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Abstracts and keywords

Dutch Transport Policy: From Rhetoric to Reality

Gary Haq and Machiel Bolhuis

Keywords: Accessibility, environmental protection, freight, mobility, Netherlands, targets

The Dutch have gained an international reputation for developing coherent policy plans for transport, environment and physical planning. This paper examines the rhetoric of Dutch transport policy and assesses what is actually being achieved in practice. Progress made in achieving the main targets on mobility, accessibility and environmental protection are discussed. The growth in vehicle kilometres of the freight sector is identified as an important problem that the Dutch will need to deal with in order to achieve all the targets adopted in transport and environmental policy.

Urban Transport and Equity: the case of São Paulo

Eduardo A. Vasconcellos

Keywords: São Paulo, access, mobility, equity.

Urban transport provision, accident rates and accessibility in São Paulo varies tremendously with income, gender and age. Sustainable transport modes are marginalised and high externalities are borne by society. A complete overhaul and reassessment of priorities is required to achieve equity in transport.

Sustainable Transport: Some challenges for Israel and Palestine

Yaakov Garb

Keywords: Israel, Palestine, sustainability, peace

WITH the establishment of Palestine and the continuing peace, there is a need to appraise the transport infrastructure and policies of both countries. In particular, will Palestine follow Israel along the road to mass motorisation or will it choose the path to sustainability? Will Israel realise the folly of providing for private transport and seize this unique opportunity?

Can Demand Management Tame the Automobile in a Metropolitan Region?

Spenser W. Havlick & Peter W. G. Newman

Keywords: Demand Management, alternative modes, land use.

Demand management strategies can be an effective tool in taming the automobile. The approaches to demand management in four European cities; Zurich, Freiburg, Stockholm and Copenhagen; and Boulder, Colorado is investigated.

The Impact of Transportation on Household Energy Consumption

Rick Browning, Michele Helou & Paul A. Larocque

Keywords: Energy, Houses, Modal choice.

This paper examines transportation energy costs as an integral part of total household energy consumption. A typical suburban household is found to expend more than half its total annual energy budget on operation of household motor vehicles. In contrast, households located in traditional, pedestrian-oriented neighbourhoods are found to use far less energy on transportation. For an instructive contrast, two household budgets were generated using a standard computer program and then compared. With transportation energies included, a household living in an 88 year old 'energy hog' house located in a traditional pedestrian friendly neighbourhood is shown to expend less total annual energy than a suburban household living in a highly energy efficient modern house. Studies and statistics developed in the Pacific Northwest are used as documentation for travel-related behaviour.

From Curitiba to Quito: Reserved traffic lanes for public transport as an ecological, economic and social policy for cities

Benoît Lambert

Keywords: Trolleybus, urban transport, Curitiba, Quito.

Quito's new trolleybus is a great success. It is being expanded already. Consisting of a know-how transfer from a Latin American city, Curitiba (Brazil), to another Latin American city, Quito (Ecuador), these two experiences display a new and original development model. By occupying urban space, and therefore limiting the presence of the car, too often promoted without considering environmental and ecological consequences, the 'reserved structuring axes' for public transport allow high mobility at low cost. The advantages of this model are numerous and could profit many other cities. Today, more and more questions of technological choices are part of the political and ecological debate. Transport is no longer a secondary issue.

Editorial

THERE is something very positive and encouraging about having detailed discussions with lively people from more than a dozen countries about transport issues. In March this year 25 people sat together for the best part of a week in IHE Delft (the Netherlands) and shared experiences of dealing with traffic and its impacts in most parts of the world. The luxury of having direct contact with Cuba, Mexico, Sudan, Surinam, Pakistan, Indonesia, Vietnam, Egypt, Kenya, Turkey, Bangladesh, the Philippines, Thailand, Nigeria, Ghana, China and the Netherlands cannot be exaggerated. Everyone was concerned about the escalation of car ownership and use, and its effects on situations as different as Khartoum, Mexico City and Bangkok.

Individual contributions were full of insight. Delegates from West Africa were keen to emphasise the importance of status and prestige and its links with car ownership. Public transport may be well used and may be important but no-one who is ambitious or successful will want to be seen taking a bus. The politics is also crucial. Senior politicians in most countries are influenced more easily by the arguments of the car makers and the road builders than by the advocates of buses and bicycles. Professionals are more likely to see their career development progress through large infrastructure projects than through pedestrian priority schemes in Nairobi or car free areas in Katmandu. These are substantial cultural obstacles to the development of new transport policies and these cultural obstacles are not being addressed.

Much discussion focussed on the experience of rapidly developing and motorising cities in coping with that growth. The UK and Dutch experiences with traffic reduction, integrated transport policies and modal shift were much admired but there was uncertainty about how to progress those same ideas in Africa or Asia. There was no doubt, however, that the ideas have to be pursued with vigour.

The week vividly illustrated the strongly positive aspects of the world transport situation. The majority of the participants were young transport professionals at the start of their careers. They were enthusiastic and aware and they will have an impact on their own countries pursuing policies based on social and environmental justice and based on local determination of local needs. They will have problems. They will meet with opposition particularly from their own governments who will all too readily accept the mythology of road building, jobs, increased auto-dependency and progress. This is a classic historic struggle between two ideologies. The presence in the debate of educated, aware professionals is a great leap forward, and the international linkages forged during such an intensive period of lively discussion is a major tool for further progress.

Perhaps more importantly still the week in Delft demonstrated that there is a freshness and a potential for international collaboration from the grass roots. This group of people have far more to say about global development as it matters to real people than do the large contingents of diplomats and consultants dragging their baggage from Rio to Kyoto via Istanbul.

John Whitelegg, Editor

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Dutch Transport Policy: From Rhetoric to Reality

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Abstract

The Dutch have gained an international reputation for developing coherent policy plans for transport, environment and physical planning. This paper examines the rhetoric of Dutch transport policy and assesses what is actually being achieved in practice. Progress made in achieving the main targets on mobility, accessibility and environmental protection are discussed. The growth in vehicle kilometres of the freight sector is identified as an important problem that the Dutch will need to deal with in order to achieve all the targets adopted in transport and environmental policy.

Keywords

Accessibility, environmental protection, freight, mobility, Netherlands, targets

Introduction

THE DUTCH have gained an international reputation for developing coherent plans on transport, environment and physical planning. With the increased attention given to environmental protection and the need for a more sustainable transport system, the Dutch policy approach has been held up as an example of 'best practice'. Dutch transport policy has been integrated and co-ordinated with physical planning and environmental policy. The objectives of these policies are explicitly stated and specific end-points are identified in the form of targets (Haq, 1997).

In 1988 the Dutch Government published the Second Transport Structure plan (Tweede Structuurschema Verkeer en Vervoer (SVV2)) which set out the policy requirements to achieve a compromise between mobility, accessibility and environmental protection. The transport plan, together with the National Environmental Policy Plan Plus (Nationaal Milieubeleidsplan (NMP+)) and the Fourth Report on Physical Planning Extra (Vierde Nota Ruimtelijke Ordening (VINEX)) provide an integrated strategy to deal with the growth in vehicle kilometres and the associated environmental impacts. The Dutch, on paper at least, seem to have made considerable progress within the area of transport and the environment. This paper evaluates the extent to which the Dutch have met the main targets for transport in the three areas of mobility, accessibility and environmental protection.

The transport sector

The Netherlands is promoted as a distribution country and as the 'Gateway to Europe'; with Schiphol airport and the port of Rotterdam being important centres of economic activity and major transport nodes of European significance. The transport sector plays an important role in the national economy and accounts for about 7-8% of the Dutch Gross National Product. The Dutch expect a 70% increase in car use by 2010 compared to 1986: from 75 to 120 billion vehicle kilometres. The number of cars in the Netherlands is expected to increase from 5 million to 6-7 million by 2010 together with a 70-80% increase in goods traffic on roads (Ministry of Environment, 1990).

Table 1 compares the modal split of the Netherlands to four other European countries. The figures for car use, based on passenger kilometres, do not vary widely between the four countries. However car use is lowest in the Netherlands (83.4%) and highest in the United Kingdom (87.8%). The Netherlands also has the highest amount of passenger kilometres travelled by rail (8.4%) compared to 5.1% in Belgium.

With regard to freight transport, Table 2 shows that the Netherlands transports the lowest amount of freight by road (63.7%) and the highest amount of freight by inland navigation (33.8%) compared to the other four European countries. However, the Dutch transport the lowest amount of freight by rail (2.5%). The adoption by the Dutch Government of Dutch Railways' Rail 21 and Cargo 21 plans has provided the impetus to

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develop and encourage greater use of rail within the Netherlands for both passenger and freight transport. The Dutch Railways Rail 21 plan aims to double transport volume capacity and improve the quality of rail travel while the Cargo 21 plan aims to increase the amount of freight transported by rail to 65 million tonnes by 2010.

The Dutch transport plan is based on the attainment of a sustainable society, which requires meeting the needs of the present without compromising future generations to meet their own needs. The main features of the plan include reducing total mobility; increasing the share of rail; promoting public transport; improving accessibility and improving environmental quality. In total, 38 main targets have been set which cover different aspects of the three main themes of the plan: mobility, accessibility and environmental protection (Ministry of Transport, 1992a).

Table 1: Modal split for passenger transport, based on passenger kilometres (1992)*

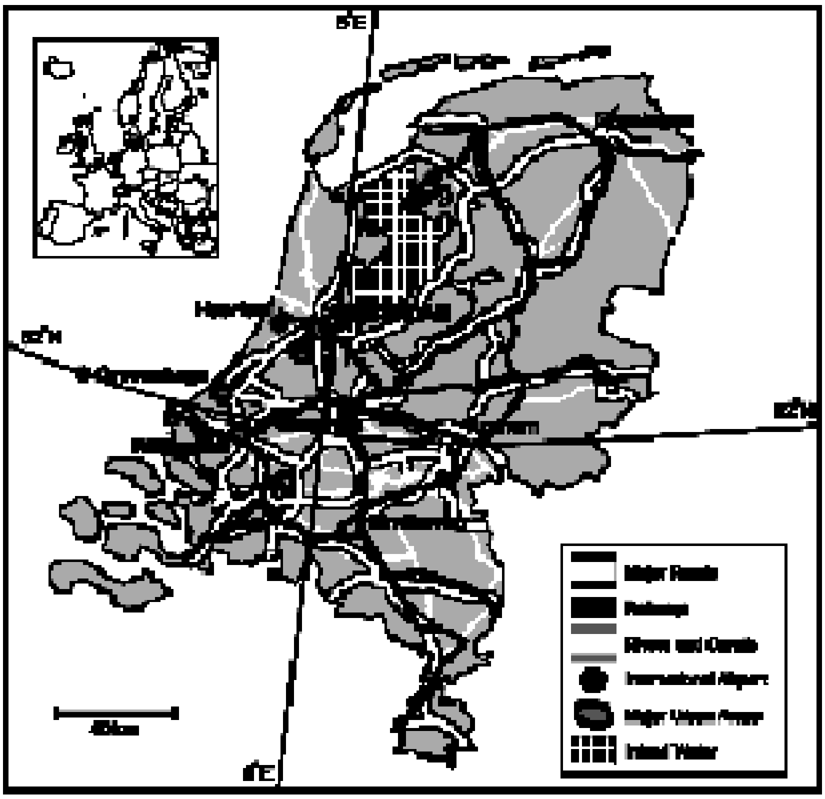
Country	*Car/van*	*Bus/tram/metro*	*Rail*
Belgium[1]	86.8%	8.1%	5.1%
France	86.5%	5.7%	7.8%
Germany	84.0%	9.4%	6.6%
The Netherlands	83.4%	8.2%	8.4%
United Kingdom	87.8%	6.5%	5.7%

[1] 1991 estimates. *Excluding cycling and walking within national borders. Source: Ministry of Transport, 1996a

Table 2: Modal spilt for freight transport, based on weight carried (1992)*

Country	*Road*	*Rail*	*Inland navigation*
Belgium	70.0%	10.9%	19.1%
France	87.8%	8.5%	3.7%
Germany	78.7%	11.0%	10.3%
The Netherlands	63.7%	2.5%	33.8%
United Kingdom	91.7%	8.0%	0.3%

*National and international transport, excluding transit. Source: Ministry of Transport, 1996a



Evaluation of Dutch transport policy

In September 1992, the Ministry of Transport, Public Works and Water Management published its first annual evaluation of the Second Transport Structure Plan, which was subsequently updated in 1993, 1994 and 1995. The reports cover four main themes of the Transport Plan: mobility; accessibility; environmental protection and support measures. Based on the SVV2, the Ministry has developed a set of indicators to measure the progress towards the attainment of traffic and transport targets and to outline future scenarios. With time, availability of data and the improvement of indicators, a more accurate understanding of progress towards the attainment of policy targets and the effectiveness of policy instruments can be gained (Ministry of Transport, 1996b).

Mobility

The Dutch have set a target to limit the expected growth of a 70% increase in vehicle kilometres to 35% by 2010 compared to 1986. To measure progress towards this target the total number of personal vehicle kilometres were calculated for working days. During the period 1988-1991 there has been a limited growth in the number of personal vehicle kilometres, which is in line with SVV2 policy. The 1994 intermediate target (index 125) has more or less been met. However, it is expected that the intermediate target for the year 2000 (index 130) will not be met. For the use of the bicycle, an increase of 30% has been set for the year 2010 compared to 1986. The number of kilometres travelled by bicycle since 1989 have been stable and a rise is expected in the future. The implementation of the Bicycle Master Plan (Ministry of Transport, 1992b), to increase the number of kilometres travelled by bicycle, and the promotion of car free cities and towns, will enable the long-term target to be met.

Accessibility

For main strategic roads a norm of a 2% chance of the probability of congestion per journey has been set, with a 5% norm for all other roads. This means that no more than

2% of all vehicles on a particular road during a working day should be subject to delays in traffic. Delays are defined as slow driving traffic or traffic where there is little movement. The indicators used to measure progress towards these targets are that part of the main road where the chance of congestion is more than 2% and 5%. These norms are not being achieved on a large number of roads and at present the SVV2 target will not be met.

For public transport the price differential between public transport and the (private) motor vehicle should be in favour of public transport. The cost of public transport is presently higher than the cost of using private transport and it is unclear whether the price differential in the future can be improved to the advantage of public transport.

Environmental protection

Environmental targets include a 20% reduction in emissions of Nitrogen oxides (NO_x) and hydrocarbon (HCs) from road transport by 1995 and a 75% reduction by 2010, compared to 1986. The target for Carbon dioxide (CO_2) emissions from road traffic is to stabilise emissions at 1989/90 levels by 1995 and reduce emissions by 10% by 2010.

Provisional figures for NO_x emissions from road traffic suggest that the 1995 target of a 20% reduction will not be met. In fact, an increase of 10 index points past this target is expected. The main contribution to the reduction of NO_x emissions has been the increase in the use of catalytic converters. However, any benefits derived from this technical fix have been offset by an increase in the number of kilometres travelled. While the NO_x emissions from passenger transport have been decreasing, the growth in vehicle kilometres within the freight sector has increased NO_x emissions.

A fall in the emissions of hydrocarbons has enabled the 1995 target to be met earlier than expected, in 1991. The main contribution to the reduction in the emissions of hydrocarbons has occurred for both passenger and freight transport with the greatest reduction seen in passenger transport.

After an initial stabilisation, Carbon dioxide emissions from motor vehicles have begun to rise. The 1995 target has not been met and a further 10% rise past this target is expected.

Freight transport has been responsible for a large proportion of the increase in Carbon dioxide emissions when compared to passenger transport. The emission of CO_2 from freight transport has increased by 39% in the period 1986-1993 compared to an increase of 15.6% from personal car transport.

The target for noise emissions is to maintain the number of main roads with noise levels more that 50 dB(A) at 1986 levels. There has been a 9% increase in the number of roads exposed to noise levels of more than 50 dB(A). However, since 1992 the number has stabilised. It is expected, therefore, that progress is being made in the direction of this target.

Freight transport

A number of targets have been directed at freight transport and have dealt with the efficiency and the movement of freight by road and water. One target aims to limit the growth in freight kilometres by road to 40% by the year 2010. Although progress has be made towards this target, it is expected that with an increase in economic growth in Europe, more freight kilometres will be travelled and existing policy will not enable the target to be reached.

The development of railways in the Netherlands is being implemented as envisaged. By 2010 freight by rail is expected to rise to 50 billion tonnes per year. A significant rise in the amount of freight transported by rail occurred in 1994 and this continued into 1995. This increase in rail freight will enable the intermediate target, to transport 20 million tonnes by rail by the year 2000, to be reached after a re-organisation of the Dutch Railways Cargo Company. However, it is still unclear whether the 2010 target will be met.

The target for freight transport is to increase inland navigation to 370 million tonnes by 2010. Since 1990 the amount of freight transported by inland navigation has declined and a return to 1986 levels can only be reached in 1998. It is expected that this target will not be achieved.

From rhetoric to reality

The rhetoric of Dutch transport policy for some factors has become reality. The evaluation of Dutch transport policy has shown that out of the total 36 targets, 18 targets will be or are being met, 9 will not be or are not being met and for 7 targets it is not clear whether the target will be met or not. For 2 targets data are lacking and therefore it

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is not possible to come to a conclusion (Ministry of Transport, 1996b).

The extent to which all the targets will be reached and maintained will be dependent on the implementation of policy measures, monitoring programmes and the annual evaluation reports. Targets which have been met or will be met include the target to reduce emissions of hydrocarbons and the noise impact from roads, and the targets to increase the use of bicycles and public transport. Among those not expected to be met are the targets to reduce the emissions of NO_x and CO_2, and the targets to reduce the growth of vehicle kilometres travelled by car and freight transport.

The setting of national targets for traffic and transport seem not to have restricted the Dutch continuing with infrastructure developments such as the extension of Schiphol airport and the planned expansion of the A2 in the Amsterdam-Utrecht corridor. Table 3 shows that after France, the Netherlands had one of the highest increases in road length over the period 1985-1993. This type of infrastructural expansion accommodates and encourages greater mobility which ultimately leads to greater emissions of pollutants.

The freight sector plays an important role in the Dutch economy and it is this sector where further action needs to be taken as economic activity increases within the Single European Market. The target to reduce freight transportation by road will not be met with existing policy. Although there has been an increase in the amount of freight transported by rail, the amount of freight by inland navigation has declined. The freight sector is responsible for the increasing amounts of Nitrogen oxide and Carbon dioxide emissions.

Table 3: Total increase in road length (1985-1993)

Country	*Increase*
Belgium	+5.7%
France	+17.1%
Germany[1]	+2.7%
The Netherlands	+8.9%
United Kingdom	+4.2%

1 Only the federal states in former West Germany. Source: Ministry of Transport, 1996a

The Second National Environmental Policy Plan (NMP2) was published in 1994. The plan highlighted the difficulties which were being encountered in achieving the targets for the freight sector with existing policy. The tightening of existing policy to control the volume of freight traffic was ruled out by the plan as it considered that this would jeopardise the competitive position of the Dutch freight sector. Any action to reduce the volume of freight traffic would need to be taken at a European level in order to avoid foreign freight vehicles replacing Dutch vehicles. The NMP2 outlined the need to take a pro-active role within the European Union to promote greater integration of environmental, transport, planning, industrial and technology policies. At the national level the Government will work in collaboration with the freight sector to make a greater effort to achieve a more efficient, cleaner and quieter vehicle fleet; to change the model spilt in favour of rail and inland waterways; to increase transport efficiency and to improve driver behaviour (Ministry of Environment, 1994).

Conclusion

The Dutch have outlined their commitment to developing a more sustainable transportation system in a number of key national policy documents. These have included a range of measures to reduce the impact of transport on the environment and to achieve a more balanced modal split. A distinct policy framework has been developed where transport, environmental and physical planning policies have been co-ordinated and integrated. These policies have attempted to address each aspect of the transport problem with measures to reduce mobility, e.g. via physical planning policy, improving accessibility and maintaining environmental quality. The setting of explicit objectives has given a clear direction to policy, with commitment being further stated in specific targets. The annual evaluation report of the transport plan shows that for some policy areas the rhetoric and policy has become reality, for targets have been met or progress is being made in the direction of the targets.

The evaluation report highlights the problems in achieving targets related to freight transport and the need to take further action. The main problem that the Dutch face concerns maintaining their position as a transport and distribution country and protecting the quality of the environment. The development of the Single European Market is predicted to increase the transportation of freight over wide distances (European Commission, 1990) and, if present trends continue, growth in freight transport will pose significant problems for the Dutch environment. The growth in freight vehicle kilometres means that air quality targets for Carbon dioxide and Nitrogen oxide emissions will not be met. The Dutch will therefore be required to implement stricter measures, which may mean more fundamental changes if all 36 targets are to be met. The introduction of stricter measures may require certain transport developments (which have economic benefits) to be abandoned. The freight sector is an area in which the Dutch will need to prove their true commitment to the environment. The extent to which the Dutch will be willing to achieve all policy targets will depend on the extent to which they are willing to put environmental interests above economic interests, in order to achieve a sustainable transport system.

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Urban Transport and Equity: the case of São Paulo

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Abstract

Urban transport provision, accident rates and accessibility in São Paulo varies tremendously with income, gender and age. Sustainable transport modes are marginalised and high externalities are borne by society. A complete overhaul and reassessment of priorities is required to achieve equity in transport.

Keywords

São Paulo, access, mobility, equity.

Introduction

TRANSPORT conditions vary remarkably among people from different social groups and classes, depending on several social, cultural, economic and political characteristics. In developing countries, profound differences among people make transport conditions even more disparate.

Urban transport conditions may be analysed in many ways. I propose that the best way to approach the problem is asking key questions about equity and transport:

- how accessibility is distributed in space?
- how people, social groups and classes may use the city?
- which are the relative conditions concerning efficiency, safety and environmental quality?
- who produces and who suffers the effects of transport externalities?

The understanding of accessibility requires first an analysis of personal mobility. By the strict technical point of view, *mobility* is represented by the quantity of trips made by a person, which is related to characteristics such as gender, age and income. Although relevant, it is insufficient, once it does not take into account the spatial and time constraints of activities (Hägerstrand, 1987). In this respect, the broader concept of *accessibility* can be used, as the quantity and diversity of destinations that can be reached by a person in a certain period of time. Accessibility can therefore be seen as something broader than mobility itself (Moseley *et al.*, 1977), as the mobility to have access to desired destinations (Portugalli, 1980).

Efficiency relates to the ease to use transport modes and can be translated by some conditions as the time to have access to the vehicle and the speed of travelling. The quality of the overall travelling condition will also be a part of the accessibility quality.

Safety refers to the probability of getting involved in a accident and the nature of its consequences. Safety depends on people (age, experience) and vehicle characteristics (size, weight, body structure) as well as user's behaviour (path, speed), highway conditions (pavement, signing) and environmental conditions (pattern of conflicts).

Environmental quality relates mainly to the quality of air and to the circulation environment. It depends on the level of concentration of pollutants such as carbon monoxide and particulate matter, and also on the quality of the living space, as translated by the compatibility between passing traffic and the use of the streets by residents and workers.

The distribution of these five characteristics among people is highly skewed in urban areas of developing countries. Social and economic, individual and family conditions, along with characteristics of land use and transport supply lead to different forms of using the space, which in turn lead to different patterns of transport quality. Actual conditions can then be related to individual characteristics and behaviour, to policy decisions concerning urban and transport infrastructure and to social and economic characteristics of every society.

A subsequent question relates to transport externalities. Externalities can be broadly defined as those effects impacting on others without compensation. In a more rigorous

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definition, external effects can be said to occur when an actor or receptor utility function “contains a real variable whose actual value depends on the behaviour of another actor (the supplier), who does not take these effects of his behaviour into account in his decision making process” (Verhoef, 1994, pp. 274). Most studies deal with three main externalities - congestion, pollution and accidents - and some include other social, less tangible effects. In the case of congestion, the direct effect is extra travel time, as caused by automobile drivers with respect to other drivers, between them and buses and between motorised vehicles and pedestrians. In the case of developing countries - as will be analysed ahead - one of the most severe effects is that caused by the automobiles on bus travel times. With accidents, the main effect is injury, suffering and/or death. Main externalities occur between motorised vehicles and pedestrians - especially between automobiles and pedestrians - with consequences varying according to the composition of traffic and average speed of vehicles. With pollution, the main effect is health damage to people. Externalities occur between those conducting motorised vehicles and all people using the traffic system.

Less tangible effects can also be analysed, as with the organisation of the circulation space and its correspondent impacts on social relations. Traffic can deeply affect them, as people are forced to change their behaviour to adapt to new conditions (Appleyard, 1981). For practical reasons, the paper considers only travel time, pollution and accidents.

The task is to analyse transport and traffic data to verify how these conditions are distributed and relate conclusions to society’s characteristics. One of the best ways of making such analysis is to study household surveys, explore social characteristics, and examine travel and space budget figures. The technique intends to replace or complement the available methodologies for trip behaviour, based solely on the analysis of individual trips, according to the traditional four-step modelling process. Few studies are available for developing countries’ conditions (Roth and Zahavi, 1981; Dimitriou and Banjo, 1983) and this analysis of São Paulo intends to fulfil part of the gap in the available information. The study also intends to contribute to a sociological and geographical approach to the urban transport problem, as a theoretical development in the field of activity analysis (Fox, 1995). It explores general travel patterns and has no statistical purposes.

Social analysis of transport conditions

The use of household survey data for social purposes requires the adoption of indicators other than the traditional ones. These indicators reveal some important features of transportation, especially in relation to the social and economic characteristics of users and the distribution of accessibility. This is very important in developing countries, where transport conditions vary widely among social groups. Several indicators which may be derived from household survey data are proposed below:

- *Mobility:* refers to the number of trips made by a person, which is related to personal (age, gender, income, level of scholarship, placement in the job market) and family characteristics (number of people, income, number of automobiles); the corresponding (opposite) indicator is immobility, expressed as the percentage of people not making trips and their relevant characteristics.
- *Accessibility:* the possibility of arriving at desired destinations, which is related to their spatial and time characteristics (e.g., hours of operation). Accessibility may also be represented by total travel time between origin and destination, using simple or generalised cost concepts of travel time.
- *Diversity:* the quality of destinations that may be reached in a period of time; reflects the lifestyle as well as actual accessibility in the face of economic and spatial constraints.
- *Productivity:* the number of activities/destinations that may be reached in a period of time, reflecting the average speed of movement.
- *Cost:* monetary and/or time costs implied in using transport modes.
- *Space consumption:* space used by a person while travelling, reflecting the consumption of a public asset (street).
- *Safety:* relative danger while using streets, according to the role played in traffic.
- *Environmental quality:* exposure (and contribution) to air pollution while travelling.
- *Comfort:* average space available inside the vehicles used to travel.

Table 1: Household characteristics

Income level	Family monthly income $(1)	Persons/ household	Autos/ household	Trips/person/day	
				all trips	motorised trips
I	up to 240	3.34	0.14	1.45	0.59
II	240 - 480	4.00	0.29	1.85	0.87
III	480 - 900	4.17	0.57	2.21	1.24
IV	900-1,800	4.27	1.01	2.53	1.65
V	> 1,800	4.11	1.61	3.02	2.28
average		3.93	0.56	2.06	1.32

(1) One Brazilian minimum wage was approximately $60 in 1987.

Table 2 - Gender and mobility

Income level	Mobility rates (trips/person/day)		
	Male	Female	Total
I	1.67	1.26	1.45
II	2.10	1.61	1.85
III	2.53	1.91	2.21
IV	2.88	2.20	2.53
V	3.47	2.63	3.02
average	2.37	1.78	2.06

Table 3 - Immobility and income

Income level	Immobility (%)		
	Male	Female	Total
I	43.1	57.1	50.6
II	30.9	48.2	39.8
III	22.8	41.3	32.2
IV	19.6	37.0	28.5
V	13.6	32.7	23.8
average	28.0	45.3	37.0

Table 4: Mobility rate and trip purpose (mobile persons)

Income level	trips/mobile person/day (1)				
	Work/business	School	Medical	Shopping	Leisure
I	0.64	0.54	0.09	0.08	0.15
II	0.80	0.59	0.07	0.06	0.13
III	0.92	0.53	0.06	0.08	0.13
IV	1.03	0.56	0.05	0.09	0.23
V	1.15	0.62	0.06	0.13	0.34

(1) Excluding home-returning trips

Table 5: Transport mode and income

Income level	Trips (%) by transport mode		
	Public (1)	Private (2)	Foot
I	37.3	8.8	53.9
II	40.1	13.3	46.6
III	39.6	24.6	35.8
IV	33.3	41.4	25.3
V	19.6	66.0	14.4

(1) bus, trolleybus, train, metro; (2) car, taxi, school bus, truck;

The São Paulo study

The analysis of the São Paulo data was performed using the 1987 household Origin - Destination (OD) survey conducted every ten years since 1967. The survey is performed in the entire metropolitan area, encompassing around 25,000 household interviews, among an universe of three million households. Some characteristics of the survey must be emphasised:

- Trip data refers to all persons living in the household (including employees in high income households) and their travel activities in the 24 hour period immediately before the interview day (workable days only);
- All trips are registered, except pedestrian trips less than 500 metres long.

The available data were processed in order to yield several rates and figures. Basic data derive from the OD report (CMSP, 1988) and subsequent computations (Vasconcellos and Scatena, 1996). All figures relate to the metropolitan area, except those from traffic accidents. The most important for the paper are summarised below.

General household data and mobility rates

Table 1 shows that mobility rates increase with income, as attested by several transportation studies (Zahavi, 1976). For all trips, the ratio between the highest and the lowest income levels is 1:2, a value that increases to almost 1:4 when just motorised trips are considered. When males and females are considered separately (table 2), male mobility is always higher than female, and both increase with income, again consistent with findings of other studies (Roth and Zahavi, 1981). In respect to immobility, the percentage of people not travelling is higher among women, in all income levels. The level of immobility decreases with income, especially in the case of men (table 3). This relates to the percentage of people making work / business trips: it is always higher in the case of men, and increases with income (from 34% in the first income level to 64% in the last one, as opposed to a 15% to 42% increase for women).

Travel patterns

Working and business trips per mobile person increase remarkably with income (table 4). School, medical and shopping trip rates seem to remain constant, despite presenting small increases at the higher income levels. Leisure trips per mobile person increase sharply in the two upper income levels.

Trip mode

Trip mode varies remarkably with income, as stressed in many transportation studies. Public transport and foot trips are dominant in low income households, while private transport dominates in level IV and V. In addition, motorised trips (public and private) are dominant in all levels but level I (table 5).

Time and space budgets

Time consumed travelling is shown in table 6. Total average time per person varies with income, which is different from other studies (Zahavi, 1976; Goodwin, 1981). Total travel time per mobile person presents instead low variability.

In respect to space budgets, as the OD survey did not include distances, figures for motorised trips were estimated using coordinates, as areal values between zone centroids. For pedestrians trips, distances were estimated using declared walking times and considering an average pedestrian speed of 4 km/h. Table 7 shows first that space consumed by a household presents marked changes with income. Part of these changes could be explained by the different number of persons per household (it is higher at the higher income levels - see table 1), but it is also explained by a higher activity level: space consumed per person increases steadily with income. Space consumed by mobile people presents less pronounced increases. Finally, space consumed per trip seems to be invariant, around 5 km per trip. However, when just motorised trips are considered, distances decrease as income increases, as figures are influenced by the high proportion of pedestrian trips in the lowest income levels.

Space consumption by mode was computed for public transport, private transport and foot. In the first two cases, distances consumed inside the vehicle were estimated by subtracting estimated walking distances from the areal total distances. Space consumption by mode presents similar patterns with respect to trip mode distribution (see table 5) - public modes and foot trips being dominant in low income levels - but with different weights, related to the introduction of distance as a measure of consumption (table 8). Hence, in level I, 76.4% of the space is consumed through motorised public transport modes, while in level V, 68.8% of the space consumption is made by private transport modes. Foot trips correspond to short distances in all income levels, however average values decrease as income increases.

A very important observation is that space consumption with public means ceases to be dominant somewhere between levels IV and V. Therefore, roughly speaking, levels IV and V are the social sectors for whom automobile transport is essential.

Travel speeds

Total travel time between origin and destination varies markedly among motorised modes; the automobile being the fastest mode, due both to its higher speed and longer distances corresponding to part of public transport trips. Access time to vehicles also shows remarkable differences, due to the availability of parking space for automobiles and the need to walk longer distances to get to transit stops (table 9).

By combining the figures for space and time consumption rates for mobile persons, one can arrive at the average daily speeds. The computation shows that while people from the lowest income level travels at 7.5 km/h (including time walking and waiting), people from the highest income level achieve speeds of 11.4 km/h, a value 53% higher. Despite this large difference, door-to-door speed of auto users is still low, due to the time consumed parking and walking. That is why Ivan Illich (Illich, 1974) reminded us that today's automotive technology is no better than the bicycle!

The same pattern holds when just work/business trips are considered, that is, higher income people travel much faster than low income people (table 10). In this case, it has to be emphasised that corresponding distances decrease with income, with maximum differences around 20%. When public transport is considered separately, income also plays an important role: people from the poorest households spend 50% more time walking to the transit stop than those from the wealthier households. The final effect of all transport-related difficulties for captive public transport users is that a long journey outside home is inevitable. This is aggravated in peripheral areas: in 1985, in the São Paulo eastern zone, 78% of people spent more than 12 hours outside home to cope with work and travel times (Pacheco, 1985).

Comfort

To this inferior initial condition regarding overall accessibility, one has to add the bus loading conditions, which often hinders

Table 6 - Time budget by mode and income

Income level	Time budget (minutes/person/day)				Mobile persons
	Public	*Private*	*Foot*	*Total*	*total*
I	35.6	3.5	12.9	52.0	105.3
II	46.9	6.3	13.1	66.2	110.0
III	52.0	12.8	11.3	76.1	112.2
IV	46.5	24.2	8.4	79.2	110.7
V	29.0	46.5	5.4	80.9	106.1

Table 7: Space budgets and average trip distances

Income level	General rates				
	km/house	*km/person*	*km/mobile person*	*km/trip*	
				all	*motor*
I	20.7	6.5	13.1	4.3	8.4
II	34.0	8.8	14.7	4.5	8.1
III	45.8	11.2	16.6	5.0	7.4
IV	54.3	12.8	18.0	5.0	6.5
V	62.7	17.2	20.2	5.1	5.8
average	38.9	10.1	16.1	4.8	7.1

Table 8: Space consumption by mode (all persons)

Income level	Space consumption (km/person/day)						
	Public		*Private*		*Foot*		*Total*
	km	*%*	*km*	*%*	*km*	*%*	*km*
I	5.0	76.4	0.6	10.3	0.9	13.3	6.5
II	6.6	75.6	1.3	14.5	0.9	9.9	8.8
III	7.6	68.3	2.8	24.9	0.8	6.8	11.2
IV	6.8	53.5	5.4	42.1	0.6	4.4	12.8
V	5.0	28.9	11.8	68.8	0.4	2.3	17.2

Table 9: Access time and travel conditions for motorised transportation

Mode	*Access time (1) in minutes*	*Travel time (2) in minutes*
auto	2.7	24
metro	15.5	33
bus	12.8	57
train	14.5	85

(1) walking (one-way); (2) from origin to destination;

Table 10: Average travel time to work/business trips.

Income level	*Travel time (1) in minutes*
I	49.4
II	45.7
III	41.2
IV	36.3
V	29.0

1) one-way

Table 11: Expenses with transportation as percentage of household income.

Income level	Monthly costs/house ($)			% of house monthly income		
	public	*private*	*total*	*public*	*private*	*total*
I	14.0	14.0	28.0	11.7	11.7	23.4
II	23.1	33.3	56.4	6.4	9.3	15.7
III	28.6	75.9	104.5	4.1	11.0	15.1
IV	28.1	150.0	178.1	2.1	11.1	13.3
V	19.0	283.7	302.7	0.8	12.1	12.9

people from boarding at the desired time and imposes extremely uncomfortable trips. Overcrowded vehicles are a daily reality in almost every developing country (Dimitriou, 1990; U.N., 1989). In São Paulo, as in other large Brazilian cities, bus services are planned assuming an occupancy rate of 7 passengers/m² in the peak hour, which frequently leads to highly uncomfortable conditions: all private companies providing bus transport in 1984 had a large percentage of people travelling under unacceptable conditions in the peak hour. Some companies had up to 84% of the passengers in this condition. Average conditions have not changed too much so far.

Travel costs

The number of daily trips for every mode, in every income level, was multiplied by the fare of that mode. For simplifying purposes, public transport trips were taken as if all were made by bus (the dominant mode). Daily expenses were converted to monthly figures considering that there are 26 equivalent days in the month (22 days at 100% expense, 4 days - Saturdays - at the 70% expense-level and 4 days - Sundays - at the 30% expense-level). For cars, a $0.25 cost per kilometre was assumed, considering that the average car travels 20,000 km per year, gasoline price is $0.80 per litre, energy performance is 7 km/litre, depreciation is $120 per month and maintenance is $75 per month. In this case, it is important to remember that figures reflect just the urban costs of using the automobile and not those related to inter-city travel which may contribute to a large portion of total costs. It is important to note that figures reflect 1987 costs. These differ significantly from current conditions which followed long lasting inflationary processes, the implementation of several economic plans and considerable changes to relative prices in the economy.

The net amount of money increases remarkably with income, especially when the automobile becomes an important mode of transportation (table 11). However, the participation of total expenses with respect to income shows an opposite tendency. Among those mostly dependent on public transport, expenses with this mode average 23% of monthly income at the lower income level and 16% at the second level up. These percentages are much higher than the 6% limit established by Brazilian laws concerning the ‘travel voucher’ (a special public transport ticket purchased by the employer and delivered to the employee: the

Table 12: Circulation space according to income and mode.

Income level	Population (million)	Space used by mode (million km/day) Public	Private	Foot	Total
I	2.98	14.5	2.0	2.5	19.0
II	4.05	26.7	5.3	3.5	35.5
III	3.72	28.1	10.7	2.8	41.6
IV	2.42	16.4	13.5	1.3	31.2
V	1.07	4.7	11.6	0.4	16.7
Total	14.24	90.4	43.1	10.5	144.0
%		62.8	29.9	7.3	100.0

Table 13: Use of space by automobiles according to income.

Income level	Population (%)	Space used (%) with automobile
I	20.9	4.6
II	28.4	12.2
III	26.1	24.8
IV	17.0	31.2
V	7.5	26.9
Total	100.0	100.0

Table 14: Personal space consumption according to income and mode.

Income level	km x m^2/person/day, per mode public	private	total
I	2.9	3.2	6.1
II	4.0	6.0	10.0
III	4.6	13.3	17.9
IV	4.0	25.8	29.8
V	2.6	50.1	52.7

Table 15: Traffic accidents in São Paulo, 1991.

Type	Vehicle occupants	Pedestrians	Total
Fatalities	1,094	1,621	2,715
All injuries	44,591	15,102	59,693
ratio (1)	1:41	1:9	1:22

(1) Fatalities/injured (severity rate). Source: CET (1992).

Table 16: Use of transport modes and relative accident risk, RMSP, 1987.

Transport mode	km/day (%)	fatalities (%)[1]
Private	30	39
Public[2]	63	1
Foot[3]	7	60

1 assumes that values for the city of São Paulo may be applied to the metropolitan area.
2 bus occupant fatalities are not indicated by current statistics but are known to be very rare.
3 considers only pedestrian trips longer than 500 metres.
Source: CET (1992).

Table 17: Relative emissions of carbon monoxide per person, 1987.

Income level transport mode	grams of CO/person/day public transport	private transport	total
I	2.9	11.7	14.6
II	4.0	21.7	25.7
III	4.6	48.4	53.0
IV	4.1	93.5	97.6
V	2.6	182.0	184.6

employer is allowed to discount the cost from the employee's salary, up to a limit of 6%).

Use of space

The collective use of space was estimated using actual distances by mode - public, private and foot. The motorised portion of public transport and automobile trips were estimated by subtracting the pedestrianised portion of the trip, according to the travel time declared by respondents (and considering a walking speed of 4 km / h).

Table 12 shows that circulation space is appropriated mainly through public transport modes (63%). Automobiles are responsible for about 30% of the consumption, while walking accounts for 7%. This latter figure is underestimated, because walking trips less than 500 metre long are not computed.

As with other studies, the use of cars is highly related to income (table 13). Table 13 shows that the two upper income levels account for 24.5% of population and 58% of automobile-consumed space.

Finally, the use of space taking account of the area occupied by people may be derived from the data. When linear distances are translated into physical areas occupied per person, differences in space consumption appear clearly. Considering that automobiles present an occupancy rate of 1.5 and occupy about 7 m^2, average consumption is 4.6 m^2 per person. The same computation for bus passengers yield an average daily value of 1.0 m^2 per person (average daily bus occupancy of 30 people and static area of 30 m^2) and a peak-hour value of 0.6 m^2 per person (occupancy of 50 people). When distances are taken into account, differences in space consumption are high (table 14).

In addition, space consumption occurs also for parked automobiles. Among the daily 4.7 million parking operations in the city in 1987, 1.5 million were free kerbside parking, representing a direct consumption of 11 million m^2 (7 m^2 per vehicle). If we consider a conservative figure of an average two-hour parking time, the final free consumption reaches the 22 million m^2 x hour level.

Safety and environmental issues

Brazil presents some of the highest traffic accident figures in the developing world (Vasconcellos, 1996). São Paulo is no exception, where more than 2,500 people die each year in traffic, most of them pedestrians (table 15). When total distances are taken into account, relative accident risks appear very different according to the transport mode used: despite corresponding to 7% of daily kilometres, pedestrians account for 60% of traffic fatalities (table 16).

When carbon monoxide emissions are computed for bus and automobile use, aggregate emissions present sharp differences among income levels (table 17).

Summary of data

Mobility

As with most studies, there is a positive relationship between income and mobility, with higher income levels presenting higher mobility per person. Differences are very high, despite social and economic discrepancies among social strata. In addition, males are more mobile than females, and this is related to different employment rates according to gender and to the division of tasks in the household.

Trip Purposes and Modes

There is a positive relationship between income and diversity of trips, with high income levels being involved in more activities other than work/schooling (e.g. leisure). Public transport use decreases, and private transport use increases remarkably with income. Walking trips are present in all income levels, more noticeably in lower levels. All conclusions are again consistent with the previously mentioned studies.

Individual and Household Consumption of Time and Space

Daily travel time per person varies from 52 minutes to 81 minutes, however they seem to remain constant around 75 to 80 minutes for income classes III to V, when the use of the automobile is already very important. Corresponding values per mobile person appears to be constant (about 110 minutes).

Space consumed daily by households increases remarkably with income, from a minimum of 21 km to a maximum of 63 km (200% increase). Corresponding figures per person present the same pattern, despite being less pronounced (165% increase). Figures per mobile person also increase with income, but much less steadily, from a minimum of 13 km to a maximum of 20 km (54% increase). These sharp differences reveal distinct strategies to use space, according to specific social and economic conditions faced by people. They can be assumed to reflect the profound social differences inside Brazilian society.

Average distance per trip presents low variation, however when walking trips are excluded, distances decrease as income increases. Travel time for working trips decreases remarkably as income increases.

Hence, upper income people consume much more space than lower income people: while very poor households consume 6.5 km per day per person (76% by public transport), very rich households consume 17.2 km per day per person (69% by car). This raises important equity concerns related to who pays and who benefits from road investments.

Considering the use of the automobile to consume space, levels IV and V are those for whom most of the space is consumed primarily by using cars. On a metropolitan scale, they account for almost 25% of people, which means that 75% of households still rely mainly on public transport and walking to consume most of the space.

Consequently, implicit overall speeds (door to door) also vary remarkably among income levels: while upper income sectors go from origins to destinations at an overall average speed around 11 km/h, lower income sectors do so at 7.5 km/h.

Costs

Monthly expenses with urban trips increase sharply with income, as a result both of higher mobility levels and the use of more expensive modes such as the automobile. However, the proportion of travel expenses in relation to household income decreases as income increases (from 24% to 13%). At the two lowest income levels, for whom public transport is essential, expenses with public modes far exceed the 6% limit implied in Brazilian laws concerning the provision of travel vouchers by employers. This is related also to the use of public modes by unemployed people and by people working at the informal labour market (where such laws do not apply), and to travel purposes other than working.

Collective Use of Space

The circulation space is primarily consumed (linear distances) by using public transport modes (63%). Automobile-consumed space accounts for 30% of total consumption while space consumed by walking represents just 7%. In a city where pedestrians account for 60% of traffic fatalities (CET, 1992), this latter figure attests the implicit violence in using road space. When linear distances are translated into physical areas occupied per person, sharp differences appear: high income people use 8 times more street space than low income people, implying important equity concerns.

Transport Conditions of the Poor

When all data are taken into account, it is possible to assess transport conditions faced by poor people in São Paulo. For the purposes of this paper, the two lowest income groups described in the above tables (income up to $480 in 1987) are considered 'poor', (this corresponds to 49% of total population).

- Mobility: lower income people make half the number of trips compared to high income people (all trips), and from four to three times less if only motorised trips are considered. Males are more mobile (as happens in all income groups);
- Immobility: persons not making outside trips correspond to more than 50% in the lowest income level (57% of the female population), as opposed to 24% in the highest (33% of the female population);
- Travel purposes: the lower mobility of the poor translates mainly into less work/business, shopping and leisure trips than those of the higher income strata;
- Transport modes: people from the poorest households use much more public transport (with corresponding walking trips) than wealthier people;
- Time budgets: time devoted to travel among the poor who make outside trips is similar to that of all other people; however, when all persons in the household are considered, corresponding travel times are much lower than that of higher income groups, reflecting less activity and less people making outside trips;
- Speeds: people using public transport spend much more time getting to the vehicle and travelling through the streets. For work trips, people from the poorest households spend 70% more time travelling than those of the higher income households;
- Space budgets: people in lower income households travel three times less linear distances per day than those in higher income households. Daily distances per mobile person are 35% lower between the two income extremes. When average in-vehicle space is considered (according to the specific transport mode used), the total daily roadway area consumed by the poorest households is more than eight times smaller than that of the richest households;
- Distances and transport mode: distances per motorised trip are 45% higher for the poor, reflecting higher distances between home and final destinations (mostly work sites). The poorest travel 76% of the distances using public transport, while the richest travel 69% of the distances using automobiles;
- Expenses with transport: the poorest spend 23.4% of their income on transportation, as opposed to 12.9% for the richest;
- Safety: more than 60% of traffic fatalities are pedestrians. Considering that low income people walk much more than high income people, it is possible to say that the minority using cars affect the majority not using them;
- Pollution: poor households throw into the atmosphere twelve times less carbon monoxide per day than high income households;
- Comfort: poor people face mostly uncomfortable conditions, due to frequent overcrowding of buses and suburban trains.

How current conditions were created

Current conditions were created by the conjunction of policy and individual decisions. The way the space is organised and the conditions offered to use transport modes influence individual choices. For those pertaining to low income groups, public transport becomes the single option. For those with better economic conditions, the decision to use automobiles intensively occurs as a consequence of the relative ease of access to it, coupled to the relative disadvantages of using public transport.

In developing countries in general - and in Brazil in particular - transport and traffic policies, coupled to economic and social policies, have crystallised remarkable differences between those with and without access to private transport. Most decisions had a common objective: to adapt space to the use of the automobile for selected social groups. The incentive to the automobile, coupled to the maintenance of poor conditions for public transport, rendered the automobile irreplaceable for middle class sectors (Vasconcellos, 1997a). Class divisions were reinforced in the streets, as society was divided into two separate groups - those relying on public transport and those providing for their private transport.

Current inequitable conditions were

generated through a series of policy decisions:

Infrastructure Provision
The dominance of the automobile was supported by the myth that road investments are made in the public interest. Large economic resources were applied in roadway expansion based on the myth that roads would be evenly shared by all. However, the mere provision of streets does not mean that people will be transported: if public transport is not made accessible for all, then streets are just private means of consumption awarded to selected groups, but constructed and maintained with public resources. This is dramatically shown by the sharp differences in space consumption according to income (see tables 8 and 14). Often, the myth of roads as public assets is accompanied by explicit condemnation of transit subsidies as heretical and by continuous pressure to make public transport systems survive on their own - which often implies overcrowded buses and low frequency services - while the hidden subsidies to automobiles remain untouched.

Access to Public Transport
The persistent poverty of most people, coupled to an often rigid market approach to the supply of public transport, generated a permanent conflict between accessibility, fare level and business profitability. As a consequence, supply is permanently subject to instability (White, 1990; Figueroa, 1991) and spatial and time coverage are often limited by the need to ensure profitable operation, leading to long walking and waiting times. Another effect is the tendency to dilapidation of the fleet, with direct impacts on passenger comfort and safety as well as on the availability of vehicles for daily operation.

Access to Private Transport
Private transport was made accessible to selected sectors - the new middle classes created by the income concentration process which characterised Brazilian economic development. Access was facilitated through bank credit and the organisation of vehicle consortia, where people belonging to a group paid monthly instalments in order to have a car. The possession and use of the automobile was also facilitated by extremely low license and insurance taxes (about $100 a year), plenty of free parking space on streets and often low gasoline prices (currently, about $0.80 a litre). (Auto owners also pay an annual property fee which varies regionally. In the state of São Paulo, the wealthiest in the country, the fee is about $300. Annual costs (for those who do pay the taxes) can then reach the $400 level, which is about 3% of the vehicle's market value.)

Travel Time
Abusive consumption of street space by automobile users was facilitated following the liberal concept of indiscriminate use of private property. The mere possession of a vehicle gave owners the right to use streets at will, without any consideration about social costs and externalities. This overconsumption occurred both dynamically (circulating) and statically (parked on public space) and was directly supported by large resources directed to improve overall traffic conditions in the city (Vasconcellos 1997b). Meanwhile, few effective priority measures were applied to bus operations, even though most kerbside bus lanes implemented in the 1980s had little effect on average speeds (CET, 1982). Even important bus corridors - like the Santo Amaro/9 de Julho convoy system - were progressively abandoned, losing most of the initial benefits. Large resources were applied to increase road capacity for automobiles, while leaving buses to their own fate, struggling for road space. As a consequence, buses continued to lose any reputation of reliability, and their patronage.

Accidents
In developing countries, contrary to widespread beliefs, accidents do not result primarily from lack of education, generalised disorder or bad vehicle maintenance. They result mostly from the inherently dangerous environment which was generated by the appropriation of space to the needs of automobile users. The paving or creation of grid-pattern, wide streets and roads crossing densely used pedestrian spaces, coupled to deep political differences among social groups and classes (which translates into different was of using space) and to the absence of effective enforcement and justice, rendered space in developing countries a very efficient accident-production environment. As stated previously, most fatalities are pedestrians. This is aggravated by the contradiction between formal traffic education and actual conditions on streets, once disrespect for traffic laws and lack of punishment are the rule.

Air Pollution
As a result of both excessive use of

automobiles and automobile-generated congestion, emissions of air pollutants are high. In addition, automobile emissions for a long time were uncontrolled, although legal limits introduced just ten years ago are starting to produce results. Finally, control of on-street emissions remains nonexistent, except for diesel trucks and buses (Cetesb, 1994) which, because they emit the most visible pollution, easily attract public and media attention.

Policy Disco-ordination

Most agencies in charge of policies influencing transport conditions act independently, with loose hierarchical or legal linkages. The problem is especially severe with respect to land use and its impacts on transport demand, and with respect to the relationship between agencies in charge of public transport and traffic. In the case of São Paulo, the disconnection between these agencies helped to keep bus traffic at very low levels of service. At the metropolitan scale the problem is even worse, once state and local authorities conflict on how to manage common decisions.

The Crisis of the State

In addition to these factors, the urban transport problem has been aggravated recently by the state's economic difficulties and the corresponding attempt to either deregulate or privatise transport services. At the institutional side, the state seems to be leaving aside its primary planning role, relying on the supposed capability of the private sector to assume financial risks and planning tasks. There is an implicit assumption that the market and the private sector can replace the state in ensuring adequate transport services. On the economic side, the fiscal crisis hinders support to efficient public transport systems and to distributive social policies. Large transport infrastructures, which rely on public investment, are becoming less feasible and subsidies to special groups are subjected to increasing opposition. The crisis is also related to the continued poverty of most of the population, which prevents people from having access to convenient public transport. Both problems are sustaining an ongoing crisis in the supply of adequate public transport modes and consequently have been supporting transport deregulation and privatisation proposals. However, transport conditions continue to be inadequate.

Alternative actions

Although some problems lie beyond the scope of transport policies (e.g., persistent poverty), many actions can support the creation of a more equitable and efficient space. The inequities and externalities which occur in São Paulo, as well as in most large cities of the developing world, can be altered only if the use of space is politically contested and hence urban, transport and traffic policies are changed fundamentally. Despite the persistence of unbalanced power relations within society, there is a clear emergence of movements intended to promote real changes, mostly based on the expectation about improving quality of life.

The reorganisation of urban transport has to be pursued to ensure a more equitable, safe, convenient and comfortable appropriation of space. The basis to redefine the use of the street shall be the commitment to preserve safety, improve quality of life and ensure proper operating conditions for public and non-motorised transport modes. The central point for this reorganisation is the questioning of abuse by the automobile and the consequent imposition of new criteria for dividing public space. This does not mean to abolish automobile technology but rather to control it within acceptable limits related to concerns about equity and quality of life.

Within the large set of alternative actions, the most important are those that would reorganise space in order to respect the rights of the majority, as follows:

Infrastructure Provision

Public resources have to be used to provide circulation space for the majority. This requires priority allocation to public transport and pedestrian traffic. All-purpose major roads are often needed in fast growing environments like those of developing countries. However they should be provided as part of comprehensive road planning efforts that respect the needs of the majority to efficient transport, especially public and non-motorised transportation. All investments on roads should be carefully analysed to determine the real beneficiaries. Part of the resources that seem to be lacking for public transport will appear if road investments are scrutinised.

The Use of the Street

The highway and street systems are collective assets, to be shared by all. No one has the right to circulate at will, regardless of others' needs and interests. No one can be allowed to misuse this collective asset, simply because of an alleged need to have access to motorised transportation. The use of these systems shall therefore be defined according to priorities given to the most numerous and vulnerable roles, which in developing countries are indisputably the pedestrian, the cyclist and the public transport passenger. This need not entail eliminating private transport, but will require submitting it to other's needs and interests. Direct restrictions can be raised through traffic management measures and indirect restrictions may be raised by compensating costs and externalities imposed by automobile owners to society through economic or fiscal measures, as in the case of parking fees, license taxes and road pricing. However, it has to be acknowledged that these restrictions, if properly applied, will inevitably have dramatic consequences for those relying on private transport.

Priority to Public Transport

Transport provision should be altered to ensure physical and operational conditions so that public transport systems can provide high levels of accessibility and achieve their maximum potential (e.g., maximum 5 minutes walking and waiting times, and bus speeds about 20 km/h across the entire network). This requires reorganisation of lines and bus stops, elimination of physical barriers, provision of special signs and signals and tough restrictions on illegal parking and loading and unloading activities. Public transport and traffic departments should be united and daily traffic operation should be organised around pedestrian and public transport needs, rather than solely private transport needs.

Safety

The complexity of the problem requires that the issue receive priority attention, as the most important environmentally related aspect of transport in developing countries (Vasconcellos, 1997c). A series of measures may be adopted (Goldsmith and Vasconcellos, 1995):

- reorganising enforcement by training a specialised force, changing the enforcement logistics and providing appropriate equipment. Enforcement actions should be directed mainly to aggressions to pedestrians, speeding, drinking and driving, and poor maintenance of vehicles;
- reorganising the judicial system to ensure the punishment of grave traffic offences by speeding up sentencing procedures;
- reorganising traffic education to supersede the contradiction between theory and practice which renders education nonsensical. Education will be socially valuable only when the circulation space is capable of mirroring the priority given in the law to the most vulnerable roles. Education will be effective and meaningful only when people feel that proper behaviour will be rewarded and improper behaviour will be punished;
- protect pedestrians from automobiles through a series of physical and operational measures, mainly those minor physical adaptations to increase overall safety conditions: the building and enlargement of sidewalks, the narrowing of intersection approaches close to pedestrian areas, the lighting of pedestrian crosswalks, the building of intermediate islands in large crosswalks, etc.;
- protect collective living areas from undue traffic by reorganising circulation. This can be accomplished initially at the neighbourhood level through circulation plans discussed with local communities. These plans may be highly successful if they manage to profit from the recent, strong commitment to quality of life among the middle class;
- control automobile speed in the entire street system, either through direct enforcement or physical barriers and speed deterrents.

Air Pollution

Air pollution problems can be minimised by reducing total automobile emissions, increasing the share of public transport on total trips and reducing the need for motorised transport. In the first case, major efforts have to be made to control vehicle emissions, through legal and technological measures and the organisation of periodic vehicle inspections. In the second and third cases, improvements may be made by combining several measures described above.

Conclusion

The analysis of distributive and equity issues in urban ground transportation requires a proper understanding of actual transport conditions faced by people and especially of the differences found among them. These differences are related primarily to individual characteristics, such as age, income, gender and level of formal education. However, they also derive from the way urban and transport policies are designed and implemented.

The analysis of current conditions in developing countries show that accessibility is deeply biased towards those with access to private transport (who enjoy access to a much larger diversity of destinations and activities), as compared to low income people. Conditions to use space are also highly biased, while safety, comfort and convenience vary remarkably between those with and without access to private transport.

Three important conclusions arise:

- *First,* poor transportation conditions are mostly class-based: few people with access to cars impose grave impacts on others, such as delay to transit users, fatal traffic accidents and air pollution.
- *Second,* these effects are not compensated and remain as externalities created by the unrestricted use of the automobile based on the supposed right to mobility and freedom.
- *Third,* current conditions also derive from two related approaches to transportation infrastructure supply: while automobile use is supported by the myth of road investment as a public interest, transit subsidies are considered unacceptable.

Therefore, the actual possibilities of change rely on taking new approaches to equity and distributive aspects of transportation supply.

- *First,* a radical change in financing transport infrastructures must be pursued: road investments should consider primarily broad equity issues on who is paying and who is benefiting from them.
- *Second,* the use of the street should be radically transformed, to ensure priority to the most numerous and vulnerable roles. In developing countries, this means protecting pedestrians, cyclists and transit users, while restricting automobile use.
- *Third,* major efforts are required to improve safety for the most vulnerable roles and new legal and technological measures are needed to improve environmental quality.

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Sustainable Transport: Some Challenges for Israel and Palestine

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The terminology used in this article reflects the current political flux and difficulties. Some of the Arabs who came under Israeli rule in 1948 prefer to be called Palestinians, rather than Israeli Arabs, thus highlighting their historical and cultural affiliation. Yet, as the likelihood of a Palestinian state nears, 'Palestinian' is likely to carry national connotations which may conflict with these cultural/historical ones. For this reason, the author retains the admittedly problematic usage of 'Israeli Arabs' for those within the Green Lines, and Palestinians for those who came under Israeli rule in 1967.

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Abstract

With the establishment of Palestine and the continuing peace, there is a need to appraise the transport infrastructure and policies of both countries. In particular, will Palestine follow Israel along the road to mass motorisation or will it choose the path to sustainability? Will Israel realise the folly of providing for private transport and seize this unique opportunity?

Keywords

Israel, Palestine, sustainability, peace

Introduction

PLANNING for environmentally sound transport in Israel and Palestine faces major uncertainty and challenges. As income levels and expectations rise, will planners be able to learn from - rather than replicate - the past transport mistakes of other parts of the world? How will global transport trends play out in the region's unique spatial and demographic circumstances? Can Arab communities in Israel overcome their relative lack of resources to cater for their population's special needs and circumstances through forward-looking planning, or will their struggle for equality be an attempt to join the general Israeli rush toward mass motorisation and car-dependent lifestyles? What kind of physical configuration, political constraints, and population are Palestinian transport planners to plan for? Will the region continue to approximate an island in transport terms, or will borders open, and with what transport implications?

This essay reviews some of these questions with two emphases. First, through all the sectors I examine runs the theme of technological leapfrogging: the opportunities for societies with still low car ownership rates to learn from rather than repeat the mistakes of heavily motorised countries. Second, I focus on the relatively under-studied questions above. Thus, while challenges for sustainable transport within Jewish Israel are massive and fascinating they have already received considerable treatment elsewhere (See for example: Gur, Cohen, and Zaaga, 1996; Solomon, Gur and Feitelson, 1996; Fletcher and Garb, 1998; Hashimshoni, 1998). My discussion of them is therefore briefer than that of less examined challenges (the Arab sector within Israel, the emerging Palestinian state, bilateral and regional transport issues).

Israeli transport at a crossroad

Israel is at a transportation crossroad. Over the last decade or so, the country has been embracing the kind of mass-motorisation trends that other advanced countries are, belatedly, coming to regret and attempt to reverse (Whitelegg, 1993; Wegener, 1997). The number of vehicles on the country's roads is growing at 6-7 percent per year, while use of public transport (primarily diesel bus) is rapidly declining with eroding prospects of rail taking up a substantial portion of this decline in the short to medium term. Land use is increasingly catering to and generating car-dependent lifestyles, in which travel to work, shopping, and recreation involves large amounts of private car travel. Thus an increasing portion of transport is based on environmentally inefficient modes, with attempts to clean these up (through cleaner fuels and catalytic converters) hampered by lack of enforcement and maintenance, and swamped by other trends such as a wildfire shift to diesel cars and an ever-growing fleet.

All these trends fly in the face of the aspirations of the emerging generation of sustainable transport planning. This aims to reduce the total amount of travel required for satisfying lifestyles, to ensure that as much of this travel as possible is conducted on more environmentally-efficient modes (rather than private cars), and to make sure that all modes

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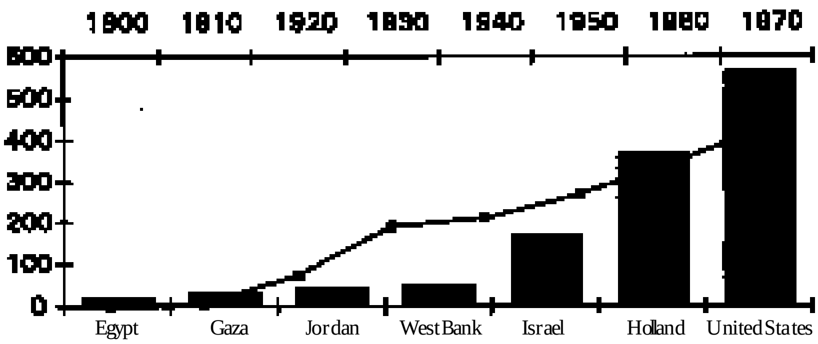
are as environmentally efficient as possible. Even as the government subsidises car travel and road building, and underfunds alternative infrastructure, many government officials and planners plea their inability to stem the growing 'need' for the car travel which these policy measures create.

This lack of policy vision is particularly worrying in a small, hyper-dense country like Israel, where even today's relatively low motorisation rates (cars per thousand people) translate into exceptionally high motorisation impacts (cars per square kilometre).

Israel's 'lag' in motorisation is a golden opportunity to leapfrog over outmoded technologies, a gift rapidly being squandered. Instead of continuing to direct transport infrastructure investments to stop-gap road-building, they must be redirected to the much talked about but little implemented measures that can increase sustainability. These include the management of travel demand, raised fuel taxes, congestion pricing, parking restrictions in city centres, and the provision of light rail and improved bus service (routing, frequency, reliability, dedicated lanes in key places) in order to give public transport a genuine competitive advantage. A central priority is providing alternatives to single occupancy vehicle commuting.

Because car-based transport competes with more sustainable alternatives for funds, passengers and land use patterns, investments made over the next five years will shape Israel's transport future for a generation or more. The country can little afford a 'realism' that throws up its hands in the face of increasing car use; these trends are anachronistic and unsustainable, and international experience has shown that they can be slowed and reversed with imaginative and bold policies and planning (Fletcher and Garb, 1998).

Figure 1: Current motorisation rates in selected countries (bars) compared to U.S. historical motorisation (line) (Private cars per 1000 population).



Sources: U.N. statistics & Rae, The Road and Car in American Life

Arab communities within Israel: aiming for more than just a fair share of car-dependency

In Israel, Jews and Arabs live spatially apart. Ninety percent of the country's Arabs live within separate towns and villages, with many of the remainder living in separate neighbourhoods within mixed Arab-Jewish cities (Gonen, 1995). Arab communities within Israel have different motorisation and land use patterns, less access to resources and planning facilities, and different travel needs, so that their transport future deserves separate discussion (Fletcher and Garb, 1998; Khaimaisi, 1995). Currently, the number of cars per 1000 people in Arab communities is 35% that of Israel as a whole (due in part to larger-than-average family sizes), though the rate of motorisation is growing twice as fast.

Most Arab settlements have a village-like structure. This is due, in part, to the fact that the 1948 emptying or near emptying of the larger Arab towns now within the Green Line truncated the upper end of the settlement-size spectrum. And because many of the settlements that have reached the size of urban municipalities have done so through outward spreading of a village as the imposition of military administration from 1948 to 1966 reduced rural-urban and inter-urban migration to a minimum (Gonen and Khaimaisi, 1993). These settlements are characterised by low to medium density (single or double storey homes on relatively large plots). Many of these villages are still usually connected to the outside world with a single large road (often bisecting the village). Smaller windy streets feed into this with little hierarchical ordering of size. Central residential quarters and markets are historically designed for pedestrian and animal traffic, not motor vehicles. Because Israel imposes severe restrictions on geographical expansion, a variety of workshop industries metallurgy, painting, car shops, food processing and packaging) tend to be intermingled with residential housing, sometimes posing considerable environmental hazards.

With the decline of agriculture and the relative prosperity of Jewish urban centres, and especially since the lifting of movement restrictions when the military administration was abolished in 1966, Arab settlements became increasingly based on a commuting economy to nearby Jewish cities (Gonen,1995). Many of the transport challenges of Israel's Arab communities are shaped by these basic circumstances of extra-

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urban settlements that are structurally villages but function as working class commuting suburbs with respect to large Jewish urban areas.

The increasing number of cars moving and parking in these villages is incompatible with their traditional layout. Congestion has become a major problem, and with pedestrians ill-separated from traffic, accident rates are high. Widening and straightening of these roads invariably infringes heavily on private property, leading to conflict, and in some cases destroying the character of a towns' historic core. Through traffic often has no alternative but to pass through the town centre. As villages and towns expand in size (under considerable constraint and often in a poorly planned manner), they become increasingly car-dependent, especially in the absence of adequate public transport.

In response to these problems and a legacy of under-investment, some planners emphasise greater investment in the road system to relieve the growing transportation stresses in Arab villages: constructing a hierarchical system of straight, wide roads according to national standards, multiple road entries into villages, and ring roads around them. 'The solution for the transportation problems in these settlements', claims one of the few overviews of the topic, 'demands a correct planning, similar to that which is done for Israel's large cities' (Khaimaisi, 1995).

No doubt in some cases there is a need for new roads to serve new centres arising from much needed investment in Arab economic growth, and to divert traffic that is ruining town centres. But should catching up and levelling standards of road capacity be the primary emphasis? The challenge is not simply to attain a fair share of the development pie, but to use this share for a transport system that is forward-looking and suited to inhabitants' needs, not just mimicking of prevailing trends.

Thus, portions of some Arab villages retain the kind of pedestrian livability that contemporary transportation planners are struggling to achieve, and these will be threatened by mass motorisation trends. Israel's car-dependent suburbs are hardly a model for emulation. Can Arab villages and towns take advantage of their 'lag' in motorisation levels to build more sustainable transport planning? The priorities would seem to be the following: town planning that lessens the need for travel (retaining and strengthening mixed use zoning and opportunities for local work while removing hazardous economic activities away from residential and commercial areas); accommodating and encouraging pedestrian and bicycle access for daily needs, especially in town centres; and building a solid public transport system while the potential ridership is still very high.

Currently, intra- and inter-urban public transport serving Arab sectors is hampered by lack of access to national resources and co-ordination, and by orientation of the large national public transport carriers to Jewish needs. Buses are often limited to a service leaving the village to Jewish population centres in the morning, and returning after work (a pattern particularly restrictive for Arab women). In many cases a single bus line will pass through many villages, making travel slow. There is little radial connection between villages and buses are often old models that have been phased out of the fleets that serve Jewish cities.

Not only has there been a legacy of proportional under-investment within Arab communities, but it is doubtful whether a sufficient portion of Israel's planned transport investments over the coming years are designed to serve the special needs of the fifth of the country's population that is Arab. The proposed Trans-Israel Highway, Israel's largest ever transport infrastructure investment, to run the length of the country from the border with Lebanon to south of Beer-Sheva, has been much debated because of great cost, its land use and environmental impacts, and its questionable priority with respect to other urgently-needed transport investments. There are those who argue that the massive uncertainty as to these requires that the project be frozen pending the comprehensive analysis that was never done (Garb, 1997). The question of the project's value and priority is even more pointed with respect to Israel's Arab community, both in the central 70 km that are on the verge of construction, and the planned northern portions of the road through the Galilee.

While land for the road will be appropriated from both Jewish and non-Jewish settlements, the consequences for Arab villages may be particularly severe as they have suffered a series of expropriations over decades, and have less access to other land (mostly owned by the government and granted almost entirely to Jewish settlements) and to non-agricultural forms of income. In addition, Arab villages were far less involved in the project's conception, routing, and in planning to take advantage of development

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along the right-of-way, especially that which took place at less-than-formal levels. Unless something changes, Jewish kibbutzim and moshavim may be in a better position to plan around and utilise the road's consequences to their benefit, through the construction of shopping and business areas alongside (Khaimaisi, 1998).

Transport for Palestine: occupation, uncertainty, and the need for planning capacity

Compared to Israel, which occupied these areas in 1967, the transport system in the West Bank and Gaza has been shaped by decades of poverty, neglect, and constraint. Planning for its future is hampered by massive uncertainty and lack of institutional and material resources. GDP per capita in the territories is around around $1,600 (1996), average monthly wages are around $350, and are significantly higher ($530) for Palestinians employed in Israeli-controlled areas. Unemployment now runs at 28% and about one-fifth of the population lives beneath the poverty line of $650 annually (United Nations, 1997; Hass, 1998).

While a high quality road system has been built since 1967 to serve Israeli security needs and to link Jewish settlements with Israel, the road network serving the Palestinian population is more or less the one inherited from Jordan in 1967, and now of a quality lower than one would expect even in developing countries of similar income levels. Maintenance of the latter is so poor that 40% of these roads are regarded by the World Bank as requiring immediate rehabilitation if they are not to be lost (World Bank, 1993).

Vehicle ownership has been increasing at a rate of 10% annually over the last two decades, though levels are still far below Israeli levels, themselves lower than developed counties. More than half of the fleet is over a decade old resulting in high pollution levels in urban centres.

Public transport is entirely road-based (buses, vans, and shared taxis) as all rail service ceased in 1948. These services are entirely in the hands of a multitude of private operators; the bus fleet of about 780 vehicles, for example, is owned by some 100 private enterprises, 70 of which own only a single bus. They are under great financial pressures: new buses and spare parts for them are very expensive; credit is limited; competition from cars and vans providing unlicensed passenger services is fierce; and comprehensive and internal closures have disrupted travel of people and goods on almost 30% of potential annual working days in the last couple of years (United Nations, 1997). Trucking of freight faces similar problems. While Israeli bus lines link Jewish settlements to Israel they provide little service to the Palestinian population.

The only port in the Palestinian areas is Gaza. Serving small boats at the turn of the century, the port became increasingly marginal after Haifa became the main port during the British Mandate, and the Gaza strip's isolation after 1948. Though modern port facilities with spare capacity exist along the Israeli coast at Ashdod (30 km north of Gaza) and Haifa, as well as at Eilat and Aquaba, a deep-water port is planned for Gaza on grounds of national sovereignty. This would have major environmental impacts. It would be inserted into an open beach near one of the world's most crowded cities, and would entail transport of goods through a densely populated area. And, by blocking transport of the northward flow of Nile sands, which now replenish those constantly eroded from Gazan and Israeli beaches, the port would strip these down to bare rock in a decade or so (Watzman, 1995). While international financing is likely to be available for the port's construction, there are still no commitments to the million dollars needed annually to pump sand around the port obstruction.

The only active airport in the Occupied Territories is now operated by Israel at Qalandia, between Jerusalem and Ramallah. The World Bank has urged the rehabilitation of this airport (at an estimated cost of $250 million dollars) to serve international traffic to the Palestinian Authority, whether through transfer of the airport to the Authority or some shared arrangement resulting from Israeli-Palestinian agreement (World Bank, 1993). However, the very reasons cited for the site being a 'highly suitable' location for such development - its centrality, within a 15 kilometre radius of 20% of the total Palestinian population - would become a real problem once air traffic expands beyond the few daily flights currently using the airport.

The construction of an airport in southern Gaza, near Dahania, is currently a major item in negotiations; the Palestinian Authority is demanding autonomous air traffic, and Israel is concerned about the security implications of unmonitored passengers and cargo entering Gaza by air. If built, this airport would expand Palestinian freedom of

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movement, but for only a tiny elite. Most Gazans will remain confined in the tiny Gaza strip until arrangements are made for 'safe passage' between Gaza and the West Bank. The latter is one of many instances where 'security' or geostrategic considerations swamp sound planning principles in the region. Although Gaza and the West Bank are already connected by roads, the perceived need for an isolated passage for Palestinians through Israel has generated a range of schemes, including those of questionable environmental merit, most recently exemplified by a proposal for a sixty kilometre-long raised bridge.

Repeatedly, transport planning for Palestine comes up against the fact that a cornerstone of the Israeli occupation, especially over recent years, has been the severe management of Palestinian mobility coupled with the preservation of freedom of movement for Israelis within the Territories. Transport plans cannot, therefore be separated from issues demanding political resolution, and planners must work with uncertainty regarding critical questions: will the transport-related components of the Peace Accords (safe passage between the West Bank and Gaza, a port, an airport) be implemented fully? Will Palestinians have control over their ability to travel between the currently fragmented pieces of their own country, and will they be able to travel into Israel? Will the extensive new high quality roads designed to allow settlers to live in the Territories without encountering Palestinian residents, continue to operate, and what will their relation be to the old, inconvenient and poorly-maintained road system that serves Palestinians?

Given this uncertainty, and the institutional capacities that were impoverished over decades of Israeli military and civil administration, the World Bank's proposed short term strategy seems wise: to produce transport planning capacity, rather than a transportation plan (Khamaisi, 1994). Similarly, its emphasis on attending initially to municipal transport needs in areas under Palestinian control makes sense. However, it is important that this training and capacity-building, initial municipal-level work, and longer term planning be founded on principles of sustainable transport.

Without this sustainable emphasis and training, it is likely that transport improvements will focus on improving the extent and quality of the road system (accommodating and encouraging private use) and on autonomy-giving port and airports, at the expense of less obvious and longer-term measures. The former is the principal emphasis in the few existing planning documents, which predict that political independence will bring a drastic rise in income levels, car ownership and use, and volumes of traffic (See, for example, the 'Transport and Communications' chapter of *Master Planning for the State of Palestine: Suggested Guidelines for Comprehensive Development* Center for Engineering and Planning, Ramallah, 1992). Measures of equal or greater importance - such as public and non-motorised transport, and the design of pedestrian-friendly city centres and mixed use neighbourhoods that reduce the demand for travel - receive far less attention.

One can imagine a scenario of continued high population growth rates, increased incomes and social stratification, and the easing of Israeli restrictions on building and travel, together contributing in short order to a wave of unregulated and car-dependent sprawl that will precede and soon pre-empt more sustainable alternatives. Such planning issues would challenge any society, so with scarce resources, high uncertainty, and massive external constraints, Palestinian transport planners have their work cut out.

Yet, precisely because it is starting late, this fledgling state can avoid building yesterday's transport problems into its future. In doing so, it will reduce the long term liabilities of mass motorisation, which have become clear over recent decades. Lessened car dependency would reduce travel related health costs, slow the destruction of open areas and communities through road building, free up salaries for investment rather than car purchase and maintenance, and avoid building into the economy a constant drain of foreign currency for the purchase of cars and fuel. An increasing number of examples from around the world show that progress and motorisation need not be equated (Hook, 1996).

In Gaza, these issues are especially pointed. With astonishing population densities, any rise in motorisation rates will make life there even more hellish, especially since these vehicles are and will most likely continue to be older and more polluting, acquired second-hand from Israel. Gaza is flat, with reasonable weather, low incomes in the foreseeable future, and very high population densities: an ideal site for non-motorised and public transport. But unless the demand for sustainable transport arises from within Gaza itself, and is recognised as cutting edge and compatible with raised standards of living, any talk of animal and human-powered transport may be rejected as an external attempt to preserve 'backwardness'.

Co-ordinating Israeli and Palestinian Transport

A looming yet largely unconsidered transport challenge - also characterised by crippling levels of uncertainty - is the co-ordination of Israeli and Palestinian transport plans. Though these two tiny countries, with segregated populations, markedly different wage rates, and dissimilar levels of environmental legislation, monitoring, and enforcement share long often porous borders. Yet there is little co-ordination of the transport-related consequences of the considerable flows of workers, vehicles, pollutants, and land use influences cross across these.

Even with the stringent restrictions on travel to work within Israel currently in force, close to 100,000 workers cross into Israel for work daily, and truck traffic (not including Israeli vehicles) is about 900 vehicles a day (Israel Foreign Ministry, 1998). The structural conditions underlying this daily flow of people and goods are unlikely to change soon. Not only is the current and future daily labour migration fraught with social and equity challenges, but there is little systematic thought about its implications for sustainable transport in both countries, and almost no collaborative planning for it.

Open borders between an independent Palestinian state and Jordan might decrease the dependence on Israel somewhat, but barring barely conceivable physical or military barriers, overall volumes can only increase as Palestinian and Israeli populations grow. Recent estimates carried out by the U.S. Census Bureau and the Palestine Central Bureau of Statistics show the Palestinian population in the West Bank (including East Jerusalem) at around 1.5 million, with 900,000 in Gaza. The combined population is expected to reach 3.2 million by 2012 through natural increase, with an additional 415,000 possible due to immigration in the wake of substantial developments in the peace process (Zureik, 1996). The resultant daily commute may be massive - one estimate for the year 2020 yields 40,000 people an hour from Gaza northward during peaks, 25,000 along the Hebron-Jerusalem-Nablus-Jenin axis, and large numbers from all the major West Bank cities to the border with Israel (Hashimshoni, 1998). The impacts of motorisation in Israel's crowded coastal plain are beginning to be felt in the adjacent Palestinian areas. By the time the nitrogen oxides and gas-phase hydrocarbons emitted by vehicles in the Tel Aviv region have undergone a series of atmospheric chemical reactions that produces ozone, they are tens of km inland, over the Jerusalem area, Palestinian areas, and even Jordan, with potentially serious health consequences (Luria *et al.*, 1994). Other imminent trans-boundary effects requiring collaborative planning are the pollution and land use impact of the proposed Trans-Israel Highway. This road is planned to run just a few km west of the Green Line between Israel and the West Bank for a good deal of its central portion. Anticipated to carry 100,000 vehicles a day in its central stretches, construction is planned to begin within a year. While project proponents have argued the merit of drawing polluting traffic eastwards, out of the Tel Aviv Metropolitan area, there have been no evaluations of the effect of this shift for areas east of the Green Line. And, just as the road is likely to be a massive magnet for development to its west, on the Israeli side, it could do the same to its east, within adjacent Palestinian areas. Yet the extent to which the project is being incorporated into Palestinian Authority planning is unclear.

Roads to peace?

While the political developments of the last few years are rendering such talk increasingly premature, the transportation consequences of future peace and the opening of borders must be thought about with social equity and sustainability in mind. These criteria figured little in the heady mixture of enthusiasm, mythology, and unreflective developmentalism that have characterised the visions of forward-looking politicians and planning committees thus far. On the whole, peace has been equated with stability and open borders for business interests, and with economic growth as classically defined. Its infrastructural correlates have tended toward grand circum-Mediterranean highways, and 'peace roads' linking regional capitals (Ecopeace Forum, 1997).

Shimon Peres, for example, is famous for his development-driven technocratic, free-market 'New Middle East', for which untrammelled car-mobility became one obvious metaphor (Peres, 1993). [However, in a recent (18th March 1998) interview session with students from the Arava Institute for Environmental Studies, Peres declared he had abandoned his long-held ideal of making Israel the infrastructural and transportation hub of the Middle East. A small and densely populated country, he claims, cannot afford these projects - regional highways should run through Jordan, not Israel!] Israel's current Prime-Ministerial candidate, Ehud Barak, when he held the position of Foreign Minister, defended his party's negotiations with Syria by painting a picture of 'full normalisation', in which 'tourists can travel from Israel to … Turkey and to Europe in their own cars', while a popular progressive columnist ended his plea for peace with Syria saying, 'What more do we need in order to be convinced that peace is a good deal? To give every Israeli a free lifetime supply of gas for trips via Damascus?'

Some of the grander regional road projects initially proposed will, no doubt, evaporate as soon as more careful feasibility studies are done. They are based, in part, on an image of Israel as 'the cross-roads of the Middle East', destined to become a regional transport hub. This image may be a largely mythical holdover from the past. Before motorised transport, when trade was far less global than today, foot and animal traffic relied on the land route through Israel with its unambiguous terrain and frequent water stops (See Hashimshoni, 1998). Today, however, the volume of trade between Arab countries is relatively small (only 2% of Egypt's imports are from other Arab countries, for example), and they have developed a transport network quite capable of handling traffic between them despite the post-1948 closure of the traditional route through Israel. Even the connection between Africa (Egypt and to some degree Libya) and Arab countries to the east is now made through the Sinai-Aquaba ferry. If anything, the 'desert route' of Jordan is more likely to become the regional transport avenue.

Thus the motivations for sweeping 'peace roads' proposals may be located not so much in real transportation demand as in international donor enthusiasm for projects that link the region's countries - especially Israel with its Arab neighbours (On these selection pressures see Cohn, 1997). This lack of real demand, combined with the stalled peace process, mean that the massive proposed regional network of peace roads is not an imminent danger.

Other issues are of more immediate concern: the acceleration of the already rapid growth in air traffic in the region, likely to occur if direct flights between countries become easier; the environmental impacts of road traffic at a few key crossing points; and the social implications of industrial relocation from Israel to take advantage of lower wages rates in neighbouring countries.

Because of it's unique characteristics and location, the pressures of regional transport developments will probably first be felt in the Eilat/Aquaba region, and it is here that anticipatory planning for greater cross-border movement is most advanced. This is an ecologically sensitive area and major tourist attraction at a point where Jordan, Egypt, and Israel are in close proximity. The unique coral reefs in the Red Sea Gulf are already under stress by shipping, there are plans for airport expansion and/or relocation, and two large road projects are proposed to facilitate trucking between Jordan and Egypt via Israel. The first is associated with the expansion of the Ein-Netafim checkpoint between Israel and Egypt, and the second with the construction of an Eilat Bypass 'Peace Highway' (Isgur, 1997). The latter would ease the impacts of traffic through Eilat, but at the possible cost of increased local air pollution, runoff from road surfaces into the Gulf, severance of wildlife movement, and scenic intrusion. A second pressure point may develop if significant volumes of shipping are redirected from Aquaba to the Mediterranean along routes within Israel to Haifa. Estimates suggest that this could initially comprise between 70 and 200 trucks a day (Hashimshoni, 1998).

Given wage disparities between Israel and surrounding countries, eased travel could increase firm efficiency, but also overall travel volumes and labour exploitation. As current processes in the textile industry indicate, Israeli firms may choose to relocate labour-intensive portions of their production cycle in Jordan and Egypt, leaving knowledge and technology-intensive portions in Israel, increasing the overall haulage volumes, the bulk of which is likely to be road-based. (For reflection on the environmental implications of European Union transport integration, see Whitelegg, 1993.) While such levels of integration lie far in the future for the Middle East, the patterns described there are suggestive.

Environmentalists and labour activists must work to ensure that their criteria are built into visions of a New Middle East, raising questions that are still barely heard. Can we ensure that the pricing of freight haulage reflects the full social and

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environmental costs of transport, so that decisions of local production versus import are rationalised? Can rail and sea transport (with the kind of inter-modal container-transfer now being developed) provide more efficient long-distance haulage in the long term than trucks along some routes? How will emission standards of heavy commercial vehicles, which will contribute the majority of pollution from cross-border travel, be co-ordinated among the region's nations? Can we ensure that increased mobility is not simply achieving flexibility for corporations at the expense of people and places?

Conclusion: Realising the Benefits of Latecoming

In a region so troubled, environmental criteria and careful planning have often been secondary to more 'pressing' agenda. Yet in different ways, each of the sectors mentioned (Israel, the emerging Palestine, Arab communities within Israel, and the region as a whole) will need precisely this kind of long-term systemic thinking if they are to not waste the moment of opportunity offered by still low motorisation levels. Israel began the 1990s with car ownership levels approximating those of the U.S. during World War 2, and levels in Jordan and the Occupied Territories were closer to those of World War 1. Can transport planning in countries utilise any of the things we've learnt about transport since then?

Without imagination, each sector can declare it impossible to argue with the inevitably rising demand for car travel, and so scramble to build the infrastructure that will meet and thus encourage this demand; each can regret not having the luxury to put long-term livability ahead of more urgent things.

With imagination and boldness, on the other hand, policy levers and wise investments might shape demand, rather than merely (and unsuccessfully) follow it; examples of successful and often less costly alternative practices can be emulated from around the world - including those in places grappling with their own constraints and emergencies. 'Lags' can be turned into gifts: relatively clean slates from which to build a different kind of future.

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Can Demand Management Tame the Automobile in a Metropolitan Region?

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Abstract

Demand management strategies can be an effective tool in taming the automobile. The approaches to demand management in four European cities; Zurich, Freiburg, Stockholm and Copenhagen; and Boulder, Colorado is investigated.

Keywords

Demand Management, alternative modes, land use.

Introduction

THE AUTOMOBILE continues to grow in its use and impact on cities around the world. For most American cities the dominant strategy to cope with traffic has been to increase the road capacity or shift traffic to less sensitive areas. This supply management approach has been criticised increasingly because, not surprisingly, it increases demand.

The alternative approach is to create options which manage demand. Data from different cities around the world show very different levels of automobile use and these are related quite clearly to the level of infrastructure provided for the automobile, to car dependent land use patterns and to economic factors (Newman and Kenworthy, 1989; Kenworthy *et al*., 1998). These studies suggest that demand management should be feasible. Governments and international agencies are hence suggesting demand management as a major strategy for municipalities (OECD/ECMT, 1996).

In regional science discussions economic factors are usually taken to be the most significant with the assumption that as incomes rise there will be an inevitable increase in the growth in automobile use (e.g. Gordon, Kumar and Richardson, 1989). Hence there is little point in developing demand management strategies based on limiting infrastructure for the automobile or even economic penalties as the income effect will overwhelm all attempts to constrain the car. Love (1992) even goes as far as claiming that the automobile is 'unstoppable' as it is an 'irresistible force'.

There is thus a conflict between these two approaches: the first suggests that public policy can be effective in managing demand, the second that consumer preferences for cars is far too powerful for any public policy aimed at curbing this insatiable demand. However, demand management can be an effective tool in taming the automobile. Five cities, four in Europe; Zurich, Freiburg, Stockholm and Copenhagen; and Boulder, Colorado have direct experience of demand management and all have been committed to policies aimed at achieving this for a number of years.

Table 1: A summary of automobile demand management strategies.

Traffic Calming:	Slowing traffic with physical devices and narrowing roads Slowing traffic with slow speed zones Slowing traffic with strong policing
Favouring Alternate Modes:	Increasing infrastructure for bikes, pedestrians and transit Decreasing parking and road capacity Social support for alternative modes, e.g. transit passes
Economic Penalties:	Paying more of full costs of car use through fuel tax or registration Congestion pricing on SOV's at peak time High parking fees
Non Auto Dependent Land Uses:	Growth management to prevent sprawl Urban villages around transit stops Mixed land use

Demand Management Strategies

There are a range of automobile demand management techniques or approaches that have been suggested, and these have been summarised into four categories as set out in Table 1 opposite.

These approaches will be used as the basis of examining the five case studies in this paper.

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Zurich (population in 1990 of 787,740), Copenhagen (population in 1990 of 1,711,254), Stockholm (population in 1990 of 1.64 million) and Freiburg (population in 1990 of 178,343) are examples of European cities that have made concerted efforts to tame the automobile through demand management whilst improving the quality of life of their citizens.

The fifth case study is of Boulder, Colorado which in 1990 had a population of 88,650. Boulder is located 42 km from Denver which is the regional influence with a sprawling population of 1.24 million.

Case Study 1: Zurich

In the last 15 years Zurich has had a spectacular increase in its transit service and managed to contain its growth in car use. The changes in Zurich have occurred despite substantial growth in per capita wealth to levels that are now considerably higher than average levels in U.S. cities (Kenworthy *et al.*, 1998). The approaches taken by Zurich are summarised in Table 2 below.

Zurich's main priority after extensive public consultation has been to expand their train and tram system, give transit priority at lights, co-ordinate interchanges, and undertake an aggressive marketing campaign based on its Rainbow Card. This created a new status for the transit pass which was given to employees rather than car parking spaces and the Rainbow Card has now become over 80% of the transit system income. This was done instead of a proposed expansion of the road system after public disquiet led to Cantons voting it out.

The other parts of their approach (i.e. trams, bus, rail, bikeways) are standard for many European cities except for the strong commitment to new urban villages around extended light rail lines which are some of the best car-free environments in Europe.

The co-ordinated campaign is so effective that the modal share of car trips in Zurich for the journey-to-work has fallen by 10% between 1980 and 1990. The strategy, says planner Willi Husler, was "to point out other better possibilities of use. That way we can fight a guerrilla war against the car and win" (Begbie, 1992).

Table 2: Zurich's approach to automobile demand management summarised.

Traffic Calming:	Regional traffic calming Extensive 30 km / h zones Enforcement
Favouring Alternate Modes:	Expansion of light rail system and bike / pedestrian lanes No extra road capacity, cap on parking Rainbow Pass for transit system
Economic Penalties:	Usual European fuel tax and registration No congestion pricing High parking fees
Non Auto Dependent Land Uses:	Containment of growth Urban villages around new light rail lines Some mixed use

Case Study 2: Copenhagen

The approach taken by Copenhagen is summarised in Table 3.

Copenhagen has had no growth in car-use in the old city for the past 15 years. At the same time it has been able to reverse the decline in the economic vitality of the city (Newman *et al.*, 1997). This has been achieved by resisting any attempts to create extra road capacity and to deliberately remove parking capacity at a rate of 3% per year. However this approach to infrastructure has been balanced by a strong commitment to bicycles with the result that the modal split in the city is about equal between cyclists, buses and cars.

Like many European cities Copenhagen had a lot of bicycle use early this century but unlike other cities it has not removed bicycling as it modernised and became wealthy. Car usage grew and threatened the more humble bike, but in the 1960s Copenhagen decided to stay with its bikes. The decision was reflected most of all in its rejection of a massive freeway system that had been drawn up for implementation as in most developed cities at that time.

In their place and at much reduced cost the city began to invest in cycleways and traffic management. Although they have only 300 km of separated bikeways (much less than in Amsterdam and other Dutch cities) the city has created safety and priority for cyclists by much cheaper means - paint on the roads and a successful education program that generated a 'culture of respect for cyclists'. Thus at every intersection there are blue strips for cyclists to ride in, giving them priority against all turning vehicles.

The result is a city where cyclists have safe and easy access comparable with other modes. Data on traffic accidents (Kenworthy *et al.*, 1998) show Copenhagen among the best in the world; this must have something to do with the 'culture of respect' generated for bikes which obviously extends to all other road users, especially pedestrians. The bike is now used by people of all backgrounds, ages and incomes.

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The latest innovation in Copenhagen is the City Bike program where colourful bikes are provided free (after a deposit is placed in the bike-holder like an airport baggage trolley). These bikes are paid for by commercial advertising and are maintained by the City of Copenhagen with assistance from the Prison system who collect and repair damaged bikes overnight. It is hard to find a free bike from among the present 2,500 bikes which are available but as the originator of the scheme, city administrator Soren Jensen, says: "When there are 10,000 bikes in a few years it will be a normal thing for anyone downtown to just jump on a city bike to move around the inner city".

But Copenhagen's contribution to demand management would not be understood unless it was seen as a part of an innovative social planning approach designed to make the city more attractive to pedestrians. Professor Jan Gehl describes the process by which Copenhagen began to win back its city over a 20 year period:

> "By the 60s American values had begun to catch on - separate isolated homes and everyone driving. The city was suffering so how could we reverse these patterns? We decided to make the public realm so attractive it would drag people back into the streets, whilst making it simultaneously difficult to go there by car" (Gehl, 1992).

As Copenhagen reduced central area parking by 3% each year they pedestrianised more streets and public squares. Each year they also built or refurbished inner city housing so people could make use of the new walking areas easily. They introduced into the streets all kinds of attractive landscaping, sculptures, and seating (including 3000 seats along footpath cafés). And each year, they introduced more buskers, markets and other street life and festivals that became more and more popular. As Jan Gehl said, "the city became like a good party".

The result has been not only a reduction in the traffic but growth in the vitality of the city area. Social and recreational activity has tripled in Copenhagen's major streets (Gehl and Gemsoe, 1996). And this despite pleas that: "Denmark has never had a strong urban culture", "Danes will never get out of their cars", "Danes do not promenade like Italians". Such pleas are heard around the world whenever a program to manage automobile demand is planned, but not all cities capitulate to it. Copenhagen is a living example that car culture is not inevitable or irresistible.

Case Study 3: Stockholm

Stockholm, which is one of the richest cities in the world, showed an absolute decline in car use in the 1980s in the global survey of cities conducted by Kenworthy *et al.*, (1998). Stockholm's aggressive traffic taming policies and actions actually produced a reduction in car trips by 229 km per capita. This cutback or reduction in car driving distance and car use was associated with a growth in transit from 46 trips per person. The data for Stockholm in comparison to 10 U.S. cities are given in Table 4. The approaches taken by Stockholm, are given in Table 5.

In examining how Stockholm managed to make such an impressive step towards taming the automobile it is hard to go beyond its strong commitment to land use planning with a transit-led development approach. The regulations which shape its planning mean that everyone lives within a short walk or a fast rail service to work.

The city is strongly contained in its growth patterns and has an emphasis on re-urbanisation which has a big effect on travel patterns. Data on population between 1980 and 1990 show an increase in the density of the central city, the inner city and the outer suburbs (Kenworthy *et al.*, 1998). This they achieved by building urban villages around their rail system in the inner city (e.g. South Station) and in new outer suburbs (e.g.

Table 3: Copenhagen's automobile demand management strategy summarised.

Traffic Calming:	Regional traffic calming but extensively pedestrian in city centre Extensive 30km/h zones Enforcement
Favouring Alternate Modes:	Emphasis on bike lanes and pedestrianisation No extra road capacity, reduction of parking by 3% p.a. for 15 years Culture of respect for bicyclists
Economic Penalties:	Usual European fuel tax but very high vehicle registration No congestion pricing High parking fees
Non Auto Dependent Land Uses:	Corridors of growth Urban villages around rail lines Mixed use in centres

Table 4: Trends in Stockholm and U.S. cities transport, 1980 to 1990.

	Car use (VKT) per person		*Transit Use trips per person*	
Year	1980	1990	1980	1990
U.S. Cities	8,806	10,870	74	66
Stockholm	4,867	4,638	304	348

Source: Kenworthy *et al.*, 1998

Skarpnak). These new developments are all dense, mixed use areas with a careful eye for the kind of design characteristics found in the old inner city of Stockholm. But most importantly of all they are built around a quality rail service that links up the whole city. They have been popular as places to live and work and have some of the highest transit levels found in the world.

Case Study 4: Freiburg

Another city which has shown that it is indeed practical to stop the growth of car use, even when car ownership is growing is Freiburg, Germany. Pucher and Clorer (1992) provide data which show how Freiburg's car ownership has risen from 113 per 1000 people in 1960 to 422 per 1000 in 1990, only a little under the average for the Zurich agglomeration, and only 14% less than the national average for Germany (481 per 1000). But as Table 6 below shows, despite this growth in availability of cars, car use has remained virtually constant since 1976. Transit passengers have increased by 53% and bicycle trips have risen by 96% between 1976 and 1991.

Freiburg's growth in car trips in 15 years was only 1.3%, yet total trips increased 30%. Freiburg's growth in mobility was supplied principally by increased use of public transport and bicycling. In fact, the share of trips by car reduced over the 15 years from 60% to 47%. Pucher and Clorer also show how the growth in car ownership has also begun to slow down (Freiburg had previously been higher in car ownership than West Germany as a whole, whereas now it is less).

The summary of Freiburg's demand management approach is given below in Table 7.

Pucher and Clorer attribute Freiburg's success at 'taming the automobile' to a combination of transportation and physical planning strategies:

> "First, it has sharply restricted auto use in the city. Second it has provided affordable, convenient, and safe alternatives to auto use. Finally, it has strictly regulated development to ensure a compact land use pattern that is conducive to public transportation, bicycling and walking" (p. 386).

Freiburg has restricted auto use through mechanisms such as pedestrianisation of the city centre, area-wide traffic calming schemes (citywide speed limit of 30 km / h in residential areas) and more difficult, expensive parking. Freiburg's improvements to transit have focussed on extending and upgrading its light rail system as opposed to buses. Buses are used as feeders to the light rail system. Land use regulations are similar to many other parts of Europe and have involved limiting the overall amount of land available to development and strictly zoning land for agriculture, forests, wildlife reserves or undeveloped open space.

Pucher and Clorer stress the important automobile use savings of the more compact urban patterns that have resulted from these latter policies. It is also worth noting that after the Second World War it was decided to rebuild Freiburg, totally destroyed by the war, on the old model, not on an automobile

Table 5: Stockholm's automobile demand management strategy summarised.

Traffic Calming:	Regional traffic calming but extensively pedestrian around each rail station Extensive 30 km / h zones Enforcement
Favouring Alternate Modes:	Strong commitment to transit Little extra road capacity Transit culture
Economic Penalties:	Usual European fuel tax and vehicle registration No congestion pricing High parking fees
Non Auto Dependent Land Uses:	Corridors of transit-oriented development (TOD) and no other growth Urban villages around new rail stops Mixed use in centres

Table 6: Transportation trends in Freiburg, Germany, 1976-1991

Transportation Factor	1976	1991	% Increase 1976-1991
Total daily trips	385,000	502,000	+30.4%
Total daily auto trips	231,000	234,000	+1.3%
Auto's share of non-pedestrian trips	60%	47%	n.a.
Bicycle's share of non-pedestrian trips	18%	27%	n.a.

Source: Pucher and Clorer (1993)

Table 7: Freiburg's automobile demand management strategy summarised.

Traffic Calming:	Regional traffic calming but extensively pedestrian in city centre Extensive 30 km / h zones Enforcement
Favouring Alternate Modes:	Strong commitment to transit and bicycle infrastructure Little extra road capacity Transit pass
Economic Penalties:	Usual European fuel tax and vehicle registration No congestion pricing High parking fees
Non Auto Dependent Land Uses:	Corridors of transit-oriented development and no other growth Urban villages around rail stops Mixed use in centres

dependent model. Pucher and Clorer note that even in the post-1960s period, as Freiburg expanded on flatter land to the west, the resulting development " ... is at a much higher density than outlying portions of American metropolitan areas", as well as being within easy reach of public transportation and well-served by bikeways.

Case Study 5: Boulder, Colorado.

Data on car usage in Boulder show that demand management efforts shifted 42% of former car users who travelled to downtown Boulder to other transportation options. This modal shift from the car to alternative forms of transportation took place over a four year period and included downtown employees and other individuals who lived in Boulder and made trips to the central business district to their place of employment and / or for shopping, eating, business transactions, recreation, or to simply watch other people, especially along the 1 km pedestrianised Pearl Street Mall. The alternative modes used include bus, bicycle, walking, car pooling, and shuttle service from outlying parking areas (park and ride).

In 1993 the Boulder City Council mandated that nearly 20% of the city's transportation department annual budget be reallocated away from car-related expenditures such as road widening, double turn lanes, more car parking, more stop lights, and better signalling to alternative mode functions. Over a fifteen year period this 20% budget reallocation will be dedicated to non-car alternatives such as smaller buses with bicycle racks, improved pedestrian crossings and footpaths, an expanded network of off-roadway bike paths for commuters, user friendly bus passes (the Eco-pass) for university students, employees, and entire neighbourhoods. A separate division called GO BOULDER was formed with a twelve person staff within the Transportation Department. GO BOULDER staff members carry out marketing campaigns, co-ordinate alternate mode innovations and work on regional traffic demand management schemes. Other cities throughout the Denver Metropolitan Area consult frequently with GO BOULDER staff in efforts to reduce Single Occupancy Vehicle (SOV) uses. Experiments are underway to implement peak pricing or congestion pricing of SOV during rush hour. Programs are in place to reduce traffic and speeding in neighbourhoods with roundabouts, speed bumps, photo radar, new small buses and private shuttle services using main transit corridors.

Specific car disincentive programs have been implemented such as doubling rates for car parking to more closely reflect car park land values, doubling parking fines, creating neighbourhood parking permits for residents only, and reducing the number of car spaces required in new residential and commercial development.

The encouragement of telecommuting, a citywide bicycle network, 300 free bicycles in the Central Business District (Spokes for Folks), Bike to Work weeks, and bicycle-mounted police officers are part of the demand management strategy to encourage non-car mobility.

The impact of Boulder's initiatives at the regional level comes as an unexpected surprise. The Denver Regional Transportation District (RTD) has installed bike racks on all 1400 buses. Bike paths are being designed with regional inter-city connections. Boulder is being included in plans for passenger rail connections because of the proven demand for alternative transportation modes. Other towns and cities in Boulder County and the Denver Regional Council of Government jurisdiction are either duplicating Boulder's car taming experiments or asking that they be considered. Traffic calming or car elimination is an integral part of land use regulation and zoning in Boulder's comprehensive plan. Mixed use development (work-live proximity), neighbourhood market centres, and rezoning of commercial land to

Table 8 Summary of Boulder's automobile demand management strategy.

Traffic Calming:	Extensive traffic calming including pedestrianisation of the city centre Slow zones (30 km / h in most residential neighbourhoods) Enforcement including digital speed displays, double fines in slow zones
Favouring Alternate Modes:	Strong commitment to bicycle infrastructure Hop, Skip and Jump bus system, new rail link, telecommuting, shuttles for kids Little extra road capacity allowed, cap on parking with assistance to park on CBD edge Eco-pass, free bikes, bus passes, computerised car pooling, flextime, four day week
Economic Penalties:	Usual European fuel tax and vehicle registration Congestion pricing for SOV's Double parking fees and fines Preferential parking fees for HOV's
Non Auto Dependent Land Uses:	Growth management and greenbelt Noise barriers and open land buffers Urban villages around rail stops Mixed use in centres

reduce car journeys and work-related trips began in 1997. Building permits which show no or little need for SOV use are given priority under the one percent per annum growth management scheme for Boulder (Havlick, 1997).

Even though the average length of car trips has increased in Boulder over the last five years, as it has in most Australian and some European cities, it is encouraging to realise public transport can capture car trips at the local level, and provide a potential model for change at a regional scale.

Boulder has had a policy to try and tame the automobile for the past ten years. It has done this through a range of strategies which are set out in Table 8. The HOP, SKIP, and JUMP bus system mentioned above in Table 8 is an example of metropolitan regional co-operation with the major mass transit provider in the Denver metro area. The large, diesel burning Rapid Transit District (RTD) bus service was very much underutilised in Boulder. They were seen as intruders and out of place in the streets of Boulder. They were seen not only as noisy, polluting and inefficient (most were empty) but also as anti-social. The staff of GO BOULDER and the Boulder City Council recognised this and began to work out an arrangement whereby the City of Boulder would help finance a colourful, fleet of small (24 passenger) circulator buses called the HOP in co-operation with the RTD. It was a very successful 18-month experiment which carried 1.5 million passengers.

As a follow up to the present HOP circulator buses, a major north-south RTD large bus route was replaced (again with city and University of Colorado student funding) by 15 small size buses called the SKIP, complete with bike racks and circulating on a 10 minute interval. The SKIP service began in August 1997. The third phase is called the JUMP which is planned to connect other nearby cities with direct express services to Boulder.

Conclusions

The idea that automobile demand management is a lost cause due to consumer preferences, that inevitably mean increased automobility, is not supported by the case studies presented in this paper. Consumer preferences are obviously a powerful force but in transport terms they are not inevitably just directed towards cars. The examples presented here show that people will respond given some realistic and suitable options. They are also going to respond to public policy which gives them options to be more environmentally responsible, e.g. the Eco-Pass and other similar initiatives in Boulder. These results would suggest that governments can be much more confident in proposing their automobile demand management strategies, particularly if they have a strong element of facilitating the common good.

In these case studies there is an important message for regional institutions, regional councils of governments, and even national governments which wish to show a reversal in the consumption of fossil fuels. The Montreal Accords on Chlorofluorocarbons (CFCs) and other ozone-related gases, and the concerns of the 1997 Kyoto Climate Change Conference can be mitigated, in part, with the encouragement and greater application of the case studies in this report. With the hope demonstrated in our exemplary cities listed above, and the potential spill-over effects in each of their large metropolitan regions, the prospect of regional sustainability is given encouragement. At the very least, the pragmatism of transport demand management is attracting serious attention in several metropolitan areas around the world.

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The Impact of Transportation on Household Energy Consumption

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The authors computed the values in this paper in British thermal units (Btu). These have been converted into in Joules and MegaJoules.
1 Btu = 1055.06 J = 252 calories
1 MJ = 947.81 Btu = 238.85 kcal

Abstract

This paper examines transportation energy costs as an integral part of total household energy consumption. A typical suburban household is found to expend more than half its total annual energy budget on operation of household motor vehicles. In contrast, households located in traditional, pedestrian-oriented neighbourhoods are found to use far less energy on transportation. For an instructive contrast, two household budgets were generated using a standard computer program and then compared. With transportation energies included, a household living in an 88 year old 'energy hog' house located in a traditional pedestrian friendly neighbourhood is shown to expend less total annual energy than a suburban household living in a highly energy efficient modern house. Studies and statistics developed in the Pacific Northwest are used as documentation for travel-related behaviour.

Keywords

Energy, Houses, Modal choice.

Background and General Approach

AT A TIME when home-buyers' and architects' interest in energy-saving technology and design strategies is once again on the increase, residential neighbourhood typology and its profound impact on levels of household energy use and pollution ironically remains an almost negligible concern for many 'green' practitioners and consumers. The intent of this paper is to examine annual transportation energy use as an integral part of total household energy budgets and to suggest certain changes as a result of our findings. Statistics and climatic conditions for the Pacific Northwest have been used, but the conclusions of the paper are applicable to all regions of the U.S.A.

Land use patterns that reinforce travel in single occupancy vehicles (SOV) are increasingly the Pacific Northwest's, and America's, preferred context for single-family residential development (Figure 1). As would be expected, vehicle kilometres travelled (VKT) per capita have also been steadily growing during this period of suburban expansion (Figure 2).

Figure 1: Populations of Idaho, Oregon & Wasghington living in cities and suburbs areas, 1950-90 (From US Census)

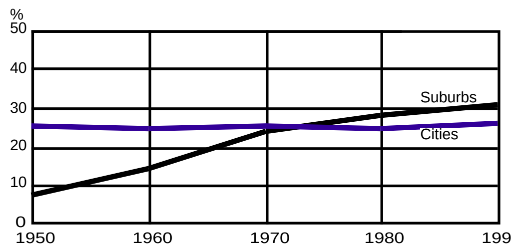
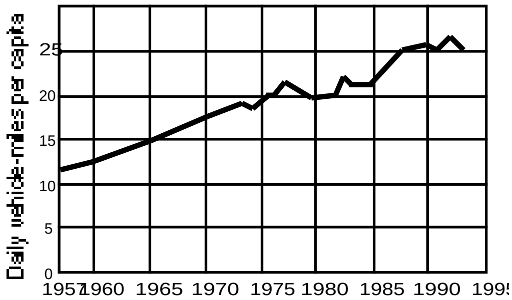


Figure 2: Daily distance driven per capita in Idaho, Oregon & Washington, 1957-95 (From FHWA Highway Statistics)



To document what fraction of a typical annual household energy budget is currently devoted to transportation, both automobile and household operating budgets have been converted to common units - Joules. Calculations included the energy lost as waste heat during the process of generating and delivering smaller quantities of useful energy. Thus, the energy consumed by an automobile is estimated by multiplying the number of litres of gasoline consumed by the entire average energy content per litre (36 MJ). In a similar way the energy lost when

Figure 3: Suburban house used in comparison modelling

generating electricity and firing a gas furnace (central heating boiler) is also included in the total budgets. The efficiency for electric power generation and delivery is estimated at approximately 38% and furnace efficiency is estimated at 70% (including fuel transmission loss).

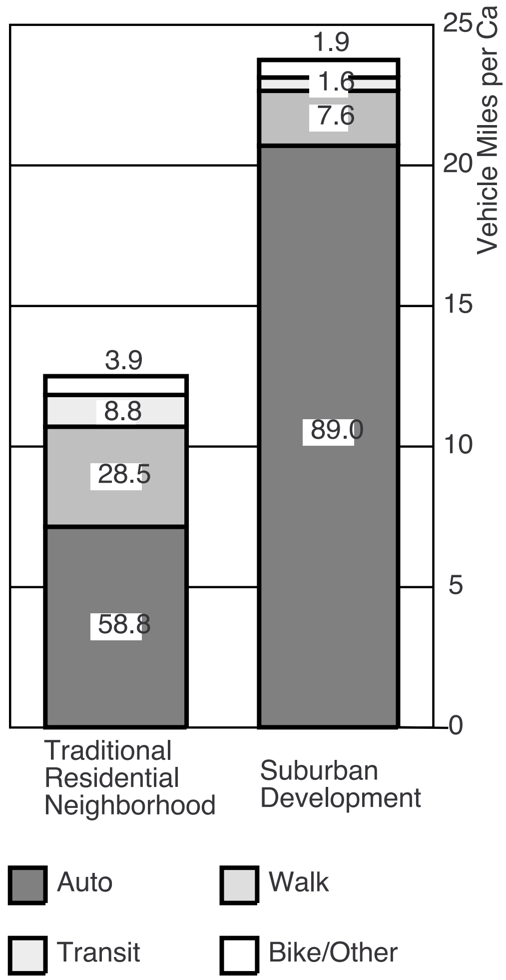
A Tale of Two Neighbourhoods

To illustrate how strongly neighbourhood type affects overall household energy consumption two contrasting residences in two different neighbourhoods have been selected. Reasonable household space heating budgets were generated using a standard computer program for building performance (Energy Scheming). Estimated yearly demands for all types of energy consuming devices and appliances using data from the Nevada Power Company were then itemised and added in to the basic calculations to arrive at total annual house energy consumption. Both houses were modelled with gas furnaces of equal efficiency, in use identical lengths of time, with thermostats set at the same temperature. All other energy consuming devices in each house were assumed to be electric, with equal loads, except as noted in the description of House #1 below.

Household #1 (Figure 3) lives in a 186 m^2 (2,000 s.f.) house (average size for new construction during 1995-96 in the six county area around Portland, Oregon) located in a suburban neighbourhood. Walking for utilitarian errands is not practical. Access to

Figure 4: Daily trip generation in the Portland area

(From Metro Travel Results, Portland, OR)



mass transit is inconvenient and use of a bicycle for transportation is intimidating. Based on averages from recent studies of aggregate odometer readings in this type of new suburban neighbourhood, household automobile usage is assumed to be 48,000 km (30,000 miles) per annum (Calthorpe, 1993).

The Bonneville Power Administration's 'Super Good Cents' building recommendations were followed in House #1, taking performance considerably beyond basic code minima, with a calculated space heating budget for northwestern Oregon of 44,210 MJ per annum. In comparison to Household #2, a slight but measurably greater desire for comfort has been assumed as regards the choice and use of household appliances. For example, Household #1 has a quick recovery water heater, while Household #2 does not. Household #1 has a 566 litre (20 cu. ft.) frost-free refrigerator, while Household #2 has a 453 litre (16 cu. ft.) manual defrost model. House #1, with all energy-using devices combined consumes a total 167,120 MJ per annum.

Household #2 lives in an 88 year old 130 m^2 (1,400 s.f.) frame house located in a traditional, inner city neighbourhood of Portland, Oregon. A wide range of retail shops and basic services are located within a few blocks of House #2, accessible by foot along pleasant, tree-lined streets. Mass transit is nearby and convenient. A typical trip to the regional centre of downtown Portland takes about 10 minutes by bicycle or bus. An in-depth travel survey conducted in 1996 by Metro, the Portland area's regional planning authority, used thousands of detailed 'travel diaries' to document individual transportation choices. Results showed that residents in Household #2's type of traditional, pedestrian-friendly neighbourhood not only drive less, but make substantially more daily trips without a car than their suburban counterparts (Figure 4). Automobile usage is assumed to be 24,000 km (15,000 miles) per annum for Household #2 (Calthorpe, 1993).

House #2 is an early 20th century 'energy hog' with no insulation, single-pane windows, poor south orientation and a large amount of infiltration coming in through almost 90 years worth of cracks and gaps in the exterior envelope. With the exception noted in the description for Household #1, the family of Household #2 owns all the same types of appliances, lights and climate control devices as Household #1 and uses them with equal frequency.

Household #2 has a calculated space heating budget of 141,380 MJ per annum, and the house, with all other appliances, etc. added in, consumes a total 248,570 MJ per annum. House #1 is therefore 149% more efficient than House #2 while also being 143% larger.

Under the assumption (currently being researched by the authors) that families facing increased driving demands, especially those with children, tend to choose somewhat larger, more commodious vehicles, Household #1 is assigned cars with fuel ratings in the current range of sport utility vehicles and family vans - about 11 litres/100 km (21 mpg). Household #2 is assigned the current normal passenger car average of 8.3 litres/100 km (28 mpg).

Household #1's car energy budget is 190,080 MJ per annum, making a total (car + house) energy consumption for Household #1 of 357,200 MJ per annum. Car energy consumption is therefore more than 50% of the total. Household #2's car energy budget is 71,712 MJ per annum, making a total energy consumption for Household #2 of 320,282 MJ per annum. The comparison of these

Table 1: Amalgamation of the various calculations for the two households

	household #1	***off grid***	***household #2***	***upgraded***	***reduced car use***
size (m^2)	186	186	130	130	130
total for house	167120	0	248570	138110	138110
CAR					
distance travelled	48000	48000	24000	24000	17393
l/100km	11	11	8.3	8.3	8.3
fuel used (litres)	5280	5280	1992	1992	1443.6
energy MJ/l	36	36	36	36	36
energy consumed	190080	190080	71712	71712	51970.3
total for house	167120	0	248570	138110	138110
plus the car	190080	190080	71712	71712	51970.3
Grand Total	357200	190080	320282	209822	190080.3

household totals shows that the household in the traditional neighbourhood (Household #2), living with uninsulated walls, single-pane windows, etc., still uses approximately 10% less energy per annum than the 'Super Good Cents' suburban house, despite its R26 walls, R38 ceilings, U-0.30 windows, etc. Automobile use makes the difference, comprising 53% of the suburban household's total annual energy budget, but only 22% of the inner city household's budget.

If, through extraordinary measures, the suburban house goes off-line entirely, becoming a self-reliant 'earthship', while the traditional neighbourhood household merely upgrades to current Oregon energy code minima, calculations indicate that the suburban household can turn the tables on their traditional neighbourhood counterparts. In this scenario the suburban earthship household will have an energy budget of 190,080 MJ per annum, (car alone). After upgrading to energy code minima the traditional neighbourhood house energy consumption would be reduced to 138,110 MJ per annum, making a total (car + house) of 209,822 MJ per annum - just 11% more than the off-grid suburban earthship. By reducing VKT per annum by 6607 km, or about 27.53% of their annual total, the traditional neighbourhood household could, in conjunction with the aforementioned upgrades, equal the energy performance of the suburban earthship household.

Back to the Future - Tomorrow's house and yesterday's traditional neighbourhood

From these results we therefore conclude that for America's foreseeable future influencing household transportation choices offers the greatest opportunity for household energy conservation rather than implementing additional energy-saving architectural design features. Attempts to affect transportation behaviour are often dismissed as 'social engineering' and thus outside the proper realm of planners and architects. However, a growing amount of hard data, including the studies cited in this paper, document how the built environment in the form of neighbourhood typology influences travel behaviour. A single example is telling - according to the Metro travel survey walking comprises 7.6% of all trips in Portland's suburbs and 28.5% in mixed-use traditional neighbourhoods. Residents of this particular neighbourhood type are thus four times more likely to go by foot on a given daily errand than are their suburban counterparts.

Design and construction professionals concerned with reducing our profligate rate of energy use must begin to take a more proactive stance in favour of mixed use, pedestrian-oriented development. Although pollution and other adverse environmental impacts stemming from overuse of private automobiles have not been addressed by this paper, when these impacts are also considered, increased emphasis on pedestrian-oriented neighbourhoods becomes even more imperative for a sustainable future.

While design professionals are limited in what they can control, it is suggested that a first step towards promoting greater household energy efficiency should be to include estimated energy consumption by motor vehicles in presentations to clients and peers on the efficiency of specific design commissions. Information presented in this paper begins to show how average transportation costs could be estimated based on neighbourhood typology and then converted to units compatible with other expressions of residential energy consumption. In this way the 'invisible', but huge, energy cost of personal vehicles in non-urban environments would be made more generally apparent; those projects in pedestrian-friendly urban environments could likewise receive greater credit for their now often unrecognised role in energy conservation.

Many clients have a sincere desire to build in a sustainable fashion. However, expanding the consciousness of these clients to think of sustainable design not just in terms of building materials and operating costs is of vital importance. In many cases they may not have thought through the full impacts of transportation and how such energy costs can be incorporated into the design process. Architects and design professionals of all descriptions should be looking beyond the technics of construction and the property lines of a specific project site. We must begin educating our clients that where we build ultimately has more impact on our overburdened environment than what we build.

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From Curitiba to Quito: Reserved traffic lanes for public transport as an ecological, economic and social policy for cities

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Abstract

Quito's new trolleybus is a great success. It is being expanded already. Consisting of a know-how transfer from a Latin American city, Curitiba (Brazil), to another Latin American city, Quito (Ecuador), these two experiences display a new and original development model. By occupying urban space, and therefore limiting the presence of the car, too often promoted without considering environmental and ecological consequences, the 'reserved structuring axes' for public transport allow high mobility at low cost. The advantages of this model are numerous and could profit many other cities. Today, more and more questions of technological choices are part of the political and ecological debate. Transport is no longer a secondary issue.

Keywords

Trolleybus, urban transport, Curitiba, Quito.

Introduction

DO RESERVED traffic lanes for public transport augur a re-humanisation of cities? That is what the new trolleybus in Quito seems to demonstrate. All the newspapers in Ecuador write about it. A city with a conservative reputation, decision centre of an old landlord oligarchy today losing some of its influence, Quito's trolleybus gives the Ecuadorian capital a refreshingly modern look. With 1.2 million inhabitants, the city spreads in a valley measuring 44 kilometres by 6; a modern centre with shantytowns stretching at its northern and southern ends for 10 kilometres. And of course, growing transport problems, apparently unavoidable. Yet, traffic jams are not a law of nature and Mr. Jamil Mahuad, the youthful, newly elected mayor of Quito, had the intention to end a 'laissez-faire' policy. Anchor point of his strategy: the construction of an 11 km long trolleybus route across town, officially inaugurated in April 1996.

Its conception is inspired by a model praised by more than one observer - the transport system in Curitiba which, besides mobility, integrates social objectives. Applying the conclusions of long term research, adapting these to limited economic resources, the transport network of Curitiba is part of a development strategy integrating land use by giving priority to mobility rather than to a particular transport mode. Indeed, too often the car or the underground railway are presented as the panacea as soon as a city reaches one million inhabitants. Curitiba shows, in a spectacular way, to which extent these are erroneous views. According to a new concept, planning does not only mean to fulfil demand; it aims at pulling up the quality of life of a whole community.

Now, is Quito a case where a country from the so-called South transfers to another country from the South its understanding and, to make this occurrence even more interesting, a know-how that goes towards sustainable development? This is what the construction of Quito's trolleybus seems to reveal. With advice from the United Nations Development Programme, Quito appears as one of the first cities to take advantage of this new approach.

A remake of Curitiba's experience in Ecuador's capital could confirm the structuring effect, from an urban as well as from an economic viewpoint, of an innovative development policy integrating land planning with transport policies. As it is, Curitiba brings the proof that a transport system with reserved surface lanes, offers a quality service that can be compared to an underground railway but at a much lower cost. By its occupation of the space normally attributed to the private car, reserved surface traffic lanes avoid the numerous dictates imposed by the 'cars-only' society. This way, a response is given to people's mobility needs, thus integrating the constraints of global ecology, the new player in international relations. Before presenting

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Quito's experience, let us first see what makes the success of Curitiba's model.

Curitiba - more than an example - a model

In 1992, while experts and politicians meet by the thousands at the Earth Summit in Rio de Janeiro to elaborate a Charter to save the planet, a Brazilian mayor tours his model city with his guests. To the world, he explains what as been done to avoid traffic jams and pollution, to offer citizens breathable air, clean sidewalks and green parks. Politicians from major cities listened and learned that a megalopolis can become liveable without putting its public finances in peril. Traffic is surprisingly fluid, thanks mainly to efficient public transport, an incitement for city dwellers to leave their car at home. Buses have priority and drive at high speed on avenues, thanks to double reserved central corridors: 2000 buses transport 1.3 million commuters every day. The success of the Paraná State capital (population 2 million) is unique: it breaks with more than one myth on the necessity of massive investment (not to say pharaonic), in public transportation. While in Europe, Copenhagen (population 1 million) is one of the major cities to have seriously limited its access to cars, Curitiba has succeeded in encouraging an important modal orientation towards the bus. A study by Kaufmann and Guidez (1996) of Bern, Geneva and Lausanne in Switzerland; and Besançon, Grenoble and Toulouse in France shows how difficult this exercise is.

Mr. Jaime Lerner, three times mayor of the city before being elected as State governor in 1995, has been a key actor in this success. An architect and town planner, he had been the second director (1968-69) of the Curitiba Research and Urban Planning Institute. First a theoretician, he became the competent prime contractor of the urban development strategy of Curitiba around 'five main structuring axes'. Each of these central roads contains two express bus lanes flanked by local roads; one block away to either side run high-capacity one-way streets heading into and out of the city centre. But what makes the originality and the strength of the Curitiba model is its successful integration of land-use legislation with transport policy.

Integration of land-use and transport policy

In the area adjacent to each axis, the land-use legislation encourages high density occupation, while the construction of buildings six floors high are allowed on the structuring axes themselves. This density coefficient is reduced the further you go from public transport. This legislation that orients planning in the centre, encourages the development of new commercial and residential zones along the structuring axes. Pollution and noise problems, excessive concentration of commercial activities in the centre, and its domination by banking, financial and service activities are therefore limited. This policy has allowed the creation of a convivial and vibrant city centre, day and night. Today, 49 blocks linking parks and bus terminals are pedestrian and for 1 square meter of green space per capita in 1970, the city had 50 in 1992. Curitiba has also reached an equilibrium between high density commercial and residential zones and the public transport offer. The municipal authority itself acquired land along the structuring axes to build housing for lower income earners - close to public transport, those people are better located to integrate into economic activity.

For a single, low fare, good on the entire network, Curitiba's public transport is organised as a 'surface subway' with terminals in which the traveller can circulate and shop, later changing route without having to pay for a new journey. The terminals are attractive; beautified by flowers, trees and a pleasant architecture. In this, one of the central ideas of the transport system is the ease with which people can transfer from a local bus to an express one, and later take another local service, all this in a pleasant environment. The new stations, with 'boarding tubes' equipped with platforms reaching the height of the bus floor, greatly reduce the time necessary for passengers to get on and off the buses. Thanks to these boarding tubes, it is possible to double the number of passengers per hour. Compared with traditional buses operating on a road where cars are allowed, these buses transport three times as many passengers. As it is, the reserved lanes make the system profitable. The boarding tube imagined in Curitiba, eliminates the need for ticket control on buses because the fare is paid before getting on the boarding platform. Also, motorised equipment is fixed to the platform, allowing access for handicapped. Finally, Curitiba's buses are painted according to their function allowing for easy identification: express services are red, green buses travel between neighbourhoods, those coming to town from suburbs are yellow.

Privatise transport without privatising the city

According to Jonas Rabinovitch, the former director of foreign relations for Curitiba and today employed by the United Nations Development Program, the 'express buses on reserved lanes', at $0.2 million per km, are considerably less expensive to develop than a surface light rail system ($20 million per km) or an underground subway, typically $60-100 million per km (Rabinovitch and Leitman, 1996). It represents an affordable solution in a country with limited financial resources. This price differential needs a clarification: in Curitiba it includes the financing and construction of boarding tubes, reserved lanes and terminals by the city; it does not include the acquisition of buses, an investment done by private companies, thus explaining the extraordinary low cost. But this gap is not necessarily overestimated - the cost of the underground subway in Rio de Janeiro reaches an extraordinary $200 million per km on some sections. Quito's trolleybus which receives no private financing cost $65 million for 11 km, that is $5.91 million per km, including vehicle acquisition.

Rabinovitch admits that these are estimates as construction costs vary greatly from city to city. Still, the numbers speak for themselves: buses or trolleybuses are tens of times cheaper than subways.

> "By putting concrete and asphalt above the ground instead of excavating to place steel rails underneath it, the city managed to achieve most of the goals that subways strive for at less than 5% of the initial cost." (Rabinovitch and Leitman, 1996, p. 30)

With the money saved, Curitiba endeavours to respond to the people's needs, including a very successful program in environmental education for children from *favelas*. Also, the buses are free for certain citizens or State employees: people aged more than 65, the police, school children in uniform, and firemen and postmen in uniform.

The integrated bus transport system with reserved lanes built since 1974 is therefore a mixed enterprise: it is formed by *Urbanisação de Curitiba*, a municipal institution, and 10 private companies under the eye of the Curitiba Research and Urban Planning Institute. 2000 buses, owned by those companies, operate on routes authorised by the municipality in response to public demand. They are obliged to follow certain requirements established by the city and are paid a fee per kilometre served as specified in the route permit. Authorisations may be withdrawn if the agreement is not respected, but would of course be preceded by warnings or financial sanctions. Adding to their payment per km served, every company gets a monthly rate of return on the capital invested in the bus fleet of 1% and a yearly 3% return on administrative costs for equipment and infrastructure. Furthermore, the municipality often buys the old buses at the end of their useful lifecycle, to use them as mobile schools or for cultural activities, etc. According to *Urbanisação de Curitiba*, 75% of the population uses public transport, thus explaining its good financial heath despite the absence of direct subsidies. The fares paid by the users are put in a city fund and the private companies are paid every ten days. In short, a private-public partnership, but without the influence of purely financial interests on urban planning.

Modal orientation

Despite its 500,000 cars, 250 per 1000 inhabitants, more per capita than any other city in Brazil (see Box 1), Curitiba doesn't have a traffic problem. According to the Bonilha Institute based in the region, 28% of bus users in Curitiba would use their car if the bus priority measures did not exist, thus resulting in gasoline consumption which is 25% lower than in other similar Brazilian cities (Rabinovitch and Leitman, 1996). In this, the public transport system is directly responsible for the relatively low pollution level registered in Curitiba despite the use of buses running with diesel motors. Besides the health benefits of this strategy, the savings this transport policy allows for the population is one of its very positive effects - on average, they spend only 10% of their income on transport (Newman, 1996), a ratio that is low for this part of the world where the poor easily can spend up to 25% of a meagre income on transport (World Bank, 1994). The attractiveness of the public transport network invites inhabitants to move more than they would do otherwise: they make 202 trips a year against 158 in São Paulo.

The boarding tubes, the automatic fare collection, bus priority at traffic lights (using transponders); these are among technical improvements progressively introduced for the optimisation of the transport system and a low operating cost. New measures are constantly studied by the Curitiba Research and Urban Planning Institute which plays a central role in this success. For example, buses with a double articulation, unique in the world, are built by Volvo for Curitiba. In

Box 1: A Note on Numbers

Data appearing in publications on transport can be far from data presented in the original source, as terms used for car ownership are sometimes misunderstood or calculations lack accuracy. In *An Urbanizing World* Passenger Cars is evaluated at 15 for Ecuador (p.275); but 'Motor Cars', in the Statistical Annex (p. 524), at 36.9. Brazil goes from 83 to 88, etc. Quite relevant is a note which explains that "motor cars… refer to passenger cars and commercial vehicles. Special purpose vehicle such as motorcycles, trams, ambulances… are excluded". Figures on "passenger, motor or private cars" often suffer from the absence of such a definition.

Clearly, for the moment, passenger cars in Ecuador are much less numerous than motor cars as defined hereabove. At the Office for Statistics in Quito, I found that total vehicle ownership went from 299,866 in 1984 to 463,289 in 1994, including automobiles which are up from 85,717 to 156,756. This last figure corresponds to passenger cars doubling as mentioned on page 275 of *An Urbanizing World*, even if the year of reference (1985 or latest year) lacks precision.

Most, if not all major research centres, e.g. World Watch Institute, World Resources Institute, etc.- take the *World Motor Vehicle Data*, published by the American Automobile Manufactures Association, as source for their figures. In this publication, registrations are presented in two columns: passenger cars and commercial vehicles. As it also gives the population for every country, car ownership and commercial vehicles per 1000 inhabitants can be calculated. Population per car and per vehicle is given. According to *World Motor Vehicle Data* (1998) with data from 1996, global passenger car ownership is 486 millions (from 480 in 1994), commercial vehicles 185 millions (from 150 in 1994) giving a total of 671 million registrations (from 629 in 1994). This is one car for every twelve human beings or a four wheel (or more) motor vehicle for every 9 people. The World Motor Vehicle Data appear as the prime source for data on vehicle registration. In fact, since the International Road Transport Union and the United Nations Development Programme are no longer producing this information, it may now be the only source available on a regular basis.

Table 1: Car and commercial vehicles ownership in selected countries (per 1000 people)

Source:	***An Urbanizing World,***			***World Motor Vehicle Data 1998***		
	Cars (p. 275)	*Others (pp. 522-525)*	*Total*	*Cars*	*Others*	*Total*
Brazil*	83	5	88	78	20	98
Ecuador	15	22	37	22	36	58
France	382	105	487	436	90	526
Indonesia	6	11	17	11	10	21
UK	313	100	413	424	62	486
U.S.A. *	588	167	755	484	286	770
Japan*	303	?	209	373	174	547
Denmark	295	78	373	331	66	397

Notes: * Data for Brazil, U.S.A. and Japan in *An Urbanizing World* are from the *World Resources Report 1996-97* of the World Resources Institute quoting the *World Motor Vehicle Data 1993* (data for 1991). Other data in *An Urbanising World* come from Table 29 of United Nations (1988) *Compendium of Social Statistics and Indicators*.

The total of motor cars for Japan in *An Urbanising World* is certainly a mistake. In addition, we may wonder if the reduction of passenger cars in Brazil is real - or just a change of definition - while the total goes up and commercial vehicles are multiplied by four! Also worth noting is the amazing reduction of passenger cars and the increase of commercial vehicle ownership in the U.S.A., or this may reflect the explosion in 'jeep' or 'recreational vehicle' (RV) ownership. Whether criteria defining 'Commercial Vehicles' have changed or more Americans are driving RVs, 'Passenger Car' ownership in the U.S.A. has changed from 147 millions in 1991 to 130 millions in 1996 and Commercial Vehicle ownership has risen from 48 millions in 1991 to 77 millions in 1996.

use since 1992, they have a capacity for 270 passengers, against 170 for buses with a single articulation. For a 59% increase in its capacity, the fuel consumption increase is just 16%. The development of a local market for this kind of bus - 33 buses with bi-articulation sold at $450,000 each - prompted Volvo to open a plant in the city.

Again and again, the example of Curitiba refutes the contemporary belief that costly technical solutions are the panacea to urban problems. Many planners have said in the past that cities with a population of more than one million must build a subway to avoid traffic congestion. The dominant dogma also says that cities producing more than 1000 tons of solid waste per day, need expensive plant to separate garbage mechanically. Curitiba has neither with results that could surprise quite a few 'experts'. Exemplary without having solved all problems of a Southern city, will the Curitiba model be emulated? The interest of Quito's trolleybus project is precisely that it seems to announce the appearance of a new development logic. It can be hoped that it will not be limited to transport.

Quito: the trolleybus conquers the heart of the public

Will the success of Curitiba be repeated in Quito? Since the opening of the trolleybus in Quito at the beginning of 1996, criticism has become rare. Before the advent of the trolleybus it took up to two hours to cover the route between Villa Flora station, in the South of the capital, and the Y station, in the North. Today, the journey time has been halved. The trolleybuses have replaced the old, polluting, noisy, uncomfortable buses with their irregular routes and schedules. At a rate of one trolleybus every two minutes, hooked to the electric cable that feeds its motor, it runs on private lanes. Inspired by those built in Curitiba, the 40 stops (one every 400 meters), are real boarding platforms alike those in a modern train station. Access to the trolleybus is eased by a mobile steel plate that comes down in front of the three doors when they open, giving access to the buses at floor level.

The trolleybus carries not less than 170,000 passengers each day, a popularity much higher than initially expected. As a result, its frequency during peak demand periods will be doubled. After six months of service, out of one thousand people questioned, 75% were in favour of the trolleybus, with only 2% dissatisfaction. The others qualify it as acceptable, *regular* in Spanish. 'People love the trolley and they respect it,' confirms engineer Raúl Maldonada, director of the operation unit of the trolleybus system. The new equipment offers security, regularity and speed to commuters, who used to lose a lot of time in their everyday transport (*El Comercio,* August 9, 1996). The building of a subway line or a fast tram on rails was withdrawn because of the weakness of buildings in the old historical centre, classified a world heritage site by UNESCO in 1978. Consequently, in January 1994, the City Council took the decision, to build an electric bus in reserved lanes with access by elevated boarding platforms and purchase in advance tickets, inspired from the Curitiba model.

A financial health allowing project extension

Of the $65 million that Quito's trolleybus has cost, $50 million have been borrowed; half from a Spanish development fund at an interest rate almost nil (0.3%), with repayment beginning after ten years; the other half borrowed from OECD at 8% p.a. for 12 years, with two years interest-free. Instant success on its initial phase, Quito's trolley extension and the increase of frequencies for the existing section should begin in a few months. Twelve additional kilometres will be built - adding to the existing 11 km - making the trolleybus cross Quito on half its length. The new investments reach $110 million for 59 new vehicles. This development will be done in two trenches of $55 million, the first one planned to end in March 1999. Let us note that in this first phase, $2.4 million will go to expanding a radio transponder system giving priority to the trolleybuses at traffic lights as is the case in the Curitiba. It is expected that once the trolleybus is completed, it will transport 300,000 Quiteños daily. At the moment the fare for a trip is approximately $0.28, with the possibility to buy books of tickets (10 trips for $2, 50 for approximately $7) and $0.20 for students, children and elders.

If those fares seem low to the most favoured of the world economy, they are high for many inhabitants of the Ecuadorian capital. This is why, inspired once again by Curitiba's experience, a single fare policy is applied: either the traveller is taking one bus, many buses, many buses plus the trolleybus or just the trolleybus. As in Curitiba, the revenues are collected centrally, short trips are the same price as longer ones done by people coming from distant poor suburbs (wealthier neighbourhoods are located mainly in the centre). That way, a certain amount of wealth redistribution occurs. It is vital that the transport service is affordable on the one hand to those on low income, and attractive and safe on the other to attract wealthier commuters who would otherwise be tempted to commute by car and whose modal choice could negate any public transport fluidity. We may wonder if this kind of solidarity by sharing the mobility cost would have been possible in the case of a major investment, like a subway?

Operating the feeder buses *'buses alimentadores'* making the link with trolleybuses, are offered as contracts to the private sector and the entrepreneur is paid per kilometre served. The municipality manages this common fund and covers the deficit on certain routes by its gains on other lines, including the trolleybus line. While in Curitiba the service on the entire network is provided by the private sector, the operation in Quito is carried out by the municipality (trolleybuses) and, for the other part, by small private entrepreneurs, some of them owning only one feeder bus. Those small entrepreneurs have to respect certain norms. The maximum bus age has been reduced from 27 years to 20 as a first step to reduce pollution - vehicles achieving European Union standards are becoming more common since the Transport Planning and Management Unit of Quito began managing the sector, supervised by the police in the past. Finally, it is noteworthy that, as has been the case in France for the building of tram lines in Grenoble, Lille, Strasbourg and Nantes, the inauguration of Quito's trolleybus has been the topic of animated political debate and the re-election of Mr. Mahuad as mayor is associated by most observers with this event.

Towards sustainable societies in the twenty-first century

According to official statistics, the number of cars would have doubled in Ecuador between 1984 and 1994. At the present rate, the Earth's car population will reach a billion within twenty-five years, this means a doubling of cars now on the road. (Tunali, 1996) Will the 'Autosphere' destroy the Biosphere in which we live and on which we depend? Climate change, biodiversity destruction, pollution of seas: the threat is real. What is at stake with traffic calming goes well beyond the quality of life in cities

Lambert: From Curitiba to Quito: Reserved trafficlanes for public transport as an ecologically, economic and social policy for cities.

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(Lambert, 1998).

In Ecuador, as in other developing countries, car manufacturers invest in promoting new roads. (Let us not forget that in the 1930s, Los Angeles had the largest streetcar network in the world. To understand how it has been dismantled (as in almost every other American city) by General Motors, Ford and Chrysler with help from other multinationals, see Snell, 1974. The PBS network (U.S.A.) film *Taken for a Ride* (1996), describes how the automobile and petroleum industries orchestrated a campaign to dismantle public transport and cultivated a dependency on private motorisation.) General Motors will open shortly a new assembly plant in Quito. Yet, negative effects of the car are well known - urban sprawl, pollution, road accidents, anonymity of cities framed by and for the car. Their destructive impacts have been known in cities like Mexico where, it is said, some children have never seen a star... smog being permanent. Road infrastructures often cross poor suburbs where inhabitants have little means to oppose mega-projects undertaken with the blessing and the financial support of big international organisations. Barely motorised, they are the victims, more than the beneficiaries, of those projects.

Walter Hook from the Institute for Transport and Development Policy (ITDP) in New York, blames the World Bank, for using and recommending to its clients a computer program, Highway Design Maintenance Standards Model Version III (HDM) precisely ignoring pedestrians and other non-motorised people.

> “The economic benefits and costs of fundamentally different approaches to meeting the same mobility needs are not compared. Only once a project has already been determined to be a road or rail or subway project are these economic impacts assessed.” (Hook, 1994, p. 8)

This absence of a multi-criteria approach that goes beyond economic abstracts, is not exclusive to the World Bank. But the series of good intentions announced in *Sustainable Transport,* a document in which the bank announces its new priorities ‘to limit the consequences of a rapid motorisation in the world’, in particular the uncontrolled development of the private car, will be judged on facts by all those concerned with the issue (World Bank, 1996, p.3).

Meanwhile, in Europe many cities such as Amsterdam, Copenhagen, Bern, Zurich, Basel, Grenoble and Strasbourg, are trying to win back control of their streets and public spaces by developing public transport, cycling paths and walking zones. Like Curitiba in Latin America, Copenhagen is really a model in Europe - as early as 1962, the Danish capital developed cycling lanes (by progressively getting rid of parking spaces along the streets) and an exemplary public transport system. Today, there are 10% less cars in the city than in 1970; 33% of trips are done by bicycle (thanks to a favourable topography, and despite changeable and sometimes difficult weather), a proportion that equals that of public transport and the automobile.

It has been said that Latin American cities are built more like European cities than North American megalopolises. This character is of course threatened by urban sprawl which cannot be dissociated from car use. Recently, Eduardo Galeano has criticised the attitude of his compatriots towards the car and the consuming society:

> “Kidnapping of the ends by the means: the supermarket buys you, the television watches you, the automobile drives you... We Latin Americans have swallowed the pill that the hell of Los Angeles is the only possible model of modernisation: a vertiginous superhighway that scorns public transport, practices velocity as a form of violence, and drives people out. We’ve been taught to drink poison, and well pay any price as long as it comes in a shiny bottle.” (Galeano, 1995, p. 20)

Thanks to people like Galeano, to models like Curitiba, mistakes made in the North could be avoided.

Conclusion

The criteria favouring choice for public transport are numerous, but one fact is obvious in almost every city - too often decisions are taken giving absolute surface priority to the deified car. But this monopoly of the urban space, the fruit of a narrow vision of mobility, is well contested today by public transport, pedestrians, cyclists and other non-motorised people (skaters). In almost all occidental cities, small associations defend the use of the bicycle as

Table 2: Four positive aspects of indirect wealth redistribution coming with public transport access.

• Social	equity is the best warranty for a dynamic, crime-free society
• Economic	many work in the centre
• Practical	solving urban transport problems needs the involvement of all social classes
• Environmental	reductions in air pollution have an immediate knock-on effect on health and quality of life

a mode of transport and are promoting a radically different approach of mobility and urban planning (Lambert, 1995). On August 1st 1997 a cyclist protest in San Francisco ended with the arrest of 250. The newspaper *USA Today* printed 'Bike riders becoming a major political force' as a headline. Indeed, isn't their message going far beyond the simple defence of non-motorised two wheels users?

Despite the unceasing 'economic growth = solution to all our problems' of traditional economic rhetoric, with the appointment in France of Mme. Dominique Voynet (Green) as Territory Planning and Environment Minister of M. Lionel Jospin's (Socialist) government, technological choices in transport will be guided by a new reality: political ecology. Let us remember here that the transition from scientific ecology to political ecology was prompted by the publication in 1962 of *Silent Spring* by Rachel Carson. Highlighting the abuse of numerous pesticides in agriculture; from chemicals like chlorinated hydrocarbons (DDT), now forbidden in occidental countries, to organophosphates, some of which have been used as weapons; Carson's book triggered an amazing controversy of which she herself was a victim (insults, threats, *Time* magazine Science section wrote about 'her emotional and inaccurate outburst'...). But in the end, Carson shook up the powerful chemical industry which perpetuates and perpetrates biocide.

Nuclear electricity, greenhouse effect, anthropogenic leeway, ozone layer destruction, landscape and quality of life deterioration - scientific controversy for technological choices are today a field of political discourse. Transportation is no longer a secondary issue. In an interview with *L'Événement du jeudi* (in June 1997), Mme. Voynet declared her intention to "Transform buses in real 'surface subways' to remedy their slow pace by the creation of reserved lanes so that they avoid traffic jams". In Curitiba and in Quito this has already been understood... by developing buses or trolleybuses as 'surface subways', it is an ecological, economic and social policy for the city which is at stake.

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