for our communities; to recreate and preserve them as enriching and joyful places for residents and travellers alike—a greater vision than what they had merely become—conduits for traffic, shaped upon the principles of fluid dynamics guiding the design and operation of water and sewer systems—the primary goal being to efficiently flow water and waste down a pipe.[2] The "pipes" in this case, however, were the most accessible venues for people to socialise and build social capital, engage in physical activity and learn about the world, as well as find peace, respite and rejuvenation from their daily lives—our neighbourhood streets.

My father was gone, but he left us with rich insight, guidance and, perhaps most importantly, a promising vision and inspiration for us to recapture our streets for our communities. Although struck down by an automobile at the hands of a reckless driver, my father's spirit lives on through *Livable Streets* to have a final word.

[1] Memoriam written for Donald Appleyard by Jacobs, Cooper-Marcus and Dickert in 1982

[2] Peter Norton (2005) Fighting Traffic, outlines how local water and sewage agencies were the first to take over the operations of city streets, adhering the principles of fluid dynamics to such things as how signals worked, where signs were placed, resulting in campaigns to keep pedestrians out of the streets entirely!

The Importance of *Livable Streets*

Livable Streets was and is a phenomenological masterpiece as it builds on my father's collective insights emerging from his in-depth analysis of the effects of the automobile and traffic on people's lives, clarifying ideas about how we should research, understand, and respond to unliveable conditions.[3]

Looking back over the decades and reflecting on the legacy of *Livable Streets*, University of California Professor Randolph Hester said "it was perhaps the most influential urban design book of its time." In 2009, *Livable Streets* was featured in JAPA as one of the most influential planning books of its own 100 year history, which I was co-author alongside Reid Ewing. In his first draft sent to me, Reid began the article stating the following:

"Donald Appleyard was one of the giants of the urban planning field, at a time when the field produced giants. While other work of Donald's influenced our careers... none had more influence on us and others than *Livable Streets*."

Furthermore, according to J.H. Crawford, Author of *Carfree Cities*:

"It was Donald Appleyard's *Livable Streets* that finally pushed the button. Appleyard…laid out the social effects of cars on cities in glaring detail, using the best social-network-analysis methods available. The book is simply an indictment of the effects of street traffic on the fabric of urban neighbourhoods."

And finally, C. Kenneth Orski sums up the significance *Livable Streets* gave towards research and practical guidance of the design and operation of our streets and cities when he says:

"Appleyard tells us exactly what is wrong with city streets and how to make small changes that will get big results"

Livable Streets was written in the progressive voice of the 1960s and 1970s, pointing out an injustice and presenting ways to right them; to improve the world; to fight for equality in our city's most accessible public spaces—our streets.[4]

In sum, *Livable Streets* provided the most compelling evidence-based arguments for why we should control the volume, and especially the speed, of cars on our streets. While there may be many reasons for the enduring legacy of *Livable Streets* and the work of Donald Appleyard, one reason emerges over all others—*Livable Streets* uncovered, articulated and perhaps more importantly, pictured the emerging conflict in our streets between traffic and people—a power struggle that was felt by many, but until *Livable Streets,* was not fully understood, let alone clearly imagined or pictured. *Livable Streets* forever transformed the theoretical and methodological paradigms of how professionals address the design and use and promise of our streets. And while many professionals may still place

[3] While the first edition argued for a national policy on street liveability, only in the last few years has a unified support and articulation of liveability in transportation emerged. And still there is a need to clarify how liveability goals should be applied to guide policy. As Donald Appleyard presents the most comprehensive and insightful analysis of liveability in general, many lessons and insights can be provided toward guiding the current national dialogue on liveability, which I present in the final sections of this Second Edition.

[4] Streets are still important today for social transformation. As I was finishing my work on this Second Edition, I was struck by the theme and title of a February 2, 2011 article by Anthony Shadid highlighting the continuing importance of our streets for social change, "*Street Battle Over the Arab Future*". Where he states "CAIRO — The future of the Arab world, perched between revolt and the contempt of a crumbling order, was fought for in the streets of downtown Cairo on Wednesday."

a priority on mobility and increasing vehicle throughput over liveability, whether unwittingly or on purpose, they do so with caution because of the multitude of the work of those who have built on the foundations provided by *Livable Streets,* furthering its legacy, allowing my father's spirit, passion and purpose to recreate our streets as joyful and enriching places to live on and in.

The Audience

Livable Streets is more than a book for planners and engineers. It is also for psychologists, sociologists, and anyone interested in people's satisfaction with their daily lives—as revealed through their behaviour, as much as by their statements when asked. This in-depth probing and analysis conducted by my father of quality of life satisfaction, or liveability, is important to recognise, as my father uncovered a critical phenomenon of human behaviour—our exceptional ability in the presence of poor environmental conditions to adapt, and actually sublimate the impacts. For example, he found that traffic drives people to retreat deeper into the shelter of their homes, eventually accepting and ignoring the negative impacts of traffic on their streets, let alone the loss of valuable, accessible public, community space. Thus he spoke to our need, as people working in the public interest, to develop skills of observation to recognise problems that exist, even if they are not yet recognised by those affected. In sum, through his research he revealed a suppressed injustice that literally pushed people away from their streets, while telling them "Things could be better!" —a core justification for engaging in exercises of planning and urban design.

Also, there is much more to the book than what most people have often cited — few seem to realise that the graphics most often cited are actually from what my father considered "a simple pilot study" when in fact the book contains phenomenological insights from my father's study of a diverse spectrum of streets ranging in context, traffic levels, streetscape, socio-demographic characteristics, etc.

Livable Streets also presents a prescient analysis of social networking. While many may think of "social networking" as a new term, *Livable Streets* establishes the importance of this important quality of the human experience.[5]

There is still an enormous amount of work to be done. Not only in retrofitting and completing our streets to be more liveable in the developed economies, but especially in emerging economies such as China, India and Indonesia where neighbourhood encroachment by cars is increasing at an alarmingly accelerating pace. The insights of *Livable Streets* can help us understand the power struggle and conflict playing out in these streets, while also giving us insight, guidance and inspiration for the promise that these streets can play in fostering enriching and rejuvenating joy in people's everyday lives.

> *Projections of future traffic fatalities suggest that the global road death toll will grow significantly, but at divergent rates between the developed and developing economies. By 2020, there is likely to be a decline in fatalities in high-income countries (down approximately 28%), versus an increase in fatalities of almost 92% in China and 147% in India.*

[5] The research methods presented in *Livable Streets* is now being considered to provide a model for how we study web-based social networking. Indeed many images used by Facebook and Google to represent their global networking activity are similar to the graphics in *Livable Streets*.

Furthermore, the road death rate in developing economies by 2020 (approximately 2 per 10,000 persons) is projected to be twice the rate of high-income countries, less than 1 per 10,000 (Kopits and Cropper 2005).[6]

Furthermore, looking more closely at car-related fatalities in China, the World Health Organisation estimates that more than 600 lives are lost and more than 45,000 people are injured on China's roads every day. Traffic incursion on neighbourhood liveability, as described and addressed in Livable Streets, will only become increasingly important, now and in the years to come. The per-capita car ownership ratio in China is about 40 cars for every 1,000 citizens (2010). To put into context the amount in which car ownership rates can grow in China, the US has about 765 vehicles per 1,000 (2002), and Europe has an average of about 300 vehicles per 1,000! Furthermore, by 2017 China is projected to become the world largest market for motor vehicle sales, surpassing the United States. Within the next quarter century, China is projected to reach an ownership rate of close to 380, and India around 140 per thousand.

Finally, according to the WHO report, China represents just a part of a global epidemic of road traffic accidents that accounts for the deaths of some 1.2 million men, women, and children each year." Unless some action is taken, the organisation estimates that China will have half a million deaths each year by 2020.[7]

Braided Threads of Events

As a UC Berkeley professor passionate about his work which focused on the well-being of children and families, our family and work activities were often combined. Many of our summer travels followed his work, taking us to fascinating places where he would often share with us his interests and ask us about ours. I realize now that he was trying to understand how we, as children and teenagers, perceived the world. At home he would continue this line of inquiry in various ways such as bringing his grad students to our classes to conduct cognitive mapping exercises where we would draw maps of our neighbourhoods and our journey's to and from school. These early memories would later inspire me to conduct similar research resulting the article "Livable Streets for *Schoolchildren*", written for the National Centre for Bicycling and Walking (www.bikewalk.org) which, among other things, examines the liveability impacts of traffic exposure exacerbated by inadequate pedestrian and bicycle infrastructure on children during their journeys to school (parts of which are featured in Part 3 of this Second Edition of *Livable Streets*).[8]

[6] Kopits, Elizabeth and Cropper, Maureen, 2005. Traffic fatalities and economic growth. Accident Analysis & Prevention 37 (1):169-178.

[7] http://www.who.int/violence_injury_prevention/publications/road_traffic/world_report/main_messages_en.pdf

[8] Central research within this work combined the liveability research approaches of my father with the image/cognitive mapping methods of Kevin Lynch. In brief, I asked the elementary school kids to sketch maps of their neighbourhood to better understand their views of neighbourhood walkability, asking them to also mark the location of their home, school, friends' houses, danger zones and places they liked to play. Comparing their maps with those of children in other neighbourhoods who were exposed to lighter levels of traffic, I was able to illustrate the necessary improvements for increasing walkability and neighbourhood liveability. I then worked with the neighbourhood to receive a grant to build paths and improve crosswalks along the busiest, most dangerous streets leading to the elementary school.

After my father's sudden death, *Livable Streets* served as lasting touchstone for me. While one might look to diaries or letters of lost loved ones, I additionally had a book filled with my father's caring expressions of concern for the welfare of children. As I pored through my father's work, I began to realise that he had actually been inspired by critical events in my own life.

One day as I was working on this second edition I contacted one of the engineers my father worked with, Daniel T. Smith, about including some of their joint research. Early in the conversation he asked me, "were you the son who was hit by a car?" I was.

You see, around the time my father first starting working on his *Livable Streets* research, I was hit by a car and nearly killed—I was 4-years old.

Thus, my father's expression throughout *Livable Streets* of the need for us to care about children's safety was not a rhetorical exercise. Nor is my understanding of what it means to be traumatically hit by a car. And while both our passions and purposes for working on street safety and liveability run deep, we should all be dedicated to following my father's example of even-handed, thoughtful and intellectually honest analyses regarding the subject. Considering he nearly lost his four year-old son, he deserves praise for never letting that experience overshadow his scholarship. Nevertheless, it is clear that this experience deeply affected and motivated him and his passionate work toward reforming the manner in which we design our streets to improve the welfare of children around the world.

It has been said that people who go into planning are answering a calling of some sort. For me, more than a "calling", but a deep well of purpose and passion was unleashed by particular events and people.

A key catalyst for me was a former student of my father's, Nick Bevilacqua, PhD, who lived with his wife and two children in a suburban neighbourhood near Walnut Creek, CA. In 1992 Nick asked me to help him and his neighbours deal with a dangerous traffic situation prohibiting children from safely walking or bicycling to their school, and ending his request for my help by saying "your father would understand." Like many of the former students and colleagues of my father I have been fortunate to encounter, I could see a glimmer in his eyes reflecting fond memories of my father who, as a teacher, colleague and father, treated those around him well.[9] How could I refuse?

Over the next several years, I volunteered my time working throughout numerous suburban neighbourhoods on a comprehensive range of issues including an in-depth analysis of the nature of critical problems now commonly understood as part of the Safe Routes to School movement.[10] Many evenings, Nick and I walked through these neighbourhoods discussing the challenges of achieving street liveability and how my father would address such problems. Sadly, these conversations were quickly extinguished as Nick was also taken from us too soon.

[9] These experiences taught me important lessons about how one's spirit lives on in others long past the time they leave this earth. Along these lines, it also showed me the importance of the "golden rule" and the need to treat people fairly, with thoughtfulness and grace. After a long life in and around the academy, I have found that these qualities are not always present in faculty. Another thing I have also learned is the academy, unlike any other institution, has a long memory. Although my siblings and I lost our father at a young age, he left us with a rich legacy of his kindness and goodwill.

[10] I also researched how and why these suburban neighbourhoods were designed the way they were, conducted my own studies on the negative effects of traffic on schoolchildren as they walked to school, and much more.

Unbeknownst to me when I agreed to help him, Nick had been diagnosed with a terminal form of cancer and was only given a short time to live. He died in the spring of 1994. At his funeral, I was told that our work, which included analysing neighbourhood problems, working with the community and public agencies to secure funds to improve connections to two schools along one of the most dangerous streets in their neighbourhood had extended his life well beyond initial predictions.

After that day, I said, "enough"! Two people close to me, who had dedicated themselves to creating better places for our communities had been taken from us — "at the height of their powers"[11]— and there was still much more work to be done!

Ever since, I have not only carried with me a strong passion and purpose toward working in the field of planning and urban design to, as my father would say, "do something you find fulfilling and makes the world a better place," but to constantly examine and overcome the barriers (institutional, financial, cultural) in the way of implementing the promising vision laid out by my father in *Livable Streets.*

Soon thereafter I applied to and attended the Masters in City Planning program at UC Berkeley where much of my master's work focused on a broad range of issues, obstacles and solutions associated with grassroots community action to retrofit suburban streets, culminating in my professional report, "Retrofitting Auto-Suburbia: A Community guide to overcoming Auto-domination".

Recently I finished my PhD in City & Regional Planning at UC Berkeley, where I combined the richness of urban design research approaches with rigorous empirical methods to better understand how urban environments influence the use of green and active modes (walking and bicycling). One of my next projects will be to complete the unpublished manuscript my father was working on when he was killed *Identity, Power, and Place*. For now, it is an honour to present to you the Second Edition of my father's *Livable Streets*. Work that continues to be as relevant today as when it was first published.

Bruce S. Appleyard, PhD

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Trauma and Tragedy: The Inspiration and Eclipse of Livable Streets

To this day, I cannot sit down and bring to memory the precise details of the event that changed my life. Yet every so often my childhood slumber would be shattered by the vision of a towering wall of the most unimaginably alien material to my flesh and bones, suddenly rolling over my right shoulder -- mangling and tossing me with indifference—a nightmare so terrifying I would struggle to awaken— to escape. Erased from my conscious memory, the terror lurked in the shadows of my childhood.

It was only in my twenties, when the nightmares finally stopped, that I realised this must have been the car that nearly killed me when I was four years old in 1969. At that time our

[11] Professor Fred Collignon's letter to students, faculty and staff of the College of Environmental Design at UC Berkeley informing them of my Father's death.

father began his rigorous and seminal research on the negative effects of cars on people, streets and communities, culminating in the publication of Livable Streets in 1981.

About a year after its publication, on September 23, 1982, our Dad was sadly killed by a speeding drunk driver who flipped over a median in Athens, Greece—crushing him.

And so it goes—a man's work that has for decades served as a beacon for recapturing the liveability of our streets was in fact both inspired and yet, in tragic irony, eclipsed by two traumatic car crashes that tore at a family, their friends and colleagues.

Bruce, one of Donald and Sheila Appleyard's Four Children.

We all dearly love and miss him, and will forever rekindle his joyful, enriching spirit for our children, partners and friends.

Driven To Excess: Impacts of Motor Vehicles on the Quality of Life of Residents of Three Streets in Bristol UK

Joshua Hart and Prof. Graham Parkhurst

"The Automobile, satisfier of private needs, demands, and whims — has created an insatiable demand for access, and a whole profession of planners and engineers both serving and further stimulating that demand."

Donald Appleyard, "Streets Can Kill Cities: Third World Beware!" (Appleyard, 1980)

Introduction

The use of motor vehicles in most urban areas of the world has reached such ubiquity and intensity that few citizens are fully aware of the extent of detriment they cause to quality of life. Nonetheless, a study conducted in spring 2008 in Bristol, UK, attempted to understand residents' perceptions of the impacts of motor traffic on their homes and streets, and on individual and community health. On streets with moderate to heavy motor traffic, our research found significant erosion of social capital, and widespread discontent from residents about the health and safety impacts of car traffic on their street. The results provide renewed focus on a debate about urban traffic and quality of life that has intensified as motor vehicle numbers - and their impacts - have increased.

The study methodology replicates the work of Donald Appleyard (1969), who demonstrated that people living on a street with relatively heavy traffic had only one-third as many social connections as people living on a relatively light-traffic street. Subsequent studies investigated street design, traffic, and neighbourhood quality of life; work that culminated with the publication of the seminal work *Livable Streets* (Appleyard, 1981). *Livable Streets* revealed the social impacts of motor traffic in fine detail through interviews and street observations, demonstrating that casual conversations, children's play, and other street-based social life tend to be suppressed, particularly as vehicle volumes and speeds increase. Appleyard's findings provided a quantitative case for policymakers to consider the social impacts of current transport policies. Figure 1 reproduces the iconic diagram of the original study, which visually represents the erosion of social interaction as traffic volumes increase. (Appleyard, 1969)

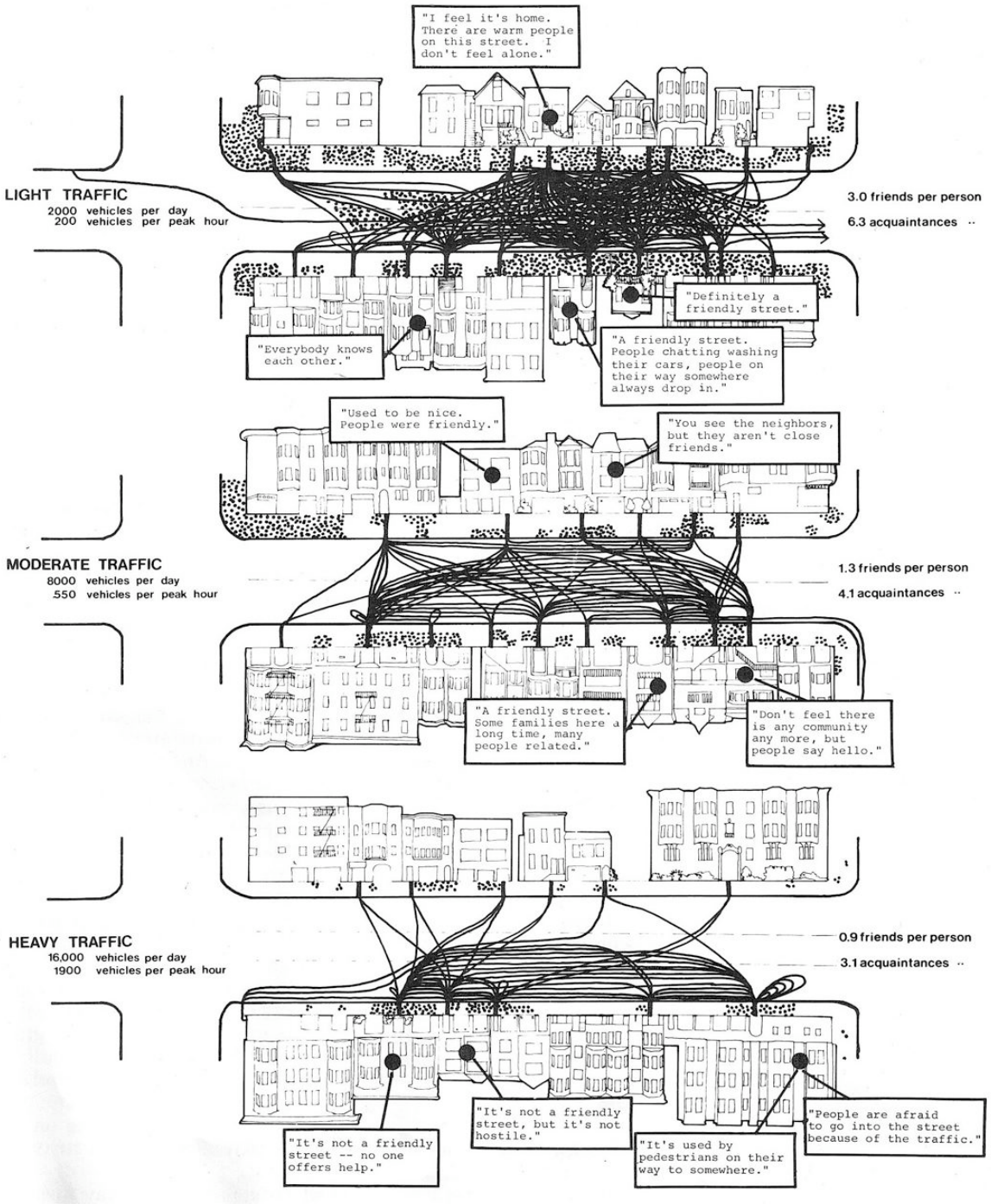
The present article begins by making the case that there was a timely need for a 21st Century replication of Appleyard's original work, due to the changing sociocultural and transport conditions over the intervening decades. There was also a need for contemporary research into the impacts of motor vehicle traffic on neighbourhoods outside of the United States. Section 2 examines the evidence of social and environmental damage and deterioration of public health associated with motor vehicle dependence. Section 3 briefly introduces the methodology and the data collection procedures. Section 4 initiates presentation of the findings, considering qualitative data about life in the streets and including perceptions about 'home territories'. These are followed by quantitative analysis of the relative numbers of friends and acquaintances reported by the

participants. A final discussion section reviews the extent to which the tools necessary to address the problems identified already exist.

Figure 1: Appleyard's (1969) diagram of intra-street social connections. Lines represent specific social connections whilst dots identify where people were reported to gather.

Appleyard's Thesis Revisited

Since Appleyard's contributions, both vehicle ownership and traffic have continued to rise: for example doubling in the UK since 1980 (Figure 2). However, vehicle-specific emissions performance has improved considerably since the 1960s, whilst building design and



adaptation have become more defensive with respect to vehicle impacts, through the orientation of residential buildings away from the carriageway and double or even triple glazing fitted as standard.

With many more car owners and users, it might be argued that the costs and benefits of motorisation are more evenly distributed, and so perhaps more readily accepted.

Additionally, with the delocalisation of community, including due to the rise of online communities, there may be less local connectivity and street interaction to be affected by traffic in the first place.

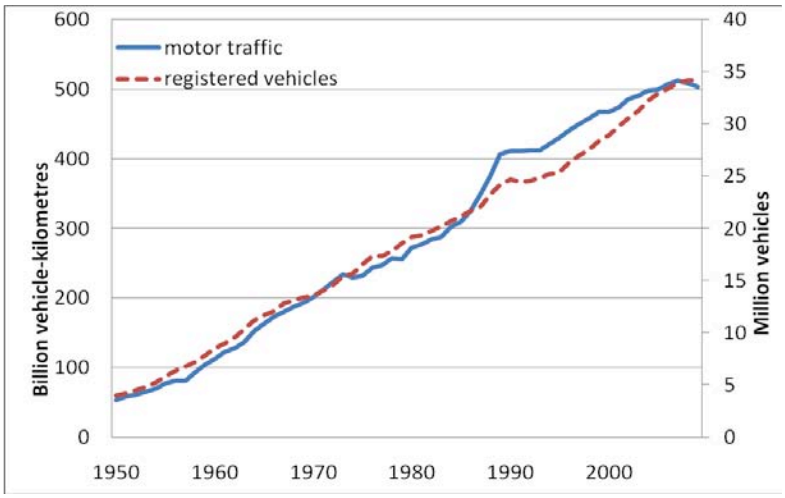


Figure 2: Increase in car ownership and distance travelled, UK 1950-2009
Data source: UK Department for Transport (2011)

The surge in motor traffic has been accompanied by ongoing documentation and analysis by academics and environmental and health agencies concerning the widespread impacts of the consequences of motorisation. In part these initiatives indicate that long-established problems continue to be significant, and at the same time novel areas of concern have emerged. Research into these impacts falls into seven inter-related categories: accessibility, noise, toxic pollution, climate change, traffic danger, physical inactivity, and social degradation, which are briefly summarised here.

The scientific basis of climatic variation was well established by the 1970s. However, that there is a real threat of catastrophic interference in the global climate system in the next years and decades if humans continue to emit CO_2 and other climate change gases at current rates has only gained (near) consensus in more recent years (e.g. Hansen et al., 2008). Future impacts are likely to include melting ice caps and glaciers, rising sea levels, spread of drought, malnutrition, disease, and extreme weather events, many of which may appear in a manner that is abrupt or irreversible (IPCC, 2007). For many, future climate change impacts are somewhat disconnected from the immediate and local decision to drive. Nevertheless, cars continue to be a significant source of greenhouse gases. For instance, California's motor vehicles alone emit well over 100 million metric tons of CO_2 annually (California Air Resources Board, 2004).

In contrast, poor urban air quality is fundamentally local in character, and motor traffic is the primary cause; polluting in areas close to where people live and breathe (Duhme et al., 1996). Scientific and medical knowledge has developed significantly since the emergence of traffic-related smogs, with global estimates suggesting that air pollution affects more than 1.5 billion people (Satterthwaite, 1999) and causes over 2.4 million premature deaths annually (WHO, 2002). Motor traffic is also considered to be one of the most

significant causes of non-point source water pollution, which has eroded water quality in rivers, lakes, and streams particularly in urbanised areas (Litman, 2010).

Similarly, awareness of the range and extent of health and quality of life effects of exposure to excessive and/or prolonged noise has developed. However, noise pollution generally receives much less attention than air pollution and crashes when the environmental effects of transport schemes are assessed. Traffic noise has been identified as causing annoyance, cognitive performance degradation, hearing loss, and sleep deprivation, and is implicated in heart disease, depression and hypertension (Simpson, 2007). Traffic-related sleep disturbances are also linked with increased child pedestrian casualties (WHO, 2005).

Greater car ownership has in general improved accessibility for those able and willing to travel by car; expanding road networks and the associated infrastructure have allowed for unprecedented personal mobility. However, expanding mobility for car owners has led to a diminishing level of accessibility for those using other means of travel than a car (Litman, 2003). Even for car travellers, what was once an accessibility benefit tends to become a mobility necessity as facilities are centralised as part of an ongoing shift of transport costs from producer to consumer.

Globally, road crashes kill or seriously injure at least 50 million people every year (WHO, 2004). The fear of being killed or injured by a motor vehicle is also one of the primary factors preventing greater use of active travel, particularly among children. Vehicle speed is strongly associated with pedestrian fatality rates in a collision, with a large increase in injuries and fatalities occurring where the vehicle speed prior to collision was above 20mph. And whilst comparatively few individuals may be directly affected by serious collisions, public health in general has seen a significant decline along with the growth of sedentary lifestyles, fuelled by an aversion to walking or cycling through car-oriented areas. The obesity/inactivity pandemic is associated with increased rates of stroke, heart attack, certain cancers, diabetes, and depression (Sallis et al., 2004). In the US, 70% of the population fails to meet minimum recommended physical activity rates (USDHHS, 2000); a deficiency that leads to over $77 billion per year in avoidable hospital costs (Pratt et al., 2000).

Lastly, but with great importance for the current study, healthy social networks are not only crucial to happiness and quality of life, they also defend against multiple forms of mortality: “over the last 20 years more than a dozen large studies have shown that people who are socially disconnected are between 2 and 5 times more likely to die from all causes, compared with matched individuals who have close ties with family, friends, and the community” (Putnam, 2000 cited in Leyden, 2003).

Given the salience of the topic at hand, and the growing importance of Appleyard’s original research in light of the ongoing environmental crisis, a number of follow-up studies have been undertaken in the intervening decades. Three were identified during a literature review as representing close replications of the original methodology. An unpublished paper produced for a research methods class of the University of California at Berkeley (Patterson et al., 1988) reports a study that involved a group of graduate students returning to the same San

Francisco streets studies by Appleyard. They found similar results: the busier streets had less developed social networks and abbreviated areas of personal territory compared to streets with fewer motor vehicles.

A decade later, in a study titled 'Livable Streets Revisited', Bosselmann and MacDonald (1997) sought to determine the social and environmental impacts of normal heavily trafficked roads compared with boulevards (with local residential streets paralleling the main carriageway on either side). The results confirmed Appleyard's findings that "heavy traffic is associated with a withdrawal from the physical environment". Despite having very heavy levels of traffic (about 45,000 vehicles/day), residents living along a boulevard designed with side streets recorded lower levels of irritation with the negative effects of traffic, showing that boulevard designs may at least partially mitigate the worst effects of heavy traffic.

Most recently, a study was undertaken in New York City by the pedestrian, bicycle, and public transit advocacy organisation Transportation Alternatives (2006). The researchers used a corps of volunteers to conduct 600 door-to-door interviews in four neighbourhoods over the course of a year. Compared with the initial Appleyard study, they selected streets with significantly lower traffic volumes; with low, medium, and high traffic streets having less than 1,000, 2-3,000, and 5,000 motor vehicles per day respectively. Nonetheless, the findings echoed Appleyard, with those on the highest-traffic streets found to hold more negative views of their block, reporting more interruptions of sleep, meals, and conversations, and spending significantly less time walking, shopping, and playing with their children.

However, it was notable that all three of these studies were carried out in the US, which has both a specific built environment context and a particular culture of car dependence. The authors were interested to examine whether similar findings would be produced through a replication of the study in a typical British city, nearly four decades after the original.

Data Collection

The urban location for the study was Bristol, a city of 520,000 inhabitants located in Southwest England, UK. In the UK context, Bristol is fairly typical of the large urban areas outside London, although with the lowest traffic speeds of this group (and so by implication the greatest congestion) and a public transport modal share of less than 15%, it is arguably the most car dependent of the major urban areas. However, for the purposes of the replication, what was more important than the choice of city was the selection of the specific residential streets for study. Three residential streets in the north of the city were identified as being very similar apart from the volumes of motor traffic passing through them (Table 1). Two were through-routes providing for local and cross-city movements, whilst the third had originally been constructed with a similar carriageway width fit for the same function but the street was never adopted for this purpose, remaining a cul-de-sac at the south end. As a result it has a much lower traffic volume. All three streets are lined on both sides principally with late 19th and early 20th Century family dwelling houses of two or three storeys in height, mostly in terraces but with some semi-detached (adjoined pairs). Most of the properties are set back about 5m from the carriageway, with small private front gardens and larger gardens to the rear. They were generally constructed without

off-street parking, and most car parking therefore occurs on the street, although some off-street parking has been retrofitted, generally through the conversion of front gardens to paved driveways. The streets are hence very typical of the pre-war housing that makes up a significant part of the UK residential stock.

Table 1 Three Bristol UK streets selected for study

Street	Category	Traffic Volume
Dovercourt Road	Light	140 motor vehicles/day
Filton Avenue	Medium	8,420 motor vehicles/day
Muller Road	Heavy	21,130 motor vehicles/day

Twenty households on each street were interviewed face-to-face about their street, social ties, and views about traffic. Like the original Appleyard study, residents were told that this was a general study about neighbourhood life and how it could be improved.

Residents' Views about their Streets

Photo. 1: Light Street (140 vehicles/ day)

From physical appearance alone, the light street (Photo. 1) was very similar to the medium and heavy streets. From the 20 interviews with residents, it emerged as a closely-knit community. A majority (13 out of 20) described the street in positive social terms. "(Light street) is a friendly street - most people know other people," said a 49-year-old woman, and "good communication between houses, togetherness" was proffered by a 15-year-old boy. Especially the elderly residents felt supported and cared for: a 70-year-old woman who lived alone remarked that, "people on the street have always helped each other in times of illness and difficulty." Another older lady living alone felt lucky to live on such a street where "everyone's kind, thoughtful, helpful, and really lovely to me. When my next door neighbour hasn't seen me for a few days, he knocks just to see if I'm okay…. there are more families here - people who stay for a while and put down roots. We share plants and look after each other. There is really a sense of community."

Of course, the street, just like any other, has its problems. Many of the older generation lamented the deterioration of the street's social life, in spite of the fact that most of them still had quite a few friends and acquaintances nearby. A man who had lived on the street for 42 years said that "people don't talk in the street as much as they used to. Everyone here used to know each other. We used to sit on the wall and chat - there would be 4 or 5 of us - those in their 60s would chat with those in their 30s. I haven't seen that since the 1980s." This kind of intergenerational socialising that is essential to healthy communities (Benson, 2002) was often centred around the minding of children who would play in the street, an activity that still occurred, but far less frequently than before. One resident intimated why: "when our kids were small, they were always in the street - there were fewer cars then."

One older lady seemed to recognise the addictive properties of the car: “I’m glad that I didn’t get a car because I’d be dependent on it now. *Some of my friends would rather go without food than give up their car*. I value my independence too much.”

Even on one of the quietest streets in Bristol, with only about 140 vehicles per day, the occasional speeding car was enough to create the perception of a potentially dangerous environment and prevent children from playing in the street. In a knock-on effect, this also prevented adults (who would not then be minding their children while they were playing) from socialising in the street. The occasional fast traffic was also the most frequently cited cause of stress. A single mother of a young child said that “a few cars come very quickly and threaten people in the street. I am constantly worried that my two-year-old will dart out at the wrong time.”

In summary, light street emerged as a community where people were relatively content with the local environment and their neighbours: a street with a healthy social life and a lower incidence of reported stress than the other two streets, apparently with a support network that could be relied upon during ‘rough times’.

Plate 2: Medium Street (8420 vehicles/day)

Filton Avenue (Medium Street, Photo. 2) is a moderately-busy residential distributor road providing access to major employment and retail centres in the city centre to the south and major peripheral commercial zones to the north of the city. Many seemed to realise that the traffic was undermining the social life of the street. An elderly couple, who had lived in their house for 48 years, said that medium street is “not very neighbourly or friendly because you’re on a main road.”

The oldest inhabitant interviewed on medium street was a 91-year-old man who had been living in the same house for 81 years. When asked to describe his street he said “traffic is really the main thing - life has changed tremendously because of the car. Neighbours don’t see each other like they used to, because people get out of their front door, get in the car, and vice versa when they get home.” A single woman in her twenties described medium street as being “busy in terms of the traffic, quite impersonal - part of the busyness means that it doesn’t feel much like a community place.” One older woman even went as far as to say that “if you were to die here, nobody would know.”

One mother on medium street said that she actively discouraged her children from forming friendships across the street, in order to avoid crossing the busy road on a regular basis - evidence that traffic flows can hinder the development of social networks. Whilst this may be an extreme example of such a mechanism, it may be indicative of the more general underlying attitudes and beliefs about traffic dominance.

Yet despite the bleak reality of a neighbourhood impacted by the noise and fumes of traffic, many of the residents expressed an appreciation of their neighbours and a desire to see a more fully-fledged community develop. A single woman in her thirties said that "we need to be a bit more friendly on this street - it's important to know your neighbours."

Heavy street (Muller Road, Photo. 3) links at its southeastern end directly to a junction of Bristol's urban motorway spur from the national motorway network. At its northwest terminus it joins an arterial road linking the city centre with more peripheral northern suburbs.

Photo. 3: Heavy Street (21,130 vehicles/ day)

The dominant picture that emerged of heavy street from the interviews was that of a street where residents largely 'keep to themselves', and have arranged their lives in such a way as to minimise the primary source of stress on their street, which they identified, more than any other cause, as the heavy vehicular traffic (14 out of 20 households).

Although several residents mentioned their "friendly neighbours" and two residents said that they "swap Christmas presents, and often have meals together," more often than not these friends and/or acquaintances were located in close proximity to the interviewee's home, and only rarely across the street. More residents expressed negative observations about the street than positive.

A middle-aged man living alone described heavy street traffic as a "mountain range, cutting you off from the other side of the road." He described the street environment almost like a war zone: "The street is hellishly busy….it's a bloody nightmare. The buses and lorries shake the house when they come by. The air pollution can be quite bad out the front, sometimes during rush hour you feel the air getting thicker and thicker." He went on to say that "people have moved out because of the traffic." Over half of those interviewed reported spending more time in the back of the house due to traffic noise.

Poor air quality turned out to be a major irritant and source of frustration. A married couple in their late thirties who have been living on the street for six years, and have a four-year old daughter, seemed desperate: "This street is unfriendly, suspicious, dirty, and not very family friendly. We don't like it, mostly because of the traffic." The father reported that air pollution was a constant irritant. He worries about his little girl: "We're very concerned about her health- she has a constant cough- and we limit the amount of time she spends outside." he said. Remarking that he had cleaned the television the day before, he took a clean white paper towel and wiped it across the screen in order to demonstrate how it was again dirty. "We're constantly breathing this in," he said with an exasperated tone.

A divorced, middle-aged man who grew up on heavy street, and moved back into the house when his parents died, has noticed

a huge increase in traffic. “The air pollution is really very bad - it’s annoying when the dirt builds up in the kitchen. There’s just always so much dirt, grit, and grime around. I’ve considered moving out because of this.”

Residents on heavy street variously adapted to the impacts of traffic pollution by choosing black curtains and painting their front door black to hide the build up of soot, frequently washing the car, the front of the house, and indoor surfaces, and keeping the front windows shut.

The prevalence of vehicle collisions, and lack of safety was another major area of concern for residents on heavy street. According to several residents, traffic collisions on the street are a frequent occurrence. A middle-aged man who has lived there for 27 years reported that “a cyclist who lives on this block got hit crossing the road, and his leg was broken. A pedestrian was killed crossing at the lights. There have been many deaths and casualties on the road.”

Residents attempted to limit the exposure of those deemed to be the most unpredictable and vulnerable groups - young children and pets - to the danger posed by passing traffic. On heavy street some interviewees reported no longer keeping pets, in order to avoid re-living the emotional pain they had felt when their animals had been killed on the busy street. Children were frequently forbidden from playing in front gardens, on pavements, or in the street.

Hence one consequence of the danger posed by cars is that children tend to become ‘invisible’. Residents from all three streets made similar observations to that of a female interviewee who said that “there are only about three children on the street”. Yet in going door-to-door to conduct the research it turned out that there were at least 13 children just in the twenty households interviewed in each of the three streets (so there were likely many more in households not interviewed). A mother of two young children who had lived on the medium traffic street for two years expressed the view that “there will never be a time when kids can play unsupervised.”

Although decisions to accompany children to school reflect a number of factors including concerns about traffic, such as personal security and practical motivations, it is notable that while every interviewed parent who lived along the medium and heavy streets reported accompanying their children to school (mostly by car), only eight out of twenty of those on light street did so. Parents in the UK can exercise some choice over where their children attend school, although many children attend the nearest school. A junior school (for ages 7-10) is located near to medium street; otherwise schools are not located close to the study streets. Detailed analyses of routes to the schools attended by members of participant households were not conducted, but based on the authors’ knowledge of the neighbourhood, it is likely that the children from all three streets would face similar traffic hazards on their journeys to school. However, it has been argued that threats immediately outside the front door are of particular salience (Timperio et al., 2004) and this may explain the finding that the parents on light street were less restrictive.

During the interviews, residents were asked to draw their ‘home territories.’ Home territory was defined as the “area over which you feel you have a sense of personal responsibility or stewardship” (Appleyard, 1981). The results confirmed Appleyard’s findings about the

relationship between traffic level and the range of home territories, as is evident from the extent of the ranges in Figure 3 (p. 26).

Social Connections

Residents were asked to identify the locations of friends, acquaintances, and family members living on their street and to indicate their 'home territory' using an aerial photograph provided. Figures 3 and 4 (pp. 26, 27) demonstrate the outcome of this exercise, in the format of Appleyard's original social diagrams, with the clear indication being that motor traffic through a neighbourhood has an inverse relationship with the number of social relationships in that neighbourhood. The mechanisms for this finding can be assumed to draw on the evidence presented in the previous section. In addition, activities that lend themselves to social interaction, such as gardening and sitting outside, are especially vulnerable to traffic-related environmental impacts, particularly noise and air pollution. Second, as traffic increases, so does the barrier effect between opposite sides of the street. Residents on heavy street reported often having to wait as long as five minutes for a gap in traffic just to cross to the other side. Finally, the threat of being hit and injured or killed by a car in the street environment not only discourages people from spending time there, but those who do may be more likely to be on the defensive, and less inclined to engage in a spontaneous chat with a stranger.

Table 2 summarises the mean number of acquaintances and friends identified in Appleyard's original San Francisco study, and in Bristol. The average number of friends reported on light street (5.35) was greater in the Bristol study than in the original San Francisco study (3.0). This difference may result from the much lower traffic volume of the light street selected for the current research compared with Appleyard's study (140 vs 2,000 vehicles/day), or may be due to other differences between the streets, such as ethnicity or cultural differences.

Table 2 Comparison of Bristol findings with Appleyard's 1969 San Francisco study

	Light Street		**Medium Street**		**Heavy Street**	
Study Location	SF	Bristol	SF	Bristol	SF	Bristol
Traffic volume	2,000	140	8,000	8,420	16,000	21,130
Avg. no friends	3	5.35	1.3	2.45	0.9	1.15
Avg. no acquaintances	6.3	6.1	4.1	3.65	3.1	2.8

Table 3 reports the results of chi-square tests conducted for all three streets and for pairings of streets with respect to numbers of friends, acquaintances, and all social contacts reported.

Table 3: Results of Chi-squared tests of difference in reported social connections

			Social relationships	
Traffic levels (degrees of freedom)		Friends	Acquaintances	Combined
All (2)	x2	61.99	28.07	83.25
	p<	.001	.001	.001
light vs medium (1)	x2	21.57	12.32	32.62
	p<	.001	.001	.001
medium vs heavy (1)	x2	9.40	2.25	9.20
	p<	.01	not significant	.01
light vs heavy (1)	x2	54.28	24.48	73.06
	p<	.001	.001	.001

Significant departures (p<.001) were found from the null hypothesis (that residents of all three streets would have similar

numbers of friends plus acquaintances). This was the case considering all three streets together, for the comparison of light street with medium street and for light street contrasted with heavy street. The comparison of medium and heavy was also significant, but at a lower confidence level ($p<.01$).

Similar findings occurred considering friends only. However, considering acquaintances only, there was no significant difference between the medium and heavy streets.

These findings suggest that the high level of traffic is more implicated in limiting the development of friendships than it is in preventing the formation of less socially-involved acquaintances. This can be explained by high traffic levels not deterring visual recognition, non-verbal communication and brief discussion as much as they would prevent the kind of in-depth discussions that could enable the development or sustenance of a friendship.

Discussion: Reversing the Tide of Motorisation in Residential Neighbourhoods

This study has replicated the primary findings of Appleyard's original research for a UK neighbourhood in 2008: higher levels of motor vehicle traffic were found to have a considerable negative impact on the social and physical environment, whilst residents identified numerous impacts on psychological and practical quality of life. Specifically, fewer friends and acquaintances from the same street were found in the medium and heavy traffic streets, and for the extent of friendships, even the difference in incidence between the medium and higher level traffic streets was significant.

Given that the three study streets had been selected primarily for being unremarkable as examples of UK traditional urban residential environments, the severity of the impacts documented presents a bleak picture of the quality of life in densely populated areas of cities and towns, particularly along major roads. There is no reason to suppose that similar findings would not be found in many other streets in Bristol, elsewhere in the UK, and arguably beyond.

Given the strength and depth of evidence that emerged from the interviewees, perhaps the most surprising finding from the study was that popular concern has not been expressed more loudly and clearly in national and local transport debates. This may arise from the dilemma that those that suffer from the effects of motor traffic are often the same people who create motor traffic in others' neighbourhoods. The ubiquity of motoring may suggest to some that there is no alternative to the status quo; leading to the conclusion that the current urban environment is the best (and only) possible one. Some residents no doubt move on from the most trafficked localities (and were therefore no longer in situ to be interviewed for this study), but not all have this option, due to economic means, family ties, or stage of life.

The limitations to adapting streets like those studied to insulate residents from traffic are overwhelming. Demolition and redevelopment is theoretically possible but would be unaffordable, practically complex, and urban redevelopment schemes are very rarely welcomed by - or carried out in the interests of – incumbent residents (e.g. Gans, 1962). Hence, the crisis can only be addressed by seeking major reductions in traffic in such localities. Here it is worth remembering that the automobile was introduced at the

turn of the 20th Century and has only dominated cities and achieved public acceptance for a few decades (Southworth & Ben-Joseph, 1997). Therefore the dominance of motor vehicles over public space may not be as immovable or inevitable as one might first assume.

Overall policy to reduce the effects of motor traffic in residential neighbourhoods must first reduce the volume of that traffic. Subsequently, regulatory measures must be applied to manage remaining traffic and parking more effectively, including that resulting from residents themselves.

Specific policies must be enacted that ensure a shift from car use to walking, cycling, and public transport use, applying economic incentives and shifting priority to non-motorised modes and public transport and away from private motor traffic. Greater coordination in planning to provide high-quality, accessible networks and flexible interchanges between active travel modes and public transport is identified as an essential part of this strategy (Parkhurst et al., 2011).

Improved information provision about the social and environmental costs of car use may have a role to play (Steg and Gifford, 2005), although it is debatable who should be the identified communicator of this information given that trust in the public authorities has been identified as a key lacuna in contemporary politics (Pew Research Center for the People and the Press, 2010). While smoking-reduction campaigns may provide a model, cognitive dissonance phenomena may be stronger with respect to car dependence, as smoking, although addictive, is ultimately a discretionary consumption choice, whereas many people currently do not have viable options besides the car, due to spatial location and other fundamental lifestyle constraints. For others though (and for the currently car dependent in the longer-run), travel choices are open to influence by social norms and emotions, with needs and constraints being overstated in many individuals' travel choice discourses (Steg, 2005). Indeed, analysis of large travel behaviour datasets shows that in any given period, a portion of citizens make choices towards car ownership and use and a portion make changes in the other direction. In recent decades the net direction of this 'asymmetric churn' has resulted in heavier motor traffic, but the presence of the counter-movements suggests there are mechanisms which policy can seek to exploit to reverse this balance (Goodwin, cited in Chatterjee, 2001).

Copenhagen provides one successful example of how to push 'churn' in a positive direction: a city centre strategy to limit parking supply gradually was implemented from 1962, with 2-3% of parking capacity removed each year, and combined with investment in the quality of public spaces, growth in cycling, and public transport provision. CABE (2002) identified this policy as having effectively improved urban liveability and widened travel choices, whilst avoiding political backlash, as the reduction in parking policy was incremental, and hardly noticed, whilst the cumulative change was balanced by capacity increases for the other modes. Here policy balance (rather than emphasising provision of the more politically acceptable policy measures) is a key issue, as enacting policies that affect the price and availability of vehicle storage can be more effective than public transport provision at managing levels of traffic in an urbanised area (DfT, 2001).

Residential neighbourhoods do not exist in isolation and many journeys made by residents will be to travel out from them

to destinations rather than within them, so it is important not to over-focus on the very local. Nonetheless, the site of impact and the location where the trips that become 'traffic' begin is the residential street. 'Filtered permeability' (Melia, 2007) has been identified as a key means by which bicyclists and pedestrians can be afforded or retain fine-grain access to a street network while cars are restricted by design, physical barriers and regulations. The concept can effectively design a non-motorised advantage into the built environment, and has been particularly successful in cities like Groningen in the Netherlands. A transformation of residential neighbourhoods themselves - from polluted, dangerous thoroughfares to quality environments directly outside one's front door can - in and of itself - encourage walking and cycling, and discourage driving (Killingsworth et al., 2003).

A number of theorists have placed the blame for our hostile streets on a planning code that fails to distinguish between the necessarily highly-predictable world of the high-speed highway, and the urban places where people live, work, and play (CABE, 2002). The philosophy of 'shared space' provides an alternative, following a logic which was initially heretical for traffic engineers steeped in the doctrine of segregation of different flows and clarity of carriageway priority for greater safety. Yet the available research would seem to indicate that in some circumstances, as a result of reducing priorities the degree of perceived safety reduces but actual safety increases, as a greater degree of care is taken by road users (Hamilton-Baillie, 2004). Shared space in residential streets has been embodied in the development of 'woonerven' or home zones, although they are potentially complex and expensive to deliver as retrofit schemes, and can have negative as well as positive community cohesion outcomes if a full consensus around the specific remodelling is not achieved. (Sherwin, Parkhurst, and Chatterjee, 2006).

Legal and regulatory measures also have an important part to play, given the political limits to introducing economic restraints and the relatively weak effect of voluntary measures. Since 2006, local authorities in the UK have had the ability to declare a 20mph (approximately 32 km/h) speed limit on built up roads (DfT, 2006) and a former (impractical) requirement that physical measures be used to reduce vehicle speeds to the legal limit has been dropped. Lower speed limits as well as strict liability laws for drivers have been successfully adopted in Netherlands and Scandinavian countries (Whitelegg, 2007). Such measures are seen as essential for the promotion of cycling and walking as at lower speeds the risks of fatality in the event of a collision are dramatically reduced (Table 4).

Table 4: Risk of pedestrian fatality in a vehicle collision by vehicle speed (IIHS 2000)

Vehicle Speed	Risk of Pedestrian Fatality
20 mph	5%
30 mph	45%
40mph	85%

Whilst for most of our residential neighbourhoods retrofitting is the only option, at least where new development is planned then there are opportunities to ensure that the location is well served by public transport, cycling and walking routes so that a car is not a routine daily necessity (Barton, 2003). Employment centres should be located within the existing urban fabric and in close proximity to public transport stops or stations. These types of compact land uses are associated

with lower levels of car use, and improved air quality (Frank et al., 2000).

Finally, we note that whilst this article has focused on problems and solutions in the highly industrialised countries, motorisation is developing rapidly in industrialising states. While it is in some senses 'too late' at least for preventative solutions in the industrialised world, considerable opportunities remain to avoid similar mistakes for those states yet to adopt mass car ownership. In all jurisdictions interventions will need to be multifaceted, bespoke for the context, but vigorously pursued, with consensus-building matched with clear leadership. By any account this is a considerable challenge, but perhaps sufficient (if rather too rare) examples exist to confirm it is possible to halt and even reverse the "mutual detriment and significant loss" of car dependence. (Whitelegg, 1997).

Afterword

The authors gratefully acknowledge the pioneering and visionary work of Donald Appleyard, who was, with tragic irony, killed in 1982 by a speeding motorist in Athens, Greece. A much anticipated 2nd edition of *Livable Streets* is expected to be published by Routledge Press in 2011. We also thank the 60 households of north Bristol for their generosity with their time and insights.

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http://www.transport.uwe.ac.uk/publications/publications.asp

Figure 3. Composite Home Territory Diagrams for Interviewees from each Street

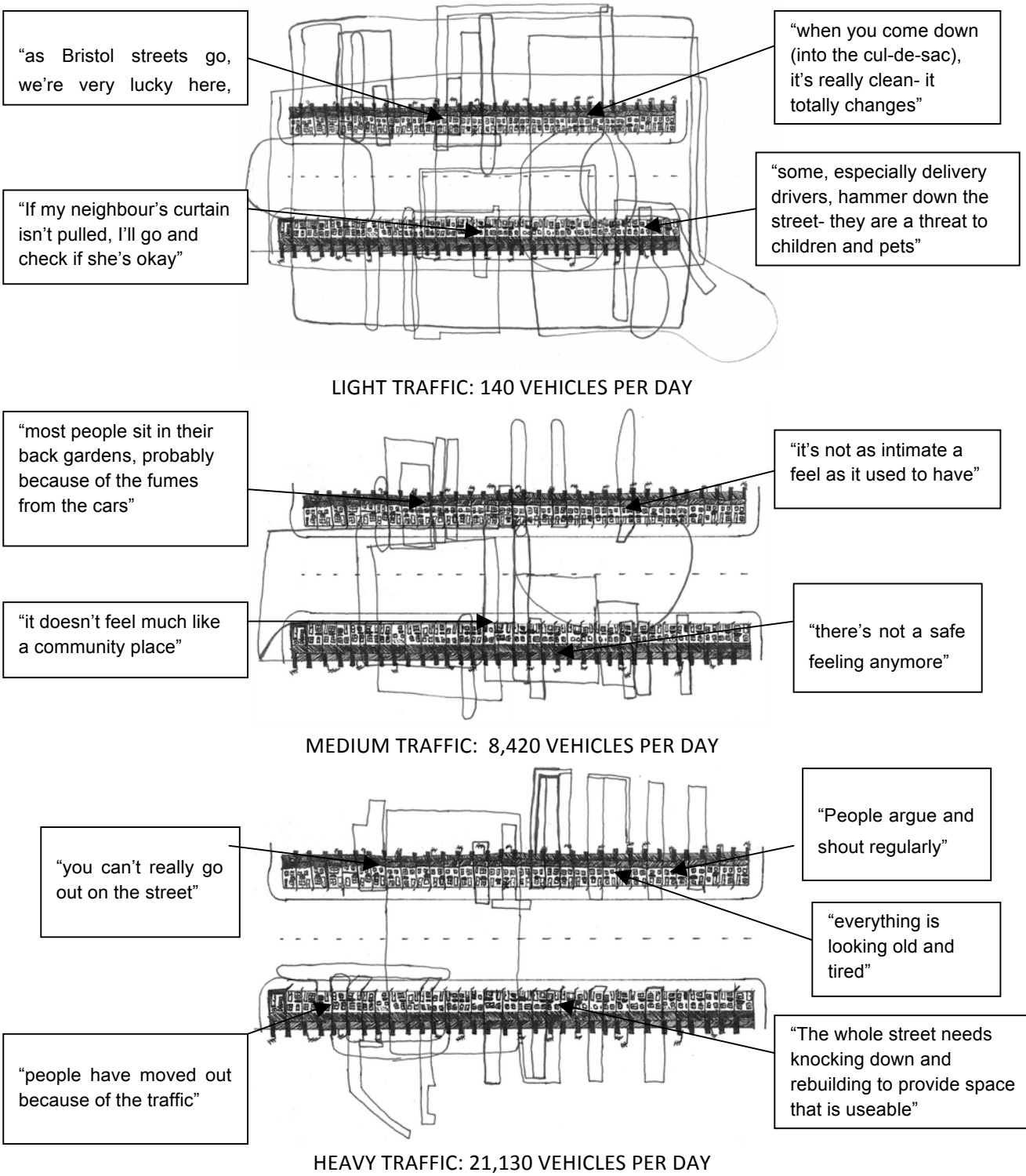
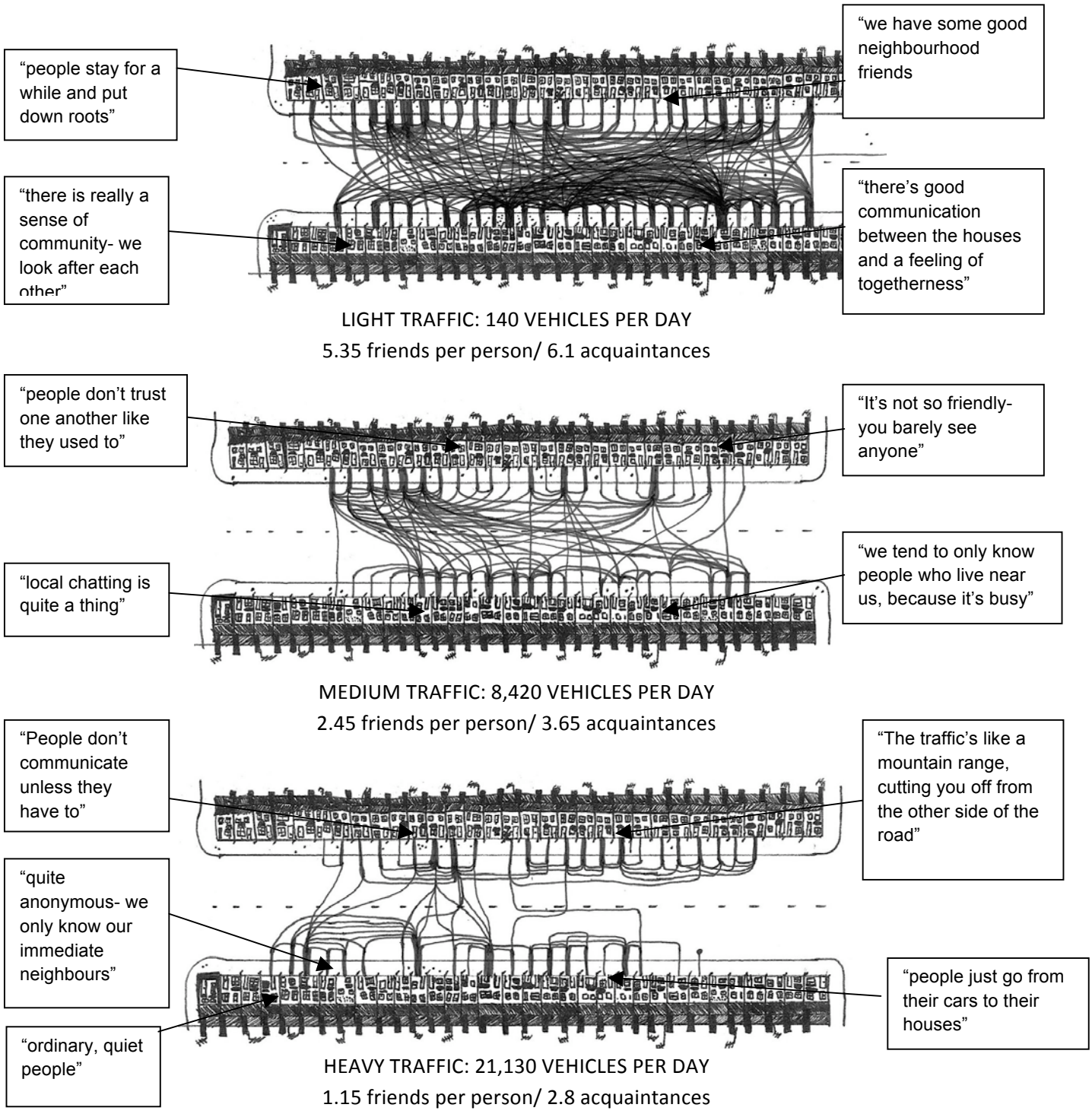


Figure 4 Community interaction on three Bristol streets



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‘Peak Car Use’: Understanding the Demise of Automobile Dependence

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Introduction

In 2009 the Brookings Institution were the first to recognise a new phenomenon in the world’s developed cities – declines in car use (Puentes and Tomer, 2009). This paper summarises the recent data covering this new phenomenon of ‘peak car use’ and seeks to understand why it is happening. It first presents the data which are confirming this trend in cities in the US, Australia and eight other nations together with some of the data from our Global Cities Database that were suggesting the possibility of this trend. Peak car use suggests that we are witnessing the end of building cities around cars – at least in the developed world. In the 1980’s we called this kind of city building automobile dependence (Newman and Kenworthy, 1989). The peak car use phenomenon suggests we may now be witnessing the demise of automobile dependence in cities. The paper therefore sets out to examine six possible causes of peak car use before making a general conclusion and setting out some of the implications for the professions who manage our cities.

The Data on Car Use Trends.

Puentes and Tomer (2009) first picked up the trend in per capita car use starting in 2004 in US cities. They were able to show that this trend was occurring in most US cities and by 2010 was evident in absolute declines in car use. The data are summarised in Figure 1.

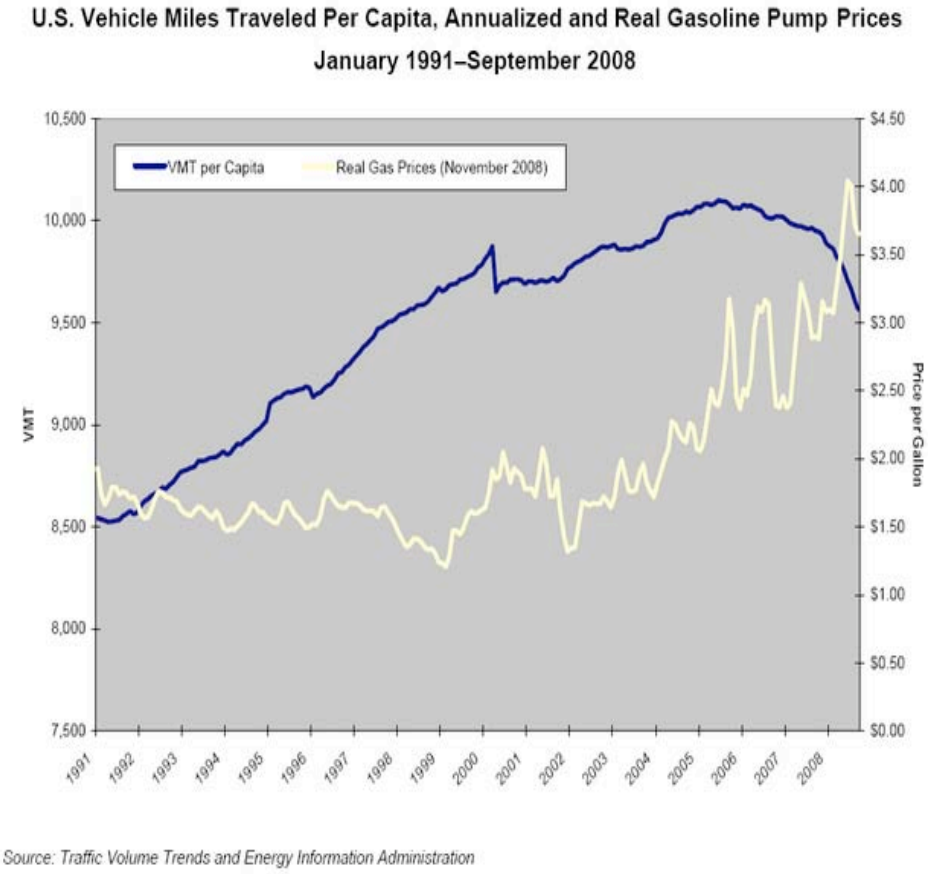


Figure 1. Peaking of US vehicle miles of travel.

Stanley and Barrett (2010) found a similar trend was obvious in Australian cities and that the peak had come at a similar time – 2004 - and car use per capita at least

seemed to be trending down ever since. Their data are shown in Figure 2.

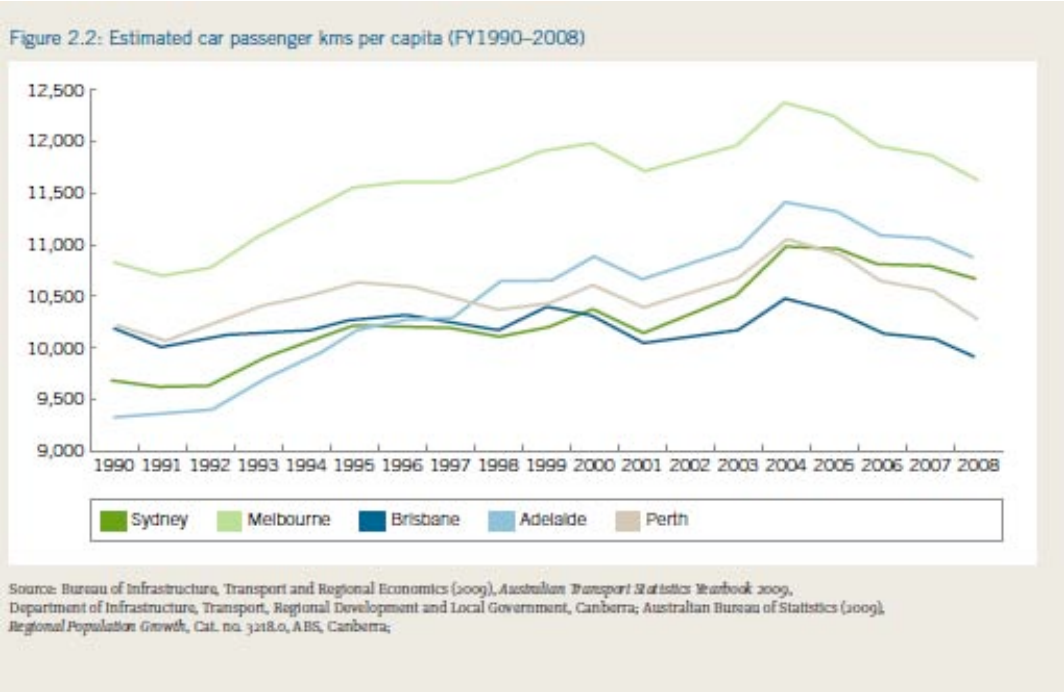


Figure 2. Peaking of car use in Australian cities

In a pre-publication paper Millard-Ball and Schipper (2010) examine the trends in eight industrialised countries that demonstrate what they call 'peak travel'. They conclude that:

'Despite the substantial cross national differences, one striking commonality emerges: travel activity has reached a plateau in all eight countries in this analysis. The plateau is even more pronounced when considering only private vehicle use, which has declined in recent years in most of the eight countries…. Most aggregate energy forecasts and many regional travel demand models are based on the core assumption that travel demand will continue to rise in line with income. As we have shown in the paper, this assumption is one that planners and policy makers should treat with extreme caution.'

The Global Cities Database (Kenworthy and Laube, 2001; Kenworthy et al 1999) has been expanding its global reach since the first data were collected in the 1970's. While the 2005/2010 data are yet to be complete the first signs of a decline in car use can be gleaned from previous data and were first recognised by us in Newman and Kenworthy (1999) and Kenworthy and Laube (1999) when it was seen that cities in the developed world grew in car use per capita in the 1960's by 42%, in the 1970's by 26%, and the 1980's by 23%. Our new data now show that the period 1995-2005 had a growth in car use per capita of just 5.1%, which is consistent with the above data on peak car use.[i]

Figure 3 summarises the changes in car vehicle kilometres per capita in cities in the developed world over the 45 year period from 1960 to 2005. It shows the percentage growth in four decades for all the cities combined. It is clear that in this sample of cities in the USA, Canada, Australia and Europe that the growth in car use is slowing down and is likely to

continue into the 21st century in developed cities.

In the twenty-six cities that comprise the 1995-2005 percentage increase in car vkt per capita we are beginning to see some cities that have actually declined. Some European cities show this pattern: London has declined 1.2%, Stockholm 3.7%, Vienna 7.6%, Zurich 4.7%. In the US, Atlanta went down 10.1%, Houston 15.2% (both from extraordinarily high levels of car use in 1995), Los Angeles declined 2.0% and San Francisco 4.8%.

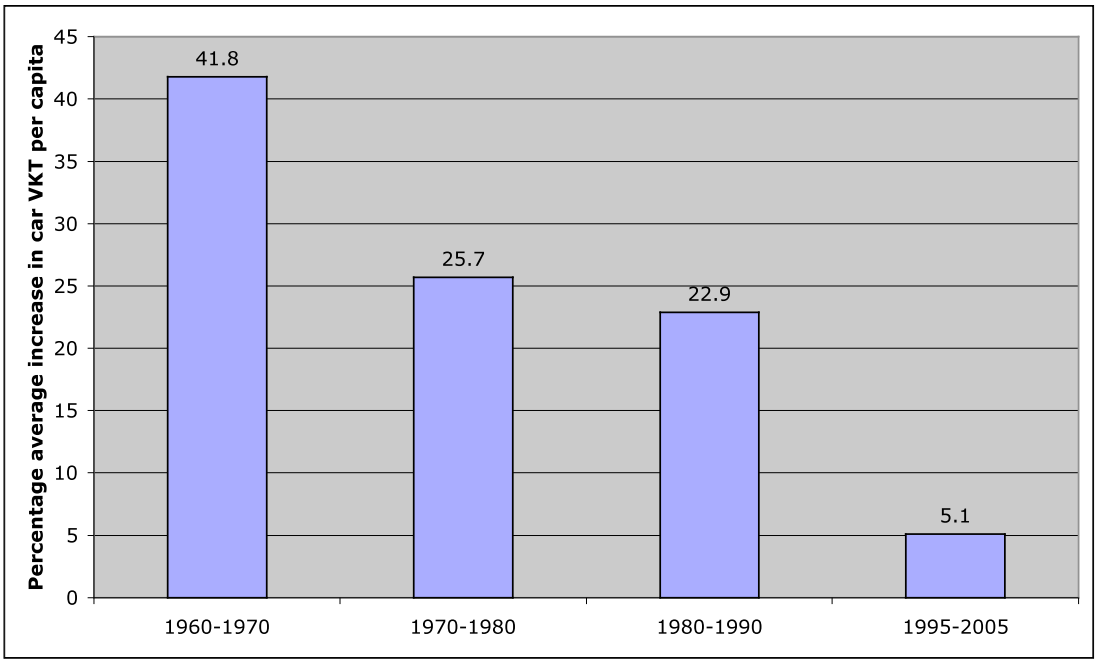


Figure 3. Car use growth trends in developed cities from 1960 to 2005 using Global Cities Database. (see Endnote 1 for details).

Peak car use appears to be happening. It is a major historical discontinuity that was largely unpredicted by most urban professionals and academics. So what is causing this to occur?

The Possible Causes of 'Peak Car Use'.

The following six factors are examined and then their overlaps and interdependencies are explored afterwards:

1. **Hitting the Marchetti Wall**
2. **The Growth of Public Transport**
3. **The Reversal of Urban Sprawl**
4. **The Ageing of Cities**
5. **The Growth of a Culture of Urbanism**
6. **The Rise in Fuel Prices**

1. Hitting the Marchetti Wall

Thomas Marchetti was the first to recognise that all cities have a similar average travel time budget of around one hour (Marchetti, 1994). This seems to be biologically based in humans – they don't like to take more out of their day than an hour just getting to their work and back home. Thus we have applied this to the technology of city building (Newman and Kenworthy, 1999) to show that cities always hit the wall when they are 'one hour wide'.

A Walking City is based around people walking at an average of 5-8 km/h thus in one hour people can walk 5-8 km; therefore a Walking City can expand to 5-8km wide before it becomes dysfunctional

to go any further. A Transit City based on an average speed of 30 km/h for trains can extend to 30 km wide. An Automobile City based on an average speed of 50 km/h in cars can reach out to 50 km wide before the average travel time will be more than is acceptable to most people. As cities have filled with cars the limit to the spread of the city has become more and more apparent with the politics of road rage becoming a bigger part of everyday life and many people just choosing to live closer in. Fast trains have been the only technology to break this car-based limit, though they are limited in their origins and destinations in cities built around cars and soon hit the wall also.

The travel time budget limit is observable in most Australian and US cities where the politics of transport has been based on the inability of getting sufficient road capacity to enable the travel time budget to be maintained under one hour. Thus there has been a shift to providing faster and higher capacity public transport based on the growing demand to go around traffic-filled corridors or to service growing inner area districts. At the same time the politics of planning in the past decade has turned irrevocably to enabling greater redevelopment and regeneration of suburbs at higher densities closer in to where most destinations are located. The Automobile City seems to have hit the wall.

2. The Growth of Public Transport

The extraordinary revival of public transport in Australian and American cities is demonstrated in Figures 4 and 5.

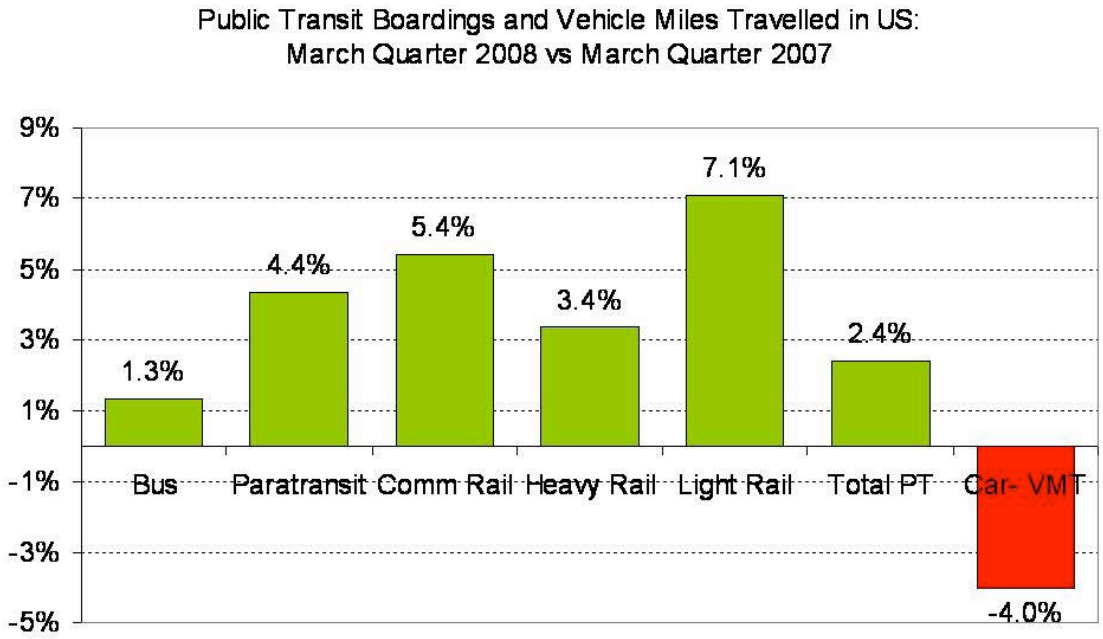
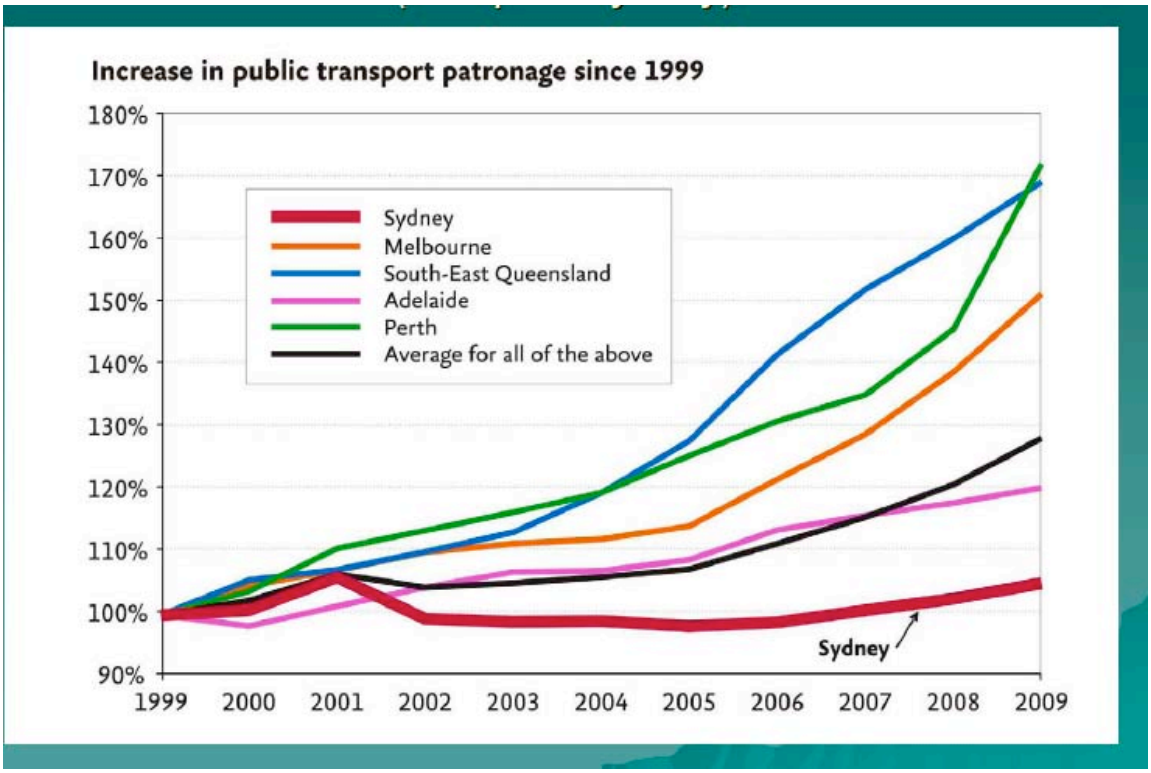


Figure 4. Recent strong growth in US transit use and declining car use.

The global cities data currently being updated show that in ten major US cities from 1995 to 2005 transit boardings grew 12% from 60 to 67 per capita, five Canadian cities grew 8% from 140 to 151, four Australian capital cities rose 6% from 90 to 96 boardings per capita, while four major European cities grew from 380 to 447 boardings per capita or 18%. The growth in transit was always seen by transport planners as a small part of the transport task and car use growth would continue unabated. However, the

exponential relationship between car use and public transport use as shown in Figure 6 indicates how significant the impact of transit can be. By increasing transit per capita the use of cars per capita is predicted to go down exponentially. This is the so-called 'transit leverage' effect (Neff, 1996; Newman *et al*, 2008). Thus even small increases in transit can begin to put a large dent in car use growth and eventually will cause it to peak and decline.

Figure 5. Growth in transit use in Australian cities since 1999

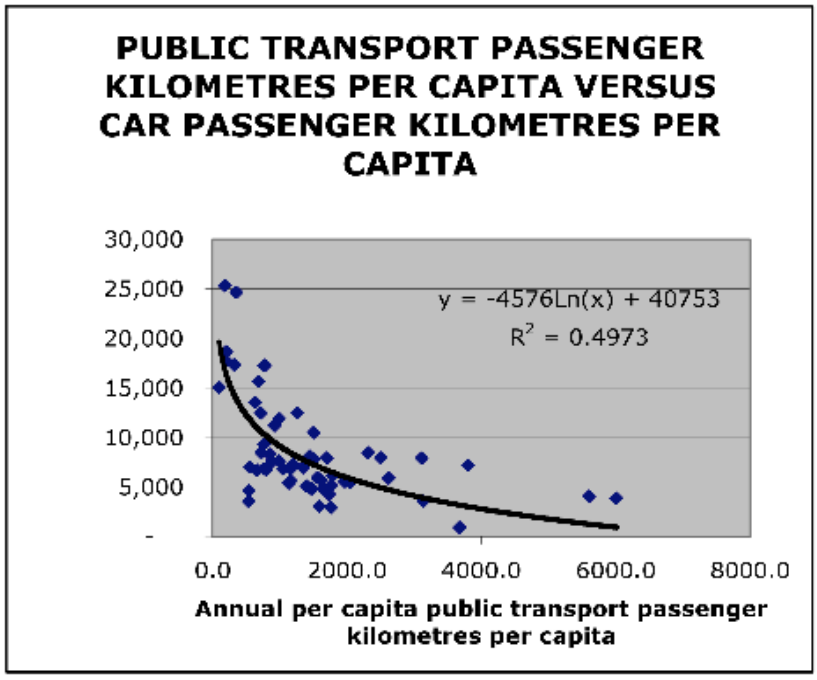


3. The Reversal of Urban Sprawl

The turning back in of cities leads to increases in density rather than the continuing declines that have characterized the growth phase of Automobile Cities in the past 50 years. The data on density suggest that the peak in decline has occurred and cities are now coming back in faster than they are going out. Table 1 (p.37) contains data on a sample of cities in Australia, the USA, Canada and Europe showing urban densities from 1960 to 2005 which clearly demonstrate this turning point in the more highly automobile-dependent cities. In the small sample of European cities, densities are still declining due to "shrinkage" or absolute reductions in population, but the data clearly show the rate of decline in urban density slowing down and almost stabilising as re-urbanisation occurs

The relationship between density and car use is also exponential as shown in Figure 7. If a city begins to slowly increase its density then the impact can be more extensive on car use than expected. Density is a multiplier on the use of transit and walking/cycling, as well as reducing the length of travel. Increases in density can result in greater mixing of land uses to meet peoples' needs nearby. This is seen, for example, in the return of small supermarkets to the central business districts of cities as residential populations increase and demand local shopping opportunities within an easy walk. Overall, this reversal of urban sprawl will undermine the growth in car use.

Figure 6. The transit leverage effect in developed cities, 1995



4. The Ageing of Cities

Cities in the developed world are all ageing in the sense that the average age of people living in the cities has been getting older. People who are older tend to drive less. Cities therefore that are ageing are likely to show less car use. This is likely to be a factor but the fact that all American and Australian cities began declining around 2004 suggests there were other factors at work than just ageing as not all cities in these places are ageing at similar rates. The younger cities of Brisbane and Perth in Australia still peaked in 2004.

Figure 7. Rapid decline in car use with increasing urban density, 1995

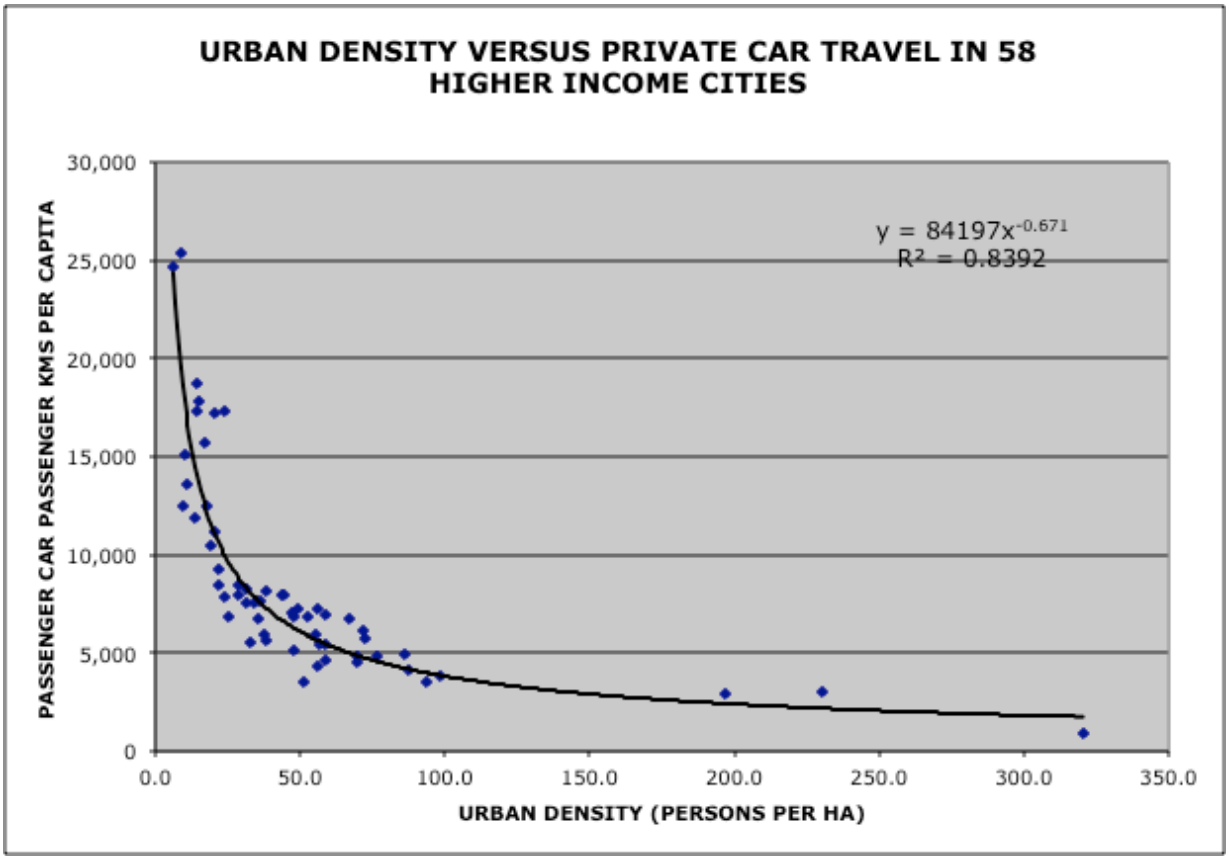


Table 1. Trends in urban density in some US, Canadian, Australian and European cities, 1960-2005

Cities	1960 Urban density persons/ha	1970 Urban density persons/ha	1980 Urban density persons/ha	1990 Urban density persons/ha	1995 Urban density persons/ha	2005 Urban density persons/ha
Brisbane	21.0	11.3	10.2	9.8	9.6	9.7
Melbourne	20.3	18.1	16.4	14.9	13.7	15.6
Perth	15.6	12.2	10.8	10.6	10.9	11.3
Sydney	21.3	19.2	17.6	16.8	18.9	19.5
Chicago	24.0	20.3	17.5	16.6	16.8	16.9
Denver	18.6	13.8	11.9	12.8	15.1	14.7
Houston	10.2	12.0	8.9	9.5	8.8	9.6
Los Angeles	22.3	25.0	24.4	23.9	24.1	27.6
New York	22.5	22.6	19.8	19.2	18.0	19.2
Phoenix	8.6	8.6	8.5	10.5	10.4	10.9
San Diego	11.7	12.1	10.8	13.1	14.5	14.6
San Francisco	16.5	16.9	15.5	16.0	20.5	19.8
Vancouver	24.9	21.6	18.4	20.8	21.6	25.2
Frankfurt	87.2	74.6	54.0	47.6	47.6	45.9
Hamburg	68.3	57.5	41.7	39.8	38.4	38.0
Munich	56.6	68.2	56.9	53.6	55.7	55.0
Zurich	60.0	58.3	53.7	47.1	44.3	43.0

5. The Growth of a Culture of Urbanism

One of the reasons that older aged cities drive less is that older people move back into cities from the suburbs – the so-called 'empty nester' syndrome. This was largely not predicted at the height of the Automobile City growth phase nor was it seen that the children growing up in the suburbs would begin flocking back into the cities rather than continuing the life of car dependence (Leinberger, 2007). This has now been underway for over a decade and the data presented by the Brookings Institution suggest that it is a major contributor to the peak car use phenomenon (Puentes and Tomer, 2009). They suggest this is not a fashion but a structural change based on the opportunities that are provided by greater urbanism. The cultural change associated with this urbanism is reflected in the Friends TV series compared to the Father Knows Best suburban TV series of the earlier generation. The shift in attitudes to car dependence is also apparent in Australia (Newman and Newman, 2006).

6. The Rise in Fuel Prices

The vulnerability of outer suburbs to increasing fuel prices was noted in the first fuel crisis in 1973-4 and in all subsequent fuel crisis periods when fuel price volatility was clearly reflected in real estate values (Fels and Munson, 1974; Romanos, 1978). The return to 'normal ' after each crisis led many commentators to believe that the link between fuel and urban form may not be as dramatic as first presented by people like us (Newman and Kenworthy, 1989; 1999). However the impact of $140 a barrel oil on real estate in the US dramatically led to the GFC (sub-prime mortgagees were unable to pay their mortgages when fuel prices tripled).

Despite global recession the 21st century has been faced by a consolidation of fuel prices at the upper end of those experienced in the last 50 years of Automobile City growth. Most oil commentators including oil companies now admit to the end of the era of cheap oil, even if not fully accepting the peak oil phenomenon (Newman, Beatley and Boyer, 2009). The elasticities associated with fuel price are obviously going to contribute to reducing car use growth though few economists would have suggested these price increases were enough to cause peak car use that set in well before the 2008 peak of $140 a barrel.

Interdependencies in Six Factors

It is not hard to see that the six factors involved in understanding peak car use are all interwoven and interdependent and can result in multiplicative effects that are greater than the sum of the individual parts. For example:

1. The Brookings Institution suggest that the growing price of oil may have been a substantive factor in pushing the trend to reduce cars, though the other structural factors around the culture of urbanism were also pulling the trend along.
2. The reurbanisation of car-based cities and the reorientation of transport priorities around transit, walking and cycling, are policies that feed on each other; once one begins the other tends to follow and together they can set in motion exponential declines in car use.
3. The motivation to move to a more urban location with less car dependence can be a combination of time saved in the travel time budget, fuel saved, a preference for urbanism and even getting older.

The urban planning profession has been developing alternative plans for Automobile Cities in the past few decades with the rationale of reducing car dependence involving all of the above factors; few however would have thought they would be quite so successful, perhaps because each of the factors had such interactivity and reinforcing effects.

Implications for Peak Car Use

The reality of declining car use in cities will have big impacts on the professions. The trends suggest they are very different to how they have been trained and how their manuals suggest they should work. Some examples include:

1. **Traffic engineers** will need to fundamentally change their traffic models and their assumption that increasing road capacity is their main raison d'etre. The rationale for roads will shift away from accommodating cars to being much more inclusive of other modes - light rail, buses, cycling and walking. Road diets and traffic calming will become the skill they need to lead with rather than being pushed into. In cases where road capacity has been reduced such as in the demolition of 6 km of high capacity freeway through the centre of Seoul to create an urban stream and boulevarde, average speed across the city actually improved and there were no adverse traffic impacts (www.design-e2.com - Seoul: Stream of Consciousness). This and other similar road diet projects that have been implemented around the world with similar experiences (Schiller et al, 2010), must lead to a change in how the traffic engineering profession conceives traffic, not as a "liquid"

that will flow over everything if space is removed, but as a "gas" that compresses according to the space constraints imposed on it. Peak car use will generate a growing rationale for removal of high capacity roads and conversion of space to support transit, walking and cycling and the urbanism of the new city.[ii]

2. **Town planners** will need to become much more adept at re-urbanising suburbs and centers than in scattering suburbs around the urban fringe (Newton, 2010). The provision of reduced parking will be a tool that can help revitalise urban development. The reduction in road space will now be seen as a positive value for any new development. The automobile city planning norm of minimum parking and maximum density will be reversed to maximum parking and minimum density to suit the new realities. Urban design of the public realm will become a much more critical factor in urban development as it has over many years in the extensive redevelopment and especially transit-oriented development that has shaped cities like Vancouver since the late 1970s.[iii]

3. **Urban financiers** will need to re-evaluate their penchant for financing toll roads and new suburbs on the urban fringe. Many recent toll roads in Australia have gone bankrupt because the numbers of cars have just not materialized in the way the models predicted (Goldberg, 2009).

4. **Urban economists** will need to find a new way of measuring economic progress other than by the number of new cars sold.

Conclusions

The phenomenon of peak car use appears to have set in to the cities of the developed world. It seems to be due to a combination of: technological limits set by the inability of cars to continue causing urban sprawl within travel time budgets; the rapid growth in transit and re-urbanisation which combine to cause exponential declines in car use; the reduction of car use by older people in cities and amongst younger people due to the emerging culture of urbanism; and the growth in the price of fuel which underlies all of the above factors. The implications for traffic engineers, planners, financiers and economists is a paradigm shift in their professional understanding of what makes a good city in the twenty first century. It does however point to the demise of automobile dependence.

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ENDNOTES

[i] These data cover 25 cities in the USA (9), Canada (2), Australia (5) and Western Europe (9) for which per capita car kilometres are consistently available for 1960, 1970, 1980 and 1990 (see Kenworthy and Laube, 1999). The trends in each region and for the average for the whole sample are set out in Table 2.

Cities	**1960**	**1970**	**1980**	**1990**
American	5,489	7,049	8,586	10,710
% change		28.4%	21.8%	24.7%
Canadian	3,482	4,386	6,096	7,913
% change		25.9%	39.0%	21.3%
Australian	2,910	4,466	5,748	6,536
% change		53.5%	28.7%	13.7%
European	1,470	2,755	3,534	4,505
% change		87.5%	28.2%	27.5%
All 25 cities	3,366	4,773	6,000	7,376
% change		41.8%	25.7%	22.9%

Table 2. Car use per capita in cities in different regions from 1960 to 1990 and the percentage changes, 60-70, 70-80 and 80-90.

Note:

For the 1995 data in our global cities database the number of cities being monitored and the cities themselves changed, so it is difficult to continue these trends from 1990. However, the update of the data to 2005, which matches with the 1995 data, so far shows that between 1995 to 2005 car vehicle kilometres per capita in US cities rose by only 2.0%, in Canadian cities by 2.1%, Australian cities by 10.4% and European cities by 5.6%, leading to an overall increase across the sample of 5.1% (Kenworthy and Laube, 2001; Kenworthy, 2011 unpublished).

The same cities comprise the sample in each year as follows:

US cities: Boston, Chicago, Denver, Houston, Los Angeles, New York, Phoenix, Portland, San Francisco

Canadian cities: Calgary, Winnipeg

Australian cities: Adelaide, Brisbane, Melbourne, Perth, Sydney

European cities: Amsterdam, Brussels, Copenhagen, Frankfurt, Hamburg, London, Munich, Paris, Stockholm.

[ii] Some data now exist to support the positive effect that a reduction in freeway provision might have in stabilising and reducing per capita car use. There are some signs of the "peaking" of freeway provision in cities of the developed world, suggested by data between 1995 and 2005 in the US and European cities, as well as Singapore.

It has been known for decades how freeways are associated with encouraging greater car use, spreading the city out and undermining transit as well as walking and cycling (Watt and Ayres, 1974). Newman (1995) saw signs of the end of the urban freeway, an important factor in a new paradigm about how to build cities. Evidence was provided about the many negative effects associated with building freeways, including severe economic ones, and how many cities are seeing the need to stop constructing them.

Much of the trend data supports this. Between 1995 and 2005 in the ten major US cities examined, the average per capita provision of freeway remained identical at 0.156 metres per person, with six out of the ten cities experiencing significant declines in freeway provision (Atlanta, Houston, Los Angeles, Phoenix, San Diego and San Francisco). In fact, all the US cities that reduced their car use per capita also reduced their relative supply of freeways (Atlanta, Houston, Los Angeles and San Francisco). In the five major European cities examined the same thing occurred, with average urban freeway provision remaining at 0.076 metres per person over the 10 years. Singapore declined marginally in per capita freeway supply. In the Canadian and the Australian cities average per capita freeway provision did increase, though even here three out of the nine cities involved did decline in per capita freeway provision (Vancouver, Brisbane and Melbourne).

[iii] The quality of the public realm in developments throughout Vancouver at places like False Creek, Coal Harbor, various inner city locations and around Skytrain stations has placed the city in a league of its own and gives it liveability rankings consistently at or near the top of such global indices (Punter 2003). Other cities such as Freiburg im Breisgau, Germany are also leaders in these respects (Schiller et al 2010).