

Keynote paper for presentation at the Velo-City 2009 Conference, Brussels 12th May 2009

RECYCLING CITIES – URBAN PLANNING AND SPATIAL FORM

David Banister

Professor of Transport Studies

Director of the Transport Studies Unit and Acting Director of the Environmental Change Institute

*Department of Geography and the Environment
Oxford University*

david.banister@ouce.ox.ac.uk

1. Introduction

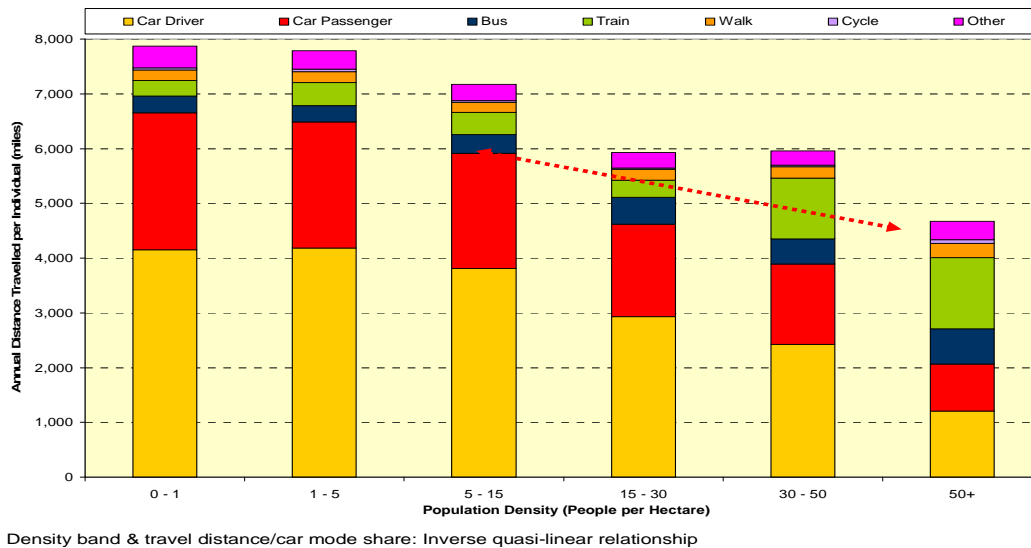
Cities must be seen as the future for sustainable development, as they allow for the most efficient organisation of both work and other activities, and as they have effective means to maintain proximity. But many cities are growing at 3-4% per annum, and often in a very haphazard way, which tends to lead to long distances between where people live and where they work or carry out other activities. These new sprawling cities create problems for the movement of people, often over distances that are too far to walk or cycle. It is these rapidly developing cities and the new megacities (over 10m) where the problems of inaccessibility are most pronounced. But it is not just these new growth points that are creating challenges for urban planners. Many of our well established mature cities also put distance before proximity, and have developed as urban forms where it is almost impossible to get around by non motorised forms of transport.

These problems are not new, but they are now central to the sustainable city that uses little or no carbon, and to cities that have huge differences between the rich and the poor. The arguments are reasonably clear, both from the transport and from the urban planning perspectives. In this paper some of the trends are outlined, focusing on the importance of the increase in travel distances and the implications that this has on the provision of efficient transport. The new paradigm of sustainable mobility is presented as a means to address some of these key problems, exploring the means by which we can make fewer trips, shorter trips, and encourage the use of public transport with increased load factors. The sustainable mobility paradigm is then contrasted with the more conventional transport thinking of trip based analysis, where urban transport problems are viewed from a traffic perspective. The paper outlines some of the main characteristics within the control of the urban planner and how this might help to reduce the length of trips. Finally, comments and conclusions are made about the vision of the city and the potential for change.

2. Trends in Travel Distance

The growth in travel distance has been one notable feature of the changes in travel patterns over time. Although the total amount of time available for travel has not changed very much (about 70 minutes per day on average), it is the distance that people travel that has really increased dramatically. In the UK, the numbers of trips per year are stable at about 1000 per person, but the average trips lengths have increased from just over 8km in 1975/76 to 11km in 2006¹. So people are not engaging in any more activities, but are travelling further to reach them, and as distance increase the possibility of using walk and cycle decreases. There has been a substitution of slower more efficient forms of transport by faster more energy consumptive forms of transport. Some of these factors can also be examined by urban form variables, such as density and settlement size, and also by public transport accessibility (Figures 1-4).

Figure 1: Density and annual travel distance in the UK (2006)



Walk and cycle distances are minimal in all of these figures, with the majority of trips and distance being accounted by the car, even in the situations where there are higher densities (and shorter distances), and larger populations (with closer services and facilities). It is only where there are measures of trips rather the travel distance that walk and cycle begin to raise their profiles (Figures 2 and 4). Figure on public transport accessibility illustrates the complexity of the relationships, but also suggests that those locations that are above the minimum threshold for service provision make more use of that service².

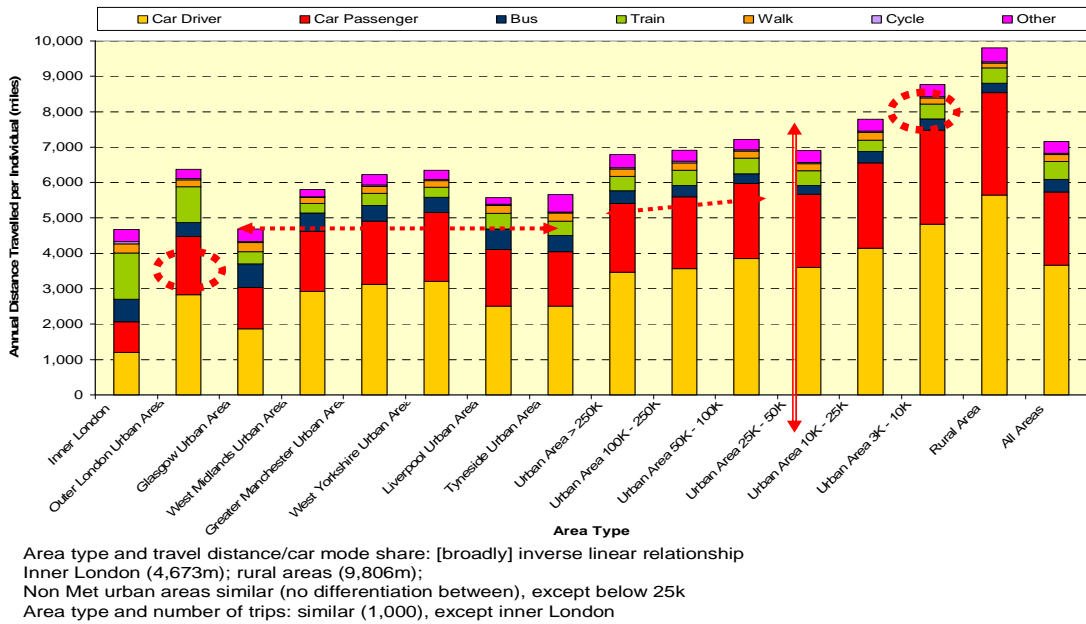
¹ Note that these figures are based on the UK National Travel Survey, which only include short walk trips on one day and probably underestimate walk trips overall, hence the higher than expected figures for mean travel distances.

² The accessibility bands in Figure 4 relate to the percentage of households within 13 minutes walk of a bus stop where there is a service frequency in excess of one bus per hour.

Figure 2: Density and annual trips in the UK (2006)



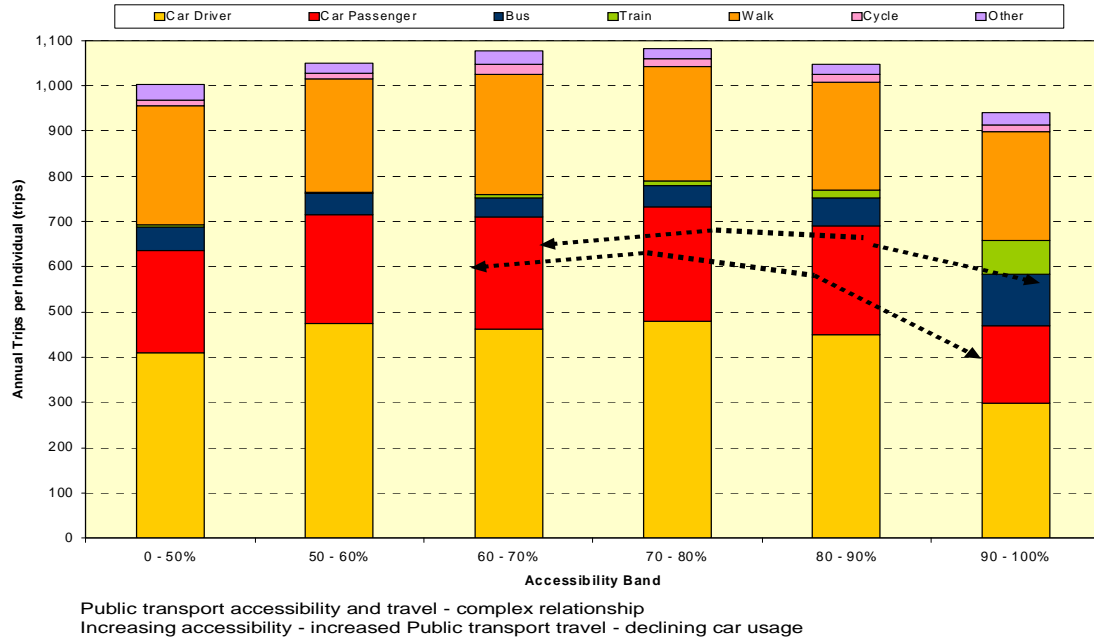
Figure 3: Settlement size and annual travel distance in the UK (2006)



These same patterns are reflected across most of Europe, and in particular in the cities where travel speeds and distances have increased over time. Mobility and urban sprawl have increased, but proximity and accessibility have decreased, and these trends have not been distributed equally. There key variables here are density, mixed use and settlement size, supported by accessibility to public transport. Higher densities and mixed uses

result in shorter distances and greater use of public transport and walk and cycle, but the relationships with settlement size is more complex. Here the most efficient locations in terms of travel distance are central cities (e.g. London), the larger conurbations, and the freestanding cities and towns. This thinking is central to the sustainable mobility paradigm.

Figure 4: Public transport accessibility and annual trips in the UK (2006)



3. The Sustainable Mobility Paradigm

Sustainable mobility provides a new paradigm within which to investigate the complexity of cities, and to strengthen the links between land use and transport. The city is the most sustainable urban form and it has to provide the location where most (70-80%) of the world's population will live. Empirical research in developed cities has concluded that the key parameters of a sustainable city are that they should be over 50,000 population, with medium densities (over 40 persons per hectare), with mixed use developments, and preference given to developments in public transport accessible corridors and near to highly public transport accessible interchanges where densities would be substantially higher (over 80 persons per hectare) (Banister, 2005). Such developments conform to the requirements of service and information based economies, settlements of this scale would also be linked together to form agglomerations of polycentric cities, with clear hierarchies that would allow a close proximity of everyday facilities and high levels of accessibility to higher order activities (Hall and Pain, 2006).

Such urban forms would keep average trip lengths to below the thresholds required for maximum use of public transport, cycle and walk modes. It would also permit high levels of innovative services and public transport priority, so that the need to use the car would be minimised. Through the combination of clear planning strategies, cities would

be designed at the personal scale to allow both high quality accessibility and a high quality environment. The intention is not to prohibit the use of the car as this would be both difficult to achieve and it would be seen as being against the notions of freedom and choice. The intention is to design cities of such quality and at a suitable scale that people would not need to have a car.

This alternative approach requires clear and innovative thinking about city futures in terms of the reality (what is already there) and the desirability (what we would like to see), and the role that transport can (and should) play in achieving these objectives. The sustainable city must balance the requirements along the physical dimensions (urban form and traffic) against those concerning the social dimensions (people and proximity), as illustrated in Table 1. The sustainable mobility approach requires actions to reduce the need to travel (less trips), to encourage modal shift, to reduce trip lengths and to encourage greater efficiency in the transport system.

Table 1: Contrasting Approaches to Transport Planning

The Conventional Approach Transport Planning and Engineering	An Alternative Approach Sustainable Mobility
Physical dimensions Mobility Traffic focus, particularly on the car	Social dimensions Accessibility People focus, either in (or on) a vehicle or on foot
Large in scale Street as a road Motorised transport	Local in scale Street as a space All modes of transport often in a hierarchy with pedestrian and cyclist at the top and car users at the bottom
Forecasting traffic Modelling approaches Economic evaluation	Visioning on cities Scenario development and modelling Multicriteria analysis to take account of environmental and social concerns
Travel as a derived demand Demand based Speeding up traffic Travel time minimisation Segregation of people and traffic	Travel as a valued activity as well as a derived demand Management based Slowing movement down Reasonable travel times and travel time reliability Integration of people and traffic

Source: Adapted from Marshall (2001), Table 9.2.

3.1 Reducing the need to travel - substitution

In its pure form this means that a trip is no longer made, as it has either been replaced by a non-travel activity or it has been substituted through technology, for example Internet shopping. The impact of information and communications technologies (ICT) on transport is complex, and current thinking (Banister and Stead, 2004) argues for complementarity between transport and ICT. Although there is a large substitution potential, the relationships between transport and ICT seem to be symbiotic with a greater opportunity for flexibility in travel patterns, as some activities are substituted, whilst others are generated, and some replaced by fewer longer distance journeys (Lyons and Kenyon, 2003).

3.2 Transport policy measures - modal shift

Transport policy measures can reduce levels of car use through the promotion of walk and cycle and the development of the new transport hierarchy (Table 2). This can be achieved through slowing down urban traffic and reallocating space to public transport, through parking controls and road pricing, and through making it easier to use public transport. Demand management is effective in restricting access and reallocating space, and making more effective use of the available capacity. A much wider notion of the street is being created, as it is no longer only being considered as a road but also as a space for people, green modes and public transport. Creative use of that space at different times of the day or day of the week means also that new uses can be encouraged (e.g. street markets or play zones). Measures to encourage modal shift must be combined with strategies to make the best use of the “released space”, so that there is a net reduction in traffic (Banister and Marshall, 2000).

3.3 Land use policy measures – distance reduction

These measures address the physical separation of activities and the means by which distance can be reduced. The intention is to build sustainable mobility into the patterns of urban form and layouts, which in turn may lead to a switch to green modes of transport. It is one area of public policy where intervention can take place, through increasing densities and concentration, through mixed use development, through housing location, through the design of buildings, space and route layouts, through public transport oriented development and transport development areas, through car-free development, and through establishing size thresholds for the availability of services and facilities. The timescale over which sustainable mobility might be realised is similar to the turnover of the building stock (about 2 per cent per annum), but decisions on the location of new housing will have a single dramatic effect on travel patterns and these effects will impact over the lifetime of that housing.

3.4 Technological innovation – efficiency increase

The role of technology is important as it impacts on the efficiency of transport directly through ensuring that the best available technology is being used in terms of engine design, alternative fuels, and the use of renewable energy sources. Standards can also be introduced to reduce levels of noise and emissions at source, and measures can be taken to ensure that access to certain parts of the city are restricted to those vehicles that are seen to be environmentally cleaner than other vehicles. This is a combination of technological efficiency and behavioural change (e.g. ecological driving and adherence to speed limits). It would also include increasing load factors in both the passenger and freight sectors.

Summarising these four actions, it seems that the key to such a shift in thinking is the creation of spaces and localities in the city that are attractive and affordable, as neighbourhood quality is central to sustainable mobility. Transport planning must involve the people³, so that there is an understanding of the rationale behind the policy changes and an increased likelihood that behavioural change follows. Public acceptability is central to successful implementation of radical change, and it must

³ People are used here to cover all stakeholders with an interest in the quality of their local environment.

involve community and stakeholder commitment to the process of discussion, decision making and implementation.

The sustainable mobility paradigm

Trip generation	→	Trip generation – through trip chaining, use of the internet and videoconferencing
Trip distribution	→	Reduce trip distances
Modal split	→	Use of more efficient modes, including walk, cycle and bus
Trip assignment	→	Allocation of available space to priority users and uses

From the urban design perspective – relates to the means by which trip distances can be reduced and the priorities allocated to space in the city. This in turn relates very much to the distribution of services and facilities, and to the ability to get to them locally. It is also making the best use of the available technology to promote the use of non travel alternatives.

4. Planning for City Futures

Trying to unravel the complexities of the interrelationships between travel, urban form and sustainable development is difficult. Underlying the discussion is the requirement to have some vision of the city in its desired form – it should be viable (economic justification), have vitality (inclusive and fair), and it should be healthy (high quality of life and environmental quality). Transport provides an essential element in city viability, vitality and health. The EU vision is based on maintaining the quality of urban life, urban planning and sustainable development, where mixed uses, high densities and good environmental conditions are seen as being central to both improving economic performance and the vitality of cities.

This vision has resulted from the assessment of the substantial research that has tried to establish the links between travel, land use and urban form. This research ranges from simple analyses of trip generation and attraction characteristics of particular land uses (e.g. residential and shopping) to more detailed analyses of travel (and energy use) in locations with distinctly different characteristics. The verdict on this empirical work is mixed. For example, Anderson et al (1996) concluded that the current level of understanding of the influence of urban form on the generation of emissions and the use of energy is weak. But others (e.g. Stead, 2001 and Hickman, 2007) have found far more significant relationships between land use and transport. In both these cases, the socio economic variables explain substantially more of the variation in trip making activities than the land use factors. Underlying all the debates, three main elements need to be examined:

Density of development has an important effect on the distances travelled, the modes used and the energy profiles. The most cited research here has been carried out over the last 15 years by Newman and Kenworthy (1989a and b, 1999) in their comparison of the transport energy profiles of 84 cities. Their powerful conclusion was that when urban density in the 58 wealthier cities was correlated with car passenger kilometres, urban density explained 84% of the variance (Kenworthy and Laube, 2001; Kenworthy, 2007). When energy use was correlated with activity intensity (persons and jobs per hectare),

77% of the variance was explained. Despite concerns over the methods used and the quality of the data, clear relationships have been established at the city level. A general conclusion is that an increase of 10% in local density results in a 0.5% decrease in vehicle trips and vehicle miles travelled (Ewing and Cervero, 2002; Table 5).

Settlement size is also important in influencing both modal shares and the distance travelled as use of public transport and walking increases with population size (Dargay and Hanly, 2004). Diseconomies of scale may feed in with the largest cities, which have a complexity of movement that is substantially greater than the smaller monocentric cities – circumferential trips are as important as radial trips (Banister, 1997). The US literature is also variable in its findings, as Ewing (1997) estimated that a doubling of density resulted in a 25-30% lower level of vehicle miles travelled (VMT), whilst Holtzclaw (1994) concluded that the difference between 20 dwellings/acre (urban densities) and 5 dwellings/acre (suburban densities) was a 40% increase in travel. Overall, the US evidence seems empirically powerful, suggesting that higher density developments can reduce VMT by at least 10-20% as compared with urban sprawl (Litman, 2007; Table 6).

The second issue relates to *proximity and local environmental quality*. Land use patterns in post industrial cities are changing as greater mixed use becomes the dominant feature. This means that journey lengths can be reduced through the use of local facilities and services. Considerable effort is now being placed in transport development areas (or the similar transit oriented developments in the US), where high quality public transport accessibility can be combined with office development, residential, leisure and retail activities, all in close proximity to each other. The importance of quality is paramount, as these accessible locations become the centre of activity and increasing the demand for public transport. This is a concentration of activity that has beneficial impacts on modal split and the use of local facilities, but it needs to be balanced against the counter trend of dispersal (and sprawl) that has an opposite effect on trip lengths and greater levels of car dependence.

Cervero and Duncan (2006) examined the degree to which job accessibility is associated with reduced work travel and how closely retail and service accessibility is correlated with miles and hours logged getting to shopping destinations. Based on data from the San Francisco Bay Area, they found that jobs-housing balance reduces travel more, by a substantial margin, than accessibility to shopping. But they also concluded that it is important to look at access to public transport at both ends of the journey. By concentrating “housing near rail stops will do little to lure commuters to trains and buses unless the other end of the trip – the workplace – is similarly convenient to and conducive to using transit.” (Cervero, 2006, p53).

Finally, there are the *local neighbourhood and design issues*. This is part of the new urbanism debate, which encourages more local activity through more walking, direct routing for slow modes of transport, and quieter and narrower streets (Duany and Plater-Zyberk, 1991, Calthorpe, 1993, Marshall, 2005 and 2008). People Travel shorter distances when they move into neighbourhoods with higher accessibility (Krizek, 2003), with median distance increasing from 3.2km in the more accessible neighbourhoods to 8.1km in less accessible neighbourhoods. Street connectivity is also important here as it can reduce distances for slow modes, but cul de sacs are also popular with residents, even though they tend to extend travel distances. Main Street programmes in the US (and

more recently in the UK) are intended to revitalise town centres by restricting access at certain times and to create vibrant communities day and night (Handy, 2004). Other initiatives to encourage urban living include extensive pedestrianisation, the closure of residential streets, gated communities, and even the removal of freeways (e.g. the Embarcadero Freeway in San Francisco). The issue of parking management is central here.

Land use effects on travel behaviour tend to be cumulative and mutually reinforcing (Hickman, 2007; Litman, 2007). This effect can be illustrated in two ways. Ewing and Cervero (2002) calculated the elasticity of vehicle trips and travel per capita with respect to four land use variables (Table 2). Their estimates suggest that a doubling on local density reduces car trips by 5% per capita and travel by about the same amount. Although the elasticities are low, Ewing and Cervero (2002) concluded that they were cumulative, giving a total potential of 13% and 33% decreases in trips and trip distance (VMT) respectively.

Table 2: Elasticities of Trips and Travel by Land use Factors

Factor	Description	Trips	Travel (VMT)
Local density	Residents and employees divided by land area	-0.05	-0.05
Local diversity	Jobs/residential population	-0.03	-0.05
Local design	Sidewalk completeness/route directness and street network density	-0.05	-0.03
Regional accessibility	Distance to other activity centres in the region	-	-0.20

Source: Ewing and Cervero (2002)

The second study was by Lawton (2001) using data from Portland Oregon to examine the impact of land use density, mix, and road network connectivity on personal travel. As urbanisation increases, per capita vehicle travel declines significantly from about 20 average daily travel miles per adult (32kms) to just over 6 miles (10kms).

These points are well summarised by Litman (2007) in a slightly different way (Table 3). He concludes that in the US a 10-20% cumulative total saving in VMT is possible through density and mixed design, and a further 20-40% is possible from regional decisions on the location of new development. The figures in the EU are likely to be less, as the trip distances travelled are lower and there is already a much greater use of land use and development controls than in the US.

Table 3: Land Use Impacts on Transport – US Evidence

Factor	Definition	Travel Impacts
1. Regional Accessibility	Location of development relative to regional urban centres	Improved accessibility reduces per capita vehicle mileage. Residents of more central neighbourhoods typically drive 10-30% fewer miles than urban fringe residents.
2. Density	People or jobs per unit of land area	Increased density tends to reduce per capita vehicle travel. Each 10% increase in urban densities typically reduces per capita VMT by 1-3%.
3. Mix	Degree that related land uses are located close together	Increased land use mix tends to reduce per capita vehicle travel and increase the use of alternative modes, particularly walking. Neighbourhoods with

		good land use mix typically have 5-15% lower vehicle miles.
4. Public Transport Accessibility, Walking and Cycling Conditions	Quality of public transport and degree to which destinations are accessible; Quantity, quality and security of walking and cycling	Residents with good access to public transport tend to own 10-30% less cars, drive 10-30% fewer miles, and use alternative modes 2-10 times more frequently than residents in car oriented developments. Residents in more walkable communities walk 2-4 times as much and drive 5-15% less than if they lived in more car oriented developments.
5. Centredness, Network Connectivity, Design and Management of Routes	Location of employment in major activity centres, connectivity of the network (including density), design and layout of streets	Typically 30-60% of commuters to major commercial centres use alternative modes, compared with 5-15% of commuters at dispersed locations. Better road connectivity can reduce vehicle mileage and better cycling and walking provision also helps these modes. More multi modal streets improves use of alternative modes, with traffic calming reducing car use and increasing walking and cycling.
6. Parking Supply and Management and Site Design	Number of spaces per unit area, costs, time limits and management, and layout considerations	Parking management strategies can significantly reduce car ownership and mileage. Cost recovery pricing reduces car trips by 10-30%. Mobility management can also reduce car trips by 10-30%.

Based on Litman (2007), Table 21.

5. *Urban Planning Futures*

This paper started with the statement that cities must provide the future, as over 70% of the population in high income countries now being classified as living in urban areas. Globally, the figure is over 50%, and it is likely that the global figure will reach 70% by 2030. Cities are the centres of wealth generation, knowledge and culture, and they also provide the highest quality of life and opportunities for all their residents.

The most important challenge is to reduce trip lengths and to look at innovative ways to combine activities to minimise overall travel distance. This allocates a key role for urban planning in locating services, jobs and facilities close to where people live, and to encourage high quality urban living that is based on clear notions of community, involvement and responsibility. This in turn requires leadership and vision.

There must be a move away from the concern over the quantity of travel, speed, distance and high levels of energy use, to one that is concerned over the quality of urban living. This form of urbanism is based on a common concept of the use of spaces that are quiet, safe and secure locations, pollution free and encourage local ownership and pride. Such an approach has proved successful in many medium sized European cities, and it now needs to be used more widely and extended to the largest cities through innovative forms of polycentric development.

The future city should be looking at the possibility of car free environments. There should be no good reason for owning a car in the city, as there is excellent provision of local facilities and high quality public transport. Such a future would release space, as most of

the time the urban car is stationary and occupying space. Car free areas have been created in certain residential areas and in the city centre, but the concept can be expanded city wide.

The key conclusions are twofold. The first is that streets should be considered as flexible spaces and the key users should be identified and given priority – the notion of multifunctional space. At present traffic is dominant and this makes it difficult to design spaces for people or for slower forms of transport. Technology allows us to make more flexible use of spaces and this should be seen as a key element in the planners thinking. These spaces should be designed to give a clear message to all users about who owns that space. The second longer term issue is to embed the principles of high quality living in cities to encourage more people to return to the cities (this is already happening) and to shorten distances so that slower active forms of transport can be used. This requires urban planners to vision on the desirable city and to develop a set of principles such as those outlined here that will move towards that future.

Cities have evolved from simple forms that were originally designed around walking distance and reasonable travel times, but they have now changed to become more car dominated, often with unreasonable travel times. With increasing concerns now over environmental quality and a complete dependence on carbon based energy sources in transport, it may be an appropriate time to reconsider the benefits of city living, so that ideals of liveability once more become dominant. This was the vision of the utopian fathers of the modern planning movement over a hundred years ago, when they were responding to overcrowding, poor sanitation and health problems within cities – perhaps we can learn from the past?

Ten Discussion Points for the Workshops – <i>Cities for People and Liveability</i>
--

- | |
|---|
| <ol style="list-style-type: none">1. Leadership and the need for vision and continuity in policy directions – this may require organisational and institutional change;2. City planning that is both imaginative and combines the principles of good practice on density, settlement size, mixed use and accessibility standards – accepting that there is no single solution, but that each city requires a different approach;3. Community involvement and engagement at the local level to maintain design quality and accommodate local requirements – ownership;4. City centres seem to offer huge opportunities, but more difficult locations may be in the suburbs and around the cities (including the city regions);5. Small cities also offer clear possibilities, but diseconomies may set in with the larger cities where distances must increase – polycentric developments and smaller centres linked by high quality public transport may be attractive;6. Look to the concept of the total journey, not just the main part of the journey – the soft modes are key in all travel;7. Slow transport in cities provide safety, noise, air quality and other environmental benefits – need to move away from fast travel as being the most desirable way to get around and explore potential for reasonable travel time and travel time reliability;8. Infrastructures for different types of activity should be separated so that they do not conflict with each other – walk and cycle movements in green and quiet spaces; |
|---|

9. Key to all the above is the use of space and the allocation of space flexibly to different types of users and uses, by time of day and day of week – this would begin to value this space properly as a common good, with restrictions on parking and extensions of space for key uses, including green space and linear parks;
10. Key to all the above is quality of space and movement, with short distances to be travelled as all key activities are within walking and cycling distance – proximity.

References

- Anderson, W, Kanaroglou, P and Miller, E (1996) Urban form, energy and the environment: a review of issues, evidence and policy, *Urban Studies* 33(10), pp. 7-35.
- Banister, D. (1997) Reducing the need to travel, *Environment and Planning B*, 24(3), pp. 437–449.
- Banister, D (2005) *Unsustainable Transport: City Transport in the New Century*, London: Routledge.
- Banister, D (2006) Transport, urban form and economic growth. Keynote paper for the JTRC/ECMT Round Table 137, Berkeley, California, March, pp. 113-142.
- Banister, D (2008) The sustainable mobility paradigm, *Transport Policy*, 15(1), pp73-80.
- Banister, D and Marshall, S (2000) *Encouraging Transport Alternatives: Good Practice in Reducing Travel*, London: The Stationery Office.
- Banister, D and Stead, D (2004) Impact of information and communications technology on transport, *Transport Reviews* 24(5), pp 611-632.
- Calthorpe, P (1993) *The Next American Metropolis – Ecology, Community and the American Dream*, NY: Princeton Architectural Press.
- Cervero, R (2006) Office development, rail transit, and commuting choices, *Journal of Public Transportation* 9(5), pp. 41-55.
- Cervero, R. and Duncan, M. (2006) Which reduces vehicle travel more: Jobs housing balance or retail-housing mixing? *Journal of the American Planning Association* 74(4), pp. 475-490.
- Dargay, J. and Hanly, M. (2004) Land use and mobility, Paper presented at the World Conference on Transport Research, Istanbul, July.
- Duany, A., Plater-Zyberk, E. and Speck, J. (1992) *Suburban Nation: The Rise of Sprawl and the Decline of the American Dream*. North Point Press.
- Ewing, R. (1997) Is Los Angeles style sprawl desirable? *Journal of the American Planning Association* 63(1), pp. 107-126.
- Ewing, R. and Cervero, R. (2002) Travel and the Built Environment – Synthesis, *Transportation Research Record 1780*, TRB Washington.
- Hall, P and Pain, K (2006) *The Polycentric Metropolis: Learning from Mega-City Regions in Europe*, London: Earthscan.
- Handy, S. (2004) Accessibility v Mobility-enhancing Strategies for Addressing Automobile Dependence in the US. Paper presented at the ECMT round table on Transport and spatial Policies: The Role of Regulatory and Fiscal Incentives, RT124, Paris, November 2002, pp49-85.
- Hickman, R. (2007) Reducing Travel by Design; A Micro Analysis of New Household Location and the Commute to Work in Surrey, Unpublished PhD Thesis, Bartlett School of Planning, University College London, November.

- Holtzclaw, J. (1994) *Using Residential Patterns and Transit to Decrease Auto Dependence and Costs*, National Resources Defense Council, Washington (www.nrdc.org).
- Kenworthy, J. (2007) Urban planning and transport paradigm shifts for cities of the post-petroleum age, *Journal of Urban Technology* 14(2), pp. 47-60.
- Kenworthy, J. and Laube, F. (2001) *The Millennium Cities Database for Sustainable Transport*, Brussels: International Union of Public Transport (UITP).
- Krizek, K.J. (2003) Residential relocation and changes in urban travel: does neighbourhood scale urban form matter, *Journal of the American Planning Association* 69(3), pp. 265-281.
- Lawton, K.T. (2001) *The Urban Structure and Personal Travel: An Analysis of Portland, Oregon Data and Some National and international Data*, E-Vision Conference (www.rand.org/scitech/stpi/Evision/Supplement/lawton.pdf).
- Litman, T.A. (2007) Land use impacts on transport: How land use factors affect travel behaviour, Victoria Transport Policy Institute, Canada, April.
- Lyons, G and Kenyon, S (2003) Social participation, personal travel and Internet use, Proceedings of the 10th International Conference on Travel Behaviour Research, Lucerne, August.
- Marshall, S (2001) The challenge of sustainable transport, in Layard, A, Davoudi, S and Batty, S (eds) *Planning for a Sustainable Future*, London: Spon, pp 131-147.
- Marshall, S. (2005) *Streets and Patterns*, London: Spon.
- Marshall, S. (2008) *Cities, Design and Evolution*, London: Routledge.
- Newman, P.W.G. and Kenworthy, J.R. (1989a) *Cities and Automobile Dependence – An International Sourcebook*, Aldershot: Gower.
- Newman, P.W.G. and Kenworthy, J.R. (1989b) Gasoline consumption and cities: a comparison of US cities with a global survey, *Journal of the American Planning Association*, 5(1), pp. 24–37.
- Newman, P.W.G. and Kenworthy, J.R. (1999) *Sustainability and Cities: Overcoming Automobile Dependence*. Washington DC: Island Press.
- Stead, D. (2001) Relationships between land use, socio-economic factors, and travel patterns in Britain. *Environment and Planning B*, 28(4), pp. 499–528.