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Urban Transportation Planning

Concepts and Application

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Contents

Development Patterns in American Cities

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●DURING the past year new techniques have been used to analyze growth characteristics of urban areas. These analyses were made in connection with several urban transportation studies in an effort to develop a sound basis for the land-use projection essential in traffic forecasting. The studies were made in Hartford, Conn., Baltimore, Md., Washington, D.C., and a group of Iowa cities including Des Moines, Sioux City, Council Bluffs, Waterloo, Cedar Rapids, Dubuque, and Davenport.

Though these communities may not be truly representative of all American cities, the findings definitely have shown that some of the former concepts of urban development are rapidly changing, along with social, economic and technological changes, particularly as they relate to the rising standard of living.

The exact pattern of growth that materializes in a community is the result of many individual decisions—a manufacturer decides where to locate his next plant, a merchant decides which of his stores to expand, a government agency decides where to relocate, a family decides where to rent or buy a home. It is quite clear that the final choice in all such cases depends on the alternatives provided at the given time.

In making these decisions many factors are weighed. For example, a family will consider type, size and kind of house, the cost, financial arrangements, neighborhood amenities, distance to stores and schools, accessibility to jobs and adequacy of governmental service, as well as many other factors.

The studies undertaken in these cities attempted to measure the importance that people place on these and other factors in making their decisions. Though different individuals may weigh these factors differently, on a group basis the more significant factors can be defined and measured. From the analyses, it was possible to develop mathematical formulas to indicate how much weight people give to these various factors. Such formulas, when used to configure such a complicated process as urban growth, are usually referred to as models.

Models have other advantages in addition to serving as an analytical device to appraise past growth trends. They also can be used in estimating the potential impact of various public policies or decisions. Thus they can be used to predict the pattern of growth that will be brought about by different urban plans or highway programs, as well as the influence that various zoning plans might have on urban growth. Cities like Hartford, Washington, D.C., and Baltimore have been employing urban growth models to evaluate alternative schemes of land development, just as assignment procedures are used to test various freeway systems.

Models developed in connection with these studies generally fall into the gravity model class and are quite similar to those proposed by Hansen (1). However, in these studies it was apparent that there were many more urban growth factors that would have to be taken into account than had originally been considered in the Hansen model. Thus improvements achieved in the analyses stemmed largely from incorporation of additional variables into an effective model.

Usually four or five models were used to analyze various aspects of urban growth. For example, in the Hartford area separate models were developed to analyze manufacturing employment, service employment and retail employment, as well as population (2).

To establish past growth trends of manufacturing employment in the Hartford area, nine variables were used in the analysis. Some of the variables considered were highway accessibility, availability of industrial land, tax rate, sewer and water service, rail service, proximity of industrial land to freeways, proximity of industrial land to airports, size of existing industrial activities and promotional aspects.

With some of the variables such as highway accessibility, tax rate and proximity of airports, it was fairly easy to get a quantitative measurement. However, for such things as promotional aspects, subjective evaluations were necessary to develop a rating index.

The influence that these various variables had on urban growth was appraised by multiple correlation. In effect, a formula was developed by multiple correlation analysis which would give a growth index for a particular zone. This growth index, when compared with the sum of the indices for all the zones, reflects the amount of the growth that can be expected in a zone anticipating a certain amount of over-all growth. The formula is as follows:

$$GI = 12\,A + 37L + 5TR + 34S + 2W + 12R + 5AF + 19TA + 1\,P + 120$$

in which

GI = growth index—manufacturing employment.

A = highway accessibility to the labor force. This was developed on the basis of the following equation in which P is the population in a zone and T is the travel time between the employment area and the residential zone:

$$A_1 = \frac{P_1}{T^x_{1-1}} + \frac{P_2}{T^x_{1-2}} + \dots + \frac{P_n}{T^x_{1-n}}$$

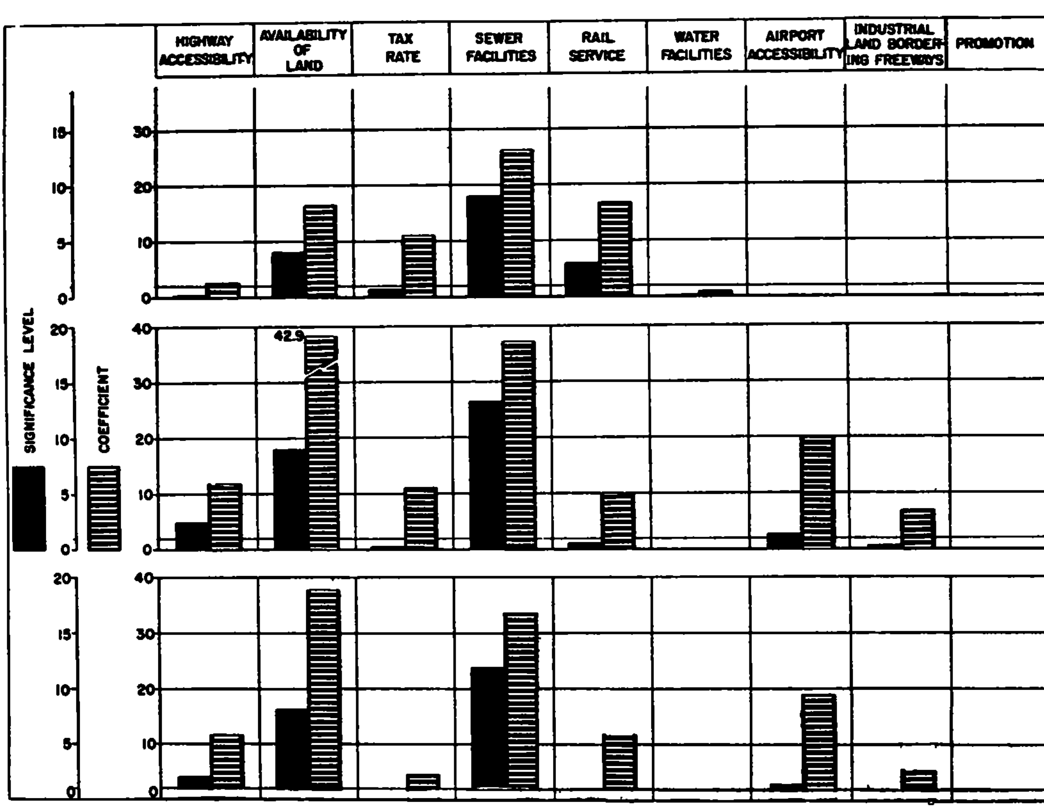

Figure 1. Multiple correlation analysis. (Source: Hartford Area Transportation Study, Connecticut State Highway Department)

L = available industrial land in each zone.
TR = tax rate.
S = sewer service in the zone. This was related primarily to the capacity of the sewer system in the zone.
W = water service. This was related primarily to the capacity of the system in the zone.
R = rail service in the zone.
AF = industrial land adjacent to freeways. Each zone was rated as to the amount of industrial land adjacent to freeways.
TA = travel time to airport.
P = promotional activities related to industrial development.

Figure 1 shows the results of the multiple correlation analyses. The cross check bar represents the coefficient of each variable, whereas the solid bar represents the level of significance of each variable. The first row of "bars" depicts the analysis based on six variables; the second row shows the analysis based on eight, and the third row portrays the analysis based on nine variables. (To make it possible to compare the importance of the various factors, all the parameters were adjusted so that their values ranged between 0 and 50.)

This particular test seemed to indicate that the most important factors were available land and sewer service. Next in order of importance were accessibility to airport, highway access and rail service. The other factors seemed to be of relatively minor significance.

As might be expected, it was found that by adding more variables the results improved. Unfortunately, however, the formula that took into consideration all nine variables did not simulate urban growth perfectly. Therefore a continuing search is being made for other variables. The fact that the importance of some of these variables could be evaluated has been quite an advantage. This has made possible a comparison of the estimated urban growth (based on the results of applying the model with indicated variables) with the actual growth pattern.

The experiences gained the past year in these cities represents a wealth of information on the numerous factors that are influencing community growth. Certainly not all of the factors have been isolated, but these studies have revealed a lot of them. The exact interrelationship between the variables needs considerable further research. Some people are of the opinion that an urban growth model should be a linear programming model that insures optimization of all the influencing factors (3). Others feel that Monte Carlo methods might be applied (4). Still others think that these models should be expressed solely in economic terms (5).

However, at the present stage of development it is vital to know what variables in urban growth appear to be most significant, and what their general influence is. Such knowledge is essential to the formulation of sound urban growth models. It is with this thought in mind that the following summary is made of the basic findings derived from these ten cities.

Not all of the findings were quantified to the same degree that they were, for example, in the Hartford area. As an illustration, in the Cedar Rapids study a very simple procedure was used for analysis of urban growth: a model based on only two factors—availability of land and accessibility of each parcel of land (6). From this the theoretical growth that should have occurred in each region was determined and then compared with the actual growth.

In other words, a growth index was developed for each zone on the basis of available land and accessibility. This can be expressed by the following

$$GI = C \times A \times K$$

in which

GI = growth index,
C = capacity,
A = accessibility index, and
K = influence of various other factors affecting urban growth.

By comparing the actual growth with the theoretical growth and considering all the characteristics of each zone, it was possible to evaluate subjectively the importance of many of the factors that were involved in growth (Fig. 2).

POPULATION PATTERNS

When it came to reviewing population and residential growth trends, the studies recognized that if builders are to build for the low-cost homes market, they must search for cheap land. Doubtless, that is why it was found that low land costs are probably the most influential factors affecting urban growth. The analysis in these

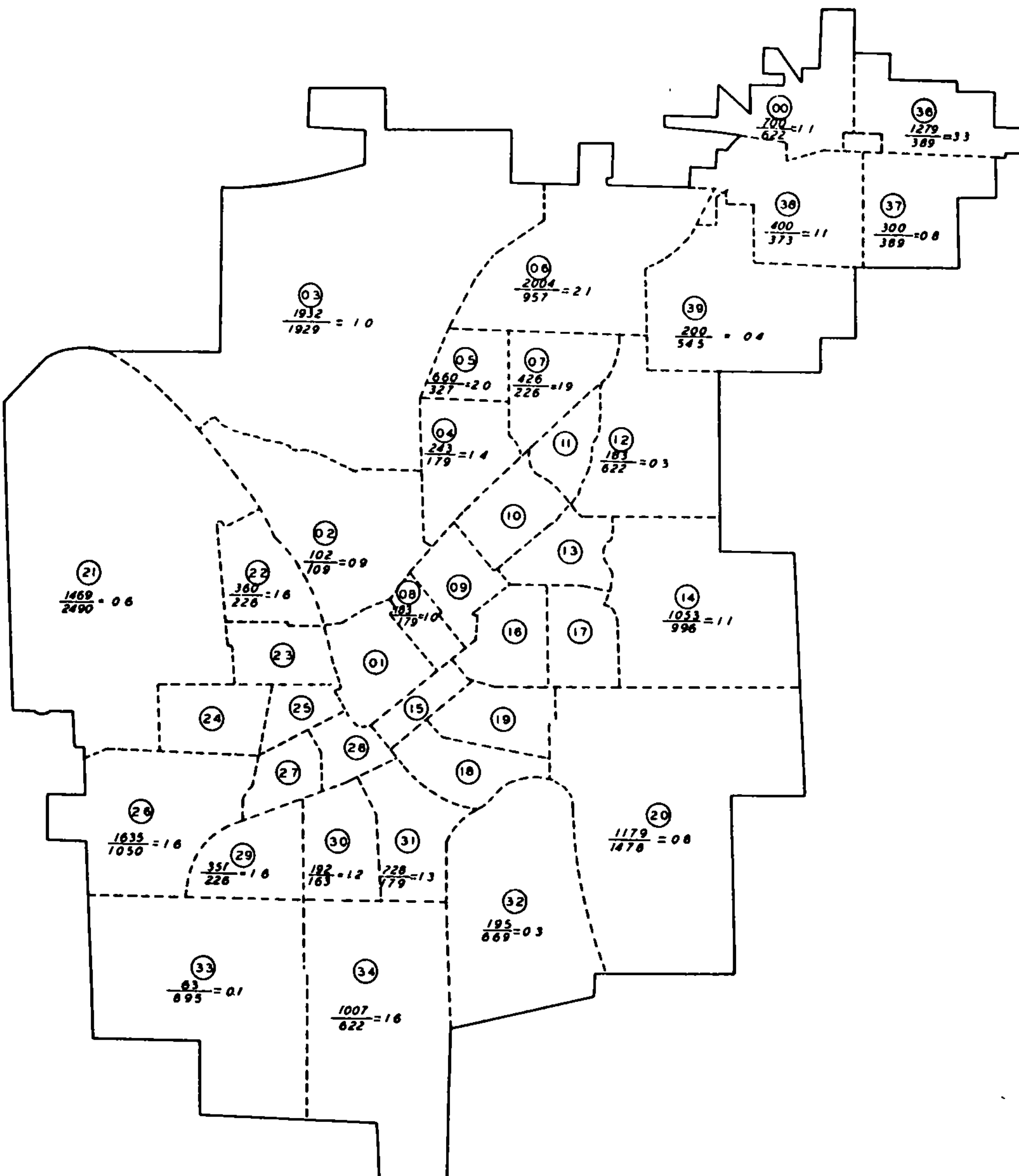

Figure 2. Transportation zones of Cedar Rapids-Marion urban areas with zone ratios of actual/calculated population growth. (Source: Iowa State Highway Commission)

cities reveals that other things being equal, an area with cheap land may develop up to three or four times as fast as it theoretically should, on the basis of accessibility and availability of land. Evansdale, Iowa, a small incorporated area outside of Waterloo, grew at this rapid rate during the last decade because of cheap land. But the pattern has changed abruptly since FHA withheld mortgages in the town because of sewer problems.

As people rise in the income scale, however, they tend to place more emphasis on the type of area in which the home is located. Is it an attractive neighborhood? Are the public services, such as schools and police protection adequate? Does the locality have any claim to distinction as a "prestige area"? Areas that meet these tests grow nearly twice as fast as those which do not. Notable examples of phenomenal growth of prestige areas are found in Montgomery County, northwest of Washington, D.C., and the Towson area, north of the City of Baltimore.

But as already indicated, there are many other elements involved in the rate of growth of a residential area. Lack of sewer or water service, for example, has held growth rates to about one-third of normal, everything else being equal. Otherwise attractive areas where land owners are deferring sale of property for tax advantages, or to make large capital gains, often have only one-half the growth that might be anticipated. A good example of this was Suffield, Connecticut, a town north of Hartford near the state line. This factor is much more prevalent that one might expect, particularly in the large metropolitan area.

Sections of a region near extablished communities have often grown several times as fast as outlying zones in which there were no established communities. Marion, Iowa, northeast of Cedar Rapids, is an illustration.

Nevertheless, one of the prime factors is the availability of land. The extent and intensity of its use, of course, depends on the zoning policy for the area.

These studies also have shown that, though accessibility of an area is an important consideration to a family, it gives a great deal of weight to the other factors that have been cited. This undoubtedly reflects the fact that most areas in a metropolitan area are served by highways. The difference in accessibility as between one place and another may be only a few minutes. Hence it is apparent that transportation facilities and services do not exert the dominant influence on urban growth, as they formerly did. The automobile has freed the family so that it can afford to weigh other factors in the selection of a home.

EMPLOYMENT PATTERNS

In considering the spatial distribution of employment, it was recognized that different types of activities place varying emphasis on locational factors. Therefore the various categories of employment were grouped by their locational requirements.

In Hartford, a pilot study was undertaken to determine the number of employment categories that should be used. From this work, it was decided to study at least three types of employment separately: manufacturing, which included S.I.C. (7) numbers 19 and 28-40; retail which included numbers 52-59, 72 and 75-89; and the "other" category, which included all the rest. Similar breakdowns were followed in the other studies.

Manufacturing

As in residential selection, the employer also has been freed by the automobile in his choice of plant location. He now knows that he can locate almost any place within an urban region and be assured of the necessary labor force. In short, accessibility to the labor force is not as important a factor to an industrialist or other employers today as it was in the past. More often the chief interest is in a specific site requirement such as water, sewer, freeway, port or rail service.

In the Baltimore area most of the largest manufacturing industries have gravitated to the corridor lying to the east and northeast of Baltimore City which has good rail and highway access as well as accessibility to water. This section seemed to best meet the requirements of industries locating in the area.

Only a few manufacturing activities are attracted to residential areas. Usually these are light industries looking for "prestige sites", as is true particularly in the area north of Baltimore where a number of smaller industrial plants have located. Over-all, however, five-sixths of the industrial expansion that occurred in the Baltimore region was influenced largely by site requirements. Only one-sixth of the expansion was influenced primarily by the residence of population.

The studies likewise revealed a definite tendency for existing large employment centers to draw new industrial activities to the general vicinity. Similarly, greater growth was evidenced where there were promotional programs for industrial land development.

Certainly the availability of rail, port and highway played a part in the location of some manufacturing plants. Areas with relatively low residential prestige often provided land to industrial developers at a price they could afford and, as a result, these areas had considerable growth. However, if the parcels of available land in such areas were too small the growth was retarded.

An interesting sidelight in these studies is that industrialists are more interested in the capacity of the sewer system than in the cost of connecting to it. On the other hand, home builders are more interested in the cost of sewer service. They really do not care whether there is adequate capacity; that is the home owner's problem.

Retail

Retail employment trends in the study cities quite apparently changed with the changing pattern of population. As the families shifted to the suburbs, the neighborhood retail trade has gone along. However, retail expansion generally follows the first wave of residential development. Retailers like to have an "insure" market before they move out. The exact location of the store will depend largely on accessibility factors.

About the only other factor that may influence this pattern is the regional shopping center. The present location and size of such centers have a marked impact on the location of new centers. Generally the new centers will locate within three or four miles of an existing center that has an adequate range of merchandise. But the pace of residential development probably will determine whether the old center is expanded or a new one developed.

Other Employment

Service activities, such as dry cleaning outlets, hairdressers, banks, etc., have followed a pattern similar to that of retail establishments. They have moved to the suburbs to be closer to the people and industries they serve. Certain types of activities, however, still find the downtown area very attractive. These are organizations that depend on accessibility to a large labor pool or specialize in certain lines. For example, in Baltimore the Commercial Industrial Trust located in the downtown area mainly because it needed a large pool of office workers. On the other hand, some of the more or less standarized office operations which do not require large labor forces will locate in.the suburbs.

Governmental

In studying the location choice pattern for many governmental activities in the Washington area, it was clear that a strictly personal decision by the head of the agency was generally involved. However, different influencing factors were noted. First of all, accessibility to the labor force is rather important. Thirty percent of the governmental expansion between 1948 and 1957 occurred in the downtown area.

Certain governmental activities seem to concentrate in outlying sururban zones where other governmental activities have already been located. Nine zones in the suburban area received more than their share of the growth, on the basis of the analysis made in the study.

Besides increase in the number of Federal employees, there was an increase in employment by local governments. Most of this growth followed changes in population, because a large portion of it was aimed at serving the new population.

Broadly, the study has shown that a great many of the changes in employment patterns have followed population adjustments. Almost all retail and service employment has shifted with population. Many governmental and office activities have moved out to be closer to the people they serve. In effect, about two-thirds of the employment follows the migrating people.

The most important conclusion to be drawn from these studies is that transportation is not the key factor in shaping cities today. With the universal use of the automobile and the development of metropolitan area street systems, the urban dweller has been given almost unlimited latitude in where to live or locate his business. Because of this, he gives considerable attention to factors other than transportation in making a final decision.

At first glance, this conclusion seems to be at odds with other recent research. For example, the Bone and Wohl study (8) of the industrial expansion along Route 128 outside Boston has indicated that transportation was a very important factor in this growth. These results were based largely on attitudes expressed by industrialists who have located along this freeway.

However, a further look at the replies of these industrialists reveals that they also were giving a great deal of weight to other factors. A large number of them stated that the attractiveness of the area as well as its advertising value was important. Though many of them did say that "commercial access" was very important to them, the fact remains that they could have obtained practically the same commercial access if they located one or two miles away from the expressway. A few minutes of travel would not have made that much difference.

Certainly the fact that Cabot, Cabot and Forbes were promoting the area along Route 128 increased its growth potential. In fact, the area along the route was not developing until this firm was able to convince one industrialist to locate along the route. This single relocation brought with it the wave of development now evident. The fact that industrialists follow fads just as people do was observed in most of the cities studied.

This would also hold with regard to the accessibility to the labor force. Perhaps if over-all employment patterns in the Boston area were analyzed, the findings would be similar to those found in the ten cities.

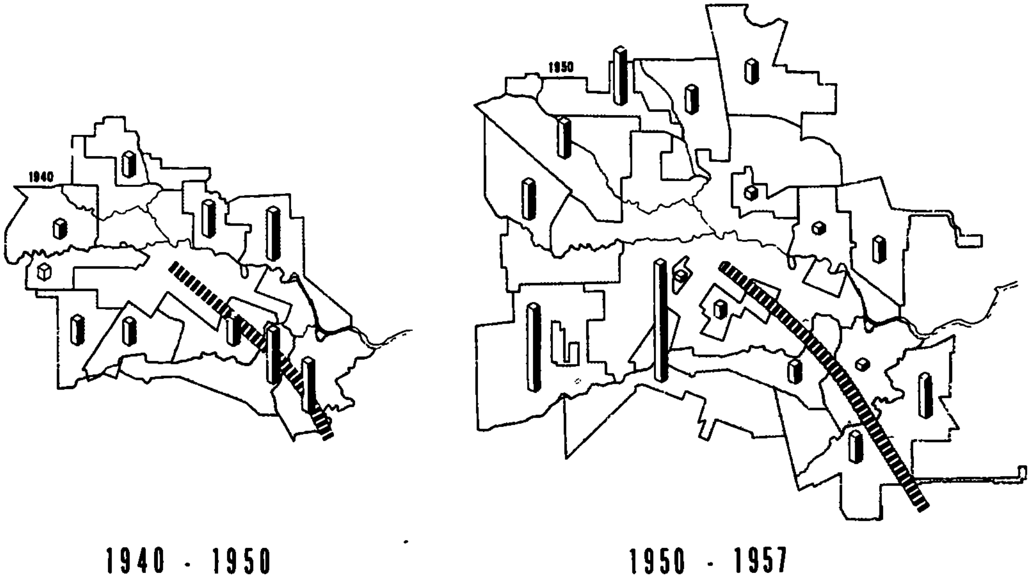

Figure 3. Houston population increases, 1940-1957. (Source: Houston Planning Commission)

Also often cited when discussing the influence of freeways on urban development, is the great expansion of residential development that occurred near the Gulf Freeway in the southeast section of Houston (9). It is true that when this facility was first opened there was a tremendous growth in its vicinity for a period of about five years (Fig. 3). However, recent growth trends in the Houston area have swung to the southwest portion of the city, which is generally considered the prestige area. What is more, a new freeway has been built which serves a rather run-down section of Houston. This has had no apparent influence on the growth patterns.

Such illustrations of the dynamics of urban growth show that all the factors related to expansion must be considered together. Any time a change in transportation facilities is introduced, it may modify the influence of the other factors. Greater accessibility, particularly at the beginning of a new development, if combined with other favorable factors, may stimulate a great deal of growth. But, as in Houston, the other factors like prestige may become dominant and changes in accessibility are not enough to modify growth patterns.

All of this tends to emphasize the basic point brought out at the beginning of this paper—namely, that urban growth depends not only on many individual decisions, but also on the alternatives offered at the time the decisions are made. If the expansion of large electronic activities in the Boston area had occurred before Route 128 was developed, these industries would have located in some other place. If Route 128 were being built today, it might not attract anywhere near the number of firms it attracted there, because the industries might not see the site advantages in the same light today as a few years ago.

The object lesson of these observations is that urban growth is sensitive to many factors that are modified by time.

In conclusion, these two points should be strongly emphasized:

1. It is obvious from the analysis of growth patterns in these ten American cities that the standard of living is becoming a major factor in development patterns. The individual, whether home owner or industrialist, is becoming more and more concerned with other factors besides transportation. This change must be recognized in urban plans.

2. The techniques used in these growth trend analyses, being admittedly in the pilot stage, are subject to improvement and refinement. However, they already have provided valuable new insights into urban growth which will be useful in planning for community facilities. Additional research in this field is sure to make an increasingly important contribution in the years ahead.

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Metropolitan Growth and Metropolitan Travel Patterns

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This paper describes briefly the nature of growth of the New York metropolitan region, particularly the dispersing tendencies and the forces behind them, and traces the changing patterns of travel behavior to these forces. The paper emphasizes the need to study travel and traffic data in considerable detail to avoid being misled by aggregate statistics. The general conclusions are (a) Central Business District employment is relatively stable, while growth in employment is taking place in outlying areas, (b) population growth is taking place in outlying areas and at low land-use density, (c) growth in journey-to-work travel is no longer focused on the Central Business District, but rather is characterized by inter-suburban travel, reverse commuting and the like, and (d) changes in traffic behavior during recent years are primarily responses to metropolitan growth patterns and are not to be construed as irrational or perverse behavior. Although the paper deals with travel phenomena in the New York metropolitan area, the data presented are in terms of detailed observations of trans-Hudson travel.

●THE preliminary returns from the 1960 census of population have thrown the spotlight of national publicity on the drastic reshaping of the American metropolis. One after another, the reports come in that the central city has lost population, whereas the surrounding areas have grown at a striking rate. There are few exceptions among the older cities.

Much the same phenomenon can be observed in the changing locational patterns of business and industry. Statistics on employment also show strong increases in newly developed areas and virtual stability or even declines in the older, traditional employment centers.

The urban fabric is thinning out, all over the United States. Although the rate of increase of urban population has been striking, the rate of growth of urban area is greater still.

Changes in travel behavior observed during the years since the end of the war reflect these changes perfectly. The purpose of this paper is to demonstrate their close relationship, at least for the metropolitan area of New York and northern New Jersey.

Marking the decade's changes on the basis of how many people live within a city's corporate limits can be somewhat misleading. Some central cities, like Boston and Newark, are tightly confined within relatively restricted boundaries that were set many decades ago and have been filled up for years. Others, like Los Angeles, have city limits set far out and include within them a larger amount of area as yet unsettled.

A closer examination of population changes within the New York metropolitan region reveals losses in the older and more closely settled portions, whether inside the central city or outside it. Thus Elizabeth, Perth Amboy, Passaic, and Montclair, as well as Manhattan, Brooklyn, Bronx, Newark and Jersey City have lost population. On the other hand, Queens County, within the New York City municipal jurisdiction, has grown. The metropolitan growth pattern seems to be one of population attrition in the older, more closely settled areas and the extension of population into hitherto open areas not encumbered by old street patterns and obsolescent facilities, where there is plenty of room to spread out.

Table 1 presents the population figures for the 22 counties comprising the metropolitan area as defined by the New York Regional Plan Association. It is to be noted that the counties of New York (Manhattan), Kings (Brooklyn), Bronx, Queens and Richmond are the five boroughs of New York City; that Hudson County in New Jersey contains the old Cities of Jersey City, Bayonne, Hoboken, and Weehawken; and that Essex County, also in New Jersey, contains the City of Newark as well as a number of smaller suburban communities.

A more detailed picture of where the population losses have occurred is shown in Figure 1. The limited data now available on areas smaller than municipalities support the view that it is the older areas that have lost population.

Metropolitan employment has also been growing rapidly in the outlying, newer areas. Unfortunately, statistics are not available to permit an analysis of the trends of employment within each of the New York City boroughs, but estimates have been made for the city as a whole and they suggest approximate stability. Table 2 presents the Regional Plan Association's estimates made in 1956 of regional employment, county by county, for 1948 and 1955 (1).

TABLE 1

POPULATION OF NEW YORK METROPOLITAN REGION
(In Thousands)

Area	1950	1960	Changes 1950 to 1960
Entire region	13,951	16,114	+2,163
Central-core counties			
Kings (Brooklyn)	2,738	2,627	- 111
New York (Manhattan)	1,960	1,698	- 262
Queens	1,551	1,810	+ 259
Bronx	1,451	1,425	- 26
Hudson	648	607	- 41
Inner-ring counties			
Nassau	673	1,300	+ 627
Essex	906	920	+ 14
Westchester	626	809	+ 183
Bergen	539	779	+ 240
Union	398	503	+ 105
Passaic	337	404	+ 67
Richmond (Staten Island)	192	222	+ 30
Outer-ring counties			
Fairfield	504	649	+ 145
Suffolk	276	667	+ 391
Middlesex	265	432	+ 167
Monmouth	225	333	+ 108
Morris	165	260	+ 95
Orange	152	182	+ 30
Dutchess	137	175	+ 38
Somerset	99	143	+ 44
Rockland	89	137	+ 48
Putnam	20	32	+ 12

AREAS WHICH LOST POPULATION BETWEEN 1950 - 1960

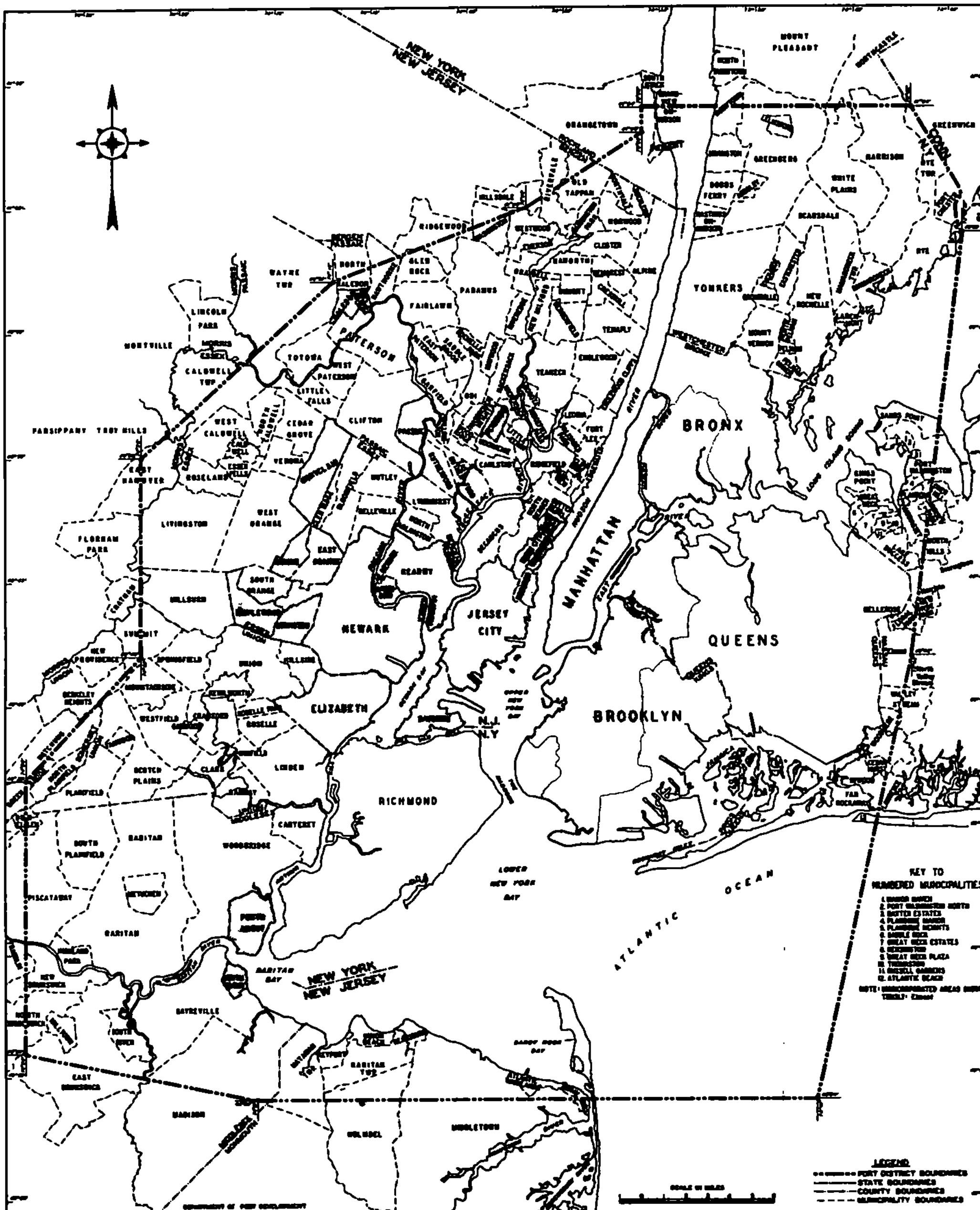

Figure 1. Municipalities within the Port of New York Authority District.

Decentralizing influences have been operative for a long while; they are firmly based on technological advance. Only recently have they come into full flower and brought attention to problems considered new.

When the energy of falling water was the principal source of industrial power, mill sites were limited in number and while the transmission of power had to rely on steel shafting, there was little choice as to where the machinery was to be erected. This

TABLE 2

EMPLOYMENT IN THE NEW YORK METROPOLITAN REGION
(In Thousands)

Area	1948	1955
Entire region	5,910	6,273
New York City	3,871	3,839
Hudson	267	247
Nassau	147	295
Essex	375	366
Westchester	189	243
Bergen	136	199
Union	143	178
Passaic	144	149
Fairfield	213	235
Suffolk	70	109
Middlesex	99	115
Monmouth	60	70
Morris	41	53
Orange	47	51
Dutchess-Putnam	54	63
Somerset	33	33
Rockland	21	28

restraint on the choice of location was characteristic of all industrial activity about a century ago. Steam power lifted these severe restrictions. Power could be generated at any location, subject only to the economic limitations of fuel transport and to the adequacy of condensing water. Cities could expand in industrial activity and in geographic extent. When electric power came along, together with central-station generation, the transformer and high-voltage transmission, most of the remaining limitations on industry's locational choices were removed. Power-using activities could be sited almost anywhere, at least as far as power considerations were concerned.

When face-to-face contact, or the written document carried by private or public messenger, were the only means of intercommunication, city men could not safely afford to be far apart. Urban activity had to take place within a restricted area, and the amount of activity that a single community could carry on had severe limitations. Spatial extent and city form were limited by what communication could accomplish. The telephone, teletypewriter, radio and television have changed that. Locational choices for business and industry again have been greatly extended.

The same story can be told of the influence of advancing transport technology. Each step along the way of providing more mobility to the individual has widened the choice of location, of residence, of work place, of leisure-time activity. The steam railroad, the electric streetcar, the motor vehicle, the airplane and the helicopter have extended the range within which cooperative activity can take place. Not only has the feasible journey-to-work radius been greatly extended, but intercommunity relationships have been strengthened, and cooperative activity now can encompass a great region containing many individual urban communities. The railroads freed industry from its need to locate at tidewater or on a navigable river or canal, and permitted inland sites to be used productively. The motor truck has opened up additional areas and industry can now use sites not formerly accessible for the movement of goods.

As advances in the technology of power, communication and transportation have permitted dispersal of industrial establishments, technical advances in production methods have caused manufacturing to seek new sites. More extensive mechanization, heavier machinery, and horizontal assembly methods have called for one-story, ground-level industrial architecture, with its great appetite for acreage. Suitable sites at tolerable costs can be found in the urban outskirts but not so easily in the older, closely developed areas. Indeed, in some instances the horizontal dimensions alone preclude accommodation within the traditional city street pattern. In others, the time and expense involved in assembling the land required from a great number of owners of small parcels has swung the balance of choice toward locations in areas not so encumbered.

Also, the desire of the growing family for living accommodations with plenty of elbow room, encouraged by national housing policy conducive to home ownership, has led to a booming period of single-family, suburban housing development, occupying land extensively rather than intensively.

Retailing also has shown a tendency to follow the new metropolitan population to the suburbs. With department stores, specialty shops and professional offices, suburban shopping centers have become much more than neighborhood facilities for convenience shopping; they are evolving into subregional commercial areas. The goods-handling aspects of wholesaling have also sought outlying locations, following the big industrial customers, and splitting off from the transaction aspects in the process.

In brief, there has been a 100-yr history of expansion outward, of growth in urban area outpacing growth in urban population, moderately at first but with a rapidly widening lead during recent years. And there is virtually no evidence of any reversal of the trend toward rapid territorial expansion of the metropolitan mass.

Profound changes have also taken place in the pattern of metropolitan travel, reflecting the changes in urban form and structure.

Although the daily tidal flow of workers from peripheral home to central work place in the morning and back in the evening is still of commanding magnitude, it is not growing in proportion to metropolitan population, or employment, or economic activity. Indeed, in many places it is not growing at all. There is evidence in the New York area that travel into the Central Business District (CBD)—Manhattan south of Central Park—is declining slightly.

Every eight years since 1932 the Regional Plan Association, with the cooperation of state, municipal and other private agencies has made surveys of the amount of travel into that area, from all points of the compass, by all modes of transportation. The Association's report on the 1956 survey (2) shows that the total number of travelers into the CBD between the hours of 7 and 10 a.m. had declined by nearly 9 percent since 1948. Of course, the number traveling during those hours cannot be equated completely with the number of CBD workers and there are undoubtedly other factors of change to be explored, but the magnitude of the change, 146,000, seems large enough to warrant the inference that there has been some decline in the number employed in the CBD. Moreover, the 24-hr total of hub-bound travelers declined somewhat more strongly, by 375,000 in the 8-yr interval, or some 10.2 percent of the 1948 level.

It is to be observed at this point that it was largely to serve the hub-bound travel that the common-carrier transportation lines were established. They still command the dominant position in accommodating this component of the New York metropolitan region's daily travel, accounting for 87.7 percent of the rush-hour traffic into the CBD.

Although the travel generated by the metropolitan center shows these signs of weakness, other components of urban travel are mounting steadily. "Reverse" commuting and travel between outlying points on weekdays and Saturday, Sunday and holiday travel all show significant growth trends. Together, they more than compensate for the weakness of central core generation.

These growing components of metropolitan travel are not well served by common-carrier transportation. The automobile has clearly captured the leisure-time travel, because of its convenience, its economy for family travel and the wide scatter of leisure-time destinations. Weekday travel between outlying points follows a great multitude of paths, rather than channeling into a few, and route densities are seldom great enough to warrant public transportation. Reverse commuting, from central home to outlying work place, presents scheduling difficulties greater than those involved in serving travelers who want to arrive at a common destination at the conventional work-starting time. Moreover, many of the new suburban employment centers are not on the common-carrier routes.

In consequence of these divergent trends, the relative use of common-carrier transportation has declined and that of the automobile has increased. The shift is a direct result of the change in metropolitan form.

The travel that takes place across the Hudson River is an important sample of the region's total travel, and there is a rich body of data describing it in detail for some 35 years. The changes that have taken place in travel behavior during a recent 10-yr period illustrate the effects of the changes that have already occurred in the region's economic geography.

In the 10-yr period, 1948 to 1958, the total number of person-trips across the Hudson River, by all modes of transportation, including long-haul travel, changed very little, from 266.6 million to 276.8 million, an increase of but 10.2 million, or 3.8 percent, while regional population was increasing at the far faster rate of 14 percent and employment at 9 percent. The number of trans-Hudson trips made by automobile increased greatly, whereas the number made by common carrier—by railroad, ferry and bus—declined correspondingly. The magnitudes of the changes are shown in Figure 2.

These general facts are widely known and have tempted some to the conclusion that the common-carrier loss has been caused by a massive diversion of New Jersey commuters from the railroads to automobiles, a diversion which has been brought about by the encouragement given to automobile travel by the improvements in vehicular facilities for crossing the Hudson River. Although this is a plausible inference from data as gross as those presented in Figure 2, it fails as a satisfactory explanation when the data are analyzed in detail.

Gross statistics can conceal more than they reveal.

The total trans-Hudson travel behavior is a complex mixture of trips having different purposes, different destinations, and different origins, trips made on different days of the week and at different times of the day, and trips made by residents of different parts of the region. It cannot be assumed that the only thing that has changed in recent years is the mode of New Jersey commuter travel. If what has occurred is to be understood, the changes that have taken place in other trip characteristics must be explored also. When trans-Hudson travel volumes are broken down into appropriate components and each component is studied separately, it is found that there have been over-all increases in those categories of travel which the automobile has dominated for a long time, and which are not and probably cannot be adequately served by common carrier. Conversely, there have been over-all declines in those categories which have been and still are the mainstays of the public transportation systems.

Moreover, the railroad passenger traffic volumes shown in Figure 2 are inclusive of long-haul passengers and an unknown, but probably substantial, part of the railroad loss reflects diversions of inter-regional traffic to air travel and long-haul buses.

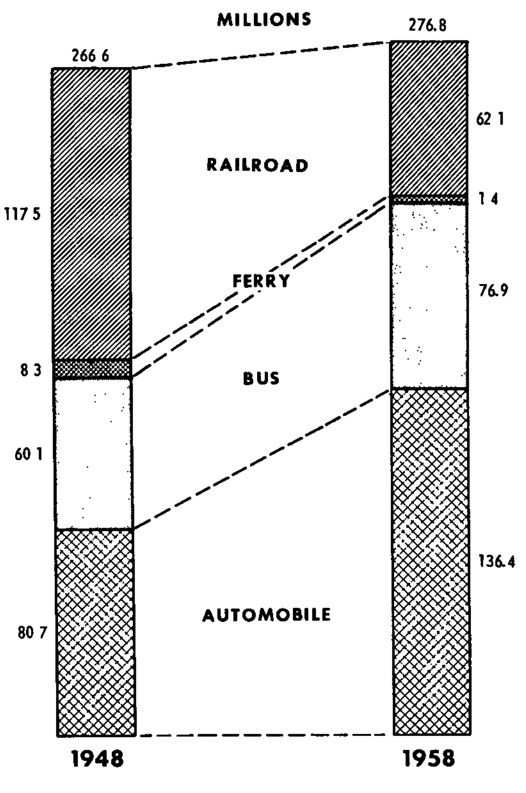

Figure 2. Total annual trans-Hudson trips.

In the first place, the over-all figures conceal the highly significant differences between what happened to work day travel and to leisure-time travel. Although the total annual trans-Hudson travel volume increased by 10.2 million trips between 1948 and 1958, the number of trips which took place on weekdays rose by only 1.1 million. Trips on Saturdays, Sundays and Holidays, on the other hand, rose by 9.1 million, about 90 percent of the total rise. The gains and losses of the different modes of transportation within the leisure-time travel category are shown in Figure 3.

The rise in automobile travel is striking but not surprising, for private transportation has clearly captured the lead position in intra-regional leisure-time travel. There are many reasons for this, some of which have already been mentioned. Much of the weekend and holiday travel is family travel, for which the automobile offers superior convenience and greater economy than do the common carriers. The automobile permits the traveler to be in command of the times of departure and return, the inclusion of the children and even of their pets adds nothing to the transportation cost, and baggage and miscellaneous paraphernalia create no serious problems. Destinations are widely scattered and there is a correspondingly wide dispersal of travel paths, a situation not well suited to common-carrier service. Indeed, a large proportion of this component of regional travel cannot be served satisfactorily at all by public transportation.

It must be recognized that much of the 1958 automobile travel in the weekend and holiday category was travel that would not have been undertaken at all if the automobile had not been available, and in that sense was not a diversion from any other form of travel. No doubt some of the 1948 common-carrier travel had been diverted to the automobile by 1958, but the automobile gain is far greater than the common-carrier loss. In any event, commuter traffic is not being considered at all.

Examination of the make-up of weekday trans-Hudson travel reveals that the increase of 1.1 million between 1948 and 1958 was the result of two divergent trends (Fig. 4). There was an increase of 10.1 million in the number of New York residents crossing the river on weekdays and a decrease of 9.0 million New Jersey residents. (In the discussion that follows, in the interest of simplicity of phrasing, the term "New Jersey residents" is used even though in strict accuracy the term should be "residents of areas west of the Hudson River." It is not known where the trans-Hudson travelers really live, but it is inferred that they live west of the Hudson if they travel eastbound during the morning rush hours or if they travel in automobiles bearing license plates of New Jersey or states to the west of the Hudson. "New Jersey residents," therefore, include all long-haul rail and bus travelers residing west of the Hudson. Rockland County residents traveling by railroad or bus are counted as "New Jersey residents.")

There is a clear reflection of an increase in reverse commuting, New Yorkers working in New Jersey establishments. As will be shown later, it also reflects a decline in the number of New Jersey residents working in New York's CBD.

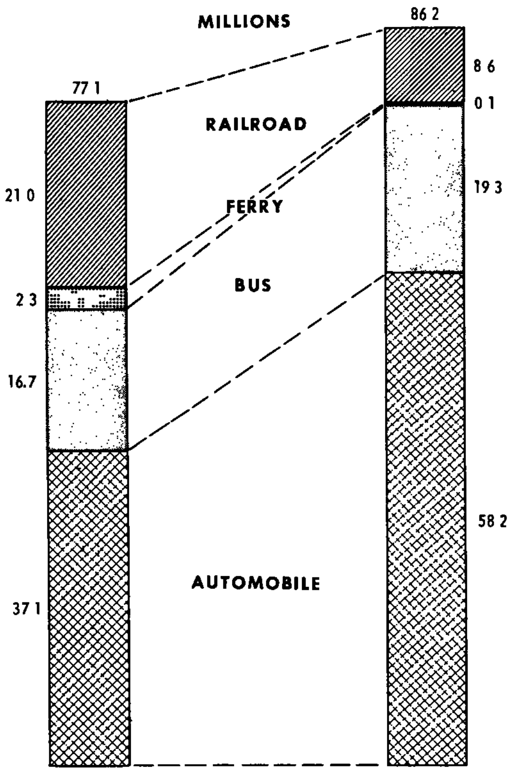

Figure 3. Trips on Saturdays, Sundays and holidays.

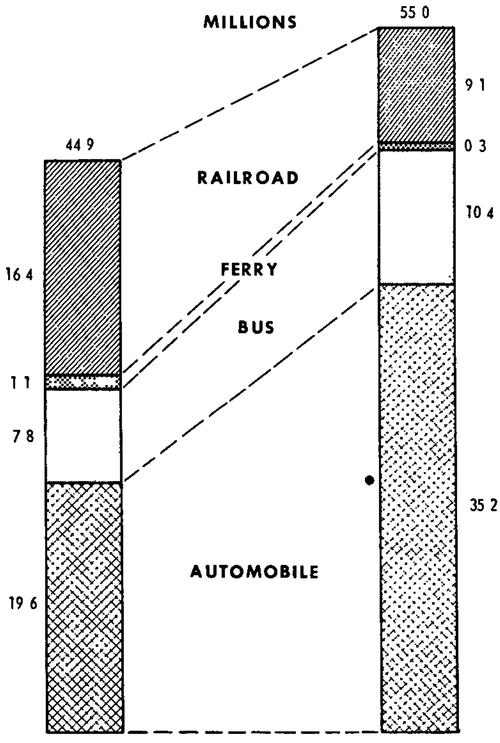

Figure 4. Trips on weekdays, by New York residents.

Despite the rise of 10.1 million, the railroads and ferries lost out in the business of carrying New York residents across the River on weekdays, and the use of automobiles and buses increased. Again, however, the automobile gain was far greater than the common-carrier loss. Much of the rise in automobile use must be attributed to travel that did not take place at all in 1948.

Automobile strength in this travel component is related to the dispersal of New Jersey job sites and of New York worker residences. New Jersey destinations span 180 degrees of the compass and, except for the Bayonne peninsula, travel to them from New York is not inexorably channelized into narrow sectors analogous to Long Island or the Bronx-Westchester peninsula. The weakening of rail travel between 1948 and 1958 may be in response to shifts in the foci of employment from the Jersey City, Hoboken and Newark core areas to more scattered points in outlying New Jersey counties, or to changes in New York residence patterns of New Jersey workers, or to the relative costs of rail travel and car-pool travel, or to a combination of these factors.

The fact remains that this is a regional travel component on which highway travel, primarily automobile travel, has a strong hold, and it is a growing rather than a declining element.

It was noted previously that the number of New Jersey residents crossing the Hudson River on weekdays had declined by 9.0 million between 1948 and 1958. Even this figure conceals the fact that those destined for Manhattan's CBD declined far more drastically, by 17.8 million. The number going to points outside the CBD, to upper Manhattan and beyond to the north, or to Brooklyn and Queens and beyond to the east, actually rose by 8.8 million.

This non-CBD-oriented travel is another component of the total regional travel which relied heavily on the automobile even in 1948 as is shown by Figure 5. Again, the

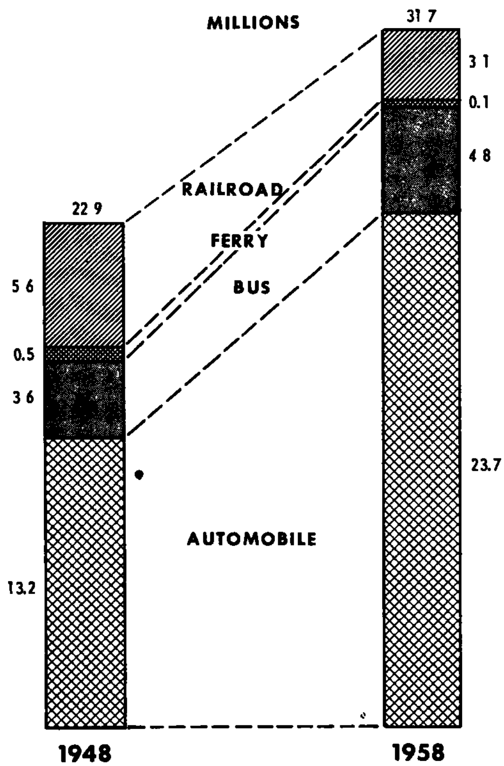

Figure 5. Trips on weekdays, New Jersey residents, to and from non-CBD points.

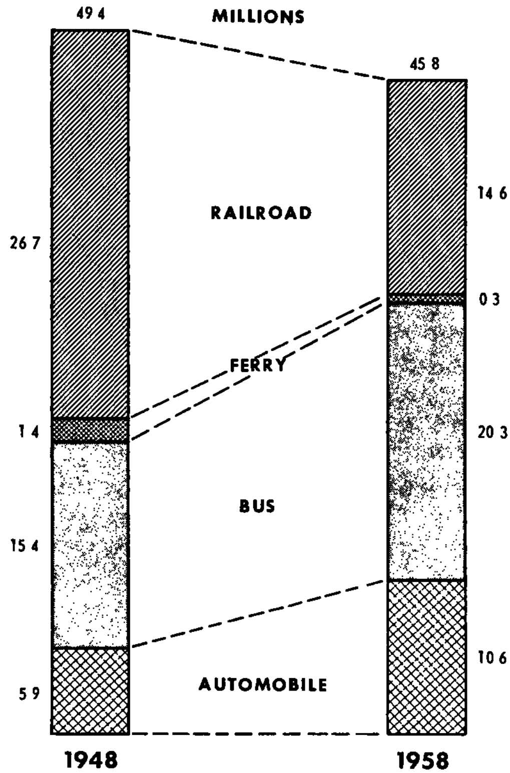

Figure 6. Trips on weekdays, New Jersey residents, to and from CBD, during off hours.

increase in automobile use in the period under scrutiny far outran the drop in common-carrier travel, and most of the automobile increase must be attributed to new travel rather than to diversion.

The travel in this component is in many respects the converse of the travel of New Yorkers to New Jersey destinations. It includes the journey-to-work travel of many New Jersey residents employed in establishments located outside Manhattan's CBD. Its increase is another consequence of the decentralization of commerce and industry that has been taking place.

As previously stated, 17.8 million fewer New Jersey residents traveled on weekdays to Manhattan's CBD in 1958 than in 1948. This is the travel component that the New Jersey commuter railroads were laid out to serve. The drop during the non-rush hours (10 a.m. to 4 p.m. and 7 p.m. to 10 a.m.) was 3.6 million (Fig. 6), a significant, almost 8 percent, decline from the 1948 level, but was far less drastic than the 14.2 million, about 20 percent, drop during the rush hours (7 a.m. to 10 a.m. and 4 p.m. to 7 p.m.) (Fig. 7).

The New Jersey railroads and the Hudson River ferries took the brunt of the losses in both rush-hour and off-hour travel. Automobile travel and bus travel rose. The gain in automobile use, however, and even the gain in automobile and bus travel together, was far less than the railroad and ferry losses. At least 24.7 million of the railroads' loss of 33.2 million passengers in this category was independent of automobile gains and at least 14.3 million was independent of the aggregate rise of both automobiles and buses. After all, there was simply a large decline in the number of daily travelers to Manhattan's CBD. Also, in all probability, the railroads' losses of long-haul travel are heavily concentrated in this weekday, CBD-generated travel component.

When references are made to "diversion" of travel from one form of transportation to another over a period of 10 years, it is important to bear in mind the fact that some of the 1948 travelers were no longer traveling at all 10 years later, and some of those traveling in 1958 had been too young to be traveling across the Hudson in 1948. Also, of those who traveled in both years, many had changed residence location, or job location, or both. The rise in bus use, for example, may be related to a northeasterly shift of Manhattan's employment foci that has taken place since the war. Other data (3) show that the majority of the passengers arriving at the Port Authority's bus terminal, in the midtown area, during the morning are destined for midtown points, a large share of them east of Fifth Avenue. The bus terminal is a more convenient Manhattan arrival point for these commuters than are the more southerly Manhattan terminals of most of the commuting railroads.

After all the shifts and losses had taken place, the common carriers still occupied a strongly dominant position in serving the New Jersey traveler to Manhattan's CBD on weekdays (Table 3).

Although the term "commuter" is infrequently defined, it usually connotes

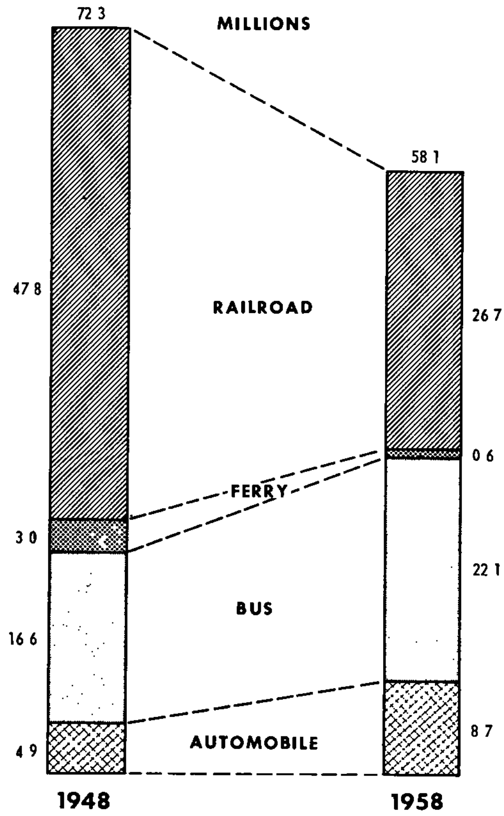

Figure 7. Trips on weekdays, New Jersey residents, to and from CBD, during rush hours.

the morning rush-hour traveler to the CBD. If that definition is accepted for the purposes of this discussion, it is plain that a great preponderance of New Jersey commuters, 85 percent of them, rely on mass transportation. But Manhattan's CBD is extensive and its various sub-areas show different degrees of reliance on the different forms of mass transportation. In southernmost Manhattan, which the New Jersey commuting railroads were originally designed to serve, and which they still serve with great convenience, the dominant position of the commuting railroads is undisputed. For the northernmost portion of the CBD, from 34th Street to 59th Street, the bus, because of midtown terminal location, has more than one-half of the commuter business. In the area between, where only the Pennsylvania Railroad has an advantage, and that only for west-side destinations, the two forms of mass transportation are in competition.

Changes in the use of trans-Hudson transportation facilities have been a consequence of changes in the locations of population and of industry and commerce, both inside and outside the central core of the metropolis. New Jersey job opportunities have been increasing faster than New Jersey population, employment in all the non-core areas has been increasing faster than population. Manhattan's CBD employment has remained relatively stationary as to total magnitude but there has been a northeasterly shift in its geographic distribution. Population increase has been largely confined to the outskirts, and it has occupied new residential areas developed at relatively low density. Many suburban residents have found suburban jobs. Mass transportation is performing much the same task it has always performed, carrying workers to and from the metropolitan area's central core, but that task has become a proportionately smaller share of the region's total transportation task. The other travel components, widely dispersed over both space and time, are less well served by mass transportation, and as they are of growing magnitudes, individual transportation is becoming of growing importance.

TABLE 3

1958 TRANS-HUDSON TRAVELERS

	TOTAL TRAVELERS (MILLIONS)	PER CENT OF TOTAL		
		BY AUTO	BY BUS	BY RAIL (PLUS FERRY PEDESTRIANS)
ANNUAL TOTAL	276.8	49.3	27.8	22.9
SATURDAYS, SUNDAYS AHD HOLIDAYS	86.2	67.5	22.4	10.1
WEEK DAYS	190.6	41.0	30.2	28.8
NEW YORK RESIDENTS	55.0	64.0	18.9	17.1
NEW JERSEY RESIDENTS	135.6	31.7	34.8	33.5
TO POINTS OTHER THAN CBD	31.7	74.8	15.1	10.1
TO CBD	103.9	18.6	40.8	40.6
DURING OFF HOURS	45.8	23.1	44.3	32.6
DURING RUSH HOURS	58.1	15.0	38.0	47.0
TO UPPER CBD (34TH - 59TH)	24.7	15.4	57.5	27.1
TO MIDDLE CBD (HOUSTON - 34TH)	13.5	20.7	34.1	45.2
TO LOWER CBD (BATTERY - HOUSTON)	19.9	10.6	16.6	72.8

Unfortunately, a detailed analysis of this sort cannot be made of the travel across the East River, or across 59th Street, the eastern and northern limits of the CBD. The detailed, necessary data do not exist. Travel across both boundaries is dominated by the city subways and bus lines and the New York City Transit Authority has no occasion for making routine counts of their passengers en route. There are data on railroad passengers into Grand Central Station from the north, and into Pennsylvania Station from the east, and vehicular flow data are available for the toll bridges and tunnels, but the free bridges and Manhattan's north-south avenues are blind spots.

Trans-Hudson travel has some distinctive features of its own, which makes it not wholly like the travel across the East River or across the Harlem River or across the Bronx-Westchester or the Queens-Nassau borders. All sections of the region are not growing as exact duplicates of each other, and the changes in Manhattan's CBD have different impacts on the linkages with different parts of the region. Nevertheless, the main features of trans-Hudson travel changes are consistent with the findings of the Regional Plan Association's study of the changes that took place between 1948 and 1956 in travel into Manhattan's CBD, the study referred to earlier. There was a drop in the number of persons entering the CBD on a weekday from all sectors, except from the northeast. The fall-off in the numbers coming from the north, across 60th Street, and from the east, across the East River, was somewhat greater proportionately than the drop in the number crossing the Hudson. All forms of mass transportation suffered losses. Automobile travel gained. Even after their losses, however, the public transportation systems in 1956 still accounted for 87.7 percent of those entering the CBD during the rush hours.

Important conclusions can be drawn from detailed analysis of recent changes in travel behavior.

First, the decline in use of mass transportation facilities and the rise in the use of the automobile are parallel phenomena rather than cause and effect. Mass transportation patronage has not declined because automobile use has increased. The decline of one and the increase of the other result from a common cause, the changes in form and structure of the metropolis. These changes, in turn, are linked to advancing technology of power, production, communication and transportation.

Second, common carrier transportation and private transportation are not properly to be considered as simple alternatives. Each has its appropriate role to play in serving the travel requirements of the metropolis. For travel volumes that are concentrated, in both space and time, like rush-hour travel to the CBD, public transportation serves best and has a natural dominance. For travel that is dispersed, either over a multitude of paths or over many hours of the day, private transportation is the principal mode. For most trips in this category the traveler has no other practicable choice.

Just as the travel trends of the recent past have been the consequences of the evolving metropolitan configuration, the transportation tasks of the future will be determined by the evolving form and structure of the Region. If public policy is to intervene it must find appropriate ways to influence the metropolitan growth pattern.

Decentralization does not need to become sheer scatter. If the future suburban landscape is to be peppered with homes and factories and warehouses and stores without any strong spatial organization, with no concentrations of work places or residences, it can be expected that there will be continuing decline in the use of mass transportation, for there will be no strong generating points of either origin or destination, and travel routes will be so thin that individual transportation will be the only kind practicable. If new work sites should be clustered, however, there would be the possibility that at least a few routes would build up enough traffic density, from residence area to employment area, to warrant the establishment of bus service. Employment clusters may have to be large enough to account for 5,000 to 10,000 workers, which means industrial concentration instead of scattered factories, to make bus transportation practicable for the journey to work. If residential areas are also more distinct, if they form clear clusters of homes, and if each cluster accommodates a large enough population in an area that is not too extensive, the opportunities for mass travel will be further increased.

Perhaps such an ordering of the manner in which the newly urbanized land is to be used can be brought about by the use of the tools now available to the planners. Perhaps new tools for land-use control will have to be devised. Perhaps new authority will have to be granted to planning bodies to permit them to be effective in such a task. The fact is that there is little experience today, and not even much theoretical doctrine, to guide planning bodies in their endeavors.

The transportation facilities that will be built during the coming decade, particularly the interstate expressways, will themselves exert a powerful influence on metropolitan growth patterns. Interchange locations will tend to identify the areas in which new development can be expected. Expressway design to facilitate the operation of buses can encourage mass transportation. Although understanding of the precise effects of new highways on land development is less than desired, there is no doubt that highway planning can be used as a tool in guiding metropolitan growth. It is imperative that the highway planners and the land-use planners learn more about how the tool can be used, and that they collaborate in using it to the maximum of its potentialities.

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A Statement of the Urban Passenger Transportation Problem

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Much controversy and confusion appears to prevail today as to how best to solve the ubiquitous problem of adequate passenger transportation in urban areas. Based on the old saw that a clear statement of a problem goes a long way toward its solution, this paper (a) sharpens up the technical language of this subject area; (b) identifies the conditions in urban areas which give rise to the recurring problem of providing adequately for metropolitan transportation; (c) explains some of the difficulties that arise because this problem has no unique solution; and (d) indicates the different approaches and different types of economic consequences that would follow the adoption of any one of several alternate proposed solutions in any given urban area.

●IN ATTACKS on the ubiquitous problem of providing adequate passenger transportation in urban areas throughout the nation, much controversy and confusion has arisen among proponents of various types of urban mass passenger transport systems. Based on the old saw, that a clear statement of a problem goes a long way towards its solution, the author of this paper is making an effort to present such a statement in a way that will point to effective attacks and practical solutions.

In the current literature on mass transit, there are a number of technical terms that are fuzzy. Other terms while describing significantly different types of passenger transport, are nevertheless used interchangeably because they are assumed to be synonymous. It is this interchangeable use of significantly different terms that leads to confusion, often retards and even paralyzes current efforts to provide adequate passenger transportation in urban areas.

For example, on examination of the widely used term mass transit, it is found that the more generic term is actually mass transport, which means modes of conveying persons or goods, from place to place, en masse or in large volumes. Modes of mass transport that operate underground through tubes, as in subways, and those that travel over streets and highways, as elevated lines, may accurately be referred to as mass transit.

Mass-passenger transport, by land, may be rendered by three distinctly different types of passenger-carrying conveyances: (a) steam or electric trains operating on steel rails, on exclusive rights-of-way, with protected grade intersections generally referred to as railroads; (b) electric trains operating on supported or suspended rails, in subways, or on elevated structures, accurately referred to as rail transit; and (c) free-wheeled vehicles usually of more than seven-passenger capacities, operating on arterials or on freeways, expressways, or in general on limited-access highways, usually sharing lanes with autos and trucks, generally referred to as buses.

Some of the significant differences in passenger services offered by these three types of mass transport are given in the following paragraphs.

Steam or electric railroads offer regularly scheduled services, as shown on their timetables, at rates reduced from single-trip fares, referred to as "commuter" rates, applying usually within metropolitan areas up to about 50 miles from the Central Business Districts (CBD's); these railroads are therefore referred to as "commuter" railroads; they provide seats for most of their regular commuters between suburban stations in their home towns, and railroad stations in the CBD's of central cities.

Rail transit, generally referred to as "subways" or "els", usually operates within close-in areas up to about 20 miles from CBD's, on schedules so frequent as to need no timetables; in rush hours, however, the majority of their passengers must stand between stations of origin and stations nearest their destinations in the CBD's.

Suburban buses serve areas up to about 40 miles from CBD's, on regular frequent schedules, with seats for most passengers but requiring some of their passengers traveling in rush hours to stand, between pick-up locations in home towns, usually within walking distances of homes, and either bus terminals in CBD's or drop-off locations within walking distances of CBD destinations.

All three of these types of mass-passenger transport are referred to in the literature of urban-passenger transportation as public transit. When privately operated bus systems are referred to as public transit, it may be a bit confusing to some. In the interest of a more accurate description of these passenger transport services, the author therefore suggests the term common-carrier mass-passenger transport, the term used by regulatory agencies. This term denotes that these common carriers hold themselves out to furnish mass-passenger transport, along specified routes, on certain schedules, to the general public. Most of these common carriers are regulated as to public safety, routes and fares by Federal, state and sometimes, also, local regulatory agencies. Common carriers of passengers in the urban transportation context may, therefore, be either "commuter" railroads, rail transit carriers or bus routes which may be of the "local" or "city" types, of the "suburban" or "short-haul" types, or of the "inter-city" or "long-haul" types.

Often in the literature of urban-passenger transportation, the term "rapid" transit, usually implying rail rapid transit, is used interchangeably with mass transit to endow rail transit with an unspecified but some assumed high speed, often unwarranted by actual performance.

To be sure, mass transport on rails, that has been operated on exclusive rights-or-way, in subways or on elevated structures or even at grade with protected intersections, having had no traffic interferences, could travel faster than autos and buses on streets and highways with numerous traffic-controlled grade intersections and particularly where peak-hour vehicular traffic demands have exceeded the capacities of the roadways. In the past, such mass transport, on rails, particularly subways and "els", warranted the designation rail "rapid" transit, as meaning more rapid than travel in autos, in electric cars on rails, and in buses on public streets and highways.

Today, however, with limited-access highways, generally available, travel speeds on rails, even though they are on exclusive rights-of-way, but because of numerous station stops and infrequent service, may not in fact be faster than continuous travel on freeways. Besides, in the context of mass transport, in journey-to-work hours, the speed which is significant, which warrants the designation "rapid" and which, in fact, determines the workers' choices of modes of journey-to-work travel, is the over-all speed between homes and common-carrier terminals, stations or street stops in CBD's.

Therefore, the term "rapid" should not derive from the maximum speed between two stations on a common-carrier route, with the longest distance between them. The term "rapid" should invariably derive from an average speed obtained by aggregating travel times, consisting of auto or bus travel time to a railroad, a rail transit or a suburban bus station, waiting time for the CBD common carrier, and travel time (including transfers) to the CBD station or stop nearest the work place in the CBD, and dividing this aggregate travel time by the aggregate distance covered in all vehicles.

For engineers, the term "rapid" transit should not be a term loosely used. Over-all speed is definitely measurable. It can, therefore, be standardized. When the term "rapid" transit is used, it should be applied to any mode of mass-passenger transport, provided the over-all speed between given residential areas and stations or stops nearest clusters of sites of employments in CBD's, exceeded a given predetermined speed. Operating practices could thus place different types of urban common-carrier mass transport into classes of "rapid" or "express" and others into "local", irrespective of whether they operated as steel wheels on steel rails or rubber tires on concrete or asphalt; whether they operated on exclusive rights-of-way or shared public rights-or-way, with exclusive or perferential lanes, in journey-to-work hours.

Again, mass transit literature frequently makes use of the term "balanced" transportation, just as an engineer would refer to a balanced system of forces in a structure. This term is so used as to leave the reader with the implication that auto transportation must be balanced with mass transit, meaning, of course, rail transit, and impliedly "rapid" transit; otherwise the whole structure of urban-passenger transportation would collapse, as any structure would if certain members were overloaded.

Most urban areas today have some types of common-carrier passenger services. Large metropolitan areas have commuter railroads; some of the largest cities, like New York, Chicago, Boston, and Philadelphia, also have subways or "els" for close-in passenger travel, particularly for journey-to-work travel to and from CBD's. Certainly, these larger metropolitan areas could not exist and function properly without common-carrier passenger services. In fact, few urban areas of any size could exist without some mass transport for journey-to-work travel to and from their CBD's.

But what constitutes "balanced" transportation? For example, in the N. J. -N. Y. Metropolitan District, trans-Hudson passenger movements for the entire year of 1958, distributed themselves approximately as follows: 49 percent in autos, 28 percent in buses, and 23 percent in railroads. Might this be considered "unbalanced" urban transportation? If so, then on all weekdays of the same year, in journey-to-work hours, to lower downtown portion of the Manhattan CBD (Battery to Houston Street), the distribution was 11 percent in autos, 17 percent in suburban buses, and 73 percent via "commuter" railroads. Would this constitute "balanced" urban transportation? (See Table I for distribution of other segments of trans-Hudson passenger movements among alternate modes of transportation.)

To constitute a "balanced" passenger transportation system, what should be the proportions of various segments of journey-to-work passenger volumes to CBD's handled by all types of mass transport on the one hand, and by autos on the other? Should these proportions be 50-50 or close to 90-10? Does a city which does not, at present have rail transit suffer from "unbalanced" transportation, even if it has bus transportation? Should not engineers demand some meaningful quantification of the term "balanced" transportation under specified conditions? Otherwise, this expression will be bandied about loosely and eventually also endowed with a highly desirable quality like "rapid" which in this case, could only produce confusion worse confounded.

Urban-passenger transportation does not constitute a single neat, unique and universal type of passenger transport system. It covers a number of possiblle permutations and combinations of passenger transport. Many of the knotty problems of urban-passenger transportation could be more effectively attacked, if not partially solved, if engineers, in discussions of this subject, would invariably insist on adhering meticulously to precise and uniquely meaningful terms.

PROBLEMS IN PROVIDING ADEQUATE URBAN PASSENGER TRANSPORTATION

There are three really major basic problem areas which most of the problems of providing adequate urban-passenger transportation grow out of.

One problem area arises out of the short periods of arrival and departure times of most workers at sites of employment, particularly in the CBD's of urban areas. As a consequence of this, journey-to-work passenger travel volumes on weekdays, invariably exhibit two sharp peaks, one in the morning, the other in the evening. During the rest of the day, there is much less of a problem of moving people; more of a problem of providing space to park autos. On the other hand, there is little journey-to-work travel on weekends and holidays and so worker traffic volumes, then, present no problem.

The second problem area arises in CBD's which are spread over large areas. In such large CBD's, distances are too far to walk between suburban common-carrier terminals and stations and ultimate destinations within CBD's. There are usually a

TABLE 1

HOW SEGMENTS OF ANNUAL TRANS-HUDSON PASSENGER MOVEMENTS WERE DISTRIBUTED AMONG ALTERNATE MODES OF TRANSPORTATION

Trips	By All Modes (Mil)	By All Modes (%)	In Autos (%)	In Buses (%)	In RR's (%)
All days	276.8	100.0	49.3	27.8	22.9
Weekdays:					
N.Y. residents to and from N.J.	55.0	100.0	64.0[1]	18.9	17.1
N.J. residents to and from non-CBD	31.7	100.0	74.8[1]	15.1	10.1
Manhattan CBD:					
Off hours	45.8	100.0	23.1	44.3[1]	32.6[1]
Rush hours:					
Upper CBD (34th-59th)	24.7	100.0	15.4	57.5[1]	27.1[1]
Middle CBD (Houston-34th)	13.5	100.0	20.7	34.1[1]	45.2[1]
Lower CBD (Battery-Houston	19.9	100.0	10.6	16.6	72.8[1]
Weekends:					
N.Y. and N.J. residents	86.2	100.0	67.5[1]	22.4	10.1
Long haul areas	21.2	600.0	68.4[1]	17.4	14.2
Short haul tributary	65.0	100.0	67.2[1]	24.0	8.8
Upper N.J. area to GWB	23.9	100.0	84.5[1]	15.5	0.0
Middle N.J. area to LT	24.1	100.0	51.9[1]	45.2[1]	2.9
Lower N.J. area to HT	17.0	100.0	64.7[1]	5.9	29.4[1]

[1]Major mode of transportation.

number of clusters of sites of concentrated employment. On weekdays in journey-to-work hours, there is also usually acute vehicular congestion on the local street system. Considerable delays are therefore encountered by passengers in vehicles traversing local streets, in reaching their ultimate CBD destinations.

The third problem area arises out of the fact that patterns of urban travel have become more diffuse. Resident zones and zones of economic and social activities have now become more widely dispersed throughout urban areas than a decade ago. This dispersion is likely to continue into the future by reason of the expected low densities in both residential and non-residential developments.

THE PROBLEM OF TWO SHARP PASSENGER VOLUME PEAKS

It is common knowledge that urban dwellers, in pursuit of their livelihoods, create diurnal movements of masses of people who travel between residential areas and benches and desks in employment areas. Most workers, both of the blue- and white-collar types, concentrate their daily journeys-to-work regularly, on weekday mornings, 7:00 to 9:00 a.m. to their sites of employment and on weekday evenings between 4:30 and 6:30 p.m. from their work places, usually bound for their homes. These sharp work travel peaks, in periods of an hour or less, occur both on rail and on highway routes that focus on zones of concentration of economic activities.

It is also common knowledge that in most urban areas, CBD's are usually the single districts, with the largest volumes of concentrated employment. Manufacturing, commerce, business as well as governmental, educational, cultural and recreational activities are those usually found in CBD's. Consequently, rail and highway routes that focus on CBD's, are particularly subject to these extremely sharp passenger volume peaks, in periods of one hour or less. Moreover, passenger volumes that converge on CBD's are so much larger than those that converge on other single areas of concentrated employment, that they usually tax most of the existing railroad, rail transit and highway passenger (bus and auto) travel routes, both in the morning and evening rush hours.

In some urban complexes, there are also, of course, other areas such as beaches, parks, amusement and recreational areas, and other places of public assembly, that constitute foci of heavy passenger volume concentrations in leisure time periods—on Sundays and holidays. These are special problems that need consideration, but only in specific instances.

The usual controlling passenger volume peaks, however, are found on those rail and highway routes that focus on CBD's, on weekdays, in journey-to-work hours. On such routes, passenger volume hourly peaks are usually of the order of 30 percent to more than 50 percent of the total day's passenger volumes to the CBD, as compared with an average hour's passenger volume which would be only about 4.2 percent of the 24-hr daily volume. This means that to accommodate, adequately, journey-to-work peak-hour passenger volumes, capacities of such railroad, rail transit or highway routes must be of the order of 7 to 12 times the capacities needed to accommodate average hourly (of 24-hr) passenger volumes. For example, if one expressway lane is needed to accommodate average hourly passenger volumes in autos at less than two persons per auto, then some 7 to 12 lanes would be needed if the expressway accommodated largely journey-to-work passenger volumes in autos to the CBD, in the morning or from the CBD in the evening. These journey-to-work passenger volumes would thus produce daily route efficiencies, passenger-wise, of only 8 to 15 percent.

It is these sharp journey-to-work passenger volume peaks or extremely low passenger-carrying route efficiencies, that are responsible for the formidable economic burdens on urban areas. These economic burdens may come to rest on common carriers—commuter railroads, rail transit operators or bus operators. Or, they may come to rest on the local urban economies, themselves, which must bear part of the burden either through subsidies to rail transit and/or commuter railroads or through extra user taxes for the expansion of predominantly journey-to-work expressway routes. Thus, if most expressway passengers in journey-to-work hours travel in autos, then these expressways are really under-utilized, passenger-wise. How to reduce this formidable economic burden, brought about by the extremely sharp journey-to-work passenger volume peaks, becomes the great challenge that taxes the ingenuity of transportation engineers.

To put one's finger on the sharp journey-to-work passenger volume peaks as one of the major problem areas of urban-passenger transportation, whatever the modes of mass-passenger transport system may be, is to open up some avenues of approach, at least, toward partial solutions.

THE PROBLEM OF PASSENGER DISTRIBUTION IN CBD'S

The second problem area (namely, CBD's which are so large, in extent, that the distances between their suburban rail or bus terminals and important destinations within them, are too far to walk) should be examined. In multinucleated CBD's, it is not unusual for common-carrier terminals and stations to be more than 2 mi from important clusters of activities. This means altogether too long a walk, more than 25 min. On the open highways, it would take less than 5 min. In the usual existing CBD common-carrier vehicles traversing congested stop-and-start local streets, in journey-to-work hours, it usually takes all of 15 to 20 min. This is a substantial addition to the weekday morning and evening travel time between suburbs and sites of employment in CBD's.

The problem consequently is this: To devise the most economical way of bringing the CBD-bound worker, with a minimum of travel delay, to within easy walking distances of concentrations of sites of employment within such extensive CBD's.

THE PROBLEM OF DISPERSION OF HOMES AND SITES OF EMPLOYMENT

The third problem area is that of dispersion of homes and sites of employment in urban complexes. The movements of persons traveling between suburban homes and sites of employment and places of business not in CBD's, but scattered throughout urban complexes, present a diffused travel pattern: multitudinous points of home origins linked with another set of multitudinous points of destinations for economic and social activities. Concentrated generating points at origins or concentrated attractors at destinations are lacking; individual travel flow lines are very thin. Flow lines usually yield no definite linear traffic flow patterns but rather area-wide patterns.

This type of peripheral travel could be served, to only a very small degree, by linear mass transport such as railroads and rail transit, particularly of the types that focus on CBD's. Any fixed linear inflexible right-of-way rail system, either old or new, to serve such area-wide origins and destinations is therefore inevitably foredoomed to failure. Common-carrier mass transport, even by buses than can travel on an area-wide network of highways would find it difficult, on an unsubsidized private enterprise basis, to serve this type of diffused peripheral travel.

The problem is not only how to retard or arrest dispersion but also how to concentrate such sites of employment in the future; otherwise, providing for the transportation requirements resulting from the wide dispersions will become highly uneconomical and too burdensome on urban complexes.

TYPES OF MASS TRANSPORT SOLUTIONS TO MEET JOURNEY-TO-WORK PEAKS

The status of present mass transport in cities, to a large extent, determines the types of mass transport solutions that will best fit them.

For example, consider the cities that are now being served by "commuter" railroads that offer journey-to-work passenger transportation to and from their CBD's, that are burdened with sharp rush hour peaks, that handle little more of other types of passenger travel, that are greatly under-utilized, that consequently incur continual deficits from their commuter passenger operations. Such cities should, of course, make every effort to encourage the most effective use possible of their commuter railroads. These railroads do represent considerable sunk capital. If the continued operations of these commuter railroads were to obviate the necessity for building alternate highway facilities primarily to serve journey-to-work passenger travel to and from CBD's, then state and municipal subsidies could be economically justified to cover such rail operating deficits as do result from meeting these work travel needs. Also, some public urban redevelopment projects might deliberately be located in areas tributary to such commuter railroads, so as to use them more effectively. This would permit them to develop more revenue passenger traffic of a type that might reduce their passenger deficits.

Again, consider cities with rail transit facilities than handle, largely, close-in journey-to-work travel to and from CBD's, that suffer from extremely low route efficiencies. These cities should make every effort to stimulate use of rail transit by other than work travel. In many instances, housekeeping improvements, such as cleaner, better lighted, safer and more attractive stations would, in themselves, induce greater use of rail transit. Greater use, particularly if in previously under-utilized periods, would reduce the usual operating deficits, and at the same time, reduce the need for more parking spaces on high tax properties in CBD's.

Then there are cities where rail transit facilities are available but which are used to capacity in journey-to-work hours. There, every effort should be made to encourage the reduction of the sharp journey-to-work passenger volume peaks at CBD stations. This may be done by either one or both of these methods: (a) through the spreading of arrival and departure times of workers at individual sites of employment, or (b) through the staggering of arrival and departure times of workers in selected clusters of sites of employment. Greater margins of liberated rail transit capacities, in peak periods, would thus become available to absorb expanding passenger travel in rush hours with the present equipment. In this way operating deficits would be reduced.

On the other hand, cities that do not now have available railroad or rail transit services may need an entirely different type of mass-passenger transport solution.

In urban areas, where most or substantial proportions of the journey-to-work passenger movements to and from their CBD's are presently made in autos, on expressways, the problem becomes one of converting the sharp passenger volume peaks into much flatter vehicle volume peaks (Figs. 1 and 2). This means squeezing passengers out of autos into a much smaller number of buses in journey-to-work periods. Otherwise, continual and increasing vehicular traffic volumes will bring about acute traffic congestion in the morning and evening rush hours if such congestion does not already exist. At that point the inevitable question would arise: more freeways or rail transit?

At such a time, before giving consideration to sinking new capital in fixed linear inflexible rail facilities, those urban areas should first consider the feasibility of bringing into being publicly acceptable express bus routes between suburbs and their CBD's, particularly where such routes fan out over 180 deg or more from their CBD's. In journey-to-work hours, it may even be desirable to provide preferential or exclusive lanes on urban expressways which have been or will be built. Otherwise, such urban areas will have to keep providing a much larger number of additional expressway lanes that will be needed to accommodate the expanding CBD-bound journey-to-work passenger volumes in autos, than the much fewer lanes that would be needed to accommodate the same expansions in journey-to-work passenger volumes, if accommodated in CBD-bound express buses.

Urban communities must also constantly keep these facts in mind. Serving the two sharp weekday morning and evening journey-to-work passenger peaks only, will invariably turn out to be deficit operations. This will be so even if journey-to-work passengers to and from CBD's could be squeezed out of autos into express buses on expressways, either through traffic regulations or through special local taxes. This

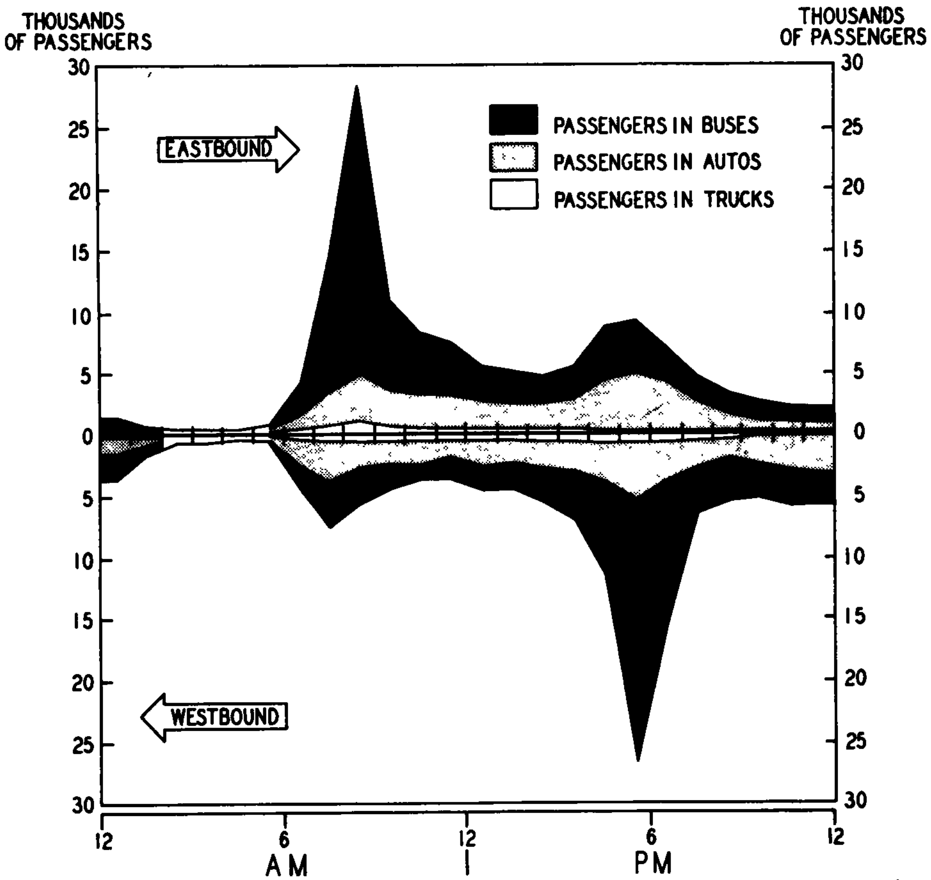

Figure 1. Hourly passengers in autos, buses and trucks through the Lincoln Tunnel on an average weekday in 1958.

will also be so even if all journey-to-work travelers used only common-carrier mass transport and autos were actually prohibited in journey-to-work hours. This will also be so unless these buses could attract substantial volumes of supplemental revenue passenger traffic, such as weekday non-rush hour and "reverse" travel (that is, from central city to suburban locations), as well as leisure time weekend travel and charter bus passengers.

MASS TRANSPORT SOLUTIONS FOR EXTENSIVE CBD'S

Any extensive multinucleated CBD, if it is to continue to be viable, must have a fast local circulating expressway or rail transit system to distribute commuter railroad, suburban bus and local intra-CBD bus passengers who must complete their journeys, within the CBD, to reach their ultimate CBD destinations.

CBD's that do not have a fast circulating system may, at first, make use of exclusive bus lanes on selected existing CBD streets in rush hours. Eventually, however, an underground or overhead mass-transit system may be needed, looping the CBD with stations located within 1,000 to 1,500 ft of important CBD destinations.

TRANSPORTATION SOLUTIONS FOR DISPERSED LOW DENSITY DEVELOPMENTS

To accommodate existing peripheral passenger travel demands between homes and sites of employment in low density areas, only an extensive network of highways and the private auto could meet this type of demand universally and adequately.

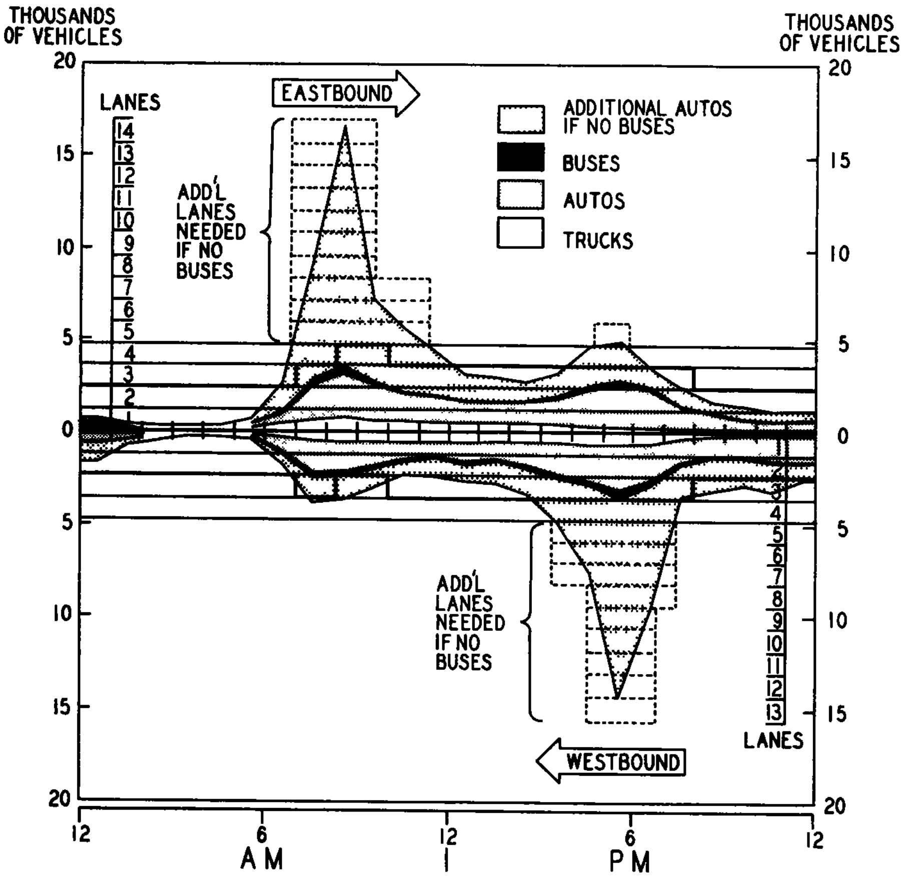

Figure 2. Hourly autos, buses and trucks through the Lincoln Tunnel on an average weekday in 1958.

In a minority of instances some opportunities for group travel in journey-to-work hours could develop to bring about a more efficient passenger-carrying utilization of the intensely used sections of the highways.

If efforts were made to cluster new work sites, more of such opportunities could be developed. Some sections of highway routes could build up enough passenger traffic densities between given residence areas and given clusters of sites of employment, to warrant establishment of bus services. Such bus services would increase, significantly, the passenger-carrying capacities of these sections of highway routes, perhaps sufficiently to obviate the necessity for expanding them, at least for some years ahead.

To capitalize on the advantages of bus transportation for journey-to-work travel, however, employment clusters would have to be concentrated in areas such as industrial parks, instead of in individual plants scattered over the landscape. Industrial parks, for example, would have to be large enough to concentrate some 5,000 to 10,000 employees, before bus transportation could become economically practicable to serve largely journey-to-work travel in low density areas. Such bus operators would also have to develop other types of off-hour, leisure time and charter bus travel, as well. Public utilities commissioners might wish to encourage the establishment of such journey-to-work bus services under proper circumstances.

In anticipation of such clustering of sites of employment in industrial parks, highway departments should design expressways so as to facilitate operation of express buses thereon, and thus encourage bringing into being mass transit by express buses as an effective means of obviating the necessity for expanding expressways to meet expansions in passenger travel in autos in journey-to-work hours.

SUMMARY

1. Precision of language, in this widely discussed controversial subject of urban-passenger transportation, will help to clarify this subject. It will bring into bold relief specific problem areas. It will indicate types of solutions that will meet the problems effectively, economically.

2. Today, no large urban areas can depend solely or even largely on autos, for weekday journey-to-work travel to its CBD. Some types of common-carrier passenger transport are essential.

3. Existing railroads and rail transit facilities that represent substantial sunk capital, that handle, largely, weekday journey-to-work passenger travel to and from CBD's, should be used most effectively, even be subsidized if necessary. Their continued operation could obviate the need for expanding highway facilities to absorb expanding journey-to-work travel to CBD's.

4. Where there are today no existing rail facilities, but where there are radial expressways into CBD's which will have to be expanded in the future, an entirely different type of solution is needed. Before considering fixed, linear, inflexible rail facilities, serious consideration should be given, first, to the feasibility of bringing into being, suburban express routes to CBD's with preferential or exclusive lanes for these bus routes in journey-to-work hours.

5. Where the CBD is extensive, ways should be found to give preference to buses on selected arterials in journey-to-work hours, so as to deliver workers, with a minimum of delay, to within 1,000 to 1,500 ft of important clusters of sites of CBD employment. Where underground or overhead structures are feasible, considerations should be given to such facilities for really fast circulation within CBD's.

6. In the suburbs, clusters of economic activities should be encouraged to make bus transportation economically practicable in journey-to-work hours. Highway departments should so design expressways as to encourage fast bus transportation, even in journey-to-work hours.

Discussion

DAVID M. GLANCY, Engineer-Economist, Bureau of Planning, Ohio Department of Highways — The following comment expresses the personal opinion of the writer and and does not attempt to state the opinion or policy of the Ohio Department of Highways, by whom the writer is employed.

As Mr. Cherniack so ably points out in his latest paper, there is no unique solution to the problem of urban-passenger transportation. He does indicate, and has in previous papers published elsewhere, that bus transit, properly planned and designed, could offer a reasonable solution to this problem in many urban areas.

In the opinion of the writer, this solution may be placed beyond reach, if some immediate action is not taken. Today, with the Federal-Aid Interstate and Urban programs, urban expressways are being built at a rapid rate. If provisions in plans and designs are not made for future bus transit pick-up, discharge and transfer points at urban interchanges, it will be impractical, if not impossible, to develop integrated bus transit systems at a later date.

Only slight modification of present designs would be necessary to allow for such future facilities. The added cost of right-of-way and construction would be small compared to the costs of revamping interchanges later and even less compared to the economic losses that could result from the inability to have integrated transit facilities for the movement of passengers in urban areas. This all boils down to what planners have been saying for years, planning more than pays for itself.

J.W. McDONALD, Director, Engineering and Technical Services, Automobile Club of Southern California, Los Angeles — The author immediately strikes a responsive chord in the first part of his paper dealing with the "fuzziness" or lack of definition for terms describing forms of passenger transport.

As another example of an approach to this problem, definitions suggested in California for clarifying thinking on mass transit are as follows:

Mass Transit—Scheduled public transportation in vehicles capable of carrying large groups and operating on specified routes—normally confined to an urban or metropolitan area. (In transportation discussions this term should probably be synonymous with "transit" and "public transit".)

Local Transit—Mass Transit generally operating on public streets and designed to furnish service to all areas adjacent to the routes by stops spaced at frequent intervals. (Typical examples would be buses, trolley coaches and street cars. The word "local" here should not be construed to mean necessarily a more limited area of service.)

Rapid Transit—Mass Transit operating on grade-separated rights-of-way and providing limited-stop, express service.

Rail Rapid Transit—Rapid Transit using rails or other fixed system of guidance for the vehicles and operating over exclusive rights-of-way.

Flexible Rapid Transit—Rapid Transit which may use but is not dependent on fixed system of guidance and/or exclusive rights-of-way.

Note that, as these definitions are set up, the more specific terms depend on the previous definitions. These definitions could, of course, be written in a form where each could stand alone, for example:

Flexible Rapid Transit—Scheduled public transportation in vehicles capable of carrying large groups and operating on specified routes along grade-separated rights-of-way and providing limited-stop express service. The system may use but is not dependent on fixed systems of guidance and/or exclusive rights-of-way.

These definitions are probably not as comprehensive as Mr. Cherniack's but the terms are less cumbersome. Subways as they exist in New York and commuter railroads may not fit, but these definitions could serve to clarify some particularly prevalent areas of confusion. For instance, in most people's minds, the general term "rapid transit" means "rail rapid transit". This is an extremely important distinction as more and more evidence is gathered indicating the superiority of a flexible rapid transit system in the changing urban areas. In these definitions it is assumed that all agree that the term "transit" refers to the transportation of persons.

Under these definitions, express buses operating on freeways would be a form of flexible rapid transit, even though the same vehicle might operate off the freeway in collecting and distributing passengers at both ends of its run.

It would seem that some commuter railroads could meet this definition of "rail rapid transit" if their rights-of-way were grade separated or protected to the extent that speed reductions were minimized.

Conventional and modified 2-rail rapid transit train systems and monorail systems would, of course, be forms of "rail rapid transit". Some subway systems might be difficult to classify, however, because they operate on exclusive grade-separated rights-of-way but do not necessarily offer an express-type service.

These definitions incorporate the word "rapid" primarily because of its common use. Mr. Cherniack is certainly justified in pointing out that this word as applied to existing "rapid" transit systems and most planned systems is misleading through its inference that high average speeds exist.

The current proposal for a rail rapid transit system for the Los Angeles area suggests trains with a potential top speed of 80 mph. The average speeds, however, from station to station are estimated to be only slightly better than the speeds experienced today by automobile commuters using, primarily, freeway routes lying in the proposed transit corridors. Current freeway construction, when completed, will improve these speeds still further and of course the elapsed time used in calculating speed by automobile is from home to work and return, as opposed to the transit averages calculated from station to station.

Mr. Cherniack questions the loose use of the term "balanced transportation". Experience in Los Angeles again confirms his point. Here it is often broadly inferred that transportation is badly unbalanced because the city lacks a rail rapid transit system. Certainly there are no fixed or standard measures of "transportation balance". "Transportation balance" should be defined as the matching of transportation modes and systems to the real and varying transportation needs of each community.

Following his discussion of need for definition in terminology, Mr. Cherniack points out and discusses three major basic problem areas in providing adequate urban-passenger transportation. Impressions of transportation problems in Los Angeles generally support those which the author describes. With respect to the magnitude of morning and evening peaks, however, these are probably less extreme in the Los Angeles low density area with relatively small CBD.

The problem of dispersion of homes and sites of employment is probably most extreme in the Los Angeles Metropolitan Area as compared with other large areas throughout the country, and as Mr. Cherniack points out, the potential of service for an inflexible rail transit system is extremely limited in such an area.

In considering Mr. Cherniack's suggested means of alleviating the problems of peak-hour movement and dispersion, however, it seems that a caution signal is in order.

First, the author suggests the possibility of "squeezing passengers out of autos into a much smaller number of buses in journey-to-work periods." This infers that one form of transportation may be considered a substitute for another. Some transportation authorities would question whether this is true to any appreciable degree. In Herring's paper, "Metropolitan Growth and Metropolitan Travel Patterns," it is pointed out that the choices made by people as to what form of transportation they use are primarily choices of best fit. To try to change the choice without changing the basic reasons for the choice would seen to be a move in the direction of transportation unbalance. If there is any coercion intended in the author's choice of the word "squeezing", the yellow signal of caution mentioned earlier should immediately turn to red.

The same question of fitting the transportation form to the real need could be raised again when the author suggests that the continued operation of rail transit facilities could "obviate the need for expanding highway facilities to absorb expanding journey-to-work travel to CBD's." It would seem that this might be true in only a very limited number of instances.

Mr. Cherniack does suggest a possible change in one of the basic factors which lead to people's choice of transportation mode—he suggests concentrated industrial parks instead of plants "scattered over the landscape". Undoubtedly there is room for better planning in this area. However, again the "go slow signal" should be observed. Transportation experts should move cautiously into the area of over-all planning. Some of the more extreme planners have suggested various forms of regimenting a way of life in the name of efficiency and reduced cost of providing public services, among which transportation is one of the more important. The best answer, according to these planners, would be to live above, below, or possibly across the street from place of work. Planning should remain a tool used to enhance but not to regiment a way of life.

Comprehensive Metropolitan Transportation Planning

Fundamental Philosophy and Concepts

HENRY FAGIN, Executive Director, Penn Jersey Transportation Study, Philadelphia, Penna.

●SEVERAL PRINCIPLES are fundamental to the Penn Jersey Transportation Study (PJ) approach to metropolitan transportation planning. These ideas are not exclusive to PJ. In one way or another each has been expressed previously. Nonetheless, it is the particular combination and the interpretation given to these principles that establishes the individual quality of the program being pursued in the nine-county Camden-Philadelphia-Trenton Metropolitan Region.

The first principle is that there are decisive relationships among all the means by which transportation takes place, and none can be determined without giving consideration to all.

The PJ Study is concerned with (a) all kinds of routes over which transportation movement takes place: paved roads, steel rails, pipe conduits, moving belts, air lanes, waterways, pedestrian paths, elevator shafts, escalators; (b) all kinds of vehicles: trains, trolleys, buses, trucks, taxis, passenger cars, bicycles, car floats, lighters, barges, ships, airplanes, helicopters, rockets, and containers, to say nothing of human legs; (c) the movement of individual things and with the movement of groups and masses and commodities in bulk; (d) private transportation and public, free as in the case of elevators or for hire as in the case of airport limousines, ferry boats, or moving vans; and (e) all kinds of things moved: people of specific ages, capacities, and resources as well as products that are solid or liquid, large or small, heavy or light, perishable or inert.

The Study is also aware of some things now figuring in the demand for transportation that may substitute electronic communication for actual movement. Persons traveling to a face-to-face meeting may substitute closed TV and stay physically separated. A telephone or facsimile copy may substitute for the sending of a letter.

Concern with all these aspects of transportation movement is basically most uneven. Some, at the center of focus will be studied intensively; others, near the periphery of attention, will be handled more casually in the current work. Nevertheless, PJ is aware that any element now apparently insignificant may in future years become crucial, or may seem vital to some substantial group in the community. Above all, PJ recognizes the need to look for combinations of routes and vehicles to serve a wide variety of movement demands, to seek the economies inherent in multiple and synchronized use of the facilities and services provided.

PJ's second principle is that areas of continuous urbanization require regionwide transportation planning. This is so whether the region comprises a city, county, or state or several of each or parts of each. PJ recognizes, of course, that there also are local aspects of transportation, to be handled at the municipal and county levels, as well as interregional aspects that must be handled at the state and Federal levels. Yet, PJ realizes that a tremendous amount of transportation activity has its daily ebbs and flows throughout all parts of its nine-county metropolitan region, and that certain aspects of this movement could neither be understood nor handled if the region was arbitrarily cut into smaller parts or dealt with on the basis only of the smaller divisions already existing within it. Moreover, PJ thinks the state capital is too remote for the regional aspects of its transportation needs—not merely remote in a geographic sense but also in terms of attention and a sense of urgency. PJ is a regional study. The programs it will recommend will have their regional aspects as well as local, county, and state aspects.

PJ's third principle is that transportation not only serves but shapes the region. When transportation policy is aligned with other public policy affecting the flow of land development in a growing and changing urban region, the combination can exert powerful leverage, channeling to some degree the forces of the real estate market. In addition to achieving the intended improvement of transportation service, PJ observes that major transportation measures taken in the past sometimes have been influential in bringing about unintended consequences. Indeed, it appears that the harm done by unanticipated adverse effects on general community development of a specific transportation program sometimes more than offsets the direct benefits derived in the way of improved transportation service. PJ therefore will weigh alternative transportation measures not only in terms of their respective promise of transportation service but also in terms of their prospective impact on the character of regional development. Hence, in addition to the traditional engineering criteria, applied to each transportation alternative, PJ asks: Is the region it will tend to generate socially desirable? Is this region economically productive? Is it politically attainable? Is it aesthetically attractive? Is it realistic in an evolutionary sense—that is, can the forces at work, tempered by the policies and programs at the command of the region, be channeled to bring the comtemplated future about? And finally back to the beginning, will the kind of region actually generated be so arranged and interrelated that the transportation provided will serve the region's functioning in the manner planned?

PJ's fourth principle is that the process of testing and reaching agreement is an integral part of a planning program. The PJ staff is not trying to design a transportation system that would win first prize in a national contest judged by city planners or engineers or economists. PJ's job is to design a professionally competent system that has the capacity to enlist the support and commitment of all the agencies and groups whose agreement is essential if anything is to happen. To achieve results from a comprehensive transportation program, there needs to be an unbroken series of yeses by many parties whose cooperation is vital and whose opposition would be fatal.

In recognition of this need, PJ was designed to assemble into a single government agency all the major governments whose combined transportation activities determine the regional transportation system. Important subcommittees bring the private transportation agencies into the program. Moreover, because agreement is needed regarding the interaction between the regional transportation program and other programs affecting the general development of the area, the PJ organizational structure brings together representatives of general government in the region—that is, the counties—and representatives of the state and Federal highway and transportation agencies. PJ's Policy Committee is the place where agreement is sought among eight suburban counties, the City of Philadelphia, two states, and the United States Government. The function of the staff is to provide the Policy Committee with the knowledge necessary for it to reach agreement on a best plan and program for the region.

PJ's fifth principle is that there are important continuing aspects of the work in which it is engaged. One vital clause of the 12-government contract under which PJ is jointly financed and directed, calls for the establishment of some type of continuing process for carrying on the work necessary to keep the program current.

Up to this point certain fundamentals of PJ that were more or less explicit in the written agreement that initiated the program have been described. All the foregoing ideas have been elaborated in the Policy Committee's discussions and decisions that gradually shaped the specifics of the program of data collection and analysis and transportation systems planning.

To develop further the idea of a continuous process, and to proceed beyond the point to which the Policy Committee has presently arrived, the author believes it is necessary to begin thinking about the needed continuing process by considering the several objectives of the present ongoing program. First, PJ is creating a plan for an evolving regional transportation system needed both to serve and to help shape a desired pattern of regional development associated with the transportation plan. It is intended for this plan, as adopted and subsequently modified, to serve as a guide to all specific transportation measures taken by governmental or private agencies. Second, PJ is preparing a program for the staged development of the regional transportation system over a period of years. And third, PJ is determining what provision should be made for keeping the results of PJ up-to-date and what sorts of continuing agency may be necessary in the future.

The first thing to notice is that none of these three objectives can be made final and complete in any ultimate sense within the three-year period of PJ's existence—nor for that matter at any other date in the future. A region is nothing like a building. In the case of a building, it is necessary to design the ultimate form in a relatively short space of time. The blueprints and the specifications are the means of organizing a burst of activity by an assembly of construction workers. Within a brief, finite period the construction is undertaken and completed. The building is finished and ready to be occupied. With a city or a region the process is very different. It is at least partially occupied to begin with. There is no such thing as an ultimate design—a region continues to change as long as human beings occupy it. Moreover, people are loath to burn their bridges ahead of them, as one planner has put it. They wisely like to keep the options open for as long as it is possible, until faced with the immediate need for action.

The urban planning process is like an endless journey into the future. At each step of the way certain decisions may have to be made on where to go next. Sometimes the next step has no special significance; sometimes, at the fork in the road so to speak, it is a commitment to a particular path for a long time to come. The nearer steps in the future can be seen most clearly; the places to be traversed later are grasped more vaguely. Beyond the present horizon, the journey is pure conjecture.

What is needed at each stage is a capacity to know what the situation is and what new possibilities have opened up. Given the fundamental inseparability of general transportation considerations and general regional developmental considerations, one element of the array of continuing needs is likely to be an agency of the region with the capacity to do continuously the same kind of basic policy and program development the PJ now has initiated. At this level of generality, transportation demand needs to be related to other demands in the region. Therefore, the required agency must have the capacity to look at region-shaping policies across-the-board. It must be the meeting place of all the governments whose activities combine to determine the form and functioning of the region. In brief, an agency akin to PJ's Policy Committee is likely to be a permanent need.

But policy in itself, important though it may be, does not serve regional demands. In terms of transportation, from time to time new facilities must be constructed and new services initiated. Elements in the general program advance from the category of possible future works to the status of projects to be constructed. They become like needed buildings—structures to be designed in full detail, to be described carefully in working drawings and specifications, to be built and completed and put into use. At this stage, the projects no longer are appropriate to a general policy and program development agency. They require the full attention of an action agency equipped to take action, to contract, to acquire, to build. Depending on the character of the particular project, it becomes the proper responsibility of a local, county, or state transportation department—or a railroad or a bus company. Or if the particular policy is to be expressed not as a constructed facility but as a regulation or a fiscal change, it may become the responsibility of a legislative or regulatory body.

Finally, there is the element of feedback. The actual experience with the operation of the transportation system and its parts generates new information about transportation demand and, equally important, about the functioning of the region as a whole. Part of this feedback remains within the operating agency, suggesting operational adjustments and the possible need for further modification of the system of facilities. But part of the feedback represents new basic information needed for the adjustment, modification, and further development of the broad, general regional development policies.

The author's guess, then, at this stage of PJ's program, is that this study may assist in launching into permanent orbit not just one but an array of activities, when the work is completed. Some of these are likely to require an agency patterned somewhat after the PJ Policy Committee; others are most likely to occur as functions of existing governmental and private transportation agencies or regulatory bodies; and perhaps some small number may warrant the eventual creation of one or more entirely new agencies not yet visualized at all.

The author has purposely restricted these remarks to the general philosophy that underlies the current program of PJ. How PJ is going about this program is the subject of the following paper.

Methodology of Planning

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●THE first of the two papers explaining the Penn Jersey Transportation Study presented the general philosophy that guides the Study's activities. The author has shown how the program is related to the social, economic, political, and physical environment of the nine-county region, a bi-state urban complex radiating outward from Camden, Philadelphia, and Trenton. This paper deals more specifically with the methodology of the Penn Jersey Study (PJ).

All of the research at PJ is disciplined by a single unifying concept, linking urban development, transportation movement, and growth of a metropolitan region. This theory suggests that there is a vital relationship between the activities that occur within parcels of land and the interchange of persons and goods as represented by transportation movements. If the opportunities for transfer among them are changed, a change in the activities on the land is brought about. Conversely, if the activities on the land are changed, the movements back and forth among them are changed.

Although this theory was stated many years ago—by the British planner, Sir Raymond Unwin, among others—it has become operationally significant for transportation planning only in the relatively recent past. Three sources have contributed especially to PJ's research methodology.

The first of these was the invaluable development of a technique for conducting origin-destination surveys through household sampling by a group of officials at the Bureau of Public Roads. Second was the theory expressed in the book, "Urban Traffic and Transportation," by Mitchell and Rapkin, which provided a synthesis of earlier thinking relating transportation and land use. And third was the significant pioneering work of J. Douglas Carroll, Jr., who made this synthesis operationally workable by demonstrating the feasibility of relating travel to land use in his transportation studies of Detroit and Chicago.

This paper shows how PJ research is oriented toward applying its unifying concept to the specifics of the particular metropolitan region it is studying. The Penn Jersey region covers approximately 4,600 sq mi and has about 4⅓ million inhabitants.

The agreement creating PJ involves 12 governmental agencies. This agreement calls for the development and examination of several different plans and programs of transportation improvements for the nine-county area. PJ is asked to identify the patterns of regional growth and change that tend to be associated with alternative sets of transportation proposals.

PJ wants to know how the region might change over a period of time in response to public improvements applied in staged sequence. Each group of proposals will represent a different development pattern and will be expressive of a basically different transportation system. A particular program will express one possible combination of transportation, industrial development, and land development patterns that are consistent with each other as to over-all region-shaping purpose and effect.

What shall be done is to simulate the development of PJ's region as it might take place during a long period of time in response to each of several alternative combinations of public policy—transportation policy being especially prominent among these. The central instrument is a projection methodology which is referred to as the "PJ regional growth model."

Regional growth model is PJ's short name for an interrelated array of sub-models, procedures, and routines which will describe the changes that might occur in land use and in travel patterns over time in response to the interaction of various programs, given the social, economic, and political forces and trends operating in and on the PJ region. The model is being designed to simulate both the growth and change of urban development and the patterns of movement that would occur in a given type of region at any particular stage in its evolution.

The PJ model incorporates new versions of various models that already have been used successfully in other places as well as some original models. PJ stresses, however, the feed-back that must occur throughout the complex system of sub-models if changes are introduced in any one of them. Thus, for example, if new highways, adding capacity to the highway network, are introduced and the relative accessibility of land is improved in various locations, PJ shall investigate corresponding changes in the real estate market to determine whether the magnitude of change is significant, and if so, how land development may be affected.

The unifying concept considers the effect of a new highway or rail facility on undeveloped land, where extensive development may take place soon after the facility is built, without losing sight of the highway needs that are created by residential or industrial growth. To use this concept, PJ's simulation of regional change and the resulting travel patterns must approximate continuous change, and, therefore, will not operate as a continuous process, but will be iterated by 5-yr periods.

At the end of each 5-yr projection, PJ will describe and introduce hypothetical improvements in the transportation system, feed in the anticipated growth factors, and develop the resulting interchange of persons and trips that would occur as the result of regional growth in the interim. This step-by-step procedure will enable PJ to take a close look at the results of the research periodically, so as to determine whether the end product of each step is acceptable as an input to the following iteration.

The following is a brief description of each of the components of the regional growth model. This model has grown out of the cooperative activities of people associated with the Study. The transportation portion of it will represent improved applications of well-known approaches. It is believed that new findings will be available regarding social, economic, and trip-making behavior. The design of an over-all model combining these diverse parts has been under the direction of Britton Harris, Research Coordinator for the Study. The model is essentially a means of combining procedures and subroutines, some of which were previously used by other study groups and some of which are being developed by the PJ staff.

The first principal component of the model is the transportation network. To describe the main patterns of movement and the interchange of both persons and goods which take place between the various types of land use, PJ divided the nine-county area into approximately 175 districts, varying in size as the concentration of population, commercial activity, or industrial use changes. The districts were designed so that principal areas of activity can be distinguished from those of less importance with a minimum of data processing. The largest traffic generating areas, including business districts and industrial zones, can be selected rapidly for analysis of area characteristics.

District maps were prepared in such a way that the principal traffic corridors are described by combinations of districts. Expressways, railroad lines, and primary highways pass through the district centroids as closely as could be determined by inspection of present route intersections and centers of urban activity.

The transportation network produces accessibility, without which an area of land could not sustain urban development. Access either must exist or be attainable through new construction. The most attractive districts are those having convenient access; that is, a capacity for interchange with other districts with a minimum loss of time. Time values for links in the transportation network are being obtained by field studies, both peak and off-peak, on all of the rail and highway links of the major transportation network.

The conversion of toll charges to time equivalents presents a problem. The Study area is comprised of counties located in Pennsylvania and New Jersey, and interstate travel takes place on toll bridges, located at various points along the Delaware River.

There also are turnpikes in both states on which tolls are collected. Toll charges vary on the bridges in some relation to the degree of convenience afforded to the public. It is recognized that toll payments affect the volumes of travel on turnpikes as well as on bridges. The effect of toll payments will be counter-balanced in the transportation network by assigning restrictions in the form of additional hypothetical travel time to the time values selected for each of the links.

The second component of the regional growth model includes the existing use of land and the land development potentials. Certain land development depends just on the sheer growth of the population; other development depends on the economic growth of the region, the expansion of commerce and industry. Moreover, new commerce and industry will be required to serve the growing population, and conversely, newcomers will be attracted to the region to man new jobs. A new housing development needs shopping facilities and other services. A new steel mill or new manufacturing plant may bring about a shifting of the labor market inasmuch as workers and their places of residence follow the availability of employment.

Industry, for purposes of present analysis and future projection, is divided into two classifications; that which is fixed because of present location and resistance to making a change, and that which is new or inclined to move. Numerous large industrial installations are considered to be at least semi-permanent inasmuch as change of location is not likely within the foreseeable future. Many plants already are located where conditions are ideal for the interchange of goods and movement of people; others are not so favorably located, but the investment in plant and equipment, the availability of skilled labor, or the cost of relocating, limit the economic advantages of seeking new locations.

New industries and those that are in a state of flux, moving or subject to change in location, present a real challenge to the regional growth model. Many small plants and business establishments requiring parking facilities and convenient highway access are moving to suburban areas where their requirements are fulfilled without loss of trade.

Light industry enjoys considerable flexibility in the selection of accessible plant locations, but other influences, including the availability of utilities and public services, as well as comparative tax rates, affect the choice of location. These factors have an important bearing on the potential of land for development.

A third type of industry serves residential demand. The construction of new homes promotes the building of shopping centers, office buildings, and small plants to satisfy the home owner's needs. Schools, churches, and public buildings become necessities that must be provided locally.

The PJ Economic Establishment Survey will provide valuable information essential for determining whether the locations of particular industries should be considered fixed or flexible.

Another key element in the projection of land development is the growth of population. Fortunately, the 1960 census data becomes available just at the time when population trends are being analyzed. The census data will be correlated with information being obtained from a new kind of household survey supplementary to PJ's standard origin-and-destination home interviews. The supplemental household survey, designed and supervised by Henry Bruck of the PJ staff, will yield detailed knowledge of family characteristics and factors influencing choice of residence. Field crews conducted 6,600 supplemental interviews to obtain sociological information from a subsample of the home interviews. The resulting data will provide important and essential input factors for the regional growth analysis.

The third component provides trip generation rates and the distribution of trip ends for the model. Trip generation rates are being studied in two ways: first with respect to knowledge of 1960 land use and trips, as reported in the 1960 interviews; and second with respect to knowledge that can be gained by reviewing and reprocessing 1947 trip data. Land-use information is also available for correlation with 1947 trips. The mathematical relationships between the number of vehicular or person-trips generated in an areal unit and the type of land use provide a means for expressing the observed phenomena in a manner which will indicate whether data obtained from surveys made

13 years apart can be related. Comparisons and tests of various mathematical models will lead to a refinement of the equations that will be used for estimating trip generation rates at future dates. The analysis of trip generation and trip-end distribution is being made by George Wickstrom and Anthony Tomazinis of the PJ staff.

The analysis of trip-end distribution involves the patterns of movement between interzonal origins and destinations when trips are distributed, first in accordance with the observed phenomenon, and second when they are projected in accordance with the anticipated termini corresponding to the effects of land-use changes. Trip-end distribution is influenced by the inclination of an areal unit to attract trips. The characteristics of trip patterns are being considered on the basis of two assumptions: first, that the propensity of an area for attracting trips is related to the character and density of activity which take place within the area; second, that the probability of a trip finding a specific terminus is determined both by the number of intervening trip opportunities of a similar nature and by travel time or distance. It is believed that a combination of these two theories will produce reliable results. To put this in terms of a familiar example, a large suburban shopping center attracts many patrons, but the residents of a particular area will select the shopping center that is closest, providing the nearest one satisfies their needs. Tests will be made to determine how these relationships operate in PJ's region.

The PJ Study carefully inventoried land use, parcel by parcel, in all nine counties prior to the survey of trips. The home-interview sample was selected from the field listing of residential addresses. Therefore, complete information is available for analysis of trip generation and trip-end distribution.

A separate analysis is being made of the factors that influence choice of mode, using additional data from a field survey of rail passenger trips. Person trips using transit will be related by mathematical expressions to the significant regional characteristics of particular districts or corridors. This type of analysis will produce insights for the determination of the essential factors that will be used for identifying potential transit volumes in the assignment of persons trips to the transportation network—a network that will combine both highway and rail links.

The final component of the regional growth model is the evaluation of traffic volumes and determination of the probable flow patterns between districts, thereby testing the results of our traffic simulation procedures. Having started with relatively large districts, connected by major highway and rail routes, population, land use, and other factors obtained from the analysis of PJ's regional data are added. Then, from an analysis of traffic-generating characteristics of various activities and the distribution of trip ends, mathematical expressions relating trips to land use are obtained. Now, PJ returns to the physical description of the area, in terms of districts, to compute the travel patterns and the volumes of interchange between districts.

Initially, by simulating the flow of persons and goods by different modes, the reliability of the methodology will be tested using only 1960 data. Having modified the procedures until they are reasonable, PJ will then use the initial output as the input to the next iteration after adding newly constructed, committed, or proposed segments of the major transportation network. These steps will be repeated to represent 5-yr intervals to the year 1985.

At the end of each iteration, a sufficiency analysis will be made of highway capacity, considering only the inter-district movements and major highway and rail links. This analysis will aid in checking a program for scheduling the construction of improvements and in estimating costs of new facilities on a 5-yr basis.

The end product of PJ's research will be a transportation plan and a recommended development program. Recommendations are being formulated to provide for a continuing transportation planning process, whereby the plans and programs described herein will be kept current and periodically updated. This continuing process will provide assurance that planning can precede the demands of the public for better transportation.

State and Local Highway Planning in Michigan

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●THROUGHOUT America, as the giant highway program moves into the city, it runs head-on into an equally impressive urban redevelopment program. The population explosion in the metropolitan centers of this country; the rearrangement of population characteristics and distribution within the urban area; blight, deterioration, and slums in the old core area of the city; the inability of deteriorated property in the central core of the city to compete for new land uses; all have prompted a tremendous city rebuilding effort across the entire country. Past Federal government financial support of this urban rebuilding program is scheduled to grow considerably in the future according to the promises of both political parties.

Without an appreciation of the urban rebuilding program, there can be no real understanding of the urban highway planning problem. The problems of urban renewal or city rebuilding and urban highway building become one in the most complicated and confused section of the American landscape. So the question comes to highway planners; for what kind of city are today's urban trafficways being built? Is it the city known in the past—the city that made the hard conversion from water to rail to motor transportation with little adjustment in the basic land-use pattern? Is it the city known today—a city plagued with overdevelopment, disorder, slums, and blight; a city of artificial boundaries; a city with a mobile population which struggles to escape the old in favor of the fresh, green, verdant periphery? Or finally, are urban trafficways being built to the fashion of the emerging new American city—the city now in redevelopment—characterized by the Baltimore Charles Center, the Philadelphia Penn Center, the Detroit Riverfront and Convention Center, the Pittsburgh Golden Triangle, the Cincinnati Riverfront Reconstruction, the rebuilt downtown of Murfreesboro, Tenn., the Kalamazoo pedestrian mall—a few of the many illustrations of the emerging new dimensions of the American city. It is to this problem that the Michigan State Highway Department, under a planning minded highway commissioner, has addressed itself. With new people with urban planning backgrounds, the department has proceeded to develop an expanded program of state-local urban highway planning.

The topic, "State-Local Highway Planning" assumes that representatives of state and local government each have, and will continue to have, a part of the responsibility for urban highway planning. Can this be assured, especially in the light of recent contentions that urban highway planning should be done exclusively at the local level, or on the other hand, that it has been and should continue to be a sole accomplishment of state highway planners?

Recently there has been some dissatisfaction expressed in certain quarters with the conduct of state-directed highway planning in urban areas. This has prompted suggested procedural changes which in some cases have taken the form of congressional legislative proposals. This dissatisfaction centers on a fear that the urban highway program, as conceived by highway planners, will not harmonize with the city as it is defined by the master plan. What has prompted this concern? The author does not believe that it is born out of a record of past failures in the urban highway building program, but stems primarily from the unsolved dilemmas which have become a part of the urban problem. We still live with the failure of any metropolitan governmental machinery to erase fractionated governments and to provide a base for dealing with urban problems. Positive land-use controls must be found to replace worn out zoning ordinances. The failure of central business district promotion to stem the tide of retail decentralization has been witnessed. A rebuilding program must be found which will check the tide of blight and deterioration in the central core of the city. Although urbanized, America is still a country of rurally dominated state legislatures. No wonder there are some who question, in the same tone, whether the city will be properly represented in the decision-making process attending the planning and construction of urban trafficways.

The same frustrations which confront the local planner and give rise to his concern about highway planning also disqualify him for the task of solving alone the urban highway problem. A regional highway system cannot be framed on the illogic of governmental incorporation. Those who have had experience in the problem of urban expressway location in large metropolitan areas will appreciate the significance of this fact. There is an obvious fallaciousness in the transportation study which illustrates an expressway design and location in terms of assessed valuation of property taken, present tax income lost, future tax potential destroyed for a unit of government which has no reason to exist in the metropolitan complex other than the coincidence of political incorporation. To even attempt to plan a transportative system on such a basis does little more than arouse political resistances which can grow into major obstacles in the effectuation stage.

How would proponents of urban highway planning at the local level expect a regional highway system to grow out of the existing fractionated governmental structure of the metropolitan area?

On the other hand, the value of a system of urban trafficways can be measured by its ability to serve the community, both existing and future. Traffic is the product of the community, not its designer. Thus, the merits of the transportation plan are in direct proportion to the excellence of the community plan with its central business district redesign, its residential neighborhood and sub-communities, its industrial parks and rehabilitation and redevelopment project. These are the determinants of the transportation plan as they are defined in the community plan. No one would contend that the highway planner is in the proper position to define these community goals and objectives. First, the urban planner must have a community plan prepared in cooperation with the community interests, which must effectuate the plan and live in the resulting community. The interpretation of the community plan in terms of traffic and transportation facilities and its integration in a regional or statewide system is, and must remain, the role of the highway planner. The two steps cannot occur sequentially, but must happen simultaneously through coordinated efforts of local and state planners.

Accepting the premise that the urban highway planning program will continue to involve both state and local planners, the key to success is coordination. The Michigan State Highway Department has long enjoyed a friendly and cooperative planning relationship with local units of government. To enhance this relationship, the department has recently developed both a new urban planning program and a prescribed urban planning procedure, both of which are designed to produce coordinated state-local urban highway planning.

The department's urban planning program has its basis in a policy established for the State of Michigan by the highway commissioner to the effect that no construction of any significant proportion can occur in any Michigan municipality unless and until an urban highway plan shall have been prepared. Preparation of an urban highway plan thus becomes the crux of the urban planning program. Responsibility for the preparation of urban highway plans has been delegated to the planning division, one of three divisions of the department's office of planning. A route location division, and a programming division comprise the other two divisions of the office.

What is an urban highway plan or an urban trunkline plan as defined here? Basically, it is a documented presentation of long-range highway objectives for an area. The documentation of these long-range objectives illustrates two facts: (a) There is mutual agreement between the local community planners and the highway department planners on a system of highways, and (b) the proposed system is compatible to and consistent with existing and proposed development projects and capital improvement programs of the local community.

These conclusions are jointly reached by the highway department and the local community. The planning division represents the department in the conduct of necessary traffic and planning studies and in the decision-making process. But who in the organization of local government should be its representative? On this subject there has been much difference of opinion. In Michigan, as is true in most other states, there is available planning enabling legislation on the basis of which local government can establish local planning commissions and delegate to these commissions the responsibility for the preparation of master plans. Master plans are statements of long-range community goals and objectives. In a community which has availed itself of this opportunity, there would seem to be no alternative but to work through the planning commission as the local representative on the urban trunkline team. But this is not the easiest of tasks, for the stature of planning commissions varies from community to community along with the generosity of legislative bodies in actually assigning planning responsibility.

However, there is much to be said for the coordinated effort between the planning division and local planning commissions. Both are recommending agencies; the local planning commission making recommendations to its local legislative body, and the planning division of the highway department making similar recommendations to the highway administrators. If there is any objection, it may come from the local legislative body or the manager who may object to their omission from the development phase of the highway plan. These objections are somewhat eased with the explanation that before any projects are constructed within the urban area the concurrence of the local legislative body is required. Therefore, the local legislative body is not omitted from the urban highway building program, although they are not made a participant in the preparation or adoption of the urban highway plan. Local concurrence with the plan is manifested by a resolution of the local planning commission to the effect that the proposed system of highways is consistent with the master plan for the community and the development and redevelopment objectives thereof. It is important to note that local concurrence does not make the trunkline plan a part of the master plan, although this is possible where exact coincidence occurs. In most cases there will be slight differences which, if made a part of the master plan, would require satisfaction of public hearing requirements.

To date, this described planning approach to the local community has been very successful. The only place where it has become difficult is where the local planning commission does not properly inform the legislative body of its activities. This situation should seldom arise, for the mayor, the manager, and one council or commission member are made a part of the local planning commission, and should take back to the legislative body a report of the activities, recommendations, and conclusions of the planning commission.

From the standpoint of documentation in the urban trunkline plan, in addition to the formal resolution of concurrence by the local planning body, sufficient illustrations of local community development and redevelopment plans are included to manifest that the proposed arrangement of state trunklines is an integral element of the community development pattern.

Once prepared, copies of the urban trunkline plan are made available to the local planning commission for use in recommending to the legislative body. In the highway department the plan is referred to the sister divisions of the office of planning. The route location division, when necessary, makes engineering feasibility studies of the proposed routes included in the urban trunkline plan, and the programming division programs for construction all, or parts of the plan, as warranted by statewide priorities.

The urban trunkline planning approach has been well received in the State of Michigan, not only in the local communities, but in the highway department. It has demonstrated to local communities the concern of the department in the proper integration of highway facilities and community development programs. The documented plan, distributed throughout the highway department, has called attention to the relationship of the proposed trunkline improvements to local development plans. Because the plan is documented and because it carries with it the approval of the local planning commission, the other agencies of the department are less prone to deviate from the planning proposals in the design or construction stages.

The second part of the urban planning program is the planning procedure guide, which has been developed by the Michigan State Highway Department. This is a natural complement to the urban planning program. This guide, entitled, "A Checklist for Highway Planning Reports", was itself the product of a coordinated state-local highway planning effort. The Michigan State Highway Department, the City of Detroit, and the Wayne County Road Commission have been joined together for the purposes of highway building under a tri-party agreement. This agreement delineates the financial, planning, and construction responsibilities of the three agencies as they regard the expressway program in the Detroit Metropolitan Area. To harmonize the efforts of these three agencies, to permit the division of work and responsibility, to define planning report requirements, to permit the establishment of a time schedule and a progress reporting system, management of the highway department requested that a guide be prepared which could function as a specification for planning studies to be done by others, but to be used by the department. Such a "checklist" was prepared in cooperation with the participating agencies.

The "Highway Planning Report Checklist" enumerated many of the considerations which should apply in the analysis of a highway proposal. The "checklist" stressed those city planning criteria and community measurements necessary to assure that a road facility would be an integral element in the over-all community design. On the basis of comparative analysis obtained by applying the itemized considerations to alternate alignment and design proposals, the "checklist" items were given meaning.

The "checklist" found ready application in the Detroit Expressway study program and, in addition, permitted the required coordination and controls requested by department management. The "checklist" also found application in the highway department as a guide in the preparation of highway plans and planning reports. The fact that it was a pioneering effort was evidenced by many requests for copies from other highway departments, governmental and private planning agencies.

A second printing soon became necessary, but before reprinting, it was decided to refine the report based on initial experience with its application. The revised "checklist" has now been completed. It is organized into three parts. Part I is the "outline", or the procedural guide for the preparation of a highway planning report. This is a general outline which is applicable to any of the great variety of planning problems which confront a highway department. Part II, which is the "checklist" proper, includes the details which expand on the skeletal framework of the "outline". In this second part are enumerated the details or considerations which should apply in the conduct of the procedural guide of Part I. These include relationship of highway proposals to other traffic systems and other modes of travel, traffic data, economic base data, land use, population growth and distribution, local plans and programs, geographical data, and many others. In addition, maps and exhibits are suggested in order to emphasize the details. These considerations are further amplified in Part III by a list of sources of information and references which explain them and their application.

The "outline", or Part I, is the framework of the "checklist". In it, four major steps form the procedure of a highway planning analysis. These are, as follows:

1. An inventory and description of the area involved by the proposed route to determine all present conditions.
2. A forecast of future conditions based on existing conditions and established trends.
3. An analysis of what must be done to provide possible alternate transportation networks that will satisfy forecasted future conditions.
4. A recommendation on the bases of the comparative analysis of alternatives of the best alignment and design for a highway facility.

The considerations suggested by the "checklist" are not new, but have long been a part of highway route analysis. The "checklist" does display them in their logical relationship to long-standing engineering tests. It also gives meaning to these considerations by making them measurements of a comparative analysis. There is little doubt that the revisions made to the original effort are but the beginning of a continuing effort to further precise and refine the necessary procedures and considerations, which will insure that the highways being built today will function in the cities of tomorrow.

There are, no doubt, other equally effective methods of coordinating state-local highway planning. Perhaps one receiving most attention at the present is the coordination of planning assistance programs. Under the Federal Housing Act, urban planning assistance grants are made available to communities under 50,000 population. A prerequisite to state qualification for these Sec. 701 funds is the existence of a qualified state agency to administer the program. Thus an attractive opportunity is provided at the state level to coordinate 701 local planning programs with state-directed transportation studies. The privilege of state highway departments to make a similar distribution of one and one-half percent highway planning funds to local communities for transportation planning, adds more opportunity for coordinated planning. A combined program using 701 planning assistance and highway planning survey assistance can provide a planning program for local communities with built-in community and highway planning coordination.

Although Michigan initiated this year a 701 planning assistance program it is doubtful if it will make much of an impact on the urban highway planning program. These financial-assistance incentive plans would appear to be most effective in the initiation of planning programs. Most Michigan cities have long histories in local planning. Whether these aids are used, or not, they are for the most part short-term programs and there will remain after their completion the problem of coordinating a continuing state-local planning program which extends from data gathering and surveys through the decision-making process of planning effectuation. It is to this larger program that the Michigan state highway planning program is directed.

As the state highway department displays a greater sensitivity to the problems of the urban areas, it is participating more and more in local planning problems. Two examples are central business district redevelopment programs and urban renewal projects. The problem of improving circulation in the central business district, which is basic to central business district redevelopment or rehabilitation, is coincident with better state trunkline service for the central city. Most of the retail areas remain chopped up by state highways, usually with a highway or two on the main business street. The same congestion which is impeding highway movement is becoming objectionable to retail interests and pedestrian movement. Often local circulation can be improved by the same measures which provide better highway service to the community. Cooperative action is in the best interest of all. The department has also been able to assist cities with the preparation of urban renewal projects by fitting highway project programming to that of local redevelopment and rehabilitation efforts. The urban trunkline plan becomes a framework for the planning of urban renewal projects. Although no financial rewards return to the department as a result of their participation in urban renewal, revised land-use patterns, which can be designed in conjunction with highway design, are an asset to the highway system as well as the redeveloping community.

It has often been said, with great truth, that with 80 percent or more of our population residing in urban areas, the economic and social well being of these urban dwellers will determine the prosperity and living standard of the nation. Also, history tells us that most of the great civilizations of the past eventually focused in community or urban environments where they have deteriorated away to national collapse. Today, planners have yet to solve the land-use problem that is eating away at the vitality of urban places. The planners have not yet found the answer to the problem of urban sprawl on the periphery, or urban decay at the core. Perhaps a revised urban transportation system is the answer, either in whole or in part. If it is, it will only be recognized through the coordinated efforts of state and local planners.

Michigan has tried the coordinated planning approach and finds that it works. An effort has been made to define the procedures and techniques, which have been found to be satisfactory but are steadily being improved. And finally, in the recognition of the new responsibilities in urban areas, a new excitement has been found as highway planners become partners with local planners in the fascinating task of rebuilding Michigan cities.

Transportation in the Center City Development Plan for Philadelphia

ARTHUR T. ROW, Assistant Executive Director, Philadelphia City Planning Commission

The roots of a development plan lie in past ideas and/or decisions. The plans themselves generally come out of an interplay over time that is extremely difficult to retrace and recapture. And the development plan adopted by the Planning Commission in 1960 will someday be one of the roots for further plans. The decision of William Penn's surveyor to place the City at the narrow point between the Delaware and Schuylkill Rivers and to reserve five park squares was the beginning. The siting of Independence Hall and adjoining buildings of the period are important elements in the Center City structure proposed today. The construction of the railroads, and later the subways, coupled with the development patterns they generated, suggest both limits and new requirements for the present plan. The Benjamin Franklin Parkway, laid out first in 1904, strengthens visual structure, locates important metropolitan cultural resources, and provides traffic access to Center City. Penn Center has both replaced an obsolete barrier to development and opened Philadelphia's eyes to Center City's potential. Ideas expressed in the Greater Philadelphia Exhibit of 1947, the CBD Study of 1950, the report Plan and Program (1955) of the Urban Traffic and Transportation Board all have, and continue to, contribute to the plan for Center City.

●A MAJOR PREMISE of the Physical Development Plan for the City of Philadelphia is that the City should have a dominant and intensely developed center.

The Development Plan for Center City is based on the premise that the following activities are the proper components of the Regional Capital:

1. The center for economic decision-making in the region.
2. The center for specialized professional and business services within the region.
3. The chief market place of the region.
4. The cultural center of the region.
5. The City government and regional offices of state and Federal governments.
6. Special manufacturing and goods distributing functions for the region.
7. High intensity residential areas.

Estimates of the Center's economic potential have been made in the context of estimates of employment distribution for the metropolitan area. Assuming a metropolitan transportation system as proposed in 1955 by the Urban Traffic and Transportation Board, it has been estimated that Center City's employment can be expected to increase by 11 percent by 1980 (1). In absolute numbers this means an increase from 375,000 in 1956 to 416,000 in 1980. Proportionately, as one would expect, it represents a relative loss from 25 percent of the 1956 metropolitan employment to 19 percent of the 1980 metropolitan employment. Yet this modest increase in employment produces an increase in floor space requirements of some 20 million sq ft. This increase in floor space, coupled with the necessary replacement of obsolete space indicates a great potential for rebuilding if the necessary improvements in access can be made.

An important aspect of this increase is its composition. Employment in retail trade is not expected to increase. The potential in goods-handling activities is 4 percent, but actually this may occur on the periphery of Center City. Business and consumer services on the other hand are expected to increase on the order of 15 and 80 percent, respectively. Business services comprise such activities as finance, insurance and real estate; professional business services; communications; public administration; wholesale agents. Consumer service increases are forecast in medical services and education.

These of course are statistical estimates of potential. The plan may deflect some of these activities elsewhere, and may, in turn, attract a greater number of other activities. The important thing is the general direction of change in a reasoned estimate of generally increasing potential if the metropolitan transportation requirements are met in a systematic way.

A characteristic of an efficient center is small size. The statistical area defined as Center City comprises 2.2 sq mi. To put this in scale, the City's area is 134 sq mi and the present urbanized area in the region is estimated at 500 sq mi.

The high intensity core of Center City (to be discussed later) is exactly one-half a square mile.

THE METROPOLITAN TRANSPORTATION PLAN

Whether or not it is an objective to increase the activity of Center City, and whether or not the economic estimates of potential are up or down, any metropolitan transportation system must focus on this area because it will remain the most important particular space in the region. Choices must be made in terms of degree of improvement of different kinds of facilities, and choices must be made in timing, but there is no choice as to the general form of the transportation network.

Figures 1 through 7 show the proposed metropolitan transportation plans within the City of Philadelphia and the immediate environs.

The general configuration of the expressway system is similar to most: radials, circumferentials or distributors, and a central loop. Underlying the expressway system is the proposed arterial street system. Within the City there are 100 mi of expressway in the system and about 500 mi of arterial street (Fig. 1). This density of expressways is probably less per square mile or per 10,000 of population than in some other cities (2). In Detroit there are proposed for example, 150 mi of expressway for a city of about the same population and geographic extent. The reason for Philadelphia's lower mileage is the proposed use and expansion of the rail rapid transit system.

Figure 2 shows the proposed rail system. It consists of improvement to the existing subway system and extensions thereto, and of improvement to the commuter rail system by connecting the two separate systems downtown (explained later). To retain ridership on these systems (and if possible to increase it) is a basic tenet of City policy. This decision is based on pragmatic grounds rather than on a scientifically based prediction of the probable distribution of travel mode. These grounds are as follows:

1. The carrying capacity of the rail transit systems (including commuter rail) represents a resource much too valuable to permit withering away.
2. The Center City as now constituted in space cannot be served by automobile alone.
3. The Center City development objectives for the future, and for certain central (regional) activities displaced from Center City, (for example the Universities) can not be achieved without a combined rail and expressway system.
4. The outlays required for expressways, for street connections to them, and for downtown parking facilities, can be kept down if ridership on the rail system can be held up.

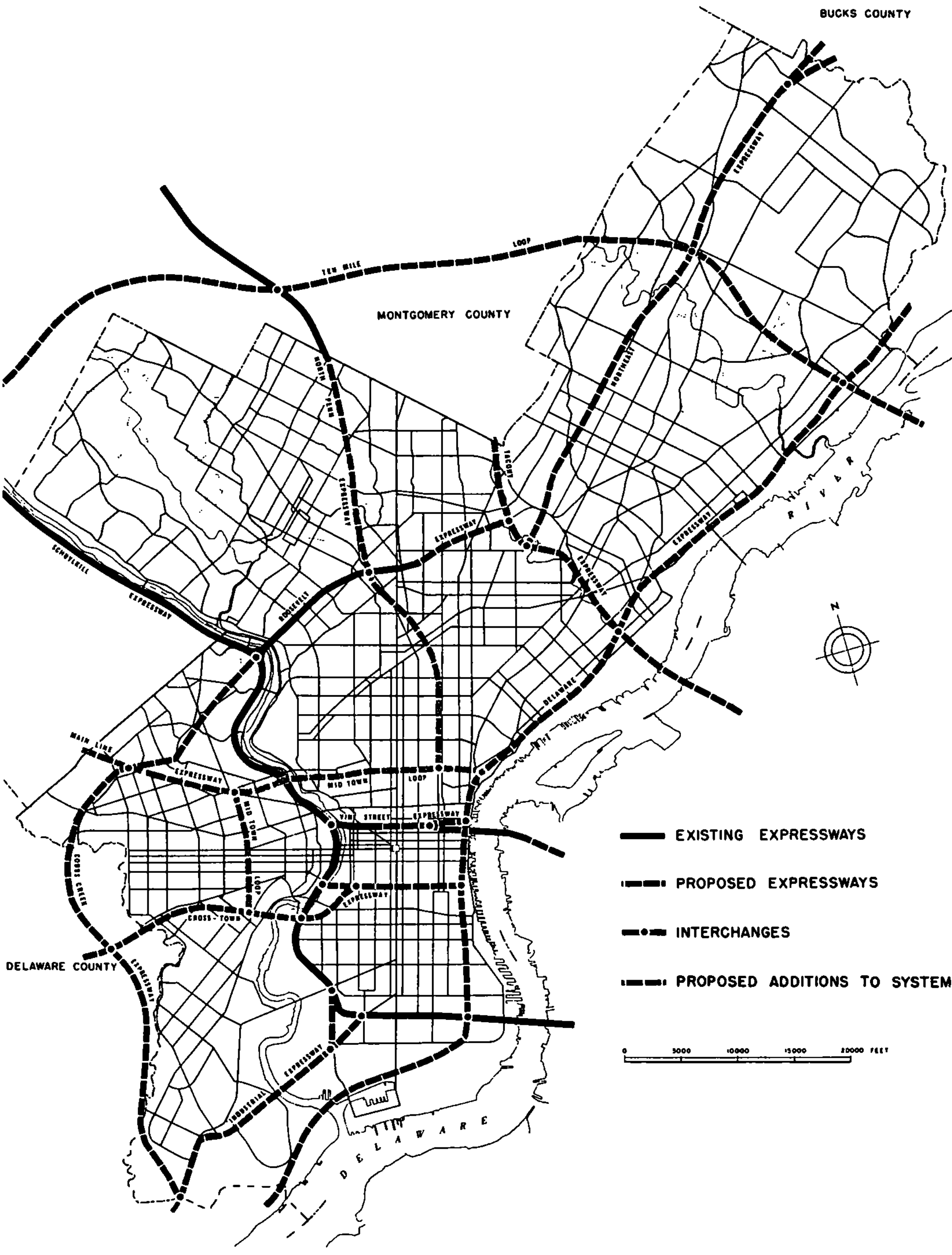


Figure 1. Expressway and arterial system.

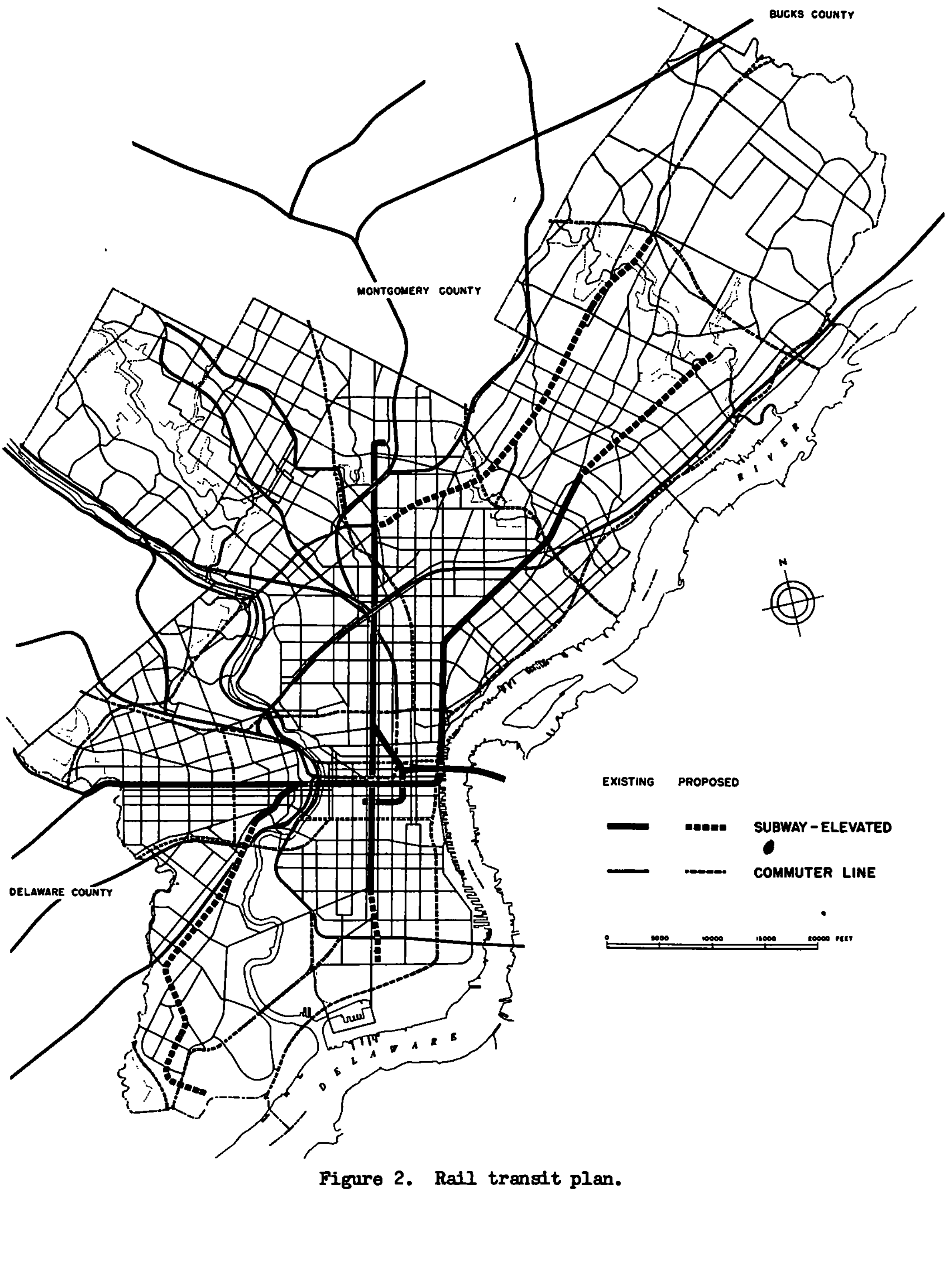


Figure 2. Rail transit plan.

In support of these grounds, it is argued that:

1. Peak-hour rapid transit riding has not declined.
2. The level of quality of ride between present automobile and (most) present transit equipment is in favor of the automobile and if speed and comfort of rail transit vehicles are improved, transit will hold its own and may recapture some.
3. Increased frequency of service and reduced fares on commuter rail lines can (and has) increased ridership.

Implied in the foregoing is a recognition that (as will be explained more clearly later) rail transit is primarily a peak-hour service facility. This means it is more expensive service than it was in the heyday of transit.

The obvious differences between the expressway system and the rail transit system are that the latter comes to a point in the center and there are no crosstown links. The rail system penetrates the heart whereas the expressway system skirts it.

THE CENTER CITY LAND-USE PLAN

The proposed spatial composition is shown in Figures 3 and 4.

This spatial composition generally fixes the daily destination pattern, hence suggests terminal points, and, consistent with the objective of protecting the viability of the various land-use areas, limits possible channels of surface movement. Conversely, the location of present and proposed channels of high capacity movement and terminals suggests elements of the spatial composition.

Central land uses may be viewed in either of two ways, either of which is inadequate as a basis for a plan. First, to look at uses in terms of the particular functions, and the characteristics and requirements of each function; and second, to look at uses in terms of their relative competitive strength to command space. It is a requirement of the plan that it propose a use pattern that is both economically and functionally workable. To some extent, but not completely, these are two sides of the same coin.

Viewed in the first way Center City is, and will be, composed of uses which have different external characteristics, service requirements, environmental requirements. Thus Center City is composed of central office uses, central department and retail store uses, subcentral office uses, institutional uses, central industrial uses, and residential uses. Each of these is a primary user in various sections of Center City. A crude but logical structure already exists.

Viewed in the second way, Center City activities may be classified in terms of their productivity on the ground (3). Thus, uses with high value added per worker combined with high density tolerance can command the most expensive space, the space which is most accessible to the metropolitan region as a whole. Uses with high value added per worker, but lower density tolerance or the converse, can command the next most expensive space and so on down to those with both relatively low value added and low density tolerance. The first is characterized by high intensity office uses, the second by department stores and less intensive or less productive office activity, through expensive high density residence, and on down to the goods-handling activities with lower density tolerances. Again the pattern of activities looked at in these terms forms a crude but logical structure.

The plan for Center City seeks to clarify this structure where it makes sense, to eliminate the anomalies, to reduce the conflicts, to tie together where there are gaps, and to produce a complex where each contributes to the health of Center City as a whole as well as to the health of the region for which this is the capital area.

Each of the major use areas actually comprises a mix of activities. In the primary office area, shown in black on Figure 4, business and consumer service activities occupy about two thirds of the space. It is assumed that in each major use area there will continue to be a mix but the primary use will occupy more space and plans for new development and redevelopment will exclude the conflicting uses. For planning purposes it has been assumed that business and consumer service activities in the office core will occupy about 70 percent of the total space.

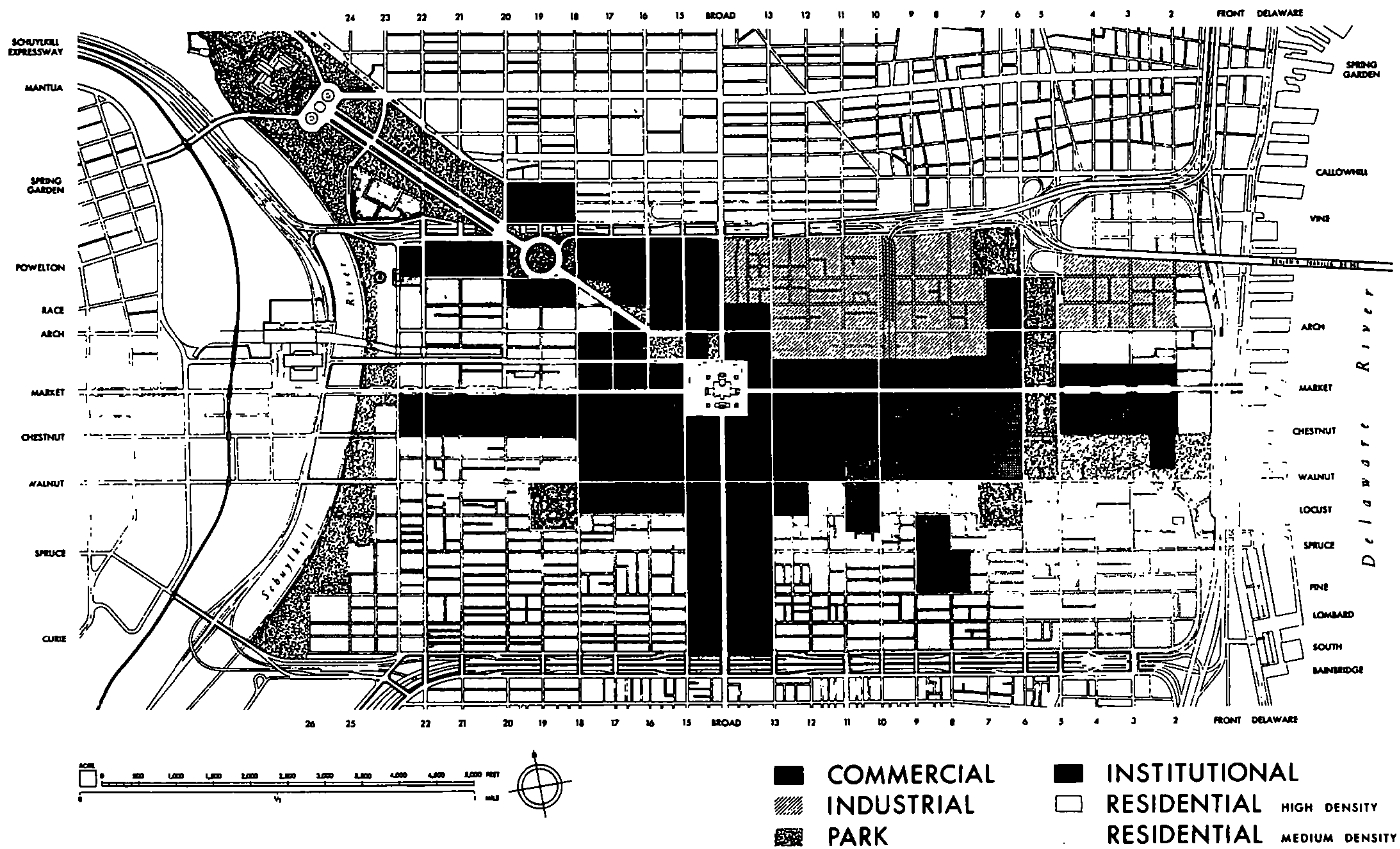


Figure 3. Proposed land use Center City, Philadelphia.

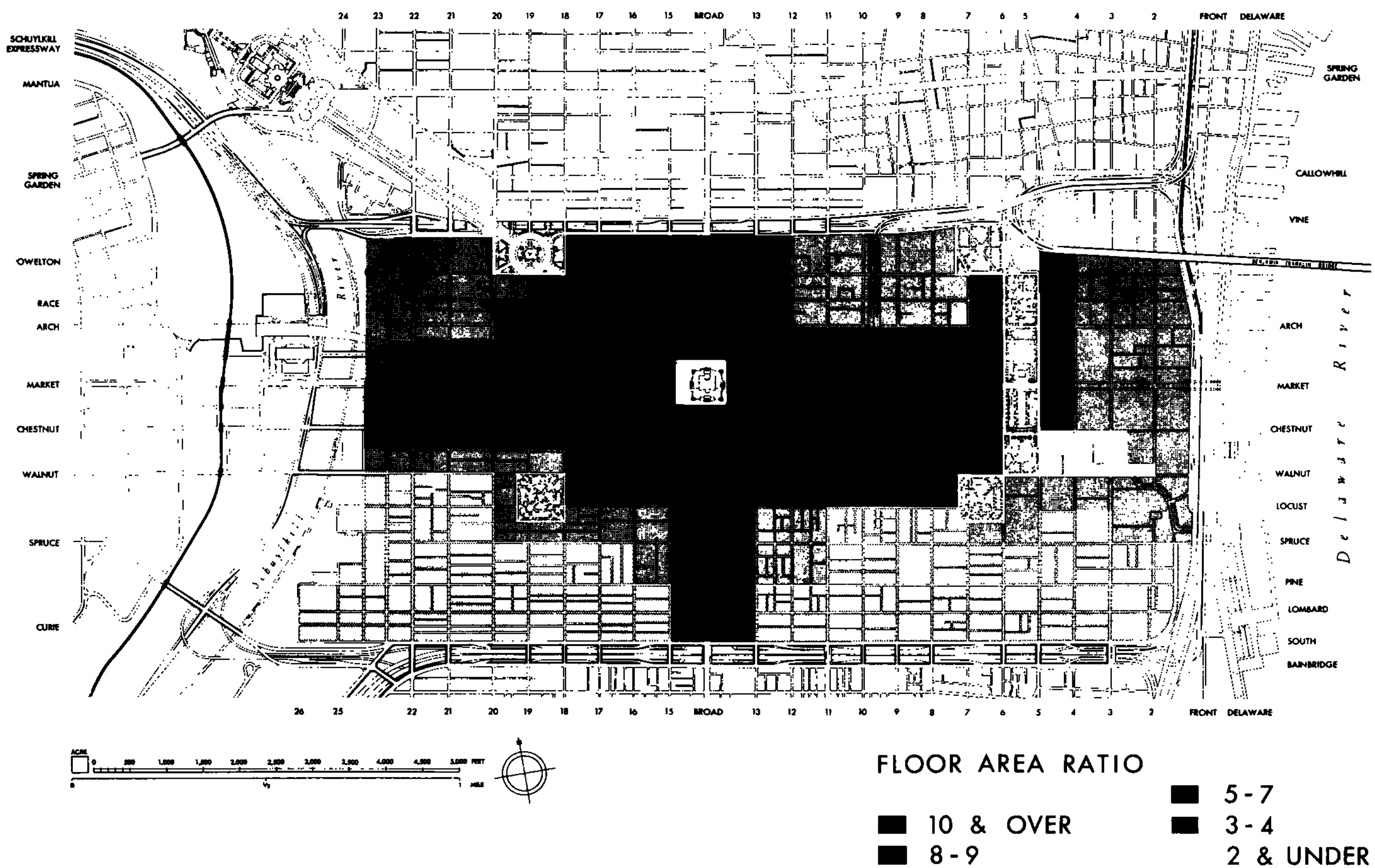


Figure 4. Proposed intensity, Center City, Philadelphia.

In simplified terms, the spatial composition proposed for Center City consists of a high intensity core of office concentration around City Hall and weighted toward the south and west, a slightly lower intensity office-retail mix to the east, maintenance of the department store concentration around Eighth and Market Streets, and a subcentral office area around Independence Mall. Retail activity will continue in a band along Chestnut Street through the office areas. Industrial uses will be confined largely to the northeast quadrant, and institutional uses primarily in the northwest quadrant and on South Broad Street. Residential uses will extend across the length of Center City on the south, and along the Schuylkill River on the west.

The intensity pattern proposed is directly related to the existing and proposed transportation system. As a bench mark to help visualize the floor area ratio proposed (ratio of floor area to ground area of the lot) Penn Center has a floor area ratio of 10.

The key to the transportation requirements lie in the scale. The highest intensity area, largely office, is proposed to occupy 215 acres. The radius of this area from its centroid is about 1, 700 ft. The immediately adjacent office-retail area to the east occupies another 40 acres. Including the next adjacent peripheral office and retail areas brings the heart of Center City to 320 acres. In short, the efficient functioning of downtown, and indeed its development potential, is based on its being a small area.

The kind of office activities seeking locations in the heart depend on easy pedestrian travel to satisfy the daily needs for face to face contact.

This central area requires high capacity delivery to and from residential areas during peak hours and flexible high speed access from a variety of origins, particularly non-residential areas, during off-peak hours. Thus, the efficient functioning of this high intensity area requires both high capacity rapid transit access and high capacity highway access. The latter then generates demand for parking facilities immediately adjacent to, or within, this core area.

Just as the land-use plan generates transportation requirements, it limits the range of their solution. The proposal to retain, enhance, and expand residential development across the southern part of Center City means that surface vehicular traffic through this area should be limited. The problem is made easier by the fact that South Philadelphia is a peninsula, but the issue is by no means eliminated thereby. Egress from the Crosstown Expressway must be dealt with in a manner that avoids violation of these residential neighborhoods.

The case on the north is the converse. Non-residential activities not only can withstand the impact of the street traffic generated from the more populous part of the region serviced through the northern entrances but require good street service for access to the industrial and institutional uses in this area.

The proposed land-use pattern requires high capacity access at its center and in the northern quadrants, limited vehicular traffic in its southern quadrants.

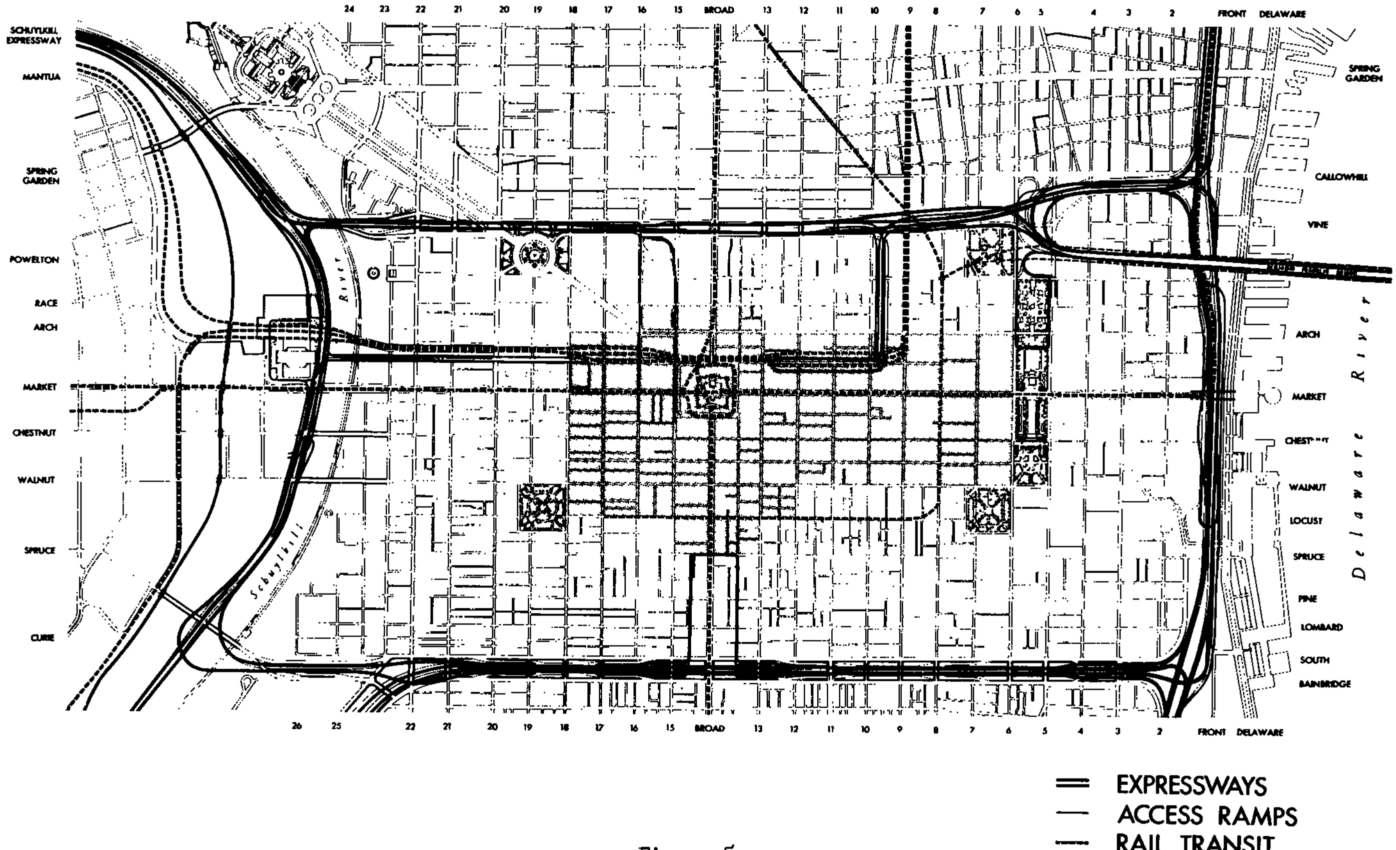
THE CENTER CITY TRANSPORTATION PLAN

It is clear from the foregoing that the transportation system serving Center City is composed of several separate systems. It is also clear that the separate systems have different kinds of problems and deficiencies to overcome. Finally it should be evident that parts (not all) of these systems are interrelated.

Figure 5 shows the "moving parts" of the total system, the expressways shown in solid lines and the rail in dashed lines. The core area is shown in gray.

The expressway loop has two functions: to serve Center City, and to bypass traffic destined elsewhere. (This latter function is also to be carried out by the midtown loop shown in Figure 5.) The effectiveness of the loop to serve Center City itself obviously depends on the ease with which the intervening distance between loop and core can be traversed. This cannot be accomplished by dumping traffic directly onto city streets already under a heavy working load where they cross the loop into the center. And it depends on the provision of parking space in, adjacent to, or easily accessible to the core.

The subway system requires station improvements in Center City. Station platforms on the Market-Frankford line east of Broad Street have to be lengthened to increase


24 23 22 21 20 19 18 17 16 15 BROAD 13 12 11 10 9 8 7 6 5 4 3 2 FRONT DELAWARE
SCHUYLKILL EXPRESSWAY
MANTUA
SPRING GARDEN
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RACE
ARCH
MARKET
CHESTNUT
WALNUT
SPRUCE
CURIE
Schuylkill River
SPRING GARDEN
CALLOWHILL
VINE
ARCH
MARKET
WALNUT
LOCUST
SPRUCE
PINE
LOMBARD
SOUTH
BAINBRIDGE
Delaware River
26 25 22 21 20 19 18 17 16 15 BROAD 13 12 11 10 9 8 7 6 5 4 3 2 FRONT DELAWARE
EXPRESSWAYS
ACCESS RAMPS
RAIL TRANSIT

Figure 5.

capacity. Platform lengthening along the entire line would increase capacity one-third because it would permit 8-car trains to operate instead of the present 6.

The Broad Street subway has adequate capacity, recently increased by the initiation of express service on trackage—the space for which was provided but not build when the line was first constructed.

To handle South Jersey service the Locust Street Bridge line will require improvement of the major station at 8th and Market Streets.

The above improvements increase capacity. But capacity is only the numerical aspect of the problem. The comfort and attractiveness of the entire system has to be increased. The City has recently purchased new cars for the Market-Frankford line, which will replace a fleet of cars built between 1906 and 1922. The quality level of such rapid transit ride is hardly equivalent to that of automobile travel. Finally, Center City stations must provide easy and pleasant transfer to foot travel at the destination point.

The most important change in the commuter-rail system is the proposal to connect the two lines underground in Center City (Fig. 6). This is shown by the heavy dashed line just north of City Hall. The present Reading Terminal at 12th and Market Streets would be removed and the line carried underground to 9th Street and then north. This device would permit the entire commuter service area of the two railroads two destination points in Center City, each in the core, although in the northern part. Thus, the entire suburban area served by the railroads can more conveniently be connected with Center City. Elimination of terminal facilities and replacement at the eastern point by a new station would increase capacity of the system by 25 percent. Finally, operating cost savings would amount to an estimated 1.7 million dollars annually.

Figure 7 shows the addition of the "static parts" of the entire complex of systems. The black areas are parking facilities, the white areas are subways and commuter rail stations.

The expressway system is connected directly to Center City parking facilities via separate ramps or widened streets. The eight major facilities shown provide 17,000 spaces. Four of these parking facilities provide 14,000 spaces accessible without entering the City street system. The most direct is the 3,000 car aboveground garage on East Market Street. This is in the core area. The next most is at South Broad Street where a 6,000 car underground facility abuts the southern boundary of the core. The remaining two are separated from the core. This distance would be covered by an east-west trolley or bus system operating between the garages.

The remaining facilities would be accessible via widened arterial streets. With one exception, all of these are in the core area.

The expressway system need not be limited to function as a channel for automobiles only. It is expected that buses will use it in increasing numbers—both inter-city and intra-city buses. The problem is how to handle the buses in the core area. It is proposed that a major bus terminal be built on East Market Street served by the same direct ramps as the parking garage. To reduce the limitations of a terminal as compared with operation along streets, the terminal would have two stops within it, one at 9th Street, and one at 13th Street.

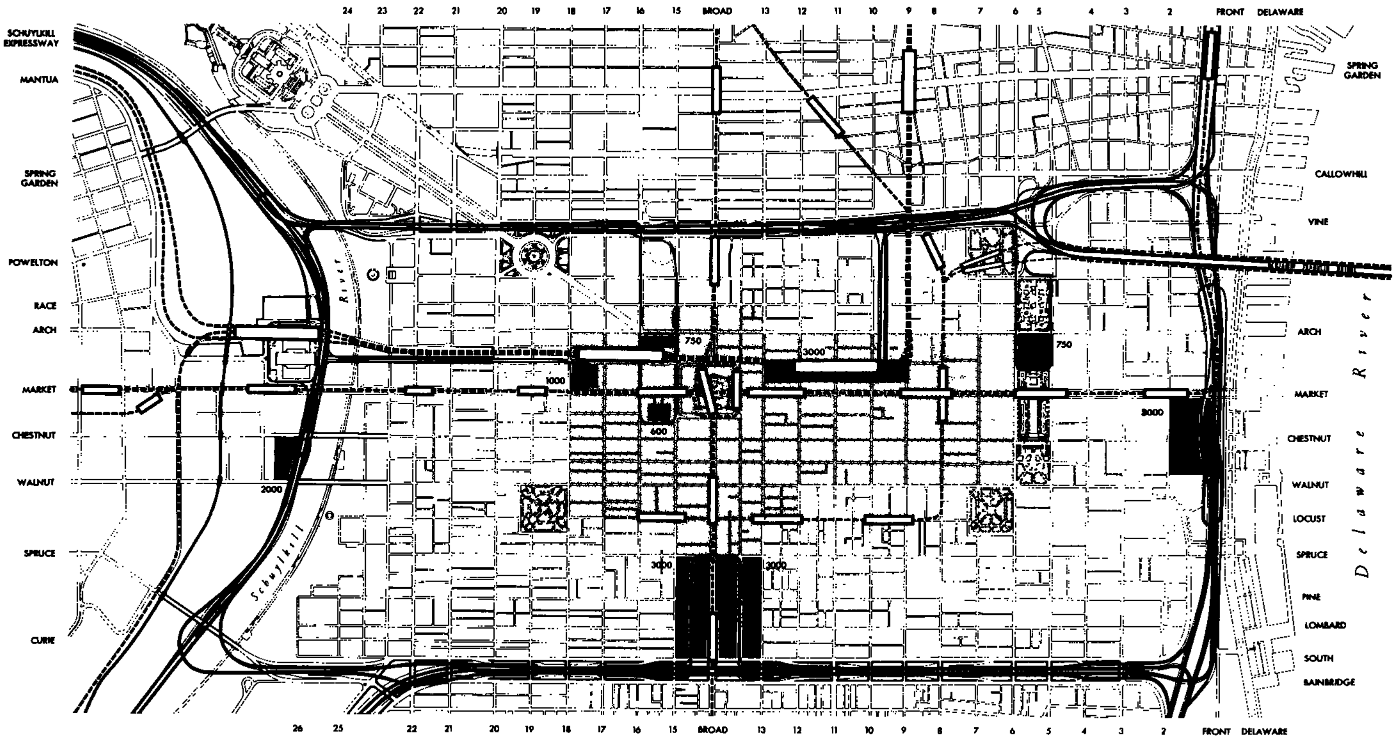
The distribution of rail stations (Fig. 6) is self explanatory.

Figure 7 shows the final step in the delivery system and the basic form of the internal circulation system.

The intervening distance between parking of car or debarking from transit vehicle should be short enough to be covered by foot. Further, as stated earlier, the functioning of the core area depends in large part on pedestrian movement. This pedestrian movement, where possible, and particularly where it is heavy, should be separated from vehicular traffic.

Proposals in the plan for facilities limited to pedestrian movement are shown as underground concourse or elevated walkways. Figure 7 shows how these tie together the delivery system and the core.

In one of the lines shown, the distance is perhaps excessive, that from the South Broad Street parking terminal to the core. The concourse is big enough to permit the installation of a moving walkway or other similar device to close the distance.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Schuylkill River
Delaware River
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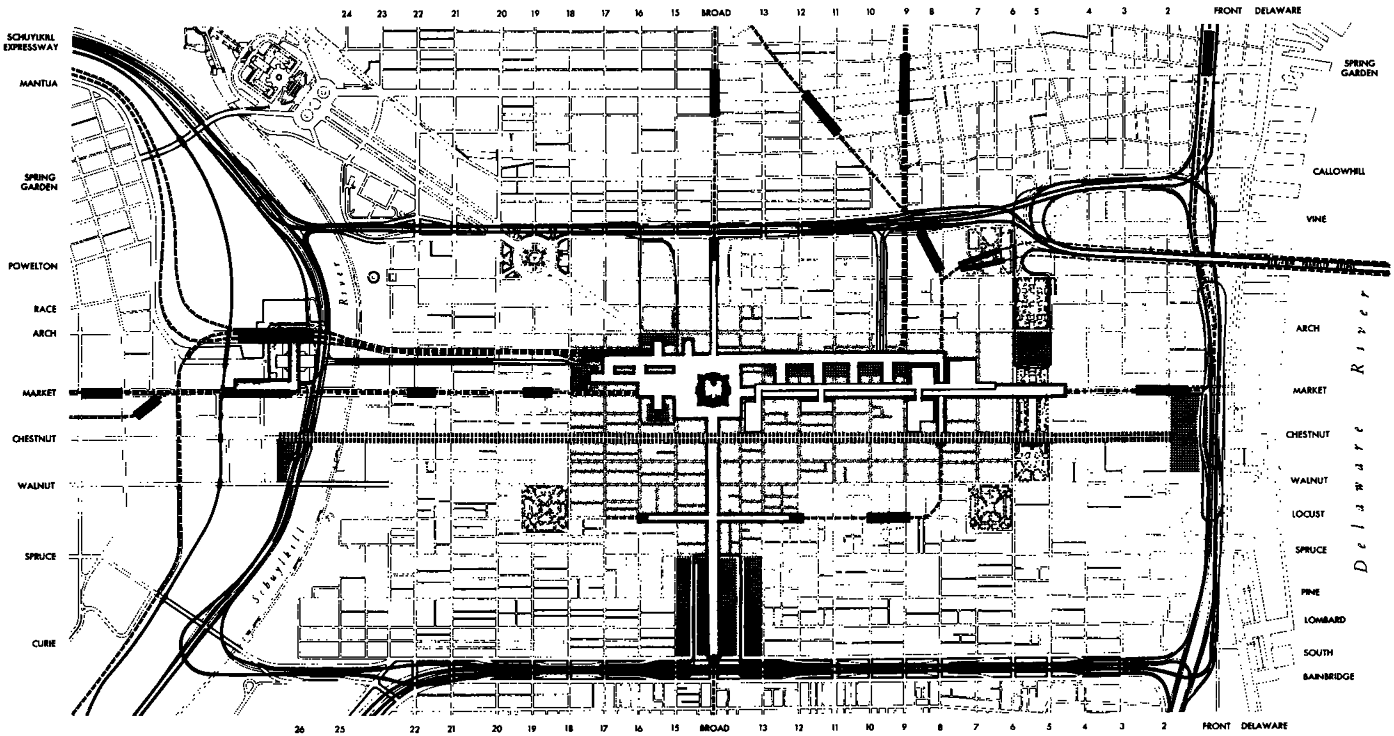
26 25 22 21 20 19 18 17 16 15 BROAD 13 12 11 10 9 8 7 6 5 4 3 2 FRONT DELAWARE
EXPRESSWAYS
ACCESS RAMPS
RAIL TRANSIT
STATIONS
PARKING

Figure 6.



STATIONS
UNDERGROUND CONCOURSES
PEDESTRIAN MALL & TROLLEY
ELEVATED WALKWAY

Figure 7.

In two other instances the distance is too great to be closed by walking. This is distance on Chestnut Street between the parking terminals adjacent to the expressways (Delaware and Schuylkill) and the core. It is proposed to connect these two garages by transit vehicles operating continuously between them. This is shown by the double dashed line in Figure 7. This system increases the carrying capacity along Chestnut Street itself and permits it to be closed to automobiles. The cartway can be narrowed and many of the advantages of the pedestrian mall realized. Finally this device permits easy movement east and west along the City's major retail street and between the core and the historic areas to the east.

SUMMARY

The proposed transportation system provides the capacity for delivery of an increased work force in Center City and for more rapid and convenient access for off-peak business and shopping trips.

It is related to the intensity pattern of Center City as proposed.

The "transportation machine" created on East Market Street composed of the underground railroad connection, the improved subway station, the major bus terminal and parking garage connected directly with the expressway system radically increases accessibility to a presently underdeveloped area. This has led to the proposal for a major development project at this location to realize the potentials of Center City.

The several proposals for Center City, taken together, produce a complex picture. But it is not a machine in which all the parts depend on all the other parts. Many of these proposals can be undertaken separately and separately improve transportation in and to the Center.

It may be argued that such a complex of systems implies competition between them. This is so. There are a variety of transportation needs to be met: work trip of clerical worker residing in the City, work trip of executive living in the suburbs, business trip of professional working in an industrial area, shopping trip of resident from City or suburb. Meeting these needs requires a variety of modes.

The issues of downtown transportation requirements have been clouded by attempts to oversimplify them, and more particularly by expectations or assumptions that each kind of system will do more than its capabilities and limitations permit. The problem of delivering persons and goods to a complex downtown area in a large and complex metropolitan region is a complicated one. To expect the solution to be simple is to expect too much. The plan summarized herein is a complex solution to a complicated problem.

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Boston Parking Problems

HERMAN CARP, General Manager, Massachusetts Parking Authority, Boston

●BOSTON, like many of the older large cities, particularly in the downtown area, is a maze of winding and tortuous streets, many of which are only 35 ft wide. Washington Street, the main street of the retail area, narrows at one point—near State Street—to a roadway width of less than 20 ft. Although Washington Street is one-way going north, you can visualize the bottleneck created by an illegal parker at this point, especially when a fairly large trailer truck parks directly opposite to load or unload.

Boston, with a nighttime population of slightly less than 800,000, has a daytime population of over 2½ millions. Not only is it the Capitol city of the Commonwealth of Massachusetts, but it is also the commercial and financial center of the whole of New England. It has rightly earned the name of the "Hub". The core of the Hub is scarcely 1 sq mi, and is peculiarly bounded by the Mystic River on the north, the Charles River on the west, a twilight dwelling zone on the south, and the Atlantic Ocean on the east. Into this vastly congested downtown district there poured daily, over meandering, expanded lanes, a minimum of 135,000 pleasure vehicles and 35,000 commercial vehicles of all sizes and types. However, since the advent of the Southeast Expressway, the Fitzgerald Expressway, the Mystic River Bridge, the Sumner Tunnel, and Storrow Drive—all limited-access, beautifully paved, divided, 6- and 8-lane highways—driving has become so popular that more than 4 million automobiles find their way into the heart of the retail area to add to the continuous confusion caused by pedestrians who have never been trained to use sidewalks. This daily hubbub continued on a pace until, in desperation, and as a defense measure to slow the march of decentralization, the State Legislature enacted Chapter 474 of the Acts of 1946. This Bill empowered the Real Property Department of the City of Boston to study the parking problem, select sites for off-street parking installations, take land by eminent domain (condemnation proceedings), pay damages, retain architects and engineers to draw plans and specifications, advertise for general contractors to construct and award contracts for such construction, advertise for lessees to operate these parking structures and execute leases, and finance the program through a 20-yr bond issue, pledging the credit of the City. The first authorization granted by the Legislature was for $5,000,000, revenue to be derived by the Board through leasehold rentals to go directly into the City's General Funds, inasmuch as the City retires the bonds when due.

The Statute is loaded with safeguards for the City. Approvals of areas, requiring off-street parking, after determination of the Real Property Board, are required of both the City Planning Board and the Boston Traffic Commission. Specific sites selected must be advertised in at least two daily newspapers in the city for two consecutive weeks before public hearings are held. Each "Order of Taking" requires the written approval of the Mayor before condemnation proceedings are begun. All requests for proposals must comply with the General Laws pertaining to the awarding of contracts, with contracts to be awarded only to the lowest responsible bidder, and leases only to be awarded to the highest responsible bidder, after publicly advertising for lessees who are by law divided into two distinct categories: (a) lease for not more than three years; and (b) lease for over three years, but not more than forty years.

In the former situation, should the city construct an off-street parking facility at its own expense, no lease can be awarded for more than three years.

In the latter case, where a lease for more than three, but not more than 40 years is entered into, the lessee is required to construct a facility—at no expense to the City—in accordance with plans and specifications prepared by the Real Property Board. On the completion of the structure, title passes to the municipality, and the lessee has thereafter the balance of the leasehold provided for in the document.

Annual rent provided for in the instrument of leasing, which is the bid of the highest responsible bidder, can in no case be less than 4 percent of the cost of acquisition of the land to the City plus all improvements which the City made thereon. Thus, the City is repaid for its taking costs within a maximum of 25 years. Rent, of course, begins with the commencement of the lease. The question could be raised at this point: Why not postpone the operation of the lease until the lessee completes the construction of the facility? The answer is one of financing, because the principal security for any construction or permanent load is the assignment of the lease. Then, this question may be asked: Why not waive payment of rent until the parking facility is completed and earning, in order to make the entire proposition more attractive to prospective bidders? The answer is statutory. Annual rent must be charged at the rate of the highest eligible bid, but in no case, less than 4 percent of the cost of acquisition, etc. As a matter of fact, the law makes the lease even less attractive, inasmuch as it provides that the successful bidder must reimburse the Board for the full expense of architectural and engineering services, which in the case of a 1½ million dollar building, would amount to more than $80, 000, in accordance with the schedule of suggested fees provided in the AIA bluebook. Even though the provisions of the statute are stringent, and hence not too attractive to prospective investors inasmuch as maximum rates to be charged the general public are established in the proposed leases, which leases may not be modified or altered, once entered into, the Board has, nevertheless, to date, awarded three 40-yr leaseholds.

Since the commencement of this parking program, the State Legislature has twice increased the City's authorization to borrow beyond its debt limit for off-street parking purposes so that the total authorized is now $20, 000, 000. Of this amount, only 13 plus millions have been borrowed and allocated for projects.

One of the great difficulties of getting the show on the road was the selection of sites. Although it has been previously mentioned that the downtown area comprised 1 sq mi, it must be explained that the retail district, of paramount importance to the economy of the City, is actually squeezed into ½ sq mi, because the Boston Common, North Station area, waterfront, and residential district of Beacon Hill were included in the original boundary. If as much property as was needed for off-street parking were condemned, it would necessitate the demolition of so many taxable buildings, the tax base would be somewhat diminished, and the original generators of motor vehicles into the area would be so dissipated, that there would be no pressing need for the parking facilities. What to do about it? Keep well in mind that two-thirds of the City's taxable income emanates from this area—truly a dilemma.

As a starting point, downtown Boston was divided into the following component districts: wholesale shoe and leather district; wholesale woolen district; retail stores district; insurance district; financial district; retail and wholesale food and produce district; and State House district. Beacon Hill, a maze of Colonial-patterned streets just beyond the State House district, is a thickly congested residential area, and therefore, not of great initial concern.

Through engineers working with the City Planning Board, it was determined that the off-street parking goal would be the removal of approximately 12, 000 cars from the crowded streets to provide for the smoother flow of traffic in and through Boston. The surveyors also indicated that the average person would not walk a distance greater than 800 ft from his car to his first visiting point. An effort was made to measure the number of cars that all present and future generators of vehicles would bring into specific areas. From this it was concluded that if off-street parking facilities could be established in each of the aforementioned districts, but within 800 ft of the next closest facility, a substantial dent in the parking problem could be made.

The Real Property Board, vested by law with ample funds and sufficient authority, determined where off-street parking was necessary, with the assent of the Mayor. The areas designated were submitted to the City Planning Board and the Traffic Commission for concurrence. They acted with alacrity. Public hearings were held and fortunately, the Chamber of Commerce, Retail Trade Board, and Boston Real Estate Board took positive stands for fast action, and the daily newspapers editorialized in favor of the proposed takings. Token opposition, understandable in view of the fact that the cons were being divested of their places of business, was summarily dealt with. Architects and engineers went to work and shortly thereafter, plans and specifications evolved. Advertisements for general contractors and prospective 40-yr lessees were placed in the press on a national scale, and the program was on its way.

Then came arguments before the National Production Authority and its Appeals Board in Washington for permission to purchase steel, and before the Federal Reserve Board for favorable interpretation of its Regulation X, so that a 40-yr lessee could borrow over 50 percent of the cost of construction without being guilty of violation. All agencies cooperated to save Boston from motor vehicle strangulation, and 11 off-street parking facilities were established in Boston's vital area between September 1950 and December 1959.

During that period of time, motor vehicles, in ever-increasing numbers, found their way to the various facilities. In districts where the land costs were not prohibitive, large areas were taken for ramp structures and metered lots. In the highest assessed retail district, small areas of less than 20,000 ft were taken, and high-rise, 10-14 story mechanical facilities were created. In that manner, land areas which would normally accommodate 60 cars, by the use of vertical-horizontal elevator equipment, were made to accommodate 700 cars, with a consequent reduction in per-car land cost. In this period, over 8½ million motor vehicles were parked off-street, accomplished through the creation of almost 7,000 new off-street spaces in the critical ½-sq mi area. These same facilities now take from the streets annually almost 3,000,000 cars.

Not only is the program meeting with great public approval, but it has proved a self-liquidating venture. Although the investment of the City has been only $13,000,000 at the end of the year 1959, the City finds itself the owner of parking facilities valued at more than $25,000,000 and the Real Property Board has been able to turn over $6,000,000 in collected rents into the General Funds of Boston.

It may be of interest to note at this point that, as a matter of law, the municipality cannot operate these facilities. This rule stems from the original concept that cities should not compete with private enterprise. Inasmuch as private investors could not acquire the essential sites, the City, through its power of "eminent domain", was able to take and then lease to them these properties for off-street parking purposes only. Thus, exigency, through the use of the municipal authority as its conduit, enabled private capital to enter a field from which, under normal conditions, it was barred. Spurred on by the City's progress in this field, three large garages were constructed privately in crucial areas, adding an additional 1,000 car spaces to the government's total. Each of these became an immediate financial success.

The Commonwealth of Massachusetts, owner of the Fitzgerald Expressway—an elevated highway which cuts through the heart of the downtown area—recently added to the ever growing number of off-street spaces by leasing out to private operators large paved areas under the expressway for pay-parking. The goal of 12,000 was nearing fruition.

But an important segment of the City was, as yet, without sufficient accommodations (namely, the State House area) which could simultaneously service the "carriage trade" district of Tremont and Boylston Streets and also Beacon Hill.

Since 1946 many efforts were made to construct a large parking facility under the Boston Common, an internationally known historical landmark. Enabling legislation was passed on several occasions, but each act fell short of its goal. The essential ingredient was lacking. Financing seemed impossible and the possibility of such a facility became more and more remote. Petitioners against the project appealed each element of each act to the Supreme Judicial Court. The results were most discouraging to the City planners.

Finally, in October of 1958, the Legislature enacted Chapter 606 of the Acts of 1958, which was "an act providing for the construction, maintenance, repair, operation or leasing of a garage for the parking of motor vehicles under the Boston Common in the City of Boston and creating the Massachusetts Parking Authority, defining its powers and duties, and providing for the financing of such garage." This piece of legislation was drawn in the light of previous failures and judicial interpretations. The garage was to be created "for the health, safety and general welfare of the public, whether residing in said city or traveling to, through or from said city in the course of lawful pursuits."

The Massachusetts Parking Authority was empowered to take portions of the Common from the City of Boston by "eminent domain". The Authority was loaned $200,000 by the Commonwealth—little enough to get started on its project—but could not in any way pledge the State's credit. In accordance with statutory provisions, the Governor appointed two members and the Mayor of Boston, one, who were to serve without compensation.

True to form, the petitioners attempted to restrain the project after the Authority made its taking. But the Supreme Judicial Court, in a history-making decision, stated: "The duty is ours to discover the legislative intent. Giving due weight to the history of this legislation and to the strong and repeated declarations as to public necessity, we are of the opinion that the introduction of Section 5 (k) (power of eminent domain) expressed in such very broad terms, must be taken as a manifestation that the Legislature intended that the city no longer should have a veto power over the commencement of this long delayed project.... In response to the prayers in the answer, declaration is to be made that the two orders of taking of interests in Boston Common are valid, and that the respondent Authority is the owner of the right and easement, and of the fee...".

The Parking Authority then, in rapid order, retained the services of an outstanding firm of engineers to write an economic feasibility report; an underwriter to perfect a bond issue of 9½ million dollars, payable in 40 years at 5¼ percent interest; and then gave a contracting company a turnkey contract to design and build a garage to contain 1,500 car spaces.

Having received a good feasibility report, the underwriters turned over to the Authority the necessary finances and construction started in March 1960, with a completion date set for September 1961. The Commonwealth's loan has been repaid and the Authority is now on its own. When the bonds have been fully retired, by law, the garage shall be turned over to the Real Property Board of the City of Boston.

With the completion of this garage under the Common, the goal of 12,000 parking spaces will have been reached. Because each parking facility serves as a new generator, the saturation point will never be reached. Therefore, the decision to terminate the program on the completion of a definite number of spaces must be made.

Traffic-Transit-Parking in Downtown Rochester: Now to 1975

JOHN F. CURTIN, Simpson and Curtin, Transportation Engineers, Philadelphia, Pa.

●DOWNTOWN REVIVAL is on the move in virtually every American city. The growth of suburban shopping centers and industrial parks has sparked planners, business and civic officials to recognize the essential function of the CBD as the commercial, educational and social hub of the metropolitan area. The major improvements in every downtown—new civic centers, multi-story parking structures, office buildings, urban redevelopment projects and expressways—are testimony of the renewed interest in downtown survival.

Nowhere has the need for downtown planning been more compelling than in transportation. Nowhere is there more congestion; nowhere have daily activities been so retarded by it; and, nowhere has the problem been so neglected.

Millions, then billions, have been spent on highway improvement between cities. More billions are going into multi-lane routes from suburbs and satellite communities to downtown cores. But when downtown is reached, the highway spending stops. Why? Not because the problem diminishes. Actually, it increases—geometrically. The reason is that downtown is an area where run-of-the-mill highway building is not sufficient. The way out of the downtown traffic dilemma cannot be spent. To attempt it means only to pave most of downtown; then there would be no downtown.

Yet, it is axiomatic that (a) the traffic circulation problem in downtown must be solved, (b) adequate off-street parking must be provided, and (c) a better balance of mass transit and automobile use must be achieved. The last factor is an oft-neglected but important element in this equation. There is a well-defined correlation between transit use and size of city; it ranges from 50 percent upwards in cities of 1,000,000 or more population to 20 percent or less in cities below 100,000 (Fig. 1).

The success or failure of downtown to keep pace with metropolitan growth hinges primarily on its plan for solving the traffic-transit-parking complex. This is the story of what one medium-size city—Rochester, New York—has done in this direction over the last 15 years and its plans for the next 15—now to 1975.

TRAVEL HABITS CHANGED SINCE WORLD WAR II

Rochester has witnessed a transformation of its travel habits since World War II. Up to 15 years ago, this was a transit-oriented city. Downtown Rochester was a tight cluster of commercial and industrial buildings serviced almost entirely by transit—first, horsecars and, later, electric streetcars.

The street system was made up of radial streets—converging on the downtown hub like spokes of a wheel—too narrow, crooked and discontinuous for present-day traffic, although quite adequate when built back in the 19th century.

Widespread use of the automobile over the last 15 years has greatly changed this picture. No longer dependent on transit, people have made their homes in outlying areas, often beyond the reach of transit lines. New highways have been constructed to these suburban communities and beyond them to towns and villages in adjacent counties. As the population and trading area has grown upward and outward, the load on already crowded downtown streets has become heavier and heavier.

City and state authorities have done an outstanding job in keeping pace with the meteoric rise of automobile travel. New radial expressways, an Inner Loop and Outer Loop, trans-state toll highway and several multi-story parking structures are among the more prominent facilities constructed for automobile use. In downtown Rochester alone, the expenditure on capital improvements for automobile use and storage over

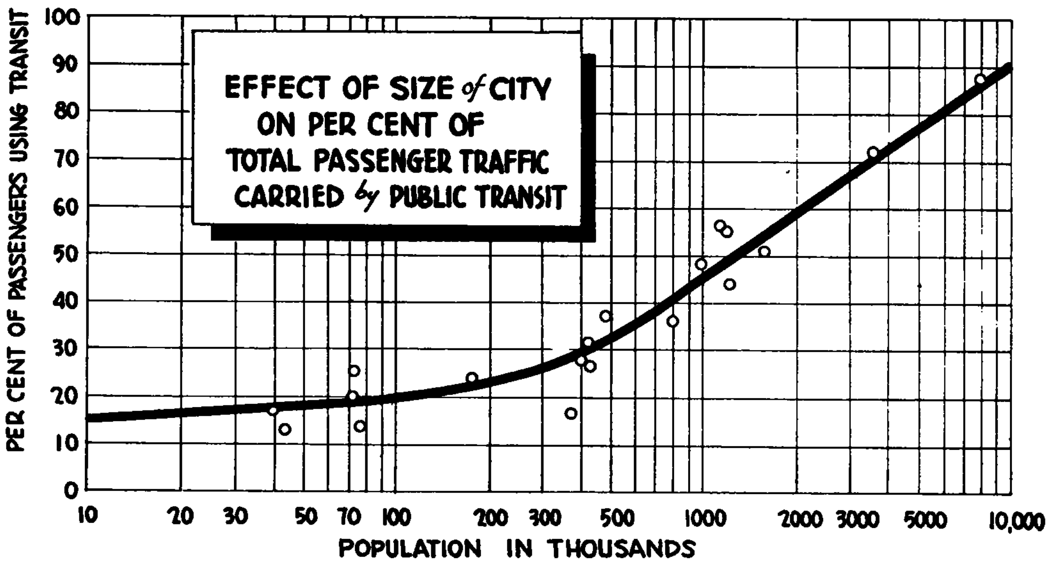


Figure 1.

the last 15 years has been greater than that for all other activities—public and private, commercial and residential.

The automobile has given people a wonderful new freedom to go places, for business as well as for pleasure. But it has also brought problems—problems of road hazard, parking, and greater operating expense that are fast becoming critical. In increasing numbers private cars are congesting Rochester streets, which were never laid out to carry so many vehicles.

MAJOR DOWNTOWN PROJECTS

This mounting wave of traffic congestion, despite the expenditures made thus far for its relief, has raised serious question concerning the whole problem of downtown circulation, both vehicular and pedestrian. Several major projects are being planned or are in construction, including the Midtown Plaza shopping center, City-County Civic Center, and Front Street Development (Fig. 2). Each of these represents a primary traffic generator, an attraction to people from all points in this trading area of nearly 1,000,000 population.

Rochester is particularly fortunate in having a compact and well-defined retail core. Seven of the city's eight major department and specialty stores are concentrated within a three-block area along Main Street and Clinton Avenue, in addition to a full complement of variety, specialty, clothing and supporting retail facilities. "This intense grouping of retail activity," the market analysis prepared by Larry Smith and Company points out, "makes the central business district the largest single retail drawing attraction in the entire standard metropolitan area, in spite of the intensive development of suburban shopping centers."

Because of the necessary compactness of downtown business cores, planners now recognize that they will never be able to develop sufficient street space or off-street parking facilities to take care of all of the people driving their cars to the center of downtown. If all workers and shoppers travel by car, 3 sq ft of automobile parking space is needed for every square foot of business floor space. This means that three-quarters of the total downtown area, exclusive of streets, would be devoted to parking facilities.

Traffic planning, although absolutely essential to a prosperous, healthy CBD, is but a means to an end. The ultimate objective is the efficient servicing of stores, offices, hotels, restaurants, theaters and other facilities which make up the basic

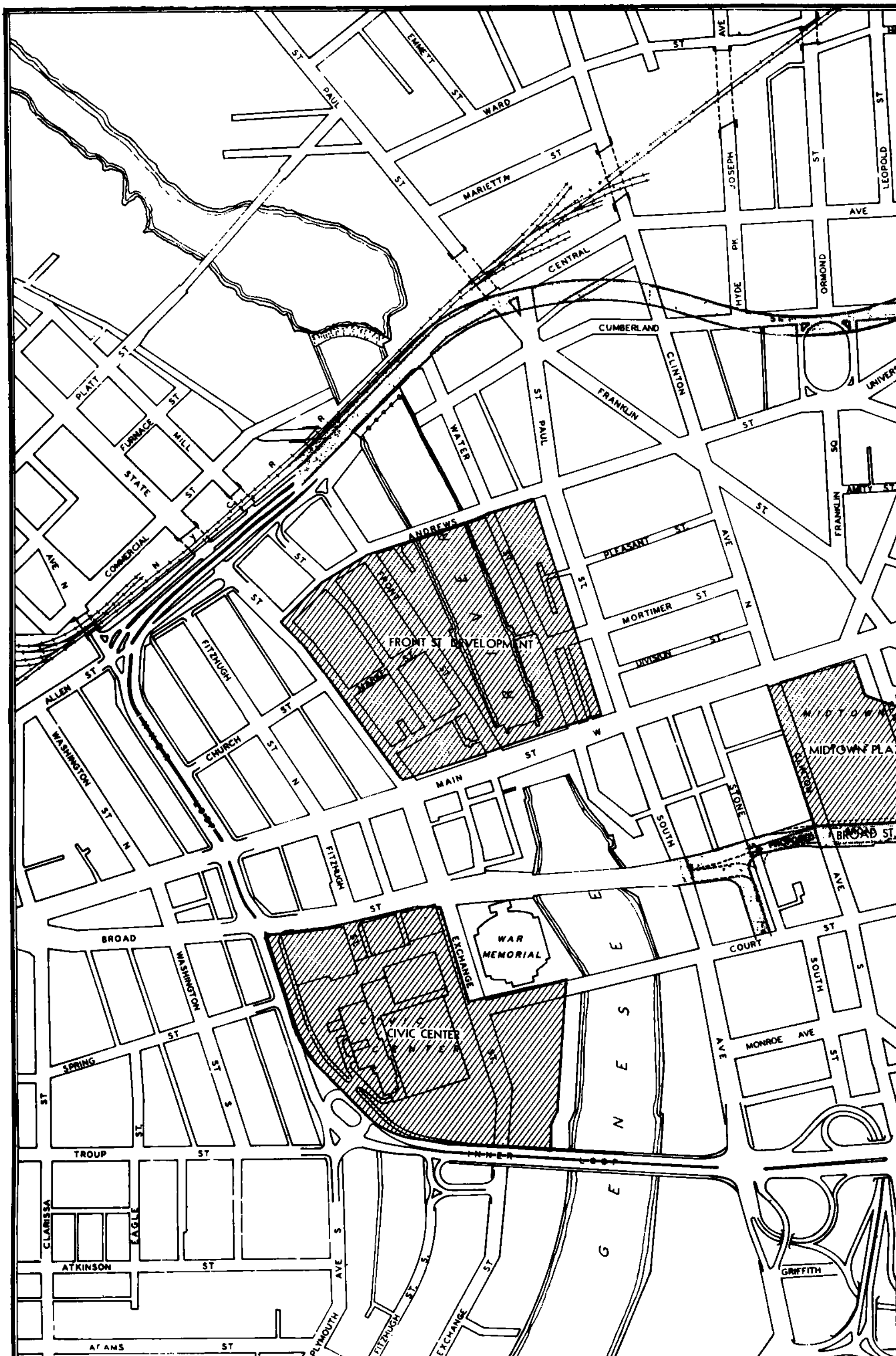
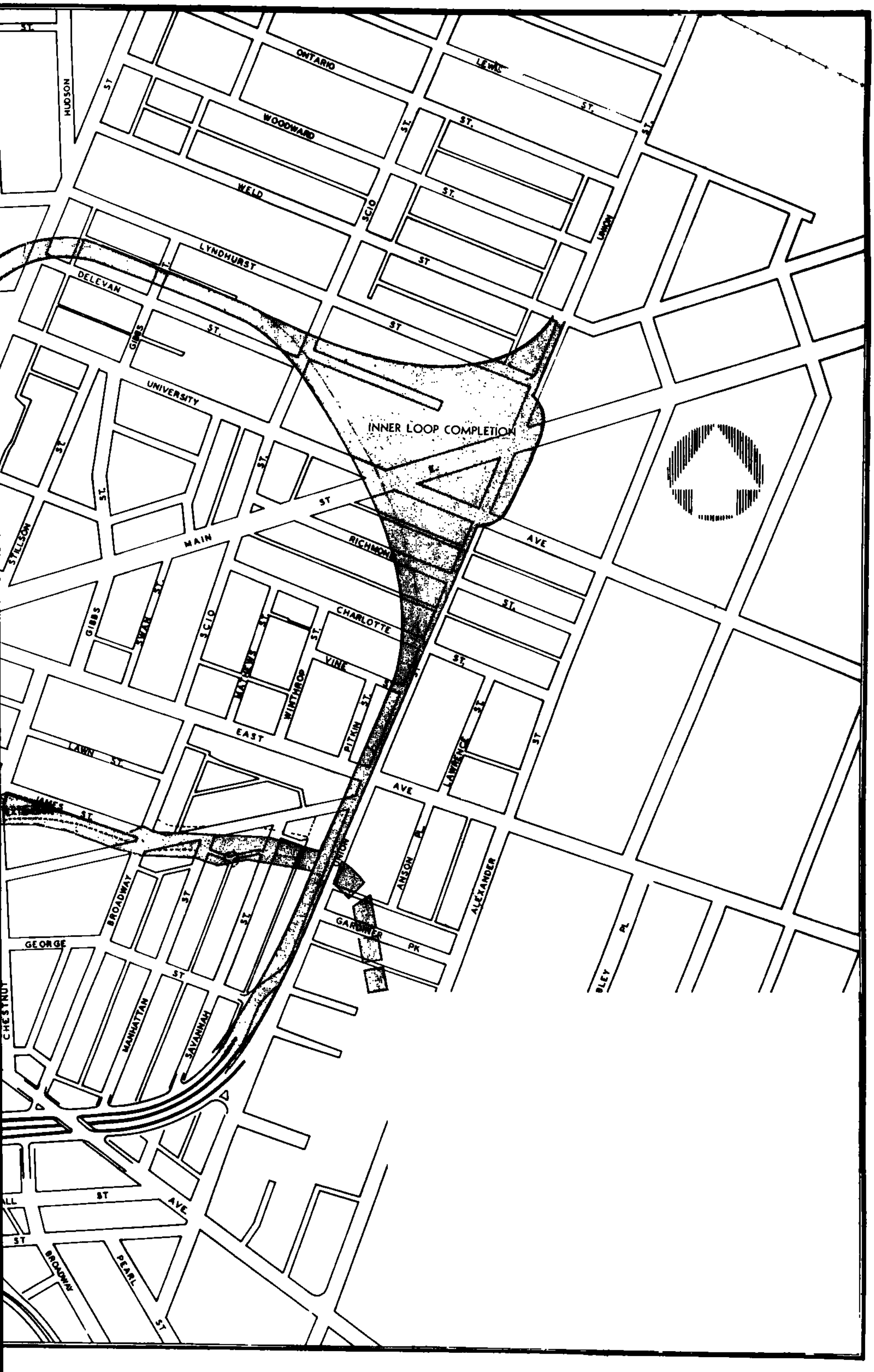


Figure 2. Plan



y improvements.

land-use pattern. People who come to the Rochester CBD by vehicle can play little part in the downtown scheme of things until they become pedestrians.

Slowly but steadily business and public officials have awakened to the fact that the movement of people is what is important. Heretofore, there has been an overemphasis on the movement of vehicles and not enough on the movement of people. But without people, the streets, stores, buildings and offices are quite unimportant. Customers, clients and employees want to move swiftly, safely, comfortably and economically. Unfortunately, Rochester, along with other American cities, has not been able to keep pace with the potentialities of the automobile on these four counts.

The transformation of the last 15 years has made Rochester an auto-oriented city in its CBD as well as in outlying sections. The Inner Loop, parking program, and other road improvements have made up an ambitious program; yet, traffic congestion is more paralyzing today than 15 years ago.

More than one-half of the land in downtown Rochester is now devoted to transportation (Fig. 3). The Inner Loop and the portion of the central city circumscribed by it includes a total of 408 acres. Fifty-two percent of this is now devoted exclusively to streets and alleys, parking lots, garages, gas stations and other auto service facilities. If space requirement was the sole criterion, transportation would be more important than all other affairs of downtown Rochester put together.

PURPOSE OF TRANSPORTATION STUDY

Recognizing the transformation which has taken place since World War II, and the direction in which this program is heading, business and civic leaders have begun to re-appraise the role of transportation in the survival of Rochester's CBD. That, primarily, is the reason for this study. This is an attempt to measure the traffic demand—vehicular and transit—on downtown streets at the present time, and to project this current situation ahead for the next 15 years with due consideration to the dynamics of change.

This analysis of the traffic and transit requirements for downtown Rochester is based on three primary sets of facts, as follows:

1. A detailed picture of the average weekday movement of people and vehicles into and within the Inner Loop;
2. The location and capacity of arterial routes, local feeder streets, on-street and off-street parking and transit facilities; and
3. Projection of population and land use for downtown Rochester to 1975.

In connection therewith, a series of traffic studies has been made—origin and destination and volume counts of automobiles, trucks and transit vehicles. In addition, field tests have included speed and delay studies and volume checks to develop the adequacy of existing parking and street facilities.

ORIGIN-DESTINATION STUDIES

The primary means of determining present travel patterns and habits was origin-destination (O-D) surveys of automobile and transit patrons. The information sought was: (a) the movement of autos and trucks passing through the CBD to permit study of possible diversion of such through traffic, (b) a measurement of cross-movements within the area by traffic terminating in the CBD, and (c) separate measurements of peak loads of traffic terminating within the CBD and of through movements.

The basic data were collected from motorists at 20 interview stations located on all primary and secondary arteries leading into the Rochester CBD. These stations were located just outside the existing and proposed Inner Loop. In analyzing the route and direction of traffic into downtown Rochester, these 20 gateways were grouped into six screenlines, each representing a major direction of traffic flow.

Roadside interviews were made at these 20 locations over a two-week period in November 1959. Altogether, a total of 27,200 interviews were made of drivers entering downtown Rochester. The information included origin of trip, destination, location

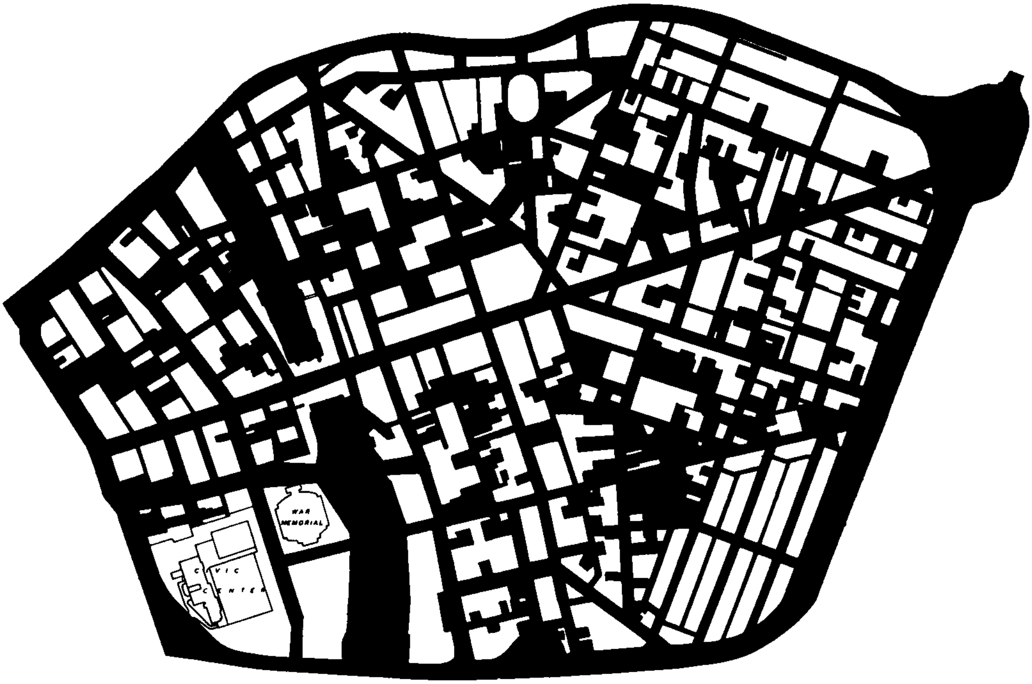


Figure 3. More than one-half of downtown Rochester is devoted to transportation.

and duration of downtown parking, purpose of trip, type of vehicle and commodity carried.

Concurrent with the O-D survey, a manual traffic count was made at each interview station. The total number of vehicles was recorded according to type, as well as number of passengers for both autos and buses. In addition, these totals were summarized by hours, providing the volumes to which the O-D data were expanded.

Field analyses of the riding pattern on transit vehicles were also determined by making an O-D survey on all buses of Rochester Transit Corporation, in which a total of 55,000 survey cards were issued to inbound, fare-paying passengers on the various routes.

This O-D information on motorist and transit patrons was coded on tabulating cards for machine processing. The coding system used outside the CBD was the Rochester area code developed by the Bureau of Highway Planning, Department of Public Works, State of New York, and used in the external O-D survey made by that state agency. A more refined breakdown within the CBD was needed for this particular study. Therefore, the highway planning zones within the Inner Loop were further subdivided into 14 zones (Fig. 4). These zones correspond closely with the CBD areas used for analytical purposes by the Rochester City Planning Commission.

Both street traffic and transit vehicle data were correlated and expanded by machine analysis to show for a typical weekday the volume and pattern of travel of automobiles, trucks and transit riders during morning and evening peak periods, as well as for the balance of the day.

TRAFFIC: NOW TO 1975

Rochester's downtown traffic problem can be summarized in a few simple figures—203,400 people travel in and out of Rochester daily and use 114,900 vehicles for this purpose. The distribution of vehicles by time of day inbound and outbound, and by vehicle types is summarized in Table 1.

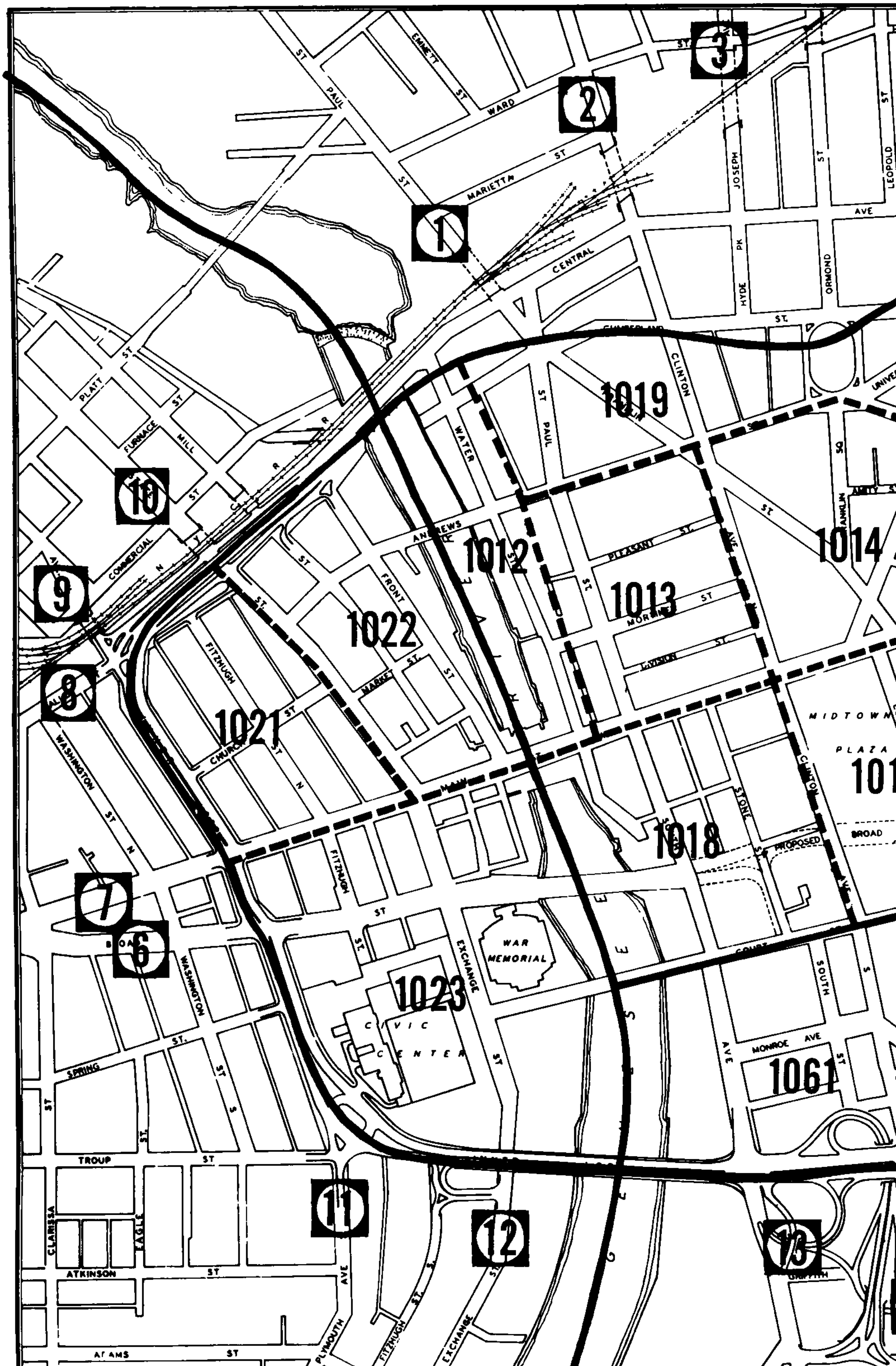
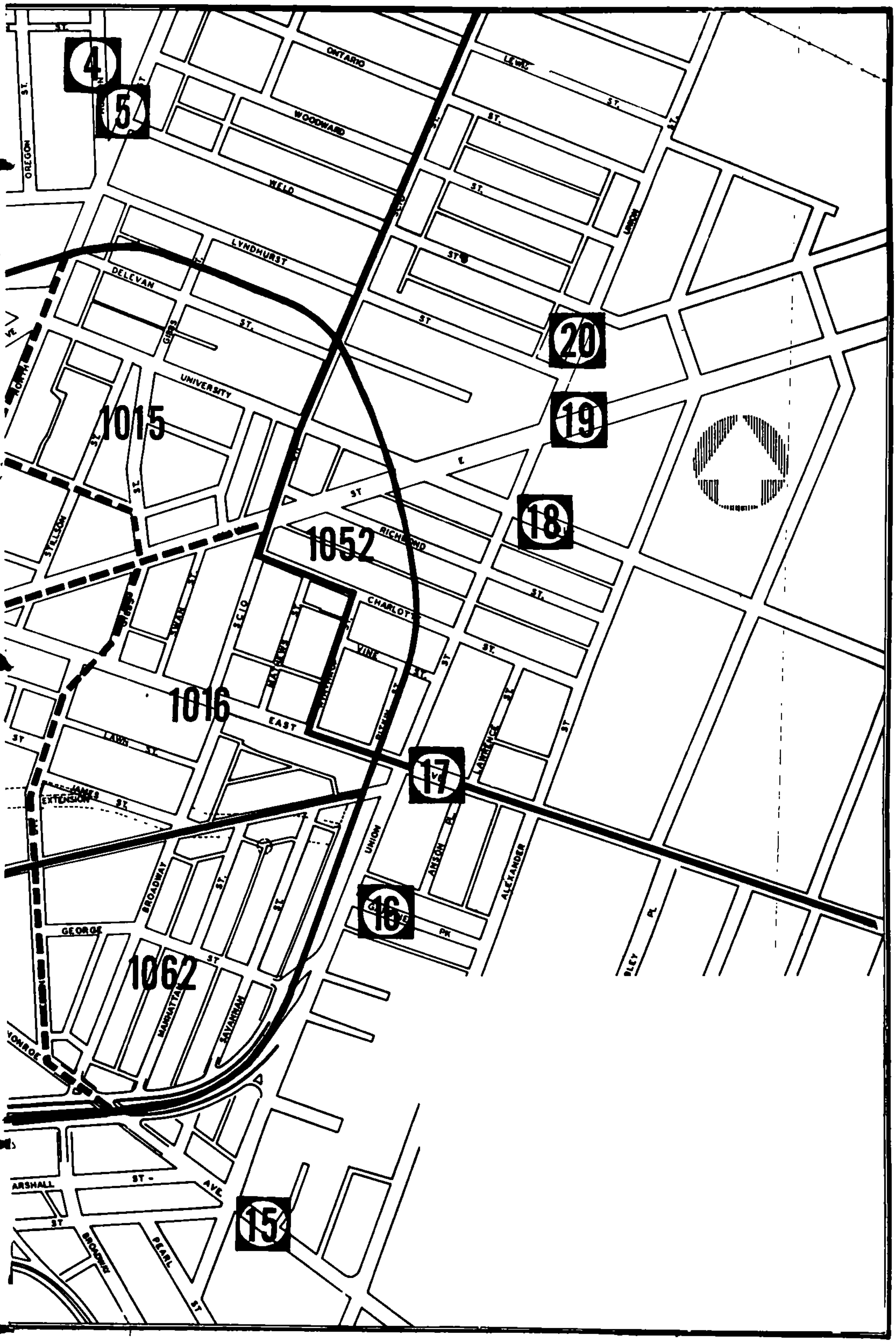


Figure 4. CBD analy



:ones and O-D survey stations.

TABLE 1

VEHICLES AND PERSONS IN AND OUT OF DOWNTOWN ROCHESTER DISTRIBUTED BY TIME OF DAY

Hour Period	Inbound					Outbound				
	Autos	Trucks	Buses	Total Vehicles	Total Persons	Autos	Trucks	Buses	Total Vehicles	Total Persons
7 00 - 7 30 a m.	4,824	411	111	5,346	12,501	3,388	300	107	3,795	7,583
7 30 - 8 00	6,805	590	114	7,509	13,927	4,690	485	112	5,287	9,688
8 00 - 8·30	5,964	735	119	6,818	13,139	3,693	609	105	4,407	7,926
8:30 - 9 00	5,189	734	105	6,028	10,986	3,108	684	94	3,886	5,476
9 00 - 9 30	3,974	716	80	4,770	7,635	2,888	747	73	3,708	4,486
9·30 - 10 00	3,471	706	74	4,251	6,533	2,577	679	69	3,325	4,230
10 00 - 10·30	3,447	739	68	4,254	6,486	2,895	762	67	3,724	4,690
10·30 - 11 00	3,187	703	68	3,958	6,143	2,812	740	66	3,618	5,003
11·00 - 11 30	3,274	675	68	4,017	6,065	3,124	713	68	3,905	5,454
11·30 - 12·00	3,296	662	69	4,027	6,117	3,432	650	69	4,151	5,974
12 00 - 12 30 p m.	3,569	474	68	4,111	6,484	3,455	508	67	4,030	5,858
12 30 - 1.00	3,396	614	67	4,077	6,338	3,305	541	67	3,913	5,945
1 00 - 1·30	3,683	637	68	4,388	6,996	3,526	632	66	4,224	6,271
1 30 - 2.00	3,482	642	70	4,194	6,555	3,709	663	66	4,438	6,676
2.00 - 2·30	3,521	621	71	4,213	6,308	3,798	681	72	4,551	7,063
2 30 - 3 00	3,265	586	75	3,926	7,212	4,018	678	73	4,769	8,030
3 00 - 3 30	3,662	601	102	4,365	8,820	4,193	629	95	4,917	8,837
3 30 - 4 00	3,984	607	104	4,695	8,892	4,528	649	105	5,282	9,980
4·00 - 4 30	4,777	676	120	5,573	11,026	5,300	605	116	6,021	12,147
4 30 - 5 00	5,638	468	121	6,227	12,091	7,011	457	116	7,584	15,451
5 00 - 5.00	5,859	316	117	6,292	12,318	7,995	363	126	8,484	18,615
5 30 - 6·00	3,989	230	112	4,331	7,452	5,745	302	122	6,169	13,663
6·00 - 6 30	3,625	195	77	3,897	6,860	4,253	169	75	4,497	9,052
6·30 - 7 00	3,405	152	72	3,629	6,508	3,346	107	64	3,517	6,178
Total	99,286	13,490	2,120	114,896	203,392	96,789	13,353	2,060	112,202	194,276

A significant finding from the O-D survey is that nearly two-thirds of all vehicles entering the CBD are traveling through this highly developed area to points outside of it, with no purpose other than to get through the area as quickly as possible. Only 36.8 percent of vehicles entering the CBD actually stop in downtown Rochester.

The destination of vehicular traffic entering the CBD at the north screenline was analyzed separately (Fig. 5). About 7 percent of the volume is tangent to the CBD, that is, it enters and leaves in the northerly direction without actually traveling into the core area. Another 35 percent of these vehicles from the north is destined to downtown points, while the balance is distributed evenly in three directions beyong the CBD. Similar analyses were made for traffic through each of the other five screenlines.

With a major share of traffic using downtown streets primarily as a through route, the Inner Loop's effectiveness as a by-pass facility is more significant traffic-wise than all other routes in the downtown area put together.

Where traffic is headed to in the downtown area is the next question answered in the O-D survey. Most people are driving to the retail core; the four zones comprising this core area receive 54.8 percent of the total traffic volume terminating in the CBD. The next significant destination area is the office core and Civic Center, west of the Genesee River. This complex attracts 11,473 vehicles daily—27.1 percent of downtown destinations. The distribution of traffic entering the CBD at each screenline and terminating in the 14 downtown zones is given in Table 2 and shown in Figure 6.

Truck Traffic

About 13,500 trucks enter and leave the Rochester CBD daily from 7 a.m. to 7 p.m. Only 3,800 of these have destinations in the downtown area. This represents 28 percent of the total truck movement. More than seven out of every ten trucks downtown are traveling between points outside the CBD.

Among trucks engaged in downtown deliveries, 40 percent stop in the retail core, 32 percent in the office core, with the remaining 28 percent distributed over the balance of the CBD.

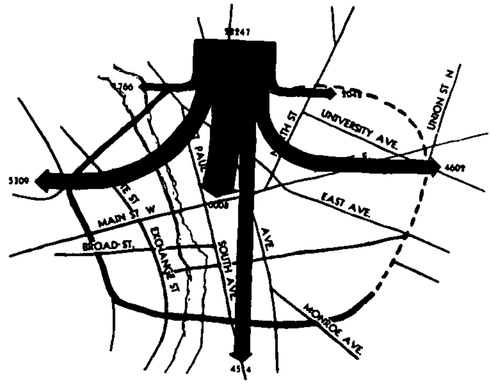


Figure 5. Destination of vehicular traffic entering at the north screenline of the CBD.

Speed and Delay

The average speed of traffic in downtown Rochester is 13.6 mph. The fastest route is the completed portion of the Inner Loop at 20.5 mph, whereas Clinton Avenue at 9.3 mph is the slowest arterial street.

Altogether, 22 percent of downtown streets are operating above 15 mph, 67 percent are between 10 and 15 mph, with the remaining 11 percent below 10 mph (Fig. 7).

The Inner Loop has some sections slowed to less than 10 mph despite the fact that it is the newest and fastest artery serving the Rochester CBD. Heavy turning volumes and traffic signals at Allen Street and Plymouth Avenue North cause a slow-down in one section of the Inner Loop below 10 mph.

DOWNTOWN STREET SYSTEM

The 20 gateways to the Rochester CBD are connected by 12½ mi of arterial streets. Most of these are four-lane routes and all carry traffic in two directions. A detailed inventory was made on each of these streets including width, location and length of bus stops; parking restrictions; timing of traffic and pedestrian signals; turn restrictions; etc. From these data, the carrying capacity of each downtown street was determined (Table 3). It should be observed that the capacities and other limiting conditions on downtown streets were grouped by screenlines similar to the traffic demand data.

The Rochester CBD is circumscribed by the Inner Loop. This by-pass artery is approximately 50 percent completed. The open portion is 1.6 mi long and has six grade crossings. These grade crossings not only reduce speeds but also lower the capacity of the Inner Loop to less than one-half of its potential effectiveness. The remaining one-half of the Inner Loop is scheduled to be completed as a limited-access highway by late 1962.

In the east-west direction, Main Street is the only direct through route. This principal artery is six lanes wide with curb lanes being used by buses exclusively. The Rochester Transit Corporation operates 17 routes along this principal artery, with 100 buses in the morning peak hour and 120 in the afternoon. Buses at 60-sec frequency in each direction virtually pre-empt this lane for use by any other vehicles.

In the north-south direction, Clinton Avenue and St. Paul-South Avenue are the through arteries at the present time. State-Exchange Street, now blocked by construction of the Civic Center, will make a third north-south arterial route. Each of these

TABLE 2

DISTRIBUTION OF CBD DESTINATIONS BY SCREENLINES

Entering CBD	Trips Having Destination in Zone 1012	Zone 1013	Zone 1014	Zone 1015	Zone 1016	Zone 1017	Zone 1018	Zone 1019	Zone 1021	Zone 1022	Zone 1023	Zone 1051	Zone 1061	Zone 1062	Total	%
North	330 32.5%	1,839 40.7%	1,681 29.0%	371 33 2%	470 21 2%	1,689 22 3%	884 16.7%	560 42.1%	660 18.1%	650 20.1%	587 12 8%	111 22.3%	146 16.2%	30 5 5%	10,008	23.66
East	243 23 9%	1,232 27 2%	2,019 34 9%	465 41.6%	766 34.6%	2,474 32 6%	831 15 7%	422 31 8%	633 17 3%	654 20.2%	579 12.6%	275 55 2%	138 15 3%	94 17 1%	10,825	25 59
South	164 16.1%	854 18.9%	1,181 20.4%	120 10.7%	520 23.5%	1,800 23 7%	1,292 24 4%	195 14 7%	499 13.6%	477 14.8%	549 12 0%	35 7 0%	372 41 2%	311 56.6%	8,369	19 79
West	280 27.5%	596 13.2%	905 15.7%	162 14 5%	458 20 7%	1,628 21.4%	2,295 43.2%	152 11.4%	1,863 51 0%	1,453 44 9%	2,869 62.6%	77 15.5%	245 27 3%	114 20.8%	13,097	30.96
Total	1,017	4,521	5,786	1,118	2,214	7,591	5,302	1,329	3,655	3,234	4,584	498	901	549	42,299	100.0

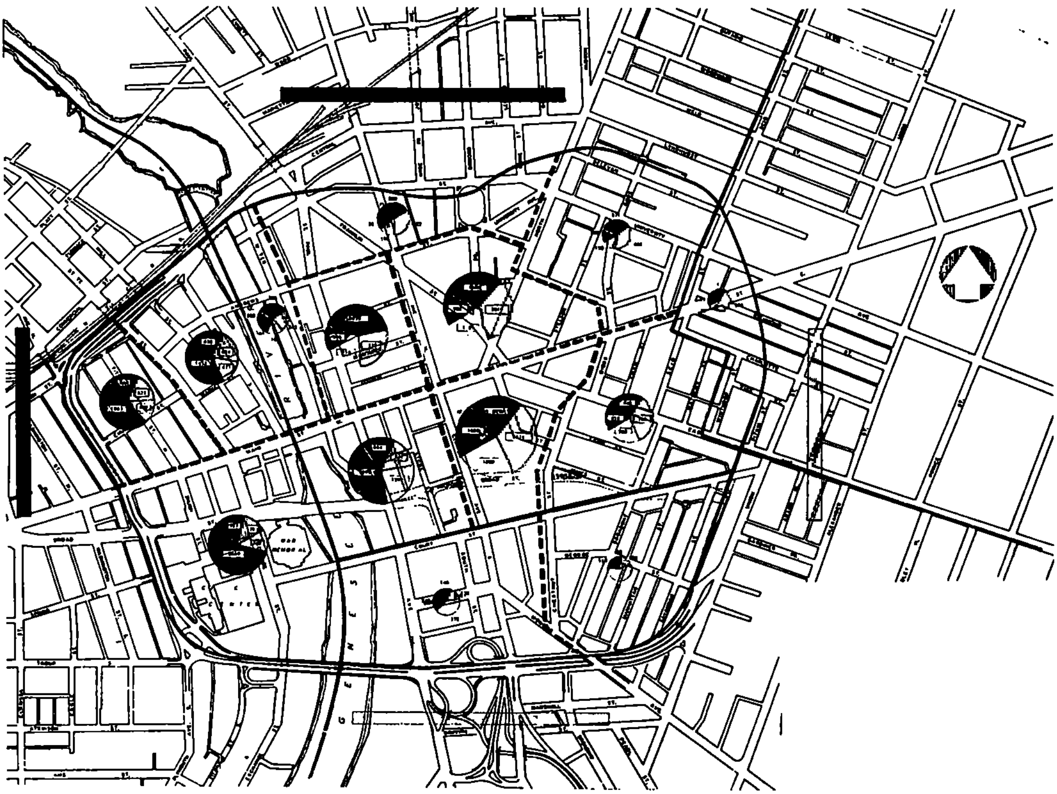


Figure 6. Downtown destinations of traffic crossing screenlines.

arteries has four effective travel lanes and carries traffic in two directions.

Traffic Signal Control

There are presently 50 signalized intersections in the Rochester CBD. Signals are on an 80-sec cycle. Field observations indicated that the efficiency of the last 10 sec of green time in the heavy flow direction is quite low. At many intersections, all vehicles had crossed in two-thirds of the green time.

Analysis of the delays recorded in the speed runs on principal arteries revealed that 79 percent of the stops and slow-downs in downtown Rochester are attributable to traffic signals. Travel times are directly affected by these delays; in many instances where the travel speeds fall below 10 mph, the primary cause is traffic signal timing and lack of signal coordination between intersections.

Curb Parking

Rochester traffic authorities have doen an outstanding job in the control and elimination of curb parking over the last decade. In the retail and office core areas, curb parking has been eliminated throughout the business day on the five principal arteries. This restriction has increased the vehicular carrying capacity of these primary routes by more than 50 percent.

Curb parking is permitted on some principal streets in the outer sections of the CBD during off-peak hours. Present practice is to place hoods over the meters in periods of heavy traffic flow.

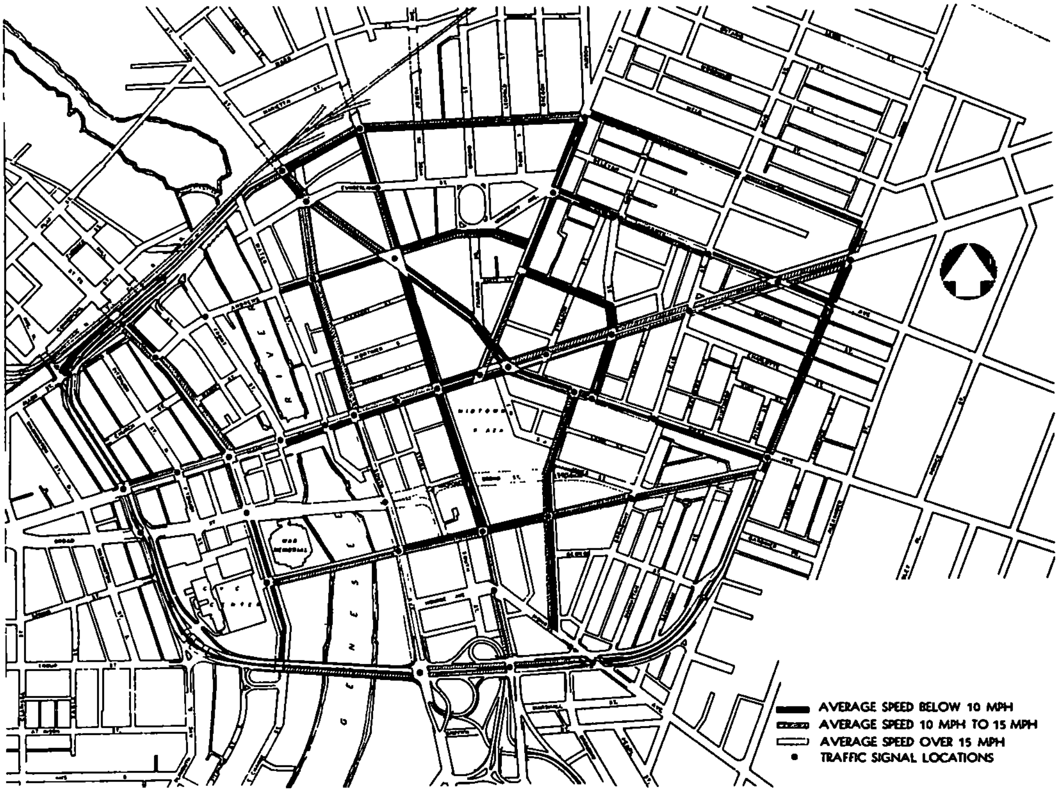


Figure 7. Travel speeds on downtown streets.

Lane Deficiencies and Surplus

The street inventory revealed that Rochester has a total of 42 lanes serving inbound traffic with another 42 lanes for outbound vehicles. The aggregate capacity of present streets is 14,700 vehicles in each direction, assuming traffic to be uniformly distributed.

The peak inbound flow each morning totals 14,327 vehicles. Outbound traffic reaches a total of 16,068 in the afternoon peak. The inbound flow would just equal existing capacity, if demand at each gateway matched its capacity. This is not the case, however; there is an actual deficiency of three lanes in the morning peak.

The principal test of the street system occurs in the afternoon peak, however. The over-all deficiency at that time is eight lanes (Table 4).

The aggregate deficiency among the four streets comprising the east screenline is three lanes. These four routes require a capacity increase of 888 vehicles hourly to meet existing peak hour demand. Similarly, routes comprising the south screenline are deficient by a total of two lanes. The northwest, north and southwest screenlines are each deficient by one lane. As given in Table 4, the only direction with surplus capacity in the morning and afternoon peaks is the west screenline, made up of Broad, Main and Allen Streets.

Although the total screenline deficiency is eight lanes, this can be overcome in a variety of ways. Most obvious are street widening and new streets. Similar results can be achieved, however, by one-way operation, progressive signal timing, curb parking elimination and by other control measures which have the effect of increasing street capacities by the equivalent of one or more lanes.

TABLE 3

WIDTH AND CAPACITY OF DOWNTOWN STREETS

Screen-line	Street	Width (ft)	No. of Lanes Inbound	Outbound	Green Time (%)	Practical Capacity, One-Way (veh/hr)
North	St Paul St	37	2	2	72	910
	Clinton Ave N.	40	2	2	46	640
	Joseph Ave	38	2	2	46	610
	Hudson Ave.	40	2	2	46	640
	North St	40	2	2	46	650
	Union St.	26	1	1	34	490
	Total		11	11		3,940
East	Main St. E.	60	3	3	54	1,200
	University Ave	40	2	2	58	820
	East Ave	40	2	2	56	800
	Gardiner Park	25	1	1		190
	Total		8	8		3,010
South	South Ave	54	2	2	41	800
	Clinton Ave S.	54	3	3	46	900
	Monroe Ave.	50	2	2	58	720
	Total		7	7		2,420
Southwest	Plymouth Ave S.	33	2	2	34	510
	Exchange St	40	2	2	46	680
	Total		4	4		1,190
West	Broad St.	60	3	3	41	930
	Main St. W.	58 5	3	3	41	900
	Allen St.	40	2	2	30	590
	Total		8	8		2,420
Northwest	Plymouth Ave N.	32	2	2	28	640
	State St.	50	2	2	46	940
	Total		4	4		1,580

TRAFFIC IMPROVEMENTS FOR 1960

As previously indicated, the existing street network in downtown Rochester is irregular and poorly suited to serve the heavy traffic flows through the CBD. The city and state governments already have taken major steps toward arterial relief by opening new routes, such as the Broad Street Extension, Inner Loop, etc., to relieve existing congestion. These capital improvements are expensive and time consuming. Before looking to projects of such magnitude, it is appropriate to consider measures for traffic control of an operational nature which would raise present facilities to maximum usefulness.

One-Way Streets

By converting St. Paul-South Avenue and Clinton Avenue arteries to one-way operation and installing a better progression of traffic signals, a substantial increase in speed and capacity can be attained. St. Paul-South Avenue present speed of 13.8 mph can be increased to 19 mph. The average speed on Clinton Avenue would increase from 9.4 to 22 mph. The total increase in capacity for these two north-south arteries would be slightly less than 600 vehicles per hour, thereby overcoming the lane deficiency of the north and south screenlines.

Progressive Signal Timing

It is proposed that the traffic cycle on Main Street be shortened to 70 sec in the morning peak and in the afternoon peak, with a 60-sec cycle in the midday and evening periods.

This recommendation is based on an analysis of the operating speeds and lane efficiencies from progressive signal timing in both directions on Main Street. An average travel speed of 21 mph can be achieved in both directions, compared with the present averages of 12 mph eastbound and 13.3 mph westbound under stop-and-go operations. This would decrease crosstown travel time by upwards of 20 percent without causing

TABLE 4

DEFICIENCIES AND SURPLUS OF TRAFFIC LANES AT CBD SCREENLINES

Screen-line	Street	Capacity (vph)	Peak Hour Demand (veh)		Inbound (vph)		Outbound (vph)		Lanes	
			In	Out	Surplus	Deficiency	Surplus	Deficiency	Surplus	Deficient
North	St Paul St.	910	977	947	-	67	-	37		
	Clinton Ave N	640	650	600	-	10	40	-		
	Joseph St.	610	496	621	114	-	-	11		
	Hudson Ave	640	562	384	78	-	256	-		
	North St	650	529	881	121	-	-	181		
	Union St.	490	588	666	-	98	-	176		
	Total				313	175	296	405	-	1
East	Gardinor Park	190	232	433	-	42	-	243		
	East Ave	800	1,394	1,210	-	594	-	410		
	University Ave	820	732	875	88	-	-	55		
	Main St E	1,200	1,163	1,380	11	-	-	180		
	Total				99	636	-	888	-	3
South	South Ave	800	723	800	77	-	-	-		
	Clinton Ave S	900	622	1,077	278	-	-	177		
	Monroe Ave	720	1,174	1,120	-	454	-	400		
	Total				355	454	-	577	-	2
West	Broad St	930	685	435	245	-	495	-		
	Main St. W	900	894	1,000	6	-	-	100		
	Allen St	670	653	751	17	-	-	81		
	Total				268	-	495	181	1	-
Northwest	Plymouth Ave N	510	549	505	-	39	5	-		
	State St	940	1,245	895	-	305	45	-		
	Total				-	344	50	-	-	1
Southwest	Plymouth Ave S	640	587	779	53	-	-	139		
	Exchange St	680	552	818	128	-	-	138		
	Total				181	-	-	277	-	1

any increase in accident hazard. Actually, the sustained speed of 20-25 mph would be no higher than present travel speeds between intersections along Main Street. The principal difference would be that vehicles would flow continuously instead of constant stopping and starting.

Present signal equipment on Main Street may readily be adapted to the proposed signal timing plan with only a change in meter settings. Without any capital expenditures whatever, the city could realize the same benefits and traffic flow as would be achieved under a 25-ft widening of Main Street.

Curb Parking Restrictions

State Street carries the second heaviest traffic volume in downtown Rochester—exceeded only by East Avenue. Thirty-four parking meters occupy the curb space between Main Street and the Inner Loop North on both sides of State Street.

The State Street area was analyzed from the standpoint of availability of off-street parking facilities in the immediate neighborhood. The parking inventory reveals that there are 430 off-street parking spaces within 200 ft of State Street, where elimination of curb space is proposed. Furthermore, the analysis of available off-street facilities indicates a surplus of 349 spaces throughout the day in the zone bounded by Front Street, Main Street and the Inner Loop. "No parking" restrictions now practiced in peak hours on State Street should be extended to all day operation in view of present and prospective street traffic volumes.

Intersectional Improvements

There are several critical intersections in the CBD, some of which will be relieved by the one-way streets, progression of traffic signals and shorter traffic signal cycle recommended elsewhere. A few of the intersections will be eliminated or alleviated by the completion of the Inner Loop. Recommendations for improving the remaining critical intersections are restrictions of left turns (allowing these left turns to be made at nearby uncongested intersections), special phasing of traffic signals and channelization.

Physical Improvement—East Screenline

The Broad Street Extension, now in construction, will provide an alternate east-west route through the CBD which should relieve pressure along Main Street and also aid diagonal traffic now handled primarily on Franklin-East Avenue.

The three-lane deficiency, previously described at the east screenline of the CBD, will be eliminated by other capital improvements planned by the city and state governments. Completion of the east half of the Inner Loop will aid substantial capacity to Main Street, University Avenue and East Avenue by grade separation of heavy cross flows at these three routes.

Also, another grade separation to aid traffic to and from the east will be provided at the intersection of Broad and Court Streets where they cross the Inner Loop near Union Street.

Third, the opening of the "Subway" Expressway should relieve the existing traffic burden on Monroe and East Avenues.

Existing Inner Loop

Improvement in Inner Loop travel speed from the present 20 mph average to an estimated 40 mph is necessary if the by-pass route is to accomplish its principal purpose—diversion of through traffic now using downtown Rochester streets.

If the six present Inner Loop grade crossings were eliminated, not only would travel speed be increased, but more significantly the total vehicular capacity of the Inner Loop would be more than doubled. In other words, these six grade separations would be the equivalent of constructing another four-lane roadway around the west perimeter of the CBD.

FUTURE TRAFFIC IMPROVEMENTS

By 1975, it is estimated that vehicular traffic will expand 24.8 percent to an average daily volume of 283,440 vehicles. This expansion is based on projected changes in land use in the CBD as determined by the Rochester City Planning Commission, modified by trip generation as revealed in this survey. In the next 15 years, it is estimated that trips actually terminating within the CBD will increase by 13.7 percent while the movements of through traffic circling or passing through the downtown area will rise 31.2 percent.

The Rochester City Planning Commission has provided detailed projections of expected changes in net floor area over the period 1959 to 1975 for retail, office, warehouse, residential and other purposes, subdivided into ten zones in the CBD. Allowance is made in these projections for some reduction in the availability of floor area due to street improvements and other physical changes.

In the retail core, an increase of 5.4 percent, amounting to 371,000 sq ft in aggregate floor space, is expected by the Commission. Most of this gain will be in retail space, although some rise in office space within the retail core is expected. On the basis of existing trip generation, it is estimated that the 15-yr changes in the retail core will cause an increase of 1,271 trips to that area, an increase of 5.9 percent.

The office core west of the Genesee River is planned for the greatest expansion over the next 15 years. The City Planning Commission looks for a gain of 1,899,400 sq ft of space, 39.7 percent of which will be in office use. This increase is projected to attract 4,192 additional trips daily to the office core, a gain of 40.7 percent from present traffic generation.

The balance of the CBD is expected to remain relatively unchanged.

Expansion of through traffic is projected at about 2 percent annually over the next 15 years in comparison with the growth of CBD-destined traffic below 1 percent annually. Therefore, the proportion of through vehicles is estimated to rise from 63.2 percent in 1960 to 66.4 percent by 1975.

Inner Loop and Downtown Streets

Because the through volume is estimated to grow at a faster rate than CBD-bound traffic, a detailed analysis was made of the volume which can be diverted to the Inner Loop by fully upgrading this facility to its maximum usefulness. The greatest relief of traffic congestion in downtown Rochester will be achieved by raising the completed section of the Inner Loop to limited-access standards, the same as is planned for the presently uncompleted portions. With full grade separation throughout, it may reasonably be expected that travel speeds of 40 mph can be maintained around this by-pass route. This would be a considerable improvement over travel on downtown streets, which would divert a greater proportion of traffic to the Inner Loop.

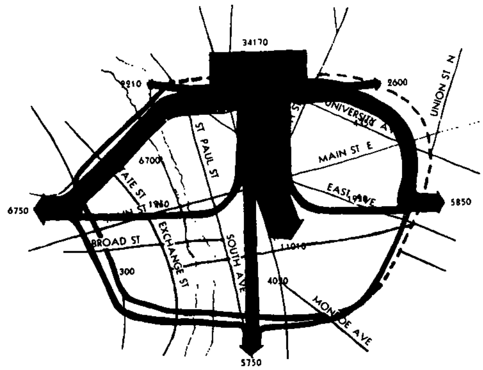


Figure 8. Destination of vehicular traffic in 1975 entering at north screenline of the CBD.

The projected distribution of 1975 traffic entering the Rochester CBD by the north screenline is illustrated in Figure 8. It will be seen that 60.5 percent of the total movement is diverted to the upgraded Inner Loop. Altogether, the Inner Loop is expected to handle 72.3 percent of 1975 through movements—68,830 of the total 95,250 through vehicles on a normal business day. The remaining through volumes using downtown streets will amount to 26,410 vehicles.

Combining this latter figure with the trips terminating in the CBD, it will be seen that average daily traffic on downtown streets in 1975 will aggregate 74,500 vehicles. In other words, the Inner Loop, fully completed and upgraded to limited-access standards over its whole length, will accommodate nearly as much traffic as all other downtown streets put together.

Speed and Delay

For the 1975 projected year, the target has been to raise average travel speed on all arterial routes above 15 mph. An over-all gain of nearly 50 percent would be achieved, raising the average speed on major streets to 20.2 mph. Comparison of present and 1975 average speeds for each principal street in downtown Rochester can be made as follows:

Street	Present Average Speed	1975 Average Speed	% Gain 1975 Over Present
Main Street	12.7	16.2	26.9
Clinton Avenue	9.4	22.2	136.0
St. Paul - South	13.8	19.1	38.5
Franklin - East	10.1	15.4	52.4
Court Street	13.0	18.7	43.9
North Street	12.4	16.2	30.6
University Avenue	11.5	15.8	37.3
State - Exchange	10.5	17.9	70.2
Broad Street	-	18.9	-
Inner Loop	20.5	25.0[1]	22.0
Total	13.6	20.2	48.6

[1]Forty mph on roadway, with allowance for lesser ramp speeds and added distance due to ramps.

Figure 9. Recomme

ntown circulation system.

Inner-Inner Loop

Proposals have been advanced by the city planning commission for continuous one-way operation around the retail core area by installation of a clockwise and counter-clockwise loop. With one-way pairing of north-south streets, Clinton and St. Paul, and a similar set of east-west routes, Broad and Court Streets, this arrangement could be completed to some advantage. The commission's plan contemplates use of Water Street along with St. Paul as the western side of this so-called "Inner-Inner Loop". Instead, the pairing of St. Paul - South Avenue and Clinton Avenue is recommended.

With this modification, the clockwise Inner Loop would comprise Clinton Avenue, Pleasant Street Extension, Grove Street, Gibbs Street and Broad Street Extension. The counter-clockwise movement would be made up of St. Paul-South Avenue, Court Street, Gibbs and Andrews Streets.

Figure 10. Pedestrian mall proposed for downtown Rochester.

A complete circulation plan for 1975 traffic operation in downtown Rochester, showing the Inner-Inner Loop and also other street improvements along with the Inner Loop up-graded to limited-access status, is shown in Figure 9.

Pedestrian Mall

Within the last year, there have been no less than three proposals for a pedestrian mall (Fig. 10). At this stage, it is not necessary to attempt to resolve the differences among these proposals.

The downtown mall can only be developed when other suitable traffic facilities have been completed. Inasmuch as the whole traffic flow pattern would be influenced primarily by access and egress from the Inner Loop, the mall proposal should be geared to completion of that arterial facility.

If maintaining easy pedestrian flow between the two sections of the mall along Main Street should become significant, this purpose could be achieved by the development of an attractive pedestrian platform which would bridge vehicular traffic in both directions at the Main and Clinton intersection.

Buses and emergency vehicles (police, fire and ambulances) should be permitted to travel through the pedestrian mall. This exception to the traffic exclusion is based on two significant facts: (a) there are no suitable alternate streets for loading and unloading buses; and (b) analysis of their travel habits shows that 73.5 percent of bus passengers in the downtown area are actually destined to the Main and Clinton intersection. It would be folly to deposit these people at any other location and force them to walk to this point.

TRANSIT: NOW TO 1975

It is well recognized that the welfare of the Rochester CBD is allied closely with the continuance and improvement of its public transit system. Buses are by far the most efficient carriers serving downtown; each bus in the system brings more than 150 people daily into downtown Rochester. Automobiles, on the other hand, carry an average of 1½ passengers each.

Over the past decade downtown Rochester has suffered the loss of a significant share of its retail business to outlying shopping areas. Paralleling this decline, there has been a steady drop in the use of public transportation. Transit riding in Rochester since 1950 has declined 55 percent.

A continuation of the trend away from the public transportation would mean more traffic congestion and further pre-empting of downtown space to relieve it; these steps can only result in accelerating the movement of business away from the CBD with further impairment of its economic worth.

Transit Riding Habit

The Rochester Transit Corporation carried approximately 32½ million passengers in 1959 and serves an area of approximately 463,000 people. Dividing the annual passengers by the population served, the transit riding habit for this system is determined to be 70 rides per capita annually. This corresponds exactly with the average for 21 medium-size cities.

Rochester Transit Corporation provided 18.3 vehicle-miles of service in 1959 for each person in its service area. This compares with an average of 20 miles per capita for transit companies in other medium-size cities. This average is affected by the southern cities; several major southern cities, notably Atlanta, New Orleans and Richmond, are well above average in transit miles per capita. If these three cities were eliminated from the average, the volume of transit service per capita in Rochester would be approximately the same as that in other medium-size cities.

Transit service in Rochester is as well received as elsewhere—perhaps a bit above par in relation to comparable northern cities—but this fact does not alter the need for wider acceptance and use of public transportation if the downtown area is to hold its own in the years ahead.

Transit O and D

To determine the pattern of riding on Rochester Transit lines, an O-D survey was made on all routes in November 1959. Printed cards were distributed to all fare-paying passengers with three simple questions to be answered relating to the point of origin, point of destination and use of transfers on that particular journey.

A total of 54,979 cards were issued; 40,541 of these were filled out and returned. This represents a survey return of 74 percent—an extremely good response for a survey of this type, and considerably more than an adequate sample for a valid cross-section of the riding habits of passengers.

Transit Share of CBD Traffic

On an average weekday, Rochester Transit buses deliver 38,115 people to the CBD. Ninety-seven percent of this total arrive in the 12 hours between 7 a.m. and 7 p.m. This amounts to 36,750 people arriving in the downtown area by bus. During the same 12 hours, passenger cars bring in an estimated 56,195 persons.

Therefore, in the 12 hours between 7 a.m. and 7 p.m., 92,945 people come into the CBD with destinations in the downtown area, of whom 40 percent arrive by bus and 60 percent by automobile.

Sixty-nine percent (38,115) of the 55,308 bus riders entering the Rochester CBD stop in the downtown area for some business or social purpose. This is the reverse of the proportion of auto users. In the traffic section of this report, it is pointed out that 36.8 percent of motor vehicles entering the CBD terminate within the downtown area.

Nearly three-fourths of transit passengers delivered to the CBD are destined to the retail core area. Of the 28,036 delivered to this section daily, 21,893 (78 percent) get off Rochester Transit buses along Main Street at bus stops between St. Paul and Franklin inclusive, or alight from buses along one of the north-south streets, immediately adjacent to Main Street.

More than 35,000 riders get on and off in the vicinity of Main and Clinton Avenue every day.

Transit Proportion to Core Area

Although automobiles bring in about 60 percent of the total number of people destined to the CBD as a whole, they do not have so large a proportion in the retail core area. In the 12 hours beginning 7 a.m. to 7 p.m., autos deliver about 31,500 people to the retail core. In the same period, buses deliver approximately 27,000 people to the retail core area, representing 46 percent of the total number of people coming to the downtown shopping core of Rochester.

More than one-half of the transit riders destined to the center city began their journeys within a radius of two miles of Main and Clinton. Nearly 85 percent of those coming downtown started from points not more than three miles from Main and Clinton. Transit is not carrying a significant number of riders to the downtown area from beyond a radius of three miles.

EVALUATION OF TRANSIT SERVICE

The adequacy of service may be determined by evaluating each of the following elements in terms of reasonable and commonly accepted standards: (a) speed of operation, (b) routing (coverage of area and direct service), (c) loading standards, (d) service frequency, (e) dependability, (f) bus stop frequency, (g) operator's attitude, and (h) equipment.

Speed of Operation

Rochester Transit Corporation operated nearly 8½ million vehicle-miles in 1959 at an average speed of 10.94 mph. The average operating speeds for 21 other transit systems serving medium-size cities is 11.09 mph, virtually the same as the average for Rochester.

An increase in operating speed of 1 mph on all of the lines of Rochester Transit would result in annual savings measured in six figures, as well as in a service more attractive to transit patrons. To a considerable degree, speed is dependent on street traffic conditions, a factor beyond the control of the transit company.

Rochester was among the first cities to inaugurate transit lanes in the downtown area. An extension of transit lanes in the CBD and on arterial approaches is one step which can be taken to improve transit speed. Higher bus speed downtown would also flow from improvements in traffic signal timing.

Routing

Present route coverage of the transit system is excellent. As a practical matter, virtually every point in the city is within ¼ mile of one or more bus routes. It can be concluded that there are no significant deficiencies in the route coverage within the City of Rochester.

Ten out of 11 transit riders completed their journey to their downtown destination on a single vehicle.

Loading Standards

This company is already providing a more generous standard of service than required by the criterion of a seat per passenger on each route in base hours. Hourly variations in daytime transit service and passenger loads entering and leaving downtown Rochester are given in Table 5. These figures represent totals on all routes in a given direction for a 1-hr period.

The company is now providing an average of slightly more than one seat per passenger measured over the heaviest hour of inbound travel each day. In this hour the load factor is 98.7; that is, passengers represent 98.7 percent of the total number of bus seats provided in the inbound direction at the edge of the CBD when measured over the full hour, 7 to 8 a.m.

As bus riders are well aware, the hour of greatest passenger congestion is between five and six o'clock in the afternoon on outbound vehicles. This is the only time of

TABLE 5

HOURLY VARIATIONS IN DAYTIME TRANSIT SERVICE AND PASSENGER LOADS ENTERING AND LEAVING DOWNTOWN ROCHESTER

	Entering Downtown				Leaving Downtown			
Hour of Day	Buses	Seats	Passengers	Load Factor (%)	Buses	Seats	Passengers	Load Factor (%)
7 to 8 a m	225	9,104	8,990	98.7	219	8,834	5,937	67 2
8 to 9	224	9,130	8,436	92 4	199	8,230	4,512	54 8
9 to 10	154	6,345	4,028	63.5	142	5,882	1,708	29.0
10 to 11	136	5,641	3,338	59 2	133	5,510	2,039	37.0
11 to 12	137	5,696	3,014	52.9	137	5,677	2,682	47.2
12 to 1 p m.	135	5,585	3,021	54 1	134	5,559	2,587	46.5
1 to 2	138	5,771	3,273	56.7	132	5,519	2,999	54 3
2 to 3	146	6,004	3,917	65 2	145	6,019	4,059	67.4
3 to 4	206	8,353	6,020	72 1	200	8,250	6,654	80 7
4 to 5	241	9,802	7,233	73.8	232	9,499	9,595	101.0
5 to 6	229	9,362	4,695	50 1	248	10,281	11,803	114.8
6 to 7	149	6,027	2,077	34 5	139	5,768	4,204	72 9
Total	2,120	86,820	58,042	66 9	2,060	85,028	58,779	69.1

the day during which there is a substantial excess of passengers over seats provided by Rochester Transit.

There is no problem of loading prior to 4 p.m. in the outbound direction. In fact, prior to 3 p.m., about one-third or more of the outbound seats are empty at every hour of the day—frequently one-half or more are empty. Between 3 and 4 p.m. the load factor is 80.7 percent in the outbound direction. Between 4 and 5 p.m. seats and passengers outbound are in approximate balance with a load factor of 101 percent. In the hour commencing at 5 p.m., the company provides 248 outbound trips and a total of 10,281 seats, whereas passengers aggregate 11,803 in this same hour, yielding a load factor of 114.8 percent.

Policy Headways

Headways between buses on all major routes in the a.m. and p.m. rush hours are between 5 and 9 min, whereas the off-peak or midday headway is generally in the range of 10 to 13 min on the principal arterial routes. In the evening hours, the spacing is widened somewhat to approximately 15 to 20 min, with several above 20 min.

It is apparent from the load factors during the midday hours that the service frequency on the routes of Rochester Transit Corporation in this period are determined not by the passenger volumes, but by policy considerations. The resultant headways of 10 to 13 min in the midday on the major arterial lines represents a generous standard of service. On the assumption that the average waiting time of a passenger does not exceed one-half the headway or interval between vehicles, the waiting time for a bus normally would be 5 or 6 min in the midday hours.

Volume of service provided in 1959, when related to the quantity of riding, was considerably greater than it had been in any prior period. The total amount of service operated in relation to patronage increased by nearly one-third between 1950 and 1959.

Dependability

An important aspect of dependability is continuity of transit service without interruption despite unusual circumstances. On this score Rochester Transit Corporation has an outstanding record under very trying conditions. This is illustrated by the performance of the company and its employees in the past winter. Despite 161 in. of snow—the heaviest in Rochester's history—uninterrupted bus service was maintained.

Field studies showed that 77.1 percent of inbound trips to the CBD were on time within the definition of 1 min early to 3 min late. The on-time performance of outbound vehicles was found to be 72.6 percent within the same range of tolerance, in the 12-hr period commencing 7 a.m. The on-time performance of Rochester Transit is generally satisfactory in the peak period and in the hours immediately following the morning peak and preceding the afternoon peak.

The finding of less than 60 percent schedule adherence for outbound vehicles between 5 and 6 p. m. indicates an opportunity for supervisory investigation of operators' performance during this period. This record also reflects a need for improvement in traffic conditions in downtown Rochester during the critical afternoon peak hour.

Although the peak hour schedule adherence is generally satisfactory, the performance in off-peak hours should be susceptible of improvement. In the midday hours, particularly, headways are longer and the inconvenience resulting from off-schedule buses is more irksome.

Rochester Transit Corporation is particularly well equipped to improve its record of on-time performance. The company has installed a two-way radio hookup throughout its system. This communications system is now being used effectively in giving instructions to bus operators on the street who are delayed.

Bus Stop Frequency

Both as to the number of downtown bus stops and their location, it is felt that the present routes are well designed. The analysis of the number of bus stops per route mile outside the CBD reveals clearly a need for some reduction in the number of stops in outlying areas.

As contrasted with the recommendation of the National Committee on Urban Transportation that bus stops in residential areas be confined to a maximum of seven per mile the average number of bus stops outside the CBD is 9.3 per mile. And, with few exceptions, virtually all routes are shown to have bus stops in excess of the seven-per-mi standard recommended by the committee.

Equipment

Since switching to diesel operations after World War II, the company has spent $3, 140, 000 on this type of equipment.

The program of equipment modernization has provided Rochester with an up-to-date fleet—one which is quite adequate to do the job required of public transportation in Rochester.

Altogether the replacement program is an important factor, the general condition, appearance and cleanliness of the bus fleet is probably of equal significance to the riding public. Appearance-wise, this company has a trim-looking fleet.

EXPRESS SERVICE

The most important single requirement for improved transit service in Rochester is greater speed. This is where the competitive disadvantages of transit riding with the automobile may be most clearly seen.

As the development of the metropolitan area expands in suburban communities, faste transit service must be provided from these outlying areas to offer a reasonable alterna tive to the private automobile.

Although transit riding has been declining not only in Rochester but in other cities throughout the country in the postwar years, some transit services have actually improved in patronage. These generally have been the upgraded bus services, the express and limited-stop operations with speeds which approach that of the automobile.

The experience in St. Louis demonstrates the attractiveness of high-speed bus operation.

The primary appeal of express bus service is speed. In addition to time saving, there are corollary appeals of comfort and attractiveness.

Rochester Transit does not operate any express service to the CBD at the present time except for newly inaugurated service on Lake Avenue. The objective is to develop a distinctive express service on a number of routes which will make it possible at least to halve the time advantage that private cars now have over regular bus service from outlying communities.

The type of transit service comtemplated on these express routes is expensive to to provide. Accordingly, it is suggested that the fare for an express ride be 5 cents above that charged for a corresponding trip on a local bus.

Five express routes are proposed for the inauguration of this service. They are Monroe-Pittsford, Chili Express, St. Paul-Summerville Express, Lake Avenue Express and Sea Breeze Express.

It is recommended that express operation between Pittsford and the CBD be inaugurated throughout the peak and midday hours. In the segment of the line outside the CBD, however, the total number of bus stops would be reduced from 59 to 5. It is recommended that the schedule call for a running time of 26 min in both the a.m. and p.m. peak periods (present running time, 31 min). The auto advantage, now 6 to 8 min, would be reduced to 1 to 3 min.

It is proposed that peak-hour express be inaugurated from Chili Center on a trial basis. There will be 67 fewer bus stops on the express line than on the present operation. With this reduction of passenger stops, express vehicles moving with traffic should approach the average automobile speed. A running time of 29 min is suggested (present, 33 to 36 min).

It is proposed that express service be operated over the St. Paul-Summerville line. The scheduled running time of express buses would be 29 min, both in the a.m. peak and in the p.m. rush hour (present, 35 min). No difficulty is expected in achieving this speed; experience may indicate the possibility of reducing it by 1 or 2 additional minutes. It is recommended that this express service be provided not only in the peak hours but throughout the midday period as a special premium service for shoppers coming to the downtown stores.

It is suggested that additional trips be added on the Charlotte express line, both in the peak and off-peak hours. The total potential of daily riding on proposed express routes from this suburban community is 1,683 persons. This is more than adequate to justify the inauguration of express bus service in this area on an experimental basis. It is suggested that the running time scheduled for these express trips be 30 min in the a.m. and p.m. peak hours. It is also proposed that this express operation be continued during the midday base hours to provide a fast and deluxe service for shoppers coming to the downtown area.

OTHER TRANSIT RECOMMENDATIONS

Route Changes

Although the entire City of Rochester is within ¼ mile of one or more transit routes, not all sections of the city have direct bus service to the retail core area. From some areas, it is necessary either to walk for some distance or to transfer from one line to another to reach the downtown shopping area. Many of these deficiencies in routing from the standpoint of the CBD can be remedied by recombination of existing routes and relatively modest changes in existing lines.

Bus Stop Frequency

The transit company should re-examine the bus stop locations on all routes with the objective of limiting stops to a maximum of 10 per mile. In other words, there should be no more than one bus stop in each block of the route. This maximum is 40 percent above the standard proposed by the National Committee on Urban Transportation. Although limiting bus stops in residential areas to seven per mile is entirely reasonable, it is felt that a reduction from the present level to a standard of seven would be more than could be realized in the immediate future. Application of a maximum standard of 10 stops per mile produces an average between eight and nine stops per mile.

Free Bus Service in Mall Area

A prior recommendation in this report is a downtown pedestrian mall along Main Street between St. Paul-South Avenue and Franklin-East Avenue. The mall is feasible only on completion of the proposed improvements in traffic circulation in and around the CBD, the most important one of which is the upgrading of the Inner Loop to a totally grade-separated facility.

A feature which might be considered, both from the viewpoint of faster operation and a stimulus to downtown circulation, would be no fare collection in the mall area. All buses operating through the mall would do so with both doors open at each stop.

Main Street Shuttle

The Civic Center represents a major new traffic generator in the area west of the Genesee. This addition warrants the re-institution of the Main Street shuttle between this area and the retail core for a further extended trial period.

Transit Lane

A principal recommendation in the preceding traffic section of this report is the inauguration of one-way operation on Clinton Avenue, St. Paul Street and South Avenue. This volume of transit service will necessitate a reserved bus lane to permit the optimum flow, both of transit and other vehicular traffic.

There is one additional location where the volume of bus movement is such as to require a reserved lane. On State Street between Brown and Main Street, there is need for the establishment of transit lanes in rush hour periods. In the maximum 60 min between 4:30 and 5:30 p.m., 56 buses are scheduled through this portion of State Street.

PARKING: NOW TO 1975

There are nearly 15,000 parking spaces in downtown Rochester. Ninety-two percent of these are in off-street lots and garages—commercial, publicly owned and private; the remaining 8 percent comprises the 1,241 parking spaces at street curbs. The number of parking facilities in each classification is summarized in Table 6, and the distribution by types if given in Table 7.

In 1950 there were 11,995 off-street spaces. Parking garages and lots developed in the past decade have expanded this capacity to a present off-street total of 13,731. On completion of the garage facilities at the Civic Center and at Midtown Plaza, the total off-street spaces will increase further to 16,556—a gain of 4,561 spaces, or 38 percent above 1950.

Meanwhile, nearly four out of every ten downtown curb parking spaces which were available in 1950 have been eliminated. This space has been withdrawn from the parking supply to provide more lanes for moving traffic in the CBD.

Field Studies

Field analyses of parking facilities in the CBD were made in November and December 1959. One phase of this field survey comprised a detailed inventory of every parking facility in the CBD.

The second phase consisted of interviewing motorists at 26 downtown parking facilities on weekdays between the hours of 7 a.m. and 7 p.m. Altogether, a total of 3,500 personal interviews were made. This information was correlated with the broader sample of motorist interviews at survey stations around the perimeter of the CBD to provide a total picture of traffic and parking conditions on an average weekday.

Commercial Spaces

Commercial parking lots provide the major share of the downtown parking supply—53.8 percent. Altogether, there are 105 commercial facilities supplying 8,053 spaces, or an average of 77 spaces per lot.

Commercial lots have an average turnover of 2.04 cars per parking space. The average parker leaves his car in the lot for 3.0 hr and walks 470 ft to his downtown destination.

Commercial garages represent 8.8 percent of the total parking supply in the CBD. There are six commercial garages which provide 1,320 spaces, or an average of 220 spaces per facility. The average turnover rate for these six facilities is 0.96. Parkers leave their cars for an average of 6 hr and walk 500 ft.

Municipally Owned Facilities

The City of Rochester operates eight parking lots for metered self-parking. These facilities generally are smaller than the commercial lots, averaging 53 spaces.

The most important municipal lot is a 196-car facility at the southeast corner of Court and Chestnut Streets. Every space in this lot is generally occupied by 8:30 a.m. despite the fact that there are no large traffic generators in the vicinity of the lot. Occupancy is made up primarily of all-day parkers. Average walking distance is 1,370 ft, nearly twice the normal average, indicating that this lot is serving employees in the retail core who are willing to walk some additional distance for the advantage of low parking rates.

The four municipally owned garages constitute only 13 percent of the total parking supply, but they exercise a primary influence on downtown parking rates and turnover. They provide a total of 1,815 spaces. Two additional publicly owned facilities are in the process of construction—Midtown Plaza and Civic Center garages, with accommodations for 1,900 and 1,300 cars, respectively.

Clinton Avenue Ramp Garage.—An eight-story structure directly behind Sibley's Department Store. This facility was completed in the spring of 1959 at a total cost of $2,600,000. It has capacity for 552 vehicles on a metered, self-parking basis (average cost, $4,700 per car space).

On an average weekday, this garage handles close to 2,000 parkers between 7 a.m. and 7 p.m. Direct access is provided to Sibley's on five of the eight floors. Average turnover for the 12 daytime hours is 3.6 cars per space.

Mortimer Street Ramp Garage.—Is located directly behind Edward's Department Store. This is also an eight-story ramp-type operation with an aggregate of 523 stalls for metered, self-parking. Total cost of this facility was $2,307,000, averaging $4,412 per car space.

The average weekday load is nearly 1,600 cars between 7 a.m. and 7 p.m., resulting in a daytime turnover of 3.0 cars per space.

Plymouth Avenue Ramp Garage.—Is located at the northwest corner of Main Street and Plymouth Avenue, with exits to the Inner Loop. This ramp garage has a greater portion of all-day parking. The capacity is 500 stalls.

Daytime use aggregates 832 vehicles, making the average turnover of 1.7 cars per space between 7 a.m. to 7 p.m.

Private Parking Space

One hundred and one private off-street parking areas are used principally for the convenience of customers and employees of business concerns in the CBD.

Generally, these are small service lots, with an average capacity of 20 spaces. In the aggregate, these lots accommodate approximately 2,000 cars daily.

Curb Spaces

Metered.—The 736 metered curb spaces in downtown Rochester include 113 locations in the retail core, 229 in the office core and the remaining 394 spaces in the balance of the CBD. Metered spaces accommodate a high turnover. The average daytime rate is 1.4 cars per hour. There has been a substantial decline in metered curb space in both core areas over the past decade (Table 8).

Unmetered.—Free curb parking amounts to 3.4 percent of the total CBD parking supply and is almost entirely in the perimeter residential areas.

The most significant change over the last 10 years has been the development of suitable off-street parking facilities. The lion's share of the city's capital budget for traffic improvements has gone into the development of five municipal garages, four of which are completed and the last under construction. In 1950 downtown garages had a capacity of 1,238 cars. By the end of last year this had increased to 2,895. On

TABLE 6

PARKING SPACE IN DOWNTOWN ROCHESTER

Type of Space	Type of Facility	Facilities (no.)	Spaces (no)	Spaces Avg Per Facility
Commercial	Garages	6	1,320	220
	Lots	105	8,053	77
Public	Garages	4	1,950	525[1]
	Lots	8	420	53
Private	Garages	-	-	-
	Lots	101	1,988	20
Sub-total			13,731	
Curb	Metered	-	736	-
	Un-metered	-	505	-
Sub-total			1,241	
Total		224	14,972	

[1]Excluding 375 spaces at Civic Center

TABLE 7

PARKING SUPPLY BY LAND-USE AREAS

Type of Space	Type of Facility	Spaces (no) Retail Core	Office Core	Perimeter	
Commercial	Garages	845	475	-	
	Lots	4,042	1,465	2,546	
Public	Garages	1,075	875	-	
	Lots	-	36	384	
Private	Garages	-	-	-	
	Lots	63	358	1,567	
Curb	Metered	113	229	394	
	Un-metered	20	177	308	
Total		6,158	3,615	5,199	14,972

completion of the garage facilities at the Civic Center and Midtown Plaza, the total will climb to 6,095, a rise of nearly 400 percent above 1950.

Table 9 shows a general upgrading in CBD parking supply by type of facility over the past decade. The over-all picture indicates an increase of 3,809 parking spaces, equivalent to 27.2 percent. Curb parking dropped 37.7 percent, while off-street capacity rose 38 percent. In absolute numbers, six off-street parking spaces have been provided to replace each curb space eliminated since 1950.

PARKING CHARACTERISTICS

In analyzing off-street parking facilities, it is important to determine the requirements of parkers. The purpose of an individual's trip influences his length of parking time, acceptable walking distance between facility and destination, and time of arrival and departure. Each of these principal characteristics was analyzed in this study to determine its effect on selection of particular parking facilities.

Duration of Parking

Hours parked by trip purpose for the retail core, office core and perimeter area are summarized in Table 10. The average parking period in the Rochester CBD is 3.6 hr. Workers, for example, in the retail core average 5 hr each time they park their cars, while office core workers average 7.3 hr of parked time daily. Shoppers average out at 1.8 hr per shopping trip in the retail core and 1.7 in the office core.

From the standpoint of use and parking turnover, it is significant that the average worker parks for a period more than three times as long as a shopper or other downtown parker. Off-street parking facilities accommodating a high proportion of workers seldom exceed a turnover of one, whereas those serving shoppers predominantly, such as the Mortimer Street and Clinton Avenue ramp garages, have turnovers of three to four per car space daily.

Arrival Time

It is no surprise that more than one-half of the parkers on business and work trips reach their parking space between 7 and 10 a.m. daily. Another 23 percent park between 10 a.m. and 1 p.m., with the remainder parking in the early afternoon (Table 11). Among shoppers the principal hours of arriving are in the late morning from 10 a.m. to 1 p.m., when 38 percent of the shoppers reach downtown parking facilities.

TABLE 8

METERED CURB PARKING IN CBD, 1949-1960

Portion of CBD	Metered Curb Spaces (no) 1949	1960	Change (no.)	Change (%)
Retail core	278	113	-165	-59 4
Office core	386	229	-157	-40.7
Remainder	284	394	+110	+38.7
Total	948	736	-212	-22 4

Distance Walked

Rochester is able to accommodate more than one-half of its shoppers within 400 ft of their retail destinations. This reflects a high degree of parking convenience. Furthermore, between 80 and 90 percent of shoppers in the retail core, office core and remainder of the CBD park less than 600 ft from their place of business.

TABLE 9

DOWNTOWN PARKING SUPPLY, 1950-1960

Type of Space	Type of Facility	Spaces (no) 1950	Spaces (no) 1960	Change (No)	Change (%)
Curb	Metered	1,182	736	- 446	-
	Free[1]	811	505	- 306	- 37 7
	Total	1,993	1,241	- 752	- 37 7
Off-Street	Lots	10,757	10,461	- 296	- 2 8
	Garages	1,238	6,095[2]	+4,857	+392 3
	Total	11,995	16,556	+4,561	+ 38 0
	All	13,988	17,797	+3,809	+ 27 2

[1]Estimated
[2]Including 1,300 spaces at Civic Center and 1,900 at Midtown Plaza now under construction

TABLE 10

SUMMARY OF HOURS PARKED, BY TRIP PURPOSE

CBD Area	Purpose of Trip	No. of Trips[1] <1 hr	1-2 hr	2-4 hr	4-6 hr	6-8 hr	>8 hr	Total	Avg Parked Time (hr)
Retail core	Work	1,041 (14.8)	1,421 (20.3)	1,013 (14.4)	689 (9.8)	717 (10.2)	2,139 (30.5)	7,020 (100.0)	5.1
	Shop-ping	2,971 (32.9)	3,853 (42.6)	1,625 (18.0)	464 (5.1)	116 (1.3)	11 (0.1)	9,040 (100.0)	1.7
	Other	2,357 (42.6)	2,141 (38.7)	770 (13.9)	92 (1.7)	62 (1.1)	108 (2.0)	5,530 (100.0)	1.6
	Total	6,369 (29.5)	7,415 (34.3)	3,408 (15.8)	1,245 (5.8)	895 (4.1)	2,258 (10.5)	21,590 (100.0)	2.8
Office core	Work	170 (2.5)	720 (10.6)	826 (12.1)	614 (8.9)	740 (10.7)	3,790 (55.2)	6,860 (100.0)	7.3
	Shop-ping	425 (37.2)	395 (34.7)	252 (22.1)	36 (3.2)	32 (2.8)	- -	1,140 (100.0)	1.7
	Other	821 (35.5)	975 (42.3)	257 (11.1)	70 (3.0)	67 (2.9)	120 (5.2)	2,310 (100.0)	2.0
	Total	1,416 (13.7)	2,090 (20.3)	1,335 (13.0)	720 (7.0)	839 (8.1)	3,910 (37.9)	10,310 (100.0)	5.5
Remain-der	Work	359 (12.2)	332 (11.3)	746 (25.5)	415 (14.2)	442 (15.1)	636 (21.7)	2,930 (100.0)	4.9
	Shop-ping	199 (18.1)	318 (28.9)	437 (39.7)	106 (9.6)	27 (2.5)	13 (1.2)	1,100 (100.0)	2.5
	Other	356 (13.9)	960 (37.5)	640 (25.0)	480 (18.7)	54 (2.1)	70 (2.8)	2,560 (100.0)	2.7
	Total	914 (13.9)	1,610 (24.4)	1,823 (27.7)	1,001 (15.2)	523 (7.9)	719 (10.9)	6,590 (100.0)	3.7
All	Work	1,570 (9.3)	2,473 (14.7)	2,585 (15.4)	1,718 (10.2)	1,899 (11.3)	6,565 (39.1)	16,810 (100.0)	5.9
	Shop-ping	3,595 (31.9)	4,566 (40.5)	2,314 (20.5)	606 (5.4)	175 (1.5)	24 (0.2)	11,280 (100.0)	1.8
	Other	3,534 (34.0)	4,076 (39.2)	1,667 (16.0)	642 (6.2)	183 (1.7)	298 (2.9)	10,400 (100.0)	2.0
	Total	8,699 (22.6)	11,115 (28.9)	6,566 (17.0)	2,966 (7.7)	2,257 (5.9)	6,887 (17.9)	38,490 (100.0)	3.6

[1]Figures in parentheses are percentages.

TABLE 11

ARRIVAL TIME OF DOWNTOWN PARKERS

CBD Area	Purpose of Trip	No. of Trips[1] 7-10 a.m.	10 a.m.- 1 p.m.	1-4 p.m.	4-7 p.m.	Total	% of Total
Retail core	Work	3,937 (56.1)	1,409 (20.1)	1,137 (16.2)	537 (7.6)	7,020 (100.0)	32.5
	Shopping	982 (10.9)	3,418 (37.8)	2,951 (32.6)	1,689 (18.7)	9,040 (100.0)	41.9
	Other	834 (15.1)	1,285 (23.2)	1,248 (22.6)	2,163 (39.1)	5,530 (100.0)	25.6
	Total	5,733 (26.7)	6,112 (28.3)	5,336 (24.7)	4,389 (20.3)	21,590 (100.0)	100.0
Office core	Work	3,100 (45.3)	1,820 (26.5)	1,347 (19.7)	583 (8.5)	6,860 (100.0)	6.5
	Shopping	146 (12.8)	642 (56.3)	268 (23.5)	84 (7.4)	1,140 (100.0)	11.1
	Other	171 (7.4)	573 (24.8)	999 (43.2)	567 (24.6)	2,310 (100.0)	22.4
	Total	3,427 (33.2)	3,035 (29.4)	2,614 (25.4)	1,234 (12.0)	10,310 (100.0)	100.0
Remainder	Work	1,446 (49.3)	548 (18.7)	555 (19.0)	381 (13.0)	2,930 (100.0)	44.5
	Shopping	101 (9.2)	223 (20.3)	430 (39.1)	346 (31.4)	1,100 (100.0)	16.7
	Other	592 (23.1)	810 (31.7)	530 (20.7)	628 (24.5)	2,560 (100.0)	38.8
	Total	2,139 (32.4)	1,581 (24.0)	1,515 (23.0)	1,355 (20.6)	6,590 (100.0)	100.0
All	Work	8,493 (50.5)	3,777 (22.5)	3,039 (18.1)	1,501 (8.9)	16,810 (100.0)	43.7
	Shopping	1,229 (10.9)	4,283 (38.0)	3,649 (32.3)	2,119 (18.8)	11,280 (100.0)	29.3
	Other	1,597 (15.4)	2,668 (25.6)	2,777 (26.7)	3,358 (32.3)	10,400 (100.0)	27.0
	Total	11,319 (29.4)	10.728 (27.9)	9,465 (24.6)	6,978 (18.1)	38,490 (100.0)	100.0

[1]Figures in parentheses are percentages.

This proximity to primary destination compares very favorably with walking distance for shoppers in other cities; generally, the walking distance for shoppers is 800 to 1,000 ft, about twice the Rochester average.

The average worker parks 50 percent farther away from his destination than the typical shopper in downtown Rochester. Shoppers walk an average of 420 ft, those on business and work trips walk 630 ft, whereas other parkers average out at 450 ft. Walking distance from parking facility to destination by purpose of trip and by CBD areas is given in Table 12.

The average walking distance for parkers in the Clinton ramp garage is 320 ft, whereas those using the Mortimer ramp garage walk 350 ft to their primary destination. Few downtown shopping areas throughout the country are able to match this proximity in parking convenience. These two municipal garages also provide a substantial degree of accommodation for the stores on the south side of Main Street.

The influence area for the Plymouth ramp garage indicates that this facility is used

TABLE 12

WALKING DISTANCE, PARKING TO DESTINATION

CBD Area	Purpose of Trip	No. of Trips[1] <400 ft	400-600 ft	601-800 ft	801-1,200 ft	1,201-1,600 ft	>1,600 ft	Total	Avg Dist. Walked (ft)
Retail core	Work	2,517 (35.8)	3,059 (43.6)	727 (10.4)	474 (6.7)	139 (2.0)	104 (1.5)	7,020 (100.0)	500
	Shopping	4,764 (52.8)	3,121 (34.5)	568 (6.3)	428 (4.7)	149 (1.6)	10 (0.1)	9,040 (100.0)	410
	Other	2,100 (38.0)	2,489 (45.0)	452 (8.1)	276 (5.0)	163 (2.9)	50 (1.0)	5,530 (100.0)	470
	Total	9,381 (43.4)	8,669 (40.1)	1,747 (8.1)	1,178 (5.5)	451 (2.1)	164 (0.8)	21,590 (100.0)	460
Office core	Work	1,430 (20.8)	2,586 (37.8)	571 (8.3)	1,620 (23.6)	379 (5.5)	274 (4.0)	1,860 (100.0)	680
	Shopping	550 (48.2)	380 (33.3)	120 (10.5)	60 (5.3)	20 (1.8)	10 (0.9)	1,140 (100.0)	450
	Other	1,043 (45.2)	759 (32.8)	320 (13.9)	135 (5.8)	27 (1.2)	26 (1.1)	2,310 (100.0)	470
	Total	3,023 (29.3)	3,725 (36.2)	1,011 (9.8)	1,815 (17.6)	426 (4.1)	310 (3.0)	10,310 (100.0)	610
Remainder	Work	1,077 (36.7)	193 (6.6)	248 (8.5)	692 (23.6)	378 (12.9)	342 (11.7)	2,930 (100.0)	810
	Shopping	730 (66.4)	220 (20.0)	70 (6.4)	50 (4.5)	20 (1.8)	10 (0.9)	1,100 (100.0)	400
	Other	2,075 (81.0)	139 (5.4)	173 (6.8)	76 (3.0)	62 (2.4)	35 (1.4)	2,560 (100.0)	370
	Total	3,882 (58.9)	552 (8.4)	491 (7.4)	818 (12.4)	460 (7.0)	387 (5.9)	6,590 (100.0)	570
All	Work	5,024 (29.9)	5,838 (34.7)	1,546 (9.2)	2,786 (16.6)	896 (5.3)	720 (4.3)	16,810 (100.0)	630
	Shopping	6,044 (53.5)	3,721 (33.0)	758 (6.7)	538 (4.8)	189 (1.7)	30 (0.3)	11,280 (100.0)	420
	Other	5,218 (50.2)	3,387 (32.5)	945 (9.1)	487 (4.7)	252 (2.4)	111 (1.1)	10,400 (100.0)	450
	All	16,286 (42.3)	12,946 (33.6)	3,249 (8.5)	3,811 (9.9)	1,337 (3.5)	861 (2.2)	38,490 (100.0)	520

[1]Figures in parentheses are percentages.

primarily by office workers and businessmen in the office core, west of the Genesee River. The predominant business use of the Plymouth ramp garage is confirmed by the fact that the average parking interval is 5.7 hr—about three times as long as the average parking interval at the Mortimer and Clinton ramp garages.

The influence area of the three ramp garages, as well as the municipal parking lot at Court and Chestnut Streets, is shown in Figure 11.

Garage Discharge Rates

Studies of hourly variation of vehicles leaving the Mortimer and Clinton ramp garages show that the peak discharge occurs regularly at 4 to 5 p.m. on normal business days. This peak, coinciding with the maximum homebound traffic movement, compounds the congestion in the retail core. At the Mortimer ramp garage the maximum discharge

Figure 11. Destinations of drive

arking in four municipal facilities.

was 59.7 percent of capacity, while the Clinton ramp garage discharged 58.1 percent in the same hour.

The Plymouth Avenue ramp garage is more fortunately situated in being removed from core traffic. However, this facility has just a single exit which discharges directly into the Inner Loop. Peak hour discharge occurs at 4 to 5 p.m. at the same time that the traffic peak takes place on the circumferential route. As a result, congestion and delay frequently occur, particularly in the vicinity of Plymouth Avenue and Allen Street.

PARKING RATES

Parking rates in Rochester are determined primarily by two factors: (a) what the traffic will bear, and (b) the rate schedules of city-owned garages and lots. The average 1-hr charge throughout downtown Rochester is 28 cents, whereas the average all-day rate is 76 cents. Detailed information on average parking rates is given in Table 13.

Rates at Municipal Parking Facilities

Municipal parking rates in the retail core are designed to encourage short-term parking. At the Mortimer and Clinton ramp garages, the 1-hr rate is 20 cents. This compares with an average 1-hr rate of 29 cents at privately owned lots and 50 cents at privately owned garages in the retail core. On the other hand, the city's rate for all-day parking is $1.00 in relation to averages of 76 and 86 cents, respectively, at the privately owned facilities. Over-all, the rates at city-owned facilities are about one-half of those prevailing at privately owned garages and lots in the same section of the CBD.

It is estimated that the average revenue per car space at three municipal ramp garages—Mortimer Street, Clinton Avenue and Plymouth Avenue—runs about 75 cents daily. It is evident that private investment could not undertake capital ventures of this magnitude at the rates currently charged for parking at these municipal facilities; no private investor would have similar benefits of tax exemption or the availability of other municipal services to sustain part of the normal costs of operation.

Average Parking Rates in the CBD

In the retail core the 1-hr average fee is 30 cents with the all-day average at 82 cents. The corresponding averages for office core are 27 cents for one hour and 85 cents for all day. The principal difference between the two areas is the greater uniformity of rates prevailing in the retail core. In the remainder of the CBD, there is a decided drop in parking rates. The 1-hr charge in this perimeter area averages 22 cents, the all-day charge 59 cents.

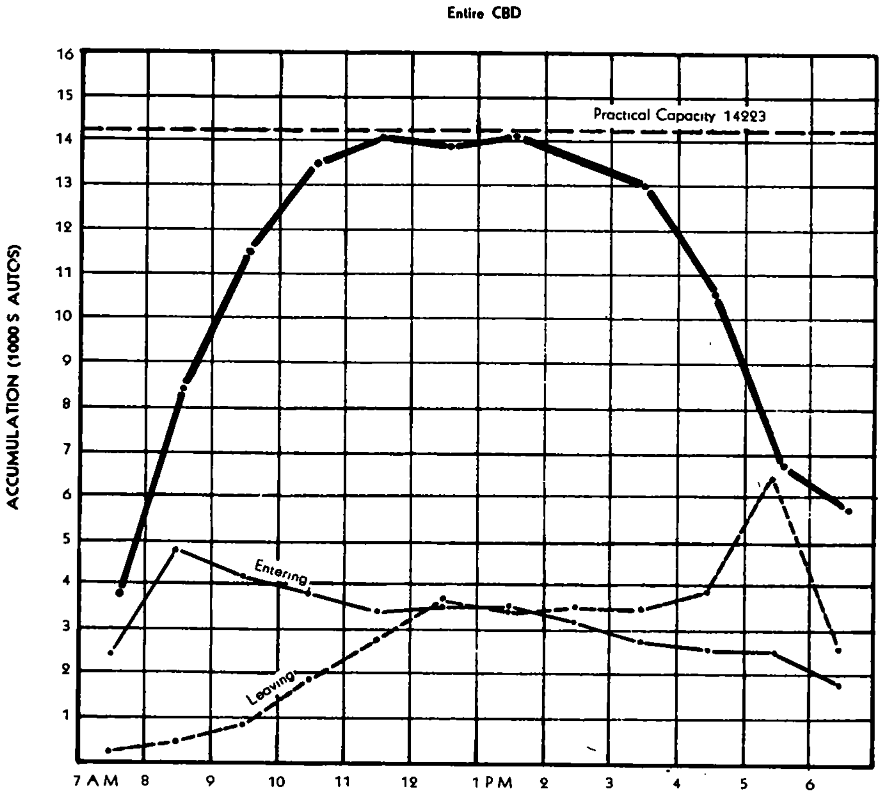
TABLE 13

AVERAGE PARKING RATES, ROCHESTER CBD

		Average Parking Rates ($)					
		Garages		Lots		Average	
Type of Space	CBD Area	1 Hr	All Day	1 Hr	All Day	1 Hr	All Day
Private	Retail core	0.50	0.86	0.29	0.76	-	-
	Office core	0.35	1.04	0.31	0.92	-	-
	Remainder	-	-	0.24	0.62	-	-
	All	0.45	0.92	0.28	0.74	0.30	0.76
Munic.-owned	Retail core	0.20	1.00	-	-	-	-
	Office core	0.10	0.50	0.05	0 40	-	-
	Remainder	-	-	0.05	0 40	-	-
	All	0 17	0.84	0.05	0.40	0.15	0.76
All facilities	Retail core	-	-	-	-	0.30	0.82
	Office core	-	-	-	-	0.27	0.85
	Remainder	-	-	-	-	0.22	0.59
	All	-	-	-	-	0.28	0.76

COMPARISON WITH OTHER CITIES

How does Rochester compare with other medium-size cities in its supply of downtown parking? Rochester's 14,972 CBD parking spaces (to become 17,756 in the near future) compares with an average of 11,933 in urban areas of 250,000 to 500,000 population. At present, Rochester is 25 percent above average in downtown parking space, and, after completion of the Civic Center and Midtown Plaza garages, Rochester will be 50 percent above average for cities of this size.



	Before 7													Total
Entering CBD		2382	4869	4067	3859	3334	3535	3528	3100	2837	2644	2491	1844	38490
Leaving CBD		211	478	890	1921	2791	3616	3363	3568	3545	3931	6437	2679	34430
Accumulation	1796	3967	8358	11535	13473	14016	13935	14100	13632	12924	10637	6641	5856	

Figure 12. Hourly accumulation of autos in downtown Rochester.

If comparison is made with cities of 500,000 to 1,000,000 (Rochester's "urban area" is close to 500,000 population), this city is still clearly out in front. When present construction is completed, Rochester will have one-third more CBD parking capacity than the average for cities in the one-half to one million category.

Rochester has not only provided more aggregate parking space than is typical for a city of its size but this has been done concurrently with a marked reduction in curb parking. The streets have been made available for traffic movement by eliminating parking at the curb. Only 8.3 percent of CBD parking in Rochester is at the curb as compared with 15.5 percent in other eastern cities.

Rochester now has 26 downtown parking spaces per 1,000 people in the metropolitan area and will have nearly 31 spaces per 1,000 population when present building is finished. This compares with an average of about 20 downtown spaces per 1,000 people in other middle-size eastern cities.

From the foregoing comparisons it is quite evident that Rochester municipal authorities have done an outstanding job over the past decade in meeting the demand for downtown parking space. Compared with cities of similar size, and also with other cities of two to three times its size, Rochester is well in the lead.

PARKING REQUIREMENTS

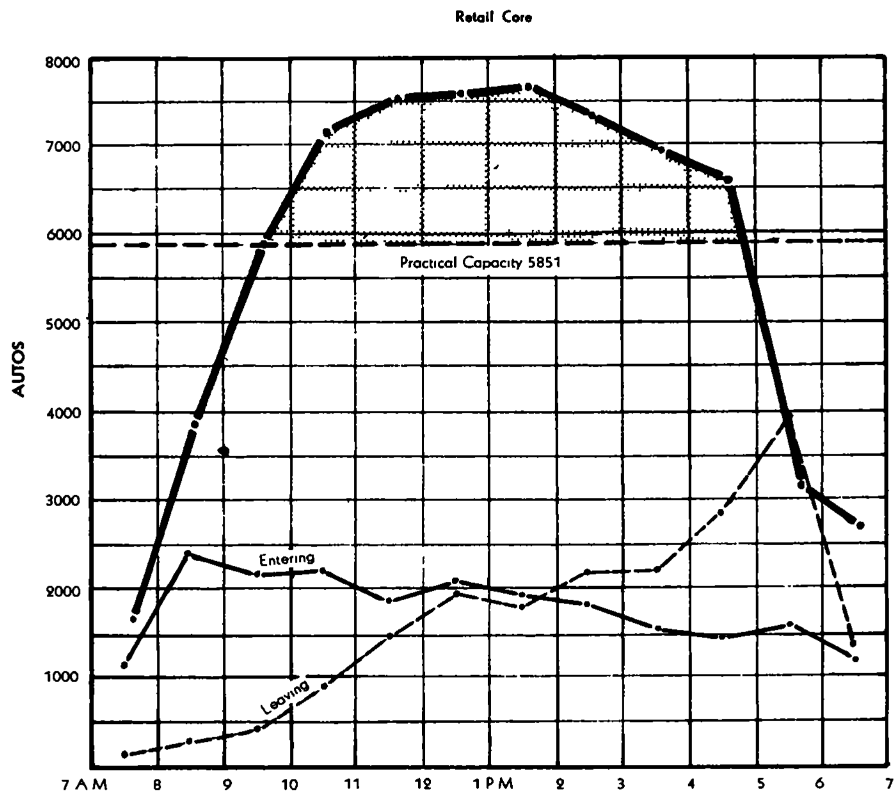
With a total of 14,972 street and off-street spaces available within the CBD, it is estimated that a practical capacity of 14,223 spaces exists.

This adjustment of 5 percent is made to account for in and out movements and motorists' lack of information on where available spaces exist. The practical capacity of 14,223, after making this adjustment, compares with a maximum demand of 14,100 in the middle of the average weekday. In other words, the practical parking capacity throughout the entire Rochester CBD is just 1 percent over the present average daily parking demand. The hourly accumulation of autos in the CBD is shown in Figure 12.

In determining parking demands, each of the 12 zones in t' e CBD was analyzed individually; the actual parking supply was determined by field inventory and an individual accumulation developed for that zone by tabulating traffic entering and leaving the area hourly.

Parking Demand—Retail Core

The principal traffic generator in downtown Rochester is the retail core area—100



	Before 7													Total
Entering Retail Core		1124	2413	2215	2310	1773	2029	1968	1830	1538	1470	1633	1287	21590
Leaving Retail Core		76	210	315	852	1496	1961	1917	2063	2100	2716	3976	1440	19122
Accumulation	637	1685	3888	5788	7246	7523	7591	7642	7409	6847	5601	3258	3105	

Figure 13. Hourly accumulation of autos in downtown Rochester.

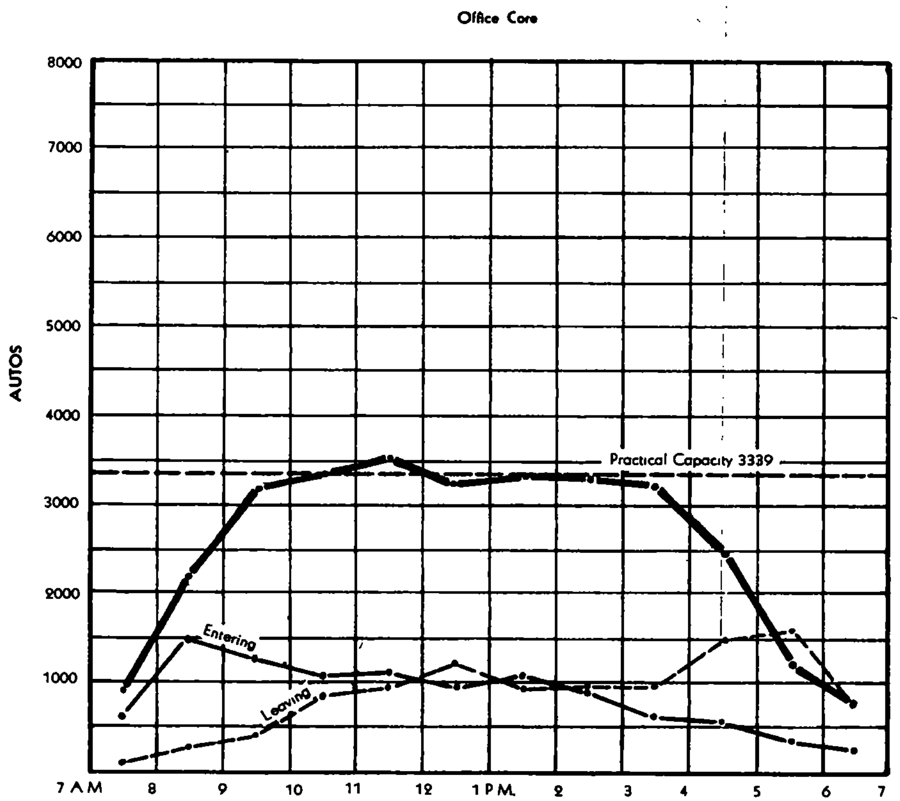
acres bounded by Andrews, Gibbs, Court and Water Streets. This area attracts 21,590 autos during daytime hours on an average weekday.

Shopping in downtown stores is the primary purpose of 42 percent of retail core parkers. Visiting other business establishments was the stated purpose of another 33 percent.

In early afternoon, 7,642 cars have accumulated in the retail core (Fig. 13). This maximum accumulation is 1,799 vehicles more than the practical capacity of parking spaces within the retail core. The two zones north of Main Street have surplus parking spaces, whereas the two zones south of Main Street have deficiencies. The Midtown Plaza, now being constructed in the southeast quadrant, will overcome this deficiency, as well as some of the deficiency in the southwest quadrant.

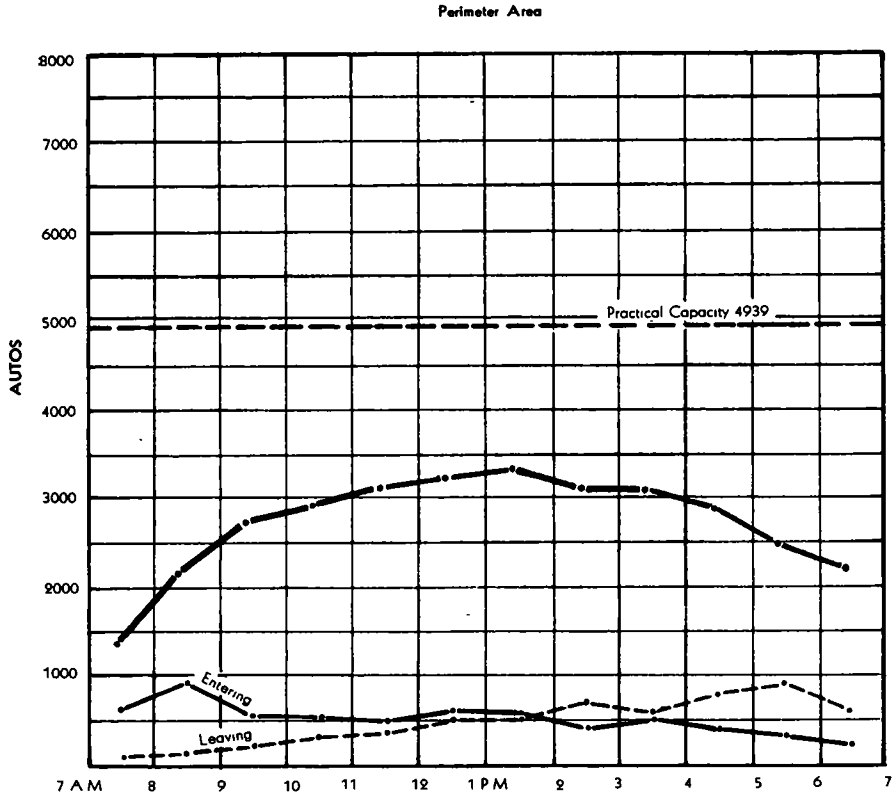
Parking Demand—Office Core

With the recent addition of 375 spaces at the new Civic Center garage, there is now a slight surplus of parking space in the office core. Altogether, the office core area is in reasonably good balance—a practical capacity of 3,434 spaces to accommodate



	Before 7													Total
Entering Office Core		632	1514	1281	1032	1054	949	1039	814	761	657	352	225	10310
Leaving Office Core		105	210	381	775	954	1184	972	848	900	1496	1559	648	10032
Accumulation	329	856	2160	3060	3317	3417	3182	3249	3215	3076	2237	1030	607	

Figure 14. Hourly accumulation of autos in downtown Rochester.



	Before 7													Total
Entering Perimeter		626	942	571	517	507	557	521	456	538	517	506	332	6590
Leaving Perimeter		30	58	194	294	341	471	474	657	545	719	902	591	5276
Accumulation	830	1426	2310	2687	2910	3076	3162	3209	3008	3001	2799	2403	2144	

Figure 15. Hourly accumulation of autos in downtown Rochester.

the peak daily demand of 3,417 vehicles. Hourly accumulation of autos in the office core is shown in Figure 14.

Parking Demand—Remainder of CBD

There are 4,939 spaces to accommodate the peak of 3,209 vehicles occurring on an average weekday. This leaves a surplus of 1,730 spaces among these seven zones outside the more concentrated core areas. The hourly accumulation of autos in this perimeter is shown in Figure 15.

Summary of Parking Requirements—1960 to 1975

Summarizing this current picture, it is concluded that Rochester is amply supplied with downtown parking space. Facilities now available are sufficient to meet parking demands throughout the CBD as a whole. Deficiencies exist in some downtown sections, particularly in the retail core, as given in Table 14 and shown in Figure 16. However, the completion of the Midtown Plaza and Civic Center parking structures will overcome these present deficiencies. With few localized exceptions, Rochester will then have

TABLE 14

PARKING SUPPLY AND DEMAND, 1960

CBD Area	Zone	Daily Auto Trips: Shopping	Business	Other	Total	Max. Accum	Avail. Spaces	Parking Spaces: Excess	Deficient	Surplus or Deficient
Retail core	1013	1,810	1,150	1,160	4,120	1,460	1,470	10	-	-
	1014	3,390	1,420	610	5,420	1,920	2,314	394	-	-
	1017	2,280	2,550	2,290	7,120	2,520	689	-	1,831	-
	1018	1,560	1,900	1,470	4,930	1,750	1,378	-	372	-
	Total	9,040	7,020	5,530	21,590	7,650	5,851	404	2,203	-1,799
Office core	1021	820	1,880	680	3,380	1,060	1,245	185	-	-
	1022	320	1,250	1,190	2,760	870	1,082	212	-	-
	1023	-	3,730	440	4,170	1,310	1,107	-	203	-
	Total	1,140	6,860	2,310	10,310	3,240	3,434	397	203	+ 194
Remainder	1012	240	470	160	870	420	419	-	1	-
	1015	150	340	390	880	430	928	498	-	-
	1016	300	1,120	630	2,050	1,000	1,498	498	-	-
	1019	160	450	450	1,060	520	452	-	68	-
	1051	90	150	220	460	220	427	207	-	-
	1061	100	330	370	800	390	699	309	-	-
	1062	60	70	340	470	230	516	286	-	-
	Total	1,100	2,930	2,560	6,590	3,210	4,939	1,798	69	+1,729
All	All	11,280	16,810	10,400	38,490	14,100	14,224	2,599	2,475	+ 124

TABLE 15

PARKING SUPPLY AND DEMAND, 1975

CBD Area	Zone	Daily Auto Trips	Max. Accum	Avail. Spaces	Parking Spaces: Excess	Defic.	Surplus or Defic
Retail core	1013	4,109	1,455	1,410	-	45	-
	1014	5,241	1,855	1,995	140	-	-
	1017	8,448	2,991	2,782	-	209	-
	1018	5,063	1,792	1,335	-	457	-
	Total	22,861	8,093	7,522	140	711	-571
Office core	1021	3,675	1,158	1,202	44	-	-
	1022	4,224	1,331	1,158	-	173	-
	1023	6,603	2,080	1,780	-	300	-
	Total	14,502	4,569	4,140	44	473	-429
Remainder	1012	1,117	543	365	-	178	-
	1015	694	337	723	386	-	-
	1016	1,873	910	1,336	426	-	-
	1019	1,063	517	411	-	106	-
	1051	252	122	407	285	-	-
	1061	771	375	671	296	-	-
	1062	617	300	506	206	-	-
	Total	6,387	3,104	4,419	1,599	284	+1,315
	All	43,750	15,766	16,081	1,783	1,468	+ 315

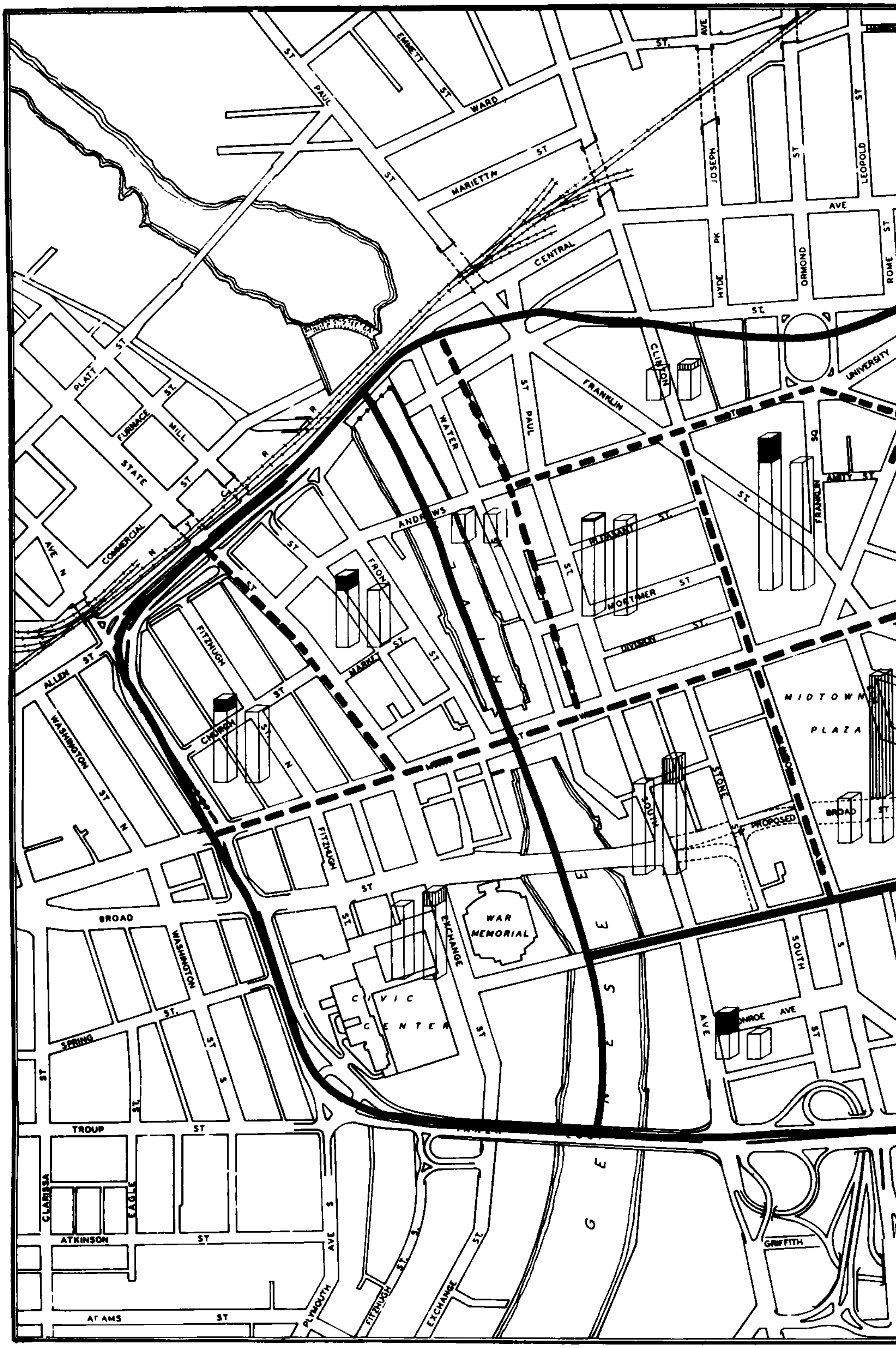
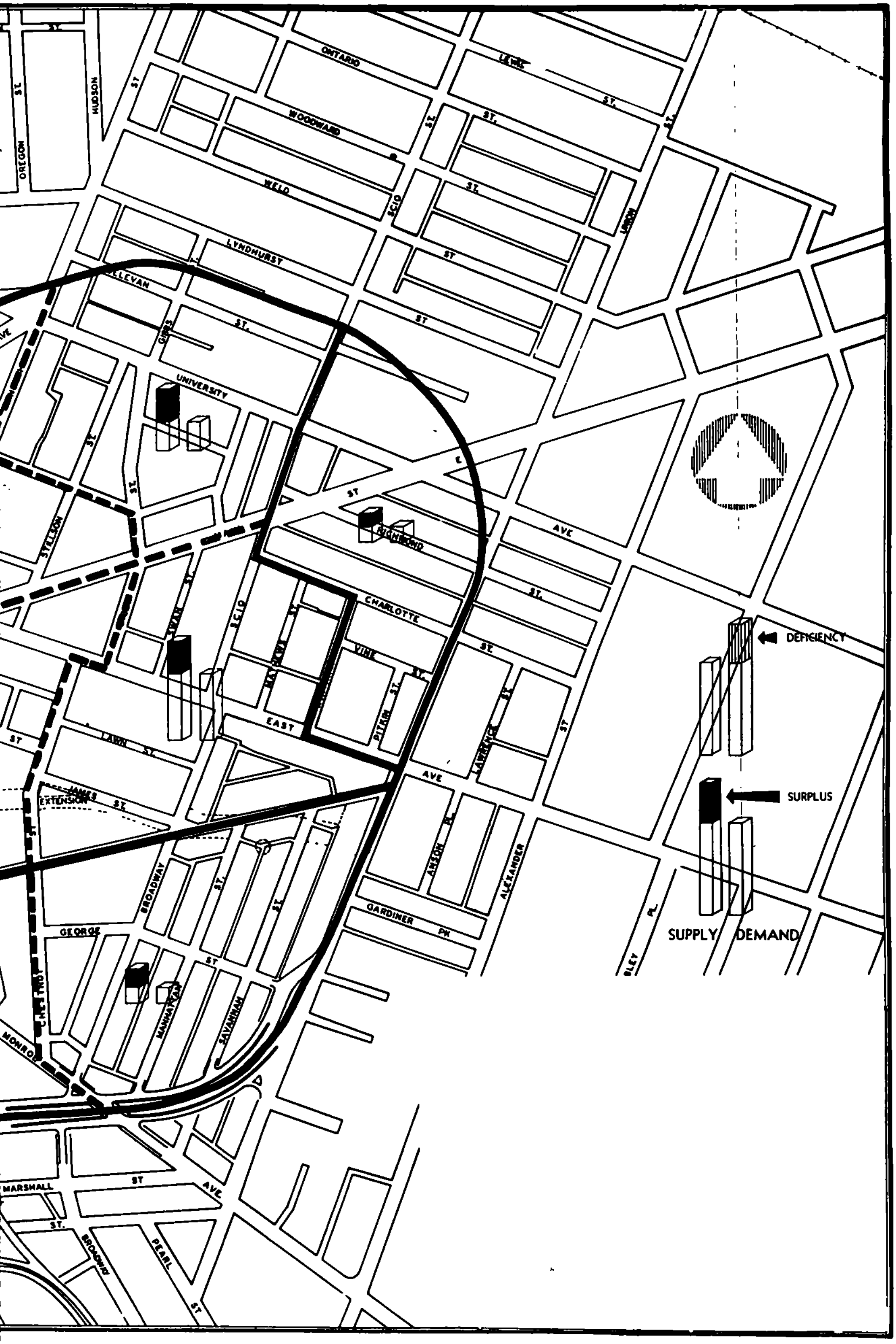


Figure 16. Parkin



supply and demand.

caught up with the demand for parking space for the next few years, at least.

Even with the Midtown Plaza garage in operation, it is estimated that a deficiency of 571 spaces will exist in the retail core by 1975. The parking supply and demand for each section of the retail and office cores, as well as the perimeter area, are given in Table 15. This tabulation indicates that the principal deficiencies will occur in the southwest quadrant of the retail core, the only part of the central shopping district which does not have a municipal off-street garage.

In its generalized land-use plans, the City Planning Commission has tentatively designated four locations for proposed garages. Two, or three at most, of these should be sufficient to fully take care of the city's future needs. It is quite unlikely, however, that any such need would exist for at least five years hence. More likely, these projected parking structures are 10 to 12 years away.

HRB:OR-440

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