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Contents

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2 Abstracts & keywords

3 Editorial

4 Car-Free Cities - Myth or Possibility? Exploring the boundaries of sustainable urban transport
Catherine McKenzie

11 Sustaining Africa's rural road networks: The asset management approach
John Howe

17 Techniques for planning local networks: Developing a walking strategy
Les Lumsdon & Rod Tolley

24 Urban cycling options in the free market
Stephen Knight

30 Prospects for sustainable transportation in the Pacific Northwest: A comparison of Vancouver, Seattle and Portland
Preston Schiller & Jeff Kenworthy

39 The TGV Effect: A potential opportunity for reconciling sustainability with aviation
Judith Patterson & Anthony Perl

46 Conference announcement

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Abstracts and keywords

Car-Free Cities - Myth or Possibility? Exploring the boundaries of sustainable urban transport

Catherine McKenzie

Keywords: Car-free cities, globalisation, sustainable development, urban theory

The paper uses case-study material from a number of North European and UK cities to explore the types of initiatives that are being considered under the 'car-free city' movement. These are analysed using models of radical and conservative sustainable development. The paper suggests that even in municipalities actively claiming to be pursuing a 'green' agenda, only a very conservative interpretation of sustainable development is being implemented. This can, in part, be explained by exploring the changing role and function of the local state in late-modern society and, in particular, its heightened role in pursuing local economic development within a global marketplace. This, it is argued, places substantial limitations on the nature and extent of sustainable urban transport policies that are being, and can be, implemented, with important social and environmental consequences.

Sustaining Africa's rural road networks: The asset management approach

John Howe

Keywords: Africa, investment, Kibaale District, maintenance, rural roads, revenue

Many rural roads in Africa are 'returning to the bush' because of inadequate maintenance. This is not helped by development loans which encourage construction of new roads and rehabilitation of existing infrastructure rather than better value ongoing maintenance. Much of the problem lies in the technical arguments put to decision makers. Here we see the argument put in a way that non-technical people can understand.

Techniques for planning local networks: Developing a walking strategy

Les Lumsdon & Rodney Tolley

Keywords: Best practice, Edinburgh and Lothian, integrated transport, pedestrians, policy formulation, sustainability, walking

Walking as a mode of transport has declined in importance due, in part, to motorisation. There is a recognition among transport professionals in the UK that this needs to be redressed. The key in developing such strategies is their adoption and implementation at a local level. An outline model walking strategy is provided and there is a case study of the Lothian Region's strategy.

Urban cycling options in the free market

Stephen Knight

Keywords: Auckland, cycling, efficiency, externalities, flexibility

The City Council in Auckland, New Zealand, has known since the late 1970s that apparently marginal activities such as cycling and walking can significantly benefit the urban environment. Despite this, lack of foresight has left the city with restricted capacity to take advantage of these low-tech options. However, the full implementation of a proposed national transport model may see the payment of ecological, social and economic costs of private vehicles by users. This may provide an impetus for a better balance between transport options for Auckland.

Prospects for sustainable transportation in the Pacific Northwest: A comparison of Vancouver, Seattle, and Portland

Preston L. Schiller & Jeff Kenworthy

Keywords: Cycling, highways, land use, Portland, public transit, Seattle, sustainability, transport, Vancouver, walking

A variety of transportation and land use performance indicators and trends are examined for the major cities of the Pacific Northwest region of North America. To the casual observer these cities may appear more similar than different. However, the data examined reveal substantial differences between Vancouver and its neighbours to the south, Seattle and Portland, especially in regards to population density, motorisation, transit use and the rate of growth in car use.

The TGV Effect: A Potential opportunity for reconciling sustainability with aviation

Judith Patterson & Anthony Perl

Keywords: Aviation, energy consumption, France, sustainability, TGV

The aviation industry is presently in a stage of rapid growth. Soon, however, increasing urban air pollution, rising greenhouse gas concentrations, regulatory policies, and finite oil reserves will create constraints on the expansion of the industry. High speed rail journeys of under three hours may become an alternative for aviation. A switch to high speed rail for short haul journeys could also free room for expansion of long haul markets for aviation thus obviating the need for airport infrastructure expansion. To explore this hypothesis, the impact of high speed rail on French civil aviation is examined. Modal substitution and intermodal complimentarity may be part of the solution for making aviation economically and environmentally sustainable.

Editorial

This journal is produced in Lancaster, a city in the north of England with a population of 50,000. For the past three months a curious drama has been unfolding in the Victorian town hall of this small and attractive city. The drama goes under the name of the Lancaster Local Plan public inquiry and represents an opportunity for citizens and citizen groups to contribute to a 10 year plan for the city in front of an independent (government appointed) inspector. For several weeks now it has been working its way through highway and transport issues. On the citizen side there is a high level involvement from 'green' organisations, transport campaigners and residents groups – all of whom are arguing that a proposed new road is unnecessary and won't solve traffic problems. Some residents have a preference for another road which is not on offer but the majority do not want any road. Lined up against these citizen groups are the local authorities who want the 10 kilometre (£90 million) road. They are supported by highly paid legal staff and barristers paid out of the taxes of those on the other side and whose job it is to demolish any argument that does not fit the case of the local authorities. The tragicomic spectacle of 6 or 7 well paid public officials and legal representatives attacking individual objectors and representatives of citizen groups highlights the fundamental malaise of our anti-democratic and adversarial public inquiry system. The irony of being attacked by a team of people who you pay for through your tax dollars is not lost on the those who attend the inquiry.

In volume 1 number 4 (1995) of this journal we carried an article by Anne Batchelor who had given evidence as a local resident against the construction of the Birmingham Northern Relief Road. She wrote fluently and passionately about the impact of this road on her life. Technical evidence presented at the inquiry showed that the road would not relieve traffic on adjacent motorways (the main reason for its construction) and senior members of the Labour party, then in

opposition, made the pilgrimage to Birmingham, pledged their support for the local residents and promised to scrap the road if and when they came to power. The sad news for Anne Batchelor and her neighbours is that the road is now to be built. All the evidence against the road was rejected by the inspector and the new Labour government elected in May 1997 reneged on its promises and approved the road.

There is something distinctly rotten and pervasively destructive about the processes and realisation of new highways. At all stages human rights are abused, the environment suffers and distinctive place identity is sacrificed on the altar of higher levels of mobility. Maybe this is what Ian McHarg discovered many years ago leading to an unusually pointed lecture to US highway engineers in 1966:

'I welcome the opportunity to describe the ecological planning method for highway route selection ... but, first, I have to reveal my loathing for you and your kind. If you all had a fatal paroxysm, I would find it difficult to mobilize a single tear. You have been engaged in an onslaught against the American environment, you have dismembered, dissected and destroyed significant areas of American cities. Your depredations must end. There is no reason that the American public should pay so dearly to have their environments attacked by such insensitive bullies.'

[Source: Ian L. McHarg (1996) *A quest for life: an autobiography* Wiley, Chichester, ISBN 0471 08628 2]

Ian McHarg would have had no difficulty generalising from his engineers to the councillors, barristers, planners and engineers who have devoted so much time, energy and cash to the destruction of environment, landscape, place and participative democracy in Lancaster.

John Whitelegg, Editor

Car-Free Cities - Myth or Possibility? Exploring the boundaries of sustainable urban transport

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Abstract

The paper uses case-study material from a number of North European and UK cities to explore the types of initiatives that are being considered under the 'car-free city' movement. These are analysed using models of radical and conservative sustainable development. The paper suggests that even in municipalities actively claiming to be pursuing a 'green' agenda, only a very conservative interpretation of sustainable development is being implemented. This can, in part, be explained by exploring the changing role and function of the local state in late-modern society and, in particular, its heightened role in pursuing local economic development within a global marketplace. This, it is argued, places substantial limitations on the nature and extent of sustainable urban transport policies that are being, and can be, implemented, with important social and environmental consequences.

Keywords

Car-free cities, globalisation, sustainable development, urban theory

Introduction

Over recent years sustainable development has become a dominant discourse in which environmental issues have been framed and articulated. Sustainable development has provided a means to explore the tensions between issues of environmental protection and the more dominant model of economic development. The urban environment has become a particular focus of the sustainable development debate, being a site of concentrated human activity through the production, consumption and disposal of both human and natural resources, and within this the issue of urban transport has become a central concern. Through its ability to impact significantly on urban quality of life, in terms of health, pollution, accidents and access to opportunity, it has received regular media

attention, and has been the focus for much political debate and citizen action in the form of new social movements. As an issue, urban transport is therefore at the cutting edge of the tension that often exists between environment and the drive for economic growth.

In 1994, as part of its response to such concerns, the European Union co-sponsored a conference in Amsterdam entitled 'Car-Free Cities?' This then led to the signing of the Car-Free Cities Charter endorsed by over thirty European Cities, and the setting up of a Car-Free Cities Club to promote good practice and information exchange. Members signing the Charter were committed to the principles of reduced car dependence and to implementing more sustainable urban transport policies (Car-Free Cities Club, 1994). Four years on from the conference, have such cities succeeded in implementing the ideals of the charter, and if not, how might we begin to explain this gulf between rhetoric and action?

Analysis of Urban Transport Policies

In order to address this question a study was conducted using 13 European and UK cities (McKenzie, 1998). All of the chosen cities were either members of the Car-Free Cities Club or had signed the Ålborg Charter on Sustainable Cities and Towns (a similar declaration of commitment to the principles of sustainable urban development) (ESCTC, 1994). (The cities studied were: Aachen, Amsterdam, Bremen, Copenhagen, Delft, Enschede, Groningen, Freiburg, Köln, Leeds, Lübeck, Munster and Rotterdam). Time was spent in each city collecting data on their transport policies and practice and interviewing key policy-makers. The city of Leeds in the UK (then Chair of the Car-Free Cities Club) was then chosen for an extensive case-study in order to examine policy-making in detail.

Analysis of the results was conducted using two models of sustainable development: *Radical* and *Conservative* (Jacobs, 1995). This provided a necessary framework for

understanding the spectrum of interpretations that characterise the sustainable development debate. The chosen models explained sustainable development as a contested concept whose common core meaning is open to radical and conservative interpretations. Jacobs' framework uses the idea of 'faultlines' along which the radical and conservative interpretations or models diverge. Radical sustainable development is environment-led; is concerned about intragenerational equity; is committed to participative political processes; and integrates environment with a broad range of other issues such as health, economy and education. Conservative sustainable development, on the other hand, is economy-led; concerned only with procedural fairness; committed only to consultative political processes and concentrates on narrower environmental protection issues. Using these basic models 'ideal types' of transport policies using each of the models were constructed. The question was asked: 'What sorts of policies would we expect to see in a municipality committed to the ideals of radical sustainable development and what would we see in one adopting the more conservative interpretation?' The framework that emerged is given in Table 1.

Using this framework to analyse urban transport policies among the chosen cities provided some interesting results. Results from this review revealed that the policies being implemented fell very clearly within the category of conservative sustainable development: the idea of environmental limits was not being applied; economic development objectives were remaining unchallenged; and environmental concerns, although seen as important, were frequently traded-off against other economic and social objectives. This had led in every case, to an expansion in road traffic-related infrastructure, such as the development of new roads and car parks, albeit alongside improvements to public transport and walking and cycling facilities and pedestrianised inner areas.

If we look specifically at the interplay between environmental objectives and

economic development, a number of important themes emerge. Two-thirds of the cities reported examples of substantial concessions being made to environmental aspects of their transport policy in order to address the demands of the business community whilst others reported going against their land-use planning policy in order to secure developments. A majority of the cities also supported new transport infrastructure projects on the grounds that they would boost local and regional economic development. Although some of the cities did cite examples where they went against the wishes of the local business community this seemed to be where they believed they were acting in the longer-term interests of the wider economy rather than any great desire to improve the environment. This was borne out when the motivation behind policy was assessed, with half of the cities claiming that economic regeneration was the primary motivating factor behind the development of car-restricting policies. A need to tackle congestion problems was seen as important, not so much because of its environmental impact but because of its impact on the quality of the inner city and commercial interests. Here Freiburg and Munster were alone in implementing city-wide strategies resulting from a desire to reduce wider environmental impacts.

This continued dominance of economic development objectives affects both the scope and outcomes of policy. For example, policies that encouraged more walking, cycling and greater use of public transport proved most popular amongst the municipalities, along with traffic calming measures. But few were prepared to take existing space away from cars or to reduce overall levels of parking. Direct increases in transport costs were also unpopular amongst all of the authorities. And although all of the cities had been trying to use the land-use planning system to restrict development to sites where appropriate transport infrastructure was already in place, this had had a mixed effect - concentrating office space in inner areas but also expanding development along main roads and motorway junctions. A number of cities had also succumbed to development pressures and had gone against relevant guidance in order to attract prestigious development. And with regard to freight transport, concern was limited to trying to reduce its impact only on the inner city.

Because most of the cities' primary motivation was to improve economic opportunities in the inner historic or

Box 1: Sustainable development faultlines

Radical

- environment-led
- concerned about intragenerational equity
- committed to participative political processes
- integrates environment with social issues such as health, economy and education

Conservative

- economy-led
- concerned with procedural fairness
- committed only to consultative political processes
- concentrates on narrower environmental protection issues

commercial core, it was in these areas that most of the car-restraint measures were being implemented. Whilst some cities claimed to be concerned with improving environmental quality for both inhabitants and users of the inner city, others were quite explicit in their desire to expand shopping or tourism

opportunities. Any idea that measures might be expanded to other parts of the city had been rejected by a majority of the cities. The limitations of concentrating traffic-reduction policies only on this inner core were most keenly felt when looking at the issue of parking. All of the cities were tightening their control over parking in the inner city - increasing enforcement, the number of managed spaces, and the cost of parking. But none were actually reducing the overall number of spaces available for parking in the city. Indeed many were embarking on ambitious construction programmes to provide new car parks along the inner and outer rings of the city, with little or no

recognition of the environmental impact of traffic displacement to these outer areas.

Similarly, nine cities were committed to road construction projects aimed at expanding the existing urban and regional network, whilst two were expanding the capacity of regional airports.

It was also noted that where transport policy is more economically-led attention to other issues associated with the radical model of sustainable development appear to receive little attention. With the exception of Freiburg there were no commitments to base transport policy more on social rather than economic need. Nor were there examples of cities developing indicators to measure the social impact of transport policies. Indeed evidence suggests that a number of these policies were likely to increase inequality, for example through traffic displacement from the inner retail zone; the building of new car parks in poorer residential districts and the high cost of using new trams and light rail compared to

Table 1: A summary of the main differences between the radical and conservative interpretations of the Car-Free City

Radical Car-Free City	Conservative Car-Free City
1. Status of Environmental Protection <ul style="list-style-type: none">• Environment-led: evidence that environment takes precedence over economic development• Wherever possible, environmental limits define transport and other areas of policy• Adoption of an extensive programme of targets and actions required to bring transport sector within environmental limits inline with national and international agreements• Global impact of transport would be reflected in the targets chosen, i.e. CO₂, energy use, land-take, as well as local environmental quality issues• Targets and policies are likely to be more extensive in their range and may include 'hard' policies such as road space reduction, parking restrictions and cost increases for motorists	<ul style="list-style-type: none">• Economic development-led environment can be traded off against other social and economic objectives• Directional targets take the place of limits, guiding the general direction of policy• Some environmental targets may be adopted but likely to be of lower status and in competition with other economic and social objectives• Targets more likely to reflect local environmental quality issues and economic development objectives• A narrower policy scope, focusing mostly on 'soft' policies such as pedestrianisation of shopping areas, improving public transport and facilities for cycling and walking
2. Equity <ul style="list-style-type: none">• Concerned about current distributional impacts of transport as well as future needs both within the city and between different areas of the globe• Concerned for the limits of technology's ability to meet those needs• Transport policy explicitly concerned with the redistribution of resources between social groups• Concerned that environmental transport policies themselves do not impact inequitably on disadvantaged groups	<ul style="list-style-type: none">• Concern about equity is principally limited to concern for future generations• Optimistic that technological improvements in transport will meet those needs• Current distributional impact of transport policy is limited to concern for the fairness of policy impacts across all social groups, not just those that are socially or economically disadvantaged• Little concern for the distributional impact of environmental transport policies on poorer households
3. Participation <ul style="list-style-type: none">• Targets and policies derived, where possible, through community-based decision-making processes• Participative decision-making methods 'outreach' to disadvantaged social groups	<ul style="list-style-type: none">• Policy decisions legitimised mostly by 'top-down' consultation processes• Little effort is made to reach such groups beyond normal consultative methods
4. Scope <ul style="list-style-type: none">• Transport policies would be integrated with a range of quality of life' objectives such as health promotion, gender issues and anti-poverty strategies	<ul style="list-style-type: none">• Transport policies would exist separately from wider health and social objectives

buses. There were also few examples of cities adopting a more community-based approach to transport planning or integrating transport policy with other issues such as health, gender and poverty.

Although these policies may well boost the local economy by reducing traffic levels in the inner core, reduce localised air and noise pollution, and improve the overall urban experience - reason enough perhaps to continue with such policies - there is little evidence to suggest that they are having any impact on overall transport use (indeed policies such as park-and-ride may even encourage further reliance on the car). Thus their impact on the wider environmental issues associated with radical sustainable development must be considered limited. Freiburg and Munster were alone in adopting a policy framework that is most closely aligned to the radical model and as a consequence achieving city-wide reductions in traffic and contributing to wider ecological issues such as CO₂ and energy reduction.

Barriers to Adopting the More Radical Model

The municipalities themselves gave a number of reasons for not progressing traffic-reduction strategies further. Surprisingly, only four of the cities believed that a lack of political will was holding them back. Nine cities believed that opposition from business interest groups was a principal reason why policies had not progressed further. In a number of cases these authorities believed that policies would be either halted or reversed in the future because of mounting pressure from these groups. All of these authorities, themselves believed that further implementation of car-restraint measures would cause damage to the local economy. The most common hurdle cited, however, was a lack of a suitable structure for regional transport and planning. Most of these cities were facing pressures for out-of-town developments which they felt unable to stop due to development pressures coupled with an inadequate national planning structure. But they also cited inter-city competition as a threat. This was particularly pertinent around the issue of parking, where any attempts to reduce parking capacity or increase prices was being met by regional competitor cities advertising an abundance of parking spaces at lower cost to motorists. Seven of the cities felt that their policies were being undermined by national or European Union transport policies which they believed were further encouraging traffic growth. This ranged from the construc-

tion of new road infrastructure and a failure to raise the cost of motoring at the national level, through to a lack of financial support for urban initiatives. National economic policies were also posing a threat to policy development. Although only four cities were concerned about current levels of finance and a lack of control over transport services, eight cities were threatened by deregulation of services, privatisation and proposed cuts in national government subsidy.

Conclusions

Understanding Transport Policy Through Urban Theory

This contrast between the rhetoric and practice of sustainable urban transport seemed so stark that it needed explanation. Why were so many cities unwilling or unable to move beyond such a conservative interpretation of sustainable development? Here, the literature pertaining to sustainable development provided few answers. Although rooted within an economic development paradigm, much of the literature pertaining to sustainable cities and sustainable transport lacks any reference to the existence of economic and cultural counter-forces that might act against a more sustainable agenda. It was therefore felt that urban theory might provide some answers, looking specifically at the role of transport in late-modern society and post-Fordist ideas about the local state.

Here, a number of pressures on urban society and economy were identified, which provided both threats and opportunities to the sustainable cities agenda. Many industrialised cities, it would seem, were finding it necessary to restructure their economy, and with it their urban space, in order to compete in a fiercely competitive global market. Many were losing their traditional manufacturing role and changing instead towards being centres for the consumption of goods and culture. This had meant that the re-creation of 'place' within space has gained importance as a distinguishing marketing feature. The role of the state itself has also changed, becoming more the 'broker' in creating the right conditions for development and selling that image amongst potential investors and consumers. It has seen its own functions change from provider of services to enabler of others to provide and it has seen the urban spaces over which it has control significantly diminish. Cities themselves have had to adapt to fill niches in the global marketplace leaving different cities with different transport needs.

This adds to a dynamism which ensures that cities are under constant pressure to change - some towards a more sustainable transport system, others towards increased car use. The economic and cultural components of modernity: capitalism and modernism, continue to act as powerful forces that fuel this dynamism, which is so important to this creation and re-creation of urban space (Harvey, 1989).

A post-Fordist analysis identified a number of ways in which the local state might be impeded in its ability to implement a more radical sustainable development agenda for a number of reasons. First is its increasingly important role as agent for the local economy and the pressures that it faces in meeting local business needs and attracting investment. This dual role in assisting economic development whilst meeting growing public concern about the environment may be becoming increasingly complex and contradictory. Second, is its limited ability to raise revenues to fund the longer term modernisation of the local economy along more ecological lines. This would include the modernisation of its transport systems. Third, is the lack of regional and national regulation which can lead to local authorities being in competition with each other rather than working towards shared objectives. This may affect efforts to bring about regional transport planning and investment and limit efforts to restrain the car. Fourth, is the issue of control over key public spaces and institutions that may be necessary to ensure that its sustainability objectives might be met. The increasing onus on the individual to make his or her lifestyle choices in a climate of deregulation, coupled with the privatisation of important areas of urban space may make it more difficult to meet such objectives. And finally, the social impact of these changes may mean that investment in transport infrastructure may be limited to key parts of the city, such as the central business district, at the expense of other parts of the city and poorer communities (Amin, 1994).

Changing Agenda

It may be the case that some environmental actors may be satisfied with the sorts of limited improvements to the local environment that a conservative interpretation of sustainable development may bring. But given the limited contribution of this interpretation to global sustainability many actors may be keen to further a more radical agenda. We must then ask what needs to change in order to bring this about?

To do this, environmental actors need to fully understand the challenges that they face. They need to acknowledge that such forces and pressures exist and be aware of the positive and negative aspects of change and the opportunities this may bring for furthering their agenda. Understanding why municipalities act, or are unable or unwilling to act, in certain ways is a necessary first step in effecting urban environmental change. Secondly, such actors need to develop a better understanding of the differences between the radical and conservative interpretations. The faultlines (see Box 1) open up the possibility of there being significant differences between users of the term. This, as we have seen, has important implications for the range of policies which are then developed and implemented. All too often the term 'sustainable development' is used without a clear understanding of the different meanings being given to it by different users. Because sustainable development is an emerging discourse environmentalists should not expect there to be only one agreed definition. But they should expect and require that these differences are made explicit. This could then lead to greater emphasis being placed on the faultlines as a basis for discussing and developing programmes of future action.

Acknowledgement of the dynamism and complexity of the cities and the constant remaking of urban space, may help environmentalists to view ideas such as the sustainable city or the car-free city, not so much as blueprints for large-scale urban restructuring but as starting points for long-term cultural and economic change. Because of the pace of change, opportunities for furthering the radical sustainable development agenda are likely to be partial and need to be taken whenever they present themselves. A recognition of this may lead to a change in emphasis away from certain types of environmental activities favoured by many environmental actors.

Instead, the furthering of the radical agenda may require the development and use of a more explicit critique of capitalism than is presently used by many environmental actors. This may cause the movement to shift its agenda towards a greater degree of economic and cultural analysis and an emphasis instead on measures which assist long-term economic restructuring within environmental parameters. With this may come a refocusing towards changing political and economic structures and spaces rather than over-emphasising technical solutions and quantitative change.

Changing the Response of the State
As the environmental movement may wish to shift the focus of its agenda to assist in the implementation of a more radical agenda, so might the local state. It too should begin by scrutinising its policies to determine its position in relation to the four faultlines of sustainable development. A policy review of this type may help to refocus its objectives and activities. As the study revealed, emphasis on key areas of importance to sustainable development, such as prioritising the environment, promoting a more equitable society and creating structures that foster genuine participation in decision-making, are often a secondary consideration to the promotion of economic development.

Given the external pressures that municipalities find themselves under, a review of this type would not in itself be sufficient to allow the council to adopt a programme of radical sustainable development. However, it may at least begin to add some transparency as to how objectives and priorities are set, how their impact is monitored and the implications they may have for meeting other objectives, such as environment and equity.

Many of the cities prioritise economic development as a means of reducing social exclusion and inequality. Yet there appears to be little or no analysis of whether their economic development or transport policies have met these objectives. The research has shown that under the conservative model of sustainable development, transport policies may not necessarily assist poorer social groups, indeed, a number of examples were identified which appeared to have the potential to make them worse off. In order to benefit poorer groups local authorities need to develop explicit social objectives to guide their transport policies.

A review of general council policy, based around establishing its position with regard to the four faultlines, may at least begin to allow space to emerge to critique some key policies and objectives which often go largely unchallenged and may also result in the development of a more needs-based transport policy. It might also challenge the usefulness of some local government environmental policy initiatives such as environmental auditing, which has had widespread take-up amongst authorities in the UK but whose value to improving social and environmental conditions has not been rigorously tested. Transparency also needs to be added to the process by which municipalities legitimise their economic activities using the

environmental agenda. Whilst municipalities cannot be blamed for not being able to deliver a radical sustainable development agenda within existing current political and economic structures and climate, more openness about what they are doing, and why, might at least lead to a more constructive and open debate.

Many municipalities legitimate their role in fostering economic development using transport and environmental policy. However, this does not always mean that the policies they pursue are in the best long-term interest of local capitalism. From the research there appeared to be two discernible reasons for this. Firstly, the political and economic climate of neo-liberalism has acted to hamper long-term planning for the economy rather than assist it. But more directly pertinent to the local state is the second reason, which is the closeness of the relationship between the council and the business community. This close relationship, whilst allowing them to respond quickly to immediate business needs, may restrict their ability to take a more objective, long-term view about the health and development of the economy.

This relationship needs, to some extent, to be decoupled. Municipalities need to reformathe such relationships and develop clearer boundaries between themselves and the business community. They need to develop clear long-term economic development objectives, in partnership with both business and the environmental community, that reflect both immediate and possible long-term environmental restraints that business is likely to face over the next few decades. And to develop a programme of support for such technological and cultural change that might be necessary to bring business within those constraints. Given the key impact of transport on both the economy and the local and global environment, it is likely that changing transport systems and use would be a priority for any such programme of change.

Creating New Structures for Radical Sustainable Development and Ecological Modernisation

The local state cannot be expected to make such changes alone. At present it is trying to implement an environmental agenda that needs long-term planning and intervention in society from within a framework of an unstable globalising economy. It badly lacks the tools that it needs to bring about the level of social change required to realise radical sustainable development, and is trying to bring about such change from within a climate

of fierce competition between itself and other competing municipalities. This, coupled with the powerful developmental forces that it may have to counter, means that individual local states are starting from a position which cannot possibly favour the successful uptake and implementation of a radical agenda. This economic climate can undermine and limit many worthy local government and community-based sustainable development and transport initiatives.

The consequence of this is that environmental actors need to look closely at the appropriate deregulation of capital and the creation of new structures: regional, national, and international; which might assist the local state in the implementation of a radical sustainable development agenda. Whilst such global instability remains it is unlikely that

the model of the new urban form based on the idea of the car-free city will be realised. Although there are signs that the dominance of urban space by the car is being challenged, the continued emphasis on the conservative interpretation of sustainable development suggests that any resulting changes will be partial. Longer term changes to the global and local economy may be necessary before a more radical change is realised. Until then, municipalities will continue to struggle with their dual role of responding to growing concerns about the environment and acting as agent for continued economic growth, in which short-term business needs often prevail over longer-term restructuring. And until then environmental campaigners will continue to win battles but may still lose the war.

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Sustaining Africa's rural road networks: The asset management approach

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Abstract

Many rural roads in Africa are 'returning to the bush' because of inadequate maintenance. This is not helped by development loans which encourage construction of new roads and rehabilitation of existing infrastructure rather than better value ongoing maintenance. Much of the problem lies in the technical arguments put to decision makers. Here we see the argument put in a way that non-technical people can understand.

Keywords

Africa, investment, Kibaale District, maintenance, rural roads, revenue

Road conditions

Africa's roads were in bad shape before the El Niño storms in the spring of 1998 added selectively to the damage. Road condition surveys for the World Bank in more than 30 countries in East and West Africa revealed a picture of severely deteriorated - and deteriorating - networks from which not even the main highways have been spared (Sylte 1996, 1997). A May 1998 journey in Tanzania between its major port and commercial centre, Dar es Salaam, and the capital Dodoma showed that the condition of sections of the highway reduced traffic to a crawl while large potholes were laboriously negotiated. Newspaper reports indicated that large areas of the northwest of the country were not reachable by road other than through Kenya and Uganda, a detour of several hundred kilometres. Off the main roads conditions were far worse with the majority in poor condition and a significant proportion unusable by normal vehicles. (Technically a road is said to be in a *poor* condition if it is not in a maintainable state and requires rehabilitation before maintenance operations can be re-instated.)

Tanzania's situation is particularly revealing because of: (i) the relative stability of its political climate over the past four

decades; and (ii) the substantial donor assistance its road sector has received - about US\$ 830 million, under the first phase (1990-95) of the Integrated Road Project - and is due to receive even more (US\$ 650 million committed to date) under the second phase. The Integrated Road Project is focused on the trunk and regional road network of about 25,000 km. There are also district and feeder road networks comprising another 26,000 and 22,000 km respectively. These are the 'rural roads' that provide local access and are of most concern to the majority of the population. It is with them and their equivalent in other African countries that this paper is concerned.

The factors underlying the poor condition of Africa's road networks would be less depressing if it were new but this is not so. The fundamental issues were identified in 1979 (World Bank, 1981). But despite almost two decades of effort, until recently progress has been patchy. Since it was initiated in 1989 the World Bank and UN Economic Commission for Africa's Road Maintenance Initiative has made progress in defining a framework for reform which gives primary emphasis to the commercial management and financing of road systems (Heggie and Vickers, 1998). Commercialisation is based on four interdependent building blocks of reform:

- Involving road users so that they can take part in decisions on levels of service and charges;
- Stabilising road financing by a mechanism to ensure an adequate, steady flow of funds;
- Clarifying responsibility in the area of network management; and
- Improving the management and efficiency of the bodies in charge of road maintenance.

These ideas are in various stages of implementation in about a dozen countries and the progress made by the best performers gives grounds for guarded optimism. However, the immensity of the reforms is such that for the next decade main roads are likely to be the

principal beneficiaries. Rural road networks will receive little benefit because there are political limitations to the rate at which road user charges and fuel prices may be increased without risking civil unrest, (which can be extreme). This is especially likely when the populace has become accustomed to very low real costs, a lesson that countries as culturally diverse as Indonesia, Nigeria and Venezuela have learned to their peril. Thus, funding the maintenance, yet alone development, of entire road networks out of locally generated funds remains a distant prospect in most countries. The main highways will necessarily come first.

For the rural road networks there are additional difficulties. First, they are normally managed by local government administrations whose weak financial, institutional and human resource base renders the sustainability of all public investments immensely difficult. Second, local administrations also feel the full effect of a number of fundamental characteristics that inhibit Africa's development. Geography, population dynamics and neglect of the financial realities necessary to sustain its road networks stand out as being crucial to its predicament.

Geography and population dynamics

The sheer size of Africa has been systematically misrepresented ever since Mercator drew his famous map of the world. Few people realise that you can put Argentina, China, Europe, India, New Zealand and the USA inside Africa and still have space left. (The total area of these countries amounts to 30,245,000 km² whereas Africa's area is estimated at 30,345,000 km².) This huge area contains a comparatively small, impoverished population that is, moreover, very unevenly distributed. Thus whilst there are areas where the population is densely concentrated - Rwanda, Burundi, and the major volcanic mountains of East Africa are examples - its density is about 20 persons per km² averaged over the continent compared to six times this figure in most of Asia.

The sparseness and poverty of its population means that it is inherently difficult to support the maintenance of all types of infrastructure. There are vast distances with very few people to generate the revenues necessary to sustain maintenance. Without maintenance even bitumen surfaced roads will become unusable in as little as 10-12 years; with gravel roads it is normally of the order of 6-8 years; and for earth surfaced roads

as little as 3-5 years, depending on climate. Rural road networks are confronted by a special difficulty - many carry very little traffic, albeit that these modest vehicle flows may be vital to sustain local communities.

There seems to have been a reluctance among all concerned to confront the unfortunate issue of the very low demands in many areas. Construction is the easy part as there is a never-ending stream of donors willing to finance capital investment. But roads incur recurrent costs if their initial effects are to be sustained into the creation of long-term impacts, and these are high measured against locally generated budgets.

Financial realities

The financial realities of sustaining road networks can best be illustrated by some simple calculations, albeit based on realistic estimated values. Under African conditions 1km of rural road might have an influence area of 10 km² (5 km either side), or influence population of 200, some 30 households. Since the annualised cost of maintenance per km is of the order of \$500 for an earth and \$1500 for a gravel road the yearly cost per household (\$17 - 50) is significant. This is because although the notional GNP per capita per year for Sub-Saharan Africa is some \$540, actual cash income for many rural households living at subsistence level is likely to be of the order of perhaps \$100 or less per annum. Even if it were possible to tax such households efficiently, something which has defeated generations of administrators and is not even feasible in the much more controlled urban areas, any realistic taxation rate would evidently still not yield sufficient revenue to pay for road maintenance.

The constraint imposed by financial realities is not one which has been heeded by its politicians and the length of road systems has expanded substantially even during the so-called 'lost decade' of the 1980s and the depressed 1990s. Tanzania again provides a reasonably typical example. The aggregate length of its trunk, main and district road categories more than doubled from around 24,000 km in 1972 to some 51,000 km in 1997 (Andreski and Malisa, 1998). Continentally the UN Economic Commission for Africa remains committed to the notion of Trans African Highway networks (Figure 1) with the Southern terminus presumably in Cape Town, although the additional route length does not represent new construction since South Africa already possesses an excellent highway system and, in this respect, is an exception.

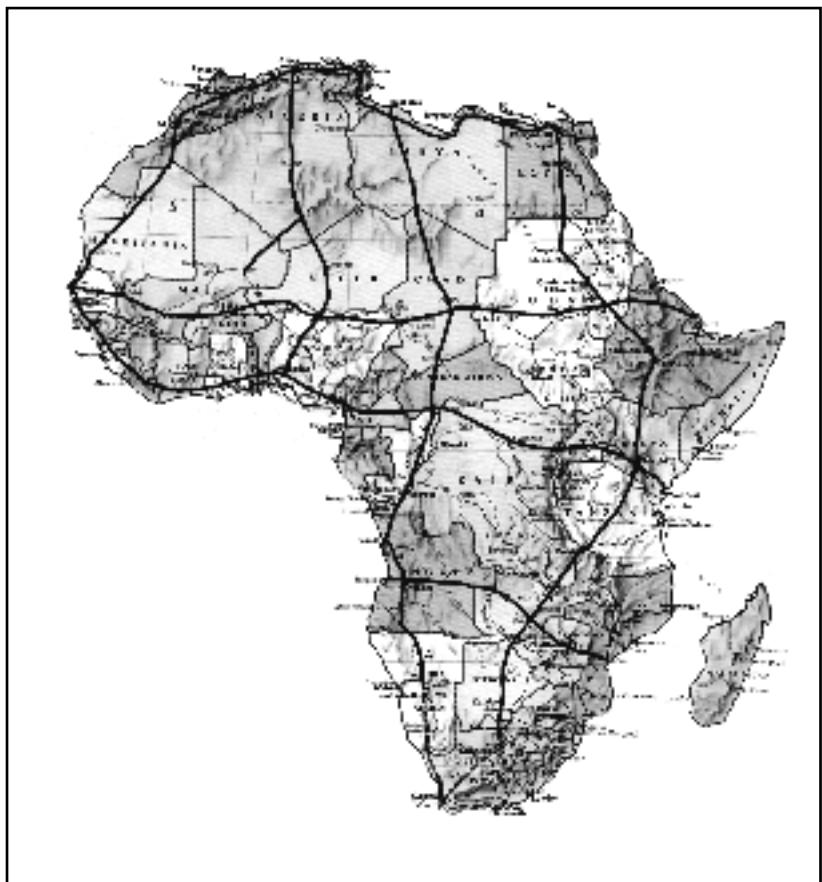


Figure 1 Trans-Africa Highway Network

East-West routes: Dakar–Djibouti; Lagos–Mombasa; Lobito–Beira
North-South routes: Algiers–Lagos; Tripoli–Windhoek; Cairo–Gaborone
Coastal route: Lagos–Dakar–Algiers–Cairo

It has been argued elsewhere that the whole vision of the Trans African Highway system needs to be rethought to conform to financial realities (Howe 1997). Suffice to note here that the continuing calls for its construction is a triumph of notions of status over common sense. A continent with a 1996 external debt of US\$ 305 billion clearly cannot afford such extravagance unless there is compelling evidence that it would provide the catalyst to accelerate economic growth. Unfortunately there is no scientific basis for such a claim. Quite the reverse. The consensus of experience supports the view that investment in road infrastructure is a comparatively crude instrument for stimulating economic activity. Sometimes it does and sometimes not. When it fails the opportunity costs, in the form of the legacy of debt servicing, can be high, as both Brazil and Nigeria have discovered. Investment has to be carefully targeted and not based on the assumption that economic growth follows automatically.

Too many roads?

The scale and intractability of Sub-Saharan Africa's road network problem prompts the

question: 'does it have too many roads?' This has already been alleged by the World Bank, but only in a qualitative rather than quantified way: 'while Africa is under-equipped in relation to its potential it is overburdened by the little infrastructure it possesses' (Riverson, et al. 1991). The 1994 World Development report offered further quantified support to this notion (World Bank, 1994). It shows (Figure 1.2, page 16) a correlation for all developing countries of paved roads per million population against notional GNP per capita in Purchasing Power Parity dollars. It is notable that the majority of the African countries are well above the trend line. A similar conclusion can be drawn from the road condition surveys referred to previously, which reveal that most countries are able to finance no more than 25-30% of their nominal maintenance requirements. Even these proportions are over-estimates since much is spent on the wages of over-staffed public works departments rather than productive work.

Lack of finance will result in attrition of the network and has already done so, although not in any strongly rational way since political instinct is to spread available money as thinly as possible over the entire network so as to benefit the maximum number of people. While this is understandable it does not necessarily constitute the best use of these resources. In most countries some degree of network reduction is likely to be necessary, albeit that it will be fiercely resisted. It will happen anyway due to attrition - the choice is to manage the process in some rational way or have it occur haphazardly.

What needs to be done?

Recent surveys in four African countries (Ethiopia, Lesotho, Tanzania and Uganda) indicate that - over and above other resource problems - finance is *the binding constraint* on rural road network sustainability (Howe et al., 1998). However, international experience suggests that the problem lies as much with the misallocation of financial resources as with their absence - specifically a destructive emphasis on construction to the almost complete neglect of maintenance. It is notable that in most of the study countries road investment has been for rehabilitation rather than the opening-up of completely new routes. The very notion of 'rehabilitation' is indicative of a failed maintenance policy, i.e. the construct-lack of maintenance-deteriorate cycle has been gone through at least once. This raises the question: 'why it is so difficult

to obtain political and local support for more sensible road investment policies? Part of the explanation may lie in the focus, language and process of communication.

Road network finance is normally discussed as an element of the government budgetary process. There is no concern with the inherent value of the assets that are being created or whether that asset base is increasing - which any meaningful interpretation of the term 'development' would appear to require. The normal dialogue is technocratic and conducted in terms that only the initiated really understand - 'routine', 'recurrent', and 'periodic maintenance', 'optimal grading' 'regravelling cycles', etc. It usually passes as a plea from the technically literate to those who do not really comprehend these terms to place their faith in the technocrat's proposals. Experience from the Road Maintenance Initiative and elsewhere indicates that for rural road network sustainability to be a realistic prospect: (i) the operational model needs to be more strongly focused on conservation of the asset base that is created by progressive investment in a road network; and (ii) the language and process of dialogue needs to be changed.

Managing rural road networks using the asset value approach

The previous situation, which is common in many countries, has led to proposals for road network management strategies based on a concept which is readily understandable by a wide range of decision makers at all levels in the administrative hierarchy. *Conservation of*

the inherent asset value of the network expressed in money terms. (The notion of asset-based management has arisen from the joint work of the World Bank and GTZ under the Road Maintenance Initiative and is practised by other utilities such as the water sector and Metropolitan Boroughs in the UK - see Metschies, 1998, Banyard and Bostock, 1998.)

The basic idea is very simple ...

- The current asset value of any road network can be estimated in monetary terms with reasonable accuracy at a particular point in time, in the same manner as the balance sheet of a company.
- Lack of maintenance will result in the deterioration of the network by physical attrition due to the effects of climate and traffic, which implies a continuous decrease in its asset value. Earth and many lightly gravelled roads will deteriorate to a point that they are unusable, except with great difficulty, in as little as 3-5 years depending on location. This is a matter of common experience so it is easy to reach agreement on what sort of interval should be assumed for estimation purposes.
- While investment in the rehabilitation of currently unusable routes or the addition of completely new roads implies an increase in the asset value of the network, this may, and is indeed likely to, be more than counterbalanced by the losses incurred from non-maintenance of existing maintainable routes.
- Thus the wisdom of any investment programme and crucially the balance

Table 1: Financing of rural road maintenance – the Rwandan case

Expenditure needs of the road sector based on the Asset Value Approach

Road Surface	Length		Asset Replacement Value per km	Total Asset Replacement Value \$/km	Total Network Value million \$	% of Asset Value ³	Annual Maintenance Requirement ⁴ \$/kmp.a.	Yearly Expenditure on Road Maintenance \$ million ⁵	Rule of Thumb for National Road Maintenance Funds		
	km	%							(9)	(10)	
	(1)	(2)	(3)	(4=1*3)	(5)	(6)	(7)	(8=4*7)	(9)	(10)	
Asphalt	900	7.3	400,000 ⁴	360	60	1.5	6,000	5.40	36	-	
Gravel	2,500	20.2	50,000	125	20	3.0	1,500	3.75	25	65-70	
Earth	8,500	68.5 ⁵	10,000	85	14	5.0 ⁶	500 ⁶	4.25	28	20-25	
Urban Road	500	4.0	80,000	40	6	4.0	3,200	1.60	11	10	
Total	12,400	100.0	-	610 ⁷	100	2.5 ⁸	-	15.00	100	100	

Notes

1 Costs comprise labour intensive routine recurrent maintenance and periodic maintenance. Maintenance for asphalted roads (resealing) is needed every 8 years and for gravel roads (refilling) is needed every 5 years, as well as spot reconstructions.

2 This table is without backlog requirements of previous years and without new construction or rehabilitation.

3 Empirical assumptions according to road surface classes.

4 The value of 1 km of asphalted road (2 cm double surface dressing) is \$400,000.

5 More than 2/3 of the network is rural roads (earth roads).

6 According to the length/man system: 2 men for 3 km (\$1 per working day + equipment + supervision).

7 The total Asset Replacement Value of \$610 million US\$ is equivalent to 41% of the Gross National Product of the country.

8 The total expenditure needs of \$15 million may also be obtained by generally applying 25% to the Asset Value of \$610 million of the total network.

between capital and recurrent expenditure can be judged on whether or not it increases the net asset value of the network. Programmes, which result in a decrease in the asset value, simply cannot be regarded as developmental. Such would be the likely consequence of an over-emphasis on investment in construction relative to that in maintenance.

- Since the calculation of the outcome of various investment options is straightforward and only in money terms, then they could be carried out in a participatory manner so that local decision makers could determine for themselves the financial consequences of their own proposed actions.

Box 1: Comparing asset values

Case 1

Nil Maintenance

Year 1 Asset balance

Asset value of road in maintainable condition 250 km @ US\$ 10,000 = US\$ 2,500,000

Asset value of non-maintainable road 220 km @ US\$ 10,000 x 0.4 = US\$ 1,000,000

Total asset value = US\$ 3,500,000

Annual maintenance cost for a stable network is @ 5% of the asset value of those in a maintainable condition = US\$ 125,000. If this were spent on maintenance then the network would have the same asset value in Year 3.

Assume that the cost of rehabilitating other roads in a non-maintainable condition is US\$ 6000 per km, based on experience in Kibaale District, and that for three years the nominal maintenance money is spent for this purpose instead of maintenance. Then 3 x US\$ 125,000 / 6000 km can be rehabilitated = 62.5 km.

The expected asset balance will then be as follows.

Year 3

Reduced asset value due to nil maintenance of roads in a maintainable condition in Year 1
250 km @ US\$ 10,000 x 0.4 = US\$ 1,000,000

Asset value of non-maintainable road (220 - 62.5 km) @ US\$ 10,000 x 0.4 = US\$ 630,000

Asset value of 62.5 km of rehabilitated road @ 6000 = US\$ 375,000

Total asset value = US\$ 2,005,000

Net asset loss Year 1-3 = US\$ - 1,495,000

It would be difficult to argue that such an investment balance is developmental and yet this approximates to what many countries are actually doing.

Case 2

Assume roads are partly gravelled so they could justifiably be considered to have a higher asset value of, say, US\$ 30,000 with an annual maintenance estimated at 4% of this sum. With nil maintenance we assume that the roads will deteriorate to 40% of their nominal asset value (i.e. to an impassable condition) over a 5 year period. Using a similar logic as for Case 1 it can be shown that:

Net asset loss Year 1-5 = US\$ - 4,000,000

In essence such an approach is likely to require giving first funding priority to the regular routine maintenance of all roads in a maintainable condition and only undertaking further investment in rehabilitation once this objective has been satisfactorily secured.

The data in Table 1 will be used to illustrate the principles of the asset value approach using supplementary data from Kibaale District, Uganda. This is for illustrative purposes only, but does impart a degree of realism to the calculations. The table is a simplified version of an original based on Rwanda, which incorporated the notion of a Road Fund so as to determine appropriate fuel taxation levels, and gives figures for an entire national road network. However, the principle can easily be adapted to a typical rural district (Metschies, 1998). In this respect the most important figures are those which indicate asset values and maintenance requirements for gravel and earth roads in columns (3) and (6), respectively. Asset replacement values are estimated at US\$ 50,000 and US\$ 10,000 per km, and annual maintenance requirements at 3% and 5% of these figures, respectively.

Kibaale District Road Network

Kibaale District is thought to have a nominal feeder road network of about 470 km. Allocation into gravel and earth roads is more problematic since due to the prevailing lack of maintenance and climate-induced deterioration, conditions change substantially within 2-3 years. Present informed opinion is that some 250 km of the network is in a maintainable condition, with the remaining 220 km having 'returned to the bush' due to lack of maintenance.

Core Assumptions

In the first scenario (Case 1) roads in a maintainable condition will be treated as having an earth surface with an asset value of US\$ 10,000 per km and annual maintenance at 5% of its asset value. With nil maintenance we assume that the roads will deteriorate to 40% of their nominal asset value (i.e. to an impassable condition) over a 3-year period. The roads that have 'returned to the bush' may be unusable, but they still have a residual asset value since the right-of-way is usually preserved, albeit overgrown, along with some earthworks, drainage and possibly structures. These roads are valued at 40% of their asset value and are assumed to have a zero annual maintenance cost. We can now examine in Box 1 the asset balance after three years as a result of different investment strategies.

Conclusion

These examples are simplistic, but all of the assumptions are close to real values. Moreover: (i) they represent what has actually been happening in many rural areas and illustrate why the rehabilitate-inadequate maintenance-deteriorate cycle is so economically wasteful; and (ii) the assumptions can easily be changed until a consensus is reached that they reflect local experiences and values.

It is then possible to vary the rehabilitation

maintenance expenditure ratios over a range of values to reflect various options and for the decision-makers themselves to determine what happens to the net asset value of the network as a result. Since the calculations are no more than simple arithmetic non-technical people can readily understand them. It seems likely that most will also agree that investment policy is not really serving a development purpose if as a result the asset value is actually decreasing.

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Techniques for planning local networks: Developing a walking strategy

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Abstract

Walking as a mode of transport has declined in importance due, in part, to motorisation. There is a recognition among transport professionals in the UK that this needs to be redressed. The key in developing such strategies is their adoption and implementation at a local level. An outline model walking strategy is provided and there is a case study of the Lothian Region's strategy.

Keywords

Best practice, Edinburgh and Lothian, integrated transport, pedestrians, policy formulation, sustainability, walking

Introduction

All over the industrialised world, the onslaught of motorisation has been paralleled by a decline in walking. As trips lengthen and urban areas sprawl, so the perception has grown that walking and cycling are inferior modes of transport in relation to the car. Walking is no longer being socially constructed as 'transport' and indeed has in many instances come to be 'reconstructed' as a healthy-living 'leisure activity', with utilitarian walking seen as the province of those who have no car-based alternative (Lumsdon & Mitchell, 1999).

However, some years after the revival in interest in cycling, there is now growing recognition of the role that walking can play in the liveable, sustainable city. Somewhat improbably - given its post-war record in transport policy - Britain is now actively taking a lead in developing pro-walking policies (Department of Transport, 1996a), and so its progress may be of interest to other countries with similar problems.

Since 1975 the average distance walked by Britons has fallen by 20% and the decline is accelerating, especially amongst children (Department of Transport, 1996b).

Lengthening trips, shortage of time and

increasing car availability are key factors (Royles, 1995). So are fears about the physical and social environment. Now even some of the shortest journeys - of less than one mile - are being made by car instead of on foot, typified by the rapid growth in parental chauffeuring of children to nearby schools. However, there is still much walking being done - one third of all journeys are on foot (DETR, 1998) and the potential for a revival in walking is very great, with a third of all journeys being under one mile. This paper proposes that the development of walking strategies at the local level is a key element in converting this potential into reality.

During the latter half of this century walking has been neglected in policy and planning in the UK and instead the main goal has been to attempt to accommodate the increasing number of motor vehicles (Goodman *et al.*, 1998). However, by the early 1990s, financial and environmental considerations began to force a shift in transport policy, and local authorities have since increasingly been encouraged by central government and others to re-orient their transport plans away from catering for cars and towards public transport, cycling and walking (Pedestrians Policy Group, 1996; CAST, 1997).

In 1998 a Pedestrians Association review of local authority policies and provision for walking found that the overwhelming majority of authorities were committed to promoting walking, but that only a minority had found it possible to turn this commitment into practice (Oxford Brookes University, 1998). This is not surprising in view of their lack of experience of incorporating walking into planning frameworks, their ignorance of appropriate techniques and the absence of staff with relevant training. The National Walking Strategy is now pointing a way towards best practice and the National Walking Forum seeks to review approaches to the development of walking. However, while there have been several publications concerning the needs of pedestrians, their

perceptions of the walking environment and the improvement of facilities (for example, Hitchcock & Mitchell, 1984; National Consumer Council, 1987; 1995; Gunnarsson, 1995; General Consumer Council for Northern Ireland, 1997) there is a dearth of guidance on strategic thinking, without which facilities may be isolated and ineffective. This paper sets out a model approach to the development of a walking strategy at a local level. It is illustrative of the type of approach which might be adopted by a local authority and as such provides guidance rather than a definitive statement. The aim is to assist those responsible for developing walking strategies with a framework within which to draft a strategic document for their particular town, city, or urban area.

Essential ingredients

At a formal level the planning process is determined by statute and evidenced in core documents such as Structure Plans and Local Plans as well as in the new Local Transport Plans. There are also opportunities for local authorities to prepare detailed policy documents on specific subject areas such as leisure and sports, town centre management, and cycling. It is often through this type of project work that core strategy is built and

Box 1: Ingredients vital for developing a viable walking strategy

- a clear understanding of the needs of walkers, not simply a re-statement of problems, but also a review of desires which motivate people to walk;
- a recognition that there is not one homogeneous market for walking – like other forms of transport, it forms a fragmented market ranging from those who view walking as an important part of their lives to those who rarely walk by choice;
- an appreciation that trip-making is complicated, and that walking forms part of a wider pattern of household travel requirements;
- continuous consultation with walkers and other local community interests;
- integration with other strategic frameworks;
- a recognition by partners such as council members, senior managers, developers and a wide range of institutions which shape the fabric of a locality that a walking strategy is part of the overall solution to sustainable transport;
- an understanding of walking's role as a catalyst for regeneration – studies have shown that a good walking environment is a good economic environment (Roberts, 1990);
- a multi-faceted approach, using not only motivational or promotional interventions but also engineering improvements and traffic reduction measures;
- preparation of the strategy as a formal document which includes aims, objectives and targets, action programmes, consultation and monitoring mechanisms.

eventually incorporated into town, regional or national strategic guidelines. The co-ordination of these formal inputs into the planning process encompasses the advocacy role of highway engineers, town and transport planners, and senior managers in advising the key partners in the process, such as council members, political parties, developers and a wide range of institutions involved in shaping the urban environment. Thus, in terms of developing a strategy for walking, many ingredients are considered to be essential (see Box 1).

Strategic framework

The remainder of this paper sets out a strategic framework, consisting of strategic direction, aims, objectives and targets; core principles; the market; policy integration; consultation; and action programmes.

Strategic direction, aims, objectives and targets

The first task is to issue a clear policy statement expressing the desirability of, and commitment to, promoting walking. This should be prominently stated in all transport and planning documents such as Local Transport Plans, Structure Plans, Development Plans, etc. It could use the words suggested by Newby & Sloman (1996):

'This Local Authority recognises the benefits of walking as a means of transport. We will prioritise the needs of pedestrians in transport and land use proposals and improve facilities for pedestrians in order to promote more and safer walking.'

The aim or goal of the strategy then needs to be simply and succinctly set out, exemplified by Derbyshire County Council (1998):

'... to increase the proportion of journeys on foot, thereby reducing reliance on the private car.'

Incorporating a set of objectives allows greater precision, perhaps by using quantified targets set against realistic timescales. A good example is that of the London Planning Advisory Committee (1997):

'The main target is to increase walking's share of all journeys in London from 34% to 39% over the next ten years'

If data on walking are lacking, an interim target could be set, such as

'to discover what percentage of trips are on foot so that a quantified target can be set in two years time.'

Core principles

At an early stage it is appropriate to set out the overall principles of design, the scale and the scope of the strategy. These core principles or benchmarks will include all or some of those in Box 2.

Table 1: York: Transport Priorities

- | | |
|---|---|
| 1 | Pedestrians |
| 2 | People with disabilities |
| 3 | Cyclists |
| 4 | Public transport passengers |
| 5 | Commercial/business vehicles requiring access |
| 6 | Car-borne shoppers |
| 7 | Coach-borne visitors |
| 8 | Car-borne long-stay commuters and visitors |

The market

One of the most difficult aspects of preparing the strategy is that there is little firm local data on which to measure demand for walking. There will be a need for pedestrian counts in determining major radial routes, say between local communities and shopping zones, to main railway or bus stations, etc. It would also be valuable to determine what motivates walkers and how walking can be segmented by journey purpose. In this and many other ways the collection and analysis of data is vital to the building of a walking strategy.

Policy integration

At a local level the walking strategy needs to be integrated into current land use and transport plans, but also into a wide range of other initiatives and plans which also should feature walking. These include Local Agenda 21, City Health Plans, Safe Routes to Schools,

Box 2: Walking strategy core principles

- a hierarchy: setting down the relationship of walking to other modes of transport. The City of York, for example, has determined that pedestrians are given priority over other modes of transport (see Table 1);
- high priority zones: prioritising key destinations or zones, or alternatively adopting a blanket approach to developing a network;
- network guidelines: determining the level of provision of major radial routes and local networks;
- design standards: agreeing standards particularly in relation to social and physical safety, level of attractiveness, signage, and removal of barriers, especially for less able-bodied people;
- functionality: balancing recreation and utility, as some routes, such as greenways, will have great potential for recreation, while others will be primarily to facilitate everyday trips to school, work or the shops;
- communication: ensuring that walking is positioned as a vibrant, social part of life;
- signage: agreeing the degree and nature of signing afforded to different routes.

Tourism Development Strategies, Green Commuter Plans and so on. This will help to reduce unintended consequences affecting walking as a result of outcomes of programmes in another field.

Consultation

The level of consultation required both in terms of preparing a first draft of a strategy and then a more complete planning document will be extensive as walking affects all local communities. It is a most difficult aspect because people are used to the idea of walking being discussed only in the context of recreation in the countryside and not in towns.

The first stage might involve building on the knowledge and changing attitudes within the authority at member, senior management and departmental level (Witherby, 1996). This also forms part of the preparatory stage of advising and updating the authority regarding the importance of walking and key issues which might shape a strategy. Good starting points would be to review pedestrianisation or traffic calming - because everyone is conversant with these - or to promote walking to work and within work by local authority employees as part of an in-house Green Commuter Plan.

The second stage of consultation would necessitate involving institutional partners, which would include all those organisations which might have an interest, a possible commitment and resources to provide for walking. They would include educational institutions, employers, retailers, visitor attractions and main recreational sites, emergency services, health authorities, and pressure groups, for example.

Thirdly, it is important to maintain contact with pedestrians, transport users, and local community groups. Wide consultation at an early stage on walking might not yield the type of information and commitment necessary to help design a strategic framework (Engwicht, 1992). However, many people will be interested in very local issues which affect them and their families and friends such as the lack of a school crossing, perceived crime associated with a particular route to the shops, etc. It may be possible to formalise this by getting people to audit the 'walkability' of their local community, using a standard checklist of criteria.

Action programmes

The strength of the strategy lies not only in the direction and policy guidelines, but in the determination of priorities outlined in action programmes. These more specific targets and

actions will enable the authority to evaluate the effectiveness of each measure and to modify the strategy in light of experience. Here we outline six proposed Action Programmes, which could overlap, or be introduced concurrently or in succession.

Audit of current network(s)

This would include an evaluation of:

- highway pavements and crossings;
- current walking areas - squares, pedestrian streets, etc.;
- major obstacles - underpasses, footbridges, urban motorways;
- environmental conditions - traffic speeds, level of dominance by the car, air pollution, noise;
- open spaces and off-road network.

Criteria for assessment would include:

- functionality (directness, for example);
- appeal or level of attractiveness;
- social and physical safety;
- accessibility;
- connectedness to other transport modes;
- design: fitness for purpose;
- extent of shared use.

The overall network might be evaluated using the so-called '5Cs':

- Connected;
- Convenient;
- Comfortable;
- Convivial; and
- Conspicuous

(London Planning Advisory Committee, 1997).

Programme of engineering works

This would be the most extensive section of the strategy, based on the design criteria determined during the audit. It would include:

- the provision of a clearly definable network of radial walking routes to key destinations from local communities, as Ramsay (1997) has recommended;
- the introduction of lower speed limits on residential roads to make them more conducive to walking;
- the development of priority zones (such as local shopping areas, retail and leisure zones, routes to major plants or office complexes, and educational institutions), which builds on what people know and offers a chance to improve past successes;
- reduction of road space and parking for vehicles to permit widening of pavements and provision of crossings at pinch points of road space for vehicles;
- a review of known difficult highway crossing points which require urgent

improvement;

- a review of the maintenance programme so that street lighting and pavement gritting are afforded a much higher priority, even if this requires a re-examination of duties, routines, and in due course formulae and regulations (for example, those affecting the smooth, free flow of vehicles).

Integration with other plans

Integration of walking into other planning and engineering documents is also important. This can be facilitated as part of the audit process but requires revision and updating as the strategy begins to take shape. There are two other important aspects:

- The strategy guidelines need to be very clear in terms of new development. For example, a council might wish to refuse planning permission on the grounds that a new development does not satisfy the requirements of car reduction or walking. This will remain a key issue in the short term as retailers and leisure providers are still pushing hard for out of town sites.
- The strategy needs to reinforce the retention of small scale mixed use areas in local plans, as these often generate many non-motorised short trips between home, work, school and local shops. In these areas trips are simplified as people can accompany children to school on the way to work, all within a half-mile of home.

Communication

Research has shown that the most cost effective way to promote changes in people's travel behaviour is by focusing marketing campaigns on groups of people who will actually consider changing their travel behaviour and then targeting promotional campaigns at them (James, 1998; Mailbach, 1993). Change is best achieved by attention to detail and listening to feedback on matters which concern the locality rather than the global picture. Key issues will be school education programmes to encourage children to continue walking, perhaps delivered as part of safe routes to school initiatives.

This process of raising the profile of walking is important especially at the early stages of strategy implementation. It is also valuable to concentrate on a wider communication campaign which includes:

- printing and distribution of clear maps showing the initial walking network with proposed extensions;
- presentations and discussions internally with senior management, and council

members. This is very time-consuming but it is the only way in which a commitment to the strategy can be achieved by an authority in a comprehensive manner. The emphasis should be on the tangible benefits of car reduction in terms of the local economy, health of citizens and environmental gain. There might also be a case for training and updating of some staff;

- a similar range of presentations with partners throughout the community, possibly achieved through the establishment of a Walking Forum which brings together representatives of major generators of trips, and other important influencing bodies.

Funding

Though funding will come primarily through the new Local Transport Plan mechanism, given the multi-faceted nature of the strategy it is essential that funding be achieved through a wide range of initiatives. These could include partnership schemes such as the Private Finance Initiative; private sector funding; developers; English Partnership; European Funding; Health Authorities and Trusts; Landfill Tax; Lottery Sports Funds; Training and Enterprise Councils; Single Regeneration Budget proposals; and Voluntary Groups such as the Civic Trust and the use of the Environmental Action Fund.

Monitoring and Review

The priority is to establish, as a matter of course, adequate data collection on walking along specific routes. This will permit:

- establishment of an annual progress report which takes into account progression against targets;
- determination of more accurate measures of success, which might involve accident rate criteria, increase in trips, number of complaints, etc.;
- initiating demonstration projects which can be used to illustrate best practice and to bolster the case for more resources.

A case study of the Lothian Region, Scotland

Edinburgh has one of the most radical transport policies in the UK and not surprisingly it has incorporated a comprehensive walking strategy (Lothian Regional Council, 1996). The target is to increase the proportion of journeys to work that are on foot from 16% to 18% by 2010. This may seem unambitious, but it will be necessary to stem the existing

decline before growth can be achieved. The target is aimed at work journeys as data exist for these, but it is evident that improving the environment for work journeys will also stimulate trips to shops, school, social activities and tourist destinations.

The strategy is to encourage walking by:

- giving priority to pedestrians and pushing forward with town and city centre traffic and environmental improvements;
- implementing traffic calming measures;
- ensuring that new development incorporates good access and design for pedestrians;
- making it safer for children to walk to school; and
- promoting combined journeys by enhancing the link between walking and public transport.

The strategy is taken forward through 14 policies, the main aims of which involve:

- re-assessing all traffic lights at major junctions to make it easier for pedestrians to cross;
- completing a pedestrian audit of all traffic management, road improvement and major maintenance projects. The audit will make sure that the safety and convenience of pedestrians is increased;
- reviewing the amount of space available to pedestrians;
- prioritising the provision of safe, convenient and clearly signed pedestrian routes to and from major public transport interchanges;
- developing a pedestrian crossing database;
- identifying the major walking routes to town and city areas, shopping areas, tourist attractions, sports venues, etc.;
- establishing pedestrian priority zones in major shopping areas;
- making walking more pleasant and convenient by slowing down vehicles using traffic calming measures; and
- creating an attractive and high quality streetscape.

Particular initiatives are then developed to implement these goals. For example, in Edinburgh city centre a pedestrian route network is to be developed, featuring a hierarchical structure of routes. 'Principal routes' have the highest pedestrian flows; the 'strategic routes' are used by pedestrians to get to and from the commercial centre; and the 'major local distributors' facilitate pedestrian access to and through local residential or shopping areas. Related to this is Phase One of the Royal Mile works in Edinburgh city centre, which between 1994 and 1996:

- reduced the width of the carriageway and

- restricted parking;
- widened pavements and improved the surface;
 - created 'special areas' for pedestrians; and
 - created a comfortable and appropriate environment using high quality Scottish materials.

Traffic volumes fell by 27% and pedestrian volumes rose by roughly the same proportion. Perceived levels of safety and attractiveness rose among residents, visitors and businesses alike (Lothian and Edinburgh Enterprise Limited, 1996).

A third example is the 'Exploration Edinburgh' initiative, which looks to develop and promote further the existing guided and self-guided tours by sustainable modes in Edinburgh. There are more than 25 walking tours in existence, many - though not all - focused on central Edinburgh and aimed at tourists. Elsewhere there are 'walk to the shops' initiatives, for example in the Gorgie/Dalry district where physical improvements to make walking more attractive and various business development activities interlock to form a strategy to arrest the long term decline of the district centre.

What is notable about Lothian's walking strategy is its realism and hard-headedness. It stresses that a modal shift towards walking is essential for air quality targets to be met. Again, it goes out of its way to stress the benefits to business and employment maintenance of high quality pedestrian facilities. One would not expect quick results from a strategy which has long-term goals and is set in the context of historical decline in walking. Nevertheless, the way in which the

walking strategy is embedded in wider policies and implicated in the achievement of their goals gives it every possible chance of success.

Conclusions

Many local authorities throughout the world have adopted strategies for cycling, but it is only more recently that walking has come to be regarded as a mode of transport which is highly relevant to sustainable urban living. Where there has been planning for walking it has tended to be presented in a tactical manner, for example in relation to pedestrianisation of central zones, rather than as a strategy which integrates walking with other everyday activities, land use planning and inter-modality.

This paper has outlined a model local walking strategy. It is based on the UK, but as a model approach it has international validity, though of course local variations will be appropriate. Planning for walking provides a similar challenge to planning for cycling - not simply to increase the number of non-motorised trips, but to reverse existing structures, guidelines and attitudes in order to encourage reduction of car use. This will not be achieved by localised improvements and expediency alongside 'business as usual' planning. It is vital that local walking strategies are holistic, integrated and strategic if they are to succeed in showing how walking can play an important part in improving our environment, our health and our way of life.

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Urban cycling options in the free market

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Abstract

The City Council in Auckland, New Zealand, has known since the late 1970s that apparently marginal activities such as cycling and walking can significantly benefit the urban environment. Despite this, lack of foresight has left the city with restricted capacity to take advantage of these low-tech options. However, the full implementation of a proposed national transport model may see the payment of ecological, social and economic costs of private vehicles by users. This may provide an impetus for a better balance between transport options for Auckland.

Keywords

Auckland, cycling, efficiency, externalities, flexibility

Introduction

New Zealand is reforming its national transportation policy. The process began in 1993 with the Ministry of Transport's Land Transport Pricing Study aimed at developing the appropriate pricing and regulatory framework to ensure users faced the full economic costs of their transport decisions. Included in the LTPS cost-benefit analysis were ecological and social costs (MoT, 1996). The New Zealand government has now released a discussion document on proposed legislative amendments. Among the proposed amendments is a suggestion that changes in the way road users are charged would better reflect the environmental impact of road use. For example, congestion pricing to create incentives for using alternative transport modes or travelling at different times of the day and thereby increasing engine efficiency.

It is up to local government to work out how to realise sustainable transport goals within any new enabling legislation. This in turn relies on local body political

commitment. This applies particularly in Auckland City, recognised as one of the country's most congested, least efficient and environmentally one of the most damaging transport centres. The whole of the Auckland Region (including Manukau, North Shore and Waitakere Cities) suffers to a greater or lesser extent from these problems. Auckland City serves as a particular case in point.

Changes in national legislation, with consequent pressure for local change, will raise hope amongst the cycling lobby in Auckland. Cycling has been marginalised to the point where as a percentage of commuter travel it is internationally low (ACC, 1998). This is despite City authorities recognising for at least 20 years the personal, community, economic and ecological benefits of cycling (ABPC, 1980).

This paper uses the cycling experience in Auckland to illustrate how failure to provide transport flexibility has hard-wired the city in favour of the private car. This makes it extremely difficult to retrofit and cater for



Figure 1 Auckland location map



Figures 2 and 3 Auckland has evolved into a series of spread out suburbs linked by long ribbons of road, all but excluding non-motorised transport

alternatives once seen as unimportant and now recognised as having social, economic and ecological benefits.

It's got to be good for you

Many major advertising campaigns now focus on convincing consumers they can buy quality goods that minimise environmental impacts while also improving their health, their home or their family, and may even save them money. A New Zealand fruit juice slogan "It's Got To Be Good For You" typifies the approach.

Oddly, despite the amassing of international evidence, New Zealand transport planners and engineers have (with notable exceptions) ignored data showing that individuals benefit from using cars less. They claim people want to drive, so they meet the need; it's up to individuals to assess the costs and benefits. Until recently there was no serious consideration of how supply

management provides facilities favouring one mode of transport, resulting in increased use of that mode (Havlick & Newman, 1998). Inevitably, alternatives become impractical, leading to the conclusion that nobody wants to do anything other than drive a car.

Now, under a market oriented political philosophy, bureaucrats can claim it is not their role to engineer society. There is no impetus to debate working for the public good. This includes providing the public with information that could benefit their health, home, family, environment and pocket book. Given this, lobbyists for alternative transport options now have to work smarter, not harder. They could show that if market-oriented planners adopt all the implications of the market place, the outcome could be a more sustainable transport system. This is explored more fully below.

Twenty four years ago, Ivan Illich pointed out that a typical American male spent almost 20% of his time devoted to his car through travelling, sitting in traffic jams, finding parks and earning enough to run it and pay it off (Illich, 1974). A 1990 German study reckoned drivers annually spent an average of 470 hours of their pay for the same thing. Meanwhile, the average German commuting cyclist spent 15 hours - about 3% of the car owners budget (Seifried, 1990).

There is no equivalent New Zealand study, but New Zealand Automobile Association figures (McCutcheson, 1998) suggest that for a second hand car buyer per annum costs vary from \$2,300 to over \$7,000. Taking \$5,000 as the median, using an average income of \$22,100 per year and allowing for the current 22.125% applicable tax rate, it would take 604 hours to cover annual car costs. Note that these figures will vary markedly throughout the country: for example, Auckland incomes are higher than average, but then the average value of a car is likely to be higher as well. However, one thing that does not alter: \$5,000 is \$96 per week, and using the 3:100 ratio, a cyclist would need only \$3.00 per week, saving \$93.00.

Community and Ecological Benefits

That cycling is good for individuals and the community is well recognised locally. Motor vehicles are the largest contributor to metropolitan air pollution and can detrimentally affect public health, welfare, ecology, the economy, property and social structure (Whitelegg, 1993; MoT, 1996; ARC, 1998). Apart from impacts such as photo-

Table 1: Space requirements of cyclists and car occupants.

Vehicle	Bike	Car
Length(metres)	2	4
Width(metres)	2	3
stationary footprint(m ²)	4	12
2 second rule footprint(m ²) ¹	11.2	16.8
at 10 km/h total area required (m ²)	15.2	28.8
total area required per person at 10 km/h (m ²) ²	15.2	24
at 20 km/h total area required (m ²)	26.4	45.6
total area required per person at 20 km/h(m ²) ²	26.4	38

Notes

1 a vehicle travels 5.6 m in 2 seconds at 10 km/h

2 1.2 persons per car

Table 2: Arearequiredfor6people travelling by bike and by car

	m ²	% of 5 car space
space for 6 bikes at 10 km/h	91.2	63.33
space for 5 cars at 10 km/h	144	
difference	52.8	36.67
10% switch from cars to bikes		3.67

chemical smog, greenhouse gas endowments and noise; there are less obvious impacts such as community disruption and isolation by arterial routes and motorways; and the major contribution to water pollution from road runoff (ARC, 1997). Cost estimates to treat all existing and future urban stormwater discharges into the Waitemata Harbour and Hauraki Gulf, in order to remove hydrocarbons, zinc, lead, copper and other contaminants, are between \$1.8 and \$2.3 billion (ARC, 1998). Meanwhile, cycling allows greater mobility for those in the community with limited transport options; cyclists travel faster than motor vehicles in rush hour traffic and take up less space; it's healthy; and cycling is the most energy efficient method of transportation known (ARC, 1997).

Despite this local knowledge, Aucklanders have been making more trips over longer distances by car while cycling numbers drop. For example, between 1986 and 1996, the average length of a trip to work increased from 10.8 km to 13.9 km (ARC, 1998). Resulting non-productive congestion costs to the Auckland economy are estimated to be \$755 million (Ernst & Young, 1997).

Cycling could reduce congestion significantly. Auckland Regional Council monitoring of peak time traffic along a main Auckland City arterial route (Dominion Road, 1997) shows an average overall travel speed of 17 km/h and a minimum speed of 9 km/h. No monitoring of cycling speeds has been done, but regular cycling commuters (including myself) agree that at peak times 10 km/h along congested roads is probably an acceptable minimum estimate.

Taking into account vehicle size (a bike's footprint is about 4 m² (2 m x 2 m), a small car's is about 12 m² (4 m long, 3 m wide)) and the two second rule stopping distance (5.56 m stopping distance required for every 10 km/h), a cyclist travelling at 10 km/h needs at least 15.2 m², while a car travelling an average 10 km/h needs 28.8 m². Using the average Auckland peak time occupancy rate of 1.2 people per car (ARC, 1998), that brings the space need per person for car drivers down to 24 m² (see Table 1).

Put another way, six cyclists would need five cars if they drove. Assuming they can travel at an average 10 km/h, the road space saved on a peak time arterial by every six cyclists would be the difference between the space five cars require as against six bikes. At 10 km/h, six bikes need 91.2 m² and five cars need 144 m² (see Table 2). Thus if 10% of those driving at peak time took a bike instead, road capacity could increase almost 3.67%. In addition, as car speed increases, the potential increase in capacity due to cycle uptake also increases (Table 1).

Political Commitment

Recognition since at least 1980 at a regional government level that cycling, along with walking, is central to integrated transport planning in Auckland (ABPC, 1980) has made little or no impact. There has been a steady decline since 1986 in the number of Aucklanders cycling to work, to 1.8% as of 1996 (ARC, 1997). At the same time there has been a steady increase in the number of car trips per person, and an increase in car ownership, from 1.38 vehicles per household to 1.55 vehicles per household by 1996 (ARC, 1997).

For example, one indicator of the lack of (City) Council support (to date) is the length of cycleways in the region. It is not possible to say these trends are due to the observed failure by the City Council in Auckland to improve the safety or accessibility for cyclists (Knight *et al.*, 1997). Part of the problem is the significant and constant change in where people live, work, shop and play, resulting in changing transport needs (ARC, 1998) and responses to those needs. This makes identifying the causes of increased car use difficult to identify. But *prima facie* evidence suggests that lack of alternatives, including cycling facilities, makes it less likely that Aucklanders would opt for other ways of travelling apart from the car. For example, one indicator of the lack of Council support is the length of cycleways in the region. As of 1997,

there were only 40 km of cycle paths, with only 10 km suitable for commuting (ARC, 1997). For Auckland City itself, there were only 21 km of what are called 'cycle facilities', most of it unsuitable for commuting (ACC, 1998).

As to why bureaucracy failed to account for alternatives has not been analysed in detail. Doubtless the reasons are similar to those elsewhere: cheap petrol, cheap cars, and no charges for adverse environmental impacts ... all leading to the assumption that private vehicle use is not only convenient but desirable. The massive benefits of private vehicle use for large numbers of people is undeniable, but the benefits have been oversold. The resulting planning inertia has left cities such as Auckland with major problems if they want to retrofit and encourage other transport modes.

Financial Support

In 1997-98, only 0.75% of the total Auckland City transport budget was allocated to developing further cycleways. Roading, meanwhile, continues to receive almost 90% of the total budget. While this imbalance is being addressed (ACC, 1998), the potential for political backsliding remains.

The release of the Auckland City Council's March 1998 Cycle and Walking Strategy led to the Council indicating an intention to spend \$14 million over 20 years, from 1998-99 through to 2018-19, on improving cycle lanes, bike stands and marking out bike routes (ACC, 1998). The document analysed the advantages of cycling and walking, recorded design criteria, set out an implementation plan, and put in place goals with costings. In short, it

provided an effective blueprint with measurable outputs to improve cycle and walking access around Auckland City. \$14 million over 20 years compares with the \$24.7 million expenditure on roads projected for 1998-99 (\$19 million for capital expenditure, \$5.7 million for major maintenance).

The problem now is ensuring that the City Council sticks to the Strategy and implements it in full. Political and financial commitment has been lacking, with few notable exceptions, throughout the region. The 1998 document largely repeats undertakings made in 1980 - undertakings that failed to materialise (Knight *et al.*, 1997). Recently, despite the 1998 Strategy recommending \$390,000 expenditure in 1998-99 on cycle network implementation, Auckland City Council's draft Annual Plan set aside about \$75,000. Lobbying by cycling groups gained Council agreement to boost this by up to \$200,000 from savings that might arise from elsewhere in the budget. These savings never did arise, and only the \$75,000 remains available for the balance of this financial year. Ten times that amount is required to be spent annually in order to realise the Cycle and Walking Strategy. Auckland City now says it will also review the possibility of accelerating the strategy in future years.

Subsidies and Economic Benefits

An extra political lever may be the user pays - free market model as it is applied within the framework of environmental externalities. Private vehicles are subsidised by rate payers and tax payers (see below). As cycling and walking have not benefited from past subsidy-promoting regional and central government policy initiatives, arguably, there is some catching up to be done. For example, regional public transport historically has received a \$30 million annual subsidy, while walkers and cyclists got \$1.8 million annually (ARC, 1997). Yet the percentage of the population using these modes to get to work are the same: 5.8% for public transport, 5.8% for walking and cycling (ARC, 1997). The \$14 million earmarked for cycling in Auckland City over 20 years is a move in the right direction, but is only making up for past inequities.

The OECD has recently stated that there should be a clearer understanding that ecological health underpins economic performance (OECD, 1997). A submission I wrote for the advocacy group Cycle Action Auckland to the 1997 National Land Transport Strategy Discussion Document (MoT, 1997a), recommended that this philosophy should be



Figure 4 Cycleways do exist, but seldom go anywhere and with few exceptions are not suitable for commuting

reflected in the national Strategy (CAA, 1997). For example:

An economically efficient result is where *ecosystem sustainability is optimised such that* the value of the benefits to the nation exceeds the value of the full costs to the nation, where those costs are fully accounted for. *Full costs must include ecological costs.* (Added wording to the original 1997 MoT statement is in italics).

If all ecological costs are accounted for in decisions regarding transportation in New Zealand, the outcome for cyclists and others should be favourable. For example, a NLTS Background Document refers to the market ensuring efficient use of resources (MoT, 1997b), Section 5.3.1, p. 18). However, this assumes full ecological costs are accounted for. This is not the case presently, and this needs to be clearly stated in the National Strategy as a lack that must be addressed during the creation of regional LTSSs. If this is not done, existing distortions will continue. Unfortunately, this is not addressed in the recently released proposal to amend transport legislation.

Elsewhere in the 1997 Discussion Document (MoT, 1997a), Goal 1.3 (p. 16) stated that regulatory regimes must be neutral. If neutrality includes the concept of accounting for all costs, then historically private vehicle use has been subsidised by not sheeting home the full costs of environmental externalities. Cycle Action Auckland therefore recommended the following change to Goal 1.3:

To propose to the Government a regulatory regime covering the provision of land transport services and infrastructure that is neutral between land transport providers and modes. *This will take full account of the environmental externalities associated with the different transport modes and, where appropriate, ensure economic instruments are used to guarantee neutrality is maintained.*

(Added wording in italics).

These ecological subsidies - possibly worth over two billion dollars regionally, as noted previously - provided for private vehicle users by the wider community are additional to subsidies for the building of roads, bridges, car parks and other support facilities. Overtly recognising these hidden subsidies will require political support, as will the implementation of planning responses in the light of such knowledge. Auckland City has failed to use such information in the past for strategic planning; it is now time for public

and central government pressure to be applied to ensure it does so in the future.

Roading Use Outcomes

As mentioned, Auckland City is attempting to address past distortions. It has initiated a database for cyclists (and pedestrians) to record examples of barriers to access to the roading system for these modes. The data available is too sketchy to allow for robust analysis at this stage, but it will eventually provide a strong source of anecdotal evidence as to the extent to which failure to allow for flexible transport options has hard wired the city in one direction.

A few examples:

- A recent subdivision opposite Rosebank School removed existing alleyway access for school children to walk and ride. Larger numbers of children are now dropped off by car. This in turn creates more congestion, reducing willingness among those children who still do so to ride, creating in turn further congestion. This is despite City Council recognition that subdivisions [new housing estates on land that was used for other than intensive residential purposes] should ensure walking and riding facilities are not just maintained, but enhanced.
- Traffic calming measures in one of Auckland's high density inner city suburbs effectively narrow roads into squeeze points, forcing drivers to slow down. It also removes any space between cyclists and vehicles: either car drivers let cyclists go first, or run them over. Cyclists, recognising their greater vulnerability, usually give way.
- Recent road widening along one of the city's main arterial routes has created a confusing lane system which exposes cyclists to more traffic, not less. In addition, footpath access has been reduced, not increased.
- Another main arterial, four lanes wide, cannot be modified to allow for safe cycling access, because the existing footpath is the minimum allowable. The alternative is to reduce the number of lanes. But subdivisions have developed as a result of the four lane access system; reducing motorised traffic access would punish suburbanites for responding to city traffic planner incentives.

A primary problem for Auckland is that it is built around an isthmus. Access into the city is geographically restricted, meaning

equally restricted options for cyclists or pedestrians to avoid the main arterials. Thus not allowing for cycling or walking facilities on these main routes is doubly frustrating, and doubly difficult to undo.

Thus Auckland City Council's attempts to improve cycling access, which have begun despite a minuscule budget, are limited by geography and a history of poor strategic planning.

Conclusion

Most rate payers and tax payers are car users, and a city's infrastructure reflects this. But hidden subsidies create distorted incentives to drive, reducing options to walk or cycle. One of New Zealand's largest urban centres, Auckland, is now hard-wired with a preference for private vehicles. Exactly how to

redress the imbalance and retrofit for cycling should be the subject of Auckland's regional land transport strategy. Investing in the integration of cycling and other options into the Auckland transport system could reap several times that expenditure in ecological, economic and social benefits. Such benefits would have been much easier to realise had politicians, planners and roading engineers heeded the information available since the 1970s, and allowed for greater transport flexibility in a geographically limited city. However, a market model for transport planning now being pushed by central government opens up the opportunity to charge the full ecological, social and economic costs of private vehicle use. This may provide an impetus for a better balance between transport options for Auckland.

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Prospects for sustainable transportation in the Pacific Northwest: a comparison of Vancouver, Seattle, and Portland.

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Abstract

A variety of transportation and land use performance indicators and trends are examined for the major cities of the Pacific Northwest region of North America. To the casual observer these cities may appear more similar than different. However, the data examined reveal substantial differences between Vancouver and its neighbours to the south, Seattle and Portland, especially in regards to population density, motorisation, transit use and the rate of growth in car use.

Keywords

Cycling, highways, land use, Portland, public transit, Seattle, sustainability, transport, Vancouver, walking

Introduction

In recent years there has been a heightened interest among transportation researchers, policy analysts, and environmentalists in the issue of sustainable transportation. In many respects this discussion has flowed from an earlier interest in assessing the environmental problems of transportation and their relation to urban form, especially the burdens created by an excessive dependence upon automobiles for personal transport (Gakenheimer, 1978; Stringer & Wenzel, 1976; Newman & Kenworthy, 1989). As with many other facets of sustainability discussions, sustainable transportation appears to be easier to describe than to define. Common threads in this discussion emphasise that sustainable transportation, in regards to passenger transport, should:

- Meet basic access and mobility needs in ways which do not degrade the environment;
- Not deplete the resource base upon which it is dependent;
- Serve multiple economic and environmental goals;
- Maximise efficiency in overall resource utilisation;

- Improve or maintain access to employment, goods and services while shortening trip lengths and/or reducing the need to travel; and
- Enhance the livability and human qualities of urban regions.

Discussants describe sustainable transportation in terms of decreasing dependency upon cars and fossil fuels and increasing the share of transport undertaken by train, bus, bicycle and foot and integrating transportation and land use planning in order to diminish the need for travel (Replogle, 1995; Spaethling, 1995). Others point to political, economic and behavioural changes or policy confusions which must be addressed in order to advance a sustainable transport agenda (Centre for Sustainable Transportation, 1998; OECD, n.d.; Wixey & Lake, 1998).

An examination of the prospects for developing sustainable transportation is especially appropriate for the area of western North America increasingly referred to as 'Cascadia' after an ecological utopian novel (Callenbach, 1975). Cascadia comprises the westerly portions of lower British Columbia, and Washington and Oregon States. It is a region sharing many common geographical, historical, political and social characteristics. Its Pacific coastal regions nurture temperate rainforests, its great rivers have been dammed for hydroelectricity, a long and narrow plain from Vancouver to southern Oregon allows for easy rail and road transport north and south, while the volcano-laced peaks of the Cascade Mountains present barriers to East-West travel and development. Peoples indigenous to this area still maintain several linkages to their past - an economy still somewhat focussed on fish and forest and a keen maintenance of traditional art forms as well as a culture substantially different from other North American areas. Cascadia shares a common history of exploration done under several flags, frontier settlement and development dependent upon the exploitation of furs, fish, and forests. The border has been peaceful since the commencement of settlement, its

only disruption is strife among motorists increasingly frustrated by long queues at crossings.

Within Cascadia the cities and metropolitan regions of Vancouver (British Columbia), Seattle (Washington) and Portland (Oregon) invite comparison. Each city has approximately the same population. Each region has been experiencing population growth at approximately 2% per year for the past ten to fifteen years. Most of the population growth has taken place outside the core cities and has generally been in the form of dispersion or 'sprawl'. Each region is experiencing concurrent traffic growth disproportionately greater than its population growth. Each region also enjoys a beautiful setting astride or adjacent to significant bodies of water and witnessing spectacular mountain ranges within easy access. Immigration histories and demographics also are more similar than different. Each serves as an important freight rail centre and each has a busy seaport. Each is within a state or province where production and service industries are growing into dominant employment and economic areas while resource extraction and exploitation (forestry, fishing and mining) are shrinking. Each of the three cities lying at the core of their respective metropolitan regions and each of the three metropolitan areas themselves has developed an ambitious plan for managing and directing growth into urban and suburban centres for the coming decades.

Each region has influential portions of its population active on environmental concerns. Each city is attempting to increase the number of residents living close to the downtown area or near other commercial nodes. Each region appears to be lessening the severity of air pollution in core locales although the area

over which a smog blanket rests appears to be broadening. Each area is growing in terms of automobile ownership, total driving, and the emission of greenhouse gases. The major road corridors throughout the region are experiencing congestion due to insufficient development of public transportation – local and inter-city – and an over-reliance on trucks for freight movement. The region's airports are also suffering inefficiencies due to overuse by 'commuter' or short-haul carriers which could be replaced by improved inter-city passenger rail. In recent years there has been an attempt to unite the three cities (plus Eugene, OR) with a high-speed passenger rail system, to decrease border delays for passengers and freight, to increase economic co-operation and to increase the ratio of freight carried on rail (Cascadia Project, n.d.). There are also, however, many traditional and contemporary differences between the three cities and regions which become clear upon examination of data from the three regions.

Comparison of data for the three Cities and Regions

The data for this paper for Vancouver and Portland have mostly come from Kenworthy, Laube, *et al.* (1997), with some updating to more recent years through direct contact with authorities in each city. Seattle data have been collected as a separate exercise from authorities in the region in order to complete the picture for the Cascadia area.

Population

Table 1 sets out data on population for the three cities and region from 1970 to 1990. Each city, which forms the core part of its respective region, has a population of approximately 500,000. Each suffered a little decline in population due to demographic changes and suburban exodus in the 1960s and 1970s. Unlike Vancouver or Portland, Seattle has not yet returned to its 1970 population level. Because of its vast area it should be noted that the population of the non-urbanised and undeveloped portion of the Seattle region is considerably larger than in the other metropolitan regions.

Area and Population Density

In terms of area and population density the three cities are a little more difficult to compare. While the City of Portland is considerably larger in area than the others, it also has one of the highest ratios of parks and public lands within its limits in western North America. It has also annexed some

Table 1: Population in the three cities and regions, 1970 to the mid-1990s

	1970	1980	1990	Mid-1990s
<i>Cities</i>				
City of Portland	379,967	366,383	437,319	497,600
City of Seattle	551,339	493,846	516,259	532,900
City of Vancouver	429,795	417,955	478,052	508,814
<i>Whole Regions</i>				
Portland Region	878,676	1,050,367	1,174,291	1,341,700
Seattle Region	1,934,500	2,240,400	2,748,900	3,101,100
Vancouver Region	1,082,187	1,268,183	1,610,899	1,831,665
<i>Developed Areas</i>				
Portland Urbanised Area	824,926	1,026,144	1,172,158	1,193,500
Seattle Urbanised Area	1,238,107	1,391,535	1,744,086	1,933,300
Vancouver Urbanised Area	1,028,320	1,170,015	1,542,933	1,815,317

Note: Mid-1990s data all refer to 1997 except for Vancouver Region which is 1996 (Census Data for CMA); Cities of Portland and Seattle which are 1995 and City of Vancouver which is 1994. Decennial Vancouver data are for 1971, 1981 and 1991.

relatively low density areas in recent years whose density it is steadily increasing. The boundaries of the City of Seattle and City of Vancouver have remain unchanged for decades. The gross density and urban density of the City of Vancouver is considerably higher than that of the other two cities, which helps to account for some of the transportation differences discussed later. Reasons for this difference, will become apparent later in the paper.

The three regions are a little more difficult to compare. Portland defines itself quite tightly as the Tri-County Area of Multnomah, Washington and Clackamas Counties (some definitions also include Clark County in Washington State), Vancouver's region (the Greater Vancouver Regional District) contains significant Agricultural Land Reserve tracts, and Seattle's four county region of King, Snohomish, Pierce and Kitsap Counties contains many areas of agriculture and forestry and settlement remote to its urban and suburban centres. Because such metropolitan region boundaries are set quite arbitrarily, the only way to properly compare them is on the basis of their urbanised land areas. Table 2 contains these data for 1990. One is immediately struck with the density of development in the Vancouver region which is almost double that of Seattle and Portland.

Housing

Multi-family housing, whether in the form of townhouses, apartments, or condominium units represents a more efficient use of urban

space than does single-family detached housing. The Portland and Seattle regions maintain a pattern of having one-third or less of housing as multi-family units (attached wall, townhomes, apartments, condominiums, etc.). The Vancouver region has significantly decreased its ratio of single-family to multi-family units from 56% in 1980 to 45% in recent years, so that higher density housing now dominates the housing stock in the region. By contrast (Table 3). Seattle and Portland have essentially maintained the same high ratio of single-family to multi-family housing. Much of the increase in multi-family housing has been in the City of Vancouver where some very large redevelopments such as at False Creek have occurred, as well as extensive re-urbanisation throughout the city (see later).

Employment

Each region and each city has been experiencing significant, if not dramatic, increases in employment. While each region has been experiencing employment growth at about the same rate of population growth, the cities and the Central Business Districts (CBDs) have not been gaining employment as at rapid a pace as their surrounding regions (Table 4).

However, as can be seen from the data above, the inner areas of each region do continue to grow in absolute terms and contain significant proportions of metropolitan jobs. In 1990 the City of Portland contained 55% of jobs (this had dropped to 46% by 1997), Seattle 33% and Vancouver 41% of jobs. This concentration and growth of work and population (see Table 1) in more traditional transit and walking-based parts of the regions remains important in shaping transportation patterns in favour of transit and non-motorised modes. Indeed, globalisation appears to be strengthening the growth in higher paid jobs linked to the global economy in favour of more vital and interactive locations such as traditional inner and central areas of cities, while lower paid employment such as in service industries is tending to locate in more auto-oriented outer areas. The renewed popularity of central and inner areas as residential locations seems to at least in

Table 2. Area and density data for the three cities in 1990

	Total Area (km ²)	Gross Population Density (per km ²)	Urban Area (km ²)	Urban Density (per km ²)
<i>Cities</i>				
City of Portland	370	1,345	131	2,370
City of Seattle	217	2,376	185	2,874
City of Vancouver	131	3,649	106	4,150
<i>Regions</i>				
Portland Region	7,958	168	1,005	1,170
Seattle Region	16,292	190	1,523	1,145
Vancouver Region	2,905	555	741	2,082

Note: The urban area and urban density data for the City of Portland and City of Vancouver refer to the inner area of the regions which in the case of Vancouver corresponds closely to the City of Vancouver, and in the case of Portland incorporates a significant portion of the urbanised part of the City of Portland (see Kenworthy, Laube *et al.*, 1999 for precise definition).

Table 3: Patterns of single and multiple-family housing in the three metropolitan regions in 1980 and 1997

Region	1980 (thousands)				1997 (thousands)			
	Single	Multiple	Total	Ratio	Single	Multiple	Total	Ratio
Portland Region	265	132	397	0.67	394	165	559	0.70
Seattle Region	643	252	895	0.72	893	405	1,298	0.69
Vancouver Region	244	192	436	0.56	316	393	709	0.45

Note: Data for Vancouver are for 1981, not 1980.

part be linked to globalisation processes
(Newman, Kenworthy & Laube, 1997;
Newman & Kenworthy, 1999).

Central Business District (CBD)

Each city has a compact, well-defined Central Business District (CBD). Table 5 shows that each has a relatively small and moderately rising resident population within the CBD, except for Vancouver whose residential character shows through with a much larger population contained in its West End area, which merges with the core CBD. The CBDs of Portland and Vancouver each contain about 15% of the region's jobs. The Seattle CBD accounts for only 8% of its region's employment. Each is trying to increase

residents in, or adjacent to, the CBD. Vancouver's West End development, a highly mixed use part of its central area, comprises some 40,000 residents and is the most successful of these efforts, along with the very densely populated False Creek redevelopment area, directly opposite, but not in the CBD, which houses over 10,000 people.

Parking supply and pricing is one of the most prominent factors affecting the choice of mode for the journey to work. While all three cities have been increasing the absolute supply of downtown parking, Seattle displays the greatest rate of increase and the highest ratio relative to jobs, though parking supply relative to jobs dropped from 1970 to 1980 and remained stable from 1980 to 1990. Seattle's overall Downtown 'strategy', however, appears to be inviting more automobile traffic through increased parking availability. Portland on the other hand has diminished its supply of CBD parking per 1000 jobs over the 20 year period from 1970 to 1990 (571 to 403 per 1000 jobs) in line with its cap on CBD parking supply, while jobs in the CBD have almost doubled. Vancouver's CBD parking per 1000 jobs rose more sharply from 1980 to 1990 due to a combination of extra parking supply and an apparent (and probably temporary) loss of jobs from this area.

Each CBD enjoys approximately the same ratio of transit ridership for the commute. However, Vancouver is reaping the benefits of downtown residential development through a rate of non-motorised commuting to the CBD more than double that of either Seattle or Portland (10.3% compared with around 5%).

Table 4. Patterns of employment distribution in the three regions, 1970 to the mid-1990s

	1970	1980	1990	Mid-1990s
<i>Portland Jobs</i>				
Portland CBD	59,039	88,917	100,872	103,000
City of Portland		372,000	417,000	430,000
Portland Region	392,628	599,885	750,779	943,978
<i>Seattle Jobs</i>				
Seattle CBD	73,161	84,651	117,252	
City of Seattle	310,286	386,684	469,802	
Seattle Region	740,927	1,033,407	1,445,243	1,761,900
<i>Vancouver Jobs</i>				
Vancouver CBD	94,758	124,239	116,800	
City of Vancouver	232,238	292,907	321,450	
Vancouver Region	394,204	632,191	792,485	950,000

Note: CBD and City data for Portland in the last column refer to 1994. All other data in this column refer to 1997. The Vancouver CBD includes the West End.

Table 5. Characteristics of the CBD in each of the three regions, 1970-1990.

CBD Characteristic	1970	1980	1990
<i>Area of the CBD (ha)</i>			
Portland	280	280	280
Seattle	196	196	196
Vancouver	531	531	531
<i>Population of the CBD</i>			
Portland	8,234	8,219	9,528
Seattle	5,630	6,045	6,785
Vancouver	44,100	43,210	45,825
<i>Off-Street and On-Street Parking spaces in the CBD</i>			
Portland	38,803	37,644	41,861
Seattle	41,500	41,000	56,863
Vancouver	28,819	37,755	46,053
<i>Parking spaces per 1000 CBD jobs</i>			
Portland	571	423	403
Seattle	560	480	480
Vancouver	341	342	443
<i>Transit use to CBD Jobs</i>			
Portland			40.5%
Seattle			38.0%
Vancouver			37.0%

Motorisation

The differences between Vancouver city and region and the neighbouring U.S. cities and regions emerge dramatically in regards to motor vehicle ownership and driving (Table 6). The U.S. regions have rates of vehicle ownership and driving fully one-third higher than that of the Canadian region. In comparing the cities of Portland and Seattle there is a slightly greater amount of driving within Seattle than within Portland, and residents of these two cities own and drive cars at approximately double the rate of the Vancouver dwellers. While the paradox of higher vehicle ownership and driving rates for city dwellers in Portland and Seattle may be partially explained by demographic factors, such as the larger household size in the suburbs, it is noteworthy that the data on vehicle ownership and driving is in the expected direction when comparing city and suburb dwellers in the Vancouver region: city

dwellers own fewer cars and drive considerably less than their suburban counterparts. Stated in another way, U.S. cities may be more like suburbs than ‘real’ cities, while Canadian cities are more like traditional cities in their transportation behaviour. Raad and Kenworthy (1998) have discussed some fundamental physical differences between US and Canadian cities in more detail, as well as the underlying planning and political reasons behind them.

The other crucial thing to note from the data in Table 6 is the rate of growth in driving in US cities between 1990 and 1997. This has clearly continued apace in the US cities with

Seattle growing by 2,530 km per capita in just 7 years (a 21% increase) while Portland’s growth was less at 1,435 km or 13%, in response to its more positive land use and transit developments through the 1990s (see policy discussion). By contrast, however, total travel per capita only rose by 360 km per capita in Vancouver (4%), which reinforces the even more positive land use and transportation evolution of the Vancouver region.

Transit

The differences between the three regions and their cities also emerge dramatically in regards to transit ridership. Portland’s total transit ridership is growing – especially since the introduction of the MAX light rail line, while Seattle’s transit ridership is stagnant. Vancouver’s total transit ridership grew significantly following the opening of its Skytrain service and has stabilised in recent years. Citizens in the Vancouver region take twice as many transit trips per year as those in the Portland region and three times as many as those in the Seattle region.

For the journey-to-work, commuters in the Vancouver region are twice as likely to choose transit than those in the Portland or Seattle regions. Vancouver City residents are also one-and-a-half to two times as likely to commute by transit than Seattleites or Portlanders. The greater use of transit by Vancouverites also leads to lower net transit costs; Vancouver transit recovers more than half of its operating expenses at the farebox, while Seattle and Portland each recover slightly less than one-quarter.

Non-Motorised Transport

In North America, where the car is King and Queen (Schiller & Bruun, 1995), data on non-motorised travel is very difficult to obtain. Nevertheless, our data appear to indicate that a small though significant number of persons in each region commute by a non-motorised mode. In the three regions in 1990, between 3.9% and 5.7% of commuters walked or cycled to work (Table 8). The City of Seattle (10.0%), with a very progressive program to encourage walking, bicycling (and transit) for commuters to its large urban university (college students are counted as commuters in U.S. transportation statistics), leads Vancouver (8.5%) and Portland (7.0%), although trend data (not shown here) indicate that the ratio of commuters who put feet first is falling in the Seattle region and only remaining flat in the City of Seattle itself. As indicated previously, the ratio of commuters walking to Central Business District employment in Vancouver is

Table 6. Vehicle ownership and car use in the three regions, 1990 and 1997

Transportation characteristic	1990	1997
<i>Total motor vehicles per 1000 people</i>		
City of Portland	1040	
City of Seattle	1040	
City of Vancouver	560	
Portland Region	849	770
Seattle Region	790	790
Vancouver Region	694	570
<i>Annual total private vehicle travel per capita (vehicle km)</i>		
City of Portland	11,498	
City of Seattle	12,556	
City of Vancouver	5,950	
Portland Region	11,238	12,673
Seattle Region	11,918	14,448
Vancouver Region	8,750	9,110

Table 7. Transit characteristics in each of the three regions, 1980 and 1990

Transit characteristic	1980	1990	Mid-1990s
<i>Passenger Boardings (millions)</i>			
Portland-Region	48.5	54.2	69.0
Seattle-Region	87.4	103.9	118.8
Vancouver-Region	133.2	180.8	226.0
<i>Transit trips per capita per year</i>			
Portland-Region	46	46	52
Seattle-Region	39	38	38
Vancouver Region	114	117	119
<i>Proportion of all commuters using transit (%)</i>			
Portland-Region	8.6	5.8	
Seattle-Region	7.9	6.0	
Vancouver-Region		12.4	
City of Portland	16.0	11.5	
City of Seattle	19.7	15.9	
City of Vancouver		24.0	
<i>Farebox recovery of operating costs</i>			
Portland-Region		23%	
Seattle-Region		22%	
Vancouver-Region		52%	

Notes:

- (1) Seattle Region 1980, 1990, and 1996 transit use and cost is based on WSDOT Public Transport. Rail Div. reports including walk-on ferry passengers. 1980 walk-ons were estimated at 4,000,000.
- (2) Vancouver Region 1980 data are for 1981, 1990 are for 1991, and mid-1990s are for financial year 1998
- (3) Portland Region mid-1990s data are for financial year 1998

approximately double that of either Seattle or Portland – an important indicator of the success of Vancouver's program to encourage residential development nearby.

Table 8. Non-motorised mode use for the journey-to-work in the three regions, 1990.

<i>Proportion of work commutes on foot and bike (%)</i>	<i>1990</i>
City of Portland	7.0
City of Seattle	10.0
City of Vancouver	8.5
Portland Region	3.9
Seattle Region	5.5
Vancouver Region	5.7

Note: City of Vancouver data are 1992 and the Vancouver region 1991.

Discussion: Policy Climate

Portland

Portland demonstrates many of the conflicts which have beset American cities in the post-World War Two era; dispersed low-density development with separation of residential and other uses, an excessive emphasis on single-family dwellings, road expansion, and travel patterns which are difficult to address with public transport. But Portland has benefited from a long tradition of civic engagement shared between business leaders, elected officials and residents organised in dozens of neighbourhood associations which shape planning and policy reactively and pro-actively. Portland also benefits from the State of Oregon's progressive land use policies which have fostered the creation of Urban Growth Boundaries separating rural and urban areas. This policy, along with pro-residential development policies, a longstanding cap on growth of CBD parking, priority to public transport access and a fine urban design program, have promoted the vitality of Portland's Central Business District (CBD). The Urban Growth Boundaries have limited some of the destructiveness of urban sprawl.

Like most other American cities Portland engaged in a freeway building binge in the 1950s and 1960s. Portlanders in the 1970s reacted by cancelling plans to expand freeways. Rather than build a freeway extension to a suburb (The Mt. Hood Freeway to Gresham which would have destroyed 3,000 homes), they used the money to build a light rail line (MAX). Along with the other innovations mentioned above, they created a transit mall and light rail loop in the heart of downtown and replaced a downtown freeway segment with a waterfront park (naming it in

honour of the Republican Governor, Tom McCall, who had led Oregon into Urban Growth Boundaries).

Portland's previously lacklustre bus system was reorganised during the planning of its first light rail line and has performed much better since light rail has been implemented. This included creation of generous bus-only lanes in the downtown area, together with greatly improved bus stops in the central city. City government has recently completed a low and modest income housing project in downtown without parking spaces – virtually unheard of in U.S. housing planning. Portlanders, originally a bit cautious about light rail transit voted for a major extension, the Westside Line, which opened in September 1998, and this has been attracting 23,000 daily riders in its first few months of operation. Portland has recently completed a new indoor sports arena adjacent to an older one which will be kept in operation. No new parking has been added since both are adjacent to an expanding light rail line.

While there appears to be considerable consensus among regional leaders that transit (especially light rail) non-motorised mode improvements and land use design which supports these should guide local and regional planning, public support has become more divided – especially in the suburbs in the past couple years. Urban growth boundaries have weathered several challenges but – unfortunately – two recent votes, one statewide and the other regional, have resulted in narrow defeats for a proposed North-South light rail extension. It appears that an inflammatory pro-highway/anti-transit minority has combined with well-funded pro-sprawl and anti-tax interests in these instances. Shortly after the defeat of the November 1998, rail extension initiative was announced one of its major opponents circulated a message condemning light rail supporters as 'dark siders' and 'the forces of evil', and boasting how their anti-rail advertisements had successfully linked MAX with the Monica Lewinsky matter: 'One of our best radio spots was a Bill Clinton impersonator saying "You think we tell whoppers in Washington [D.C.]. You should hear the whoppers those light rail people are saying in Portland Oregon".' (Zucker, 1998). The Portland 'whoppers' referred to are statements in support of the light rail project's benefits. These same 'forces of good and light' (but not 'light' rail) are curiously silent when asked to specify their own transportation improvement plan – perhaps because it is more highways and more traffic. Whether or

not a more informed discussion will take place in the near future before another vote is unclear at this moment.

In recent years Portland has enjoyed acclaim from American planners and environmentalists engaged in growth management and transportation efforts as a model to emulate. As the regional data compiled for this paper indicate, while there are a few positive trends in Portland some of its acclaim may not be fully warranted. Most of its positive image seems to stem from its revitalised Downtown area. Over some twenty years it has been transformed into a transit-oriented, human scale, green and attractive environment which presently accounts for some 30% of metropolitan retail turnover, up from 5% in the 1970s. The way in which considerable new development has focussed on the light rail line is also a strong feature of Portland's reputation. Most other U.S. cities can only boast freeway-led development. Nevertheless, the region as a whole has some way to go before it begins to claw back its high automobile dependence and comparatively low transit use per capita.

One problem frustrating transportation planning in Portland is the extent to which Clark County, immediately to its north on the Washington State side of the Columbia River, is acting as a 'sprawl relief valve' for Portland. Washington State has only recently instituted growth management legislation and it will likely be years, if not decades, before its effects are felt. Homeowners in search of cul-de-sac ranchettes and three car garages have been drawn there. Although a large percentage of Clark County commuters clog two bridges to Portland, in 1996 they rejected substantially a very reasonable plan to link Clark County to Portland with a new light rail line.

Seattle

An adage oft-heard around Seattle is that 'while Los Angeles developed and perfected the freeway, Seattle developed and perfected the shopping mall!' Neither assertion is completely accurate, yet there is more than a grain of truth to Seattle's attachment to sprawled development of which the shopping mall is the centrepiece. Like Portland, Seattle once had ambitious plans to cover its city and area with freeways and bypasses. Like Portland, Seattle's citizens arose in anger, after experiencing the first fruits of freewaydom, and forced local officials to curtail future freeways and limit expansions of existing ones. But Seattle was not able to cross the threshold which Portland had; it was not able

to substitute a rail transit improvement for its last significant freeway expansion.

Seattle made great strides in the 1970s reorganisation and rationalisation of its bus transit system. It expanded its use of electrified buses in the city at the same time that it was sending buses out over a vast suburban area. It succeeded in transporting an admirable share of the commute to and from downtown. But, despite the building of a costly downtown bus transit tunnel, recent years have witnessed faltering ridership not keeping pace with population and job growth, and falling significantly behind the rate of increase of car travel. A three-county proposal, approved by voters in 1996 will concentrate light rail in a relatively short (given the expansiveness of the region) and extremely expensive tunnel and grade-separated segment in one Seattle corridor. A limited commuter rail service will be put in operation on existing tracks. The same plan will expend transit funds to build expensive HOV (High Occupancy Vehicle; transit and carpool) ramps and interchanges in the suburbs despite admonitions that such facilities generally do not work well for transit (Leman, Schiller & Pauly, 1994; Schiller, 1998). The transit plan will provide some badly needed improvements, its new light rail line will likely attract good ridership, but at an enormous price and with limited regional coverage. The City of Seattle and the surrounding region appear to lack the leadership on transit improvements found among Portland's leaders. Years in advance of the construction of the light rail system Seattle's downtown business leaders are warning the City against creating a surface bus mall once the current transit tunnel is converted to exclusive rail use because it might interfere with automobile access to downtown.

While Seattle has been a leader in the provision of pedestrian and bicycle facilities, and in some aspects of neighbourhood traffic calming and university transit pass programs, it is still a difficult town for walking; fully one-third of its streets lack sidewalks. In 1995 Seattle's former Mayor Norm Rice campaigned strenuously among his constituents for the reopening for motor vehicles of a one block pedestrianised downtown street at the behest of Nordstrom's, a major retail interest. The City also rewarded the retailer with a twelve storey, \$73 million, 1200 stall parking garage (atop the downtown transit tunnel) paid for in large part by public funds intended to improve housing for low-income families. Seattle is talking of focussing development in 'urban villages', and strengthening

commercial areas. Unfortunately much which is proposed is of such a vast scale and expense that voters quickly become wary and rejecting (Schiller, 1994). Meanwhile inexpensive and cost-effective extensions to highly popular and well-used pedestrian and bicycle facilities are languishing.

The region's leaders are also preparing an additional costly runway for SeaTac Airport, while ignoring the extent to which an improved inter-city passenger rail system and better management of the current airport could divert many air passengers from the short distance and commuter flights to rail. Such flights consume 40% of the airport's operations – a pattern common to U.S. airports. Seattle is presently constructing two new large sports stadia. Both are much larger facilities than those in Portland – and both will entail parking expansions. Meanwhile a moderate pace of road expansion continues.

Vancouver

Vancouver has benefited from a Canadian planning tradition which has been influenced by European thinking to a far greater extent than either Seattle or Portland. Vancouver and its region have chosen to strengthen central areas, whether in the City or in outlying cities (see Raad & Kenworthy, 1998). The extent of this commitment can be seen in the fact that since 1976 the population of the city-core of the region rose from 413,700 to 476,378 in 1991, the majority of that increase (41,626) occurring in just five years between 1986 and 1991. Much of the new housing to accommodate these population increases has occurred in 'urban village' style settings such as False Creek where no motorised traffic is permitted through the housing area. Parking is underground and car access is from the rear. As a consequence, such developments are built on walkways and cycleways and are set within extensive gardens and natural areas with local facilities such as shopping and entertainment only a short walk or ride away. Older areas near downtown, such as the West End, while built on a traditional street grid, offer excellent environments for walking and cycling because of the generous sidewalks, landscaped streets and short distances to extensive mixed uses lining the main streets. Small parks and gardens have been created by closing short sections of many streets. Electric trolley buses run every 6 to 8 minutes because of the high demand and provide a viable alternative for longer trips.

Suburban town centres are well defined and many public facilities and amenities such as sidewalks and pedestrian signals are

located in them as a matter of practice. Vancouver has electrified many of its bus routes within the city, and plans transit services which emphasise and strengthen its arterial grid system. As implied above, Vancouver has also planned its street and zoning system so as to foster commercial and mixed-use development along arterials well-served by transit adjacent to residential areas. Vancouver, unlike its neighbours to the south, has not allowed freeway construction within its city limits. Vancouver appears to be following a 'Toronto' model of urban redevelopment; it is expanding the number of residents living in or near its centre, intensifying mixed-use development, and improving transit services for developed areas rather than spreading transit services more thinly into less dense suburbs.

Indeed, the Vancouver region is strongly punctuated by high density, mixed use nodes of development at stations all along the Skytrain line. High rise apartments and condominiums are built very close to the stations together with a variety of shops, workplaces and other facilities. Still within walking or cycling distance of stations, there are a range of other medium and low rise compact housing projects and less intense mixed land uses. Each station has an effective bus interchange with many services feeding into it, and cycling to stations is encouraged through provision of dedicated cycleways and locker facilities. The new urban development at station precincts such as Joyce, Patterson, Metrotown, Edmonds and New Westminster provide very good demonstration projects of the way to exploit the land use advantages of investments in transit and how to make transit, walking and cycling central to the life of an area. They also show how this change towards transit-focussed growth can be a very rapid process (Skytrain was only opened in 1986).

Since opening, Skytrain has been extended, and at present controversy ensues over whether future rail transit extensions should be in the form of Skytrain or less costly light rail. The nature of this controversy is considerably different from many localities in the U.S. where rail transit in general is quite controversial. Unlike some transit planning in the U.S., the planning system in Vancouver is firmly geared towards the creation of compact residential, mixed use, low auto use environments. So, while there is still suburban sprawl, it is less dominant than in U.S. cities. The popularity of transit and rail extensions, provision and encouragement of non-motorised transportation, and the

effective integration of urban development and transportation planning indicate that Vancouver is the best prepared of the three cities and regions to develop towards more sustainable transportation should the will, leadership and determination to build on existing achievements be forthcoming.

Conclusions

In the Cascadia region Vancouver seems to be the furthest along in terms of sustainable transportation planning and practice. It also demonstrates how change can take place in a relatively short period of time given a favourable political and planning environment. Portland appears to offer some hope, especially in terms of planning directions and some of its transit practices as well as its commitment to an urban growth boundary and healthy, livable central area. Despite a relatively low urban density it has been able to increase its transit ridership significantly in the past decade. Seattle started to attempt to manage growth and integrate land use and transportation planning many years after its neighbours to the north and south. Its regional planning organisation (the Puget Sound Regional Council) has developed much expertise in the area of transit and pedestrian-oriented development but lacks implementation authority. Despite having a

population density considerably greater than that of Portland, Seattle has not been increasing its transit ridership. While there is proven success of neighbourhood traffic calming, bicycling and university transit pass programs in the City, and an occasional bright pedestrian spot in the suburbs (such as the older suburb of Kirkland), Seattle seems to be going in the wrong direction in terms of many transportation performance measures. It seems to be unable yet to develop the political will to move progressive plans into practice – or even the consensus necessary to speak the language of sustainable transportation. Whether Seattle can be a ‘late bloomer’ or whether it is closing the stable door after the horse of sprawl and automobile dependency has fully bolted is uncertain.

Some bright spots on the sustainable transport horizon of Cascadia are the friendly reception being afforded to proposals, led by Seattle and Washington State, to significantly upgrade the inter-city passenger and freight rail system linking the three regions and Vancouver’s commitment to fund a new light rail system. Perhaps these will help generate sufficient enthusiasm for related improvements in public transportation and supportive land use practices in those parts of the region most heavily afflicted with automobile dependency.

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The TGV Effect: A Potential opportunity for reconciling sustainability with aviation

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Abstract

The aviation industry is presently in a stage of rapid growth. Soon, however, increasing urban air pollution, rising greenhouse gas concentrations, regulatory policies, and finite oil reserves will create constraints on the expansion of the industry. High speed rail journeys of under three hours may become an alternative for aviation. A switch to high speed rail for short haul journeys could also free room for expansion of long haul markets for aviation thus obviating the need for airport infrastructure expansion. To explore this hypothesis, the impact of high speed rail on French civil aviation is examined. Modal substitution and intermodal complimentarity may be part of the solution for making aviation economically and environmentally sustainable.

Keywords

Aviation, energy consumption, France, sustainability, TGV

Introduction

The rapid transportation of goods and people over long distances currently makes aviation an indispensable part of the global economy. The aviation sector is in a phase of rapid expansion, with approximately 6% annual growth rate, which exceeds the global economy's expansion. Aviation is an integral component of travel and tourism, the world's largest industry, and is increasingly important for freight transport.

In an economic model with no external constraints, today's high rates of growth could continue indefinitely. However, to envisage unconstrained growth is unrealistic.

Increasing urban pollution, rising greenhouse gas concentrations, national and international regulatory policies, and finite oil reserves all create external constraints on the growth of transportation, including the air sector. At this time, there is no technology that can rival the speed of air travel for long-haul inter- and

intercontinental routes. However, high speed rail could be a viable substitute for trips of up to 1,000 kilometres. In this paper, we present an analysis of the impact that the introduction of high speed rail had on civil aviation in France, and examine the implications for environmentally and economically sustainable aviation.

External Constraints on the Aviation Industry

Urban Air Quality

Air pollution is now definitively recognised as having a significant negative impact on the health of urban populations. Increased hospital admissions for respiratory problems (e.g. Burnett *et al.*, 1994) and overall mortality rates (Lipfert & Wyzga, 1995) are unquestionably linked to poor air quality. Although aviation emissions form a small fraction of total pollutant loading in a national jurisdiction, most major airports are located near large population centres, and thus contribute to the degradation of urban and regional air quality. For example, a comprehensive emissions inventory conducted in 1995 identified Zurich operations as contributing 6.8% to the NO_x emissions in metropolitan Zurich, the single largest source (Zurich Airport Authority, 1996). Given that emissions reductions are occurring from both surface transport and stationary sources, growth in the aviation industry is predicted to significantly increase airports' relative contribution to urban airsheds (Netherlands Ministry of Housing, 1995; Perl *et al.*, 1997). The growing threat to urban public health may therefore trigger restrictions on future airport emissions.

Greenhouse Gases

Aviation's share of greenhouse gas contributions is rising in North America. Aviation contributed 10.0% of total CO₂ emissions in the U.S. transportation sector in 1995 and is predicted to generate 12.9% of

total CO₂ transportation-generated emissions by 2010 (Grant *et al.*, 1998). International summits in Toronto (1988), Rio (1992), Kyoto (1997), and Buenos Aires (1998) have grappled with the challenge of limiting greenhouse gas emissions. The agreement reached at Kyoto calls for greenhouse gas reduction targets that cannot be met through 'business as usual'. If indeed Canada, the United States, and European nations were to implement the Kyoto protocol in its present state, the question remains: how is a sector of the transport industry that is growing at 6% per year going to cut its fuel consumption (and thus CO₂ emissions) to 5% below 1990 levels?

Upper Atmospheric Chemistry
Aircraft are the sole source of anthropogenically generated nitrogen and sulphur oxides, soot, carbon monoxide, and unburned hydrocarbons emitted into the upper troposphere and lower stratosphere. The potential for damage to stratospheric ozone by NO_x from aircraft was first recognised over 25 years ago (Johnston, 1971), and continues to be the focus of scientific research by NASA and the European Aeronox programme. Effects of the other effluents from jet engines on this part of the atmosphere are also being studied (e.g. Fabian & Karcher, 1997). Findings may place new environmental problems on the aviation policy agenda, as well as increasing the seriousness of currently identified problems.

Environmental Policy Initiatives
Two European examples illustrate the range of initiatives that may be applied more broadly to civil aviation in the future. Sweden integrated a carbon tax into its fuel taxation as early as 1991. As well, differential landing fees based on noise output have been in place for some time. The Swedish Civil Aviation Administration is developing a new aircraft classification system that will incorporate pricing for air emissions into future landing fees. Such pollution pricing was introduced at Zurich's Kloten Airport (ZRH) in 1997.

The aircraft emission charges schedule at Zurich was built upon an extensive foundation of environmental research and planning. The development of the emissions pricing policy began by *reducing* airport landing fees by 5% across the board to make the scheme *revenue neutral*. The classification scheme is based upon an Engine Emission Factor, calculated by multiplying an emission index (drawn from International Civil Aviation Organisation or Federal Aviation Administration references) by the maximum

engine thrust. The Engine Emission Factor is then subdivided into 5 classes for pricing. Class 5, with the most efficient engine technology (e.g. the Airbus A320-200 equipped with mid-1980s CFM56-5-A1 engines) pays no pollution surcharge, and thus receives a 5% reduction in landing fees compared to the previous tariff. Class 1, with the least efficient engine technology (e.g. Lockheed L1011-500 equipped with late-1970s Rolls-Royce RB211-22B engines) pays a 40% premium on the basic landing fee as a pollution surcharge. Revenues generated from the pollution surcharge are dedicated to financing infrastructure improvements that would further reduce air-side emissions, such as additional taxiways to reduce taxi time, ground base power hookups to eliminate the use of auxiliary power units, and emissions monitoring equipment.

Fossil Fuel Reserves and Resources
The ultimate limiting factor on aviation is fuel. The spectacular growth of world economies in the 20th Century has been driven in part by *cheap*, abundant oil. Recent analyses of world oil reserves, rates of consumption, and the rate of discoveries are predicting an end to the abundant supply of cheap conventional crude oil within a decade (Hatfield, 1997; Campbell & Laherrère, 1998). The International Energy Agency has now endorsed the view that supplies of conventional crude oil will peak in the next 10 to 20 years, and then decline (IEA, 1998). As reserves decrease it will be more difficult, and costly, to extract the remaining oil or switch to any unconventional liquefied petroleum product (Hatfield, 1997; Campbell & Laherrère, 1998). Because aviation is so energy intensive, higher fuel prices are bound to have a profound impact on airline cost structure, pricing, and travel demand.

High Speed Rail as an Aviation Alternative

The first high speed rail service that has demonstrated the capacity to attract passengers who previously travelled by air is the French Train à Grand Vitesse (TGV). The TGV was inaugurated on September 27, 1981, running between Paris and Lyon in two hours 40 minutes (Haycock, 1995). In 1983, Paris-Lyon travel time was reduced to exactly two hours (*ibid*). TGV services from Paris have been progressively expanded linking Paris to Nantes (two hours 5 minutes), Bordeaux (three hours), Toulouse (five hours 10 minutes), Marseille (five hours 33 minutes), and Nice (seven hours); (Lewino & Dauvergne,

1989; Fortin, 1994).

The TGV was also the world's first high speed train to be directly linked into an airport. At Charles de Gaulle (CDG) and Lyon-Satolas airports, TGV transfer stations were built enabling direct transfers from planes to trains, which could then substitute for short haul flights in feeding passengers to long distance and intercontinental aviation networks.

Among the changes that the TGV has brought to French transportation has been an uncoupling of civil aviation from some of the unsustainable growth patterns found elsewhere in the world. Because the TGV is powered electrically, locally it is a virtually emissions-free mode of transport. Thus, reductions in flight frequency, and aircraft size, caused by traffic diversion to the TGV, would reduce energy use and atmospheric emissions, with almost no offsetting increase in fossil fuel use and emissions in the rail mode.

In France, much of the electricity is produced by nuclear generating stations (75%). Some of the electricity in France is also generated hydraulically (15%). For example, the Société National des Chemins de Fer Français (SNCF) operates some hydroelectric generating stations in the Pyrenees, and the quantity of electricity generated there, and fed into the national grid, is equivalent to the amount of electricity consumed by the TGV system (Francois Lacote, Directeur, Direction de la Recherche et de la Technologie, SNCF, *pers. comm.* 1998). Therefore, a mix of non-carbon based energy sources power the TGV.

Following the accidents at Three Mile Island, Chernobyl, and minor releases of radioactive materials from other generating stations, nuclear energy has been viewed by many as a high risk energy source. An additional problem with nuclear power is the safe long term storage of radioactive waste. Yet these risks and challenges must be weighed against the environmental problems posed by every conventional source of electricity. Fossil fuel combustion leads to a long term storage problem of carbon dioxide in the atmosphere. Large scale flooding of forests (both tropical and boreal) for hydroelectric generation destroys habitats and threatens biodiversity.

At present, the greatest certainty regarding energy sources for intercity transportation is that all options impose environmental costs, and that the cost parameters of nuclear, hydraulic, and fossil fuel sources differ in their distribution of burden and risk. In the future, however, renewable and low impact energy sources (e.g. solar or wind power) will

become commercially viable. When this occurs, high speed rail offers the only passenger transport technology poised to make immediate use of these new energy sources for intercity transport. The key point for long term transport planning is that TGVs are the most 'energy diverse' form of intercity transport presently available.

The TGV Effect: the impact of high speed rail on French civil aviation

To quantify the changes that occurred in French civil aviation following introduction of high speed rail, we examined five airports of comparable size: Lyon, Bordeaux, Toulouse, Marseille, and Nice. Only partial data was available for a sixth city, Nantes. Because TGV service started at different times, it is possible to compare growth rates among airports before and after the high speed rail alternative was introduced.

The parameters analysed were:

- 1) intercity passenger traffic, between Paris and each airport, 1976-1997
- 2) total domestic passenger traffic for each airport 1975-1996
- 3) aircraft movement data, between the two Parisian airports, Charles de Gaulle (CDG) and Orly, and each regional airport, 1975-1996

Multiple sources were used. Passenger traffic between Paris and the individual airports was obtained from the International Civil Aviation Organisation (ICAO; Figure 1). Total annual domestic passenger volumes for each airport were obtained from the annual ICAO Digest of Statistics (Figure 2). Aircraft movements between Paris and regional airport trips were collated from the Official Airline Guide, International Edition. Data concerning the number of flights per year by model of aircraft was extracted from these volumes for each city (see Figure 3).

The data in Figures 1 and 2 was analysed to obtain growth rates for intervals of different TGV service levels. The interval up to 1981 is the pre-TGV era. 1981-1984 captures the impact of full TGV service to Lyon. From 1984-1989, only Lyon and Marseille had TGV. Between 1989 and 1997, TGVs came to serve all cities in the analysis. In all cases, data were fit to a growth model $y = b * m^x$, minimising least squares errors. The growth rates obtained in Tables 1, 2 and 3 represent an average annual compounded rate of increase.

The pre-TGV interval shows healthy growth rates in all cities (Tables 1 and 2). The most dramatic evidence of the TGV effect (Claisse & Duchier, 1995) is the 17% average

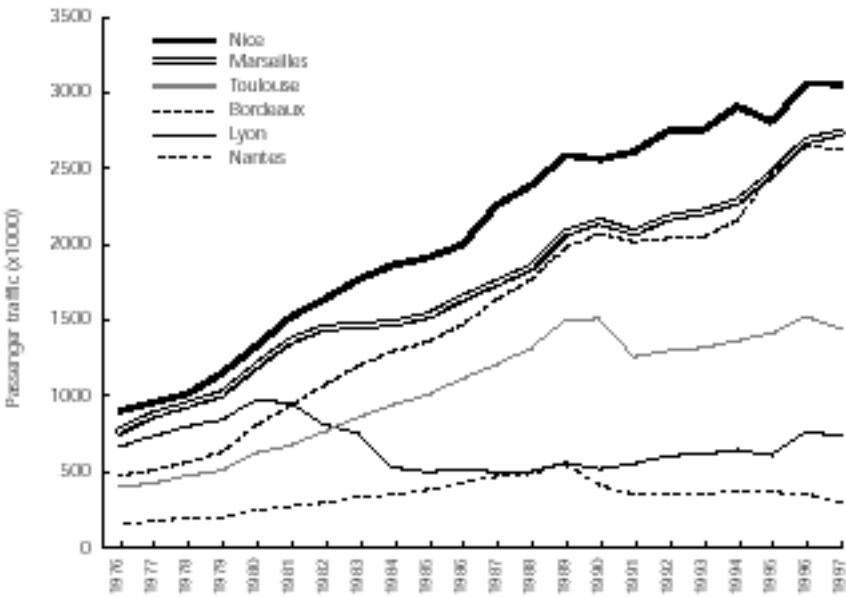


Figure 1. Paris Intercity Passenger Traffic 1976-1997

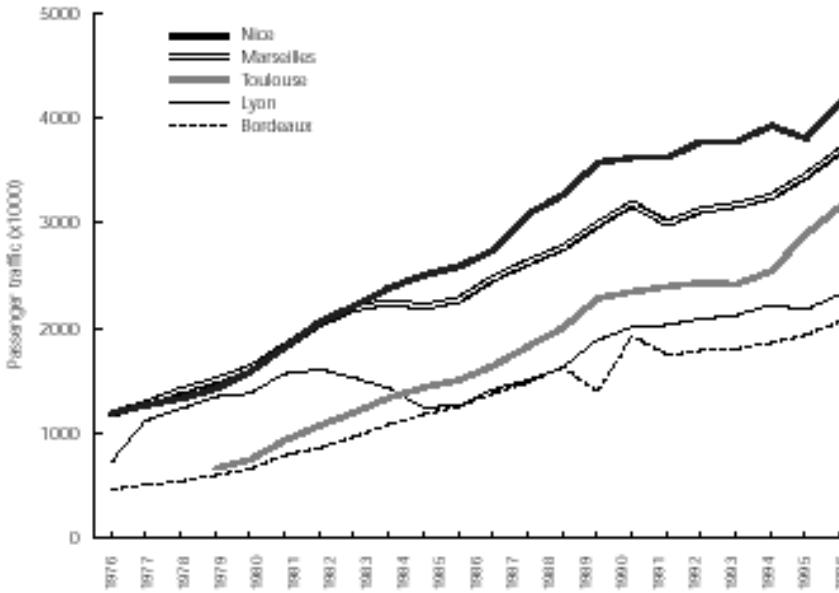


Figure 2 Total Domestic Passenger Traffic 1975-1996

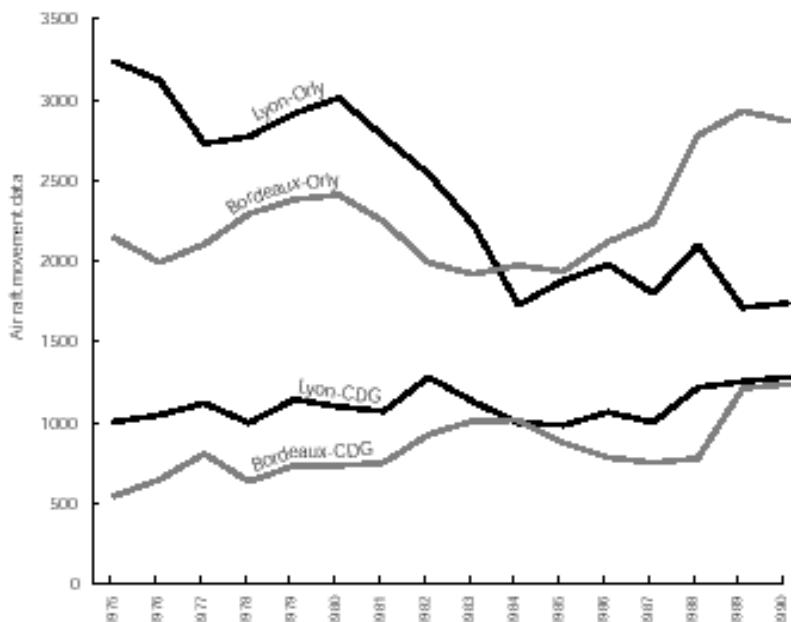


Figure 3. Aircraft Movement Data

annual drop in Paris-Lyon passenger traffic in 1981-1984 (Table 1). This reduction was large enough to impact the entire annual total domestic passenger traffic at Lyon-Satolas airport, which registered an 8% drop (Table 2). The growth rate in total domestic passenger volumes declined at both Parisian airports as seen in Table 2, although it is not justifiable to attribute this exclusively to the TGV effect.

In 1984-89, the overall growth in total domestic passengers (Table 2) is very close for all cities. The loss of the Paris market at Lyon-Satolas appears to have been made up, with a growth rate of 8.7%, second only to Orly for that interval. The growth was clearly not made up by flights between Paris and Lyon, where the average annual rate of growth was just 0.8% (Table 1).

The TGV Atlantique's inauguration provides another demonstration of the TGV effect, this time most strongly in Nantes, with a 5% drop in air passengers to Paris (Table 1). At Bordeaux, growth rates of 10-12% over prior years fell back to a 0.3% annual increase (Table 1). These changes were not as dramatic as at Lyon, supporting Pavaux's findings (1991), that high speed rail's penetration of the aviation market correlates with travel time. If high speed trains offer a journey time of less than three hours, then three quarters of the common carrier market (air and rail) for intercity travel will be captured by the train (Pavaux, 1991). The market share of high speed rail decreases linearly as the logarithm of train travel time increases (*ibid*). This relationship between travel time and air-rail modal split is clearly reflected in the minor impact that the TGV has had on air traffic between Paris and Marseille, Nice, and Toulouse.

The pattern of aircraft movements between both Bordeaux-Paris and Lyon-Paris confirms the Pavaux findings and highlights the TGV effect. In 1984-89, after two hour Lyon-Paris TGV service was operating, the rate of increase in annual air movements from Lyon-Satolas to Orly was only 0.53% (Table 3). This contrasts starkly with Bordeaux, which had no TGV service at this time, and experienced a 9.3% increase in flights to Paris.

Following the TGV's introduction, there was not only a decrease in the number of flights between Paris and Lyon, but also in the size of aircraft. The dominant aircraft used between Paris, Bordeaux and Lyon pre-TGV were the Caravelle, DC-10, and Dassault-Mercure. The Airbus 300 entered service on both of these routes in 1978. From 1984-89, the Caravelle, Dassault-Mercure, and Airbus 300 were used for Bordeaux-Paris flights

Table 1: Growth rates in Paris-othercity passenger data

	1976-1981	1981-1984	1984-1989	1989-1997	1976-1997
Bordeaux	11.65%	12.01%	9.56%	0.28%	6.62%
Nantes	12.20%	9.12%	9.18%	-4.48%	3.50%
Marseilles	11.84%	2.56%	6.87%	3.66%	5.69%
Nice	11.31%	7.15%	7.19%	2.36%	6.07%
Toulouse	15.04%	11.43%	9.02%	3.97%	8.48%
Lyon	8.05%	-16.98%	0.80%	4.29%	-1.26%

Table 2: Growth rates in total domestic passenger traffic

	1975-1981	1981-1984	1984-1989	1989-1996	1975-1996
Paris-Orly	10.91%	6.10%	8.97%	1.30%	6.81%
Paris-CDG	17.01%	2.26%	5.35%	6.01%	6.36%
Bordeaux	11.30%	11.34%	5.01%	3.61%	7.61%
Lyon	12.03%	-7.85%	8.65%	2.59%	3.87%
Marseille	9.39%	2.52%	6.42%	2.58%	5.24%
Nice	9.57%	6.86%	7.74%	1.84%	6.41%

Table 3: Growth rates in intercity aircraft movements

City pairs	1976-1981	1984-1989
Bordeaux to Orly	3.03%	9.31%
Lyon to Orly	-0.72%	0.53%
Bordeaux to CDG	1.77%	1.46%
Lyon to CDG	0.55%	5.04%
Bordeaux to Paris (combined)	2.69%	7.01%
Lyon to Paris (combined)	-0.40%	2.25%

while Paris-Lyon traffic was handled by the Caravelle, Dassault-Mercure, and increasingly, the small ATR turboprop. Generally, aircraft weight corresponds to quantity of pollutant produced (Woodmansey & Patterson, 1994). Therefore, fewer flights with smaller aircraft mean significant emission reductions on the Lyon-Paris flight path and at Lyon-Satolas airport, compared with Paris-Bordeaux during the same interval. Specific changes in these emissions can be quantified and priced (Perl & Patterson, 1998).

Air - TGV Interconnections

The construction of TGV stations at CDG and Lyon-Satolas airports was intended to create competitive advantage in an intensifying struggle among European airports. Compared to its rivals for major hub status in Western Europe, CDG suffered from poor surface transport links to both Paris and the rest of France (Perl, 1998). Pressure from government on both SNCF and Aéroports de Paris to enhance their performance triggered collaboration to introduce a TGV link (*ibid*).

The construction of a TGV station inside the air terminal made it possible to switch from a plane to a train almost as easily as changing planes. The key to how far such intermodal facilities will go toward replacing transfer between long and short haul flights with air-rail connections depends on whether combined air and TGV tariffs will match the

price of deregulated airline tariffs. That tariff reform depends on how air and rail industry leaders respond to the economic and environmental implications of the TGV effect.

The TGV: A key opportunity for sustainable growth in aviation

In this paper, we have identified the changes that occurred in a hub and spoke air service network between Paris and regional centres when TGV service was progressively introduced. This situation allowed us to gather data as a quasi-experimental test of the TGV's effect on domestic civil aviation. Cities that initially gained TGV service could be contrasted with cities lacking TGV service, which served as a control group. Significant reductions in aviation passenger traffic have been identified in this analysis as a result of TGV service. However, this will not translate into reduced environmental impacts if the airport slots are simply re-allocated to allow more flight to other destinations.

In the case of Lyon-Satolas, TGV service has generated a lasting reduction in the number of people flying to Paris and back. Figure 2 illustrates that before 1981, Lyon, Marseille and Nice all had comparable passenger volumes and growth trends in domestic air travel. When TGV service to Lyon commenced, this growth trend was broken, and the subsequent upturn in domestic air travel has never caught up with the levels attained by Marseille and Nice. Without analysing data on annual aircraft movements by model of aircraft for each city, data which remain out of the public domain, we cannot specify the yearly emission changes that occurred at these airports. However, it is logical to infer that fewer numbers of smaller sized aircraft were serving Lyon-Satolas, compared to the much heavier traffic volumes found at Nice and Marseille.

A key question that merits further investigation is the impact of the TGV effect on broader patterns of air travel and airport usage. Since the TGV's introduction in a few markets has not arrested the overall growth in French air travel, the actual influence of modal shifts from air to TGV remains open to different interpretation. One interpretation would view the TGV effect as simply adding to total intercity mobility, since the aircraft and airport capacity that would be displaced by fast trains will simply be redeployed elsewhere. From this perspective, TGVs add nothing to aviation's sustainability since travel by plane continues growing.

An alternative interpretation would grant

that TGVs can do little to dampen the demand for air travel to points beyond their service area, but also posit that much, if not all, of this growth would have occurred in any case. Instead of redeploying existing planes and airport capacity to serve such growth, new equipment and infrastructure would have been added to the total capacity of airlines and airports, thus yielding even higher levels of unsustainable growth. In terms of infrastructure development, in particular, the development of the TGV could be seen to have postponed the decision to increase runway capacity at CDG airport as well as making it possible to defer a decision on developing a third Parisian airport. Furthermore, the existence of TGV service could be seen as a necessary transportation alternative that can enable future restriction on aviation, whether through pollution pricing or regulation. Without a viable alternative for intercity travel, and business travel in particular, attempts to manage and reduce externalities from aviation are more open to resistance on the grounds that they undermine economic activity.

While a conclusive verdict on the TGV Effect's significance for aviation remains to be written, the results of further analysis are likely to highlight the contingent nature of this intercity transport option. Like most transport technology, the actual environmental and social outcome of TGV service will depend on the pricing and regulatory framework that connects this mobility option to other alternatives, like aviation, and to the demand for travel more generally. All else being equal, adding another technological option to the mobility mix for rapid intercity travel, especially one that offers higher energy efficiency than aircraft, and is not dependent on liquid hydrocarbon fuel, can only help future efforts to align our mobility patterns with sustainable development.

Sustainability in civil aviation is about more than the environmental impacts of aircraft engine emissions. In its broadest conception, it is about finding the real opportunities to 'do better with less' that will enrich those firms and jurisdictions that pioneer ways to make aviation less polluting without a proportionate (drastic) reduction in mobility. For short to medium distance travel, high speed rail has proven itself capable of substituting, in part, for aircraft. Although these reductions in frequency and aircraft size can have significant and beneficial consequences for aviation's environmental impact, even greater environmental savings

may arise from linking air and fast train journeys over medium to long distances, in the way that aircraft on short routes feed long-haul flights at hub airports.

Airlines can share in the economic benefits of such intermodal innovation. By freeing up space (in both physical and ecological senses) at crowded and polluted hub airports, fast trains could feed passengers into longer distance flights. Both airlines and railroads could profit from such interline connections. And as Richard Branson has shown in Britain, airline and train ownership are not mutually exclusive.

As in any economic transformation, there will be leaders and laggards in capitalising on the opportunity to link fast train travel with aviation. Leading firms will reap significant rewards by moving people and freight with reduced environmental impact. There will also be laggards that cling to 'business as usual' strategies even after they have become a significant liability. Environmental leaders can gain credibility from their early initiatives, which in turn facilitate partnership with government and environmental advocates in framing sustainable transportation practices. One key difference between firms that identify the economic opportunities of leading sustainable aviation initiatives and those that resist change as a threat to their business will be understanding the lessons of recent evolution in the relationship between air and other transport modes, as illustrated by the TGV effect.

Conclusions

The aviation industry is in a period of expansion, growing at a faster rate than the global economy. In an unconstrained economic model, this growth could be expected to continue as long as demand warranted. However, increasing urban air pollution, greenhouse gases, and changing upper atmospheric chemistry each pose constraints that impinge on unhindered growth. Some jurisdictions, notably Sweden and Switzerland, have already applied pollution pricing, a carbon tax, and differential landing fees (based on noise) to civil aviation, and implementation of the Kyoto protocol is likely to widen the adoption of such policy instruments. The ultimate restriction on aviation (and indeed all carbon-based energy use) is the finite quantity of fossil fuels. But there remain opportunities for growth in the aviation industry that take account of energy and environmental alternatives to business as usual.

We have demonstrated the consequences on passenger numbers, aircraft frequency, and fleet mix following high speed rail's dramatic gain in modal share for journeys up to three hours. The construction of high speed rail stations in airports, such as those at CDG and Satolas, provides opportunities for that modal shift to move beyond a zero-sum loss of traffic for airlines.

The ability to switch from air to high speed rail at an airport with the same degree of ease

as switching planes makes possible a significant opportunity for airlines to reduce energy intensity and environmental impact by offering intermodal journeys. As these trains are electrically powered in France, this provides emission reductions when the trains replace short-haul flights. Such optimisation of transport modes would move aviation closer to the principles of sustainable development.

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