The Bicycle and Urban Sustainability

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Abstract

This paper presents a rationale for promoting bicycles for basic transportation, in the context of global efforts to achieve more sustainable urban development. The importance of urban transportation systems, and the negative impacts of automobile dependence are discussed. An empirical approach to developing local sustainable transportation initiatives is presented, based on comparative study of North American and European municipalities that have successfully promoted alternatives to automobile use. The general conclusion is that the overriding freedom of movement of motorists must be restrained as infrastructure improvements that support alternative modes are implemented.

The Bicycle and Urban Sustainability[i]

One occasionally hears cyclists speak of the sense of injustice they feel when travelling by bicycle in Toronto. The feeling is sometimes triggered by a dangerously close encounter with a motor vehicle. Usually, though, it is simply the final stage of an all-too-familiar progression through irritation, anger, and indignation, as a routine journey becomes an ordeal, a series of conflicts over territory, a string of casual insults inflicted by (from the cyclist's perspective) "bullies" in cars. Forced into the gutter, cyclists are both literally and figuratively marginalised. Behind the sense of righteous indignation is the perception that, while so much effort and expense is invested in designing and building better roads for motor vehicles, the bicycle, which inflicts much less harm to the environment, infrastructure, and other road users, is so badly neglected.

In many Northern European cities, cycling is a completely different experience. Unlike most North American cities, using a bicycle for routine urban travel in Holland, Denmark and Germany is neither dangerous nor impractical. These municipalities have all taken concrete steps to reinforce the cyclist's right to safe passage, and to encourage citizens to use bicycles and public transport instead of cars — and they do so in droves.

The lack of safe cycling space, in this and many other cities, is a symptom of larger issues, which extend beyond the rights of individual road users and involve questions of social and environmental justice. These issues are highly relevant to the global sustainability agenda. Indeed, I would suggest that the quality of a city's traffic environment, in terms of infrastructure for and attitudes towards non-motorists, is an indication of its progress towards sustainable development.

A few North American cities have slowly begun the process of becoming more "bicycle-friendly." The City of Toronto, for example, has recently completed a "Bicycle Master Plan," which envisions a network of safe cycling routes throughout the city. This paper sets out to establish a rationale for carrying out such a plan, as part of a concerted effort to change the local traffic environment. It is instructive to look to the successful initiatives of Europe's famous "cycling cities" for policies and programs that can be adapted to the local urban environment. But first, in order to explain why municipalities around the world are trying to increase the use of bicycles for personal transportation, and why Toronto should follow their lead, the concept of sustainability will be explored.

Principles of Sustainability

The last half of the 20th century has witnessed increasing recognition of the significance of global environmental problems, and the importance of local action in both creating and addressing these issues. "Sustainability" has emerged as an idea that captures the essence of an approach to development that is considered by many to be essential to our survival. The concept of sustainable development was brought to the fore by the World Commission on Environment and Development (WCED), chaired by Gro Harlem Brundtland, in 1987. The Brundtland Commission expressed concern over the negative environmental impacts of current practices of uneven economic development, and the long-term implications of environmental and social degradation for the future of humanity (WCED 1987). While protection of the natural environment is recognised as vital to global sustainability, this recognition springs not from a strictly environmental ethic, but from anthropocentric values. The primary concern is for the survival of future generations of humans. The essence of sustainability lies in finding ways to meet current human needs while leaving enough "natural capital" (clean air and water, and other natural resources) to allow future generations to sustain a

similar, or improved, standard of living. This has been called the “principle of inter-generational equity” (Haughton and Hunter 1994: 17).

As the Bruntland Commission pointed out, the vast disparity between North and South — ‘developed’ and ‘developing’ nations — flies in the face of this principle. A world order that perpetuates geographic inequity should not be considered sustainable (WCED 1987). Indeed, many of the world’s most significant environmental problems result from the passing of environmental “costs” across international borders. Furthermore, environmental and social justice are just as important *within* national boundaries. At all levels, a political climate that supports environmental protection in the interests of future generations is difficult to achieve without broad agreement on how to meet current basic needs. Social justice, or “intra-generational equity,” is thus another key principle of sustainability (Haughton and Hunter 1994: 17). These three aspects of equity—between generations, between social classes, and between nations and geographic regions — are fundamental to the concept of sustainability.

The interdependence of environmental and social well-being places constraints on the kind of economic activity that can be considered sustainable. This is not to suggest that economic progress is necessarily always in conflict with environmental protection. Rather, sustainable development involves striving for a balance between environmental, social, and economic health, with the focus squarely on the long-term future. Economic practices that ignore “externalities” that compromise the quality of life for any segment of society are not acceptable by these standards. It is to be understood that this includes any activity that results in permanent environmental degradation, and is therefore likely to compromise the quality of life of future generations. Moving beyond rhetoric about sustainable development will clearly require some rather sweeping changes in current dominant modes of production and consumption, changes that will necessarily take time.

Indeed, we may never be able to say with any certainty, “this is sustainable.” We can, however, agree to take precautions and try to refrain from practices that clearly appear *unsustainable*. This implies we might treat the goal of sustainability as a direction in which to move, rather than as an end state. While the condition of sustainability may never ultimately be *achieved* in any strict sense, we can certainly take on the challenge of progressing *towards* more-sustainable development. This will allow us to think in terms of realistic improvements, rather than being paralysed by uncertainty over calls for revolutionary change. Thinking about sustainable development as a direction also suggests that progress towards urban sustainability is something that can, to some extent, be measured. If so, we should be able to compare different strategies and initiatives, with a view to applying the most successful methods in other situations.

These basic concepts are useful in conceptualising sustainable urban transportation. The need to balance long-term social, environmental, and economic goals, and to weigh choices with the broadest regard for equity, constitute a set of criteria for evaluating the sustainability of existing urban systems and processes. The idea that we can measure and compare the results of different strategies for sustainable development suggests a comparative approach to planning for the future. I will argue that the methods used in some cities to promote alternatives to automobile transportation have made those cities more socially, environmentally, and economically sustainable, and that these strategies should be adapted and applied in cities such as Toronto. But first, to justify my focus on urban transportation, a few words are necessary on the importance of urban processes, and the central role of transportation in the sustainability of cities.

Sustainable Urban Transportation

The urbanisation of human settlement is a continuing global trend, one that has accelerated since the industrial revolution to the point where the majority of humans now live in urban areas (Gilbert *et al* 1996: 1). The concentration of human activity that defines an urban region typically entails equally concentrated emissions of noxious effluents. Larger cities are often able to achieve lower per capita resource consumption and waste emissions than are smaller settlements, but their net environmental impacts are more likely to exceed the absorptive capacity of the immediate environment (Newman and Kenworthy 1999: 14). Urban processes can have far-reaching impacts on the environment, and may indeed contribute to global climate change. As the sites of an increasingly large portion of the earth's human activity, and as sources of significant environmental impacts, cities are therefore a necessary focus for the global sustainability agenda. Furthermore, the municipal level of government is the logical entity for the delivery of practical local strategies for sustainable development, especially in light of current trends towards devolution of responsibilities and powers to local authorities and civil society (Gilbert, *et al* 1996). The United Nations Conference on Environment and Development, in 1992, noted, in chapter 28 of its "Agenda 21,"

> Because so many of the problems and solutions being addressed by Agenda 21 have their roots in local activities, the participation and co-operation of local authorities will be a determining factor in fulfilling its objectives… As the level of governance closest to the people, they play a vital role in educating, mobilising, and responding to the public to promote sustainable development.
>
> Agenda 21: Program of Action for Sustainable Development
> UN Department of Public Information (1993)
> UN, New York, Chapter 28

Transportation is clearly essential to most urban activities. Urban travel is not a need in and of itself, except when people just “go for a drive.” Rather, the spatial separation of activities generates the need to travel. Goods must be shipped, consumers must have access to markets and employment, and so on. Concentrations of production and consumption activities create concentrated traffic, and require transportation facilities with sufficient capacity to avoid congestion. On the other hand, new transportation facilities provide access to new locations, creating new land-use opportunities. Nodes that focus large numbers of travellers (highway inter-changes, transit stations, etc.) create potential marketplaces, prime locations for development.

While the desire to partake of urban activities generates a demand for travel, transportation facilities can also *induce* travel. When discretionary (non-vital) activities are more easily accessible as a result of a new transportation facility, more people choose to take advantage of them. Conversely, when transportation facilities are temporarily or permanently eliminated, demand for travel may decline, as some people choose to forgo certain activities, or combine them with other activities that also require a trip (Cairns, Hass-Klau & Goodwin 1998). Thus there is an intimate relationship between urban land-use development and transportation. Sustainable transportation is therefore an essential component of sustainable urban development.

The phrase “sustainable transportation” would seem to suggest a tangible system, something we can imagine and eventually build. And yet, the concept is vague. Can we possibly conceive of an economically viable system that is able to meet our current transportation needs indefinitely, without depleting resources or putting someone, somewhere, at a disadvantage? Actually, this is a misleading question, since our “current transportation needs” are unnecessarily high, as will be discussed below. The solution will involve not only improving the

transportation system, but also reducing the amount of travel required. Again, it is helpful to think of sustainability as a direction.

Although it may be difficult to visualise a system that meets our huge demand for travel *and* achieves environmental, social, and economic sustainability, we can certainly use this combination of criteria to demonstrate how current practices are *un*-sustainable. The following list of 'crimes against sustainability' shows how automobile-dominated transportation systems fail to meet these criteria:

Any system that depends on limited, non-renewable resources of petroleum is clearly not a reliable option for future generations. Even in the short term, our government's ability to control the cost of operating its own transportation system is limited by reliance on foreign sources of oil. Canadian consumers reportedly spend more on their cars than they spend on food, clothing, home furnishings, and electronics combined, so price fluctuations can have a significant impact on their quality of life (Statistics Canada 2000). On the production side, an economy that relies heavily on the automobile industry is vulnerable to even slight fluctuations in demand. However, the significance of this sector of the economy, which accounts for twenty-five per cent of Ontario's economic output, frustrates efforts to assemble support for reducing automobile dependence (Morton 1998: 87).

The publicly funded infrastructure required to support travel by private auto is very costly, and consumes large amounts of valuable real estate. What is more, the widespread availability of 'auto-mobility' (cars and highways) encourages urban sprawl, which requires even more land and more infrastructure (roads, sewers, water mains…) than is needed to service compact urban development. Day-to-day living in sprawling development, in turn, demands greater mobility, since sprawl is characterised not only by low urban density, but also by the segregation of land-use activities. When more travel is required to conduct daily

activities, alternatives to driving, such as public transport, cycling, and walking, become less feasible. Traffic danger and noise tend to discourage outdoor activities, including socialising in the streets, so that this important public realm is further eroded. Construction of urban freeways, primarily to provide suburban motorists with access to employment and services in the city, often involves the acquisition and demolition of homes in the older neighbourhoods along their path. Funding such projects depletes financial resources that could otherwise go towards public transit improvements that would benefit city dwellers — especially those with low incomes.

Internal combustion engines (used in almost all motor vehicles) generate air pollution that affects the health of people, plants, and animals, and also damages building materials and public structures, especially old historic buildings. Many municipalities issue increasingly frequent air quality advisories, advising citizens to refrain from vigorous outdoor activities like cycling and running as levels of photo-chemical smog exceed safe limits. The Ontario Medical Association estimates that smog results in 1,900 premature deaths per year across the province (Pollution Probe 1991). The transportation sector is also the largest source of so-called greenhouse gases in Canada. Emissions from countless personal vehicles thus threaten to affect the world's climate.

Unfortunately, the development of alternative fuels runs counter to the interests of the largest corporations in the world, the oil companies and auto manufacturers. Alternative fuels may not become economically competitive until the price of gasoline increases significantly. Automobiles are already expensive, and a system that favours the use of cars over other more-affordable means of travel increases the disparities between rich and poor. Any increase in the cost driving could effectively raise the 'dividing line' between rich and poor. Many lower-income families have several members working part-time jobs in far-flung locations, and typically choose to reside in suburban areas for reasons of

housing affordability. Not only are they often the least able to find housing close to their workplaces, they may also be unable to take advantage of public transit, which usually serves centrally located workplaces best (Soberman 2000). Those who simply cannot afford to operate a vehicle are at a distinct disadvantage in competing for work, and may also find it difficult to access low-cost retail outlets and regional shopping malls that are remote by pedestrian standards. They may also miss out on entertainment and cultural events, which often take place downtown.

All these issues have serious implications for social justice, but perhaps none of them have such direct impact on people's lives as traffic accidents. Each year, a quarter of a million Canadians are injured in traffic accidents, and approximately three thousand are killed, including roughly four hundred pedestrians and seventy cyclists (Transport Canada 1999). In the city of Toronto, half of all traffic fatalities are pedestrians or cyclists. In the US, car crashes are the leading cause of death for every age from 6 through 27, and kill over forty thousand Americans each year, an average of over 100 deaths each day (US D.O.T. 1999). Since the invention of the automobile, road accidents have taken more lives world-wide than war, and currently result in over half a million deaths and fifteen million injuries each year (International Red Cross 1998). A decade after championing the principle of sustainable development, Dr. Brundtland, now Director-General of the World Health Organisation, predicted that traffic accidents will soon become the world's third largest cause of death and disability (W.H.O. 1998).

While the carnage inflicted by automobiles certainly changes the lives of countless crash victims and their families, the *fear* of traffic accidents can affect everyday travel choices. For instance, it is estimated that almost a million citizens of Toronto ride bicycles for recreation. Among those who live close enough to their workplace for bicycle commuting to be feasible, the most frequently cited

factor discouraging them from doing so is the perception that riding in traffic is dangerous (Decima 2000, US DOT 1992a).

Having pointed out some of the negative aspects of excessive automobile use, it is worth examining the merits of the bicycle as a means of personal transportation. In contrast to the automobile, the bicycle emits nothing into the atmosphere, and is virtually silent. It poses very little threat to the health and safety of other road users, or to the integrity of the environment.[ii] Infrastructure for cycling takes up less space than that required by motor vehicles, and is much less costly.[iii] The space required for bicycle parking also is minimal. All in all, the bicycle encroaches on public space much less than the car, while engaging and immersing the traveller in the immediate environment, rather than insulating him or her from it.

Short automobile trips generate the most pollution, per kilometre, since a vehicle's motor is not able reach optimal operating temperature. These are also the trips that are most amenable to bicycling, and so the bicycle's potential to reduce air pollution is higher than one might think, based simply on its ability to reduce the overall distance travelled by auto. The bicycle itself is also much more affordable than the automobile, and requires no fuel to operate. In fact, it is the most energy-efficient way for humans to travel. For distances under a few kilometres, especially in the urban core, it can also be the quickest, something the courier industry has been aware of for many years (U.S. D.O.T. 1992a). Under the right conditions (*i.e.*, with protection from motorised traffic) the bicycle can provide better local mobility than can the auto, for a broader (in terms of both age and affluence) segment of society.

Moreover, cycling regularly instead of travelling by motorised means can improve one's cardiovascular fitness without requiring the dedication of extra time to exercise. Making cycling safer and more convenient would improve the health,

productivity, and longevity of the population, thus lowering overall medical costs. More than just a “green vehicle” that is less harmful than the automobile, the bicycle can positively benefit society.

Sustainability Indicators

In terms of the afore-mentioned environmental and social criteria, automobile-dominated transportation systems are clearly unsustainable. Aside from their global impacts, they have a profoundly negative affect on personal safety and the quality of urban life. Mexico City, with its lethal air, and Bangkok, with its extreme congestion, are vivid examples of cities that suffer the effects of unsustainable transportation systems. On the other hand, there are cities that are perceived to be much more liveable. Cities like Amsterdam and Copenhagen, for example, are widely considered attractive places to simply ‘live’ — to walk the streets, to eat, drink, visit and socialise. Rather than dwelling on what doesn’t work, it may be more fruitful to look to these liveable cities for guidance. But what makes them seem more liveable? While “liveability” is admittedly a subjective quality, surely there are more objective standards of sustainability.

As I have suggested, thinking about sustainable development as a direction, rather than a condition, means that progress towards sustainability should be measurable. Quantifiable “sustainability indicators” might be defined, in order to compare the ways different cities meet the travel needs of their citizens. Quantities such as the average commute length, per capita expenditure on transportation, amount of “green space” per capita, annual number of days with poor air quality, and traffic fatalities per capita can all provide some sense of the impact of a city’s transportation system on the quality of life available to its inhabitants. Some municipalities have begun to define other standards that measure ‘softer,’ less technical variables. For example, Seattle’s list includes the

number of pedestrian-friendly streets, and in The Hague, the number of thirty-kilometre-per-hour residential zones is considered an important measurement. Copenhagen counts the number of seats available for public use in its streets (Newman and Kenworthy 1999: 20). I suggest that the number of people using bicycles for routine travel is a good example of such a sustainability indicator.

Annual smog and green-house gas emissions, and transportation energy consumption, can be used to measure the environmental impacts of a city's transportation system. These quantities are a function of both the total amount of local travel and, when measured on a per capita basis, the overall fuel-efficiency of the city's transportation system. Calculated in terms of kilograms per person-kilometre of travel, they yield very precise indicators of sustainability. Toronto, for example, has low per capita emissions of CO_2, compared to most North American cities, thanks perhaps to its well-used transit system. However, smog levels in Toronto are similar to those of typical American cities, in part because its fleet of vehicles is older and less fuel efficient than those of U.S. cities (Newman and Kenworthy 1999: 122).

A good deal of work has been done collecting and comparing such empirical information on cities around the world (Nijkamp and Perrels 1994, Newman and Kenworthy 1989, 1999). Newman and Kenworthy, for example, have spent two decades collecting and analysing data, and have been able to demonstrate positive relationships between the above-mentioned measures of liveability and sustainability and such factors as a city's "urban activity intensity" (population and job density), per capita investment in public transit, and provision of facilities for walking and cycling. They have also demonstrated negative relationships between the same sustainability indicators and the level of car ownership, the proportion of trips taken by car, the supply of roads and parking, and the amount of suburban "sprawl" (low-density peripheral development) versus compact central development. While each city is unique, some generalisations are

possible. Newman and Kenworthy group cities into the following categories: North American; Australian; European; wealthy Asian; and developing Asian. They make comparisons between and within these groups, investigating the effects of differences in wealth, culture, and the degree of motorised versus non-motorised local transportation. Even when these variables are accounted for, the relationships described above are found to hold.

Planning for Sustainable Urban Transport

The conclusions of researchers like Newman and Kenworthy can be summed up as follows: more-compact cities, with higher-density, mixed-use development, plentiful inner-city employment and housing opportunities, extensive public transit systems and infrastructure that facilitates non-motorised travel are more sustainable than sprawling, automobile-dominated cities with segregated residential, commercial, and industrial zones and thinly populated core areas. The empirical evidence supports theoretical arguments in favour of compact cities, put forward since the fifties by urbanists such as Hans Blumenfeld, Jane Jacobs, Lewis Mumford, and Peter Hall. Indeed, debates over the ideal urban form and the desirability of controlling urban spread have continued for at least half a century (Isin 1996). Calls for regional planning initiatives, restrictions on new peripheral development, and intensification of central urban areas have received widespread support, in principle. It is no longer considered innovative for a city's official plan to express commitment to principles of sustainable development. Yet cities continue to spread, growing in size faster than in population. Many large cities have evolved beyond the "metropolitan" form, in which the central city is the focus of surrounding suburbs and satellite cities, and have become less centrally-focused "polycentric urban regions" (Gottdiener 1994). This raises the question, do governments and planning agencies really have the power to control the pattern of urban growth?

Some answer that the new urban form is an expression of market forces and the desires of consumers who obviously don't *want* to live in high density city-centres (Gordon and Richardson 1997). They suggest that attempts at government intervention would distort the market, leading to inefficiency, and in any case, would never achieve more than partial success against the structural forces of capitalism and the "preferences" of individuals. Postmodern urban theorists argue that the role of the urban planner is not to "legislate" urban form, but to "interpret" the urban experience as it unfolds, helping multiple stakeholders to better understand and take advantage of trends (Bauman 1987). A few even dispute the purported inefficiency and high public costs associated with sprawl, arguing that the apparent preference for suburban living reflects lower individual costs and greater lifestyle satisfaction (Jenks and Williams 1996).

By focussing on urban form as a primary cause of these positive and negative effects on the environment, the economy, and human lives, this debate has tended to ignore some of the underlying forces at work in the production of urban space (Isin 1996, Gottdiener 1994). Consumer preferences are not innate, but are influenced by culture, knowledge, and the quality and availability of information. Producers themselves are able to influence consumer preferences, through advertising and the media. Market forces are already "distorted" by government programs such as mortgage incentives and subsidies to key sectors of industry and trade — including those essential to the hegemony of the automobile.

On the other hand, effective regional planning is difficult to achieve in practice for a post-metropolitan agglomeration of jurisdictions competing to attract business investment. Even if regional co-operation can be achieved, the aims of higher government departments often conflict with those of the municipalities, and even those of other ministries. Ontario's "balanced" approach to transportation

planning in the Greater Toronto Area is a perfect example of this. While contributing financial and technical support for the promotion of “nodal development” along Toronto’s subway system, as part of an effort to contain the city’s growth, the province simultaneously funded “big pipes” and highways to service the area north of the city, literally paving the way for suburban development (Perl and Pucher 1995).

This example points out that the provision of public infrastructure is one form of “government intervention” *can* have a marked effect on urban growth patterns (Wells and Hutchinson 1996). Unfortunately, the mobility of the private auto superseded the accessibility of public transportation as a government vision for many years, particularly in North America after the second world war. This was also a time of rapid urban growth in North America, and hence new construction. The infrastructure that remains, a legacy of the dream of “a car in every driveway,” is the raw material that transportation and housing planners of today must work with. Urban renewal mega-projects, particularly those for which existing infrastructure must be scrapped, no longer fit within the ideological or budgetary frameworks of down-sizing neo-liberal governments of today. Instead, infrastructure improvement is one of the few entry points into the production of urban space currently available to municipal governments.

As discussed above, significant improvements in transportation infrastructure have the potential to influence long-term development patterns. Indeed, this might appear to be the primary motivation for building Toronto’s new Sheppard subway. While few are predicting success in terms of ridership, its ability to stimulate the kind of development North York has seen along the Yonge subway remains to be seen. In the mean time, making existing infrastructure more amenable to “softer” modes of transport can affect urban travel choices in the short term. If mistakes were made in the past as a result of an unhealthy

emphasis on the automobile mode, the new approach should surely focus on alternatives.

The combination of bicycle and public transit can provide a viable substitute for the automobile on many urban trips. While the subway is often quicker than the car, walking or taking a bus to the subway station can add too much time and inconvenience for some residents. Users of commuter-rail are even more sensitive to access and egress distances than subway users (Ghaeli and Hutchinson 1998). Improving bicycle accessibility in the suburbs, particularly along routes to subway and commuter-rail stations, could induce some of the commuters who usually arrive at the station by car to pedal there instead. Long-distance automobile commuters might decide to switch to public transport. This has the potential to expand the “catchment area” at outlying public transit stations, thereby promoting the viability of the public transportation system.

This scenario can be found in operation in many parts of Europe. Indeed, most of the cities that score the highest, with respect to the above-mentioned transportation sustainability indicators, exhibit just such an integration of well-utilised public transportation and high levels of cycling (Cervero 1998).

In the next section, I will discuss some of the different approaches to bicycle-use in Europe and North America. While bicycle-use is also very high in some Asian countries, similarities between European and North American cities, in terms of urban development, governance, wealth, and culture, justify restricting the comparison this way. Furthermore, some European cities have invested much effort in improving the cycling environment, and in the process have learned important lessons that other municipalities may benefit from.

Bicycle Transportation in North America and Europe

While there is some truth to the view that Europeans have always cycled more than North Americans, the bicycle has not always been as popular as it is now, in many European cities. Even Amsterdam, the most well-known “cycling city,” experienced a decline in cycling of over sixty percent during the post-war automobile era (de la Bruheze 2000). The high levels of cycling currently enjoyed in many Dutch, Danish, and German cities were achieved through deliberate choices in transportation and development policy, not least of which included investments in bicycle-friendly infrastructure (Pucher 1997). These cities can serve as models, providing examples of what is possible, and ways it can be achieved.

If North American municipalities are indeed serious about pursuing sustainable development, they will look to the examples set by European cities, many of which have already faced similar challenges to those now becoming urgent in Canadian and US cities. The constraints of narrower streets, older buildings and infrastructure, and more densely populated development have made many European cities more vulnerable to the harmful impacts of mass-motorisation. Congestion, damage to historical architecture, noise and air pollution, encroachment on public space, and traffic accidents, including those involving non-motorists, have reached critical levels in some cities, provoking public outcry and political response.

It has been deemed necessary, by leaders in many European countries, to try to shift the choice of travel mode in the direction of less harmful and more efficient alternatives to the private automobile (OECD 1998). Experimentation has been necessary, in both policy and infrastructure design, since traditional methods have tended to provide for private auto mobility rather than promoting public accessibility. European experience has demonstrated that the only way to

achieve significant reductions in automobile use is through a combination of "carrot and stick" policies. Investment in public transportation and "alternative transportation" infrastructure can provide incentives for travellers to switch modes (the carrot), but if the automobile remains the most attractive option, simple promotion of alternatives fails to generate significant changes in travel habits. In such a 'free market' situation, a decline in congestion that may occur as some drivers switch to other modes can even act as an incentive for others to drive (Meyer and Miller 1984).

Policies that reverse the usual practice of providing mainly for the convenience of motorists have initially been met with opposition, but, in the long run, the popular response to traffic calming, pedestrian-friendly zones, and greater accessibility for cyclists has been overwhelmingly positive (OECD 1998). This may be partly due to noticeable improvements in safety, as measures to lower traffic speed not only reduce the frequency of collisions, but also the severity of injuries to pedestrians, cyclists, and motorists, when collisions do occur. An indication of the magnitude of this effect can be seen by comparing the number of nation-wide cyclist fatalities per 100 million bicycle trips, which ranges from 1.6 in the Netherlands and 2.4 in Germany, to 26 in the U.S.A. (Pucher and Dijkstra 2000).

Before reviewing some of the methods that have been used in European municipalities to increase the use of bicycles and other alternatives to the car, a brief survey of the levels of automobile- and bicycle-use in existing transportation systems will illustrate the wide range of differences. The first table below summarises the proportion of trips taken by different modes, in Canada, the United States, and several European countries. All of these countries are very similar in terms of economic development and technology, political systems, and degree of urbanisation.

Although driving is the preferred mode in every country except Sweden, the automobile is most dominant in North America. There is much greater variation in the use of bicycles for urban travel, with even the least bicycle-oriented European countries supporting far higher levels of bicycle transportation than in North America. These differences cannot be explained by climate or topography: the climate in Europe is worst precisely where bicycling is most prevalent; the bulk of North America's population resides in areas that are relatively flat. Furthermore, Switzerland and Austria are mountainous countries, although most of the urban areas in all these countries are, at most, only moderately hilly. Europeans would not appear to choose the bicycle out of economic necessity either, since per capita incomes in Sweden, Switzerland, the Netherlands, and Denmark are at least as high as in Canada and the US. Finally, although average distances are greater in North American cities, this does not explain the magnitude of the difference. Roughly half of all urban trips in America are shorter than five kilometres, while forty percent are under three kilometres, well within easy cycling distance (US D.O.T. 1992b).

Modal Split Distributions for Urban Travel in Europe and North America[iv]

Country	Percentage of Trips by Travel Mode				
	Bicycle	Walking	Transit	Auto	Other
Netherlands	30	18	5	45	2
Denmark	20	21	14	42	3
Germany	11	22	16	49	1
Switzerland	10	29	20	38	3
Sweden	10	39	11	36	4
Austria	9	31	13	39	8
England and Wales	8	12	14	62	4
France	5	30	12	47	6
Italy	5	28	16	42	9
Canada	1	10	14	74	1
U.S.A.	1	9	3	84	3

The next table lists the bicycle's share of trips in the cities with the highest levels of cycling in both Europe and North America. Within each country, different cities exhibit quite different levels of bicycle use, indicating that cycling is not primarily a matter of "national culture." On the other hand, it is a fair generalisation to say that, for the most part, bicycle use in Europe is 'in a different league' from that in North America.

Percentage of Trips by Bicycle in European and North American Cities[v]

Europe	
City	%
Gronigen, NL	48
Amsterdam, NL	34
Utrecht, NL	32
Copenhagen, DK	30
Muenster, D	34
Bremen, D	22
Munich, D	15
Freiburg, D	19
Hanover, D	16
Cologne, D	11
Nuremberg, D	10
Salzburg, A	19
Ferrare, I	31
Oxford, UK	20

United States	
City	%
Davis, Cal.	21.6
Madison, Wis.	3.35
Cambridge, Mass.	2.93
Portland, Ore.	2.0
Seattle. Wash.	1.49
San Francisco, Cal.	0.95
Boston, Mass.	0.87
Manhattan, N.Y.	0.65

Canada	
City	%
Ottawa	1.5
Toronto	1.5

Compared to many parts of Europe, North America does not have a long history of mass bicycle use.[vi] However, the current high levels enjoyed in Europe's "bicycle cities" are not simply a legacy of traditional habits. Cycling declined in all

of these cities with the advent of the mass motorisation. By 1975, bicycle use had fallen to less than half of pre-war levels across most of Europe (de la Bruheze 2000).

The factors that contributed to its subsequent revival in some European cities can be identified through comparative study. This is indeed the focus of much research in the field of bicycle transportation planning, amongst academics and practitioners around the world. International research and policy analysis is well developed among European bicycle planners, and is the focus of several recurring conferences aimed at investigating possibilities for the transfer of knowledge.[vii] Delegates meet primarily to discuss the results of specific policy and infrastructure improvements.

American researchers also have attempted to correlate high levels of bicycle use with particular characteristics of cities. They have found, for example, that the presence of a university or college seems to increase the proportion of cyclists, particularly in a small city, where students constitute a significant portion of the population. On the other hand, not all university towns have high levels of cycling (U.S. D.O.T. 1992a). The provision of bicycling facilities—bike lanes and separate paths—also seems to have a positive effect, unless the facilities are poorly connected and fail to serve appropriate destinations (Nelson and Allen 1997).

The unusually high level of bicycle use in Davis, California suggests that this might be a good place to look for clues about the kind of factors that can most favourably influence travel behaviour in American cities. It has the highest ratio of bike lanes to arterial roads, the shortest average commute distance, the highest percentage of students, is the most compact and densely populated of all American university towns, and has by far the most bicycle commuters. These factors seem to have a synergistic effect, so that isolation of the most important

ones is problematic. However, “it is almost certain that these high rates of cycling in Davis are due to a set of proactive policies and programs, many of which were inspired by the decision of UC-Davis back in the 1960’s to minimize the presence of cars on campus.” (US D.O.T. 1992a: 52).

The findings of European and North American researchers concur: Climate, topography, and other attributes a city may enjoy have much less effect on cycling activity levels than deliberate municipal policy decisions. The cities in which cycling has increased significantly are those that have implemented policies to increase the safety and convenience of cycling while making automobile-use less appealing (Pucher and Dijkstra 2000, OECD 1998). Methods that have achieved demonstrable success, particularly when used in combination, include the following:

Building better facilities for bicycling

Bike lanes and paths that form a network providing safe access to practical everyday destinations; special intersection treatments, including queue-jumping lanes, separate traffic lights, and advanced stop-lines for cyclists; exemptions from one-way and turning restrictions; cyclist-activated traffic signals; and bicycle ‘short-cuts’ where streets are indirect and circuitous.

Urban design sensitive to the needs of non-motorists

Requirements for new development to incorporate short blocks and narrow roads; accessible shopping, service, and cultural centres, with parking behind, rather than in front of buildings; safe crossings for existing main streets; policies to encourage new residential development close to city centres (including assistance with soil remediation on former industrial sites).

Restricting the freedom of movement of motor vehicles in city centres
Replacing selected traffic lanes with bicycle- or bus-only lanes; reducing the supply and increasing the cost of parking, especially in the city-centre; locating new parking facilities just outside the city-centre, close to public transit facilities; creating car-free zones in shopping and entertainment districts; restricting truck traffic on certain routes; restricting right-turns at red lights.

Calming traffic in residential neighbourhoods
Speed humps, raised intersections and crosswalks, chicanes, and pinch points to slow traffic; artificial dead ends that only allow the passage of bicycles, excluding motorised through-traffic; area-wide reduction of speed limits; turning restrictions and directional restrictions for motorists.

Rigorous traffic education for all road users
Mandatory driving instruction that stresses the importance of anticipating conflicts with non-motorists, especially those who may not be following the rules; more emphasis, in driver testing, on the ability to drive in a manner that minimises risk to other road users; traffic education as part of the junior school curriculum, including safe walking and cycling behaviour.

Strict enforcement of traffic regulations protecting vulnerable road users
Higher penalties for traffic violations, and targeted enforcement of regulations against behaviour that endangers vulnerable road users; greater emphasis on motorists' responsibility in accident investigations.

Of course, such methods require political support from a strong local constituency. With such low numbers of cyclists in most North American cities, it is difficult for municipalities to justify the kind of public spending involved in many of these measures. Until recently, promotion of cycling in Canada and America (with the notable exception of a few cities like Davis, California) has focused

primarily on special events, like “Bike to Work Week” and “Particip-action” advertisements. Cycling safety measures have largely been confined to promoting (and mandating) helmet use, especially among children (Pucher, Schimek, and Komanoff 1999). Bicycling safety courses are increasingly available, but these tend to emphasise the cyclists’ responsibility for their own safety. The “Transportation Equity Act for the 21st Century (TEA-21)” has made significant funds available for “alternative transportation” projects in the US, but very little has yet been done to alter the dominant position of the automobile.

There is some debate as to whether the lack of public investment in cycling is justified by, or leads to, the low levels of bicycle use in North America. Nevertheless, politicians respond not only to the concerns of their constituents, but also to those of “expert” advisors. An important factor in shaping transportation policy decisions is the approach taken by planning staff and consultants. Indeed, while the increasing number of traffic accidents and randomly parked bicycles in post-war Amsterdam gave rise to the image of the cyclist as a careless, unpredictable and undisciplined traffic participant who seriously impeded other traffic, traffic planners saw cyclists as normal traffic participants who were always taken into account in traffic policy (de la Bruheze 2000). In contrast, North American transportation planners saw little need to accommodate mixed traffic modes. Less constrained by available space, they were able to design wide roads that seemed to have plenty of extra capacity for the few cyclists who might wish to use them.

Not all European transportation planners have been sensitive to the needs of non-motorists. Indeed, the concept of a “hierarchy of roads,” which prioritises the free-flow of motorised traffic, originated in Great Britain (Ministry of Transport (UK) 1963). Most municipal works departments focused on auto-mobility for decades, providing very little for non-motorists (OECD 1998). Strangely enough, some cycling advocates in the UK and the US have also contributed to the

neglect of cyclists' special needs. They saw the provision of bicycle lanes and separate paths as an attempt to get cyclists out of the way of motorists, and feared that cyclists would be banned from mixing with regular traffic. Wanting to maintain the cyclist's right to use *all* roads, they opposed such special provisions. Their fear was not unfounded, and indeed, many jurisdictions made the use of roads illegal for cyclists, where parallel bicycle facilities existed (Forester 1977, 1975). In Toronto, "The Strok Report," commissioned by the City of Toronto in 1975, recommended that cyclists be relegated to separate paths, and spurred the creation of the Toronto City Cycling Committee by local cycling advocates who opposed this recommendation. The committee managed to prevent the report from being adopted by council as official policy, but its members took over ten years to reach consensus on supporting bicycle lanes (Wallace 1992).

Apparently unable to separate the issue of providing safe cycling facilities from that of restricting cyclists' freedom of movement, some cycling advocates went to great lengths to demonstrate that separate facilities actually made cycling more dangerous (Forester 1977, 1996b, Franklin 1988, 1999). Championing the concept of "vehicular cycling," which maintains that cyclists should act, and be treated, as operators of regular vehicles, they asserted that the most critical cycling safety issue was the typical cyclist's lack of "roadcraft" skills. Their elitist viewpoint positioned them as experts in the eyes of both non-cyclists and other self-styled expert cyclists, and their opinions were lapped up by bureaucrats anxious to minimise spending on special provisions for bicycles. Their ideas also fit the attitudes of law-makers, who saw cycling safety more as an individual responsibility than a societal obligation. One advocate in particular, John Forester, had a great deal of influence on US bicycle transportation policy, and his material can still be found in many state and municipal cycling safety publications. While his use of statistics and many of his conclusions have largely been discredited, "the attitudes engendered by Forester have slowed the development of cycling related infrastructure by over twenty years in the United

States." (Bill Wilkinson, head of the Bicycle Federation of America, quoted in Davidson 1997).

Perhaps more important than the opinions of bicycling advocates in influencing the attitudes of transportation planners and engineers is the simple ubiquity of motoring in North America. One of Canada's leading transportation educators, who often commutes by bicycle even in winter, tells his civil engineering students that the bicycle, as a means of basic transport, is "not practical in Canada's climate" (Miller 1999). Students continue to enter the field saying "transportation" when they mean "automobile traffic." Travel statistics published by this professor's research department every four years lump cycling and walking trips into the same category (TTS 1996). Far from indicating a conscious rejection of cycling, these examples speak of the simple neglect of walking and cycling as legitimate modes of transportation that has, until recently, characterised the approach of the academy and profession of transportation planning in North America. While the automobile mode is the subject of massive textbooks, and public transit has its obligatory chapter, cycling and walking are typically mentioned as mere footnotes. The public money devoted to each of these elements of transportation infrastructure is distributed in very much the same proportions.

The North American "carrot only" approach to promoting cycling has failed to generate any significant change in travel habits (Pucher, Schimek, and Komanoff 1999). Where unrestricted auto use is viewed by the electorate as a basic freedom, policy-makers are hesitant to enact measures to limit this freedom. In cities like Toronto, where motorists physically dominate the streets, cyclists are injured out of all proportion to their presence in traffic.[viii] Under these conditions, promoting increased cycling without seriously addressing cycling safety issues could be considered irresponsible. Even if the number of cyclists on the road were to double or triple, any corresponding decline in motorised traffic would be

practically unnoticeable. Congestion, aggressive and careless driving, and the attendant dangers to vulnerable road users would be just as problematic. Without significant measures to protect cyclists, and to restrict the volume and speed of motorised traffic, injuries and fatalities will surely increase. Efforts to improve safety for vulnerable road users must start at the source of the danger: car and driver.

Conclusions

The automobile has brought great benefits to our society, greatly expanding the world of options for those who can afford to use them. One could even argue that those who do not drive have also benefited from the productivity of a mobile work force and the economic competition stimulated by access to wider markets, both of which have been greatly facilitated by the automobile. In the process, however, the balance between environmental, social and economic considerations that forms the foundation of sustainability has not been maintained, or even approached. Auto use has become so pervasive that it restricts non-motorists' access and quality of life, and impairs their health and safety. The legacy of infrastructure and urban development that has been partner to this escalation threatens to place future generations in a position of automobile dependency.

Experience in European cities has shown that overcoming automobile dependence is indeed difficult, but not impossible. Despite arguments that European methods will not work in the North American context, there are signs that this is not entirely true. The importance of the automobile industry to the American and Canadian economies is not that much greater than it is to Germany's, and levels of car ownership are very similar. On the other hand, the American city of Davis, California shows what can be achieved through

deliberate infrastructure and policy initiatives, even in America. The bicycle can play an important role in providing more sustainable urban transportation. The really significant barriers are in the minds of individuals — of citizens making lifestyle choices, and of the scientists, technicians, bureaucrats and politicians who shape the context of those choices.

Notes

[i] This paper has been adapted from a Major Paper submitted in 2001 as part of the requirements of York's Master in Environmental Studies program. The Major Paper presented the results of a statistical analysis of 2,574 traffic collisions involving cyclists. A complete report on that study will be published by the City of Toronto in 2003.

[ii] In North American cities, collisions with pedestrians account for about 4% of all bicycle crashes, and are usually much less severe than collisions between pedestrians and motorists (Aultman-Hall and Kaltenecker 1999: 677, Forester 1996a: 275).

[iii] In Toronto, adding a traffic lane to an existing road can cost between $350,000 to $500,000 per km. for design and construction, and provides additional roadway capacity of 800 vehicles per hour. The costs associated with the addition of a 1.5 metre wide bike lane, which can accommodate 2,000 bicycles per hour, range from $5,000 to $10,000 for a simple re-striping to $35,000 - $150,000 per km where a road widening is required (Personal interview with Daniel Egan, City of Toronto Works and Emergency Services).

[iv] Source: Pucher 1997.

[v] Sources: Pucher 1997, U.S. D.O.T. 1992a, City of Toronto Traffic Data Centre and Safety Bureau

[vi] At the turn of the century, one Canadian in 12 had a bicycle. Cycling was popular among the well-off, but by the 20s, the affordable Model-T increasingly became the vehicle of choice (Morton 1998: 11).

[vii] Two of the largest conferences, "Velo City" and "Velo Mondial," attract delegates from all continents. More recently, "Pro-Bike/Pro-Walk" has been quite successful in the U.S.A.

[viii] Cyclists account for approximately two percent of traffic in Toronto, and are involved in 2% of all reported collisions, yet they represent eight percent of the city's traffic casualties (Lucas 1998).

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