Urban Transport: Moving from the 19th century to the 21st century concerns

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Biographical sketch

Dinesh Mohan is Volvo Chair Professor for Biomechanics and Transportation Safety and Co-ordinator of the Transportation Research and Injury Prevention Programme at the Indian Institute of Technology, Delhi. DM obtained his BTech in Mechanical Engineering from the Indian Institute of Technology Bombay, followed by a Masters degree in Mechanical and Aerospace Engineering from the University of Delaware and then a PhD in Biomechanics from the University of Michigan, Ann Arbor. He started his research career working on vibrations of anisotropic plates and moved on to mechanical properties of human aortic tissue. This was followed by work on head, chest and femur injury tolerance, injuries in human free falls, effectiveness of helmets, child seats and the first evaluation of airbags in real world crashes. This background helped him work on epidemiology of road traffic crashes and injuries in rural India, helmet design, pedestrian, bicycle and motorcycle crash modelling, and technological aids for the disabled. Concerned with mobility and safety of people outside the car he is trying to integrate these issues within a broader framework of sustainable transport policies, urban transport options and people's right to access and safety as a fundamental human right.

Abstract

Almost every country and major city government is involved in planning for the future in view of the pressure put on us by fears of climate change. In large number of low and middle-income cities the proposed measures will have little impact in the next decade or so because the solutions suggested already exist in some form or the other. On the other hand, what has to be ensured is that urban transportation planners do not move toward infrastructure development that will fix our future to high energy use and CO_2 emissions. This change will not be easy as traditional mobility planning is embedded in text books, is very attractive as a symbol of progress and profitable for large consultancy/contracting/manufacturing corporations worldwide. Pressure for changing policies will be successful if majority of city residents can be convinced that there current and future mobility/accessibility needs can be met at lower risk levels, at lower costs and wider availability of choices. Proposed solutions will have a greater degree of successful implementation in the future if the following issues are addressed in theory and design: traffic safety, design for informal activity on roads and reduction of crime by design, equal spread of low income people in all parts of the city.

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INTRODUCTION

> "*I regard the growth of cities as an evil thing, unfortunate for mankind and the world, unfortunate for England and certainly unfortunate for India...It is only when the cities realize the duty of making an adequate return to the villages for the strength and sustenance which they derive from them, instead of selfishly exploiting them, that a healthy and moral relationship between the two will spring up.*"
> *M. K. Gandhi*

> "*The unprecedented urban growth taking place in developing countries reflects the hopes and aspirations of millions of new urbanites. Cities have enormous potential for improving people's lives, but inadequate urban management, often based on inaccurate perceptions and information, can turn opportunity into disaster*."
> State of World Population 2007, UNFPA*.*

Here we have two views about cities, almost reconcilable. The first by a humane visionary, and the second a consensus view of some professionals in the early 21st century including me. It is difficult to say who will be right in the "long run", especially in light of the assertions of the Intergovernmental Panel on Climate Change (IPCC) and their predictions about global warming (IPCC 2007). But, cities are here to stay, and I guess Gandhi's second concern (above) will have to be taken seriously if IPCC is correct in their assessment.

For many millennia human beings had to limit their greed because excess consumption demanded more manual labour. This limited their travel, the size of house they could build, clothes they could own and food they could eat. This put a limit on the use of natural resources. The industrial revolution changed all that. Our machines provide us with ready to cook food, houses, clothes and effortless travel. This has changed the concept of needs and greed. Our world is now a place where the rich and powerful can use up huge amounts of energy to transform natural resources into objects of daily use, travel and ultimately weapons of mass destruction. The world view has changed into a belief that there are endless resources and science and technology has solutions to every emerging problem without constraint. Most of the responses to IPCC warnings have this belief as their base. But, Gandhi's concerns refuse to go away, even if at times I find it very difficult to be a faithful follower.

Unending problems of traffic congestion, CO2 production, road traffic injuries (RTI) and pollution in every single city of the world has forced us to re-evaluate both our theories and practices. Professor Hermann Knoflacher warns us that "Car traffic

is cooling social relationships by heating up the atmosphere! Traditional transportation engineering is a discipline to maximize congestion and as a side effect damages the urban fabric and finally the city. Global warming as a consequence is inevitable (Knoflacher 2007)". Voices like his are not alone or new. Jane Jacobs, the legendary urban planner explains our current problems "Of course, if you have advisors that come from the West as advisors you're likely to get such a city. What American traffic engineer going to the Middle East doesn't want to make limited access highways and doesn't think in terms of wide streets and automobile capacities? They victimize American cities this way. Why won't they victimize foreign cities this way?"

Banister argues that "…that the current situation is unsustainable, and that transport must contribute fully to achieving carbon reduction targets…The belief that technology provides the solution is misplaced, as technological innovation can only get us part of the way to sustainable transport… Significant reductions of CO_2 emissions in transport in the EU can only be achieved through behavioural change. There is little sign that people are aware of the scale of the challenge, or prepared to make the necessary changes" (Banister 2009).

City	Trip modal share, percent			
	Car and motorcycle	Rail	Bus	Walking & Cycling
Bristol*	65	12*		23
Leeds*	61	36*		3
New York (Metropolitan)	60	20	8	7
Nantes*	58	14*		28
Helsinki*	54	20*		26
Paris* (Metropolitan)	47	19*		34
Brussels*	44	18*		38
London (Metropolitan)	42	17	18	23
Frankfurt*	42	21*		37
Singapore	40	25	27*	8
Stuttgart*	36	25*		39
Amsterdam*	32	16*		52
Tokyo (Metropolitan)	29	41	5	25
* Combined bus and rail				

Table 1. Trip modal shares in high-income country cities

Their concern arises from the fact that most western cities have not been able to solve the problems that all of us have to deal with in the near future. According to the latest report from the Texas Transportation Institute congestion has increased in every single urban area in the USA in the past 25 years in spite of all investments in transit and road construction (Schrank & Lomax 2007). Peak time delay in urban areas increased almost threefold between 1982 and 2007. The report warns us that

"One lesson from more than 20 years of mobility studies is that congestion relief is not just a matter of highway and transit agencies building big projects". USA is not alone in this. Almost all cities in the world face severe congestion on arterial roads. During peak times car speeds average 10-15 km/h in cities like London, Paris, Tokyo, Jakarta, Tehran or Mexico City. The fact is that rich cities have not been able to reduce car use to very low levels in spite of extensive public transport infrastructure in place (Table 1) (Mohan 2008a).

All the cities in included in this table (except Singapore) had matured before cars became important in early twentieth century. Their structures were determined by the need for people to walk or take the tram or the train. Even these early metropolitan cities have not been able to keep car use to very low levels. These data show that the car is used for more than 40% of the trips in most cities even when public transport is available. Evidence from cities like London, Paris and New York indicates that public transport use is greater than 60% only in the small inner core where parking is very limited and roads are perpetually full. In the rest of the city car use is generally more than 60% as roads are less crowded and there is easy availability of parking. Detailed studies from these cities point out that car owners generally shift to public transport only when no parking is available at the destination and average car speeds are less than 15 km/h. This empirical evidence suggests that car use (not ownership) is low only when walking and bicycling trips also form a significant proportion of all trips in cities.

All urban transportation policy reports prepared by consultants in many countries around the world (including India) assume that car use can be reduced just by providing more pubic transport facilities and assert that if their prescriptions are followed 70-80% of the trips would then be taken by public transit. The fact is that no city in the world has accomplished this feat! Further, car use as a proportion of all trips is so low in low and middle-income countries that only very innovative thinking and practices may reduce growth in personal transport trips. In the richest cities of India, Mumbai and Delhi, recent estimates suggest that car trips constitute less than 10-15% of all trips. In all other cities, this proportion would be lower. Additionally, the share of public transport is in these two cities is certainly higher than most of the cities in Europe or North America. Therefore, it is difficult to imagine how car and motorcycle use can be contained as we get richer if the international experience is anything to go by. Obviously, business as usual and copy-cat emulation of rich cities is not going to help.

OLD VS. NEW CITIES

Most cities in the 21st century are growing under very different conditions from those that matured before the 20th century. Changes in city form and transport technology are discussed briefly to understand the issues confronting us. Urban transport can be roughly divided into the following periods:

Pre 1850: Pre-mechanisation era. Travel speeds (walking) about 5 km per hour. This limited city diameter to less than 5 km and influenced city form as the rich and the poor travelled at similar speeds.

1850 – 1920: Steam engine / rail / tram / bicycle era. Rail based transport is the first mechanised form to appear in mid nineteenth century, the bicycle in its present form at the end of the nineteenth century and the commercial motor car soon after. Average speeds go up to 10-15 km/h, city form decided by existence of rail tracks, and city size increases to about 10 km in diameter.

1920-1950: Metro-bus-car era. The diesel engine, good pneumatic tyres (making possible large buses) and mass produced cars become available in the first two decades of this period and change transport modes especially in the USA. Average urban speeds increase to about 30 km/h, buses start replacing rail based trams and metro goes mainly underground. Bicycles as personal mode starts reducing.

Post 1950: Car era. In this period cars become the dominant mode of travel in all rich country cities and for the upper-middle class everywhere. Underground metro systems also expand, but mainly in rich cities. Buses and para-transit remain the main modes for pubic transport in low income cities. Average car speeds on arterial roads go up to about 50 km/h, but door-to-door speed rarely exceeds 25 km/h. Cities can now be 20-30 km in diameter and form dictated by car travel.

Most large cities in high income countries (HIC) grew to their present size between 1850 and 1950. Technological developments were critical in changing the shape and form of the city. Cities that have grown after 1950 do not have the characteristics of strong central business districts (CBD) in any part of the world. Car ownership started increasing in the 1920s but most families did not own a car until the middle of the 20th century. By then the essential land use and transportation patterns of large cities in HICs except in the USA were well set with large CBDs. This encouraged building of high capacity grade separated metro systems, and in turn, the transport system encouraged densification of CBDs as large numbers of people could be transported to the centre of the city. The non-availability of the car to the middle class decided the widespread use of public transport and city form. However, this period when the bus and roads became comfortable (1920-1950), was also the period of great economic and social upheaval and little thought could be given to improving urban transport with innovations in management systems and technology. Car ownership increased much faster in the USA and so many cities did not have the political pressure to provide for public transport.

Most Indian cities have expanded after 1960 and all have planned for multiple business districts. In addition, in the second half of the 20th century most families did not own a personal vehicle and so all leisure activity revolved within short distances around the home. In the past two decades motor cycle ownership has increased substantially in Indian cities, as a result about 50% of Delhi's families own a car or a motor cycle at a very low per capita income level of about USD 1,400 per year. Such high levels of private vehicle ownership did not happen until incomes were much higher in HIC cities. Therefore, the high ownership of motorcycles, non-availability of funds to build expensive grade separated metro systems and official plans encouraging multi nodal business activity in a city has resulted in the absence of dense high population CBDs and city forms which encourage "sprawl" in the form of relatively dense cities within cities.

Changes in technology and declining demand for public transportation

Most middle class families did not own air-conditioned cars with stereo systems in HICs before 1970. The cars were noisy and occupants were exposed to traffic fumes as windows had to be kept open. Under such conditions, the train was much more comfortable. This created the condition in which there would be a political demand for metro systems that came from the middle class and could not be ignored. On the other hand, brand new, quiet, stereo equipped, air-conditioned cars are being sold in India now at prices as low as USD 5,000-6,000, and used ones for quarter the price. This has made it possible for the middle class first time car owner to travel in cars with comfort levels Europeans had not experienced till the late 20th century. Air-conditioned, comfortable, safe and quiet travel in cars with music in hot and tropical climates cannot be matched by public transport. Owners of such vehicles would brave congestion rather than brave the climate on access trips and the jostling in public transport.

Wide ownership of MTWs has never been experienced by HIC cities. This is a new phenomenon, especially in Asia. The efficiency of MTWs – ease of parking, high manoeuvrability, ease of overtaking in congested traffic, same speeds as cars and low operating costs make them very popular in spite of MTW travel being very hazardous. Availability of MTWs has further reduced the middle class demand for public transport. In addition it has pegged the fare levels that can be charged by public transport operators. It appears that public transport cannot attract these road users who can afford an MTW unless the fare is less than the marginal cost of using MTW. At current prices this amounts to less than Rs 1 per km (US$ 0.02). The only option available is to design very cost efficient public transport systems that come close to matching this price.

Cities in low and middle-income countries that have grown after the 1950s seem to be different in character with multiple business districts, mixed land use (largely by default, illegally), relatively short trip distances and a large share of walking and public transport, even if the latter is not provided by the city authorities. When public transport is not provided officially, informal systems using mini-buses, three-wheelers and vans operate semi-legally or illegally and provide a majority of the motorized trips. No low or middle income city is without such systems. Car share remains below 20% even at per capita incomes of incomes of US$ 6,000-8,000 (Bogota, Mexico City). This is an important point to note as Indian incomes are not likely to reach these levels in the next twenty years. It is also clear that no city in a low or middle-income country has been able build a metro system that attracts a majority of public transport passengers. This is partly because no city that has grown after 1950 has a large and dense central business district. All large Indian cities are growing around the periphery and will not have dense centres in the future (Mohan 2008a). These issues force us to look at the modern growing cities with a different perspective for planning our future.

NEW MEGACITIES AND CLIMATE CHANGE

Current situation

Almost every country and major city government is involved in planning for the future in view of the pressure put on us by fears of climate change (CEC 2001;Di Lucia & Nilsson 2007;ETAAC 2008;European Commission 2001;Fuglestvedt et al. 2008;Hensher 2008;King Review Team 2007;King Review Team 2008;Li & Tamura 2003;Nicolas & David 2009;Niederberger 2005). But, Banister (2009) warns us that "At present the scale and nature of the changes necessary in the transport sector to address climate change have not been seriously debated…The real challenge confronting society is greater than this, namely the expected growth in travel from all cities and the desire for longer distance travel. Serious debate and action on these issues has not even started, and all the time the climate change clock is ticking". The main non-fuel and technology based policy being discussed are summarised in Table 2.

Policy issues	Recommendations	Low and middle-income city situation
1. Reducing the need to travel - substitution	Trip-chaining, use of information and communications technology (ICT)	A majority minimise trips and already do trip-chaining. Potential of ICT not clear.
2. Transport policy measures - modal shift	Reduce levels of car use through the promotion of walk and cycle & use of public transport	Car use levels much lower than the best European cities. In some cities motorcycle use may be high. Use of non-motorised modes and/or formal or informal "public transport high
3. Land use planning measures – distance reduction	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	High densities, mixed land use present (if not by plan, illegally). Majority of trips short distance.

Table 2. Policy options being considered in the face of climate change and the situation in low and middle income cities.

In large number of low and middle-income cities the proposed measures will have little impact in the next decade or so because the solutions suggested already exist in some form or the other. On the other hand, what has to be ensured is that

urban transportation planners do not move toward infrastructure development that will fix our future to high energy use and CO_2 emissions. This change will not be easy as traditional mobility planning is embedded in text books, is very attractive as a symbol of progress and profitable for large consultancy/contracting/manufacturing corporations worldwide. Pressure for changing policies will be successful if majority of city residents can be convinced that there current and future mobility/accessibility needs can be met at lower risk levels, at lower costs and wider availability of choices.

Way forward

Issues outlined in Table 2 will have a greater degree of successful implementation in the future if the following issues are addressed in theory and design: traffic safety, design for informal activity on roads and reduction of crime by design, equal spread of low income people in all parts of the city.

Road safety

One of the greatest factors influencing and forcing people to adopt personal modes of mechanised transport is the their perceived risk of road traffic injuries in travel (Mohan 2007;Mohan 2008b). This high risk of fatality and injury as pedestrians and bicyclists deters people from adopting these modes or using public transport if their income is high enough to own personal vehicles. Also, it is clear that unless pedestrian risk is reduced to very low levels, it is possible that modal shifts from cars to public transport could increase RTI fatalities in a city as total risk per trip by bus would be more than that by car. Therefore, ensuring safety of non-motorized modes of travel becomes a pre condition for encouraging public transport use, and ultimately cleaner air in our cities.

City structure, modal share split, exposure of motorists and pedestrians may have a greater role in determining fatality rates than vehicle and road design alone. Cities with high motor vehicle fatality rates must be those where exposure and speeds of motorists is high, and pedestrian fatality rates can be low if pedestrian exposure is low. Within the US where incomes, availability of technology, knowledge, and road design and vehicle specifications can be similar across cities, these differences in speeds and exposure are probably accounted for by the structure of cities.

With the same proportion of land devoted to road space, we can have large blocks with fewer arterial roads or smaller blocks with a larger number of arterial streets. In the former type of cities the avenues would be wider than the latter type of cities. If the arterial streets are wide, it encourages high speeds during off-peak hours resulting in high pedestrian and bicycle crash rates. High pedestrian and bicycle fatality rates discourage use of non- motorised modes and use of public transport also. If it is not easy to for city residents to walk, bicycle or use public transport, then they will prefer use of private modes of transport. When a majority of commuters are dependent on motor vehicle use for their essential needs the system creates a political demand for greater provision of motor vehicle facilities and road space. This in turn can make it difficult for the political system to be harsh on drivers

in terms of speed enforcement and controlling drinking and driving. In this situation, not only do people tend to use motor vehicle for short trips, but also demand facilities that reduce trip time for long trips. These conditions are just right for increasing exposure of people on roads with less than optimal conditions for ensuring road safety. Therefore, it seems that if we have to promote walking, bicycling and public transport use we will have to make traffic safety a priority along with city structure designs that incorporate the following: (a) Street design ensuring safety of non-motorised modes. (b) Vehicle speed control by street design and ultimately ITS control on vehicles. (c) Denser layout of through traffic streets with narrower cross sections. (d) Smaller size of residential neighbourhoods.

Crime and transport

Crime and fear of crime affects travel choice significantly and actins as a major barrier to the use of public transport, cycling and walking. It is also clear that just depending on more aggressive street policing is not very effective in reducing crime in all neighborhoods or in reducing the perception of risk especially among women. Forty seven years ago, in her book *The Death and Life of Great American Cities*, author Jane Jacobs suggested that crime could be reduced by having "eyes on the street" (Jacobs 1961). This book is quite possibly the most influential American book on urban planning to this day. By “eyes on the street” Jacobs meant shops on ground floors abutting the side walk, abundance of kiosks and cafes and a vibrant walking atmosphere. She was quite clear it could not be done by policing alone.

However, street design in many cities does not allow for shops and businesses abutting the sidewalk. On the other hand we have “eyes” on all our streets, except in very rich neighbourhoods, in the form of hawkers and vendors. These vendors also serve a huge social need, provide employment and nutrition to city dwellers (Tinker 1997). Without them our streets would not provide the relative crime free atmosphere we have. These vendors then become essential as a part of our transportation planning process. It is not very difficult to plan for them as every road needs a treeline which occupies a corridor of 1-1.5 m of space on the pedestrian path. Vendors only need 1-1.5 m and they can occupy spaces between trees without bothering pedestrian traffic. It is important to develop street design standards incorporating street vendors as an essential component.

Reviews of the environmental criminology literature indicates that more permeable residential street networks are associated with higher levels of crime than less permeable configurations such as cul-de-sacs. Mixed-use developments and parking in rear lanes in suburban residential areas have also been associated with increased levels of crime (Cozens et al. 2004;Cozens 2008). Many new urbanists, street furniture and public facility designers are also working on designs that automatically reduce incidence of crime and perception of risk by all road users (Cozens, Neale, Whitaker, & Hillier 2004). Much more attention needs to be given to this aspect of urban space design and planning as it will ultimately lead to greater adoption of suatainable forms of transport.

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