

local feeder service, and income as well as by traditional preference.

Additional Space Demand: Task 4 Results

Table 6 presents a sample of the output of tasks 3 and 4 for the medium case. The parking space supply is the number of spaces, existing or planned, that are available to the patrons at each level. These figures do not include those spaces used by park-and-ride rail patrons but not designated as part of the station lots (shopping centers, schools, local streets). The demand is the number of vehicles demanding parking spaces in the study years, assuming average trip origin area, medium level modal and submodal split variables, and medium level park-and-ride response. The medium case is presented as the most reasonable projection of parking demand based on the underlying assumptions and the reasonableness of its output in terms of magnitude, impact, and ability to be implemented. Furthermore, the reasonableness of these projections is substantiated by the fact that all sites selected are at the interface between a rail line and an Interstate route or major arterial. A large fraction of projected demand comprises trips diverted from these highway facilities.

The additional spaces demanded are the differences between demand and supply. These figures represent the demand by future potential patrons who reside within the trip origin area for park-and-ride spaces that will

not be satisfied by the existing parking supply. Future parking demands for all three levels of analysis were calculated on an unrestrained basis. The analysis assumes that land is available and that the rail system can provide the required level of service and capacity. Restraining the projection by any one of several factors (land, line capacity, frequency of service, or speed) would result in lower parking demands.

Based on the results of this study, four sites have been given priority for development. If and when developed, these sites will have a combined total increase in parking capacity of 6300 spaces by 1980 and 7400 spaces by 1985. These projects were placed in the Transportation Improvement Program for the Delaware Valley region and are now in the final design and detailed traffic impact analysis stage of development under PennDOT's direction.

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Designing a Parking Management Program

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Parking management measures have received considerable attention as a means of controlling automobile use in urban areas, but relatively little attention has been given to the specifics of combining proposed parking strategies into a scheme to help an area realize particular transportation and planning goals. The goal of reducing vehicle kilometers traveled has been selected for the purpose of this discussion, although other goals including reducing peak-period congestion, improving traffic circulation, improving aesthetics, and stimulating retail business should be examined to ensure that the proposed parking strategies are consistent with these goals. This paper focuses on possible traveler responses to various parking control strategies and discusses the implications of these responses for program design. Control of both on- and off-street parking may be necessary in some areas to reduce automobile use. Because parking controls are often fragmented, the coordination of efforts by local and regional agencies is critical to the success of a parking management program.

Parking management is one of the most interesting transportation planning techniques, because it can be used to actually modify automobile-use patterns whereas other techniques are directed toward making alternatives to single-occupant automobile use more attractive. Parking management assumes that the amount, location, and price of parking can affect travel mode choice, trip frequency, and trip destination and that these choices can be modified to produce more desirable travel patterns.

In years past, efforts to manage parking were concentrated on providing an ample supply of spaces at a nominal rate so that retail business could flourish and commuters would find it convenient to drive to work. The Environmental Protection Agency's (EPA) 1973 transportation control plans (TCPs) for a number of cities, including Boston, Denver, and San Francisco, created widespread negative publicity for modifying demand and reducing vehicle use. Measures such as parking surcharges, elimination of on-street parking, and freeze or reduction of off-street parking supplies were proposed to reduce the amount of automobile use in polluted areas so that national air quality standards could be met.

In the December 10, 1973, version of the Energy Emergency Act, the House Committee on Interstate and Foreign Commerce attached a rider forbidding the EPA to impose parking surcharges without the consent of Congress. Surcharges had been included in transportation control plans for 10 areas in California, Massachusetts, New Jersey, and the District of Columbia. Although the Energy Emergency Act was not passed by Congress, the EPA administrator announced that congressional intent on the surcharge issue was clear (1). As a result, all surcharge regulations were withdrawn, and the review date for new parking facilities (to determine their impact on air pollution) was postponed until

January 1, 1975. This was also to be the effective date of parking facility review under the indirect source regulations.

In the August 22, 1974, Federal Register, the EPA administrator published proposed amendments to the parking management regulations. The appendix to the proposed regulations contains guidelines for parking management plan development that describe information requirements and concentrate on how transportation and land use relate to meet air quality standards (2).

Various aspects of parking were covered by EPA in three different ways: as measures in the transportation control plans (including various on- and off-street controls), under the parking management regulations (for new facilities in areas with TCPs), and under the indirect source regulation (for new facilities in any area in the country).

In January 1975 the parking management regulations were suspended on the grounds that proposed Clean Air Act amendments would include provisions on parking management. The parking management regulations were then suspended indefinitely on July 15, 1975, again on the basis of expected congressional guidance regarding parking programs. At that time, the EPA administrator stated, "In the absence of congressional action, EPA may finalize revised parking management regulations in order to complement other transportation control measures" (3). As of January 1977, neither EPA nor Congress had acted.

Because parking management had become associated in the public's mind with the most draconian EPA tactics, and because talk about restricting parking often resulted in making enemies of retail businesses, developers, and other influential community members, the July 1975 suspension of parking management regulations might well have been the last word on parking if the U.S. Department of Transportation (DOT) had not been simultaneously faced with increased demands on its limited funds. One way DOT made its transportation dollars go farther was to emphasize efficient use of the existing transportation system, and it issued the transportation system management (TSM) regulations on September 17, 1975. One of the items in the appendix to the now famous regulations is management and control of parking.

Although nothing could have brought parking back more quickly than its inclusion in a DOT regulation like TSM, some areas, e.g., Cambridge, Massachusetts, had begun to implement parking programs on their own. Reducing congestion on downtown streets, improving delivery of city services such as snowplowing and garbage pickup, making transit more competitive with the automobile, maximizing tax dollars by discouraging open-air parking lots and encouraging developments with higher assessments, and improving the quality of urban life have all been cited as reasons for the development of parking management programs.

In general, parking management may be described as any alteration of parking supply or parking rates that discourages or prevents parking in certain areas, at certain times, or by certain groups. A number of parking controls or strategies have been used or proposed in managing an area's parking supply. Brief descriptions of some are contained in this paper; more extensive descriptions may be found elsewhere (4, 5).

Work trips are the target of most parking controls because they usually occur at set times during the day on a regular basis and can thus be diverted from single-occupancy automobile to shared ride with fewer adverse impacts than can other trip types. An individual must continue making work trips to earn an income, regardless of the disincentives, and will switch from single-occupant automobile to other modes (including shared

ride). The intent of the parking controls is not to reduce person trips but to encourage people to make trips in such a way that single-occupant vehicle use is reduced. One alternative to making any trip other than the work trip (in the face of disincentives) is to not make the trip at all. This possibility is usually considered to have disastrous economic implications (loss of income to retail businesses, hotels, motels, resorts; loss of sales of recreational equipment). Therefore, reeducation is aimed at the commuter, who is a captive trip maker.

Although parking management may be used to meet a wide variety of goals, this paper will concentrate on vehicle travel reduction, which, when not accompanied by a reduction in person trips, implies more efficient utilization of the transportation system. Parking strategies have been proposed as a means of reducing total vehicle travel, work-trip travel, peak-period travel, and travel within the core area. It is important to be aware of potential undesirable effects of various parking control measures, to examine the types of incentives and disincentives that each measure implies, and to consider the effect of each measure in terms of the area's goals for parking management. For example, a reduction in total vehicle travel might mean a decrease in person trips and therefore decreased mobility; a reduction in work-trip travel implies that automobiles left at home might increase nonwork travel; a reduction in the amount of peak-period travel may simply mean a redistribution of trips over time and no net change in vehicle travel; and a decrease in vehicle travel in the core area may be offset by an increase in travel elsewhere.

In general, parking control measures fall into two groups, rate controls and supply controls, each of which may be subdivided into on-street and off-street controls as shown below.

<u>Control</u>	<u>On Street</u>	<u>Off Street</u>
Rate	Erect meters or increase meter rates Add surcharge	Impose tax Add surcharge Change rate structure to discourage long-term parking
Supply	Issue permits or licenses Ban parking either totally or at specific times Erect meters or adjust meter times	Freeze, cut back, or restrict growth Use time and vacancy rate restrictions

In this paper I discuss measures under each category, impacts of parking strategy on travel behavior, and the potential of a parking scheme design to reduce vehicle travel.

RATE CONTROLS

Description of Rate Controls

Increased rates for both off-street and on-street spaces have been widely proposed to control parking. A reduction or restriction of off-street supply could force a rate increase; rates could be imposed if parking is currently free; or existing rates could be arbitrarily raised. Meters could be erected on streets where parking is now free to provide a cost-and-time disincentive, and rates on currently metered spaces could be raised to provide an additional disincentive.

Higher rates at private off-street facilities could result in a number of legal problems. Conversion of the rate structure from its current daily maximum to a flat rate, for example, requires that the commercial parking facilities be regulated by local government. To regulate rates requires one to show that parking is a business that affects the public interest and that the regulation is nec-

essary in the interests of public health, safety, morals, and general welfare. There are no direct precedents for this type of parking regulation. Furthermore, the authority of local governments to regulate business must be delegated by the state; this transfer of authority is by no means automatic and may be a barrier to cities' regulatory efforts (4, 5).

One backdoor means of encouraging privately owned facilities to raise rates may be through raising rates at municipal garages (if municipal garages are significant competitors). In Boston, privately owned facilities try to keep their rates competitive with municipal rates, so requiring city facilities to increase parking charges might result in an overall increase.

Parking Tax

City taxes on nonresidential parking transactions have been proposed to discourage automobile use and to generate revenue. San Francisco had a 25 percent tax from October 1, 1970, to June 30, 1972, at which time the tax was lowered to 10 percent (6); Pittsburgh levied a 20 percent tax in 1969. The Supreme Court upheld the validity of the latter tax in *Pittsburgh v. Alco Parking Corporation* (Sup. Ct., slip opinion 73-582, June 11, 1974):

By enacting the tax, the city insisted that those providing and utilizing the nonresidential parking facilities should pay more taxes to compensate the city for the problems incident to off-street parking. The city was constitutionally entitled to put the automobile parker to the choice of using other transportation or paying the increased tax.

Taxation is inherently a state power, and cities may levy taxes only with specific grants of authority from the state constitution or legislature. States have made different provisions for local taxation. Some local governments have been granted broad authority to establish local tax policy subject only to prohibition by or conflict with state law; other local governments are limited to certain types of taxes such as revenue-producing taxes on business (4, p. 118). Use of tax revenues by cities depends on the authority under which they were generated; proceeds from a revenue-producing tax will typically be put in a city's general fund.

Parking Surcharge

Most parking surcharges, flat fees on top of the existing ones, range from \$1.00 to \$5.00. They may be applied, for example, to all parking within a specified area such as a central business district (CBD), to all long-term parking (4 or more hours), to all parking in transit-adequate zones, or to all parking arriving in an area between 7:00 and 9:30 a.m. The scheme depends on which group is to bear the burden of the disincentive. Parking surcharges vary in magnitude and may cause changes in travel behavior.

Changed Rate Structure

Rate structure changes favoring short-term parking in business and commercial areas have been proposed to discourage commuter but not shopper and tourist parking. Cities, however, often lack adequate police power to directly control rate structures of private parking facilities. These structures can be designed to encourage short-term at the expense of long-term parking (most facilities currently favor long-term parking by charging the same for a 3-h as for an 8 to 9-h parker), or rates can be applied on a flat, per-hour basis, ostensibly favoring neither, but usually the commuters pay more.

Discussion of Rate Controls

Rates and Rate Structures

Many city officials believe that controlling parking rates is crucial to an effective parking management plan. Their reasons include ease of administration (relative to supply controls), ease of enforcement, and potential for increased revenue. It is often proposed that parking rates should favor short-term parkers (shoppers and tourists), so that retail sales in controlled areas do not suffer. Besides (the argument goes), commuters are usually in a better position to use transit or shared-ride modes. However, it is conceivable that, if short-term parkers are favored, short-term trips may increase. This behavior was observed in Philadelphia, where rate changes at individual garages produced short-term increases of 15 to 20 percent (7).

Flat per-hour parking rates seem more reasonable. They would increase commuter fees, since present rate structures usually favor the all-day occupant and, depending on the magnitude of the charge, could provide the type of disincentive desired to divert commuters to other modes. The short-term parker may or may not face increased rates, depending on the per-hour charge. Although such a policy will not encourage shopping trips, it will not discourage them either; the short-term parker will be better off, since shorter occupancy will cost less. The fact that a flat-rate system does not encourage short-term trips is important if the objective is to reduce total vehicle travel in an area. If commuters leave their automobiles at home and commute by transit or car pool, then automobiles will be available for those at home to make shopping and other nonworking trips; and if parking rates encourage shopping trips to the CBD, then it can be assumed that there will be some increase in nonwork vehicle travel in the core, which may or may not offset reductions in vehicle travel from commuter disincentives. A flat rate takes into account the fact that vehicle travel is vehicle travel regardless of who generates it, but at the same time places a heavier burden on the long-term parker, who is generally a commuter and more likely to be induced by a disincentive to seek new modes to work, than on the short-term parker, who is likely to be a shopper or a tourist and likely to do his or her retail spending elsewhere if the disincentive is sufficiently burdensome. A flat-rate approach might be a reasonable compromise between those interested in reducing vehicle travel and those interested in the economic effects of parking policies.

Rate Increases in General

Type of control relies on the notion that there are enough individuals (mostly commuters) who can be encouraged to make different mode-choice selections when parking rates are raised above a certain level. If the vast majority of individuals elected to pay increased rates, then the parking control measure, having achieved only minimum reductions in vehicle travel, would have failed.

Those developing parking price schemes must determine the level of price increase necessary to divert a given percentage of single-occupant automobile drivers to transit or shared-ride vehicles. The Philadelphia rate case does indicate that use of parking facilities changes with changes in rates, but it does not give any indication of behavior that can be expected when rates at all facilities are increased.

Although increased parking rates may be justified as a disincentive to automobile use, the equity of such increases deserves consideration, since they will be felt more by lower income drivers. In general, wealthy com-

Table 1. Impact of controls on parking rates and supply.

Control	Measure	Increases Cost to Commuter	Encourages Short-Term Use	Requires Enforcement	Encourages Flexible Work Hours
Rate	Tax	X			
	Surcharge	X			X
	Rate change	X	(X)		
	New meters or increased rates	(X)	X	X	
Supply	Permit or license	(X)	(X)	X	(X)
	New meters or adjusted times	(X)	X	X	X
	Reduced or limited growth	(X)			
	Time and vacancy rates	(X)	(X)	X	X
	On-street parking ban				
Total	(X)		X		
	At specific times		X		X

Note: X = direct and (X) = indirect or optional.

muters are more likely to pay the additional money and continue driving while lower income commuters are more likely to seek alternative means of getting to work. Therefore, low-income automobile commuters who have no alternative to driving alone will be penalized.

Table 1 summarizes the impacts of parking rate controls.

SUPPLY CONTROLS

Off-Street Supply Controls

Description of Off-Street Controls

Off-street supply controls are designed to limit the amount of parking, and it is assumed that the uncertainty or difficulty of obtaining a parking space will cause some automobile users to divert to transit and shared-ride modes. This control, nevertheless, runs counter to many cities' goal of accommodating drivers by providing ample off-street parking.

Prohibiting the construction of additional parking capacity is probably feasible, but regulating the number of spaces that existing parking facilities utilize (retrospective application of controls) may prove quite difficult. Off-street facilities are privately and government owned, so that regulation of both may be subject to legal challenges. Private facilities may claim that a regulation is "taking without compensation." Furthermore, any classification scheme must be reasonable and must provide equal protection for all facilities. Government facilities are usually exempt from zoning regulations, and the ability of one level of government to regulate the facilities of another may be greatly complicated by sovereignty. These regulatory issues are explored in depth elsewhere (4).

Freeze on Parking Spaces

Freezing the number of parking spaces, as it is generally practiced, puts an upper limit on off-street parking spaces equal to those in existence on a certain date. The effectiveness of a freeze depends on the amount of parking on the freeze date compared with that needed for development over the next few years. If the number of existing spaces exceeds current demand, then the impact of the freeze will not be felt until some time in the future.

In Boston, as spaces are eliminated, they are put on a "freeze bank" and may be allocated to new or other developments within the freeze area. Developing a reasonable and equitable means of distributing the spaces in the bank to those who desire them has proved difficult; other areas may not wish to permit banking of spaces, particularly if capacity greatly exceeds demand.

Reduction of Off-Street Parking Spaces

A reduction in the number of off-street parking spaces has been proposed for areas with excess capacity. Although this approach could be effective—via voluntary space cutbacks by government and cutbacks of private space through a nonconforming use zoning approach—it will undoubtedly have to weather legal challenges. Those whose lots are phased out will probably level the accusation of "taking." In addition, which spaces to phase out may be even more difficult to decide than which to allocate in a freeze.

Restricted Parking Supply Growth

Restricted parking growth may be necessary in areas undergoing active development. Parking controls are intended to keep the supply of spaces below demand to encourage decreased drive-alone automobile use, but extreme constraints on parking supply may have an adverse effect on business location decisions. In rapidly developing areas, it may be necessary to permit some increases in supply while still keeping overall supply below overall demand for spaces. EPA has suggested this strategy for providing a gradual increase in parking supply (for instance, 100 spaces) each year and then recommends (2):

Applicants for the limited number of new parking space permits could then be judged based on predetermined and published criteria. Such criteria could include such diverse elements as community need, proximity of mass transit, financial per space contribution to mass transit, VMT [vehicle miles of travel] impacts and efforts made to minimize VMT.

Other schemes might be based on measures of growth, such as one space for every two new jobs created, or on some floor area ratio for construction completed in the last year. The difficult problem of allocating the spaces equitably to a group of qualified applicants remains to be resolved at the local level and seems to be basically similar to allocating banked spaces in a freeze.

Time and Vacancy Rate Restrictions

Time and vacancy rate restrictions have been proposed as a means of favoring one automobile-driving group over another (for example, shoppers over commuters) or of putting pressure on drive-alone commuters, the group with the greatest opportunity for shared ride. There are two different ways of achieving this. The first is to require that certain facilities in the area open only after 9:30 a.m. (for example, making them primarily for shopper and other short-term use), and the second is to require that some percentage of the spaces in all facilities be available at 9:30 a.m. There must be some reasonable basis for distinguishing between regulated and unregulated facilities, if the measure is to be applied selectively. In

Boston, a 40 percent vacancy rate was proposed under the first transportation control plan and was to be applied to all facilities in the core area. In *South Terminal Corporation v. EPA* (Ct. App., 1st Cir., Sept. 24, 1974), the court ruled that such a measure did not constitute a "taking":

The Government has not taken title to the spaces, and the decision about alternative uses of the space has been left to the owner. . . . The right to use is not extinguished entirely; nor is it transferred to anyone else. Indeed, the ingenuity of operators may result in fewer disadvantages than urged. . . . In any event, even a diminution of profits or a requirement that some loss be suffered is not enough, when all other accoutrements of ownership remain, to be a "taking."

Discussion of Off-Street Controls

Freezes, Cutbacks, and Restricted Growth

Measures to control the number of off-street parking spaces within an area, including freezes, cutbacks, and restrictions on growth, will probably have a similar impact on commuter parking and will be considered here as a single group.

Programs that establish freezes and provide for phasing out of parking spaces in underutilized, outdated facilities and for incorporating the spaces in new developments may actually be increasing the effective capacity of parking in the freeze area if the new spaces are used and the old ones were not. If supply currently meets all needs, then vehicle travel will not be reduced below its current level unless some of the available spaces are eliminated. Probably the easiest off-street supply restrictions to implement, parking freezes and restricted growth programs, alone might serve to keep vehicle travel at approximately current levels in the short run. In the long run (assuming that business and retail trends continue at approximately the same levels and that no mass exodus to the suburbs occurs), market forces will probably raise the price of off-street parking as demand begins to exceed supply. A rate increase caused by market forces or as part of the parking program will have the same kinds of impact on commuters as those discussed for rate controls. As demand for spaces exceeds supply, traveler behavior changes.

If off-street parking supply restrictions are to reduce vehicle travel, it will probably be necessary to create a situation in which (a) on-street parking is restricted and (b) demand for spaces exceeds supply at the present time. This may occur naturally in some areas and may have to be created artificially in others by reducing the number of spaces.

Assume for a moment that no price increase will accompany a supply restriction and that commuters will react only to the problem of space availability. One possible outcome is that to assure themselves of parking spaces, commuters will arrive at the CBD earlier; thus, either the morning peak period will occur somewhat earlier or the duration of the peak will be increased. Ideally, enough drivers will find parking so inconvenient they will choose other modes.

Vacancy Rate and Time Restrictions

If a vacancy restriction is applied uniformly to all off-street facilities in an area, so that, for example, 40 percent of all spaces must be available at 9:30 a.m., then the impact will probably be analogous to an on-street parking ban. That is, businesses may be encouraged to institute staggered work hours, and commuters arriving before 9:30 a.m. who are unable to secure an off-street space may park on-street until the additional 40 percent is available. If on-street parking is restricted, changing

commuter mode choice depends on willingness of area businesses to have staggered or flexible work hours. Although such work hours may reduce peak-period volumes, relieve congestion, permit higher average speeds, and thereby reduce localized carbon monoxide concentrations, there is no reason to assume that they will also reduce vehicle travel.

The other method of imposing a vacancy restriction is to designate certain parking facilities that may not open before a certain time. This would be legally possible only if there were some reasonable basis for distinguishing between late and early opening facilities. Such a basis might be the location of parking facilities in predominantly retail shopping and tourist areas, as opposed to those in the commercial-office district. Used alone, a regulation that garages in shopping areas could not open until 9:30 a.m. would probably not have a discernible impact (because if the facilities had a great deal of commuter use, the distinction would be invalidated), particularly if stores do not open until 10:00 a.m. If, however, such a restriction were used in conjunction with other supply measures such as a freeze, people might be increasingly willing to walk or take transit from the shopping area to their places of work. In the limited supply case, the effect of this type of vacancy restriction on travel behavior will probably be similar to the effects of a vacancy requirement at all facilities, except that the number of individuals affected may be smaller, depending on the number of garages that open after 9:30 a.m.

On-Street Supply Controls

Jurisdiction over supply and regulation of on-street parking is usually held at the local level (with some state constraints), and controls of this type are not expected to encounter the legal difficulties that have been raised with regulation of private off-street facilities.

Parking Ban

A parking ban is intended to reduce the availability of parking (usually to commuters) and can be applied in a variety of ways. On-street parking can be totally eliminated in areas with sufficient off-street parking supply or transit access or both. Or, in areas with relatively small supplies of off-street parking, on-street parking could be banned between certain hours, for example, 7:00 to 10:00 a.m. This would favor shoppers and may be desirable or even necessary if some provision such as vacancy rate (for example, 40 percent of spaces at off-street facilities available at 10:00 a.m.) is not used, since commuters typically arrive at the CBD first and will have first chance at the spaces. An interesting variation of the ban is to make on-street spaces in nonretail areas available only to car pools; this is a much-needed incentive for areawide car-pool programs.

A ban on on-street parking is an attractive parking control measure because it can usually be implemented and enforced entirely by a city's existing departments; it needs no new grants of power; and it raises minimum legal challenges. The main costs to the city of such a ban are erecting signs and increasing enforcement.

Most parking bans aim at limiting on-street parking for work trips by banning parking between 7:00 and 10:00 a.m. or 7:00 and 9:30 a.m. This time restriction will theoretically work to the advantage of shoppers, since they arrive at the CBD later than commuters. This type of parking ban is also seen as a necessary compensating mechanism for areas that will have a limited number of off-street spaces. Again, because the commuter arrives earlier and will have the best chance of getting a space, the ban is seen as a way of reserving some spaces for

shoppers in the absence of a vacancy rate provision at off-street facilities.

If a city's aim is to reduce peak-period travel, then such a ban may well contribute to this goal; if the aim is to reduce vehicle travel, then a ban may not work. A ban assumes that (a) once a commuter has arrived at work the vehicle will not be moved until it is needed for some "legitimate" purpose or until the commuter goes home and (b) businesses in the area will continue to operate within their preban work schedule.

When off-street capacity is limited and employers are willing to allow flexible or staggered work hours, the effectiveness of a ban may be limited to a reduction in peak-period travel; effects on total vehicle travel will be minimized. In mixed office and retail areas, staggering hours so that employees can arrive after the ban has been lifted may tend to have an adverse effect on availability of parking for retail customers.

Metering

Metering of on-street spaces in business and commercial areas can be used to achieve a number of goals. Meter rates may be adjusted to provide a cost disincentive (particularly in areas where parking has previously been free) and meter times can be used to encourage shopper parking over commuter parking by imposing a 1 or 2-h limit. However, effective use of meters for parking control depends on a rigorous enforcement program. This involves having fines large enough to present a disincentive and a systematic way to recover fines. Many areas will find these criteria difficult to meet. Maintaining an enforcement staff is costly; determining upper levels of fines for violations may be done by the legislature; and expediting court procedures for ticket processing may be costly and time consuming, particularly if it involves computerization of the recording and summons-issuing tasks.

In some areas, metering alone cannot change mode choice. A commuter's decision might involve: (a) cost of driving and parking at a meter versus cost of other modes, (b) time limits on the meter, (c) expected quality of enforcement (if enforcement is known to be good and tickets can be expected for time violations and for meter feeding, meters will be a greater disincentive for commuters than if enforcement is expected to be lax and a commuter feels that the risk of being ticketed is quite low), and (d) cost of a violation (if a violation is very costly and enforcement and recovery are known to be good, then the disincentive posed by metered spaces may be significant).

Metering may be most effective when used in conjunction with other control measures, such as the parking ban, and with off-street measures to prevent a diversion from off-street to on-street parking when off-street controls are introduced.

Area Licenses or Permits

Area parking licenses or permits have been proposed when one class of user may be legitimately distinguished from another. For example, residential permit programs have been established in mixed commercial and residential areas to give the city resident some sort of priority in on-street parking. In Cambridge, the system is set up so that on certain streets parking is restricted to vehicles with residential permits except on Sunday. In some areas residential permits could be used primarily to exempt city residents from a 7:00 to 10:00 a.m. on-street parking ban. Other programs would require permits for parking only during business hours, for example, from 7:00 a.m. to 6:00 p.m. Constitutional is-

ues have been raised about some residential permit systems on the grounds that they restrict the right to work and travel. Although there are no causes in point, one study suggests (4, pp. 131-132) that such a program would probably be determined constitutional if the ordinance has

... 1) a clear statement of public need for the ordinance, under the police power over public health, safety, and welfare; 2) reasonable provisions for parking by nonresidents to the maximum extent consistent with its purposes; 3) no unreasonable restrictions on commercial vehicles; 4) provisions for adequate notice to the public; 5) no provision for arbitrary exceptions; 6) the same effect on non-area city residents as it does on non-city residents; and 7) the cost of a residential permit is kept minimal.

The first provision could probably be met on the grounds that the ordinance is designed to reduce automobile traffic in residential areas to protect residents from the detrimental effects of high levels of automobile use: danger to children playing in or near streets, exposure of residents to high levels of air pollutants and traffic noise, and disruption of community life. The purpose of this provision is to clearly justify the use of an area's police power as the authority for such a program.

Most residential permit programs are designed to prevent commuters (noncity residents) who cannot find parking spaces in commercial and business areas from spilling over into adjacent residential areas and causing parking shortages, increased traffic, and congestion there. A residential permit program generally increases the urban resident's probability of finding a legal parking space near the home.

Singapore has implemented an area license scheme that restricts entry to the CBD before 10:15 a.m. to vehicles bearing a special permit. Permits may be purchased on a daily or monthly basis (S\$4/d, S\$80/month) from stations at the edge of the CBD. Some schemes also propose restricted parking but not entry (8, 9).

For the person working in or near a restricted area, such a program has an impact on work trip mode choice only if the worker is accustomed to driving to work and finding an on-street parking space in the residential area. If the commuter typically parks off-street in an employer-provided lot or in a commercial lot, then clearly the choices are not greatly changed, except that the commuter must expect increased competition for the off-street spaces. The effect on those accustomed to parking on-street greatly depends on the availability of alternative parking. If the major employers in such an area can be convinced to expand their employee parking facilities (either free or at a nominal charge), then the impact of the program on commuters may be minimum. On the other hand, if employer space cannot be expanded and commercial space is limited, then there will be a point at which the commuter must compare the cost of driving to work plus paying to park at the commercial facility with the cost of all other available modes to work (including shared ride).

Table 1 summarizes the impacts of parking supply controls.

INSTITUTIONAL CONSIDERATIONS

Various institutional constraints and peculiarities that may influence parking management have been mentioned here. The institutional arrangements that govern parking are often unfamiliar to transportation planners because parking controls are typically held at the local level and parking policy has traditionally been a city concern. As a result, parking policy may be a product of the interaction among a variety of city agencies and interests including the public works or traffic department, the planning department, the airport authority, the urban

renewal authority, the zoning board, and the police department. Control will probably be fragmented. For example, an urban redevelopment authority will dictate off-street parking policy within an urban renewal area; the traffic department will control on-street parking; and another city agency, such as the Real Property Board in Boston, will run the city's off-street facilities.

Because of this fragmented control and multiplicity of actors and interests, development of a parking management plan is necessarily negotiation intensive. In that respect, it is similar to many other TSM measures, such as establishing preferential lanes or modifying bridge tolls to favor car pools. Identifying the various institutions involved in parking should be an integral part of the early development of any city's parking management plan.

DEVELOPMENT OF A PARKING MANAGEMENT PROGRAM

Because parking policy may be a product of many local interests, one should begin by finding out what the existing institutional arrangements governing parking are and perhaps by identifying particular instances in which legislative changes are desirable (for example, formation of a citywide parking authority). While acquiring information on the existing distribution of authority, one should be able to simultaneously acquire an understanding of the political climate as reflected in parking policy (for instance, encourage CBD development at all costs, discourage new construction, encourage renovation of existing buildings, increase transit use, continue to improve automobile accessibility) and to gain an understanding of the divergent interests influencing parking policy and the constraints on radical change in parking policy (for example, revenues from certain facilities may have been pledged as security for bonds).

Once one understands the existing parking situation, information on location, number of spaces, ownership, and current charges should be gathered. Then parking information should be fed into the metropolitan transportation planning process to develop parking strategies compatible with overall transportation goals. This process should clarify the role of parking management and make it possible to develop a statement of goals. Strategies to meet the goals should be developed with input from all interested (affected) city and regional agencies, and, where applicable, state and federal agencies, and the public. Involvement of the public is particularly important in helping people to understand planning motivation and the alternatives.

A strategy for implementation should be selected from the alternatives, weighing the impacts, costs, and practicality of each. Prior to implementation of a parking plan, all implementing, enforcing, and monitoring agencies should have agreed to carry out the responsibilities that fall to their agencies.

CONCLUSIONS AND RECOMMENDATIONS

There is every reason to expect that parking management can be used to modify travel patterns, but it is not clear at what level parking price increase or supply decrease will cause a particular mode change or vehicle travel reduction. Experiments with parking controls and other automobile restraints will continue to widen the data base, so that eventually a clear relationship between controls and responses can be established.

Parking management planning must become part of

transportation system planning. Parking policies, transit policies, and highway policies must be coordinated to reinforce one another if the transportation system is to be used in the most efficient manner possible. For example, a city cannot expect to increase the transit trips while continuing to improve automobile accessibility and to provide ample parking.

Finding the appropriate group of measures to achieve the desired results and to "plug all of the leaks" in the parking system requires an assessment of the institutional arrangements governing parking as well as an understanding of parking supply and use characteristics. Restricting on-street parking will have a tendency to increase use of off-street parking, so that a policy to reduce automobile use should contain both on-street and off-street measures. To exercise some parking controls may require additional grants of authority from states to cities. In addition, it may be desirable to make institutional changes, such as consolidating parking authority in one city agency. Major changes of this type should be identified early in the parking management process, for they may take a long time to implement.

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