"Transit and the Metropolis: Finding Harmony"

from *The Transit Metropolis: A Global Inquiry* (1998)

Robert Cervero

Editors' Introduction

Rising traffic volume and congestion are leading citizen concerns in most cities and towns the world over, and of course produce other sustainability-related problems such as air pollution, greenhouse gas emissions, depletion of nonrenewable fossil fuels, destruction of open space by roads and suburban sprawl, and degradation of local neighborhood quality of life. Vehicle ownership continues to grow rapidly in most countries, and the number of miles driven per capita has doubled in nations such as the USA over the last generation. How can this situation ever be changed? While there is no easy answer to this question, a number of combined strategies involving land use, public transit, other alternative travel modes, and pricing are likely to make the difference. This chapter explores some of these areas crucial to improving urban sustainability.

University of California at Berkeley professor Robert Cervero has studied relationships between transportation and land use the world over and is a leading authority on strategies to reduce automobile use. In this selection from his book *The Transit Metropolis: A Global Inquiry* (Washington, DC: Island Press, 1998), he asks why automobile use continues to grow and public transit use decline, and what characteristics can lead urban regions to buck this trend. Solutions, he believes, can be of several sorts. Regions may adapt their land use to fit around major transit systems such as subways or light rail lines ("adaptive cities"). Or they might adapt their transit systems to fit their low-density land use by employing on-demand shuttles and vans and/or flexible bus systems ("adaptive transit"). Or various hybrid options are possible. Pricing of transportation and other "transportation demand management" policies will play a role as well. The long-term goal, in Cervero's view, is the "transit metropolis" where strong public transit alternatives exist to balance private vehicle use.

Other resources on the subject of reducing automobile use include Peter Newman and Jeffrey Kenworthy's *Sustainability and Cities: Overcoming Automobile Dependence* (Washington, DC: Island Press, 1999; excerpted later in Part 2), Anthony Downs' *Stuck in Traffic: Coping With Peak-Hour Traffic Congestion* (Washington, DC: The Brookings Institution, 1992), and David Engwicht's *Reclaiming Our Cities & Towns: Better Living with Less Traffic* (Philadelphia: New Society Publishers, 1993). Two excellent internet resources on transportation are the Surface Transportation Policy Project (www.transact.org) and the Victoria Transportation Policy Institute (www.vtpi.org), both of which offer an impressive array of materials on transportation policy and how it might be reformed.

Public transit systems are struggling to compete with the private automobile the world over. Throughout North America, in much of Europe, and even in most developing countries, the private automobile continues to gain market shares of motorized trips at the expense of public transit systems. In the United States, just 1.8 per cent of all person trips were by transit in 1995, down from 2.4 per cent in 1977 and 2.2 per cent in 1983.[1] Despite the tens of billions of dollars invested in new rail systems and the underwriting of more than 75 per cent of operating expenses, ridership figures for transit's bread-and-butter market – the work trip – remain flat. Nationwide, 4.5 per cent of commutes were by transit in 1983; by 1995, this share had fallen to 3.5 per cent.

The declining role of transit has been every bit as alarming in Europe, prompting some observers to warn that it is just a matter of time before cities like London and Madrid become as automobile-oriented as Los Angeles and Dallas. England and Wales saw the share of total journeys by transit fall from 33 per cent in 1971 to 14 per cent in 1991.[2] Since 1980, transit's market shares of trips have plummeted in Italy, Poland, Hungary, and former East Germany. Eroding market shares have likewise been reported in such megacities as Buenos Aires, Bangkok, and Manila.

Numerous factors have fueled these trends. Part of the explanation for the decline in Europe has been sharp increases in fares resulting from government deregulation of the transit sector. Public disinvestment has left the physical infrastructure of some transit systems in shambles in Italy and parts of Eastern Europe. However, transit's decline has been more an outcome of powerful spatial and economic trends that have been unfolding over the past several decades than of overt government actions (or inaction). Factors that have steadily chipped away at transit's market share worldwide include rising personal incomes and car ownership, declining real-dollar costs for motoring and parking, and the decentralization of cities and regions. Of course, these forces have partly fed off each other. Rising wealth and cheaper motoring, for instance, have prompted firms, retailers, and households to exit cities in favor of less dense environs. Spread-out development has proven to be especially troubling for mass transit. With trip origins and destinations today spread all over the map, mass transit is often no match for the private automobile and its flexible, door-to-door, no-transfer features.

Suburbanization has not crippled transit systems everywhere, however. Some cities and regions have managed to buck the trend, offering transit services that are holding their own against the automobile's ever-increasing presence, and in some cases even grabbing larger market shares of urban travel. These are places, I contend, that have been superbly adaptive, almost in a Darwinian sense. Notably, they have found a harmonious fit between mass transit services and their cityscapes.

Some, like Singapore and Copenhagen, have adapted their settlement patterns so that they are more conducive to transit riding, mainly by rail transit, whether for reasons of land scarcity, open space preservation, or encouraging what are viewed as more sustainable patterns of growth and travel. This has often involved concentrating offices, homes, and shops around rail nodes in attractive, well-designed, pedestrian-friendly communities. Other places have opted for an entirely different approach, accepting their low-density, often market-driven lay of the land, and in response adapting mass transit services and technologies to better serve these spread-out environs. These are places, such as Karlsruhe in Germany and Adelaide, Australia, that have introduced flexible forms of mass transit that begin to emulate the speedy, door-to-door service features of the car.

Still other places, like Ottawa, Canada, and Curitiba, Brazil, have struck a middle ground, adapting their urban landscapes so as to become more transit-supportive while at the same time adapting their transit services so as to deliver customers closer to their destinations, minimize waits, and expedite transfers. It is because these places have found a workable nexus between their mass transit services and urban settlement patterns that they either are or are on the road to becoming great transit metropolises.

What these areas have in common – adaptability – is first and fundamentally a calculated process of making change by investing, reinvesting, organizing, reorganizing, inventing, and reinventing. Adaptability is about self-survival in a world of limited resources, tightly stretched budgets, and

ever-changing cultural norms, lifestyles, technologies, and personal values. In the private sector, any business that resists adapting to changing consumer wants and preferences is a short-lived business. More and more, the public sector is being held to similar standards. There is no longer the public largesse or patience to allow business as usual. Transit authorities must adapt to change, as must city and regional governments. Trends like suburbanization, advances in telecommunications, and chained trip-making require that transit agencies refashion how they configure and deliver services and that builders and planners adjust their designs of communities and places. In the best of worlds, these efforts are closely coordinated. This will most likely occur when and where there is the motivation and the means to break out of traditional, entrenched practices, which, of course, is no small feat in the public realm. Yet even transit's most ardent defenders now concede that steadily eroding shares of metropolitan travel are a telltale sign that fresh, new approaches are needed. Places that appropriately adapt to changing times, I contend, are places where transit stands the best chance of competing with the car well into the next millennium.

It bears noting that a functional and sustainable transit metropolis is not equated with a region whereby transit largely replaces the private automobile or even captures the majority of motorized trips. Rather, the transit metropolis represents a built form and a mobility environment where transit is a far more respectable alternative to traveling than currently is the case in much of the industrialized world. It is an environment where transit and the built environment harmoniously co-exist, reinforcing and enhancing each other in the process. Thus, while automobile travel might still predominate, a transit metropolis is one where enough travelers opt for transit riding, by virtue of the workable transit–land use nexus, to place a region on a sustainable course.

It is also important to emphasize . . . connections between transit and urbanization at the regional scale versus the local one. While considerable attention has been given to transit-oriented development (TOD) and the New Urbanism movement in recent years, both by scholars and the popular press, much of this focus has been at the neighborhood and community levels. Micro-scale designs that encourage walking and promote community cohesion have captivated the attention of many proponents of TODs and New Urbanism. While good quality designs are without question absolutely essential to creating places that are physically conducive to transit riding, they are clearly not sufficient in and of themselves. Islands of TOD in a sea of freeway-oriented suburbs will do little to change fundamental travel behavior or the sum quality of regional living. The key to making TOD work is to make sure that it is well coordinated across a metropolis. While land use planning and urban design are local prerogatives, their impacts on travel are felt regionally. . . .

[. . .]

TYPES OF TRANSIT METROPOLISES

[There are] four classes of transit metropolises:

- *Adaptive cities.* These are transit-oriented metropolises that have invested in rail systems to guide urban growth for purposes of achieving larger societal objectives, such as preserving open space and producing affordable housing in rail-served communities. All feature compact, mixed-use suburban communities and new towns concentrated around rail nodes . . . . examples are Stockholm, Copenhagen, Tokyo, and Singapore.
- *Adaptive transit.* These are places that have largely accepted spread-out, low-density patterns of growth and have sought to appropriately adapt transit services and new technologies to best serve these environs. [Models include] technology-based examples (e.g. dual-track systems in Karlsruhe, Germany), service innovations (e.g. track-guided buses in Adelaide, Australia), and small-vehicle, entrepreneurial services (e.g. colectivos in greater Mexico City).
- *Strong-core cities.* [Cities such as] Zurich and Melbourne have successfully integrated transit and urban development within a more confined, central city context. They have done so by providing integrated transit services centered around mixed-traffic tram and light rail systems. In these places, trams designed into streetscapes co-exist nicely with pedestrians and bicyclists. These cities' primacies (high

shares of regional jobs and retail sales in their cores) and healthy transit patronage are testaments to the success of melding together the renewal of both central city districts and traditional tramways.

- *Hybrids: adaptive cities and adaptive transit.* [Cities such as] Munich, Ottawa, and Curitiba are best viewed as hybrids, in the sense that they have struck a workable balance between concentrating development along mainline transit corridors and adapting transit to efficiently serve their spread-out suburbs and exurbs. Greater Munich's hybrid of heavy rail trunkline services and light rail and conventional bus feeders – all coordinated through a regional transit authority – has strengthened the central city while also serving suburban growth axes. Both Ottawa and Curitiba have introduced flexible transit centered around dedicated busways, and at the same time have targeted considerable shares of regional commercial growth around key busway stations. The combination of flexible bus-based services and mixed-use development along busway corridors has given rise to unusually high per capita transit ridership rates in both cities.

[. . .]

TRANSIT SERVICES AND TECHNOLOGIES

I have opted for the term *transit* to describe generically the collective forms of passenger-carrying transportation services – ranging from vans and minibuses serving multiple origins and destinations (many-to-many) over nonfixed routes to modern, heavy rail trains operating point to point (one-to-one) over fixed guideways. *Transit* is the catchall used in the United States and Canada; however, almost everywhere else, *public transport* is the vernacular. And while in much of North America, *public transport* or *public transit* is associated with mass transit services provided by the public sector, almost everywhere else it means services that are available to the public at large, whether publicly or privately deployed. It is this broader, more inclusive definition of public transport that is adopted [here].

Types or classes of transit services can be defined along a continuum according to types of vehicles, passenger-carrrying capacities, and operating environments. The following sections elaborate on the forms of common-carrier transit services – i.e., those available to the general public. . . .

Paratransit

The smallest carriers often go by the name of *paratransit*, representing the spectrum of vans, jitneys, shuttles, microbuses, and minibuses that fall between the private automobile and conventional bus in terms of capacities and service features. Often owned and operated by private companies and individuals, paratransit services tend to be flexible and highly market-responsive, connecting multiple passengers to multiple destinations within a region, sometimes door-to-door and, because of multiple occupants, at a price below a taxi (but enough to more than cover full operating costs). Driven by the profit motive, paratransit entrepreneurs aggressively seek out new and expanding markets, innovating when and where necessary. Much of their success lies in their flexibility and adaptability. Unencumbered by strict operating rules, jitney drivers will sometimes make a slight detour to deliver someone hauling groceries to his or her front door in return for an extra charge. Besides being more human-scale, jitneys and minibuses can offer service advantages over bigger buses – often, they take less time to load and unload, arrive more frequently, stop less often, and are more maneuverable in busy traffic, and, studies show, passengers tend to feel more secure since each one is closer to the driver.[3]

In many parts of the developing world, jitneys and minibuses are the mainstays of the transit network. The archetypal service consists of a constellation of loosely regulated owner-operated collective-ride vehicles that follow more or less fixed routes with some deviations as custom, traffic, and hour of day permit. Jitney drivers respond to curbside hails pretty much anywhere along a route. Every paratransit system, however – whether the 2,000 *matatus* of Nairobi, the 15,000 *carros por puesto* minibuses in Caracas, or the 40,000-plus jeepneys

of Manila – differs in some way. Some load customers in the rear of vehicles and others on the side; some are governed by federations of jitney owners while others engage in daily head-to-head competition; some have comfortable padded seats and others have hard wooden benches. Manila's jeepneys (converted US army jeeps that serve up to twelve riders on semifixed routes) carry about 60 per cent of all peak-period trips in the region. They cost 16 per cent less per seat mile than standard buses and generally provide a higher quality service (e.g., greater reliability, shorter waits) at a lower fare. Jeepney operations have historically been the last to petition for fare increases.[4]

Although banned in most wealthy countries, a handful of US cities today allow private minibus and jitney operators to ply their trade as long as they meet minimum safety and insurance requirements. New York City has the largest number of privately operated van services of any American city – an estimated 3,000 to 5,000 vehicles (seating 14 to 20 passengers) operate, both legally and illegally, on semifixed routes and variable schedules to subway stops and as connectors to Manhattan. Surveys show that more than three-quarters of New York's commuter van customers are former transit riders who value having a guaranteed seat and speedy, dependable services. Miami also has a thriving paratransit sector that caters mainly to recent immigrants from Cuba and the West Indies who find jitney-vans a more familiar and congenial form of travel than buses. Today, virtually all US cities allow private shuttle vans to serve airports.

Studies consistently show that jitneys and minibuses, whether in United States or Southeast Asia, confer substantial economic and financial benefits, both to the public sector and to private operators – namely, they are more effective at coaxing motorists out of cars than conventional transit in many settings, and do so without costly public subsidies.[5] However, as passenger volumes rise above a certain threshold (usually 4,000 or more per direction per hour), the economic advantages of paratransit begin to plummet, reflecting the limitations of smaller vehicles in carrying large line-haul loads. In both the developing and developed worlds, paratransit best operates in a supporting and supplement rather than substituting, role.

Bus transit

Urban *bus transit* services come in all shapes and sizes, but in most places they are characterized by 45- to 55-passenger pneumatic-tire coaches that ply fixed routes on fixed schedules. Buses are usually diesel propelled, though in some larger metropolises (e.g., Mexico City, Toronto), electric trolley buses powered by overhead wires also operate. Because they share road space, buses tend to be cheaper and more adaptive than rail services. However, on a per passenger kilometer basis, bus transit is generally a less efficient user of energy and emits more pollution than urban rail services. It is partly because of environmental concerns, as well as image consciousness, that some cities have sought to trade in their bus routes for urban rail services.

Bus transit is particularly important in developing countries, such as India, where some 40 per cent of all urban trips are by bus. In the Third World, the private sector serves more than 75 per cent of bus trips. In Karachi, Pakistan, private enterprises operating medium-size buses handle 82 per cent of transit journeys.[6] Because they are highly vulnerable to traffic congestion, buses are notoriously slow in megacities such as Shanghai, China, where it is generally faster to pedal a bike for trips under 14 kilometers in length.[7] One remedy is to reward high-occupancy travel through preferential treatment, such as reserved bus lanes and traffic signal preemptions. Bangkok, Thailand, has opened some 200 kilometers of reserved, contra-flow bus lanes to expedite bus flows in a city where rush-hour speeds often fall below 10 kilometers per hour.

In most developed countries, bus transit falls largely under the domain of the public sector, though concerns over rising subsidies have prompted more and more public transit agencies to competitively tender services to private contractors. In much of the United Kingdom and Scandinavia, public bus services have been turned over to the private sector outright. For many small to medium-size metropolitan areas of the United States, Canada, and Europe, conventional coaches (operating over fixed routes on published schedules) are the predominant transit carriers; in larger areas, buses often function mainly as feeders into mainline rail corridors. Providing exclusive

busways can allow buses to integrate feeder and line-haul functions in a single vehicle. In . . . Ottawa and Curitiba, dedicated passageways are provided for buses, enabling rubber-tire vehicles to emulate the speed advantages of conventional steel-wheel trains on line-haul segments, yet perform as regular buses on surface streets as well. Guided busways, or O-Bahns, introduced so far in Essen, Germany; Adelaide, Australia; and two British cities, Leeds and Ipswich, are particularly suited to corridors (such as freeway medians) with restricted right-of-ways. Because of faster operating speeds, the theoretical maximum passenger throughputs of busways are as high as 20,000 persons per direction per hour, more than twice that of conventional surface-street buses.[8]

Trams and light rail transit

Rail transit systems are mass transit's equivalents to motorized expressways, providing fast, trunkline connections between central business districts, secondary activity centers, and suburban corridors. The oldest and slowest rail services – *streetcars* in the United States and *tramways* in Europe – functioned as mainline carriers in an earlier era, but as metropolitan areas grew outward, those that remained intact were relegated to the role of central city circulators. In cities such as Zurich, Munich, and Melbourne, aging tramways have been refurbished in recent times to improve vehicle comfort, safety, and maneuverability. Trams are enjoying a renaissance in a number of European cities because their slower speeds, street-scale operations, and Old World character blend nicely with a pedestrian-oriented, car-free central city.

The modern-day version of the electric streetcar, *light rail transit* (LRT), has gained popularity as a more affordable alternative to expensive heavy rail systems, particularly in medium-size metropolitan areas of under 3 million population. Compared to tram services, LRT generally operates along exclusive or semi-exclusive right-of-ways using modern, automated train controls and technologies. The LRT vehicles tend to be roomier and more comfortable than tram cars, with more head clearance and lower floors. In the United States, where the most LRT trackage has been laid since the early 1980s, costs are often saved by building along disused railroad corridors. Medium-size US cities with fairly low densities, such as Sacramento, California, have managed to build LRT for as low as US$ 10 million per route mile; in Sacramento's case, costs were slashed by sharing a freight railroad right-of-way, building no-frills side-platform stations, and relying predominantly on single-track services. Light rail transit is generally considered safer than heavy rail because electricity comes from an overhead wire instead of a middle third rail. There is thus no need to fence in the track, not only saving costs but also allowing LRT cars to mix with traffic on city streets.

Today there are more than 100 tramways and LRT systems worldwide (mostly in Europe and North America), with the number continually rising. Among the factors behind the growing popularity of LRT and refurbished tramways are their lower costs relative to heavy rail investments and their ability to adapt to the streetscapes of built-up areas without much disruption. Other advantages include: they operate relatively quietly, thus are fairly environmentally benign and unobtrusive; they are electrically propelled, thus are less dependent than buses on the availability of petrochemical fuels; and they can be developed incrementally, a few miles at a time, eliminating the need for the long lead times associated with heavy rail construction.

. . . With four-car trains running as closely as three minutes apart, LRT can carry some 11,000 passengers per direction per hour; cutting the headways to ninety seconds (as found in some German cities, including Karlsruhe), maximum capacity can be doubled to more than 20,000. Advanced light rail transit (ALRT) systems – such as the skytrains in Vancouver, Toronto, and London's Docklands propelled by linear induction motors – can accommodate more than 25,000 passengers per direction per hour because of their higher engineering and design standards (though automated train control in lieu of on-board drivers constrains carrying capacities). It is for this reason they are also called intermediate capacity transit systems (ICTS).

Heavy rail and metros

In the world's largest cities, the big-volume transit carriers are the *heavy rail* systems, also called *rapid rail transit*, and known as *metros* in Europe,

Asia, and Latin America. Metros . . . work best in large, dense cities. Indeed, the relationship is symbiotic. The densities found on Hong Kong's Victoria Island and New York's Manhattan Island could not be sustained without heavy rail services. And heavy rail service could not be sustained without very high densities. Presently, more than 90 per cent of all peak-period trips to and from central London are by transit, mainly via the underground "tube"; for the remainder of greater London, transit serves fewer than a quarter of all peak-hour trips.[9]

Today, worldwide, there are some 80 metro systems, including 27 in Europe, 17 in Asia, 17 in the former Soviet Union, 12 in North America, seven in Latin America, and one in Africa. Some metros have been enormously successful, including Moscow's and Tokyo's, each of which carries 2.6 billion to 2.8 billion customers a year, more than twice as many as London's or Paris's metro systems, both of which are double the size of Moscow's and Tokyo's. On a riders per track kilometer basis, the world's most intensively used metros are, in order, São Paulo, Moscow, Tokyo, St Petersburg, Osaka, Hong Kong, and Mexico City. Most Western European, Canadian, and US metros have one-third to one-quarter the passenger throughput per track kilometer of these cities, in large part because more of their residents own cars and the cost of driving is relatively low.

In contrast to light rail systems, few new metros are being built today, partly for fiscal reasons and partly because most areas that can economically justify the costly outlays already have them. Except for Southern California, no new heavy rail lines or extensions are being planned, designed, or constructed in North America. The World Bank lending for metro systems ceased completely in 1980 and has resumed again only recently. The Bank generally frowns on funding rail projects, even in megacities paralyzed by traffic congestion, viewing them as cost-ineffective means of achieving the Bank's principal missions of alleviating poverty and stimulating economic growth.[10]

The niche market of heavy rail services is high-volume, mainline corridors. Accommodating more than 50,000 passengers per hour in each direction, heavy rail services provide high-speed, high-performance connections within built-up cities as well as between outlying areas and central business districts. In city cores, heavy rail systems almost always operate below ground, thus the names undergrounds (in Great Britain and its former colonies) and subways. To justify the high costs for right-of-way acquisitions, relocations, and excavation, undergrounds require very high traffic volumes (toward the upper end of the capacity threshold). Outside the core, metro lines are normally either above ground (called elevated or aerial alignments) or at-grade within expressway medians. Most heavy rail stations are far more substantial and sited farther apart than LRT stops, usually two or more kilometers from each other, except in downtowns, where they might be three or four blocks away. Because heavy rail systems are often the most expansive metropolitan rail services and operate at the highest speeds, their impacts on accessibility, and accordingly on urban development, tend to be the greatest.[11]

Heavy rail systems are almost universally electrically propelled, usually from a third rail, and each car has its own motor. Since contact with the high-voltage third rail can be fatal, rapid rail stations usually have high platforms and at-grade tracks are fenced.

Commuter and suburban railways

In terms of operating speed and geographic reach, *commuter rail* or *suburban rail*, stands at the top of the rail transit hierarchy. In Germany and central Europe, where suburb-to-city rail links are widespread, these services go by the name *S-Bahn*. Today, commuter rail services can be found on five continents in over 100 cities in more than 100 countries. Japan dominates the world's commuter rail market. In 1994, Tokyo carried almost six times the number of suburban rail commuters as Bombay, the largest commuter rail market outside Japan. Metropolitan New York's suburban rail is today only 2 per cent of Tokyo's. Nevertheless, metropolitan New York, along with a dozen or so other North American metropolises, is in the midst of a commuter rail renaissance. More commuter rail tracks are currently being planned, designed, and constructed in the United States and Canada than any form of rail transit. In all, twenty-one US and Canadian cities either have commuter rail services or hope to have them

within the next decade. This would raise the total US and Canadian commuter rail trackage to some 8,000 kilometers, more than five times as long as LRT and seven times as long as heavy rail.

Commuter rail services typically link outlying towns and suburban communities to the edge of a region's central business district. They are most common in big metropolitan areas or along highly urbanized corridors and conurbations, such as the Richmond–Boston axis in the northeastern United States. Commuter rail is characterized by heavy equipment (e.g., locomotives that pull passenger coaches), widely spaced stations (e.g., 5 to 10 kilometers apart), and high maximum speeds that compete with cars on suburban freeways (although trains are slow in acceleration and deceleration). Services tend to be of a high quality, with every passenger getting a comfortable seat and ample leg room. Routes are typically 40 to 80 kilometers long and lead to a stub-end downtown terminal. Outlying depots are normally surrounded by surface parking lots that enable suburbanites and exurbanites to access stations conveniently by car. With the exception of the greater New York area (along the MetroNorth corridor to Connecticut), relatively little land-use concentration or redevelopment can be found around US commuter rail stations – after all, the very premise of commuter rail is to serve the low-density lifestyle preferences of well-off suburban professionals who work downtown. Serving commuter trips almost exclusively also means that ridership is highly concentrated in peak hours, more so than any other form of mass transit service.

NOTES

1 Urban Mobility Corporation. 1997. The 1995 Nationwide Personal Transportation Survey, *Innovation Briefs*, 8(7), p. 1; Pisarski, A. 1992. *Travel Behavior Issues in the 90's*. Washington, DC: Federal Highway Administration, US Department of Transportation.

2 Pucher J. and Lefèvre, C. 1996. *The Urban Transport Crisis in Europe and North America*. Basingstoke, UK: Macmillan Press.

3 Cervero, R. 1997. *Paratransit in America: Redefining Mass Transportation*. Westport, CT: Praeger.

4 Roth, G. and Wynne, G. 1982. *Learning from Abroad: Free Enterprise Urban Transportation*. New Brunswick, NJ: Transaction Books.

5 Roth and Wynne, op. cit.; Walters, A. 1979. The Benefits of Minibuses, *Journal of Transport Economics and Policy*, 13, pp. 320–334; Takyi, I. 1990. An Evaluation of Jitney Systems in Developing Countries, *Transportation Planning and Technology*, 44(1), pp. 163–177.

6 Armstrong-Wright, A. 1993. *Public Transport in Third World Cities*. London: HMSO Publications.

7 Shen, Q. 1997. Urban Transportation in Shanghai, China: Problems and Planning Implications, *International Journal of Urban and Regional Research*, 21(4), pp. 589–606.

8 Under ideal conditions (e.g., very light traffic, flat terrain, straight lanes, no interruptions to flow such as traffic signals), buses operating on a conventional highway can move as many as 9,000 passengers per lane per direction. Sources: Trolley, R. and Turton, B. 1995. *Transport Systems and Policy Planning: A Geographical Approach*. Harlow, Essex: Longman Scientific & Technical; Vuchic, V. 1992. Urban Passenger Transportation Modes, in G. Gray and L. Hoel (eds), *Public Transportation in the United States*. Englewood Cliffs, NJ: Prentice-Hall, pp. 79–113.

9 Dasgupta, P. and Bly, P. 1995. *Managing Urban Travel Demand: Perspectives on Sustainability*. London: Department of Transportation.

10 The International Institute for Energy Conservation. 1996. *The World Bank & Transportation*. Washington, DC: The International Institute for Energy Conservation; Gutman, J. and Scurfield, R. 1990. Towards a More Realistic Assessment of Urban Mass Transit, in *Rail Mass Transit for Developing Countries*, Institute of Civil Engineers, London: Thomas Telford, pp. 327–338.

11 Knight, R. and Trygg, L. 1977. Evidence of Land Use Impacts of Rapid Transit Systems, *Transportation*, 6(3), pp. 231–247; Cervero, R. 1984. Light Rail Transit and Urban Development, *Journal of the American Planning Association*, 50(2), pp. 133–147; and Huang, H. 1996. The Land-Use Impacts of Urban Rail Transit Systems, *Journal of Planning Literature*, 11(1), pp. 17–30.

"Traffic Calming"

from *Sustainability and Cities: Overcoming Automobile Dependence* (1999)

Peter Newman and Jeffrey Kenworthy

Editors' Introduction

Australian researchers Peter Newman and Jeffrey Kenworthy touched off an international debate in 1989 with their analysis of the relation between urban density and petroleum consumption in their book *Cities and Automobile Dependence* (Brookfield, VT: Gower Technical, 1989). This work showed both the enormous range of urban densities worldwide and the very strong correlation between higher densities and decreased resource use. In their later book *Sustainability and Cities* (Washington, DC: Island Press, 1999), they place transportation squarely at the center of the urban sustainability challenge, and outline various strategies for moving away from automobile dependence. Newman and Kenworthy argue that five key policies are needed to overcome automobile dependence:

1 Traffic calming "to slow auto traffic and create more urban humane environments better suited to other transportation modes,"
2 Improved transit, bicycling, and walking "to provide genuine options to the car,"
3 Improved land use, especially "urban villages" that can "create multinodal centers with mixed, dense land use that reduce the need to travel,"
4 Growth management "to prevent sprawl and redirect development into urban villages," and
5 Economic incentives, such as "taxing transportation better."

In this selection Newman and Kenworthy discuss approaches to calming traffic, and provide historical background on the global traffic-calming movement that began in Europe in the 1970s. This effort to reclaim automobile-dominated streets for human use is now worldwide and goes far beyond simply improving public safety. It may be seen as part of an effort to humanize public space and reclaim cities for people instead of cars. Other authors have made this point as well, such as Engwicht in his books *Reclaiming our Cities and Towns: Better Living with Less Traffic* (Gabriola Island, BC: New Society Press, 1993) and *Street Reclaiming: Creating Livable Streets and Vibrant Communities* (Gabriola Island, BC: New Society Press, 1999), Donald Appleyard in *Livable Streets* (Berkeley: University of California Press, 1981), and Bernard Rudofsky in his classic *Streets for People: A Primer for Americans* (New York: Doubleday, 1969).

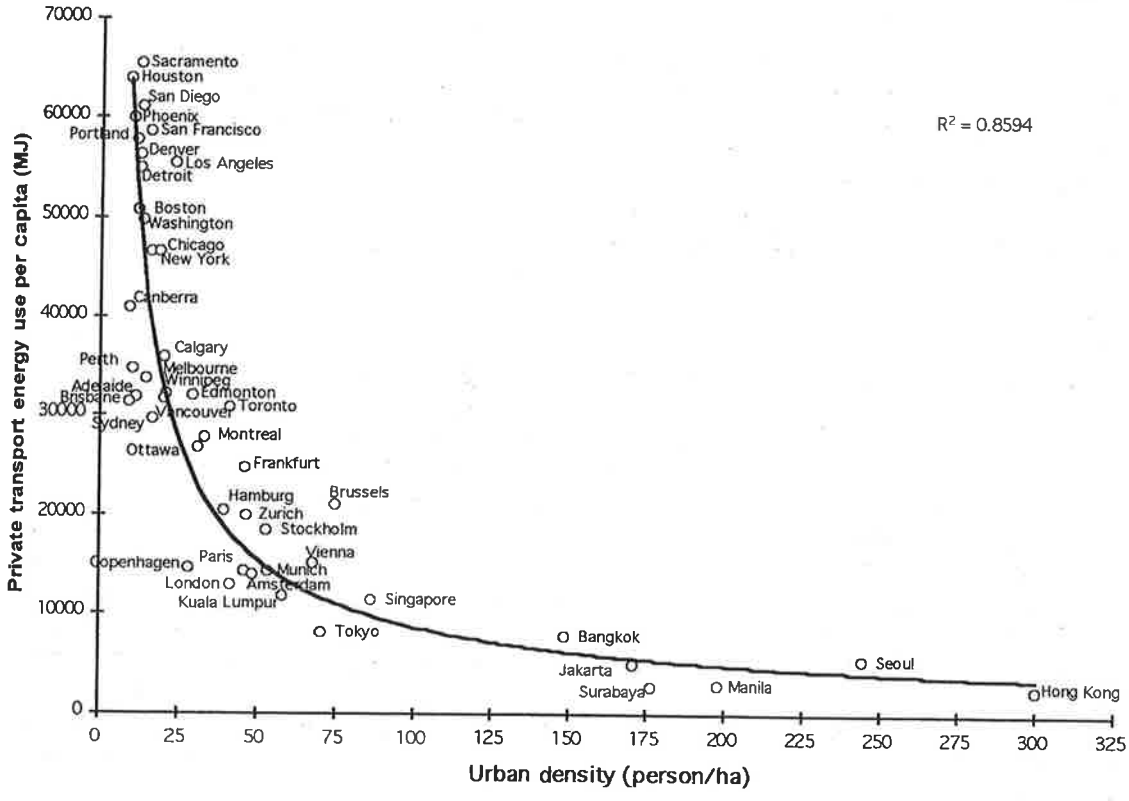

Figure 1. In a previous book, Newman and Kenworthy developed this classic diagram showing the relation between urban density and energy consumption for transportation.

Traffic calming (from the German *Verkehrsberuhigung*) is the process of slowing down traffic so that the street environment is safer and more conducive to pedestrians, cyclists, shoppers, and residential life. Traffic calming is best done by physically altering the street environment through different road textures; changing the geometry of the road through chicanes (also known as S-shaped diverters), neck-downs (also known as chokers), speed plateaus and bumps, and other traffic engineering devices; introducing new street furniture designed to create a more human, safe environment; and planting attractive landscaping.

Together, these changes make drivers slow down by causing them to see less open black-top and to perceive the road as a space that is to be shared with pedestrians, cyclists, and transit vehicles. Through the avenues of trees and street gardens that accompany good traffic-calming schemes, urban wildlife habitats and corridors through cities can be created and soft surfaces can be increased so there is less stormwater pollution. Traffic calming has the potential not only to lessen the direct negative impacts of road traffic but to foster urban environments that are more human and interactive, more beautiful, and more economically successful due to the greater social vitality possible in a city's public spaces.

It is not known exactly where or when the concept of traffic calming originated, but the German term is believed to have first been used in German federal government reports in the early 1970s. The late John Roberts of Transport and Environment Studies[1] in London was the first to translate the word into English and to bring the concept to the attention of transportation planners in other parts of the world. The idea of traffic calming, however, has its roots in earlier movements to protect city environments from the worst excesses of the automobile. This reached a watershed in the early 1960s with the publication of the major report entitled "Traffic in Towns," by Colin Buchanan.[2] Although the British approach was to create more calmed city centers and protected

residential precincts, the Buchanan report was used mostly to build large ring roads and bypasses that helped create automobile dependence. The report was used to justify major road proposals in Australian and North American cities as well. However, the European approach is based more on the organic integrity of the urban street and this approach is now gaining currency in the United Kingdom.[3]

Traffic calming emerged in Europe in the late 1960s from a number of sources: the Dutch *woonerf* or "living yard," created streets that had one shared surface with much planting to slow speeding traffic through inner-city streets and the original pedestrianization schemes in cities such as central Copenhagen.[4] Traffic calming gained rapid growth and acceptance in Europe in the 1980s through the successful action of many environmental groups trying to curtail the impacts of the automobile on European cities.[5]

Traffic calming's major objectives are to:

- Reduce the severity and number of accidents in urban areas;
- Reduce local air and noise pollution and vehicle fuel consumption;
- Improve the urban street environment for non-car-users;
- Reduce the car's dominance on roads by reclaiming road space for living space;
- Reduce the barrier effects of motor traffic on pedestrian and cycle movement; and
- Enhance local economic activity by creating a better environment for people.

With these broad objectives, traffic calming can also be of benefit to urban regeneration, housing renovation schemes, and city beautification programs (e.g., Freiburg, in southern Germany). These assist more deeply in reducing automobile dependence by bringing urban activity back to areas of the city that are inherently less dependent on the automobile (i.e., denser central and inner areas of cities built more around transit and nonmotorized modes). Traffic calming in Germany was in fact pioneered and promoted much more aggressively by the housing and urban development ministries than by the transportation ministry. This was primarily because of the positive impact traffic calming can have on the character and environmental quality of neighborhoods, making them much more desirable urban redevelopment and residential areas, while a significant number of transportation planners viewed traffic calming changes with suspicion.[6]

TECHNIQUES OF TRAFFIC CALMING AND THEIR IMPLEMENTATION

Traffic calming was originally restricted mainly to improving residential streets, and this is still a major focus. Traffic calming seeks to alter road layout and design without actually totally rebuilding a street system. It does this through a whole suite of possible techniques such as narrowed entries to streets, plantings of trees with strong vertical elements, variable street surfaces, speed restricting devices, and visual barriers that encourages cautious driving. . . . However, it has been recognized that to be really effective and to not just shift traffic problems from one area to another, traffic calming must be applied more on an area-wide basis,[7] which means involving arterial or main roads.

There are now many examples of traffic calming on through roads and in other busy areas throughout Europe (e.g., Frankfurt, Hamburg, Nürnberg, Berlin, and Copenhagen). Denmark has a nationwide program of traffic calming on main roads called Environmentally Adapted Through Roads.[8]

The approach to traffic calming has to be somewhat different on main roads because of the volumes of traffic involved, although there is overlap in the basic techniques used. In busier areas where there is a need to better balance the needs of motor vehicles with the needs of pedestrians and cyclists, the main goal is to be able to reclaim road space for other uses by reducing the speed of traffic and its impact. In most cases roads are simply reduced from six to four traffic lanes, or from four to two lanes, through critical areas of a city. . . .

In some cases the reductions in road space are accompanied by significant improvements to transit such as new rail links (e.g., Nürnberg), and in others no major changes are made but incremental improvements are implemented. Road capacity is not necessarily reduced because the loss

of lanes is offset by slower speeds that reduce vehicle headways and enable more vehicles to pass. Similarly, parking supply is not necessarily reduced and in some cases may be increased nominally. Often, parallel parking on two sides of a road is converted to angle parking on alternate sides separated by landscaped strips.

The implementation of traffic calming, however, is not just a technical process but a wide-ranging community process whereby local residents can have a strong input into identifying the problems and helping to find the solutions. It has been repeatedly shown that consultation with and involvement of the community are essential to the widespread acceptance of traffic-calming schemes. In fact, an important aspect of traffic calming is the way it has been able to provide a focal point for mobilizing and galvanizing many communities around the world into developing and fighting for a vision of a more sustainable and socially acceptable solution to the problem of traffic in urban environments.[9]

EFFECTS OF TRAFFIC-CALMING SCHEMES

Many of the major traffic-calming schemes in Europe have been formally sponsored by national and local governments as demonstration projects, and one of the aims has been to test the effects of the traffic-calming schemes on key environmental indicators and safety factors. Much of the available evidence about the effects of traffic-calming schemes comes from before-and-after studies of these projects.

The following is a brief summary of the general effects of traffic-calming schemes, along with some specific examples:

Reduced accidents. Accidents, particularly the severity of accidents, are generally significantly reduced with traffic calming because speed is the most critical factor in road accidents – particularly regarding the risk of serious injury and the danger to pedestrians and cyclists. In Berlin, for example, an area-wide scheme resulted in the reductions shown in Table 1.

Most other schemes report similar kinds of data, such as in Heidelberg, which experienced average accident reductions of 31 per cent and a 44 per cent reduction for casualties after thirty-kilometer-per-hour [eighteen-mile-per-hour] residential speed limits were introduced along with selected physical traffic-calming measures.[10] Area-wide schemes in The Netherlands have reduced accidents involving injury by 50 per cent in residential areas and 20 per cent overall (measured per million vehicle kilometers) and no increase in accidents has occurred in surrounding areas.[11]

Type of traffic	Accident measure	Percent reduction
All traffic	Fatal accidents	−57
	Serious accidents	−45
	Slight accidents	−40
	Accident costs	−16
Nonmotorized	Pedestrians	−43
	Cyclists	−16
	Children	−66

Table 1 Accident reductions in Berlin Moabit (neighborhood) using comparable before and after periods

Source: Reported in Pharoah, T. and Russell, J. 1989. *Traffic Calming: Policy Evaluation in Three European Countries.* Occasional Paper 2/89, Department of Planning, Housing and Development. London: South Bank Polytechnic.

The Center for Livable Communities, in their Livable Places Update for March 1998, summarized some of the best US examples of traffic calming, and in relation to accidents, found the following:

- The City of Seattle, where traffic-calming projects have been carried out for 20 years, surveyed the results of 119 completed projects and found an overwhelming 94 per cent reduction in accidents.
- In Portland, Oregon, 70 traffic circles and 300 speed bumps have been introduced and the number of reported accidents decreased by 50 per cent.
- A 1997 study of US street typology and accidents by Swift and Associates showed that as street width increases, accidents per mile per year increase exponentially. The safest residential street (curb to curb) turned out to be 24 feet (7.2 meters). Present US street regulations require

36 feet, primarily for access by fire vehicles, though the study found that fire vehicles can access 24-foot-wide roads when required. New Urbanism design guidelines are for 24-foot roads.

Noise reduced. Traffic calming generally results in a reduction in vehicle noise. Pharoah and Russell report that noise changes result from five factors: changes in traffic volume and composition, changes in carriageway layout, changes in carriageway surface, changes in vehicle speed, and changes in driving style.[12]

Air pollution benefits. Research in central Europe shows that in built-up areas, the higher the vehicle speed the more will be the proportion of acceleration, deceleration, and braking, and this increases air pollution. By contrast, traffic-calming schemes in some German residential areas have shown that idle times are reduced by 15 per cent, gear changing by 12 per cent, brake use by 14 per cent, and fuel use by 12 per cent.[13]

Evidence of the air pollution benefits of a slower, calmer style of driving comes from detailed work in Buxtehude, a German demonstration project (population 33,000). Table 2 shows the changes in the different types of emissions with a reduction of speed from 50 kilometers per hour (30 miles per hour) to 30 kilometers per hour (18 miles per hour) under two types of driving. In both aggressive and calm driving, emissions are reduced at the 30 kilometers per hour level, though the calm driving has a generally greater reduction and fuel use is lower.

	Driving style	
	Second gear, aggressive (%)	Third gear, calm (%)
Carbon monoxide	−17	−13
Hydrocarbons	−10	−22
Nitrogen oxides	−32	−48
Fuel consumption	+7	−7

Table 2 Changes in vehicle emissions and fuel use from 50 km/h to 30 km/h

Source: Reported in Pharoah, T. and Russell, J. 1989, op. cit.

It is also worth noting that even in instances when individual vehicles may experience an increase in fuel use and emissions (e.g., drivers do indulge in more acceleration, braking, and greater use of second gear), this may not result in an overall increase in local pollution and fuel use if the traffic-calming scheme has also resulted in lower traffic volumes.

Enhanced pedestrian and street activity. Traffic calming seeks to make the public environment safer and more attractive, so it is to be expected that traffic calming will result in a greater level of pedestrian and cycling activity in the area affected. In general, it can be expected that the results will be more noticeable in busier areas with a mix of land uses and the potential for people to make good use of reclaimed areas, such as for outdoor cafes and markets, children's facilities, etc.

Some formal measurements of the benefits are available from a summary of European experience by Pharoah and Russell (1989), such as in Berlin's federal demonstration project, where nonmotorized traffic on a wide range of streets in the scheme increased by between 27 per cent and 114 per cent; in Vinderup, a village in Denmark, where the main through route was traffic-calmed and outdoor activities increased by up to 47 per cent; and in Copenhagen, where traffic calming has led to immediate increases of pedestrian activity of between 20 per cent to 40 per cent, and in the long term, where central area activity is now 80 per cent pedestrian and 14 per cent by bike.[14] Where traffic calming reduces road capacity there is an overall decrease in traffic[15] and therefore better conditions are created for pedestrians.

Traffic calming also tends to increase the area used by pedestrians and cyclists and the extent to which streets are crossed by these users, since the severance effects of traffic are reduced. Pedestrians and cyclists tend not to confine themselves purely to walkways, but rather they extend their territory to the roadway in some instances.

Reduced crime rates. Appleyard (1981) showed that visiting among neighbors decreases when traffic increases,[16] and when neighboring ceases and people stop watching out for one another, then criminal activity can occur. The *Livable Places Update* (March 1998) overview on traffic calming quotes a Harvard University study that showed violent crimes in communities where residents willingly

worked together were as much as 40 per cent lower than in neighborhoods where such relationships were not as strong. Race and income were not factors in people's willingness to take part in such community activity. An example of a place where crime rates diminished after traffic calming is Weinland Park in Columbus, Ohio.

Positive economic implications. As pointed out in the objectives of traffic calming, economic revitalization of an area is an explicit aim in some schemes. A study by TEST (1989) attempted to confirm the hypothesis that "A good physical environment is a good economic environment" and examined ten European cities in detail. Roberts sums up the work by saying, "the message is simple: there is a strong likelihood that traffic restraint in all its forms, and environmental improvement, and a healthy economy, are causally related."[17]

The basis of this finding would appear to involve at least the following factors:

- People like to come to humanly attractive, green cities.
- Businesses like to locate in areas with a high quality urban environment.
- Car access is not banned, but it is not facilitated to the point of dominating everything else.
- Other modes are generally facilitated.

Hass-Klau (1993) shows conclusively that pedestrianization and traffic calming both have positive effects on the economic performance of an area; the more aggressive is the traffic calming, the more pronounced is the positive economic effect.[18]

In the United States, a West Palm Beach, Florida, neighborhood was economically depressed and bisected by fast-moving traffic. A traffic-calming scheme slowed the traffic through road narrowing and construction of speed bumps, traffic circles, and pedestrian islands. Then the city raised intersections, made sidewalks level with the street, and added a fountain, benches, and an amphitheater for "block parties." The development spurred new private investment and the cost of commercial space rapidly moved from five dollars per square foot to twenty-five dollars per square foot.[19] Similar case studies are given in the UK Friends of the Earth publication.[20]

TRAFFIC CALMING: A BROADER APPROACH

Traffic calming can be viewed as a broader transportation planning philosophy and not merely as a series of physical changes to roads.[21] Traffic calming in this broader sense is aimed at reducing total dependence on the automobile and promoting a more self-sufficient community with a transportation system more oriented to pedestrian, cycle, and transit use.

These broader objectives can be summarized as follows:

- A reduction of average motor vehicle speeds to discourage long-distance road travel in urban areas and promotion of a more compact urban form; traffic calming of main roads is included in this approach.
- Specific land use policies that better integrate transit and land development; the policies are directed at reducing the number, length, and need for motor vehicle trips.
- Strong promotion of walking, cycling, and transit.
- Restrictive measures against private traffic, including parking restrictions, limited major road building, and the direction of funds into transit and nonmotorized modes, as well as taxation policies on fuels and cars, including policies on company cars and road pricing.
- A shift in transportation planning philosophy from a traffic-generation approach of seeking to predict future traffic levels and the roads and parking needed to cope with them, to a traffic-dissolving approach of setting limits on motor vehicle growth and ensuring that transportation/land use policies and practices are aimed at minimizing the need for more motor vehicle facilities.

A good example of a broader traffic-calming policy in action is the Dutch national policy from 1982 that openly promotes transit, walking, and cycling. It states that:

> Henceforth other functions will be given priority over motor traffic [and] the car's dominance should be diminished by deliberately increasing travel times, by creating a less dense network of main roads, and by reducing speeds.[22]

NOTES

1 See Transport and Environment Studies (TEST). 1989. *Quality Streets – How Traditional Urban Centers Benefit from Traffic Calming.* London: TEST.

2 Minister of Transport. 1963. *Traffic in Towns.* London: HMSO.

3 Standing Advisory Committee on Trunk Road Assessment (SACTRA). 1994. *Trunk Roads and the Generation of Traffic.* London: Department of Transport, United Kingdom; Department of Environment. 1994. *Planning Policy Guidance 13: Transport.* Whitehall, London: Department of Environment and Department of Transport.

4 Gehl, J. and Gemzøe, L. 1996. *Public Spaces, Public Life.* City of Copenhagen.

5 More detail on the evolution of traffic calming may be found in Hass-Klau, C. 1990. *The Theory and Practice of Traffic Calming: Can Britain Learn from the German Experience?* Discussion Paper 10, Rees Jeffreys Road Fund. Oxford: Transportation Studies Unit, Oxford University; Tolley, R. 1990. *Calming Traffic in Residential Areas.* Wales, UK: Brefi Press; Newman, P. and Kenworthy, J. 1991. *Towards a More Sustainable Canberra: An Assessment of Canberra's Transport, Energy and Land Use.* Institute for Science and Technology Policy, Murdoch University.

6 Hass-Klau. *The Theory and Practice of Traffic Calming.*

7 Hass-Klau, C. 1990. *The Pedestrian and City Traffic.* London: Belhaven Press.

8 Danish Road Data Laboratory. 1987. *Consequence Evaluation of Environmentally Adapted Through Road in Vinderup.* Report 52, Danish Road Data Laboratory, Danish Roads Directorate, Herlev, Copenhagen; *Consequence Evaluation of Environmentally Adapted Through Road in Skærbæk.* Report 63, Danish Road Data Laboratory, Danish Roads Directorate, Herlev, Copenhagen.

9 E.g. Tolley. 1990. *Calming Traffic in Residential Areas.*

10 Hass-Klau, C. 1990. *An Illustrated Guide to Traffic Calming: The Future Way of Managing Traffic.* London: Friends of the Earth.

11 Hass-Klau, C. (ed.) 1986. New Ways of Managing Traffic. *Built Environment,* 12 (1 and 2).

12 Pharoah, T. and Russell, J. 1989. *Traffic Calming: Policy Evaluation in Three European Countries.* Occasional Paper 2/89, Department of Planning, Housing and Development. London: South Bank Polytechnic.

13 Hass-Klau. 1990. *The Theory and Practice of Traffic Calming.*

14 Gehl and Gemzøe. 1996. *Public Spaces, Public Life.*

15 Goodwin, P.B. 1997. Solving Congestion. Inaugural Lecture for the Professorship of Transport Policy, University College, London, 23 October.

16 Appleyard, D. 1981. *Livable Streets.* Berkeley: University of California Press.

17 Roberts, J. 1988. Where's Downtown? 'It Went Three Years Ago.' *Town and Country Planning,* May, pp. 139–141.

18 Hass-Klau, C. 1993. Impact of Pedestrianization and Traffic Calming on Retailing: A Review of the Evidence from Germany and the UK. *Transportation Policy,* 1 (1), pp. 21–31.

19 Center for Livable Communities. 1998. Benefits of Traffic Calming Realized Across the Country. *Livable Places Update.* March.

20 Friends of the Earth. 1997. *Less Traffic, More Jobs: Direct Employment Impacts of Developing a Sustainable Transport System in the United Kingdom.* London: Friends of the Earth.

21 Hass-Klau. 1990. *The Theory and Practice of Traffic Calming.*

22 Ministry of Transport and Public Works. 1982. *From Local Traffic to Pleasurable Living.* The Hague: Ministry of Transport and Public Works, The Netherlands.

"Bicycling Renaissance in North America?"

from *Transportation Research A* (1999)

John Pucher, Charles Komanoff, and Paul Shimek

Editors' Introduction

Despite attempts to develop new devices such as the Segway scooter as an alternative to the automobile, the tried-and-true solution for short-distance personal mobility in many parts of the world has been the bicycle. Simple, cheap, pollution-free, and easy to maintain, the bike has been used widely in nations ranging from China to Cuba. At rush hour waves of cyclists pass down the streets of European cities such as Copenhagen or Amsterdam, as well as those of countless cities in the developing world. Many nations have also sought to promote cycling as a convenient way for public transit patrons to reach transit stations.

While both bicycling and walking seem ideal transportation modes for a sustainable city, a key question is how these can be encouraged within low-density, automobile-dependent communities such as in North America and Australia. While there are signs that cycling is on the increase, much bicycle use in these places is for recreation. What would it take for the bicycle to become a more all-round transportation alternative? In this selection leading transportation researchers John Pucher, Charles Komanoff, and Paul Shimek explore this question. Pucher is a professor in the Department of Urban Planning at Rutgers University in New Jersey, where he has written widely on transportation topics. Komanoff is president of Komanoff Energy Associates in New York City, and a leading consultant on issues of energy use, transportation pricing, and alternative transportation modes. Shimek is a researcher at the Volpe National Transportation Systems Center in Cambridge, Massachusetts.

Other useful materials on bicycle use include an article by Pucher and Lewis Dijkstra, "Making Walking and Cycling Safer: Lessons from Europe," published in *Transportation Quarterly*, 54(3), 2000; *Pedestrian and Bicycle Planning: A Guide to Best Practices*, by Todd Litman *et al.*, available from the Victoria Transportation Policy Institute at www.vtpi.org; and material from the Association of Pedestrian and Bicycle Professionals at www.apbp.org.

Several northern European countries have been enjoying a bicycling boom. Over the past two decades, cycling has increased significantly in Denmark, Germany, Switzerland, and The Netherlands.[1] The number of bicycle trips has grown substantially in these countries, and in many cities cycling's share of travel has risen as well. In Germany, for example, bicycling's modal share for urban trips rose by half between 1972 and 1995, from 8 per cent to 12 per cent.[2] Currently, the bicycle's share of local trips is 30 per cent in The Netherlands, 20 per cent in Denmark, 12 per cent in Germany, and 10 per cent in Switzerland – over ten times higher than in the United States.[3]

All these European countries have very high standards of living, and all have experienced rising incomes, growing auto ownership, and rapid suburbanization. Yet bicycling is thriving in this environment, primarily due to long-term commitments to enhance the safety, speed, and convenience of bicycling while making driving more difficult and expensive. These policies were adopted by democratic political systems, partly to mitigate the social and environmental harm of excessive auto use in cities, but also to accommodate rising demands for mobility within the physical constraints of congested urban roads, high-density cities, and limited land supply for parking.

Many groups have been advocating increased bicycling in the United States, not just for recreation but also for commuting and other utilitarian purposes. The League of American Bicyclists, the Bicycle Federation of America, and bicycling groups in virtually every state and many cities coordinate bicycling events, offer training courses, and lobby for cycling facilities and cycling-friendly roads and traffic policies. Many environmental organizations, community activists, and urban planners support cycling because it is an energy-efficient and non-polluting transport mode, and some transport planners view space-efficient cycling as a way to reduce roadway congestion. Aside from the cost of travel time, cycling is also cheaper than any mode except walking and thus affordable to even the poor. Moreover, the public costs of bicycling are modest, especially compared to motorized transport. Finally, fitness experts and health professionals advocate cycling for its cardiovascular benefits.

In recognition of the benefits of bicycling, and in response to strong public pressure, public policies in the United States have become more supportive of bicycling, especially since passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991. The successor to ISTEA, the 1998 Transportation Equity Act for the Twenty-first Century (TEA21), continues this trend. . . . [T]he decade of the 1990s has witnessed a dramatic increase in funding of bicycling facilities in the US, with the focus so far on investments in new bike paths. Most states and many cities now have programs to facilitate bicycling, including bicycle coordinators in state departments of transportation. Traffic policies and roadway design in some locales are gradually becoming more conducive to bicycling. Unfortunately, little has been done to educate motorists about cyclists' rights and to enforce traffic laws that allow cycling on most streets and roadways. . . .

[. . .]

Do the growing interest in bicycling and the accompanying policy shifts suggest that America may be poised for a bicycling renaissance? Some bicycling advocates and trade publications already claim a massive boom in bicycling in the United States in recent years.[4] While cycling has certainly increased, sightings of a boom are open to question. This article uses a variety of sources to assess the actual extent of growth in cycling in the United States over the past two decades. . . . On the basis of our seven North American cities, and using information from European experience, we conclude by assessing the effectiveness of alternative policies to promote cycling. . . .

[. . .]

FACTORS AFFECTING CYCLING IN NORTH AMERICA

Cycling has increased in North America over the past two decades, both in the aggregate and for seven case study cities. While the increases are encouraging, the share of total trips by bike in the US still stands at only about 1 per cent, far lower than in most European countries[5]. . . .

Although climate and topography affect cycling levels, the case studies show that they do not explain differences in cycling rates among North American cities. A more important deterrent is the low-density sprawl of most American metropolitan areas, which increases average travel distances and renders utilitarian cycling less feasible. This factor alone may explain the higher cycling levels in Canadian cities, which are more than twice as dense as American cities.[6] European cities are denser still, leading to average trip lengths only about half those in the US.[7]

Nevertheless, even in the United States, a considerable percentage of urban trips are within cycling distance. According to the NPTS, 28 per cent of trips by all modes are one mile or shorter, and another 20 per cent are one to three miles. Of course, some of those short trips are links of

longer trip chains that are less readily bikeable. Nevertheless, the high percentage of short trips suggests great potential for increased bicycling, even in the low-density, sprawled cities of the US.

Why, then, does bicycling in the United States remain at low levels? Here we summarize eight key factors.

Public attitude and cultural differences

Is bicycling for transportation considered a normal thing to do? In The Netherlands and Denmark, it is usual for young and old, rich and poor, and students and executives alike to bicycle for many different purposes. In the United States, most cycling is for recreation, and most cycle commuters are men. Even though a majority of Americans own a bicycle, cycling is considered a "fringe mode" in the US,[8] befitting its 0.9 per cent share of total trips. Utilitarian cycling is even less mainstream, with the bicycle used for only 0.3 per cent of all work trips in 1995, according to the NPTS.

Culture, custom, and habit are important. While the other factors listed below help explain which forms of travel behavior become widespread and thus considered "normal," countries with unbroken traditions of utilitarian cycling have an easier time maintaining that tradition. Where cycling is viewed as normal, people consider doing it when it is convenient, and they have access to the necessary equipment and knowledge. Similarly, motorists exhibit more respect toward cyclists, partly because they are more likely to cycle themselves or know others who do. In general, where there are few bicyclists, cycling is considered abnormal, and this climate tends to be self-perpetuating.

Public image

There is no single image of bicycling in America, but a multiplicity of perceptions dependent upon the type of cycling and the context in which it is viewed. Recreational cycling has a youthful, vigorous image since it is associated with sport and fitness; some car ads even feature recreational cyclists. Bicycling as a whole also has a positive environmental image, thanks to zero air pollution, negligible noise, and minimal energy use. In cities, where the vast majority of utilitarian cycling takes place, cyclists suffer from a renegade image associated with disobedience of traffic laws, and a pervasive sense of cyclists as an alien presence on roads intended for cars. Indeed, the various images of cycling are so heavily determined in relation to automobiles that utilitarian cyclists are variously seen as too poor to own a car, "anti-auto," eccentric, or deviant. The perceptions of cycling as lying outside the mainstream of American life discourage bicycle use.

City size and density

Small, compact cities are more amenable to cycling since more destinations are accessible within a short bike ride, motor traffic volumes are lower, and there are less likely to be obstacles such as expressways and bridges. Indeed, to our knowledge, no very large city (1 million or larger) in either Europe or North America has bike use exceeding 10 per cent of trips. Europe has many more small, dense cities where biking is convenient for reaching many destinations.

Cost of car use and public transport

The cost, speed, and convenience of alternative modes have a crucial impact on modal choice. In the US, the low user-cost of autos is crucial in discouraging virtually all other modes, even walking. Low gasoline taxes, few road tolls, and ubiquitous free parking make auto use almost irresistible in the United States. At negligible marginal user costs, car use becomes a habit even for short trips that could be walked or cycled.[9] Not only are road tolls, taxes and fees far higher in Europe, but the extensive availability of transit makes car ownership less essential, thus reducing the number of car owners and increasing the tendency to use bicycles for many utilitarian trips.

Income

Rising incomes make car ownership and use more affordable. Every econometric analysis of the

relationship between income and auto ownership finds a very high positive correlation. This helps explain why university students are more likely to bicycle, and suggests that the bike share of travel should decrease over time as countries get richer and an ever-larger share of the population can afford cars. This generalization does not always hold, however. Although Denmark, The Netherlands, and Germany are among the wealthiest countries in the world, they have very high bike modal shares.

Climate

Cycling levels are obviously affected by climate. Three case study cities with relatively high levels of cycling (Davis, San Francisco, and Seattle) enjoy mild winters and, in the case of the first two, little rain. The extreme heat and humidity of summers in the southern United States clearly discourage cycling there. Yet the effect of climate on cycling may be exaggerated. In spite of mostly cloudy days and frequent rain and drizzle, northern Europe has the highest cycling levels, far higher than in southern Europe, where it is drier, sunnier, and warmer.

Danger

The possibility of accidental injury and death is a major obstacle to bicycling. Making cycling as safe or safer than driving will require behavioral changes by both drivers and bike riders, as well as development of more cycle-appropriate infrastructure. While several European countries have national cycle training programs and more strictly enforce traffic rules for both drivers and cyclists, efforts at such behavior modification have been far less extensive and less successful in the US. Moreover, in the United States the elevated risks of cycling appear to be magnified by cultural attitudes that attribute cycling accidents to the supposedly intrinsic perils of bicycles. In contrast, motorist casualties are not ordinarily associated with the idea that driving is dangerous.[10] From there it is a short step to blaming cyclists for their own peril, an attitude that permeates the reactions of everyone from police and courts to the cyclist's own family and friends and contributes to cyclists' marginal status. Thus, measures to reduce the statistical frequency of cycling accidents may need to be coupled with efforts to change public understanding of the nature of road dangers – a difficult task at best.

Cycling infrastructure

Unquestionably, separate bike lanes and paths for cyclists, together with better parking facilities, make cycling more attractive to noncyclists. However, we are not aware of any rigorous statistical studies of their actual impact on increasing cycling levels; to some extent, such facilities may be a response to increased cycling instead of its cause. Nevertheless, every European city with high cycling levels has an extensive route system, including separate bike paths and lanes as well as general street use in traffic-calmed neighborhoods.

STEPS TO INCREASE CYCLING IN NORTH AMERICA

Following are seven proposals for making cycling more widespread in the US and Canada.

Increase cost of auto use

Probably the most effective way to increase bicycling in North America would be to discourage auto use and increase its marginal cost, particularly for short auto trips that are both underpriced and most amenable to cycling. A sizeable increase in the price or inconvenience of driving would encourage people to seek other ways to travel and begin loosening the automobile's domination of daily transportation. Unfortunately, this approach is politically difficult. Indeed, the new federal transportation legislation (TEA21) fixes the federal gasoline tax at the same low level (approximately two cents per liter) for the next six years, and recently taxes on auto ownership have been rolled back in several states. A more promising approach may be restructuring road taxes and auto insurance to shift lump-sum charges into marginal use fees, thus providing positive incentives to shorten trips

and make greater use of non-auto modes.[11] Blocking highway expansion also increases the time cost to drive and can make cycling more attractive, although it could also work against cycling by fomenting "rat-running" (driver use of local streets) and "road rage."

Clarify cyclists' legal rights

To a great extent, cyclists in the United States and Canada operate outside the prevailing system of traffic governance. As we have noted, many motorists and even police are not cognizant of cyclists' right to use ordinary roads, and there is scant appreciation of the vulnerability cyclists feel when autos impinge too closely. In contrast, many northwestern European cities actively promote cycling through conferences, fairs, and school programs, and their traffic rules, policing, licensing, and judicial systems uphold cyclists' rights far more than do their North American counterparts. However difficult it may be, establishing motorists' accountability for their actions toward cyclists is crucial to improving bicycling safety and encouraging cycling. A key first step, noted in the Toronto case study, would be to establish as a principle of law that cyclists have precedence over motor vehicles where both are vying for the same road space and neither clearly has right of way over the other. With their preferential right of way established in law, cyclists might improve their adherence to traffic laws, leading in turn to greater consideration from motorists in a reinforcing process of mutual respect.

Expand bicycle facilities

As discussed earlier, separate facilities (bike paths and lanes) are not a panacea for making cycling easier and safer. Nevertheless, rail trails and mixed-use greenway paths have increased recreational bicycling, and strategically located cut-through paths (as in Davis) can reduce trip times and thus encourage utilitarian cycling as well. The most successful bicycling programs examined in this article – in Davis, Madison and Seattle – include separate facilities in their overall strategy. Moreover, in every European country with at least 10 per cent bike modal split, separate cycling facilities (and traffic-calmed neighborhood streets) are integral parts of the bike route system. Separate paths and lanes are especially important for those unable or unwilling to do battle with cars for space on streets. Training courses may help, but they do not eliminate the inherent danger of cycling on the same right of way with motor vehicles, particularly for those whose mental or physical conditions limit their capacity to safely negotiate heavy traffic. The slowed reflexes, frailty, and deteriorating hearing and eyesight of many elderly make them especially vulnerable, while limited experience, incomplete judgment, and unpredictable movements put children at special risk on streets. And regardless of age, many people prefer to avoid the anxiety and tension of cycling in mixed traffic, aside from safety hazards. Bicycling should not be reserved for those who are trained, fit, and daring enough to navigate busy traffic on city streets.

Make all roads bikeable

More than other countries, the United States must rely heavily on the general road network for bicycling. Some cities have bike lanes and paths that link up to some extent, but none has a complete route network approaching the dense network of bike paths and lanes in virtually every Dutch, Danish and German city and throughout the countryside, with official route designations, signage and maps. Even Davis and Seattle, with their impressive cycleways, must also rely on the general road system. Thus, a fundamental strategy to make America bikeable must be to improve roads through wider curbside lanes and shoulders, drain grate replacement, pothole patching, clear lane striping, and bike-activated traffic signals, while punishing motorist behavior that infringes upon cyclists' legal right of way. Seattle's efforts to improve the road infrastructure are a good model, but no US jurisdiction has taken real steps to inculcate motorist responsibility for cyclist safety.

Hold special promotions

Bike-to-work weeks and employer-based promotions appear to have been helpful in inducing North

Americans to try – and then continue – cycling for transportation. Similarly, large-scale rides ranging from recreational and charity events to San Francisco's monthly Critical Mass rides help build cyclist confidence and provide mutual support and enthusiasm for cycling. In some cases such rides have also focused public attention on the needs of cyclists and helped force a shift toward more cycling-friendly public policies.

Link cycling to wellness

Numerous studies have documented the health benefits of regular exercise, and physical inactivity has come to be seen as a major cause of premature death in industrial societies, second only to tobacco. Cycling, potentially an ideal, low-cost way of getting that activity, has been linked in the public mind to risktaking and danger, in part by health-based helmet promotions that implicitly link cycling to danger. The British Medical Association's finding that cardiovascular-related gains to longevity from cycling far outweigh collision risks, though widely reported in Europe, is little known in North America.[12] New programs from the California Department of Health Services and the US Centers for Disease Control and Prevention seek to integrate routine physical activity into people's travel, work, leisure, and family life by making physical environments more amenable to walking and bicycling.[13] Holistic and pro-active efforts by the health community could boost cycling by casting it as a prudent, healthful choice.

Broaden and intensify political action

As emphasized by transportation researcher Martin Wachs,[14] political action is essential to bring about changes in public policy to encourage more and safer cycling. Bicyclists in many parts of the United States are already well-organized, and have learned to wield political clout to obtain funding for cycling facilities. Cyclists have won pro-bicycling provisions in ISTEA and TEA21 that portend major expansions and improvements to systems of bike paths, lanes, and parking. TEA21 also encourages better roadway design, which provides an important basis for making more roads bikeable. Nevertheless, it remains to be seen how effectively cycling groups can pressure state highway departments to carry out the federal mandates. Similarly, cycling groups will have to continue to exert pressure at the local level to maintain and improve existing elements of the cycling infrastructure, such as bridge access, against the threat of prohibitions or banishment to substandard facilities. Cyclists will also need to open up another front: inducing police and courts to enforce the rights of bicyclists to use city roads and to curb driving privileges of motorists who violate those rights.

PROSPECTS FOR BICYCLING IN NORTH AMERICA

With the right set of public policies, bicycling in the United States could increase dramatically. As noted by both Wachs and Gordon and Richardson, to date there has not been sufficient political support to pass and implement those policies. So far, only the easiest no-conflict measures have been implemented; most new bike paths and lanes in the United States do not directly compete with auto use. By contrast, many European cities have implemented policies that sharply restrict auto use in favor of walking and bicycling, especially in city centers.[15] German, Dutch, and Danish cities give cyclists priority on certain streets and intersections and routinely employ "advanced" green lights and traffic-calmed streets. Some one-way streets have been made two-way for bicyclists, and cyclists are exempted from many turn restrictions for cars. Some European cities have dedicated car parking space to bike lanes or bike parking, not just to enable cycling but to discourage auto use. Enacting such measures has taken concerted political pressure, even in cities where 20 per cent of the populace cycles regularly. Such auto-restrictive initiatives do not yet appear politically feasible in America. Too many Americans drive cars (and would feel hurt by such measures), and too few Americans presently bicycle (and feel they would benefit enough to fight for such measures).

It is possible to imagine a *deus ex machina* giving a strong boost to cycling in America – perhaps an oil shock, or a cultural or style change toward bikes and away from cars, or ascendancy of a

charismatic politician closely identified with cycling. But the more likely scenario is slow, painstaking progress: modest extensions and improvements in separate bicycle facilities, even more modest improvements in roadway design, and isolated instances of effective enforcement of cyclist rights to use public roads. Those measures may produce significant growth in bicycling in those cities that implement them. But overall, they will not produce a bicycling boom, unless the visible success of cycling enhancements in one or two major cities attracts imitators elsewhere.

NOTES

1 Dutch Ministry of Transport. 1995. *Cities Make Room for Cyclists: Examples from Towns in the Netherlands, Denmark, Germany, and Switzerland.* The Hague: Ministry of Transport, Public Works, and Water Management, The Netherlands; Tolley, R. (ed.). 1997. *The Greening of Urban Transport.* Chichester, Sussex: John Wiley & Sons; Zegeer, C. (ed.). 1994. *FHWA Study Tour for Pedestrian and Bicyclist Safety in England, Germany, and The Netherlands.* Washington, DC: US Department of Transportation; Pucher, J. 1997. Bicycling Boom in Germany: A Revival Engineered by Public Policy. *Transportation Quarterly*, 51(4), pp. 31–46.

2 Pucher. 1997. Bicycling Boom in Germany.

3 Ibid.

4 Sani, M. 1997. Could Better Roads Boost Commuting? *Bicycle Retailer and Industry News*, 1 December.

5 Pucher. 1997. Bicycling Boom in Germany.

6 Schimek, P. 1996. Automobile and Public Transit Use in the United States and Canada: Comparison of Postwar Trends. *Transportation Research Record*, 1521, pp. 3–11; Pucher, J. 1994. Canadian Public Transport: Recent Developments and Comparisons with the United States. *Transportation Quarterly*, 48(1), pp. 65–78.

7 Pucher, J. 1995. Urban Passenger Transport in the United States and Europe: A Comparative Analysis of Public Policies. *Transport Reviews*, 15(2), pp. 89–107, and 15(3), pp. 261–277.

8 Gordon, P. and Richardson, H. 1998. Bicycling in the United States: A Fringe Mode? *Transportation Quarterly*, 52(1), pp. 9–11.

9 Pucher. 1995. Urban Passenger Transport.

10 Komanoff, C. 1997. Restoring Cycling Habitat. *Bicycle Forum*, 45, pp. 6–13.

11 Litman, T., Komanoff, C. and Howell, J. 1998. *Road Relief – Tax and Pricing Shifts for a Fairer, Cleaner, and Less Congested Transportation System in Washington State.* Olympia, WA: Energy Outreach Center.

12 British Medical Association. 1992. *Cycling Toward Health and Safety.* London: Oxford University Press.

13 Seeley, Anne (California Department of Health Services, Active Communities Coordinator). 1998. Personal communication.

14 Wachs, M. 1998. Creating Political Pressure for Cycling. *Transportation Quarterly*, 52(1), pp. 6–8.

15 Pucher. 1997. Bicycling Boom in Germany.