PROCEDURES FOR MEASURING THE ACTIVITY LEVEL AND THE PARKING DEMAND OF THE CBD

Steiner M. Silence, Federal Highway Administration

This paper focuses on analytical procedures for evaluating proposed transportation alternatives for the CBD. Problems on delimitation of the CBD are discussed. Procedures for measuring the activity level and the parking demand with origin-destination studies, cordon count studies, and parking or special studies are included. The importance of trends in travel mode over time is emphasized. Also, several transportation alternatives are suggested. These alternatives include bus improvements, parking innovations, and revised time patterns.

•CHANGING times and national priorities have brought a resurgence of interest in the CBD. New proposals are made daily for some kind of "solution" to downtown traffic, parking, and transit problems. The reference to "new" is misleading because most of these approaches were suggested more than 50 years ago. They are new, however, in the sense that they have not been greatly applied and that new or changing emphasis could allow successful implementation. Changing times also bring uncertainty, and there are few solid benchmarks on which to base sound administrative decisions. The one thing that seems obvious is that the current surge of activity in the CBD is bound to stimulate a need for new information and knowledge.

The focus of this revived interest is the central hub or locus of traffic congestion and yields the highest concentrations of daytime population, air pollution, and noise. In cities of between 1 million and 5 million population, only about 10 percent of all metropolitan trips are directed to the CBD and more than 80 percent of these are work trips. It is the high concentration of these trips that creates the CBD's characteristic problems. On the other hand, it is the unique services historically performed in the fields of trade, finance, government, transportation, and communications that generate the particular interest accorded this area. Almost everyone is desirous of solving the long-standing problems, but few are willing to go on record as wishing to lessen the importance of the downtown area.

The primary focus of transportation planning in the past has been to vary (usually increase) the supply of transportation service to meet ostensible demands. Many of the more recent measures propose limiting the demand for service. This calls for the regulation of activities or the promotion of "more desirable" behavior by controlling prices or the supply of facilities. Such thinking demands considerable philosophical and institutional change, and our planning must consider such solutions in order to be responsive to modern needs. On the other hand, an objective view requires that proposed solutions meet the tests of clarity, simplicity, feasibility, salability, and political feasibility.

It seems clear that an effective means of solving CBD transportation problems lies in the development of a unified policy for all transportation services. Implementation of such a plan, however, is far from simple and involves diverse interest and diverse views as to what the "best" policies and the "best" result should be. Again from this viewpoint, the planning procedure that we want must meet a variety of problems and allow evaluation of a variety of solutions to be effective.

The purpose of this paper is to suggest a pattern of information gathering and analysis that would assist in evaluating proposed combinations or mixes of transportation alternatives in light of community goals. The local traffic engineer and the urban

A more detailed discussion of these procedures follows.

Delimiting the CBD

Almost anyone can construct a mental image of downtown. The picture may vary based on past experiences or on the city he knows best, but the term CBD or downtown is generally considered to be understood for purposes of conversation. All this notwithstanding, the literature is sparse on methods of selecting or delineating the CBD.

So why make a thing about it? If we have come this far without being precise in our definitions, we may well not need such precision. This is true in at least one sense. When a local agency deals with a local problem, such as zoning, planning, or traffic management, there is little apparent reason for precision in CBD definition. The real reasons for an objective determination involve the development of trends in activity over time or the making of comparisons between cities. In other words, the reason is for statistical purposes, but these purposes gain importance as the results become more critical.

I will clearly state that more research is needed. Most past work ignores the boundary problem. A considerable number of studies comparing the CBD's of several cities have been conducted without reference to any standardized definition of the CBD. This approach assumes that CBD definition is intuitive. It is most commonly used when one wishes to get most out of existing data [of either a cordon count or an origin-destination (O-D) type]. Persons employing this approach occasionally feel that they may, as their tutors once admonished, have combined apples and oranges. This introduces an element of uncertainty that might be better removed.

Some accept boundary delineation as an important and continuing problem and then proceed to draw conclusions after expressing the hope that ultimately a satisfactory universal definition of the CBD will be developed. Unless an approach is put forward and practically universally used, such groundless hopes will continue to be voiced; we will continue to collect insufficient data on unsatisfactory cordons, and it is reasonable to expect that the delineation problem as stated here will never be effectively solved.

Another means of avoiding CBD delineation is for the writer to conclude that delineation is a local matter and not within the purview of other jurisdictions. There is considerable merit in this because boundaries should be worked out locally; however, common definition would provide a data base useful to other jurisdictions as well. This allows an assessment of problems of importance not only to the community but also to the state and nation.

It is not within the scope of this paper to solve the whole question of standardizing delimitation. For now, it remains a problem of agencies at all levels to establish acceptable criteria and apply them to our major cities. We can only hope to come to better agreements on this matter as time goes on.

Person Travel to the CBD

The primary point at issue in better serving the CBD is how much activity exists, what are the trends in its magnitude, and what is it likely to be in the future. With some scale as to the magnitude of this demand, we can then face the secondary question of how to serve it (or more appropriately how well to serve it). For the moment, we will neglect the point that the level of transportation service provided will undoubtedly influence the magnitude of the demand or activity.

The activity level can be measured in a number of ways depending on one's personal interest and selected goals. For example, an environmentalist might measure carbon monoxide and unburned hydrocarbons and rate them against a predetermined acceptable level, a transit man might measure ridership or clear profit or loss, a businessman might measure retail sales or company profits, and a traffic engineer might measure vehicular speed or volume. There are interrelations among these measures, but they are seldom clearly defined. Daytime population, as indicated by person travel to the CBD, is taken here as the best single measure of transportation effectiveness. No measure is ideal for all purposes, but person travel seems to be the most effective way to relate transportation service to several possible urban goals.

There are a number of approaches that might be taken to obtain a measure of the activity discussed here. Most of them have definite disadvantages, and none is without fault. All of them relate to the problem at hand, however, and any one or a combination of procedures designed to make best use of the advantages of several procedures may be called for.

ORIGIN-DESTINATION STUDIES

The chief advantage of O-D information is that the interviewer obtains actual trip origins and destinations within any established study area. Separate checks can be made of trips "passing through" the study area with greater or lesser accuracy. O-D cordon data used in this manner or combined with cordon count data offer a measure of the possible advantages to be obtained by providing a bypass of the selected area. O-D data are also carefully controlled by the time of day, and the temporal distribution of person trips can be readily obtained by purpose, mode, or other stratifications obtained as a part of the basic data (Figs. 1 through 5).

On the other hand, O-D data are difficult and expensive to obtain (particularly home-interview data), and new data are not collected frequently. Check samples might be obtained from time to time, but these can seldom be considered conclusive.

The base data from a home-interview O-D study might be used to good advantage to factor cordon count data under certain conditions. Factors obtained in this way might be applied to a number of cordon analyses until a new O-D data collection is made.

Another problem with using O-D data is that the typical urban transportation planning study takes count checks over screenlines and factors these trips to compare more favorably with count data. The need to correct these data shows that there are some problems of direct comparison between O-D and count data.

Another point that should be raised is that O-D data do not need to be collected at the home but might be collected at a downtown destination or even at a parking space. A number of suggestions have been offered as to various methods by which O-D data can be obtained (1).

CORDON COUNT STUDIES

A cordon count involves the taking of (at least) count information on most entry and exit points to a defined area. The line defining the area is known as the cordon. By totaling the entrances and exits at each counting point, the total accumulation of vehicles or persons within the area can be determined. Occupancy of individual automobiles can be checked at cordon stations, or a separate occupancy study can be made and related to vehicle counts to obtain better measures of person travel. Transit ridership figures across the cordon for the study period should also be obtained.

Cordon counts are frequently taken to check screenline crossing as part of a comprehensive transportation planning study, as a part of a CBD study, or as a part of a comprehensive parking study.

Both manual and machine counts are typically made. The manual counts can be used to classify vehicles by type and perhaps occupancy, and the machine counts obtain entering and leaving volumes and can be factored by use of the manually obtained data.

CBD cordon line counts are made to record daily and long-term trends in movements to and from the CBD. Volume counts are recorded by type of vehicle, direction of travel, and usually 15-min intervals. Passengers in automobiles, trucks, and buses are also recorded. This information may be collected annually or at least every few years to provide the historical relation of transit riding and automobile riding.

CBD cordon counts are normally taken for one weekday each year. The day selected is usually in a month whose average daily traffic is close to the annual average. Counts are usually made for 12-hour periods. The study is normally made in the same month each year.

Cordon counts are frequently made annually in our largest cities by the traffic engineering department. They provide a valuable source of information on which to base transportation decisions. The primary difficulty is that the studies are seldom summarized or checked against available O-D information that might add greatly to their usefulness. This deficiency detracts from the usefulness of the data.

Figure 1. Inbound travel by purpose.

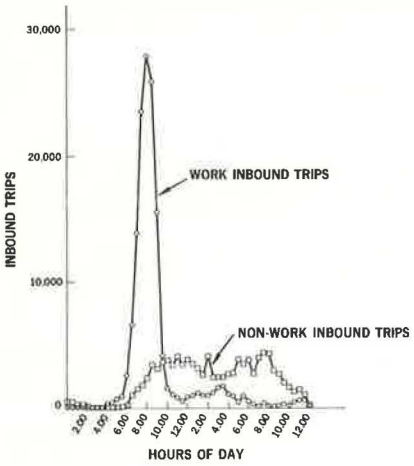


Figure 2. Inbound travel by mode.

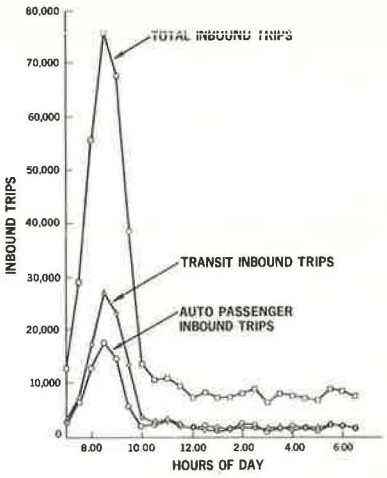


Figure 3. Outbound travel by mode.

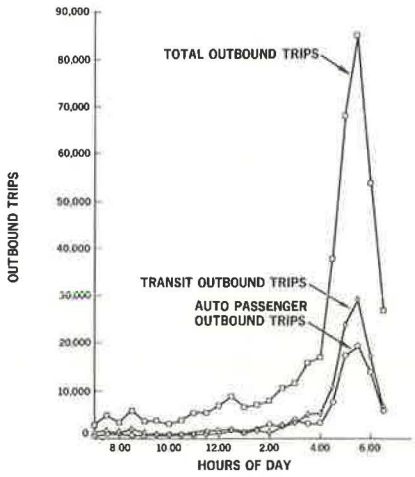
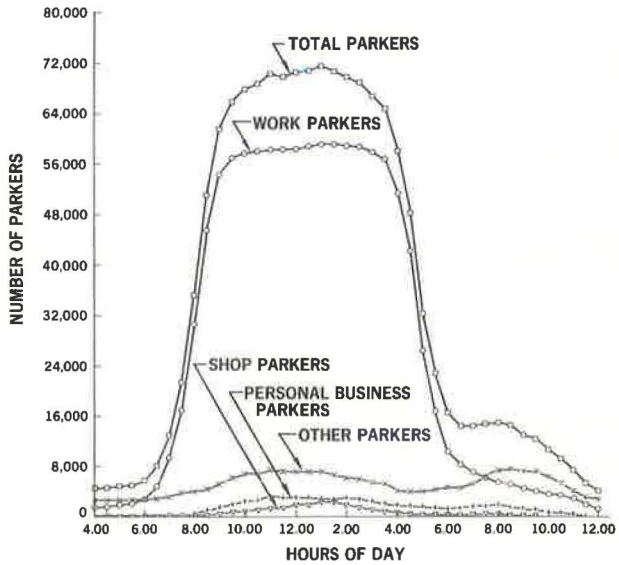


Figure 4. Parking accumulation by purpose.



transportation study staff have a unique knowledge of the travel patterns of the community. These and other groups working together can provide substantial data resources on which to base transportation decisions. The following criteria would seem to be most important for guiding the development of such procedures:

1. The methods should address and be responsive to the questions raised by the community and by the governments. They should be flexible such that additional questions raised in the future may be considered.
2. It should be possible to initiate the analysis with existing data sources, but allowance should be made for improvement of these sources as needs become clearer.
3. The methods should allow means of evaluating the probable effects of proposed alternatives without the need for demonstration or full-scale test.
4. The methods should be capable of application as frequently as necessary at low cost so that the effects of procedures already implemented can be evaluated and their effectiveness measured. Simplicity is desirable and there is no need to make a method complicated in order for it to be effective.
5. Finally, the results of this analysis should be consistent with and measurable against other community planning efforts including long-range transportation planning.

With these goals in mind, we can now proceed to develop a skeleton of procedures and then return to discuss them in greater detail.

ANALYTICAL PROCEDURES

Before work can proceed, a conclusion must be reached about the boundary or limits of the CBD (sometimes called the cordon). Means of accomplishing such a delineation have been proposed but have not been standardized to any great degree. Although a later section discusses this matter in greater detail, a full coverage of delineation methods is beyond the scope of this paper.

The primary commodity that we wish to measure and better understand is person trips entering and leaving the CBD on typical (or above average) days, normally weekdays. Because problems are usually related to the hourly "peaking" of these movements, we should also obtain the temporal distribution of trips across the cordon as well as accumulations of activity within the cordon (in either persons or vehicles). Total person trips entering or leaving should also be stratified by mode of travel, trip purpose, and perhaps other available categories by hour of the day. Occupancy checks of private automobiles in order to determine person movements might be made for all vehicles and can also be obtained by sampling.

One purpose of such studies will ultimately be to develop a temporal distribution of travel by mode over the years. The object here is not to rely on trend projections but to use past trends as a check on other independent estimates such as a transportation study. Do present estimates of downtown travel compare favorably with the trends? If not, can the projections be supported by anticipated inputs of transportation, investment, and so forth? Past studies rate floor space as a fair indicator of most types of downtown activity. Some caution is necessary because in some communities floor space appears to be increasing very rapidly without a commensurate increase in downtown activity.

Means of improving CBD travel should be listed, and likely alternatives should be analyzed in depth. It is not only the choice of improvements that is important here, but also the probable effort of such improvements if initiated on the temporal distribution of person trips.

An analysis should also be made of the individual and collective effects of proposed improvements or sets of improvements on cordon crossings. Several benchmarks, discussed later, for improvement may be used for evaluation. The main point is that specific objectives should be decided on to evaluate the results.

Finally, the results of the analysis shown as alternatives or systems of improvements must be synthesized and brought together in the form of a plan for action. Probable results should be described in as much detail as possible so that implementation can proceed when final approval and funding are obtained.

PARKING OR SPECIAL STUDIES

Procedures for parking studies in the past have frequently allowed the development of some of this information. These studies have frequently included a count cordon as a part of their study design. Although the work has sometimes not related vehicle travel to person travel, it might be possible by the application of occupancy relation and transit data to obtain an estimate of person travel at a given point in time by this means. Purpose data and parking information would also be available if this route were taken.

The disadvantage of this is that a minor error in automobile occupancy or incorrect assumptions used in handling transit data might lead to substantial inaccuracy in the final results. In other words, the use of old data from several sources is not desirable.

Another similar means of developing person-trip information is to relate it to the actual activities that take place in the CBD. Some cities may already have a good base of information on employment, retail sales, and land use from efforts that have gone on over the years. Some work of this type has been assembled as a part of local transportation studies.

The obvious disadvantage of this type of information is the rather abstract means that might have to be taken to translate the information into the person-trip base provided by the other types of studies mentioned. Although modal relations might well be available from transit ridership or revenue data, travel by time of day is unlikely to be available without a special effort to obtain such data. Calibration would be difficult, and again some of the assumptions that would be required to use such data might well affect the conclusions.

Trends in Travel Mode Over Time

One purpose of the type of analysis proposed here is the development of trends over time. Although the most important of these from a transportation point of view is choice of travel mode, substantial value would also be obtained if such annual trends were obtained stratified by purpose and perhaps by parking cost, type of parking used, duration of stay in the study area, income of entering persons, and so forth. This is idealized, and the description provided here relates only to trends in entering travel by mode.

The most effective of the data sources listed in the previous discussion relative to modal choice over time is the cordon study. It offers frequent data points and is relatively inexpensive to reproduce at any time. It does not offer much on trip purpose. This is not as important as modal choice, and modal selection is particularly well covered.

There are a number of misconceptions among the general public as to the shape of trends of travel mode selection over the years. Figure 6 offers a look at the percentage of person trips by mode for Chicago from 1926 to 1961. The absolute trend in person travel directed to the CBD has not changed appreciably over the years as shown by Figure 7. The percentages are closely representative of the real number of persons using the available modal choice. It can be seen from Figure 6 that both automobile passengers and rail transit passengers to the central area have increased over the years, and the decline in bus travel reduces the total portion of travel by transit to the CBD.

The representation of Chicago downtown travel shown here is obviously not typical of all cities. Some cities of more than 500,000 population do not have rail facilities. It would be interesting to see the shape of this curve for other cities, however, for comparison purposes and as a check against projections of future travel.

Projections of CBD Activity

The previous section relates to the development of trends in modal travel to the CBD over time. It might be inferred from the discussion that we would then extend these trends to reach a future projection of mode of person travel. This is not the intent because we believe that there are better ways of making future projections including the whole range of modal split procedures that have been developed over the years.

Figure 5. Parking accumulation by type.

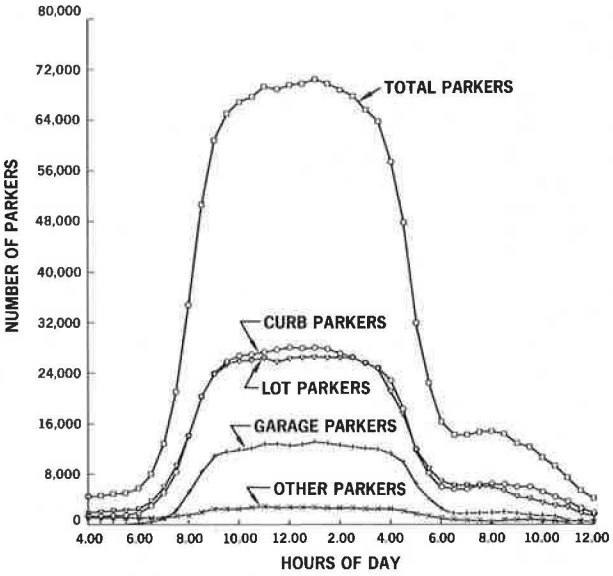


Figure 6. Modal distribution of persons leaving Chicago Loop (p.m. peak hour).

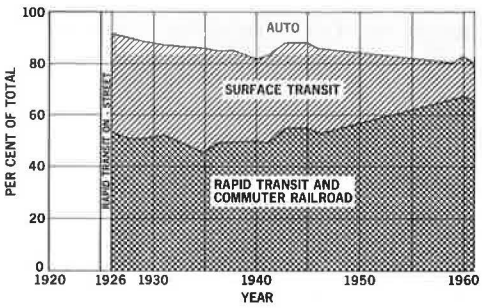
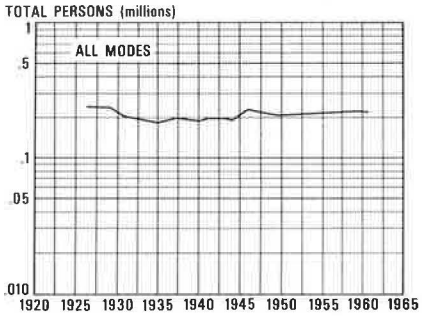


Figure 7. Trends in peak-hour Chicago Loop cordon movements (one direction).



Furthermore, it is our contention that trends can be reversed or at least altered by the application of other measures, some of which are discussed here.

The point of this is that projection of present trends in CBD-directed travel leads to a conclusion of what future travel will be like. Projection made in relation to transportation planning studies may offer an entirely different conclusion. If a revision in either activity level or modal selection is anticipated, it will probably come about because of changed conditions in the CBD. If conditions do not change, an entirely different result may be expected.

The annual cordon count supplemented by the occasional collection of O-D data oriented to the CBD would allow the periodic checking of such trends and revision of such projections from time to time based on anticipated or imminent changes.

Most urban transportation planning studies for large cities now project considerable increases in CBD activity in the future. This is frequently in direct conflict with present trends. It seems likely that the relations involved in making such projections should be checked against probable future development in terms of types of activity, levels of activity, and intensity of activity in order to more effectively provide for future needs.

MEASURES THAT MIGHT BE APPLIED

The following discussion relates to measures proposed to solve urban transportation problems. Most of them have their greatest application in the CBD or its surroundings. Some items specifically not mentioned are technological advances that may receive broader application at a future time. The material is grouped into functional areas to allow the combination of related ideas. Discussions are not exhaustive and are only intended to provide a buffet from which one can choose and then embark on his own more exhaustive study.

Bus Improvements

One means of improving urban transportation that has received more attention in recent years is the bus roadway or bus roadway system. This is due in part to the successful operation of bus lanes on the Shirley Highway in the Washington, D.C., metropolitan area and on I-495 through the Lincoln Tunnel in New York City.

Providing a roadway for buses removes them from normal traffic congestion and improves travel time for bus riders. This improvement in travel time may allow time savings over private passenger vehicles and still provide other transit advantages. The concept is more flexible than rail service in that the bus picks up and delivers passengers near home.

Bus roadways may be provided exclusively for buses or may also serve other vehicles. The numbers and types of other vehicles allowed would be restricted. Vehicles that might be allowed could include car pools, trucks, emergency vehicles, police, or a combination of types of vehicles.

Bus roadways may be constructed as new facilities or use existing lanes. Removal of parking on an arterial street might provide the street width necessary to include a busway. Abandoned railroad rights-of-way have also been proposed for construction of busway systems.

Private or publicly owned minibuses carrying from 9 to 16 passengers could be operated by commuters as a sort of large car pool to reduce operating costs. Small units such as this might be leased for charter line-haul commuter service. A private individual, governmental unit, or private company might set up car pools and lease the vehicles primarily for work travel. These operations provide for relatively low operating costs because commuters normally drive. A company or the government could take advantage of fleet purchase prices and insurance rates if they provided such service.

Small buses (those accommodating 16 to 30 passengers) could also be operated on fixed schedules on circulatory routes in the CBD. This concept might also be applicable to medical or airport complexes or for neighborhood pickup and distribution feeding line-haul transit stations.

Other novel transit operating concepts might include the following:

1. Demand-actuated systems on low-cost or free taxicab or jitney service for the aged, the disabled or sick, or the very young on either a routing or phone-call basis; and
2. Several buses linked together into a train for improved line-haul service.

Parking Innovations

Fringe parking is a term that has come to mean parking on the outskirts of the CBD or farther out in the metropolitan area with public transportation service to the city center. Such parking encourages the commuter to leave his car at the lot and to ride public transportation.

Fringe parking may be provided at or near strategic interchanges on the freeway system. There are sound reasons for not providing parking in the interchange, but space can frequently be found adjacent to interchanges or frontage roads. Such parking may merely provide a formation point for car pools.

Free or inexpensive parking near downtown can reduce congestion. Bus or people-mover service can be provided to shuttle persons to their final destination.

The elimination or restriction of on-street parking can greatly reduce traffic congestion. Combined with an adequate off-street replacement program, the elimination of street parking adds travel lanes to increase capacity and at the same time eliminates the accident potential created by high-turnover curb parking.

The planned application and control of parking rates offer a means of controlling the use of parking facilities to promote other transportation objectives:

1. Rates in the core area might be revised in favor of better service to shoppers. This can be accomplished by establishing a low first-hour parking rate with increasingly higher hourly rates leading to a very high all-day parking charge. This is the reverse of most present parking rate structures.
2. On-street parking rates can be raised to more accurately reflect the value of such spaces. High rates for on-street parking should reduce all-day use, promote higher turnover, and shift meter feeders to off-street parking.
3. Merchants and businessmen can cooperate to better serve downtown shoppers. Parking validation systems may ensure spaces earmarked for shopper use and allow participating merchants to pay their proportionate share of costs. Incentives of this type might be supported by the city to keep shopping interests in the CBD.

Zoning requirements for the type and location of parking facilities need not be applied piecemeal but should be related to transportation goals based on analysis of downtown transportation needs.

Most zoning codes specify minimum parking space requirements according to type and intensity of land use on a per square foot, per seat, per bed, or similar basis. These requirements might be revised to restrict the number of parking spaces provided. This practice would eventually reduce the supply of parking spaces and discourage personal vehicle trips to the CBD. Conversely, such a policy may affect downtown business and the tax base of the community so that caution is required in its application.

Parking fees provide a direct means of imposing a congestion toll on vehicle users. Free parking attracts because its cost is hidden. The elimination of free parking and initiation of a progressive parking rate structure provide another means of reducing urban area traffic congestion. Other pricing methods are as follows:

1. Where tolls are paid on entry to congested areas, the tolls might be raised to promote transit use or car pools.
2. A tax might be levied on all vehicles entering parking facilities between, for example, 7:00 and 10:00 a.m. This might cause the commuter to consider alternative travel.
3. Free transit service has been proposed as an incentive to increase ridership. Although present revenues would become a new burden on the community, the costs and inconveniences of fare collection, token sales, and exact change systems would be eliminated, thus reducing costs.

4. A tax on parking might provide revenue to support improved transit service.

Improved integration and interchange among modes is a real need in some cities. One way that this can be accomplished is by the provision of a center where modal transfer is simplified. A center might include rail facilities, bus terminals, taxicab loading areas, limousine loading, curb frontage or turnouts for kiss-and-ride passengers, off-street parking, car rental areas, or some combination of these services. The terminal would require good connections to local and regional access roads and might have direct freeway access.

Complementary uses such as shopping, pedestrian services, service stations, and ticket agencies might be included to offset the cost.

Car pool matching systems might bring together travelers into fewer vehicles for trips to congested areas. A questionnaire submitted by each individual car pooler would provide information on travel times, locations of home and work, and willingness to ride, drive, or share driving. Home origins might be matched based on a grid map of the area or on other information such as zip codes, telephone exchanges, or transportation study zones. Other incentives to car pools might be provided in the form of lower parking costs for car pools and reduction or elimination of tolls based on automobile occupancy.

Revised Time Patterns

Urban traffic volumes exhibit marked peaking characteristics primarily because of the controlling influence of work trips. A relatively simple and inexpensive method of reducing peak-hour traffic is to introduce staggered work hours at major traffic generators. Reductions in the travel peaks should result in immediate improvement in travel service even if no additional transportation capacity is provided.

Employees are generally agreeable to changes of up to 30 min before or after their normal duty hours. The results of staggered work hours should be less congestion and better utilization of transportation facilities.

A logical extension of the staggered work hours concept is the 4-day week. This simply consists of rescheduling the workweek from five 8-hour days to four 10-hour days. There are several ways in which this could be scheduled including revisions in total number of days per week a firm stays open and the ways in which a given employee's 4 workdays are scheduled.

The net result of this improvement would be a decrease of travel to the CBD in the range of 17 to 33 percent. Other results would include a reduction in parking demand and a possible reduction in transit ridership.

The concept of Gleitende Arbeitzeit has been introduced in Germany, and the name can be translated as "gliding work time." Under this arrangement, each employee is allowed to report for work any time between, for example, 6:00 a.m. and 10:00 a.m., work for 8 hours, and then depart. The concept could not be adopted for all types of employees, but would allow a good many to revise their travel schedule, thus reducing congestion.

All of these proposed improvements can be analyzed to greater or lesser degree in terms of the procedures discussed here. The biggest single problem in applying them is the present lack of means of judging their relative or absolute effectiveness. This is not possible currently because of a lack of information, but relations can be developed in the context developed here. The more likely event at this time is the introduction of these measures because of their ostensible "goodness" without at the same time judging, measuring, or evaluating their effectiveness.

REFERENCE

1. Manual of Traffic Engineering Studies. Institute of Traffic Engineers, 1964, pp. 47-64.