The Transportation/ Land Use Connection

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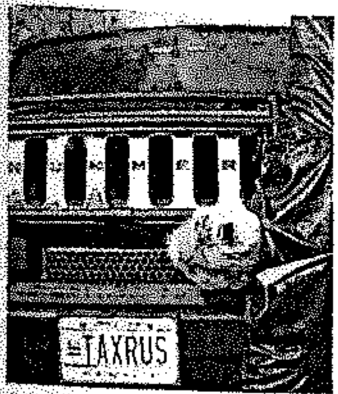

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CHAPTER 6

Transportation Policy Evaluation

Organization: Chapter 5 set the land-use context: this chapter focuses on transportation policies. It starts with a section that explains why we organized those policies into three categories, and then proceeds with a section on each:

1. *Policies to improve transportation infrastructure.* Adding more supply has been the obvious first response to the problem of congested or unsafe surface transportation in urban areas. For highways, the choices are primarily (1) new roads or more lanes, and (2) getting more out of existing capacity. As this gets more expensive, more attention is paid to adding capacity for modes alternative to the car: trains, bikes, and legs.
2. *Policies to improve the use of vehicles.* The lion's share of the vehicles travelers use to get around are purchased and owned privately. Nevertheless, many are not used with high efficiency; the passenger and back seats of cars often go unoccupied. Publicly owned vehicles, such as buses and train cars, are often also underused. This section investigates policies to get more person-trips out of fewer vehicle-trips.
3. *Policies to mitigate traffic externalities.* When streets get "improved" to facilitate the flow of vehicles, those improvements have negative effects on the social and economic environment along those streets. More and faster traffic on a street increases noise, inconvenience to pedestrians and bicyclists, accident risk, and, ironically, congestion. Economic theory and desires for an integration of land-use and livability considerations with transportation planning require that those effects be dealt with, primarily through better design.

A short section at the end of the chapter provides tables that summarize the characteristics of many of the policies.

Basics: Policies, investments, and other actions in all three categories are essential for an effective and balanced transportation system.

- New roads or more lanes are part of the package. New roads will obviously be necessary in expanding urban areas. New lanes might be cost-effective in areas of heavy congestion and where right-of-way can accommodate those lanes or is not abutted by dense development. Such new lanes can make sense as HOV lanes.
- Getting more out of existing capacity clearly makes sense. Transportation System Management (TSM), including Intelligent Transportation Systems (ITS), does that. Among the many possibilities for policy and investment:
  - Better engineering to fix turns that are too tight, bottlenecks, or lanes that are too narrow.
  - Better coordination of traffic flow (e.g., signalization; controlling flow with ramp metering).
  - Better management of incidents and accidents: possibly the most cost-effective thing that can be done to get more out of the existing system.

  - Better information for travelers: ITS solutions (e.g., 511 numbers), and more.
  - Education and enforcement. The bad driving habits of a small percentage of drivers can cause a lot of accidents and congestion for the majority.
- TSM by itself cannot bring congestion to efficient levels. TSM effectively works like adding lanes; it increases the capacity of the highway. But triple convergence almost guarantees that highway space remains scarce.
- Thus, Transportation Demand Management (TDM) is required for more efficient urban transportation.
  - The ideal policy is pricing road use and parking by time and location: congestion pricing. Achieving that ideal will happen in some metropolitan areas, but it will take 10 to 20 years. In the meantime, other less direct mechanisms can influence trip costs in ways that improve efficiency: for example, parking cash-out, priority transit, and HOV lanes.
  - Yet other policies ration demand and influence behavior through regulation (e.g., trip-reduction ordinances, or limits on parking spaces).
- Local mitigation techniques, such as traffic calming, are also probably essential because pricing access to the local street system is very difficult, and pricing of highways (or other effective highway demand management) will encourage drivers to look for unpriced alternatives, such as travel on arterial streets.
- In general, discouraging highway vehicle trips will increase the demand for substitutes—high-occupancy vehicles (HOVs), mass transit, bicycle, and walking—so policy must be coordinated: if prices or regulations encourage a shift in the demand for auto travel, they will work better if other policies are simultaneously encouraging a supply-side response in other modes of travel.

Shortcuts: Why are you reading this report? Right, because you care about solutions to urban transportation problems. If you are a technician, read this chapter. If you are a policy maker with limited time looking for an overview, Chapter 7 packages these policies: you could skip the details here and jump there.

A FRAMEWORK FOR THINKING ABOUT TRANSPORTATION POLICIES

The fundamental principle of transportation planning, evaluation, and project selection should be to invest in transportation projects for the *transportation* benefits that they provide. The reason is that if there are other, more important objectives than transportation (e.g., land use, economic development) they will (1) mainly be achieved through the transportation impacts and be double-counts of those impacts, and (2) probably be better achieved by having agencies specializing in those objectives aiming policies at them directly. The benefits of transportation projects and policy accrue directly and primarily in two ways:

- Better access. That could mean more destinations, but practically, in urban areas, it means (1) that the transportation policy reduces some or various measures of travel time from what they would have been in the absence of the policy, and (2) that, given that the major contributor to measures of urban travel time is urban congestion, a transportation policy should be aimed at reducing congestion—especially peak-period congestion—from what it would have been in the absence of the policy. The objective here should focus on travel time for *people and freight*, which is not always the same as travel time for *vehicles*.
- Less accident damage (property and personal).

Any actions that attempt to achieve those two benefits should simultaneously pursue a third and conflicting one:

- Controlling (to an often unspecified politically acceptable level) negative environmental, land-use, social, and economic externalities. We include in that constraint the ones about fairness and the distribution of impacts (also referred to as "environmental justice").

Conventional transportation policy already focuses on these first two objectives. Urban freeways, for example, with their wide lanes, limited access points, and gentle curves allow, *in uncongested conditions*, relatively high-speed and safe travel.

Freeways, like all transportation projects, have effects that go beyond transportation: that point is clearly a theme of this report. Most of those other impacts (especially land-development impacts) are, in an economic sense, just another way of describing what is fundamentally an access/travel-time benefit. Reducing the amount or variability of travel time improves access, which makes households and business put a greater value on land that enjoys those benefits, which raises land values, which intensifies land development. The increase in land values helps put a dollar value on the transportation benefits. Focusing on travel times and safety, in principle, covers most of the benefits of surface transportation improvements or policies.

But the travel that transportation systems facilitate generates external costs. Air, noise, and visual pollution impose external costs on nontravelers. Congestion is another big one: highway congestion reduces the transportation benefits the highways were specifically designed to provide. The high costs associated with these externalities motivate policy response.

In short, our point: transportation policies aim primarily at reducing the amount and variability of travel time and accident cost, subject to the constraints of dealing with the external costs that those policies impose.

The conventional way to organize transportation policies is under two broad headings: policies that affect supply (capacity), and policies that affect demand (behavior). Table 6-1 shows that organization. It further divides the policies, as we did for land-use policies in Table 5-4 on page 149, as to whether they are primarily regulatory (requirements) or market-based (incentives).

TABLE 6-1. SUPPLY-SIDE AND DEMAND-SIDE TRANSPORTATION POLICIES

	SUPPLY SIDE	DEMAND SIDE
PRIMARILY REGULATORY	Building more roads or expanding existing ones Building more transit facilities and increasing service and amenities in existing transit systems Improving highway maintenance Adding roving response teams to remove accidents Traffic management centers ITS mechanisms for speeding traffic flows Deregulating public transit activities Upgrading existing city streets Staggering work hours for more workers Developing means of transit feasible in low-density areas Building special roads for trucks only	Prohibiting certain license numbers from driving on specific days Changing federal work laws that discourage people from working at home Ramp metering on expressways Encouraging transportation management associations Encouraging more people to work at home Keeping minimum residential densities higher Clustering high-density housing around transit stops Limiting growth and development in local communities Improving the jobs/housing balance Using traffic-calming devices to slow flows Concentrating jobs in a few suburban clusters Making some lanes HOV lanes
PRIMARILY MARKET-ORIENTED	Converting free HOV lanes to HOT lanes	Road pricing with tolls set to raise peak-hour flows Commuting allowance for employees Charging high taxes on gasoline Charging high taxes on parking during peak hours Eliminating tax deductibility for employers for providing free parking Increasing automobile license fees "Cashing-out" free parking provided by employers

Source: Downs 2004a, 78.

There is a lot to recommend that type of organization. Engineers started with supply policies, focusing on new supply. As it has become harder and more expensive to build new roads and rails in developed areas, they have shifted to transportation system management. As supply solutions came up short and as planners and economists got more involved, demand-side solutions get more attention. As the land use/transportation connection gets more attention, the emphasis on design and mitigating the negative effects of highway projects gets more attention also. The sidebar illustrates the shift that has occurred.

Another advantage of the supply/demand organization for us as authors is that was the one we had been using up to two days before the deadline for delivery of the final version of this chapter to APA for typesetting.

But categorizing policies as supply-side or demand-side has some problems. Chief among them is that demand and supply are not independent: those forces operate on each other, iterate, and ultimately equilibrate.

To make that less abstract, consider two examples:

- Access management. Access management is supply-side. It makes more efficient use of capacity by changing highway design so that turbulence is reduced. It usually means reducing curb cuts and creating medians: fewer left-turning movements off the highway and fewer entries onto the highway. Ramp metering is a variation of access. But access management

EXPANDING THE TRANSPORTATION POLICY PALETTE

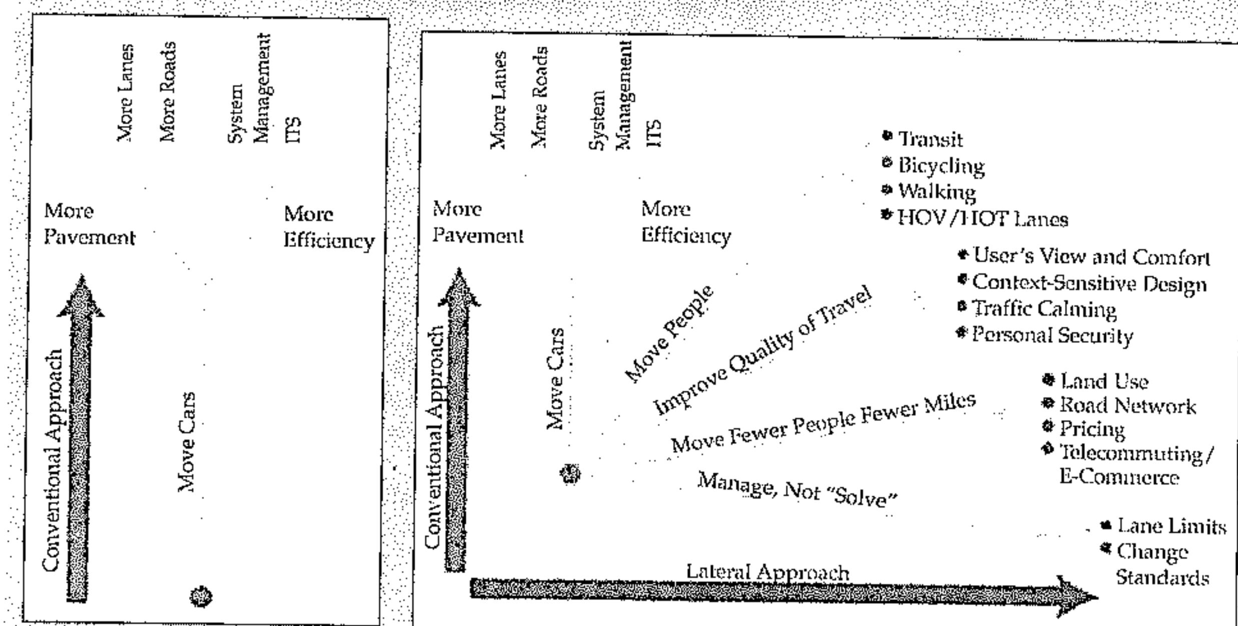
By Troy Russ, AICP, Principal, Glatting Jackson Kercher Anglin, Inc.

Conventional Approach to Transportation Planning

Since the 1950s, transportation professionals have been directed to move more vehicles. Thus, they focused making more, bigger, or more efficient roads. Their efforts coincided with growth in vehicle miles traveled (VMT) greater than population growth, declining population densities in cities, and an obesity epidemic partially caused by a poor walking environment.

A Balanced Approach to Transportation Planning

An alternative transportation approach seeks to make streets, highways, and transit systems more livable by striking a new balance between the goals of moving traffic and building livable communities, and by supporting broader community land use goals. Such an approach looks more at the movement of people (not just vehicles), the quality of a trip, and land-use actions to reduce transportation problems.



is also demand-side: it influences behavior. It changes where and how people can drive and how land-uses develop.

- HOV lanes. Adding a lane to a highway and restricting it to HOVs can clearly be thought of as supply-side. But the motivation for doing so might be demand-side: the faster travel in the HOV lane encourages some single-occupant-vehicle (SOV) drivers into carpools and buses, reducing the demand for SOV travel (at least temporarily) in the unrestricted lanes.

For this chapter, we use a different organization. It derives from a simple observation: travel requires paths and vehicles:

- Paths for urban surface transportation are roads, parking lots and structures, rails, bike lanes, and sidewalks.
- Vehicles are, correspondingly, cars, motorcycles, trucks, and buses; trolleys and light- and heavy-rail cars; bicycles, skateboards, roller blades, strollers, wheelchairs; and legs.[1]

Transportation policies are about improving the performance (management) of a transportation system composed of paths and vehicles. Paths and vehicles deliver the ultimate transportation products: mobility and access. Transportation policies deliver access by aiming for (1) more, or more efficient use of, paths; or (2) more, or more efficient use of, vehicles.

Transportation policies are about improving the performance (management) of a transportation system composed of paths and vehicles. Paths and vehicles deliver the ultimate transportation products: mobility and access.

That framework helped us clarify issues we found muddy and allowed us to take a razor to the long list of things we could talk about in this chapter:

- Paths are mostly provided publicly. The reasons are not an arbitrary historical artifact: transportation systems cut over a lot of property and political boundaries, and require big risk and investment. The paths that are provided privately are a small part of the regional transportation system, have little effect in the larger scheme of regional transportation, or are subject to heavy public regulation (e.g., privately built and operated toll roads). Thus, public policy is very concerned with paths, which are almost exclusively public.
- Vehicles are primarily provided privately. Most of the cars, vans, trucks, bikes, wheelchairs, and legs are privately owned and operated. The public sector may address standards for design and operation of those vehicles (that's public policy), but it does not provide or finance them, and it allows a lot of consumer choice. Urban passenger-rail cars and most buses *are* provided publicly (primarily), but there is no strong economic reason that they have to be.
- Getting more motor vehicles on the road does *not* have a logical connection to the broad goals of reducing travel time or accidents. We consider it no further as a potential public policy. Using vehicles more efficiently (HOV) or increasing alternatives (legs and bikes) is logically related to both of those goals.
- Accident prevention is in practice handled primarily as a constraint on adding or fixing paths or HOVs so that they can handle more people. The amount of transportation money that gets spent on improvements that are exclusively or primarily about traffic safety is relatively small.[2] Thus, we focus our discussion on benefits relating to congestion relief.
- The negative derivative effects of transportation improvements (externalities) can be caused by the construction of paths or the operation of vehicles. People are aware of these problems and use state agencies, local governments, and interest groups to try to mitigate them by changing policy—by getting governments to take action.

Given all these points, we organize the policy discussion in this chapter as follows:

- **Policies affecting paths (i.e., the transportation infrastructure that vehicles use).** Most "path policies" involve increasing transportation capacity: more lane miles, more throughput per lane, more parking, more rail transit, more transit ridership, more bike paths, and so on. There are two major subheadings: more paths and more efficient paths.
- **Policies affecting vehicles.** Aside from public buses and rail cars, most vehicles are privately supplied. The public policy emphasis is on encouraging more use of legs and bikes relative to motor vehicles, and more efficient use of motor vehicles.
- **Policies to reduce negative effects on community livability.** Local streets require trading quick and easy travel by motor vehicle for neighborhood environmental amenity. This improvement to amenity often benefits travel by bike or foot.

POLICIES TO IMPROVE TRANSPORTATION INFRASTRUCTURE

Surface transportation policy focuses on providing the infrastructure needed for swift, safe, and reliable travel. Reducing the growth of traffic congestion on urban freeways and arterial streets (i.e., reducing deterioration of Level of Service) has become the main object of that policy.

Conventional policy views this as a problem of capacity, so the objective has been to build more and use what we have more efficiently, which reflects the organization of this section.

Though we are talking here about highways, the notion of trip components and times is critical in understanding ridership on transit. Consider that, for a park-and-ride trip by transit with a transfer, the components are: walk, drive, park, walk, wait, ride, wait for transfer, ride, walk.

Increasing infrastructure capacity

Physically increasing highway capacity means more pavement. This comes in the form of new lanes on existing highways or new highways.

The increasing cost of providing more pavement has motivated attention to other types of paths. In particular, an increasing number of growing metropolitan areas are building, or thinking about building, rail transit systems. The most common is light-rail. More attention is also being paid to improving bike and foot paths.

Conventional transportation policy focuses on improving limited access highways and major arterials. That focus could be broader. Taylor (2002) gives a simple example that makes the point. He divides an SOV commute trip into eight separate components related to vehicle (walk to car; drive to arterial) and path (collector, arterial, freeway, parking structure), and shows time spent on each path. For his hypothetical but reasonable trip, the length is about 11 miles and the total time (door to door) is 36 minutes. But only 40 percent of that time is spent on the congested freeway. Almost another 40 percent is spent on collectors and arterials getting to and from the congested freeway. Walking takes 17 percent of the time, almost all of it getting from the parking lot or structure to the final space at the place of work.

The example makes several points: (1) if the main benefit is time savings, policy and investment ought to focus on where those savings are possible, (2) the returns to investment in congestion relief on freeways will be smaller than most people think because travel time on freeways accounts for less than half the travel time for a typical trip, and that percentage will drop if congestion is relieved, and (3) many paths and modes are important to even a single trip. Though we are talking here about highways, the notion of trip components and times is critical in understanding ridership on transit. Consider that, for a park-and-ride trip by transit with a transfer, the components are: walk, drive, park, walk, wait, ride, wait for transfer, ride, walk.

In this section we analyze and evaluate various policies for increasing the capacity of surface transportation infrastructure. While each varies in its effects overall, none will cure the problem of traffic congestion in growing areas. The reason is triple convergence: new capacity reduces travel times in the short run, which travelers take advantage of in the long run.

More lanes for congested highways

Transportation authorities commonly respond to traffic congestion on highways and arterial streets by expanding, usually by adding lanes. That response makes sense only to the extent that congestion is a good indicator of the need for the additional capacity. Congestion is a good indicator in a relative sense; improvements to congested urban freeways are more likely to yield larger net benefits than similar improvements to less-congested highways. But congestion is not necessarily a good indicator in an absolute sense: the proportion of trips of relatively low value varies across similarly congested highways.

Different from the issue of net benefits are the issues of triple convergence and latent demand, but they are frequently addressed as if they were the same thing. Cervero (2003), Downs (2004a), and Chapter 4 and Appendix C point out that new travelers and new development take advantage of new capacity, which can accelerate the rate of traffic growth until congestion returns, perhaps in only a year or two. The expensive new capacity appears at that point to provide no benefit to a commuter who used the corridor before and after the improvement; travel to work is as slow and unreliable as it was before the improvement.

Overlooked in this lamentation is that there are now more commuters using the facility, and some are living in locations and housing that they find better. These new travelers gain value from the new facility. It is possible that the added capacity was a good investment even though it was quickly used up. It is also possible that the congestion relief and added capacity for new trips was largely offset by increases in congestion during construction (see Appendix D for an overview of how to evaluate transportation improvements in terms of full benefits and costs). In the absence of tolls, however, calculating net benefits is difficult and uncertain.

Large numbers of people traveling every day on congested highways means a lot of frustration, and that frustration rains on elected officials: (1) somebody needs to do something, (2) it's too crowded, (3) build more roads, (4) now, (5) or else.

The details in Chapter 4 about congestion, underpricing, and external costs cover most of the issues relevant to an evaluation of new lanes as a policy. Transportation investment decisions of this type would be improved if the revenues from congestion tolls were there to provide information about user values. In the absence of congestion tolls, evaluations should consider, hypothetically, what people would be willing to pay in tolls *if* the new capacity were to be tolled. The answer might often be: not much, and not anywhere near the amount it would take to pay the debt service on the amortized cost of the new capacity.

Why do highway expansions that probably could not pass a cost-benefit test get built? The main reasons: political pressure; the difficulties in measuring costs and benefits; an impatience with having to deal with the real complexities of the type of thinking (never mind the numbers) that benefit-cost analysis introduces; and the availability of funding. Large numbers of people traveling every day on congested highways means a lot of frustration, and that frustration rains on elected officials: (1) somebody needs to do something, (2) it's too crowded, (3) build more roads, (4) now, (5) or else. . . . And state DOTs have fuel-tax revenues to spend (though never enough to cover all of the projects on their lists). New lanes, highways, and interchanges are going to get built.

If the capacity added is large, if the area to which it is added is not very congested and not a likely location for significant new development, and if regional growth is slow, triple convergence may be slow: excess capacity may remain. For all the reasons explained in earlier chapters, that excess capacity (better access; reduced travel time) is an inducement to development. Cervero (2003) found that the quality, quantity, and location of new development in the vicinity of a new road project are both a result of the road project and a determinant of how quickly growth in traffic volumes will accelerate the degradation of the new capacity. Road improvements and faster travel times encourage building along new highway corridors, mostly by redistributing regional economic activity away from other areas in the region (as opposed to by generating new economic growth for the region) (Boarnet 1995, 1997).

New capacity will always be part—and probably always the biggest single part—of any integrated program for management of urban surface transportation systems. As urban areas grow, new road capacity (especially for growth at the urban edge) and fixes to old capacity will be needed. Our point is that there are good reasons to consider shifts in emphasis toward other policies for managing the transportation system.

More highways and bypasses

As an urban area grows, both limited and unlimited access highways can evolve from serving mainly through traffic to serving local traffic. Shopping malls near freeway interchanges and poor system management along commercial strips (too many driveways and unsynchronized stoplights) reduce traffic flow, reliability, and safety. Vehicular movements inhibit transit, cycling, and walking. A solution is to build a bypass, ostensibly to serve through traffic.

The most common resolution is a suburban (often exurban) bypass. The advantage of a bypass from a state DOT's perspective is its *relatively* low (though still high) construction costs. Adding lanes or new arterial streets and highways in urban corridors is expensive. Trucking interests and through travelers support the bypass. Many metropolitan residents support the bypass for the access it provides to lower-cost residential areas with a preferred bundle of public facilities, services, and prices (taxes). And many exurban land owners support the bypass for the windfall increase in property values the new access generates.

Bypasses are controversial. The controversy arises from the potential land-use impacts of bypasses

But bypasses are controversial. The controversy arises from the potential land-use impacts of bypasses. A bypass built in the urban fringe encourages decentralized development (and reduces pressure for centralized development and infill) by improving access to developable land. Much of this development consists of low-density residential development. A bypass can also hurt businesses in the bypassed corridor, especially if conventional land-use policies guide the development of land near the new bypass.

Retailers follow their customers and employers follow their workers to areas near the new bypass. Edwards (1991) reports that the central business districts (CBDs) of many small and medium-size cities, for example, suffer decay as businesses move to more accessible locations along bypass highways or near freeway interchanges. Thus, in addition to having to deal with the problems of growth and change along the bypass, the local jurisdiction must deal with the problems associated with the decay of the bypassed cluster.

A good example of these effects are found along a portion of Michigan state highway 11, built originally as a bypass south of the Grand Rapids, Michigan CBD. Over several decades, the unlimited-access bypass has become a local shopping magnet. Regional shopping malls anchor each end of the nearly 10-mile-long retail strip. Big-box retail and strip development fill in between and beyond the malls. Bypass capacity has expanded over time to three lanes in each direction, plus a turning lane. A large commercial and industrial area has developed south of the bypass. Peak congestion on the former bypass is sufficiently high that a new freeway bypass is nearing completion on exurban land several miles to the south.

The disadvantages get a lot of press. The now seven-lane arterial is congested, ugly, and virtually unusable by people traveling by nonauto modes. The congestion prevents the corridor from functioning as a bypass for most of the day. Parking lots cover most of the land near the street, unoccupied much of the time because of parking requirements or desires. As the retail grew along the bypass, it fell to nearly nothing in the bypassed CBD. The costs of land development along the bypass are high.

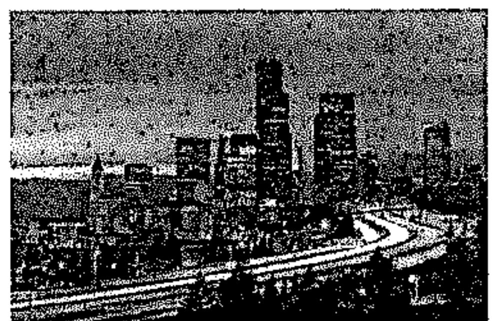
Less salient are the advantages. Remarkable amounts of trade occur in this 10-mile strip. Though ugly and long, from a regional perspective the retail is, in fact, clustered along this thin linear corridor. The corridor itself is congested, but access to it is relatively easy all along its length. Though arguably less than optimal, the large, congested linear cluster serves relatively well a variety of important local economic functions. And the retail concentrated there discourages strip development elsewhere. The benefits of land development along the bypass are also high.

Another potential disadvantage is the "need" for the new freeway bypass farther to the south. This new bypass, though limited access, could have many of the impacts of the old one. Does it make sense simply to keep building bypasses?

The answer is not an unequivocal "no." Multiple layers of bypasses in relatively large metropolitan areas can evolve to form a grid of high-speed, high-volume urban arterials. Large commercial subcenters form at especially accessible locations, such as near freeway intersections. These subcenters provide substantial economic efficiencies. Though urban freeway systems frequently suffer congestion, congestion pricing could, theoretically, treat that problem and encourage more intensive land development.

Nevertheless, the disadvantages of bypasses have lead to consideration of alternatives.

One alternative to a conventional suburban bypass is to build express lanes—lanes with no access to the adjacent development—in existing corridors. Constrained by the harbor, two large lakes, and steep slopes, Washington state officials added express lanes to serve drivers traveling through Seattle on Interstate 5. These lanes are in the same right-of-way as the other lanes that provide access to the intensely developed parts of Seattle. The construction costs of this option are high relative to those of standard bypasses, an option that was simply unavailable in Seattle.



nibh, istockphoto.com

Interstate 5 in Seattle. Washington state officials added express lanes to serve drivers traveling through the city in the same right-of-way as the other lanes. Where topography restricts building bypasses, the high costs may still provide great benefits.

A perceived advantage of the express lanes is their relatively low impact on land use. The express lanes do, however, speed commuting into and out of the downtown, with several likely land-use effects: (1) more low-density residential development farther from the CBD, but near the existing corridor (to the north and south in the case of Seattle), and (2) more development in the CBD. The result is more and longer commutes on the express lanes, which contributes to congestion (that pesky triple convergence again). The additional capacity will not in the long run eliminate congestion; some form of rationing is also required. But the express lanes effectively protect the CBD as a commercial center by not just maintaining, but improving, access.

The express-lane option requires care in design. Rather than bypassing the entire city of Medford in southern Oregon, for example, Interstate 5 was elevated to pass directly above the CBD (again, topography and development limited the feasibility of the construction of a low-cost suburban bypass). Rather than building a relatively expensive interchange to provide direct access to the CBD, lower-cost interchanges were constructed on the northern and southern edges of town. The bulk of new commercial development since then has occurred near those interchanges. Two new clusters have developed while the former CBD, located between them, has deteriorated markedly, an effect many citizens did not envision or desire.

A second alternative is to build an exurban bypass and use restrictions on land development to prevent sprawl. Though that option is not often exercised, it can work. Interstate 205 in the metropolitan area of Portland, Oregon, and I-280 connecting San Francisco with San Jose provide anecdotal evidence that this policy can work as long as decision makers can tolerate it.[3] After the I-205 bypass was built, the expected increases in development (including the inevitable regional mall at an interchange) occurred in the urban area it traverses. But along the segment of the highway to the south of the metropolitan area, such development has not occurred: I-205 still looks like a parkway. The reason: lack of full urban services or the zoning that would allow them to be built (specifically, in Oregon, the areas in question are still outside the metropolitan urban growth boundary) has prevented the development of land with otherwise good access.

The land-use-regulation option is not often exercised. Many of the owners of land near a bypass will oppose restrictions on development because the access provided by the bypass increases land values. These capital gains are windfalls because the landowners typically pay little of the cost of building the bypass.[4] Windfalls or not, they motivate aggressive lobbying. That lobbying often succeeds.

An option for the government is to purchase land near interchanges when it purchases the highway rights-of-way. That strategy, however, raises project costs and raises issues about property rights: should the land be appraised for its value as vacant land (e.g., farmland) without access, or as commercial land with access? At this writing (2007), issues of property rights, takings, and givings are a hot topic in many areas of the country.[5] There are likely to be strong political forces working against limiting land-use impacts near a bypass.

Jeremy Edwards, istockphoto.com

Cannon Beach, Oregon presents a case study of the benefits of restricting land development near bypass interchanges. In this case, topography, municipal land purchases, and land-use restrictions all played roles. An alignment that would have brought the bypass much nearer to the beach was ultimately not chosen, despite and because of the beach's scenic attributes.

Sometimes, however, politics and topography work as planners hope. Cannon Beach, Oregon, grew along a section of Highway 101 built near a scenic stretch of Pacific Ocean beach. As the town grew, so did congestion on the highway. The congestion in town motivated construction of a bypass in the 1950s farther from the beach. In the short run, a lack of both demand and good buildable land (much of the land along the new bypass was wetland) kept development in check. In the longer run, municipal ownership of large amounts of the property, restrictive zoning supported by the Oregon land-use program, and the happy convergence of aesthetics and tourist-related business interest have prevented development along the bypass, while the downtown area continues to thrive.

A third alternative is to build a bypass with no interchanges. The bypass then improves travel conditions for through traffic without improving access to exurban areas. Though simple in concept, the solution has the same political problems as land-use restrictions. Being near a freeway or rail line provides no access benefits to properties that cannot access it: in fact, such facilities would diminish land value with noise, emissions, visual blight, and *decreased* access (because they are barriers to local travel). The owners of land near the bypass have incentive to lobby for interchanges. The technical debate turns on the question of efficiency: if we build this expensive bypass for through traffic, are we willing to forego the economic advantages of access to cheap undeveloped land to protect and stimulate the economic advantages of the downtown and other existing subcenters?

What can we conclude from our analysis?

- Expensive construction in existing corridors may in the long run provide more net benefits than are revealed by comparing construction-cost estimates. The objective should be to maximize net long-run benefits, not minimize short-run costs.
- Bypasses even with their consequent land-development impacts may be desirable if they truly serve their intended function of relieving downtown

areas of traffic that really does not want to be there. That congestion relief may facilitate other streetscape improvements that improve livability.

- Having the best of all worlds—cheap construction, free-flowing traffic, and limited impact on land development—does not come easily. It requires coordinated policy: limiting access to the highway (preferably with congestion tolls), and binding, long-term restrictions on land development.

More parking

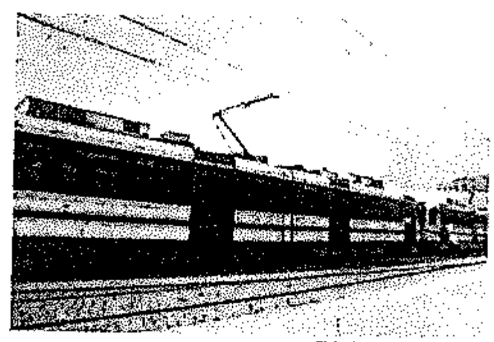
Chapters 4 and 5 discuss parking in detail. We add a just a few points here to put parking in context.

On the transportation side of the equation, flying down a path with no ability to land does not often make for a useful trip: a stopping point at the end of a path—parking—is essential for all wheeled travel. That simple logic suggests that expanding parking capacity where it is constrained can have the same effects on congestion that expanding lane capacity can have.

Since travel depends on cost, the direct and indirect (time) cost of parking is quite relevant to the demand for trips. The logic should be clear by now: (1) the effects of adding parking capacity are similar to those of adding lanes, as are the effects of underpricing it, and (2) since flying without landing has little value for most travel, the pricing of parking can be used as a demand-side policy to ration scarce highway capacity. These points are expanded a little later in this chapter, and greatly in Shoup (2005a).

More priority mass transit

An alternative to building more highway capacity is to build mass transit capacity on separate rights-of-way. Examples include commuter rail, heavy rail (subways, els, and monorails), light rail transit (LRT), and bus rapid transit (BRT). Advantages of grade separation are that these HOVs do not get caught up in traffic congestion, and they do not contribute to it directly by taking up scarce highway space.



Slobo Mitic, istockphoto.com

Light rail transit (LRT), as shown here in Sacramento, California, operates in a separate right-of-way, which prevents delays by bypassing congestion.

The disadvantage of grade separation is its cost. Construction of new commuter rail lines, for example, requires large upfront capital expenditure, and fares rarely cover half of operating costs.

The arguments in support of subsidies are numerous, but three stand out. The first is to provide mobility for the poor, which mass transit accomplishes, though probably not cost-effectively. Recent trends toward the suburbanization of lower-income households increases the challenge. The second is to provide highway congestion relief. The idea is that good performance characteristics will encourage some people off congested highways. The third is to change the pattern of future urban development to one that is oriented toward transit, with all the purported benefits.

Can subsidies to rail transit positively impact highway congestion? The travel demand elasticities reported in Appendix C provide some insight. The elasticity of transit ridership with respect to transit fares is low: a 10 percent decrease in fares almost everywhere results in a less-than-10 percent increase in transit ridership. Commuter ridership in all but the most densely developed U.S. cities is a very small proportion of total commuting. Thus, a big drop in transit fares has only modest proportionate effects on transit ridership and almost negligible effects on highway congestion even in the short run.

The effects of lower fares on congestion in the long run are even smaller. The reason is that the elasticity of peak VMT on congested highways with respect to travel time is very high: triple convergence again. The fundamental problem is that the transit subsidy does not address the cause of inefficiently high traffic congestion: unpriced access to the highway.

What are the effects on land use? Most commuter rail systems are oriented radially, so they improve access to both the CBD and to areas in suburbia beyond the end of the train lines. Thus, commuting on rail is especially attractive to commuters to the CBD because it gives them the option of living in the urban fringe. They can drive to the suburban train station, then make relatively good use of the half-hour transit ride by preparing for the work day or reading the newspaper. The walk to work in the CBD is often less time consuming than getting into and out of a parking structure.

The effect on land use is similar to that of a new lane in a congested highway. The rail transit line improves access to both the CBD and exurbia, so the intensity of development increases in both places. In exurbia, this pattern means primarily more low-density development, though the train line could support the development of suburban subcenters and higher-density development.

Transit tends to fare better, as it were, at the other end of the line, usually the CBD. Indeed, part of the appeal of light rail systems are the benefits to a CBD ailing from suburbanization. Radially oriented rail improves access to the CBD from suburbia. As usual, that better access translates into development.

Handy (2005) finds that LRT alone does not automatically create higher densities around stations. Other conditions must exist to increase the likelihood of higher-density development:

- A region is experiencing significant growth.
- The light-rail system adds significantly to the accessibility of the locations it serves.
- Land-use regulations (zoning, comprehensive planning, public investments) are conducive to development.
- Public-sector support in the form of capital investments and land-use policies, such as high-density zoning allowances, restrictions on parking, and financial incentives, are in place.

LRT alone does not automatically create higher densities around stations. Other conditions must exist to increase the likelihood of higher-density development.

Landis and Cervero (1999) find that BART had impacts around stations in downtown San Francisco but not around stations in the suburbs. Examples of high-density development around suburban Metro stations are evident, however, in certain counties in the Washington, D.C., metropolitan area, specifically Arlington County, Virginia, and Montgomery County, Maryland. In other words, such development doesn't happen automatically: the form, density, and timing of the development around stations are highly dependent on demand conditions (markets: demographics, land and building prices, density) and how land-use and design tools are applied.

LRT is special when it comes to the CBD. First, it can serve somewhat like a streetcar on congested CBD streets (but with less frequent stops) because the rail lines are laid in the city streets. Second, installing light rail allows and encourages upgrading and updating of CBD infrastructure. Finding the money to upgrade dilapidated infrastructure in many CBDs is a big problem. Light rail is a source of funds. Done well, a light-rail installation can give a CBD a significant facelift whose short-run benefits may be as important as the accessibility it provides. From a development perspective, street-cars (trolleys) may work even better: they are less expensive, stop more frequently, and are perceived by developers to carry a more local clientele that they can more directly design for.

More bike and walking facilities

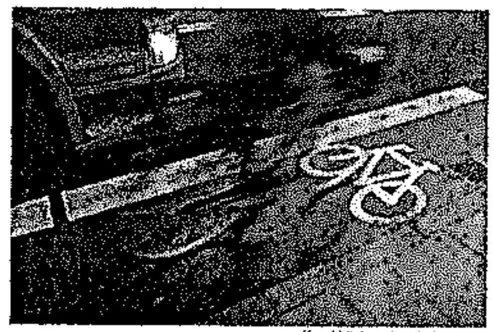
Bike and walking paths are important—we make the case in the later section of this chapter on externalities. But bike paths are often controversial. The lowest-cost bike path is one built on the shoulders of roadways. Car drivers who are not avid or commuter bicyclists believe that bike lanes take something away from drivers: that they take up space that could be used for lanes, that the presence of cyclists complicates driving and increases the risk of fatal accidents, and that cyclists don't pay the fuel taxes that pay for roads. For cyclists such lanes are clearly better than the nothing they have typically received, and better than sidewalks, but they lack both safety and amenity.

An alternative is separated bike paths. Bicycle groups have had some success in lobbying for consideration of bike paths in transportation planning. Old rail lines have been converted to high-amenity bike paths. Neighborhood streets, away from arterials, are frequently designated as bikeways (more on this in the last section of the chapter). Separated bike paths are being built along new suburban arterial streets. And efforts are being made to build connected bike paths through new residential developments.

Bike paths in practice serve also as foot paths. Foot paths, either sidewalks or paths separated from streets, have potential to save car trips. The trick, of course, is to get origins close enough to destinations. Conventional zoning and parking requirements often prevent this, putting distance between commercial centers and residential neighborhoods, and requiring a long hike across a dismal parking lot. With higher residential densities and some thought to the design of commercial development, walking trips could become more important, especially for shopping.

The effects on overall urban transportation in the U.S. of these efforts probably are not large in relative terms by any common measure (e.g., person- or vehicle-miles traveled), but there are several arguments for giving these paths more attention:

- They give a subset of travelers a relatively safe, healthy, and enjoyable alternative to driving.
- Positive livability externalities (see a later section of this chapter).
- One has to start somewhere. In Holland bikes are a significant mode for commuting in urban areas. Yes, Holland is small, densely settled, and flat, but there are many metro areas in North America where bikes have potential. This general paradox of short-run/long-run is one inherent in transportation infrastructure: in the short-run—before people, technology, and the built environment adapt—the new transportation infrastructure looks very inefficient; but if they would adapt in the long run, and if that adaptation provides significant transportation benefits, then one cannot get to those benefits without starting to build in the short run.
- They provide a lot of recreational amenity not only for cyclists, but also for walkers, strollers, and skaters.
- Though users of those pathways do not pay for them directly with user fees, there are benefits to the motorized vehicle drivers that are paying for them with fuel taxes: the absence of walkers and cyclists from the roadway at least reduces driver stress and may eventually reduce in measurable ways the rate at which congestion would have otherwise increased (especially in the long run with different land-use designs and patterns for centers and corridors, which require better ability to make more nonmotorized trips for their success). And they don't pollute the environment (for which drivers don't pay).
- From an equity standpoint, it seems hard to justify the priority that a single human in a high-speed steel box typically gets over single humans on two legs or two wheels sans motor.



Knud Nielsen, iStockphoto.com

Car drivers who are not avid or commuter bicyclists believe that bike lanes take something away from drivers: they take up space that could be used for lanes, the presence of cyclists complicates driving, and cyclists don't pay the fuel taxes that pay for roads. On the other hand, cyclists appreciate such lanes, but they lack both safety and amenity.

Improving the efficiency with which infrastructure is used

Building more capacity is expensive and getting more so. Using congestion as a guide, the most needed capacity is in the highest cost areas. Most business owners work relentlessly to get more productivity out of their investment in production infrastructure (i.e., plant and equipment); so should public transportation authorities. In this subsection we look at methods for getting more vehicle trips out of existing highway and rail transit capacity (we look at methods for getting more person trips out of existing vehicle miles in the next section).

Better highway efficiency: transportation system management (TSM)

The objective of TSM is to get more out of existing capacity (i.e., faster, more reliable, and safer travel). The basic problem is turbulence: even a little disrupts the smooth, linear flow of traffic when congestion is heavy, reducing travel speeds dramatically and encouraging driver behavior that increases the chances of an accident, which further reduces travel speeds and the reliability of travel time.

TSM strategies therefore target a variety of sources of turbulence:

- **Poor highway geometrics.** For limited-access highways, this means turns that are too tight, bottlenecks, or lanes that are too narrow. The fixes are primarily engineering ones: lanes are not added, but the roadway is physically reconfigured to reduce or eliminate the source of turbulence. That could include unbending curves, separating flows with barriers, and widening lanes and shoulders. Many of these types of fixes reduce the risk of accident and injury if speed is held constant, but there is now good evidence, which we discuss later in this chapter, that such improvements will, in many cases, increase speed and, with it, the number and severity of accidents. Trade-offs, again.

Most business owners work relentlessly to get more productivity out of their investment in production infrastructure (i.e., plant and equipment); so should public transportation authorities.

- **Inefficient traffic coordination or use of system capacity.** The best example is signal timing. If the flow is a jerky go and stop, throughput drops. Optimized signal timing and signals on demand improve flow. Ramp metering and expedited toll payment, discussed in other categories below, could also fit here. Many urban areas temporarily reverse the direction of travel on some lanes on an hourly basis to deal with uneven bidirectional flows (e.g., the Golden Gate Bridge in San Francisco; Rock Creek Parkway in Washington D.C.; Seattle I-5 express lanes).
- **Inefficient merging of vehicles entering a busy road.** This happens at highway onramps. The main strategy involves smoothing the entry of vehicles both through improvement in highway geometrics near the intersection (e.g., merging lanes) and ramp metering to help the entering traffic merge smoothly. This also happens on arterials: the problem there is too many vehicles trying to get on the road, and the problems caused when they slow down to get off in too many places (e.g., unprotected left turns into driveways on a busy arterial). The problem has motivated attention to access management.
- **Incomplete information about congestion and alternatives.** If drivers know about traffic problems before they're part of them, they can take steps to avoid them. Radio station traffic helicopters treat this problem. Sensors installed along highways allow transportation managers to monitor highways in real time. Information about highway conditions can be communicated by radio, overhead displays, or through GPS navigation systems. Systems are on the horizon that will recommend routes around the unusual traffic backup.
- **Too many cars on the highway at the same time.** An efficiently designed system used by well-informed drivers can still get overly congested at peak periods. There's capacity to spare off-peak. Policies aimed to spread demand over time include flex-time work schedules and telecommuting. These policies are especially valuable at the morning commute because

commuters appear more time constrained in the morning than in the evening, and on days with bad weather, major pile-ups, or special events.

- **Traffic incidents (e.g., accidents, breakdowns).** Grenzeback and Woodle (1992) report that accidents and disabled vehicles contribute to about 60 percent of the vehicle hours lost to congestion.[6] Appendix C provides some information on types of incidents and why they can be so expensive. Even seemingly expensive methods of clearing incidents might be worthwhile given their high costs (avoiding those high costs mean large benefits).
- **Toll plazas requiring cars to slow down or stop to pay tolls.** High-tech electronic tolling systems that read a bar code or detect a "smart card", as described in Chapter 4, are increasingly being used to collect tolls on highways and bridges.
- **Bad drivers.** Speeding, cutting in, reducing safe driving distance, and shooting at people in other vehicles all disturb smooth traffic flow. TSM measures include more and more sophisticated law enforcement: speed monitoring signs, automatic photographing of vehicles, and ticketing of drivers for running red lights. Given the ubiquity of the system and the cost of labor for conventional methods of enforcement, automated systems have advantages.

We lack the space or will to discuss all the methods transportation agencies use or are experimenting with to reduce turbulence and smooth traffic flow. The Federal Highway Administration's recent publication, "Traffic Congestion and Reliability: Trends and Advanced Strategies for Congestion Mitigation," provides details and direction for further reading.[7]

More useful is an evaluation of TSM efforts as congestion mitigation strategies. Our conclusions:

- Many TSM strategies make economic sense. Most TSM strategies are analogous to the strategies private business owners use to "drive costs out of the system." Thinking in terms of full costs might change obsolescent practices. When a fender bender occurs on a congested freeway, should drivers leave cars where they are (in travel lanes) until the police come? That lost time for so many other travelers is expensive.[8] The lack of competition among transportation system suppliers (compared to that in many industries) has probably allowed too little emphasis on TSM relative to increases in capacity.
- Incident management is a particularly promising technique for driving costs out of the system. Downs (2004a, 99) cites multiple evaluations showing that the benefits of congestion relief and reduced accidents exceed the cost of Traffic Management Centers.[9] Such centers coordinate response activities across multiple agencies, monitor the transportation flow (increasingly, electronically), dispatch vehicles to respond to incidents, divert (with information or barriers) traffic to alternative routes, and collect information about incidents that allows improvements in response.
- Improving efficiency requires more than increasing the numbers of vehicle trips. The reason is that trips vary in their value. Ramp metering provides a good example. It works to smooth the flow of cars entering a highway, so turbulence falls and the number of trips increases. But ramp metering benefits most those drivers who are already on the highway (e.g., those who have long commutes from suburbia) at the expense of those drivers entering the highway on the closer-in metered ramps. It's not clear that the value suburbanites place on their trip is higher generally than that of people who live closer in. Ramp metering may get more throughput, but it tends to reward and encourage suburban sprawl.


Tim McCaig, istockphoto.com

Ramp metering works to smooth the flow of cars entering a highway, so turbulence falls and the number of trips increases. But metering most benefits those already on the highway at the expense of those entering.

- TSM will not cure traffic congestion. TSM effectively works like adding lanes; it increases the capacity of the highway. But triple convergence almost guarantees that highway space will remain scarce.
- TSM has land-use impacts. The impacts are similar to those from adding capacity. The TSM improves access to both the existing commercial centers served by the highway and the suburban areas from which commuters and shoppers come. Thus, land in the commercial centers becomes more intensely developed as does land in the urban fringe.
- TSM should be used in conjunction with demand management. The objective of TSM is sensible: get the most value out of investment in infrastructure. But driver, business, and household reactions to lower travel times in the short run lead back to inefficient levels of congestion, though at higher volumes. Preventing this requires rationing. There are a variety of ways to ration, each with advantages, as we discuss in the next major section.

TABLE 6-2. SUMMARY OF TSM POLICIES

	SUPPLY-SIDE POLICIES	EFFECTIVENESS		COST		IMPLEMENTATION		POLITICAL ACCEPTABILITY
		Extent	Impact	Direct to commuters	To all society	Need for new institution	Ease of administration	
HIGHWAY	Building new roads without HOV lanes	Variable	Moderate	None	Great	Cooperative	Moderate	Poor
HIGHWAY	Building added HOV lanes	Variable	Moderate	None	Great	Cooperative	Hard	Moderate
HIGHWAY	Rapidly removing accidents	Variable	Great	None	Minor	None	Easy	Good
HIGHWAY	Improving highway maintenance	Broad	Moderate	None	Moderate	None	Moderate	Moderate
HIGHWAY	Upgrading city streets	Variable	Moderate	None	Moderate	None	Easy	Moderate
TRANSIT	Building new and expanding existing off-road transit systems	Narrow	Moderate	Minor	Great	Cooperative	Hard	Poor
TRANSIT	Increasing public transit usage by improving service, amenities	Narrow	Minor	None	Moderate	None	Hard	Moderate
ITS	Coordinating signals, traffic monitoring, ramp metering, electronic signs	Narrow	Minor	None	Minor	None	Moderate	Good

Sources: Adapted from Downs 2004a and Ferguson 1998 and 2001

In sum, a variety of TSM projects effectively increase VMT and travel-time reliability without converting more urban land to roadway, at least in the short run. (See Table 6-2 for a matrix of TSM policies and their effects.) That additional trip-making capacity is a benefit for both existing drivers and new drivers that now find conditions attractive enough to make a trip that they previously would have skipped, postponed, or made by a less convenient route or mode. In the long run TSM has effects similar to those from increasing capacity by adding lanes: the new capacity reduces the time cost of travel (its objective), which encourages more and longer trips, route switching, low-density land development at the urban fringe, and higher-intensity development in existing centers. With time, congestion returns. Improving long-term efficiency requires pricing or some other form of rationing (discussed later) in conjunction with TSM.

Better rail-transit efficiency

Here's a scenario with a basis in reality. The political leaders in a growing metropolitan area feel pressure to do something about traffic congestion. Pricing access to highways looks Kevorkian. Federal money is available to fund 80 percent of the cost of a rail transit system. That federal construction money looks great to local businesses, and rail looks a lot better than buses for attracting commuters out of their cars.

But ridership fails to meet expectations, in part because the system takes at least a decade to complete, and highway congestion appears unaffected. In addition to traffic congestion, the metropolitan area now has an expensive and underused rail system.

Pricing car travel would cure both of these problems, but that option is a political swan song, not a theme song. The burning question for the transit agency becomes: how do we increase ridership?

Dropping fares usually isn't a realistic option. Moreover, fares rarely cover 50 percent of *operating* costs (25 to 30 percent is probably a closer average), so operating subsidies are piled onto capital subsidies. The evidence suggests that, in general, dropping fares altogether would not have much effect: commuters who have the choice of driving are more sensitive to the nonmonetary costs of transit travel than to fare. A likely exception to that generalization is fare-free transit zones in dense downtowns, though there the issue is probably still more one of the convenience of the transit system (coverage, frequency, and no fares to mess with) than the fare itself.

What are these nonmonetary costs of transit travel? Chief among them are the time costs of starting from an origin (e.g., home), waiting for the transit vehicle, riding to the stop nearest the destination, perhaps transferring and waiting again for that transfer, then getting to the final destination (perhaps with a longish walk). The time costs can easily be double those associated with the same trip by car. In fact, that's what national averages show: average time for a commute trip by car, 23 minutes; by transit, 46 minutes. Then there are costs of reduced comfort, security, and flexibility, and the empirical evidence that people find waiting time more expensive than traveling time.

Transit operators realize that attracting drivers out of their cars requires performance. The dedicated rail right-of-way provides some of this performance because the train doesn't get stuck in congestion. The main benefit is decreased travel time relative to alternatives. Additional performance benefits, many of which ultimately make a difference because of effects on the amount and variability of travel time, include the following:

- Quick and easy access to secure and attractive stations
- Better coverage and service that reduces transfers
- Reliable service

- Easy to board, attractive, comfortable, and secure vehicles
- Efficient fare collection systems.

The last two of these are relatively easy to provide. Most rail commuter systems offer a variety of methods to pay the fare, including daily, weekly, or monthly passes. Most train cars are easy to board and reasonably attractive. The level of comfort varies, however, and is often inferior to that of a car. Climate control is especially difficult. And security has its costs: its better when the train is full.

Reasonable line-haul travel times and reliability are also reasonably easy to provide on exclusive or priority rights of way. It is a little trickier but solvable to keep LRT or BRT on time because they operate like a streetcar when in the CBD. It is essential to set traffic signals to give LRT priority over cars at intersections. Without separate rights-of-way, however, buses are subject to the same traffic and delay as regular traffic.

Accessibility is a critical characteristic, and is more difficult to provide. People who have options will be put off if it takes an unreasonably long time to access the platform at the station, and, once there, the train is nowhere in sight.

There are several options for improving access to rail transit, each with differing land-use implications:

- Improving car access to suburban rail stations. Usually this means park-and-ride lots and kiss-and-ride drop-off ramps. The disadvantage is that this improves access to the urban fringe, encouraging more sprawling suburban development.
- Providing a local bus system to feed rail stations. This feeder system has to be good enough so that the trip by transit competes with the trip by car.
- Increasing the number of commuters who live within walking distance of transit stations. A 15-minute walk to the transit station may appeal almost as much as a 15-minute drive. To be likely to make this walk, commuters

BRT IN EUGENE-SPRINGFIELD, OREGON

In 2007 the Lane Transit District began operating its BRT system—EmX. The first line connects downtown Eugene and downtown Springfield along the four-mile Franklin Corridor. Buses travel every 10-20 minutes and provide service to two high-transit-ridership generators: the Sacred Heart Medical Center and the University of Oregon. The system has several features to help reduce travel time:

- **Transitways.** Approximately 60 percent of the route is designed with exclusive lanes (transitways) for the EmX vehicle. They allow EmX vehicles to bypass traffic congestion and maintain constant travel times as congestion increases.
- **Stations.** Station spacing along this first route is approximately every half-mile, for a total of eight facilities. Raised platforms are designed to accommodate level boarding, and amenities include real-time information, lighting, furniture, and bike storage.
- **Intelligent Transportation Systems (ITS).** Computer, communication, and sensor technologies allow EmX to use signal priority and queue jumpers, which give the EmX vehicle priority through intersections, and give passengers real-time information updates.

EmX uses a diesel hybrid 60-foot articulated vehicle with wide doors on both sides to allow for boarding on both sides of the bus in stations along the medians. Travel on EmX is currently free, although the system is designed to accommodate pre-boarding fare collection in the future. One month after beginning operations, daily average new ridership on the EmX Franklin Corridor is approximately 4,000 passengers, almost a 50 percent increase over previous transit ridership on the Franklin Corridor route.

ECONorthwest, summarized from (1) Wright, Jeff. "EmX rolls with strong ridership." *The Register-Guard*, February 14, 2007, and (2) Lane Transit District www.ltd.org (accessed 26 February 2007), including photos.

have to live well within a mile of the station. Quite a bit of housing in this short radius is needed to make much of an impact on ridership.

Transit operators often become advocates for the second and third options. Both work better where densities are higher. Indeed, rail transit worldwide works best when development densities are high. But high-density housing requires relaxation of suburban density and parking requirements.

Is low-density zoning the cause of low-density development? It might be. As described in Chapter 2, high-density housing can have negative fiscal and congestion effects, so neighbors oppose it, and zoning prevents the market from supplying it. There may be households, such as the growing cohort of empty nesters, who would be happy to live in higher-density housing and commute to work and play on a good rail transit system. Allowing high-density housing near transit stations seems a happy scenario from a metropolitan standpoint. Careful design and financing could minimize negative external impacts.

In some places, however, high-density development may be wishful thinking. Commuter rail lines have to usually be built to serve suburbanites (actually skipping past poorer inner-city neighborhoods) because these are the people who need to drive less to reduce congestion. Relaxing zoning in these areas may simply have no effect. The tendency then is to try to encourage high-density development through even more subsidy, this time of land development.

Urban containment can address the problems associated with each of the tactics above. An urban containment boundary prevents some of the sprawl induced by park-and-ride transit. The reduced supply of land reduces ridership, but the park-and-ride lot still attracts riders from nearby suburban areas.

The urban containment boundary also increases the demand for high-density development near transit stations. This may especially be needed if, as is usually the case, suburban highway capacity is being increased at the same time as rail transit. The reduction in supply of accessible and developable land raises suburban land prices encouraging more intense development. Relaxing zoning restrictions to allow it makes sense around transit stations.

Another alternative is BRT. It offers many of the advantages of rail transit, but potentially with more route flexibility that can reduce transfers. BRT routes can take advantage of separate right-of-ways, making them faster, more reliable, and safer than cars along congested corridors. Such rail-like right-of-way investments can provide land developers and their customers signals of commitment to an area that make it attractive for economic development. The buses can operate more flexibly than LRT on city streets. Successful examples include Curitiba, Brazil, and Bogota, Colombia.

Relatively quick, convenient, and reliable rail and bus feeder service, or BRT, could lead to long-term economic development benefits in terms of land-use, design, and travel patterns. But capturing those benefits requires a well-integrated and efficient system, which takes time to build (potentially decades) and more time to generate its full effects. To capture the long-run benefits of rail transit, which might well be thought of as a "legacy investment" (think about New York City's subways), decision makers should probably use a 50- or 100-year rather than the typical 20-year planning horizon.

Relatively quick, convenient, and reliable rail and bus feeder service, or BRT, could lead to long-term economic development benefits in terms of land-use, design, and travel patterns. But capturing those benefits requires a well-integrated and efficient system.

Toronto provides an example. Toronto invested heavily in rail transit in the 1950s, prior to highway-induced suburbanization. Rail transit has since provided a variety of benefits to urban form, the economy, and the livability of that city—impacts that a conventional benefit-cost analysis done in 1950 would likely have missed. These impacts have depended on implementation of a variety of regional land-use and transportation policies that have made rail transit competitive with the auto in Toronto.

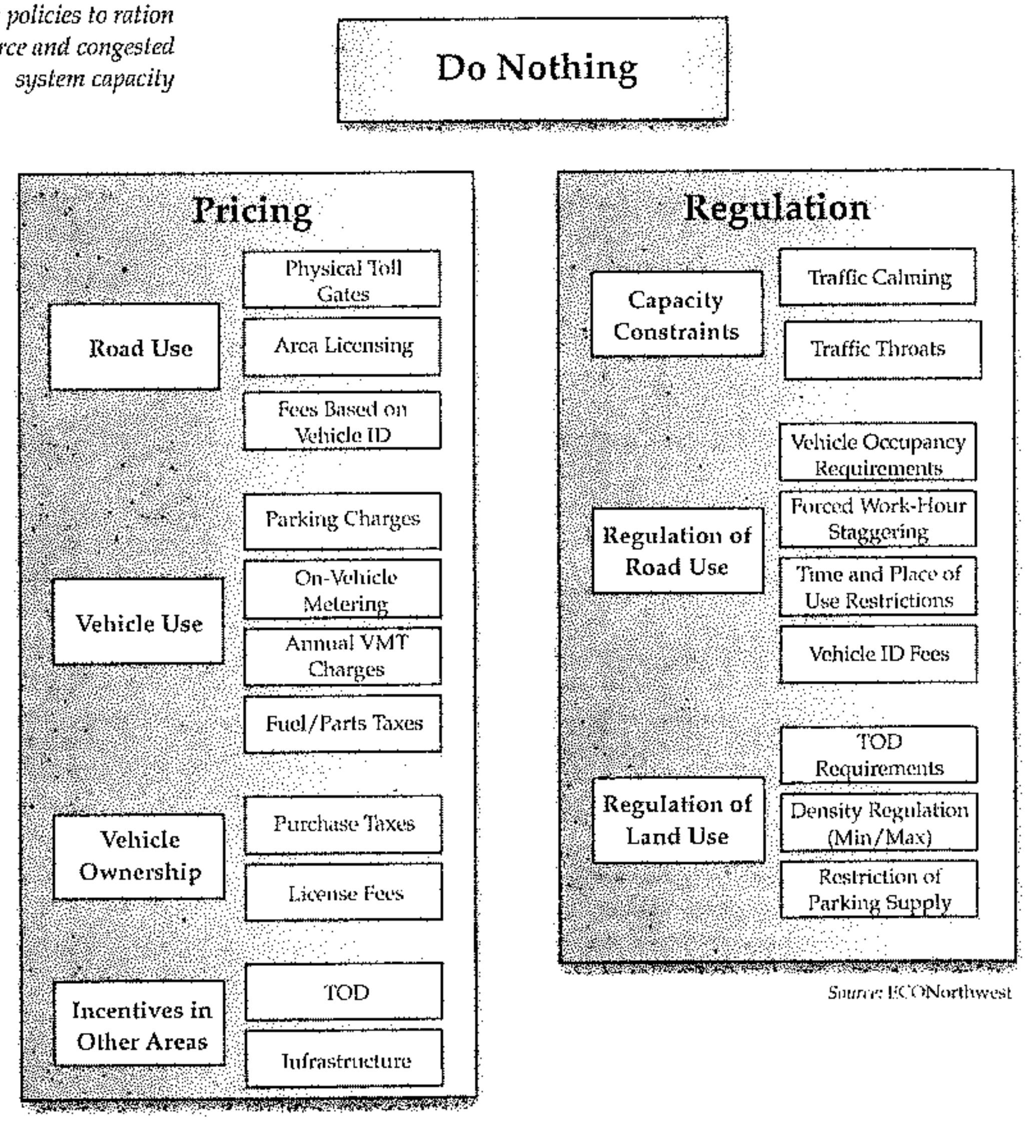
POLICIES TO IMPROVE THE USE OF VEHICLES

The public sector supplies most transportation infrastructure—the paths. The private sector supplies (builds, purchases, owns, and operates) most of the vehicles that use that infrastructure. But public policy can affect the way those vehicles are used.

The benchmark policy is peak-period pricing of highways and parking (i.e., congestion pricing). That policy prices vehicle trips, not person trips. Vehicle trips can, in concept, fall by a large proportion (and treating congestion requires only a small proportionate drop) without much if any decrease in person trips. A lot of vehicle capacity goes unused a lot of the time: passenger and back seats of cars and vans, empty seats in public buses and trains, bikes collecting dust in the garage, and legs that spend too much time crossed in front of a chair. Peak-period pricing of congestion and parking provides strong incentives to use that capacity more efficiently.

But pricing policies, and others that substitute for them, are difficult to implement. They affect behavior, and that's "social engineering" (which is apparently even worse than planning). The fundamental beliefs that planners are up against are: (1) I've paid for this system with gas taxes and my

Figure 6-1. Transportation demand management: a framework for thinking about policies to ration increasingly scarce and congested system capacity



Source: ECONorthwest

purchase of a motor vehicle, (2) the fact that I've traveled this way for several months (or years or decades) means that I have a right to travel this way forever, and (3) I know what's good for me better than the government does.

That last point requires careful attention because it is so often true. Planners need a good understanding of where travel demand comes from and how people get benefits from the transportation system before they start slowing traffic, raising auto costs, and telling people that they are better off on transit. Appendices C and D contribute to that understanding—we provide an abbreviated discussion here.

A variety of factors influence the demand for a good or service. Especially important are the price of the good or service itself, the prices of substitute goods or services, and the purchasing power (i.e., wealth or income) of consumers. This section focuses on the first two of these in the context of demand for trips by modes other than the SOV:

- Policies that decrease the cost of modes alternative to SOV. These include subsidies to HOV travel on the highway (e.g., carpools, jitneys, and buses); HOVs that travel in other rights of way (e.g., rail transit or bus-ways); and travel on foot or bicycle on sidewalks or in bike lanes. Reducing the costs associated with travel by these modes (all else the same) increases travel overall, and shifts some person trips out of SOVs.
- Policies other than congestion pricing that ration travel by SOV. Congestion pricing rations space on the highway to those most willing and able to pay. While we sang its praises, the back beat was its political impediments. But there are other ways to ration space, each with its advantages and disadvantages. A big advantage of these policies, however, is that they attack the problem of congestion directly, and thereby encourage person trips by models alternative to SOV. In the parlance of transportation, such rationing is done with transportation demand management (TDM). Figure 6-1 illustrates three broad ways to ration demand:
  - Do nothing. Congestion will grow and drivers will respond to the price of that congestion
  - Change prices. This is the standard economic solution to scarcity.
  - Regulate use. This is a more typical government solution to scarcity.

  A big advantage of TDM policies is that they attack the problem of congestion directly, and encourage person trips by models alternative to SOV.

The organization of this section could follow that of the previous one: first more, then more-efficient, vehicles. But there are already plenty, really too many, private motor vehicles. If highways, parking, and vehicle emissions were all properly priced, there would be demand for additional private or public vans, buses, train cars, and bikes. Industry can supply this demand. Thus, we skip the "more-vehicles" category of action for SOVs. (We acknowledge that a policy of "having more HOVs" is a reasonable one, but we deal with much of that topic above in the section on better rail and transit service. The main purpose of more vehicles in most cities is to reduce headways, not supply more capacity for excess passengers.) We focus on policies that encourage more efficient use of the vehicle capacity we already have, or could easily produce.

We organize the discussion based on how a policy affects the demand for vehicles: Does it reduce the cost of using an alternative to SOV (i.e., more HOVs)? or Does it ration the use of SOV, encouraging the use of other modes?

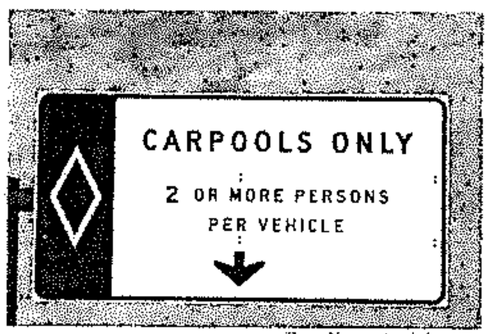
Increasing HOV

Congestion, parking, and emissions pricing (the benchmarks) work by increasing the total cost (out-of-pocket money plus time) to the driver of an

SOV trip, even though they decrease private time cost and total *social* cost. This higher total private cost encourages travelers to seek alternatives to travel by SOVs, primarily HOVs, which spread the higher out-of-pocket costs over more travelers. The greater demand for HOVs encourages improvements to HOV infrastructure and rolling stock. Travel by HOVs increases and highway congestion decreases.

Might things work the other way? Will reductions in the time and out-of-pocket costs and improvement in the other characteristics of travel by HOV encourage more travel by HOV and less congestion? Yes, the demand for travel by HOV will increase. But no, this will not reduce congestion, at least in the long run. The result is usually more travel and continued congestion. Nevertheless, improving the characteristics of alternatives to SOV travel are likely to improve the political prospects for congestion pricing—there's a decent alternative waiting to be used when the tolling starts—and can have desirable effects on land development.

In this subsection we first discuss the effect of dedicating existing highway space to HOV travel (i.e., carpools, vans and jitneys, and buses). Then we discuss subsidies of rail transit or BRT. We deal with the alternative modes of walking and biking (or whatever rolling mode gets used on sidewalks, bike lanes, and roads) in the later section on controlling neighborhood externalities.



Thana Navarro, istockphoto.com

Pricing congestion, parking, and emissions encourages SOV drivers to seek alternatives, primarily HOVs, which spread the higher out-of-pocket costs among more riders.

HOV lanes

HOV lanes improve car commuters' incentive to increase the vehicle occupation rates of their cars or vans. The incentive comes in the form of faster travel speeds. As long as there are relatively few multiple-occupant vehicles, dedicating one or more lanes to their use allows them to cruise past SOVs stuck in congestion.

HOV lanes similarly improve the demand for trips on standard public buses. A big cost, usually bigger than the fare, of riding a bus is the value of the time it takes walking and waiting to catch it. That point is critical to understanding how people make the choice between SOV and HOV trips. Transit trips are more likely to have multiple modes, and transferring modes has a time and convenience penalty. One has to walk (sometimes encumbered by bags, foul-weather gear, and weather), and one has to wait. Because there is variability around transit arrival-departure time, one must arrive early: wait time is inevitable if one is risk averse about missing a connection. Unless you live near a rail stop and work near another on the same line, there is a lot of access and waiting time.

An HOV lane can help compensate riders for the cost of time by providing faster and more reliable travel than that by SOV. An HOV lane makes a regular bus perform on the line-haul portion of the trip like BRT.

Dedicating a lane to HOV use has the short-run effect of speeding HOV travel, which may improve the overall efficiency of the transportation system: the time saved by the relatively many people in the HOVs may more than make up for the now even slower travel in the now fewer SOV lanes.

The faster HOV travel encourages more drivers over time to organize carpools, join van pools, pick-up respectable-looking hitchhikers, or buy blow-up dolls to serve as passengers. (There is evidence for all these responses: innovation emerges in a market economy—tell me the rules and I'll find creative ways to obey them.) The consequent drop in the number of SOVs, if significant, should increase travel speeds in the unrestricted lanes (at least temporarily: triple convergence again), and the increase in the number of HOVs should slow travel in the restricted lane.

One might expect that travel in all lanes will converge to the same speed on average. This is like the lines at the check-out counters at the grocery store: in equilibrium they all move on average at about the same pace. But travel in HOV lanes is likely to remain speedier on most days to compensate for the hassle of organizing the group travel. The result is that the drivers in SOVs are likely to see the HOV lane as underused.

Many moderately disgruntled commuters can produce quite a bit of political pressure to drop the restriction on the HOV lane(s). Roark (1981) notes that commuters tend to accept the building of an additional lane for HOV use (rather than restricting an existing lane) or converting a lane from the low-flow side of the highway. Commuters better accept HOV lanes that are physically separated from other lanes by a permanent barrier. Carpool lanes that require two occupants tend to work better and are more readily accepted better than those that require three occupants (due to lower organizing costs).

There are also ways to reduce the hassle of organizing group travel. An example strategy is "rideshare matching." Employers or the public sector can use web sites or other methods to help those interested in carpooling to match up with others in their area who travel at similar times to similar locations. They can help provide locations for informal carpools, which skip the organizational hassles and can often operate on demand.

"Car sharing" is another clever example of a way to reduce a disadvantage of car-pooling. Commuting by transit or carpool means lack of access to a car during the work day. With car-sharing, participants purchase hourly or monthly plans to use a "share" of a pool of vehicles, and are able to use any vehicle in the program any time they like. Vehicles are ideally located throughout a downtown and once enrolled, participation in the program is simple.

More ways to improve mass transit

HOV lanes help, but both public rail and rubber-tire mass transit face serious challenges in suburbia. Buses and rail cars running mostly empty are common sights in many metro areas. Filling these vehicles, and hopefully additional ones, is a priority for transit agencies.

Consider the challenges for rail transit. Simple geometry dictates that very little of suburbia will be within walking or even reasonable cycling distance of a rail transit station. To see this, think of a city with five radial transit lines that radiate from its CBD. Transit stations are located every mile along every line.

To start, let's go out five miles from the CBD—not far by suburban standards. The circumference of the urban area at this point, with a radius of five miles, is larger than 30 miles around. If there are five radial transit lines, each with a station at the five-mile market (i.e., right on our line), only one-sixth of the distance on that ring is within a half mile of a transit station. Move this out to 10 miles and the ratio falls to one-twelfth.

Now think in terms of land area. There are roughly 75 square miles of land in a ring of radius five miles. Given our assumptions, there are about 26 transit stations that service this area. If the bulk of their riders are within one-half mile of each station, each station serves a primary market area of about three-quarters of a square mile; 26 stations cover about 19 square miles; about 25 percent of the area has good access to the rail stations. Now double the radius to 10 miles. The land area quadruples to over 300 square miles. The number of transit stations only doubles to 51, so now stations cover about 38 square miles; and about 13 percent of the area has good access to the rail stations: double the radius, and the coverage drops to half. Suburbia is hard to service with radial transit.

The challenge for commuter transit in suburbia is finding efficient ways to feed rail transit stations and fill the buses that use HOV lanes on highways.

The elasticities reported in Appendix C suggest that the biggest impediments to bus ridership are:

- time spent walking;
- time spent waiting, especially with uncertainly about how long the wait will be due to poor reliability; and
- the comfort and security of the transit vehicle.

The last of these can be treated directly with an inflow of cash. Unless the alternatives are unacceptably bad, transit vehicles have to meet a standard of comfort not much lower than that offered by cars. They have to be clean, the seats have to be comfortable, and the commuter has to feel reasonably secure. If you have ridden in crowded buses or subways at rush hour, nose-to-pit with your fellow travelers as you jostle through the humid darkness, you see that is a hard test to consistently pass. Oh, and your cell phone doesn't work underground (although that's changing).

Reliability is especially important for trips that feed rail transit. More reliability means less waiting in uncertainty at both the bus stop and train station. Reliability is a tough problem for fixed-route buses operating on congested suburban streets. A brute-force option is to increase the number of vehicles on each route; more vehicles means shorter headways, and less waiting on average (though it's hard to guarantee that actual waits are close to the now shorter average).

A high-tech treatment is to communicate to riders electronically, perhaps over the Internet via home computer or cell phone, the location of the bus in real time. Commuters can then time their departure from home. Similar communication between the bus and the train helps ensure that the train doesn't pull out just as the bus arrives at the station.

The performance characteristics of rubber-tire mass transit in most suburban areas require considerable improvement to draw many travelers out of their cars. That improvement requires cash, but also flexibility and entrepreneurship.

An alternative to a fixed-route system on a fixed (but often unreliable) schedule is a flexible jitney service. The operator takes advantage of logistics software to pick up commuters in a van or small bus at their house. This eliminates walking. Electronic communication might eliminate uncertain waiting. Similar communication between the van and train helps coordinate the transfer. This system could be private or public, but it clearly represents a leap from that typically available at present.

In short, the performance characteristics of rubber-tire mass transit in most suburban areas require considerable improvement to draw many travelers out of their cars. That improvement requires cash, but also flexibility and entrepreneurship. As we noted in Chapter 4, the private sector might be in a good position to provide these services, given the opportunity to do so by relaxing restrictions against private jitney services.

Rationing vehicle trips

Treating congestion on highways and in parking lots, and reducing smog requires rationing. Pricing has several hard-to-beat advantages: (1) it reduces congestion and pollution; (2) it discourages the low-value trips (those trips whose drivers are unwilling or unable to pay the congestion, parking, and emissions tolls); and (3) it generates revenue that both signals the net benefits of and pays for highway and parking capacity.

Proper pricing will not be implemented soon in a big way in most metropolitan areas. But other rationing techniques and policies have been identified, analyzed, tested, and implemented. This section starts with a discussion in the abstract of the various mechanisms available to ration the limited supply to the huge demand that exists at low prices. We then turn to description and evaluation of strategies used in practice. We finish with an evaluation of planned congestion as a demand-management option.

The need and the possibilities

We discussed marginal-cost pricing as a method for rationing demand in Chapter 4. There are alternative methods of rationing that warrant consideration:

- *First-come, first-served (queuing).* This is essentially the current method for allocating highway space. There is an efficiency rationale for queuing: those who most value the trip are the most willing to wait in line. Limiting the quantity of cars allowed on the highway, however, would improve travel speeds. For example, cars could line up at each interchange, with the first X number allowed onto the highway over any given period of time. This is a common mechanism for rationing access to popular rides at amusement parks, popular concerts, and popular sporting events. The time and energy spent queuing is itself, of course, inefficient.
- *Regulation.* A local government can choose how many trips to allow and to whom to allocate those trips. A simple example of a regulatory mechanism is allowing only certain license plate numbers: even numbers one day, odd the next. More likely, some sort of priority system would be developed. Health care is often rationed this way in public health systems. For example, the value of a vehicle trip could be rated by a point system according to the social value of each characteristic of the trip. Drivers with highly rated trip characteristics could apply on-line for a trip pass, print it, and take it to the control booth at a highway entrance point at the appointed time. (That should be a good defense against those claims of social engineering: try it at your next public meeting.)
- *Tournament.* Rather than setting up a priority points system ahead of time, the government could, in concept, allow drivers to compete or make their case for access to a permit. Though impractical given the large number of drivers, a tournament format could be, and sometimes is, used on the land-use side of the connection: a city restricts its number of residential building permits (justified based on its limited capacity to provide adequate public facilities), and allocates those permits to developers with the "best" proposals.
- *Lottery.* Again, the transportation authority chooses how many trips to allow, but the trips are ranked using some random mechanism, such as coin flips or a random-number generator. The lucky drivers get a pass to take the trip. Though seemingly egalitarian, fortune may not smile on people with extremely high-value trips. And revenues are not generated to pay for capacity. Lotteries are commonly used to allocate permits to float backcountry rivers, whose capacity cannot be further expanded without changing the experience that recreationists value and endangering the environment that is the source of that experience.
- *Tradable permits.* The government distributes the chosen number of trips to vehicles somehow equitably (e.g., by lottery or in proportion to the current use of the highway). The permits are transferable across vehicles, so drivers could buy and sell permits for trips at specific times. The government could create an on-line market or allow private market makers (e.g., Ebay) to match buyers and sellers. Trading establishes a price for permits that varies by time of day, which allocates trips to those most willing to pay. The allocation of trips is efficient. But the revenues generated by sales of permits go to those to whom the permits were initially allocated rather than to the transportation authority to pay for highway capacity. Tradable permit systems are in use to control some forms of air pollution; in this case, revenues cannot be used to increase the capacity of the environment to absorb pollutants.

- *Auction*. The government can choose the maximum allowable number of vehicle trips and let the participants in auctions set the price. Drivers, for example, could submit bids online for a permit to enter the highway over any short time period, and the available number of permits would be allocated to the highest bidders, with all bidders paying the lowest winning bid. That lowest winning bid is the price of access to the highway and would vary with demand; bidding establishes the congestion price. This kind of mechanism is used for auctioning federal government bonds.

At an abstract level, these, along with congestion pricing, are the mechanisms available for rationing space on a highway. Let's make it less abstract.

Rationing tactics in practice

Politics precludes full-cost pricing of car trips. But the results of nonpricing have motivated thinking to identify politically palatable policies that push the costs of vehicle trips in the right direction. We organize these by how they affect vehicle-trip demand.

- **Raise the out-of-pocket cost of a vehicle trip**. Congestion pricing, which raises the cost of private vehicle trips, is long run and not part of our list here. What's left, and what's right?
  - Raising the fuel tax. Among the best of the second best policies. Chapter 4 discusses its pros and cons in detail. Still a political challenge, but a surmountable one: it is not a new tax, it has an administrative structure in place, people understand it, and it has a relationship to the cost of driving. The big limitation: it is not sensitive to the key elements that define congestion: place and time.
  - Cashing-out free parking. Employers who typically provide employees with free parking could instead offer them the choice of free parking or a cash payment equal to the cost of the parking to the employer. It appears that no one loses, and some drivers will respond to the cash incentive to commute by an alternative mode. Shoup (2005b) estimates that such strategies could reduces automobile commuting by anywhere between 10 to 30 percent.
  - Converting some of the fixed costs associated with car travel to variable costs. Car owners already pay insurance premiums and fees. Neither usually varies with the miles the vehicle is driven. But the probability of an insurance claim rises with miles traveled (all else the same), as does the likelihood of incurring various public enforcement and administrative costs (pay-at-the-pump insurance premiums). A VMT tax may be a more appropriate method for charging for these costs. Though harder to collect, the vast majority of drivers may be no worse off, and many drivers might be better off driving less and saving on their insurance and registration payments.
  - Establishing tradable travel permits. Maybe clunky in practice, but the idea is simple: choose the desired level of traffic and distribute that number of travel permits freely to the everyday users of the corridor. Set up a trading website and let the market work. Commodities exchanges and futures markets are well established and efficient, why not add vehicle trips to the trading? The government doesn't get the revenue (that's part of the appeal, after all), but it still gets the price signals.
  - Returning congestion charge payments in a lump sum to drivers. This sounds odd: take their money a little at a time, and give it back all at once. But it could work to ration demand. On any given day, the

congestion toll has its usual effect of discouraging trips of low value.

- **Raise the time cost of an SOV trip.** Increasing travel time is a bad way to state the objective. The right way to say it is either or both (1) increase the degree to which travelers, as travelers (not as employees or taxpayers), pay for the full costs of their travel, and (2) pursue certain policies for the benefits they yield, and, in doing so, accept increases in the costs of SOV travel as one of the costs to pay for those benefits. Possible policies that meet this second condition:
  - Access management. Reducing or restricting the number of entrances to and exits from a highway or arterial street serves TSM purposes. Traffic moves more smoothly. But fewer access points means slight or substantial increases in the time costs of some car trips.
  - Traffic calming. Traffic on local streets generates negative noise, safety, and social externalities. Traffic calming involves street designs (e.g., speed bumps) that slow vehicular travel, which increases travel times and discourages trips (more on this in the next major section).
- **Place regulatory restrictions on car travel.** As a practical matter, many people are more sensitive to cash outlays than to inconvenience. In concept, time is money: a person who spends less time in traffic could be working more hours for pay. Converting time to money isn't always easy in practice; many hourly wage earners have no control over hours worked, and many salaried workers have no control over their salary. Regulations that serve a reasonable purpose, but that impose cost in terms of time or inconvenience, may generate less opposition than pricing. These include:
  - Relaxation of minimum parking requirements or imposition of maximum parking requirements. If parking has a beauty, it is the kind only an engineer can love, and it takes up a lot of space. A rational concern about not finding parking motivates trips by transit, foot, or bike.
  - Restricting car use in some areas (car-free zones). Proceed with caution. Shopping malls are car-free areas that are surrounded by parking lots. Cities around the country in the 1970s and 1980s experimented with downtown pedestrian malls, with some disastrous results. Nevertheless, it can work: witness Santa Monica, California, Boulder, Colorado, Charlottesville, Virginia, and any number of pedestrian areas in European cities. Prerequisites are worthwhile destinations and good access to the area either by car or alternative modes.

Society as a whole is obviously better off with better management of its scare resources: land, infrastructure, and environment. The trick is finding ways to distribute the net gains in politically acceptable ways.

Table 6-3 shows the path by which these and other policies affect the demand for auto trips. There are probably other tactics and strategies that could both work and pass political muster. Indeed, there must be because too much vehicle travel generates a social loss. Society as a whole is obviously better off with better management of its scare resources: land, infrastructure, and environment. The trick is finding ways to distribute the net gains in politically acceptable ways.

Doing nothing: congestion as rationing

The underpriced congestion and pollution costs of travel by auto have probably resulted in current highway capacity exceeding the optimal capacity in some areas, perhaps substantially. A paradox?: How can we have congestion and too much capacity at the same time? If you've read this far, you should be able to answer that question.[10]

Some planners have proposed that congestion simply be allowed to increase. As congestion increases, the cost of a trip as perceived by the driver

TABLE 6-3. HOW TDM POLICIES AFFECT THE DEMAND FOR AUTO TRIPS

TDM POLICY	DETERMINANT OF DEMAND AFFECTED	EXPECTED STRENGTH OF EFFECT ON AUTO TRIPS
Promote HOV use	Tastes	Weak
Coordinate carpools	Waiting time	Weak
Decrease fares or HOV costs	Transit fare	Moderate
Improve access to transit	Walking time	Moderate
Improve transit service	Waiting and Riding time	Moderate
Provide HOV parking	Riding time	Moderate
Guarantee a ride home	Waiting time	Moderate
Increase parking fees	Auto trip cost	Strong
Parking Cash Out	Transit trip cost	Strong
Increase parking fees	Auto trip cost	Strong

Sources: Compiled by ECONorthwest from Orski 1991, Ferguson 1990, Kuzmyak 1990, Wachs 1991, and Shoup 2005a, 2005b

increases, which encourages some drivers to switch to other modes. Halting new investment in an already overbuilt highway system allows local governments to direct funds toward improving access to other modes or toward projects that reduce the negative effects of the auto on urban environments. Though highway traffic volumes and travel times would, under this policy of planned congestion, remain higher than optimal, the efficiency of the entire transportation system would improve relative to what it would be if highway capacity had been expanded.

Doing nothing might also ease the transition from the current policy environment to a more efficient system of prices in the future. Congestion pricing would increase the demand for high-occupancy modes. Using funds diverted from capacity expansion to improve the quality of these modes might increase the political acceptability of pricing highway access because good alternatives would already be available. Second, a high level of congestion by itself increases the acceptability of pricing. Allowing congestion to build on existing highways may be an effective short-run approach to smoothing the transition in the long-run to a more efficient system of prices.

To make the argument more concrete, consider a congested bridge. An efficient peak-period congestion toll could reduce travel on the bridge sufficiently to eliminate the need for bridge expansion. In other words, the bridge might be the right size, but in the absence of efficient pricing (tolling) it remains overly congested. Moreover, money from state and federal fuel tax revenues is available to increase the capacity of the bridge. Nobody in the community would pay noticeably more for a new bridge: if this community chooses not to use the money, some other community will. Thus, the new capacity not only improves travel conditions (at least temporarily), but it also funnels money into the community in the form of construction contracts.[11]

The proponents of planned congestion would argue that the bridge should not be expanded, but neither should the funds available for construction be turned down. Congestion on the bridge exists not only because access to it is underpriced, but because of the inefficiently high cost of using other modes. The funds earmarked for adding capacity to the bridge would be better spent improving infrastructure that serves other modes within the corridor.[12]

There is sense in all this, but there is a downside: the mammoth cost of the overly congested highway system. Millions of commuters spending perhaps 10 to 30 (or more) extra minutes every day commuting to work until pricing is implemented. Millions of dollars worth of lost time daily.

The following analogy may make the issues more clear by stepping away from transportation temporarily.

Yosemite and Yellowstone National Parks are congested during the summer peak. The logic goes like this: these parks are a national treasure for all; it would not be fair to price out lower-income visitors; we should have low entrance fees. The entrance fee is $20–$25 per car, good for seven days of use: for a family of four, that's less than a dollar a day per person; the weekly pass costs about what it would cost two people to spend two hours in a movie theatre. So, yeah, for these parks the price perceived by the user is low—very low.

Underpricing leads to over use: congestion. Among the costs of congestion are negative externalities: air and water pollution; loss of scenic value; loss of the experience value. The Park Service tries supply-side solutions: builds more camp grounds; puts in a bus system; adds other attractions to keep people occupied and satisfied. But eventually, expanding supply just seems too stupid. Nobody really wants all those people there, including the people who are there.

Some people shift to the off-peak season: it's less desirable than an uncrowded summer visit, but more desirable than a crowded one. Some people endure the congested entry and exit because it is a small part of the cost of their trip: they are passing through the crowded tourist areas on their way to a week alone in the high country.

But the majestic and accessible main valleys and attractions are very crowded. One solution: forget about it; do nothing and let people keep coming until it is too unpleasant to come anymore.

That solution seems unlikely to be efficient in any economic sense (though it has some populist appeal). Reducing the congestion by rationing the demand, even crudely, is likely to increase the total net benefits of visitors. Access to scenic rivers, such as the Colorado and Rogue, for example, is rationed according to a lottery. A poor person is as likely as a wealthy one to get a permit. This system does not maximize the *dollar value* of economic surplus, but it's both much better than doing nothing and retains the populist, egalitarian appeal.

So is do nothing the right solution? Definitely not if that remains the primary method of rationing demand. The cost in terms of lost travel time is too high. But it might be a better short-run policy than some inefficient capacity expansion, particularly if it speeds implementation of congestion pricing and the shift to higher-occupancy modes that pricing encourages. In short, there are better policies for addressing highway congestion than ignoring it, but there are not many that are easier.

POLICIES TO MITIGATE TRAFFIC EXTERNALITIES

Chapters 3 and 4 explain external costs as a form of market failure, why that failure is inefficient, and how public policy might address external costs via pricing or standards. The examples used were the standard ones from environmental economics: air and water pollution.

The construction and use of transportation clearly has negative impacts on air and water resources, and much of that impact is an external cost in the sense that those imposing the cost do not pay its full cost directly. But Chapters 3 and 4 have covered the theory and practical techniques for dealing with these types of external costs.

TABLE 6-4. SUMMARY OF TDM POLICIES

STRATEGY	DEMAND-SIDE POLICIES	CONGESTION RELIEF EFFECTIVENESS		SOV REDUCTION*	DIRECT COST		IMPLEMENTATION		POLITICAL ACCEPTABILITY
		Extent	Impact	Impact	Direct to commuters	To all society	Required institution	Ease of administration	
LAND USE	Adopting local growth limits	Narrow	Minor	Unknown	None	Minor	None	Easy	Good
	Clustering high-density housing near transit station stops (TOD)	Narrow	Minor	Moderate	None	Minor	Cooperative	Hard	Moderate
	Keeping densities in new growth areas above minimal levels	Broad	Moderate	Moderate	None	Minor	Regional	Hard	Poor
	Improving the job-housing balance	Broad	Minor	NA/ Moderate** to Great	None	Moderate	Regional	Hard	Poor
	Concentrating jobs in big clusters in areas of new growth	Narrow	Minor	Minor, depends on J/H Balance**	None	Great	Regional	Hard	Poor
ALTERNATIVE HOURS	Encouraging people to work at home	Broad	Minor	Positive	None	None	None	Moderate	Good
	Changing federal work laws that discourage working at home	Broad	Minor	Positive	None	Minor	None	Moderate	Moderate
	Staggered work hours	Moderate	Minor	None	None	None	Cooperative	Moderate	Moderate

ALTERNATIVE MODES	Encouraging formation of TMAs, promoting ride sharing	Narrow	Moderate	Moderate	None	Minor	Cooperative	Hard	Moderate
	Build comprehensive bicycle/transit network**	Variable	Minor	Moderate	None	Moderate	Nohting new	Moderate	Moderate
PRICING	Providing income tax deductibility for commuting allowances	Variable	Great	Great	None	Minor	None	Easy	Poor
	"Cashing out" free parking provided by employers	Broad	Great	NA/Great**	None	Minor	None	Hard	Moderate
	Substantially Increase gasoline taxes	Broad	Moderate	NA/Great**	Great	Moderate	None	Easy	Poor
	Increasing automobile license fees, sales taxes	Broad	Minor	NA/Great**	Moderate	Minor	None	Easy	Poor
	Eliminating income tax deductibility of free employee parking	Broad	Great	NA/Great**	Great	None	Cooperative	Moderate	Poor
	Instituting peak-hour tolls on main roads	Broad	Great	Moderate	Great	None	Regional	Moderate	Poor
	Parking tax on peak-hour arrivals	Broad	Great	Moderate	Great	None	Regional	Hard	Poor

TMA = transportation management association
Adapted from Downs 2004a; Ferguson 1998, 2001; and Zupan 1992
* Based on Zupan 1992 If "Not Addressed NA" then Authors' Opinion **
** Author's opinion

In this section we limit our discussion to a different type of external effect, though we admit the differences are hard to separate: the effects that occur to the social and economic environment along a street as it gets "improved" to facilitate traffic flow. More and faster traffic on a street increases noise, inconvenience to pedestrians and bicyclists, accident risk, and, ironically, congestion.

Congestion on highways and major corridors increases the demand for travel on less-congested local streets. Congestion pricing, by raising the cost of highway travel further, will further increase demand for travel on unpriced local streets. That diversion of trips to local roads is a strong source of political opposition to congestion pricing.

With or without congestion pricing, the negative externalities of vehicular traffic on the local street system merit attention. In this section we investigate policies to trade off the transportation capacity that the local grid offers with the desire for safe and pleasant neighborhoods.

Consistent with our views in the rest of this report, we see the options for dealing with these types of external costs as broadly: pricing (markets) or standards (government regulations). We have already exhausted ourselves, our readers, and the literature with our previous description of pricing policies. Clearly, any of the pricing policies described early in this chapter can have a beneficial effect on creating livable streets. For example, parking pricing can reduce travel, encourage mode shift, and help finance better design for livable streets.

More and faster traffic on a street increases noise, inconvenience to pedestrians and bicyclists, accident risk, and, ironically, congestion.

Moreover, some of the nonpricing policies aimed at travel performance can also help create livable streets: with careful consideration and planning, a bypass may be able to divert faster, through traffic and leave a local main street with a traffic flow that permits and encourages walking and livable design. Another example: depending on how it is implemented, TSM measures to increase roadway performance may enhance or detract from livability. Appendix C shows that two roads of three lanes are more effective at carrying traffic than one road of six lanes; but TSM measures like one-way couplets will speed up traffic and, other things being equal, decrease walkability.

Thus, in this section we limit ourselves to a brief discussion of policies and designs aimed directly at dealing with the negative effects car traffic has on urban areas as social places. Another way to define the topic of this policy investigation would be "policies for creating livable streets."

The street environment is a place where drivers, pedestrians, and bicyclists continually engage each other in an informal negotiation over who commands the street. Streets engineered for fast-moving cars generate noise, exhaust, and threat of injury that cause people to retreat from the street environment—the most accessible public space to any home for socializing and physical activity.

Appleyard (1981) championed the idea of livable streets a quarter-century ago: slowing traffic and lowering volumes enhance the street's sense of comfort. Some recent research:

- Slowing traffic makes a street much safer. A pedestrian struck by a vehicle going 30 mph is eight times as likely to be killed as one hit at 20 mph, who will likely survive the crash 95 percent of the time.[13] And the likelihood of such an accident happening is lower at 20 than at 30 mph.
- Jacobsen (2003) presents evidence that collision rates decline as the number of pedestrians and cyclists present increases. Drivers apparently travel with more care when they expect people to be around the street, which indicates that sharing the street between cars and pedestrians also makes them safer.

- Narrow streets make the street safer. Swift (1998) found a high correlation between street width and accident rates.
- Dumbaugh (2005) found that beautifying streets with "livable streetscape" elements, such as buildings with complex facades close to the street and street trees, which are often viewed by traffic engineers as decreasing vehicle safety, actually cause drivers to slow down and drive more carefully, thereby increasing a street's overall safety for all users.[14]
- Residents who live on pedestrian- or bicycle-friendly streets are more likely to use those modes of travel. Krizek and Johnson (2006) found that on-street bicycle lanes significantly increase the odds of bicycle use by people who live within 400 meters.
- Sampson, Radenbush, and Earls (1997) find that sense of community, more than social or economic class, strongly affects neighborhood crime rates.

The main policies for dealing with the external costs that highways and traffic impose on the livability of streets are (1) an agreement among multiple institutions that they want to deal with the livability issues as part of the evaluation of transportation solutions (i.e., an agreement to do the kind of integrated planning recommended throughout this report), and (2) design guidelines (softer) and standards (harder).

The next sections discuss some of those design guidelines in two parts: policies aimed at calming traffic, and policies aimed at making places more walkable. The two clearly are related, but the they have a different emphasis.

Calming traffic

Implementing new design standards requires education, engineering, encouragement, and enforcement. Traffic calming is primarily an engineering strategy. Slowing traffic, not hindering access, should be the goal. Typical measures for slowing traffic are speed humps and raised crosswalks; narrower lanes, bends, and center islands; roundabouts; and partial and full street closures.[15]

The tension between efficiently moving traffic and keeping streets livable is obvious: if you try to maximize on one you lose a lot on the other. Figure 5-3 illustrates the trade-offs. Traffic engineers occasionally find themselves in what for them is a bizarre world: they have built a wide street and are now being asked to re-engineer it so that it does not work as well (for traffic). Appendix C explains, however, that the trade-off in travel time may not be as severe as some policy makers believe: on main streets with signalization, it may be that throughput can be maintained or even increased at slightly slower speeds.

For main streets, some on-street parking: can be critical for merchants; can be compatible with, and perhaps even enhance, livability by creating a buffer between the traffic and the pedestrians; and can calm traffic and (in some cases) improve flow. Among the many design ideas for mainstreets are the following:

- A distinct gateway announcing entry to a shared street (one shared by motorists with pedestrians and bicyclists; by passers-by with residents, shoppers, and workers).
- Sidewalk bulb-outs at intersections to reduce cross distance and clear time for pedestrians.
- Building design that has a strong relationship to the street.
- Wider sidewalks. Where space is tight, on-street parking (parallel or diagonal) can be punctuated by mid-block sidewalk bulb-outs for seating and gathering.

A HISTORY OF TRAFFIC CALMING AND DUTCH WOONERFS

Traffic Calming began as a grassroots movement in late 1960s in the Dutch city of Delft, when residents upset about cut-through traffic tore up their brick streets to create serpentine paths in order to slow the cars. These shared streets came to be known as Woonerfs, translated literally as "residential yards." (They have also been referred to as "living yards," "streets for living," "living streets," and finally in Britain as "Home Zones," which additionally refers to the network of streets surrounding and leading to the core of the neighborhood.)

A Woonerf is a shared street incorporating a range of modes and activities, with provisions for moving traffic, parking, socializing among neighbors, and allowing children to play safely in front of their homes. Traffic is allowed access (ideally between 100 to 300 vehicles per hour during the afternoon peak period, when pedestrian and vehicle conflicts are more likely to occur), but speeds are slowed by both physical and visual measures. The Dutch originally specified the ideal speed as being the pace of walking horse (about 10 mph). Most people walk at about two to three mph. One of the key design features to slow traffic is to narrow the travel lanes and break up the visual continuity for the drivers, emphasizing the street as a residential place, rather than a channel for traffic. According to Donald Appleyard, "The design philosophy of the Woonerf is to create a kind of 'gestalt' message that the streets belong to the residents and that drivers must attend 'incessantly to the fact that the car is only one of the users and a guest.'" Drivers are made to feel it is natural to drive slowly via physical and visual measures, which include the following:

- Clear and distinct gateways to enhance the neighborhood's identity and sense of place
- Curves in the travel lane that break up the driver's sight line
- Visual features that serve both the needs of the residents and to slow traffic (e.g., trees, planters, landscaping, furniture and play equipment)
- Placing vehicles and pedestrian space on the same level, and thus eliminating continuous curbs (demarcated sometimes by bollards)
- Use of varied pavement with special treatments
- Parking spaced occasionally throughout the woonerf

Driver education courses and testing, as well as grassroots campaigns within neighborhoods, will improve driver awareness and show how to use the traffic calming features appropriately. Enforcement strategies include defining vehicle liability laws so that pedestrians and residents have priority on traffic calmed and, particularly, on shared streets. For example, many countries—like the Netherlands—support giving legal priority to pedestrians and cyclists in shared streets, making the driver responsible for the burden of proof in any dispute.

The sidebar gives more information on the history and practice of traffic calming; this endnote[16] gives yet more sources.

A common concern about traffic calming, especially when it includes narrow streets, is access for emergency vehicles. Indeed, design requirements that make things easy for emergency vehicles may preclude good designs for livability. Nevertheless, on a shared street, maximizing for emergency response may make no more sense than maximizing for traffic throughput.

The reasonable response is compromise. It may take some aggressive lobbying to get the ball rolling, but it may be possible to find mutually agreeable accommodations. The response a planner might want from the providers of emergency services is smaller, more maneuverable vehicles. That may be costly, but it could be worth the cost. What a planner might have to give in return includes:

- parking restrictions that allow fire trucks to make turns even when they're tight;
- staging areas for emergency vehicles near fire hydrants to help fire trucks maneuver;
- design changes (e.g., connecting local streets to form a network, rather than relying on cul-de-sacs); and

- alley access, undergrounding of electric lines so they do not get tangled in ladders, reflective visible street signs, and fire hydrants placed at intersections.

Creating walkable communities

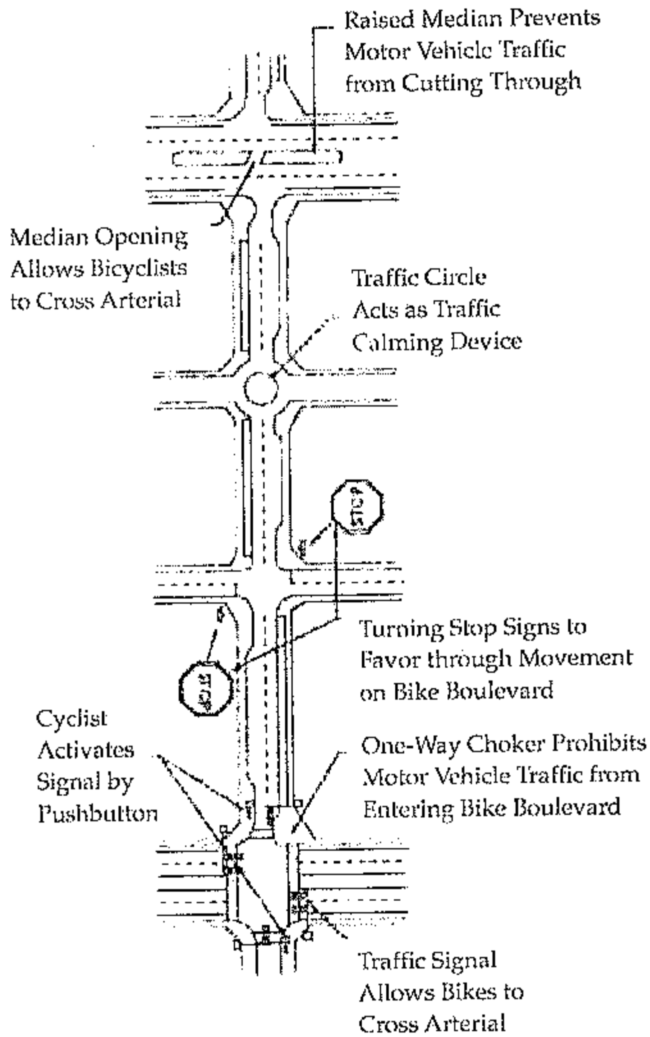
If we had to select a single measure of livable streets and public space, it would probably be "walkability." Yes, there is drive-through and electronic commerce, but walking is basic to any economic and social activity that requires people to meet in places, which essentially means nearly everywhere (work, shopping, education, recreation). Walking is part of almost every trip. In most cases, if there are a lot of people walking on streets, it is because those streets are attractive places. Causality might go either way: the attractive streets attract walkers, or the volume of walkers encourage businesses and governments to make streets attractive.

The previous parts of this chapter have been about policies to deal with motor transportation, and most of those policies are about system-level issues, not neighborhood issues. Chapter 5 and the sidebar below talk more about design.[17]

Livable communities have to accommodate non-motorized rolling stock too: primarily bikes. Yes, also roller blades, skateboards, strollers, Segways, and so on, but put in the context of this report, those are a primary source of transportation for only an unmeasurable percent of non-recreational person-miles of travel.

A bicycle in motion requires space to allow for the balancing and related weaving required to keep a bicycle upright and moving forward, and to give the bicyclist some margin for passing cars (left) and obstacles (right). That means about a five-foot width to ride comfortably. Figure 6-2 shows how bike lanes can be accommodated on the streets, as well as how to make bicycle boulevards. Placing bike racks on buses and allowing them on rail cars is an effective way to make cycling competitive timewise with a regional-level auto trip, even if the origin and destination are located in low-density suburban areas with poor transit service.

Figure 6-2. Typical bicycle boulevard features



Source: Oregon Department of Transportation 1995.

SUMMARY OF POLICY OPTIONS

We've covered a lot in this chapter, and done so using a non-traditional organization. There is much more to be said, and many other articles and books say it. Tables 6-2 and 6-4 (above) crib from some of the best works we have seen to give you a quick way to remember the many policy possibilities. They return to the supply-side (Table 6-2) and demand-side (Table 6-4) organization. For a more detailed matrix (more evaluation criteria) that assesses all the policy options that focus on urban congestion, see Downs's (2004a) final chapter and mega-matrix.

So many policies, many of which move in different and potentially canceling directions. How does one assemble these into a comprehensive package of complementary, reinforcing policies that address transportation issues in the context of land use? Turn the page to Section III and our conclusions.

WALKABLE COMMUNITIES

By Paul Zykofsky and Dan Burden

Walkability requires mixing important destinations (what we called Diversity in Chapter 5; one of the five "Ds") so they are in close proximity to each other (two more Ds: Density and Distance), and doing so in a way that relates to the street network in an attractive way (Design, yet another D). Pedestrians are much more likely than motorists to notice the details on a building's façade, items in a display window, the slope of a sidewalk, or the quality of a bench. A walkable community is a place that residents of all ages and abilities feel is safe, comfortable, and convenient.

Walking speeds and distances

The average adult walks three to four feet per second (about two to three mph); children, seniors, and people with disabilities move slower. The current standard used for pedestrian street crossing is four feet per second.

Untermann (1984) found that most residents will typically walk to destinations that are five minutes from their homes. At three feet per second, a person can walk from one-sixth to one-third of a mile in five to 10 minutes. Using the quarter-mile walk as the standard, a walkable neighborhood will roughly cover 125 acres.

Spatial needs

An average-size person takes up almost two feet of width while standing; that same person walking needs approximately four feet of width to allow for swaying or carrying a bag or briefcase. Since walking can often be a social activity, there should be at least six feet for two individuals to walk side-by-side.

Sidewalk design

Sidewalks should be buffered from the street. In commercial areas the buffer is often the "furniture zone" where utilities, signs, benches, transit shelters, planters, and trees should be placed. In a low-density commercial zone the zone should be at least four feet; five to eight feet is most common. In a residential area, a continuous landscape strip distances and buffers pedestrians from the road, accommodates curb cuts without sloping the sidewalk, and can create a tree canopy to shade the sidewalk; it should be at least six feet wide to allow for healthy growth of trees. If space is tight and the sidewalk must be attached to the curb, an extra foot or two should be provided as an added buffer from the street. Avoid rolled curbs: they encourage drivers to park in the pedestrian realm.

Street design

Noise and safety risk cause people to distance themselves from streets with high speeds and high volumes. To encourage walking, residential streets should be designed to keep speeds at or below 25 mph, while larger, busier avenues should be kept at or below 35 mph.

Crosswalk design

Slower vehicle speeds and shorter crossing distances improve safety. In streets with on-street parking, curb extensions (bulb-outs) at intersections and mid-block crossing locations slow traffic entering and exiting the street, reduce the crossing distance, and make it easier for pedestrians to see and be seen by motorists.

Crosswalks in commercial areas should be at least 12 feet wide to allow people to flow in both directions. On wide streets, median refuges or islands with a median nose provide added protection. The clear path for pedestrians through the median island should be six feet. Countdown signals that let pedestrians know how much time they have left to cross reduce stress and accidents. At mid-block crossing locations, add refuge islands. An innovative design is to angle the crossing area by 45 degrees, forcing pedestrians and cyclist to look in the direction of oncoming motorists, and engage them visually.

CHAPTER 6 NOTES

1. We take you back to the Cartesian mind-body duality: the body (legs) are the vehicle to get the mind (spirit) where it wants to go.
2. We are not counting the growing expense of refitting old bridges and overpasses to meet higher maintenance and earthquake standards. We assert, by definition, that those are not about traffic safety and accidents.
3. "Anecdotal" because we know of no analysis that tries to control for other factors that affect development in the area, especially market forces.
4. The windfalls are smaller with congestion pricing, but there still are some: the value that commuters place on faster travel above the congestion fee still capitalizes into land values.
5. *Kelo vs. New London* (U.S. Supreme Court); Measure 37 in Oregon; Proposition 207 in Arizona.
6. The large proportion of congestion associated with disabled vehicles seems to suggest that policy should concentrate on ways to limit the impact of disabled vehicles rather than on pricing congestion. The problem is that disabled vehicles could not have this large effect in the absence of high traffic volumes. Moreover, the volume of traffic would increase with improvements in clearing obstacles;

experienced commuters implicitly take into account the probability that a disabled vehicle will slow their trip when they make decisions about when and where to travel.

7. http://www.ops.fhwa.dot.gov/congestion_report/index.htm (accessed February 2007).
8. We've seen modest accidents (no major injuries) block a lane and a half on a crowded two-lane (one-direction) interstate. Traffic backed up for at least three miles. The lanes probably held almost 200 vehicles per mile at the speed of less than 5 miles per hour. Average delay was probably 30 minutes per vehicle on one side. There was a more modest backup in the other direction as motorists slowed to take their turn looking. Doing some assuming and multiplication, that modest accident probably caused around 700 hours of vehicle delay, with a value of $5,000 to $20,000, depending on assumptions about persons per vehicle, value of time, and value of freight. Downs (2004a, 64) cites data suggesting that the average delay of a lane-blocking accident could be in the range of 1,000 to 5,000 vehicle hours. Cost of wasted gasoline might add another 10 percent. There is a good reason to move these accidents off the travel lanes quickly.
9. One study cited found a benefit-to-cost ratio of 23:1.
10. Hint: it has to do with the pricing of road use.
11. We refer to this method as benefit-benefit analysis: the highway creates travel benefits, and the cost of building it provides an economic benefit. The benefit of the benefit-benefit approach is its simplicity; its drawback is its irrelevance.
12. One of the major impediments to low-cost transit service is the fact that transit often gets stuck in auto traffic. Infrastructure that allows transit to avoid congestion delays would decrease the perceived cost of using transit relative to using a car. The congestion that remains on the bridge would further encourage travelers to use the alternative mode. Fitzroy and Smith (1993) note that even if congestion is priced, thus encouraging travel by other modes, the cars that remain on the highway continue to impede the progress of transit vehicles. They describe the impacts of policies implemented in Zurich in the late 1970s designed to give transit vehicles priority over autos. Between 1985 and 1990, transit trips increased by 33 percent. SAFETEA-LU allows some of this substitution to occur; it should encourage MPOs to be more explicit about, and take responsibility for, decisions about the relative amount of investment in different modes.
13. One theory is that since human's top sprinting speed is about 25 mph, we have evolved to survive head trauma at that speed.
14. This is an example of a general phenomenon: risk compensation. Reducing risk has lower effects, in this case on traffic accidents, than might be expected because drivers naturally exercise less caution as the risk of an accident falls. The economics are identical to those of latent demand: lower time costs encourage more travel, less risk encourages less caution. Car safety features, such as seat belts and anti-lock brakes, have had similar effects on driver behavior.
15. "Traffic Calming Measures. "http://www.trafficcalming.org/measures2.html, accessed on June 18, 2006
16. For more on traffic calming see Ewing (1999); Appleyard (2006); Federal Highway Administration (1994); Ben-Joseph (1995); and http://www.homezones.org.uk/public/guidance/index.cfm
17. We could theorize about pricing policies for pedestrians, but we'll spare you.