HIGHWAY RESEARCH BOARD

Bulletin No. 19

Parking

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PARKING

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Washington 25, D. C. July, 1949

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CAN PRIVATE ENTERPRISE HANDLE THE PARKING PROBLEM SUCCESSFULLY?

K. VAUGHAN-BIRCH,
Traffic Engineer, Vancouver, B. C.

The significance of the fact that there are two groups possibly more vitally concerned with the parking problem than the motorist seems sometimes to be overlooked.

These two groups are the downtown property owners, merchants, etc., and the municipal authorities, both of whom are vitally and selfishly concerned with the maintenance of business and property values in the central business district.

While the motorist's interest in the problem is a natural one it should not be forgotten that in the final analysis he has a choice the others have not, he may without compunction or loss transfer his patronage to another location where the parking demand has not yet reached the difficult stage.

Fundamentally the problem is one of getting people into and out of our business districts, not necessarily vehicles. Improvement in mass transportation facilities therefore offers probably the greatest relief. Furthermore, it might well be argued that if any subsidy is to be considered the best results might be achieved by its application to the transit system.

Municipal authorities are mainly alarmed at the loss of revenue brought about by the decrease in property values in the central business area. One approach to the problem therefore may lie in reassessment of suburban business properties and a revision of the tax structure which would provide for higher taxation of such properties.

Consideration should be given to any and all other steps which might be taken to combat the problem. It is quite evident, however, that a certain percentage of the population will persist in the individual convenience of the private auto, and, if parking accomodation is not provided in the central business district, will shop in suburban areas. Progressive merchants will then establish branch stores which will in turn attract mass transit patrons (who would otherwise journey downtown) in addition to local residents and so the vicious circle in the pattern of decentralization becomes evident.

TWO MAIN FACTORS - CONVENIENCE AND COST

Primarily, therefore, the motorist must be satisfied. From his standpoint there are two main factors. Experience in many cities indicates that the degree of success of any parking plan depends to a large extent on these factors. The first is CONVENIENCE. The motorist evaluates in terms of time both the distance to destination and the ease with which he may park and subsequently pick up his vehicle. The second is COST. The parking fee must be one which the motorist is willing to pay.

With respect to the first, surveys have been carried out in a great many cities, some of them very extensive surveys, with the object of determining what amount, where, and what type of parking accomodation is needed to meet the requirements of the motorists in the cities concerned. Much attention has been given to this aspect; to the need for planning convenient parking accommodations.

After all the factual information is gathered and the answers to the foregoing questions known, however, action becomes bogged down in many cases because of the seeming impossibility to hurdle the next

obstacle, the matter of finance in which is wrapped the other factor - cost.

ECONOMIC ASPECT

While a number of parking studies, particularly, in recent times, deal with the cost of parking accommodation the economic aspect has not been given the importance it deserves. A full knowledge in this regard is necessary before an intelligent decision can be reached with respect to the method of financing the parking project and through what agency it is to be financed. Both of these lead to the important point - the cost to the motorist.

Much has been said pro and con on the question of municipal participation in the parking business. Advocates of private enterprise, however, appear to overlook an unusual feature uncommon to any other merchandising or service field, the competition to off-street storage formed by free or low cost accommodation (street parking) which in many instances is as conveniently located.

It is true, of course, that the streets can take care of only a small percentage of those seeking storage. While the amount of this space is steadily decreasing it must be acknowledged that curb parking accommodation will generally be available at least between the rush hours on all but the most important thoroughfares and, consequently, will continue to affect the economic aspect.

In any event it must again be remembered that the suburban area, with in most cases its free parking accommodations, is still beckoning the motorist. It is therefore quite evident that parking accommodation must not only be provided in the central business district but must also be made available at a cost which the motorist is prepared to pay if decay in this area is to be prevented or the amount lessened.

MUNICIPAL OWNERSHIP

The economic analysis which forms a part of the study of the downtown parking problem in Vancouver clearly indicates that municipal ownership holds the answer to the problem of providing low-cost short-time storage. It is stated in the Report[1]:

"In an increasing number of cases, the failure of private enterprise to provide a satisfactory answer to the parking problem has resulted in municipalities having to accept this responsibility. Information to be published in the 1947 Municipal Year Book shows that 40 percent of 875 reporting U.S. cities of 10,000 population and over now operate one or more parking lots in their downtown business districts. The number of cities in this category has increased by 25 percent since 1946.

This trend has occurred despite expressions of concern about governmental interference with private business. It has, however, become increasingly evident that provision of parking facilities must be considered a public utility similar to City water works, sewers, roads and pavements. The principal reasons for the trend toward municipal operation are: (1) Only the municipality can acquire, by the right of expropriation, property suitable for parking: (2) Only by public ownership can continued operation and relative permanency of parking facilities be assured: (3) Economically, the service can usually be provided at less cost by the municipality.

The provision of parking accomodation on expensive downtown property is a good example of the type of project which can be undertaken most effectively by the municipality. This is true providing the municipality does not become involved in the sale of gasoline or oil, or the rendering of other services which can obviously be handled more efficiently by private enterprise.

In general, municipalities can provide more economical service on projects which involve relatively large initial investments coupled with small annual labor costs. Financing by municipalities involves interest charges on bonds, the

[1]Report on the Downtown Parking Problem, City of Vancouver, B. C.

annual cost of which is currently about one-half the usual minimum expected return on an equivalent investment by private enterprise. A substantial portion of each revenue dollar is required to pay financing charges on the investment in property used for parking. It follows that the more expensive the property, the greater is the advantage to the consumer in having the facilities provided by the municipality rather than by private enterprise."

LAND COST: INFLUENCE ON PARKING FEES

It is stated further in this report with respect to the economic analysis of parking lots that "the crux of the economic problem of providing off-street parking accomodation in Vancouver, at prices acceptable to the average motorist and within tolerable walking distance of his destination, is land cost. There is an abundance of land in the downtown area on which the cost of providing short-time parking by the municipality under favorable conditions would be less than 5 cents per hour. This land area is far more than enough to provide for immediate requirements. Not all of it is suitably located for parking near the congested areas along Granville and Hastings Streets. It would, of course, be uneconomical to acquire land for parking lots where it would not be reasonably well patronized.

Calculations show that the City can provide off-street parking accommodations for 5 cents per hour on land which costs about $3.50 per sq. ft. If land can be acquired for less, the operations could be conducted at a profit. If land costs were higher, a subsidy would be required, or the motorist would have to pay more for the service. These figures apply to open parking lots, suitably developed, designed for self-parking and with liberal allowances for car clearance and aisle spaces."

The land cost in many United States cities of comparable size may be considerably higher than the $3.50 per sq. ft. quoted above. Indeed much of the land situated in the Vancouver central business district is very much higher in price.

In this connection it was found that in Vancouver the estimated cost of storage on a slef-parking lot or a two-level open-deck structure (again self-parking) would be approximately the same on land costing about $5.22 per sq. ft., the unit cost being about 6.3 cents per hour for self-parking. Where the land exceeds this cost the two-level structure would be more economical.

The basis of the calculation with respect to the foregoing figures included among other things a 3% interest on investment, a building cost of $3.00 per sq. ft. of floor area at upper level and a 3% straight line depreciation on overhead structure.

"SELF-PARKED" VERSUS "ATTENDANT PARKED"

It will be noted that all the foregoing refers to self-parking. There are many factors both for and against self-parking. However, in view of the average motorist's dislike to spend time waiting while an attendant brings his car, it would appear that self-parking, providing not too many levels are involved, would generally be more attractive to him.

It is true, of course, that less space per car is required when the vehicles are attendant-parked. This unit saving in vestment cost of parking space is offset, however, by the additional labor cost on attendant-parking.

From the study conducted by Mr. Ricker, as set out in his report on the "Traffic Design of Parking Garages", an average time of approximately 6 minutes is taken in storing and delivering a vehicle. Calculations indicate that in Vancouver the average labor cost of storing and delivering a car is approximately 10 cents.

The handling cost is the same irrespective of the length of time the vehicle is parked. Consequently, the cost of short time "attendant-parked" storage is higher and the long-time parking cost less than for the corresponding period on the "self-parked" plan as illustrated in the following table quoted from the Vancouver report relative to three level open-deck garages:

Time Parked	"Attendant-Parked" 3 Level Garage			"Self-Parked" Parking Lot
	Fixed Cost	Labor Cost	Total Cost	Fixed Cost = Total Parking Cost
1 hour	5¢	15¢	20¢	8¢
2 hours	10	15	25	16
3 hours	15	15	30	24
4 hours	20	15	35	32
5 hours	25	15	40	40
6 hours	30	15	45	48
7 hours	35	15	50	56
8 hours	40	15	55	64

The above costs are based upon a land cost of $6.80 per sq. ft. (For all-day "attendant-parking" in Vancouver, it is estimated that on land costing more than $6.80 per sq. ft. it is cheaper to build a three level open-deck garage than to acquire additional land for parking at ground-level.)

There are many other factors concerning attendant-parking not the least of which is the difficulty of providing on a sound economic basis sufficient help to give quick service during the peak periods which the average motorist expects. On this account "attendant-parked" projects are not recommended for Vancouver to meet the short-time parking demand.

SHORT-TIME PARKING ACCOMMODATION MUNICIPALITY'S RESPONSIBILITY

Whether it is practically possible to segregate short from long-term parking seems a little uncertain. It would appear, however, that the short-time parking demand such as is now largely taken care of on the street should probably be looked upon as a municipal responsibility and the long-term (employee-type) parking as something which might be handled by private enterprise.

In most cities on this continent, up until comparatively recent times, operators of parking lots and garages appeared to be solely interested in the long-term parking. Certainly their rates discouraged short-time parking and encouraged the long-term parker.

INTENSE BUILDING DEVELOPMENT INCOMPATIBLE WITH TRAFFIC NEEDS

A great deal has been said concerning the large percentage of the total land area in any business district which would be required to provide sufficient accommodation to meet the demand and whether this in itself is detrimental to that area. There seems to be little object in academically discussing this point because in practically every large city today parking lots of low standard are to be found at fairly frequent intervals in the central business district, many of them next to tall skyscraper type buildings. It is obvious that these orphan sites are the out-come of the intense development of adjacent property. They are not born out of the parking demand.

It would appear that tall buildings are incompatible with our traffic needs. Traffic generators of this type create an impossible situation with respect to parking. The regulation of building height has been practiced, of course, for many years. The need for limitation of height, however, was usually based upon other than traffic considerations.

ZONING AS APPLIED TO PARKING

Such regulations might well form part of zoning as applied to parking. The question of zoning is a controversial one. Many qualified persons are of the opinion that it is virtually impossible to apply such zoning to existent central business

districts. Undoubtedly, there are many difficulties in the way of zoning generally and also in regard to limitation of building height in relation to the parking problem. One important point in this connection is that zoning may in fact accelerate decentralization instead of correcting the situation.

One qualification of the foregoing remarks concerning zoning is quite important. It is that the provision of off-street loading and unloading facilities in the case of commercial buildings, and the provision of off-street vehicle storage space in the case of dwellings, should be made mandatory, this need being of a different nature to the general parking requirements.

MUNICIPAL PARTICIPATION NECESSARY

All of the points enumerated indicate that the short-term parking space demand can best be treated on a community or area basis. An evaluation of the parking demand generated by any given type of business, which may be subject to change, presents many difficulties. The provision of parking accommodation by the municipal authority on a local improvement basis therefore offers the best possibility of success in dealing with this matter.

Municipal participation, as previously indicated, is desirable for three main reasons: (1) Generally only the municipality has power of expropriation. (2) It can assure that sites selected will be permanently maintained for parking. (3) It can usually provide such parking accommodation at a lower cost.

As final argument in further support of the desirability of municipal participation in the parking business it might be emphasized that the parking problem becomes more acute as development becomes more intense, consequently where the demand is greatest the difficulty in providing storage at acceptable rates is the greatest. Moreover, the high land costs and taxation in intensely developed areas encourages the owners to use their particular sites in a manner which will provide the greatest return on investment. Parking is usually not such a use or, usually, it is not such a use until the parking situation has become so intolerable that motorists in desperation accede to high parking rates. This seems to be the crux of the situation.

There is little evidence that private enterprise has so far met the parking need. Furthermore, it is obvious that private enterprise cannot be expected normally to do this, to provide (and retain) the low cost parking accommodation in the early stages of the development of the central business district which is the key to the problem.

THE EFFECT OF BUILDING SPACE USAGE ON PARKING DEMAND[1]

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No phase of highway transportation receives more attention today than does vehicular parking. It constitutes the major inconvenience of almost every automobile driver destined to an urban central business district and with increased automobile registration and usage, the demand for parking will continue to increase substantially. However, motor-vehicle transportation is not efficient unless adequate parking and terminal facilities are provided. Furthermore, the lack of such facilities seriously affects the entire community with respect to land usage, urban finances and municipal development.

It is generally agreed that the primary function of downtown streets is to move vehicles and not to provide space for their storage. Thus, to promote increased efficiency of mass transportation, fire engines, police cars and other emergency vehicles, as well as to alleviate traffic congestion, delays and accidents, curb parking should either be restricted or prohibited altogether. But if this is done the resulting lack of downtown curb parking spaces, generally where the demand for parking is greatest, places the burden almost completely upon off-street parking lots and garages. Unfortunately, due mainly to high land values, these facilities are utterly inadequate in both capacity and location.

These facts call attention to the urgent necessity for more off-street parking facilities. They should be properly located, their rates attractive and their size and number sufficient for both present and anticipated future demands. However, immediate remedies are retarded by a lack of data based upon adequate factual analyses.

Proper analysis of the parking situation necessitates not only the acquisition of local basic facts, but also their expert interpretation and effective application. Although comprehensive parking surveys have already been conducted in numerous municipalities, it has been pointed out that thus far nothing more than generalizations have been made concerning the parking characteristics of the shopping, employee, business, recreational and other groups[2]. Consideration must be given to the nature of demands by particular generators of traffic and these demands related to trip purpose, hour of parking, the length of time parked and the distance walked from the parking place to the ultimate destination. Such detailed information pertaining to stores as well as to office, industrial, educational, recreational, medical and other types of buildings, could be used to promote the proper location, design and operation of new terminals or the improvement of existing parking facilities.

Statement of Purpose - One of the purposes of this study was to investigate the possibilities of utilizing the parking survey data, collected in various

[1]Condensed from *A Study of the Traffic Generated and the Parking Demand Created by Buildings with Various Types of Space Usage* by J. T. Stegmaier; a dissertation prepared under the direction of the co-author in partial fulfillment of the requirements for the degree, Doctor of Engineering, at The Johns Hopkins University (Baltimore, 1948).

[2]Wilbur S. Smith and Charles S. LeCraw, *Parking*, ed. The Eno Foundation for Highway Traffic Control, Inc. (Saugatuck, 1946).

cities, to determine the parking habits of drivers destined to individual generators of different types. Past surveys, at least, were not planned to supply this kind of information and unless future ones are so planned, certain inherent difficulties are apparent. In the first place, only a few cities have conducted or indeed are likely to conduct parking surveys that are thorough enough to contain the basic information desired. Secondly, the area covered by such surveys customarily corresponds only to that of greatest demand, usually the downtown district, and therefore the selection of generator types is limited to those which lie within this area.

A second intent of the study was to look into the possibility of securing mass information about the parking demand created by various types of buildings from urban origin and destination data as a by-product.

And finally, a third purpose was to demonstrate how we may increase the usefulness of this mass information of generator parking demand, by relating it to the physical characteristics of the generators, that is, specifically, by correlating parking demand with such factors as the floor area of various buildings, the number of seats in theaters and other places of recreation, the guest capacity of hotels, the concentration of industrial employees, the number of beds in hospitals, etc. Correlations of this sort obviously would be useful in estimating the anticipated parking demands of new and future land uses and would thus help to provide adequate parking facilities where they belong. Heretofore the acquisition of this kind of data has been one of the most difficult phases of a parking investigation.

PARKING HABITS

Analysis of Data - The data accumulated in the Baltimore City Parking Survey[3] were used as the basis for determining the parking habits of drivers destined to particular generators. This survey and the origin and destination survey conducted in Baltimore were financed jointly by the Public Roads Administration, the Maryland State Roads Commission and the City of Baltimore. The authors are deeply grateful to these sponsors and to members of their staffs too numerous to name, not only for permission to use the data, but for their advice and generous cooperation throughout the study.

It might be well to give a few details of this survey. It was conducted in the spring of 1946 and was confined to 127 blocks of the downtown business district. All of the parking facilities within that area were inventoried and the drivers using them were interviewed. These interrogations supplied information concerning the daily weekday parking pattern including the time of parking, length of time parked, destination after parking, distance walked and purpose of trip. The data were coded and then punched on business machine cards for mechanical tabulation. It is important to note that, while actual destinations were recorded on the questionnaires, the punch cards did not show where the parker went except to give the sector or block in which the generator was located. This was the smallest unit into which the study area had been subdivided and only infrequently did it fail to have in it buildings other than the one under analysis. For this reason the punch cards did not reveal the specific building to which the parker walked. This could only be obtained from the interview questionnaires. It should be stated that coding and punching to permit sorting by sectors was completely adequate for the original purposes of the parking survey. Had the use of the data for individual generator parking demand been visualized, it would have been possible to facilitate the identification of the questionnaire against the punch card by giving each individual

[3]Report of the Transportation Study, - Baltimore Metropolitan Area, PARKING SURVEY OF THE DOWNTOWN AREA - BALTIMORE CITY, Vol. IV, ed. Maryland State Roads Commission in cooperation with the City of Baltimore and the Public Roads Administration, Federal Works Agency, Baltimore 1946.

parking operation a serial number by which it could have been so identified.

However, for the purpose of locating curb parking facilities, the sector or block numbers had been assigned an additional digit which pin-pointed the side of the block. This made it possible to sort the cards for parking operations which were followed by trips to buildings fronting on the entire face of at least one side of a block. There were only three such generators under study. The punch cards which pertained to trips of each of these three were sorted and listings were made of all pertinent information recorded thereon.

Presentation of Results - Since the purpose here is merely to indicate a procedure and to give evidence of the reliability of the method, the results of only one such analysis will be presented. These pertain to a combination of two large contiguous department stores ("A" and "B") which front on one side of the same block. These two department stores are the largest such retail businesses in Baltimore's downtown shopping area and together created a demand for the parking of 1413 automobiles between 6 A.M. and 6 P.M. on the average weekday. Figure 1 shows that the purpose of nearly 81 percent of the trips was to shop and less than 13 percent to work. This varies by less than 3 percent from the weighted distribution of purposes for auto drivers destined to these two buildings, as analyzed from the O and D survey data, thus indicating a reasonable correlation of the results. Over 73 percent of the shoppers parked between 10 A.M. and 3 P.M., at the average rate of 172 vehicles per hour. Public lots and garages accommodated nearly 84 percent of the parked vehicles, the remaining 16 percent occupying curb spaces. Nearly all employee drivers parked at off-street facilities. Curb spaces were but little used prior to 10 A.M., probably due to parking restrictions, but from noon until 3 P. M. the curb was used as often as public garages. Throughout the day the relative use of various types of off-street facilities remained fairly constant.

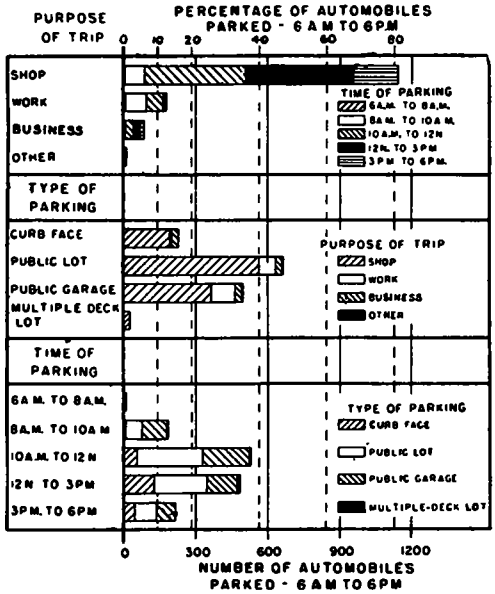

Figure 1. Analysis of Trips by Parkers Destined to Department Stores "A" and "B" by Purpose and Time and Type of Parking

Figure 2 clearly indicates that drivers working at the stores park for a long time.

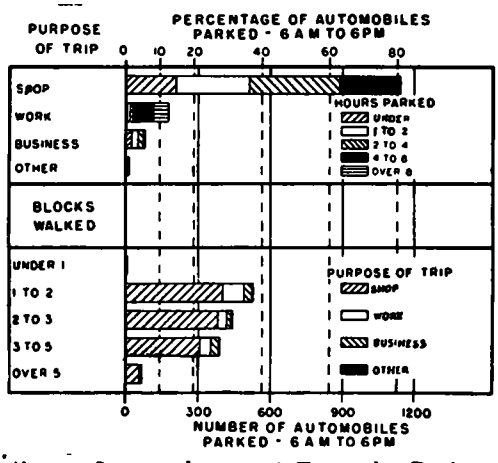

Figure 2. Analysis of Trips by Parkers Destined to Department Stores "A" and "B" by Purpose, Hours Parked and Blocks Walked

What may be surprising is the revelation that the weighted average length of time parked by shoppers was 2.8 hours. Recalling that 73 percent of these shoppers arrived within a five-hour period, it may be concluded that the shopper-parking turnover hardly exceeds two vehicles per day. It should be stated in this connection that some of these trips, resulting in long parking and reported as shop-

ping visits to these stores, probably included walking trips to other stores, luncheon, the beauty parlor or the theater. A further interesting feature of Figure 2 is the distribution of distances walked from parked cars to the stores. Note that the suspected short shopper-walks and long worker-walks are not apparent. It is probable that a considerable number of workers reached the garage, which was close by, before the heavy influx of shoppers, thus pre-empting spaces which the latter desired.

Similarly, in Figure 3 it is seen that the short-time parker did not park any nearer his destination than the long-time parker. If anything, the opposite was the case. Also, a very large proportion of those parking on a public lot walked two to three blocks, while a larger percentage of the public garage parkers walked only one to two blocks. This was no doubt due to a lot and garage, respectively, which are located within these distances and which are particularly convenient to shoppers destined to these two stores. Owing to the existing restrictions on curb parking in the adjacent blocks, the distances walked from curb spaces were relatively long. Nevertheless, note the short-time nature of this on-street parking.

The parking patterns of these figures are consistent with patterns of trips originated by these same two stores when the trip data drawn from the Baltimore Origin and Destination Survey were analyzed and presented in a somewhat similar manner. Also, when the number of automobile drivers who came to the stores (exclusive of those who merely dropped off passengers), as revealed by the analysis of the O and D data, is compared with the number of parkers as revealed by the parking survey data, we find a remarkably close agreement. Auto drivers numbered 1333 and auto parkers 1413, a difference of only 5.6 percent. In the case of the second of three generators studied in this manner, an office building, drivers number 322 and parkers 359, a difference of 10.1 percent. However, in the case of the remaining generator so studied, a large general market, drivers total 488 per day and parkers 831, the difference being 41.3 percent. It is believed that the lack of agreement in the latter instance may be explained by the fact that the number of auto drivers was determined by the answers to questions concerning trips to the market on every weekday, whereas only two weekdays are market days. On the other hand, the number of parkers was developed from the parking survey and a very large proportion of those parking facilities near the market, which might well have been utilized by its patrons, were interviewed only on market days. This no doubt created an apparent parking demand much in excess of that which would occur on the average weekday. In view of these favorable correlations, it was considered reasonable to presume that each automobile driver represented a potential parker.

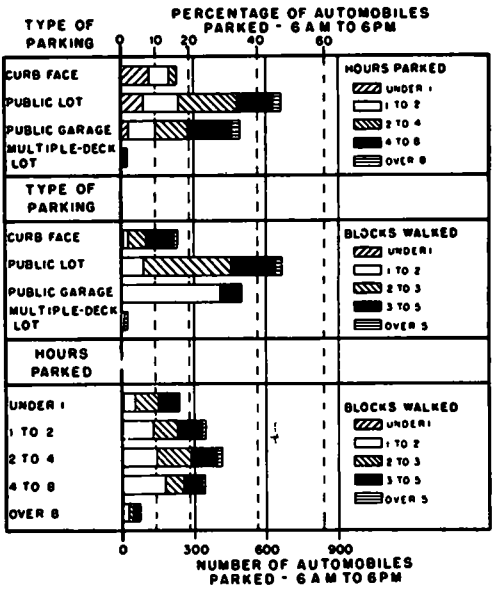

Figure 3. Analysis of Trips by Parkers Destined to Department Stores "A" and "B" by Type of Parking, Hours Parked and Blocks Walked

PARKING DEMAND

Analysis of data - The origin and destination data of the Baltimore Transportation

Study[4] were used as the basis for determining the parking demands of various generators as a by-product of origin and destination surveys. Although the Baltimore Study followed the conventional pattern for such surveys it may be well to recall that the smallest unit into which the Metropolitan Area was subdivided was a sector, which varied in size from a city block in the central business district to several blocks in the outlying areas. For this reason sorting the coded punch cards on a given sector of destination gave no assurance that the sorted cards represented trips to a particular building within that sector. In a few instances, where only one generator was located in the sector, this was true; but in most cases, particularly in the downtown areas, reference had to be made to the original questionnaires in order to determine which trips were made to the selected generators.

The following fifteen buildings and one neighborhood shopping community were selected for study as generators of parking demand:-

Three Department Stores
A Railroad Passenger Station
A Retail and Mail Order Store
A Neighborhood Shopping Community
A General Market
An Industrial Plant
Two Office Buildings
A Theater
A Public High School
A University Campus
A Hotel
A Bus Terminal
A Private Hospital

Referance was made to the original questionnaires where necessary, and those punch cards were sorted out which definitely referred to trips to the selected generators. It was then assumed that each automobile driver trip (exclusive of those who merely dropped off passengers), destined to the respective buildings, constituted a demand for one parking space. This, of course, does not mean that one parking space is required and must or should be provided. Peak-hour demand and vehicle turnover per parking space must also be considered and these factors vary with the type and location of the generator as well as the purpose of the trip. Although peak hours were apparent, turnover factors could not be determined directly from O and D data since they contained no pertinent parking information. However, by taking into consideration all of the elements involved in each case, the turnover factors were estimated to range from one vehicle per space to a "to work" purpose to four vehicles per space for purposes other than to shop or work. The two vehicles per space turnover rate for retail department store shopping was based largely upon the results of the parking habits study presented above.

Presentation of Results - The parking spaces required to satisfy the parking demand created by the various generators are presented in Table I. The adaptability of these figures for determining such factors as floor area per parking space required, theater seats per parking space required, etc. is obvious. Equally as evident is the applicability of this information to the formulation of tenable zoning ordinances, which require that automobile parking spaces be provided for in conjunction with the construction of certain new buildings, as well as major structural alterations to existing buildings. These facilities should satisfy the parking needs in a convenient location to insure usage and should be off-street to prevent interference with moving traffic. Provisions for such facilities are recommended by numerous highway and traffic engineers and city planners. Many cities and other political subdivisions have already approached the parking problem by the incorporation of such ordi-

[4]Report of the Transportation Study,--Baltimore Metropolitan Area, TRANSPORTATION NEEDS, Vol. I. Also MANUALS OF INSTRUCTION, ed. Maryland State Roads Commission in cooperation with Baltimore City and the Public Roads Administration, Federal Works Agency (Baltimore, 1945-1946).

TABLE 1

Summary of Parking Space Demand Created on 24-hour Weekday by Various Generators and Relationships with Floor Area or Other Basic Units

Generator	Purpose of Trip	Auto Driver Trips[a]	Estimated Turnover	Parking Spaces Required	Gross Floor Area or Other Basic Unit	Gross Floor Area or Other Basic Unit per Parking Space Required
Department Store "A"	Work	104	1	104	182,145 sq ft. (selling area)	283 sq ft (selling area)
	Shop	1036	2[b]	518		
	Other	62	3	21	305,145 sq. ft. (total area)	475 sq. ft (total area)
	Total			643		
Department Store "B"	Work	146	1	146	185,000 sq ft. (selling area)	518 sq ft. (selling area)
	Shop	415	2[b]	208		
	Other	10	3	3	245,000 sq. ft (total area)	686 sq. ft. (total area)
	Total			357		
RR Passenger Station	Total	1187	1 2[c]	989	93,583 sq. ft.	95 sq. ft.
Retail and Mail Order Store	Work	286	1	286	1,300,000 sq. ft	1,816 sq. ft.
	Shop	808	2[b]	404		
	Other	78	3	26		
	Total			716		
Neighborhood Shopping Community	Work	294	1	294	120 shops at 5,000 sq. ft. each equals 600,000 sq ft	813 sq ft.
	Shop	582	3[d]	194		
	Other	1000[e]	4	250		
	Total			738		
General Market	Work	5[f]	1	5		
	Shop	399	2[b]	200	45,000 sq ft 650 stalls	199 sq ft 2 9 stalls
	Other	64	3	21		
	Total			226		
Department Store "C"	Work	144	1	144		
	Shop	735	2[b]	368	100,000 sq ft.	180 sq ft
	Other	134	3	45		
	Total			557		
Industrial Plant	Work	447	1	447	1,913,000 sq ft	4223 sq ft
	Other	19	3	6	3138 employees	6.9 employees
	Total			453		
Office Building "A"	Work	313	1	313	591,000 sq. ft	1628 sq. ft.
	Other	150	3	50	(net rentable area)	(net rentable area)
	Total			363		
Office Building "B"	Work	292	1	292		
	Other	49	3	16	252,000 sq ft	818 sq ft.
	Total			308		
Theater	Soc-Cul & Recreation	205	1 5[g]	137	50,000 sq. ft. 3000 seats	318 sq. ft 19.1 seats
	Work	20	1	20		
	Total			157		
Public High School	Work & School	201	1	201	256,400 sq. ft. 1527 students	1263 sq. ft. 7 5 students
	Other	7	3	2		
	Total			203		
University Campus	School	266	2[h]	133	398,500 sq ft (net academic area)	910 sq ft (net academic area)
	Work	283	1 2[h]	236		
	Home	60	1	60	613,500 sq. ft (total area)	1401 sq. ft (total area)
	Other	26	3	9		
	Total			438	3335 students 4346 seats	7 6 students 9.9 seats
Hotel	Work & Business	100	1[k]	100		
	Recreation	56	1 4[m]	40	162,000 sq ft. 425 guest rooms 700 capacity	1013 sq ft. 2 7 guest rooms 4 4 capacity
	Other	61	3	20		
	Total			160		
Bus Terminal	Total	29	1 2[c]	24	25,000 sq ft (net terminal area) 46,000 sq. ft. (incl garage area)	1042 sq. ft (net terminal area) 1917 sq ft (incl garage area)
Private Hospital	Work, Home & Medical	172	1	172		
	Other	78	2[n]	39	197,000 sq ft 400 beds	934 sq. ft 1 9 beds
	Total			211		

[a]Except those to serve passengers
[b]Low due to peak-hour traffic
[c]Greater than unity due to 24-hour period
[d]Higher due to shorter time parked at specialty shops
[e]Also omits trips "to home".
[f]But many workers drive trucks
[g]Low due to evening peak hour.
[h]Higher due to evening and night classes
[k]Business not at hotel--actually "to room" purpose.
[m]Low due to evening peak hour
[n]Low due to visiting-hour peaks

nances. Others are considering or advocating this type of building regulation.

But in addition to the diverse opinions on the area of each parking space and the minimum distance between parking areas and generators, there exists a flagrant lack of conformity among the basic factors thus far advanced. This situation stems mainly from a deficiency of reliable criteria, the most credible data to date having been obtained from studies of only relatively homogeneous land uses, which provide a limited amount of information. The type of study outlined here, which investigates absolutely homogeneous areas, namely, individual generators, should provide data that will be entirely applicable and indispensable in formulating necessary ordinances.

Floor areas or other basic units were secured for each generator and this information was in turn related to the parking space requirements mentioned above to produce the basic factors which also appear in Table 1. Although discrepencies appear to be large among the factors for different buildings of the same type, that is, department stores and office buildings, it can be reliably stated that this variation is due to the different character of the traffic generated.

CONCLUSIONS

1. This study demonstrates a method for obtaining detailed information, directly from urban parking survey data, concerning the parking habits of automobile drivers destined to various types of traffic generators with varying space usage.

2. It likewise demonstrates and establishes a method of securing, as a by-product of urban origin and destination surveys, mass information concerning the parking demand created by such generators.

3. The results which are presented should be regarded only as examples of the kind of information which such analyses may produce. They must be used with caution until substantiated or modified by further applications of the methods.

4. In order to insure that the samples are stable, generators must attract a considerable number of trips. From experience gained in this investigation the minimum number appears to be at least one thousand.

5. The heterogeneous buildings of neighborhood shopping communities, while not generating an appreciable traffic individually, may create a sizable parking demand when considered collectively. This is due to their mutual proximity and consequent added power of attraction.

6. Buildings of approximately the same size, which house activities that are similar in character, may create parking demands that are quite dissimilar. Therefore it is evident that sweeping generalizations are dangerous.

7. It is elementary that information emanating from studies of this type is indicative of demands only as they exist and does not disclose potential demands which may arise as a result of changing conditions.

RECOMMENDATIONS

1. The procedures demonstrated in this study are recommended for use in connection with and as a by-product of urban origin and destination and parking surveys, wherever comprehensive parking information is sought pertaining to a considerable number of large generators. It is obvious that, if the number of generators is limited or if they are small, it will probably be less expensive and more accurate to conduct a spot-check survey by interviewing a large sample at the site.

2. In order to facilitate the application of these methods it is recommended that present O and D and parking survey techniques be revised to include the following:

a. Whenever the smallest subdivision of the O and D or parking survey area is occupied by more than one generator, specifically code the individual buildings selected for special study at the outset. This would prevent laborious scanning of the original questionnaires.

b. If this is not practicable, the

names or addresses of the buildings should be reported as destinations. In this case all of the original interview forms should be carefully listed and filed by serial number in such a way as to facilitate their matching with the punch cards.

c. When (a) is not practicable in the case of the parking survey, include a serial number on the original questionnaires and on the punch cards so that for each parking operation they may be readily associated.

TIME-MOTION RELATIONS IN OPERATION OF GARAGES

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The parking problem robs us of the primary attribute of the private automobile - its capacity for speed, or more exactly, the reduction of travel time. The majority of trips have been found to be relatively short in length, and a large proportion of them have the downtown district of a city as their destination. Perhaps it is reasonable to say that the average time-length of such trips is not over 30 minutes. Upon arrival in the downtown area, the driver is faced with a choice of either a great deal of milling around to find a curb space near his own destination, or of placing his car in an off-street facility. If he chooses the curb stall, he must often search through several extra blocks of congested traffic, and then accept a rather severe limitation of the duration of his stay. If he chooses an off-street lot or garage, he loses the ready accessability of his car, and must spend a considerable period waiting for its acceptance and delivery. In either case he adds materially to the time-length of his trip. While the time consumed in parking and unparking may not be large in absolute terms, or in comparison to the time saved over horse-and-buggy transportation, it is large enough to cause the motorist to seek other means of transportation or other destinations. He compares the time of waiting for his car to be delivered from a garage - in some cases 20 or 30 minutes - with his known experience of less than two minutes to remove it from the family garage, or less than one minute to unpark from a curb stall.

Public officials and businessmen alike are dedicated to the maintenance and improvement of downtown business areas through the provision of additional off-street parking facilities. It is of the utmost importance that these new facilities be sound financially and also meet the demands of motorists, i.e., that people not only be attracted into the center of the city, but that the accommodations provided be demonstrably more desirable than the alternatives at the curb. The factors which attract parkers into off-street facilities may be summarized as:

1. Location nearby the destinations of the motorists.
2. Low parking fees.
3. Attractive appearance.
4. Protection from weather, theft, and damage.
5. Rapid service in acceptance and delivery of cars.

It is the belief of the author that the last-named factor - rapid service - is the most important. The element of time saving is common to all the other factors, since efficient operation is necessary if parking fees are to remain low, and on the other hand, hasty operation, which may result from trying to "push" an inadequate design, will result in minor accidents and a dangerous-appearing operation.

With this in mind, a research project was undertaken at the Yale Bureau of Highway Traffic to study the design of parking garages as it affects the time of handling incoming and outgoing cars.[1] Field observations were made in numerous parking lots and garages to evaluate the various design

[1]For a complete report of this research refer to THE TRAFFIC DESIGN OF PARKING GARAGES published by the Eno Foundation for Highway Traffic Control, Saugatuck, Connecticut.

features and operational methods. Time-motion studies were made on the critical operations to determine their relative importance, and to compare different parking arrangements and types of design. Parking lots are conceded to require less time than do garages for the handling of cars, as well as being cheaper and more readily created. In these studies, more attention was given to garages because of the greater complexity of the traffic design.

In this paper, primary consideration is given to attendant-parking garages, because the operations are more complex, and time savings are important to attendant efficiency as well as customer satisfaction.

ACCEPTANCE OF CARS

In the acceptance of cars into a garage, the operations may be broken down into two classifications - those which entail the customer's time, and those which may be carried on independently of his presence. The first has the smaller time value, and seldom requires the customer to stay in the garage more than a minute. The steps may be described briefly as follows:

1. The customer drives into the garage. If the storage of cars is proceeding smoothly, this step merely involves the travel time from the street into the reservoir space at low speed. The time value may be a matter of 5 to 15 seconds.

2. A garage employee issues an identification ticket. Various types of tickets are used, but practically all have the common features of a receipt issued to the customer, a section placed on the car, and a section marked with the car registration and stall location which is filed in the cashier's office. The issuance of a ticket requires time stamping, writing down of the car registration, tearing the ticket into sections, and placing these in their proper place. A good floor man will issue an average of 120 tickets per hour, or at a rate of 30 seconds per car.

3. The customer, after accepting his receipt, leaves the garage. Most customers will leave immediately, particularly those who park in the garage regularly, or who are on business trips. Others, such as shoppers and hotel patrons may spend considerable time unloading passengers and bundles. In the latter case, the car cannot be stored until they have finished.

It may be seen then that the steps involving the customer are simple, that he is doing something all the time, and, in general, this process is quite satisfactory from the customer's point of view.

MOVEMENT TO STORAGE FLOORS

Let us now turn attention to the movement of cars to the storage floors, which may be considered almost separately from the steps described above. The procedure in a typical garage may be described as follows:

1. A driver employed by the garage (hereafter termed an attendant) gets into the car and starts the motor. This soon becomes a standardized operation to experienced attendants, in spite of the differences between various makes and models of cars. The average time required is 8 seconds.

2. The attendant drives the car along the main floor and up or down the ramps to the storage floors. The travel time on the main floor depends upon the location of the car relative to the ramp, but in any event, is of small duration. The travel time on the ramp is more interesting - and more important.

The type and location of ramps is the governing factor in the layout of most garages. Many different kinds have been patented and built, each having its advantages and disadvantages. The choice for a particular garage, however, must be based on the shape and layout of the land parcel. No one type of ramp is superior to all others, and a garage designer should be familiar with each type in order to select the one most suitable for a particular garage. There are two general classes of ramps. One, which may be termed the "clearway", provides a completely separate path for vehicles traveling on the

ramp from that of vehicles being parked and unparked. The other is the "adjacent parking" type, in which parking stalls are placed along the ramp, and the ramp is in effect used as an aisle for these stalls. The travel time on clearway type ramps is smaller and more consistent, since there is no interference from other vehicles and a fairly uniform speed may be maintained. Speeds of 10 to 15 mph. are common, with an average floor-to-floor time of about 12 seconds. When cars are not being moved into or out of the stalls abutting the adjacent parking type, these ramps may operate with almost the same efficiency as the clearway type. It is obvious, however, that serious delays may be incurred due to a blocking of the ramp whenever cars are parked or unparked. This delay is difficult to measure accurately, due to the unpredictability of its occurrence and the irregularity of arrivals of successive cars on the ramp. Measured in an overall effect for the average travel time of all cars moving on the ramp, it was found that the travel time might be increased from 15 to 30 seconds due to this kind of delay.

The ineffectiveness of fast driving on the ramps is easily demonstrated. In one garage studied, the differences between normal driving and "fast" driving, as evidenced by the squealing of tires, was found to be less than one second per floor. Other factors which affect ramp operating speeds and convenience of operation are: amount of curvature, superelevation, and sight distance at approaches to storage floors.

3. The attendant drives along the aisles of the storage floor until he reaches the stall in which he parks the car. Driving speeds on the storage floors were found to average 9 mph. The actual time spent depends upon the length of the aisles, that is, how large the garage is, and the type of car location system used. When attendants are allowed to place the car in any convenient stall they may sometimes save time, but during busy periods may use extra time in finding an open stall. Further, they must mark the location of the stall on part of the identification ticket and return it to the cashier's office. On the other hand, if the cars are placed in pre-assigned stalls, the attendant may drive directly to that stall with assurance of finding a vacant space and does not have to perform any location bookkeeping. The time of driving on the floor may occupy a period of 4 to 25 seconds.

4. The attendant parks the car in the stall. It can be shown geometrically on the basis of car dimensions and turning radii that, for parking at 90 deg. to the aisle, considerably less space is required to back cars into stalls and drive them out than to drive in and back out. This is also confirmed on the basis of experience and operating time. In all garages observed, parking stalls were placed 90 deg. to the aisles and cars were backed in. A few minor exceptions were noted because of special layouts near corners, ramps, or columns. The parking time varies inversely with the width of the stall and the width of the aisle. With adequate dimensions for safety and convenience, a reasonable average parking time is 18 seconds. With inadequate space, parking time may often be increased to a matter of several minutes, depending on the number of passes required to wedge a car in between other cars or building restrictions.

5. The attendant turns off the motor, pulls up the handbrake, and gets out of the car. This is another operation which soon becomes automatic, and will average six seconds.

6. The attendant notes the location of the car on the office stub of the identification ticket, if this system is used. A reasonable time may be about 15 to 30 seconds. However, it may be considerably less as the attendant will often write this information down while walking away from the car or while waiting for an elevator.

7. The attendant walks to the interfloor driver travel means. The walking speed of attendants was found to be about five feet per second. In some garages the elevators or stairs were placed in a remote corner, apparently to save parking

space. This is a false economy since these interfloor driver travel means are a center of activity and the attendant must spend a large part of his time walking to and from them. From this point of view they should be placed at the centroid of the parking area, with free access to all aisles.

8. The attendant goes down the interfloor driver travel means to the main floor. The average travel time per floor on a stairway is 12 seconds. The travel time on passenger elevators varies with the speed of elevator, the number of elevators, and the distribution of parking stalls between the various floors. It will average perhaps one minute per trip, including waiting time. The travel time on service elevators or man lifts is about six seconds per floor. The travel time on fire poles is about two and one-half seconds per floor.

9. The attendant walks to the reservoir space for another trip.

The entire time required for storage of an individual car may be seen to average about three to four minutes. This corresponds to an attendant handling rate of fifteen to twenty cars per hour. The total number of cars handled in a given period can be obtained by multiplying this rate by the number of attendants.

RESERVOIR SPACE

The relationship between the time required for the customer to leave his car and for the attendant to remove it to the storage floor is concerned with the operations in the reservoir space. Thus it may be readily seen that the reservoir space is the most important single area in the garage. When it is full, customers must wait in the street before entering the garage, regardless of the number of cars already stored, and this adds directly to their waiting time and dissatisfaction with the parking operation.

A theoretical basis for determining the capacity of reservoir space has been worked out and has been checked empirically against the few garages observed to have adequate reservoir space. The storage of cars in a garage may be thought of as a kinetic problem of the rate of arrival and the rate of storage, rather than the static problem of total number of cars stored. From parking surveys and experience in similar garages an estimate can be made of the expected arrival rate -- that is, how many cars per hour will be presented for storage. For a garage which is in the design stage it may be difficult to determine the exact time required to store each car. However, it is certainly reasonable to assume that enough attendants will be hired so that the average rate of storage will equal the average rate of arrival. If this is the case, then the reservoir space need only be adequate to store the cars which arrive at momentary rates higher than the average rate. Studies were made of the arrival times of cars in garages and it was found that they arrived on a random basis which could be described through the theory of probability or Poisson's Law. In applying this theory, it is necessary to select an arbitrary degree of perfection, that is, the percentage of time that over-filling of the reservoir will not be allowed.

AN APPROXIMATE SOLUTION OF THE RESERVOIR PROBLEM[2]

Consider an interval A of time. Let it be assumed that the probability that x cars arrive at the reservoir during A is given by the Poisson distribution:

$$\frac{e^{-m}m^{x}}{x!} \qquad (x = 0,\ 1,\ 2,\ \ldots) \qquad (1)$$

The rate of removal of cars from the reservoir will be represented by m'. L will represent the reservoir's capacity.

It is desired to know the probability that the reservoir will never be overfilled during A and to know how large L should be (when m and m' are given) in order that the probability of no overfilling be equal to some preassigned probability, say 0.99. Approximate answers to these

[2]The author is indebted to David F. Votaw, Instructor in Mathematics, Yale University, for the derivation of the formulas shown in this section.

questions will now be given.

The probability of no overfilling equals approximately

$$\sum_{x=0}^{L+m'} \frac{e^{-m_m x}}{x!} \qquad (2)$$

The expression in (2) is closely approximated by the cumulative normal (Gaussian) distribution when m is large (say 30 or more).
We have:

$$\sum_{x=0}^{L+m'} \frac{e^{-m_m x}}{x!} = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\frac{L+m'-m}{\sqrt{m}}} e^{-u^2/2}\, du. \qquad (3)$$

In obtaining (3) from (2) one makes use of the fact that the mean value and standard deviation of x are m and $\sqrt{m}$, respectively.

Using tables of the normal distribution we have that when m is large and the probability of no overfilling equals 0.99,

$$\frac{L+m'-m}{\sqrt{m}} = 2.4; \text{ and so}$$

$$L = (2.4)\sqrt{m} + (m-m') \qquad (4)$$

APPLICATION OF RESERVOIR SPACE FORMULA

The relationship between the capacity of reservoir space, rate of arrivals, and rate of storage is shown in Figure 1. The central curve represents the desirable condition, wherein the average rates of arrival and storage are equal. This may be represented by the formula:

$$L = 2.4\sqrt{m}$$

Where L = capacity of reservoir and
m = average rate of arrival.

As an example, if the expected arrival rate is 100 cars per hour, the reservoir should have a capacity of $2.4\sqrt{100}$ or 24 cars.

The upper and lower curves in Figure 1 illustrate the conditions where the rate of storage is 0.9, 0.95, 1.05, and 1.1 times the rate of arrival. As an example, if the rate of arrival is 100 cars per hour and the rate of storage 90 cars per hour, then the reservoir should have a capacity of $2.4\sqrt{100} + 100 - 90$ or 34 cars. This arithmetical increase is obvious, since the cars not stored will accumulate in the reservoir.

It would seem to be a false economy to provide extra reservoir space to offset a planned deficiency in attendants. On the other hand, it will certainly be necessary to hire additional attendants if insufficient reservoir space is provided. It cannot be emphasized too strongly that the reservoir space is of the greatest importance in rapid acceptance of cars into a garage, and that most existing garages are deficient in reservoir space.

DELIVERY OF CARS

One important difference between the acceptance and delivery of cars is that the customer's time is involved in the entire operation of delivery. Further, much of this time he is inactive -- just waiting -- which makes it pass slowly. The customer's time may be considered in three parts -- paying the cashier, the actual time for an attendant to deliver his car, and waiting his turn for an attendant.

The time spent at the cashier's office is small. Standard procedures are employed, including time-stamping the ticket, computing the elapsed time and charge, and making change. This procedure need not require more than 30 to 45 seconds. More often, the customer at the cashier's office is required to wait in line, not because of the time required for the cashier operation, but because cars are not being delivered fast enough, and his waiting time can thus be broken into two parts.

The operation of delivering a car from the storage floor to the outbound reservoir space is almost the reverse of the storage operation, and equivalent in time. In instances where cars are being accepted and delivered at the same period, attendants may reduce the time per car

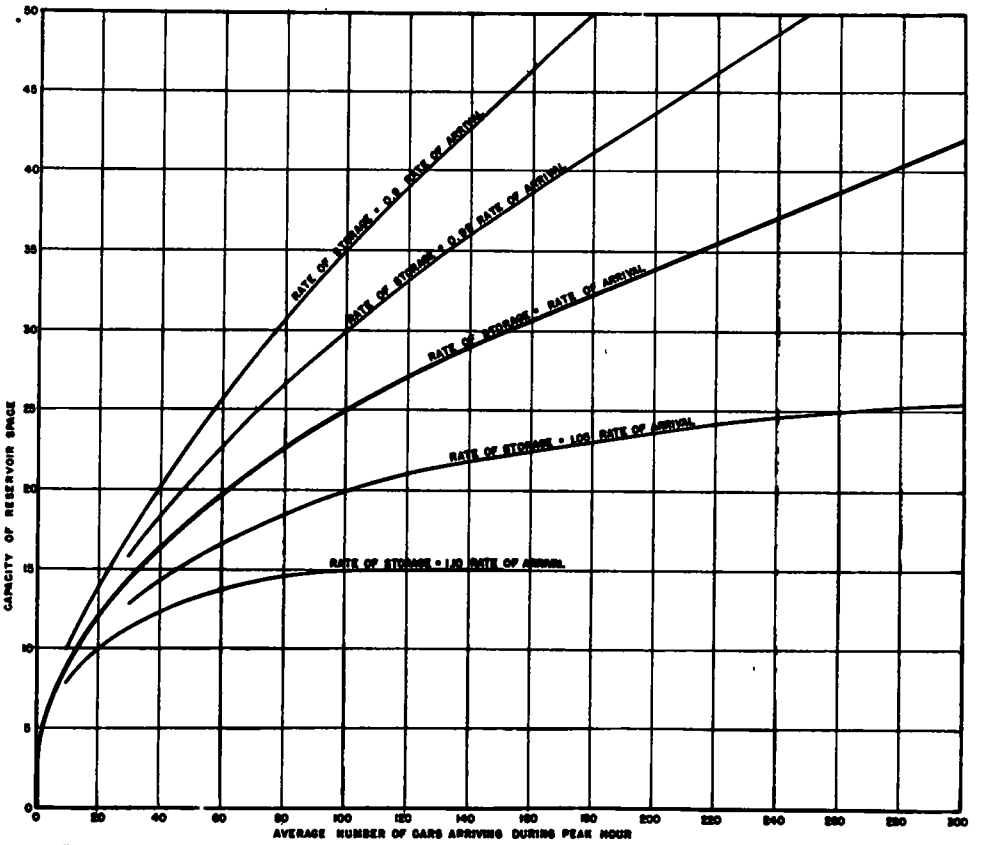

Figure 1. Relationship between Capacity and Rates of Arrival and Storage.

handled by as much as one third. While this makes for efficient employment of attendants, when the delivery operation is considered alone the time per car is thus increased by one-third.

The delivery rate - cars per attendant per hour - depends on the design of the garage, the quality of personnel, and the methods of operation. Good traffic design of the ramps, stall, and aisles will form a basis for keeping this time to a minimum. The design and location of interfloor driver travel means is also important. Beyond this point, the personnel and operations are a function of management. Although in some garages a fortuitous combination of size, layout, operation, and parking demand make it possible to deliver cars in an average time of two minutes each, this is certainly a minimum value. A reasonable average is three to four minutes.

So far, we have accounted for perhaps five minutes of the customer's waiting time. Yet, as stated earlier, customers must often wait 20 to 30 minutes for the delivery of their cars. This condition is illustrated in Figure 2, which describes the operation of a large garage during a peak rush when the stores were open during the evening. These data were collected by counting the number of waiting customers at five-minute intervals, and by recording the time of delivery of each car. It may be seen that the number of customers waiting at some periods exceeded 70 drivers, and that the average waiting time was 30 minutes. On this particular evening, only eight attendants were on duty - obviously not a sufficient number for good operation. The average customer arrival rate was about 120 per hour, the average delivery rate about 90 cars per hour, while cars were being both stored and delivered

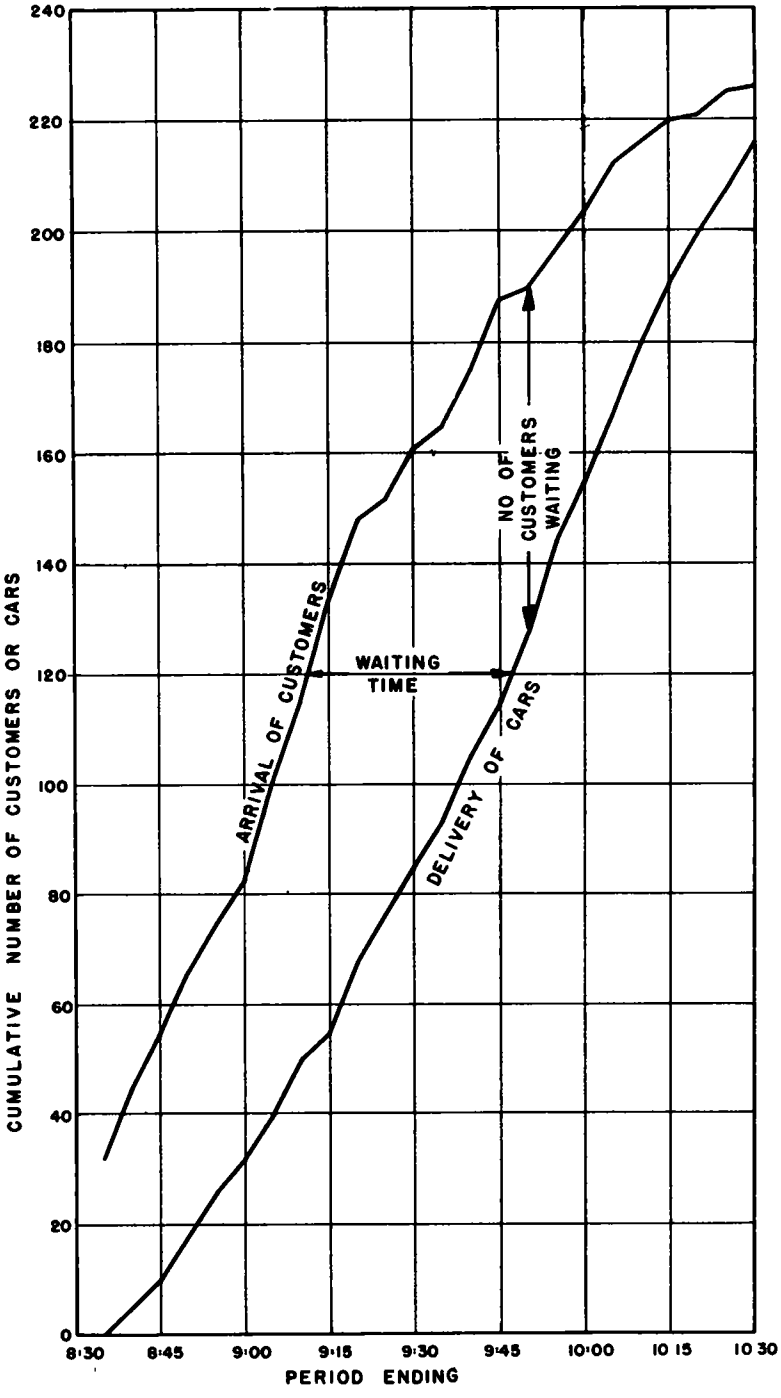

Figure 2. Garage Operation during Rush Period - Eight Attendants.

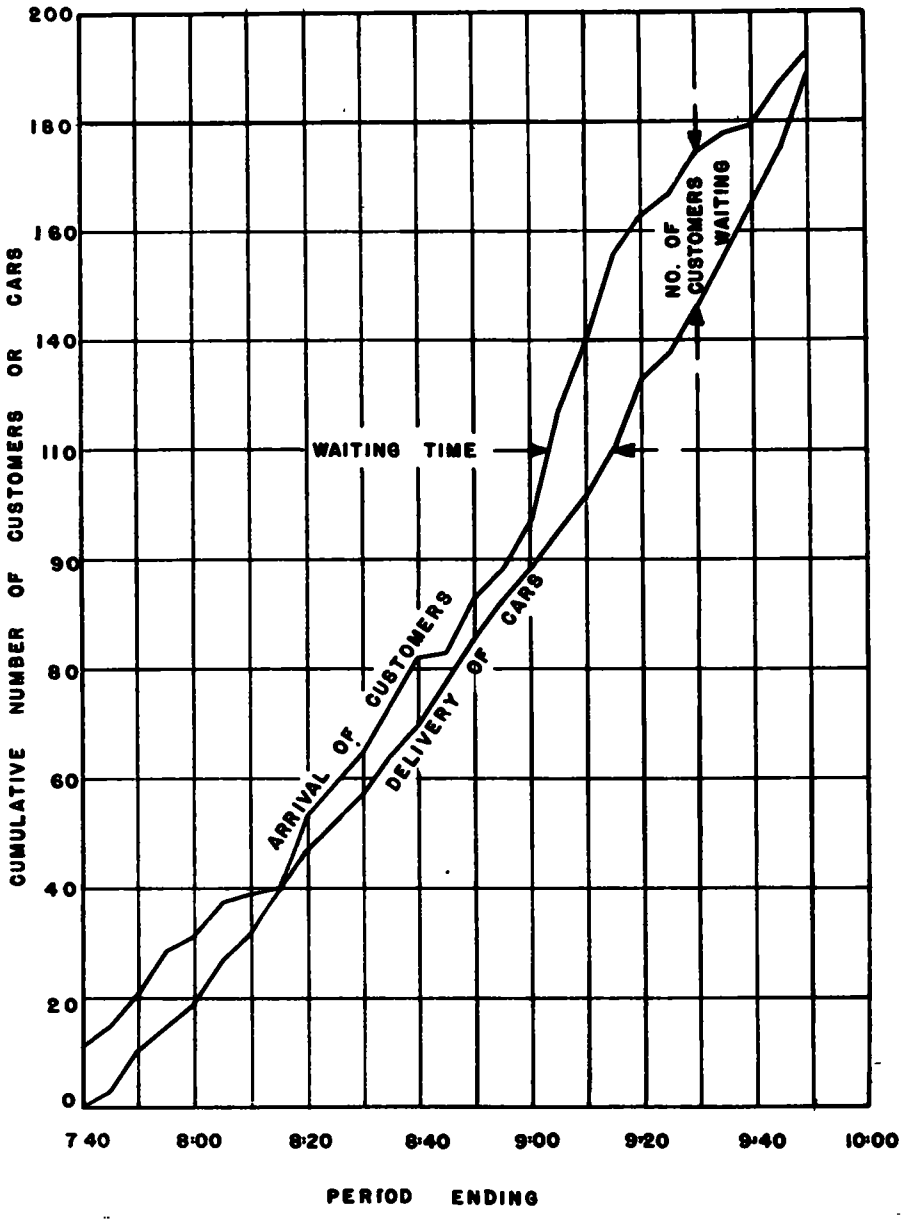

Figure 3. Garage Operation during Rush Periods - Ten Attendants.

(before 9:30), and about 120 per hour when only delivery operations were necessary.

Figure 3 shows the operation of the same garage on another shopping night. In this case, ten attendants were on duty, but four of them were relatively inexperienced. The peak number of waiting customers is 30, with a waiting time of 19 minutes. The customer arrival rate was about 110 per hour, and the average delivery rate 90 per hour. This inconsistency is due to the fact that several times early in the evening the rate of delivery exceeded the rate of customer arrival, so that the attendants sometimes had no work to do, and were never pushed as hard as on the former evening. It should also be noted that under evenly balanced operat-

ing conditions the number of waiting customers would equal the number of attendants, and the average waiting time would equal the delivery time.

CUSTOMER PARKING

The alternative of customer parking has a definite advantage in satisfying the customer's desire for minimum time. While the time spent in storing his car may be longer, the delivery time is almost certain to be shorter, and he is busy throughout the period, with practically no waiting time.

Customers generally drive more slowly than experienced attendants. Ramp speeds were found to be from 4 to 12 miles per hour. Parking time, in stalls of adequate size, averaged 26 seconds. Other operations, such as elevator travel and walking, are not materially different from those in attendant garages. The normal time for acceptance or delivery in a well-designed garage should not exceed five minutes for customer-parking. While time savings to customers during the acceptance of cars are greater in attendant-parking garages, customer-parking has a definite advantage for delivery.

DESIGN FOR PEAK FLOWS

The accumulation of cars in a garage reflects the accumulation of cars in the central business district. The inbound and outbound movements also parallel the well-known rush periods of morning and late afternoon.

It is undoubtedly true that the public's habit of concentrated peak movements is somewhat irrational, and that attendants hired for the peak periods may be practically unemployed during off-peak periods. However, service during these peaks is a key element in the demand for parking, and the design and operational procedures must be based on peak rates of movement.

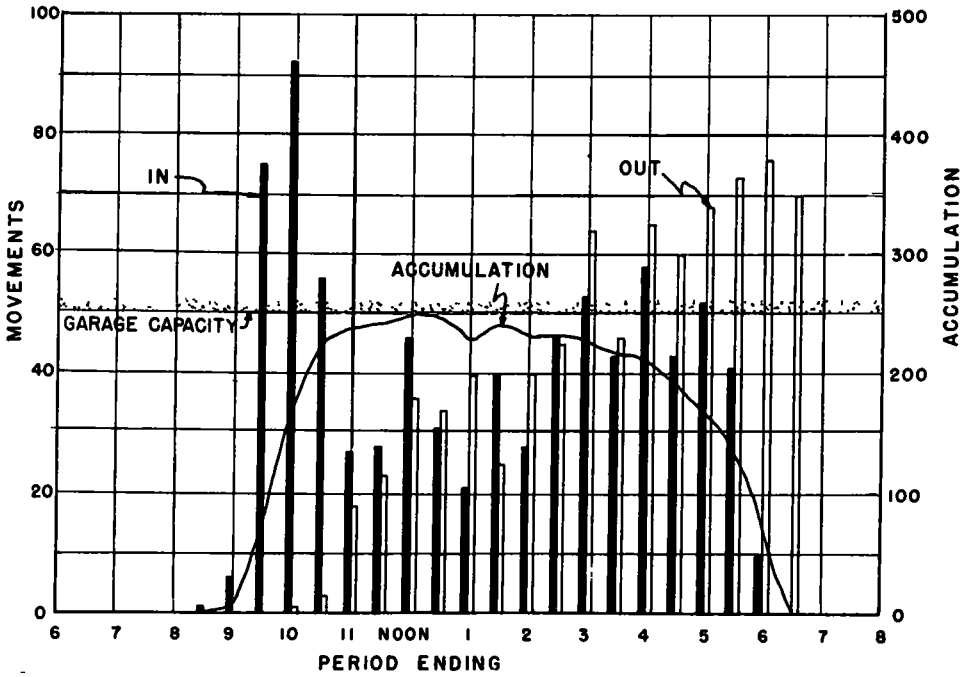

Figure 4. Movements In and Out and Accumulation of Cars in a Garage.

Figure 4 shows the inbound and outbound movements and accumulation of cars in a shopper's garage. The peak movements are 167 cars per hour inbound, and 149 cars per hour outbound. The use of this garage is definitely limited by its storage capacity.

Figure 5 shows the time of arrivals vs. the duration of stay for the same garage

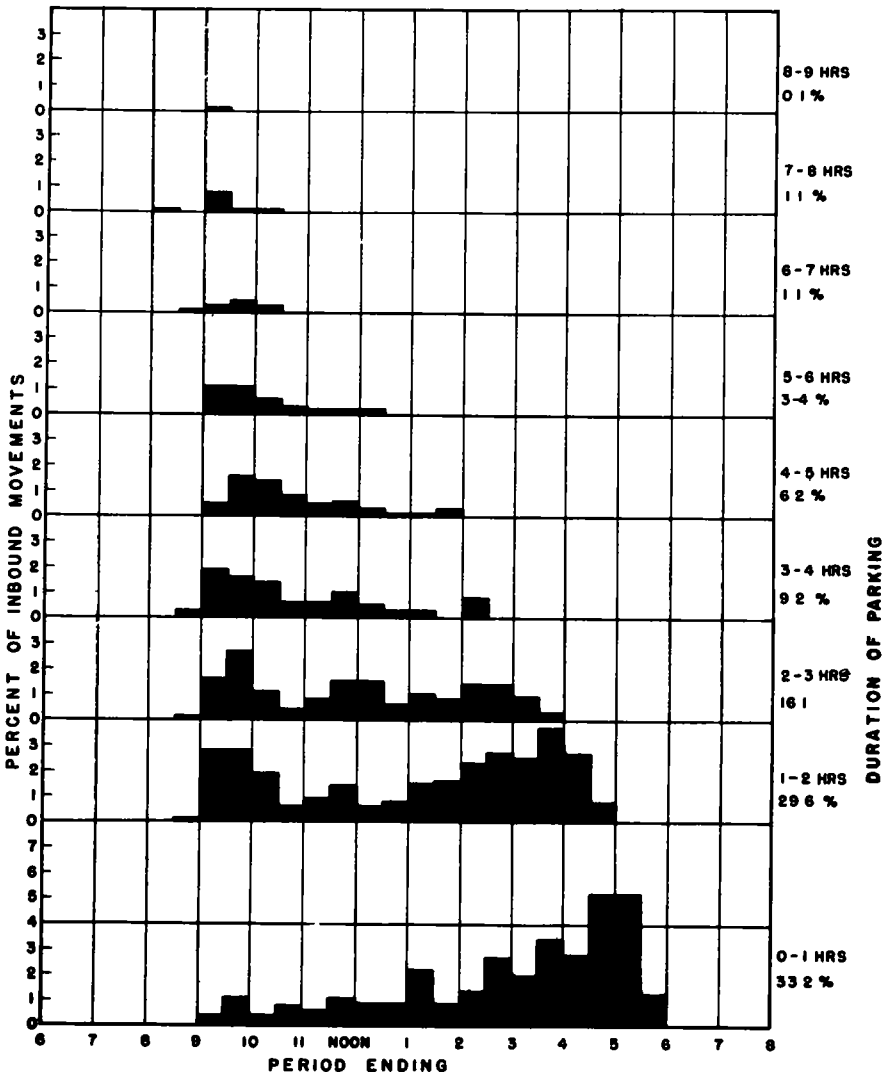

Figure 5. Time of Arrivals versus Duration of Stay.

and same day of operation. The preponderance of short-term parkers is caused by the particular demand of shoppers, and by the fact that the store management discourages all-day parking.

SUMMARY

The most important factor in attracting customers into off-street parking facilities is the reduction to an absolute minimum of the time which the customer is required to spend in storing and unstoring his car. There are no golden rules for traffic design, but in general, free paths for movement and adequate sized stalls should be provided. Adequate reservoir space is essential to the proper acceptance and storage of cars.

Proper management is of at least equal importance to design in the rapid handling of cars. Operating techniques must be simple, and geared to high rates of acceptance and delivery. The morning and evening peaks are the periods of highest demand, and a sufficient number of attendants must be employed to handle cars at an average rate at least equaling the

rate of demand. The congestion of waiting vehicles or customers should not be accepted as inevitable, or as a sign of good business.

Proper design and operation of garages will allow the handling of 20 cars per attendant per hour, or more. This means that a car can be delivered within 3 to 4 minutes after the customer calls for it. This amount of waiting time would seem reasonable and should be attractive to customers.

Customer-parking also provides for reasonably rapid service, with an average of about 5 minutes each for acceptance and delivery. While many other factors must be considered in choosing between attendant and customer parking, it does have the advantage of eliminating long waiting periods.

DISCUSSION

Mr. Campbell: "Can the formula for the approximate solution of the storage reservoir problem be applied to outdoor theater use?"

Mr. Ricker: "Basically the formula can be applied to the similar problem at outdoor theaters. Some modifications may be necessary depending on values used for the average rate of arrival and probability of no overfilling. The handling time, that is, the process of selling tickets, would be much shorter, and a complete time-motion study both inside and outside the theater would be required."

LEGAL. ADMINISTRATIVE AND FINANCIAL ASPECTS OF URBAN PARKING SURVEYS

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A commemorative United States postage stamp issued recently in honor of the late Will Rogers provides the occasion for recalling a remark on the parking problem which he made: "If you ever find a place to park your car in New York, don't move it. Leave that car there for parking purposes and buy another one for driving around." This commentary, made in a semi-humorous, semi-philosophical vein, suggests how desperate is the plight of the American motorist in our urban agglomerations.

Public authorities have not been unaware of the need for solution of the vexing parking problem, and not unwilling in many cities to investigate the facts. Parking surveys sponsored by the State highway departments with the financial and technical assistance of the Public Roads Administration, have been completed or are in process in forty-five cities of many different types and sizes, ranging in population from 12,200 (Albert Lea, Minnesota) to 878,300 (Cleveland, Ohio).[1]

These studies of automobile parking facilities in central business districts of cities, up until recently, have provided data needed for evaluation of three significant factors in the parking problem, to wit:[2]

(1) The location and amount of space currently available for parking of vehicles;

(2) The amount of space needed for parking facilities as a function of the present usage, and

(3) The approximate locations of such needed facilities.

The techniques which have been perfected to evaluate these features appear to be entirely adequate for that purpose. It has been estimated that the total costs of conducting and consummating surveys of such scope range from approximately $3,000 in the smaller places to approximately $40,000 in the larger ones.

Thus, having developed the means to ascertain the basic facts relating to the supply of and demand for parking facilities and their necessary location, it seems appropriate to expand the surveys to include additional aspects of the parking problem, particularly those dealing with legal, administrative and financial questions. It would seem that little action will be taken to alleviate the situation until these matters are properly dealt with. The proposed expansion of urban parking surveys is designed to offer guidance in this direction.

Let us assume that in a particular city, there are 5,000 off-street and curb parking spaces, and that 4,000 additional spaces are needed in designated locations.

[1] Parking surveys of varying scope have been undertaken in many other cities under the auspices of planning boards, traffic commissions, city councils, highway or public works departments, and other local bodies.

[2] Perhaps this is over-simplification, since much supplementary information on parking habits is developed simultaneously, but in terms of ultimate objective, these facts are the salient ones.

We need to know a lot more than these facts before any intelligent provision for additional spaces can be made. Are State or city agencies legally authorized to provide off-street parking facilities or to encourage private enterprise to do the job by the judicious use of incentives? Who is going to pay for the cost of the facilities, and will contributions be related to benefits received and ability to pay? What kind of a city agency should be assigned the task of dealing with all phases of the parking problem and does such a creature now exist in the city in question? What are the economic implications of not providing the terminal facilities so urgently needed in our downtown areas? A lot of other queries could be posted.

The general approach here suggested is to obtain an outline of existing laws, present administrative machinery, and existing means of financing parking facilities in a particular city. The adequacy of these will then be measured in light of the ascertained need for parking facilities. Deficiencies in legislation, in administrative implementation, and in finance will then become apparent. Appropriate recommendations for action should follow.

A word about the probable costs of such an expansion of the urban parking surveys, before we proceed with the details: Like that aspect of the survey which is its complement, the costs will vary with the size of the urban area and its complexity. It is conceivable that expenditures might vary from $200 to $3,000 or $4,000, and very probably would not exceed 10 percent of the cost of the regular survey undertaken heretofore. Surely it would be wise to spend an additional $3,000 in order to safeguard a $30,000 investment and make it pay handsome dividends. Federal financial participation in all phases of these parking studies is authorized, of course.

What then, more precisely, are the possibilities in connection with each of the suggested expanded phases of urban parking surveys -- legal, administrative, financial and economic?

LEGAL ASPECTS

Basic to a study of the legal aspects of an urban parking survey is an inventory of State laws, local ordinances, and pertinent judicial decisions. The following might be labelled a check-list of types of materials that are involved:

(1) *State general enabling legislation dealing with off-street automobile parking facilities.* There are now at least 79 laws in 27 States and the District of Columbia in this category. This type of statute may be State-wide or area-wide in application. It may, accordingly, constitute an authorization for the specific city surveyed. A copy of the legislation should be obtained and analyzed with respect to its major provisions. This could include the policy declaration, an analysis of the body vested with administrative authority, and those phases dealing with planning, financing, land acquisition, construction, maintenance, and operation. The most recent amendments, if any, should be included[3].

(2) *State enabling legislation of special and local character dealing with off-street automobile parking facilities.* Some states utilize special rather than general enabling legislation to authorize the establishment of parking facilities. Some 56 laws in 15 States and the District of Columbia of this character are applicable only to specific places or to special projects within a specified place. A review of the State laws of this type will reveal whether the city being surveyed is covered by any special enabling act. Copies of any pertinent enactments should be obtained and adequately analyzed, in a manner similar to that suggested under (1) above[4].

[3] A monograph entitled AN ANALYSIS OF GENERAL STATE ENABLING LEGISLATION DEALING WITH AUTOMOBILE PARKING FACILITIES, revised 1947, *Bulletin No. 2*, Highway Research Board, may be helpful in this connection.

[4] It may be helpful to examine, in this connection, a study entitled AN ANALYSIS OF STATE ENABLING LEGISLATION OF SPECIAL AND LOCAL CHARACTER DEALING WITH AUTOMOBILE PARKING FACILITIES, 1947, *Bulletin No. 7*, Highway Research Board.

(3) *Zoning or other local ordinances regulating land use in relation to parking facilities.* Requirements for the provision of off-street parking facilities in connection with various property uses are frequently contained in zoning ordinances, building codes or other local laws controlling land use. At least 167 local governments in 29 States and the District of Columbia have ordinances of this kind. Classification by population groups indicates that approximately two-thirds of the localities have populations of 50,000 or less. Twenty-nine places have over 100,000 persons, and four, over 1,000,000. Apparently local governments of all sizes and complexions have been concerned with the problem of off-street parking facilities, and have sought some relief through the police power.

It is significant that 56 of the 167 localities referred to above also have comparable provisions requiring off-street truck loading and unloading facilities.

Any existing laws in this class should be analyzed with respect to the body vested with regulatory or enforcement authority, the termination of non-conforming uses, the extent of parking facilities required for specific property uses and for general uses by districts, designated size of parking space required, location and design features, provisions relating to maintenance and operation, and related matters.

(4) *Public regulation or licensing of commercial off-street parking facilities.* At least 15 municipalities including some of the largest cities in the United States, have enacted local ordinances regulating the licensing parking facilities that are operated by private enterprise for profit.

Any such regulatory laws for the city surveyed should be obtained and analyzed with respect to the prescribed method of administration, scope of the regulation, licensing procedure, license fees involved, rate regulation, design and maintenance standards, safety rules, claim check practice and damage liability, penalty provisions, and related items. Frequently, administrative regulations are issued pursuant to such local ordinances and these should be analyzed in like fashion.

The concept of parking as a "public utility" and as "affected with a public interest" might well be explored, particularly as it would apply to standards of service, rate regulation, safety requirements, and related matters.

(5) *General authorizations.* Sometimes municipalities are authorized to establish, finance, and construct off-street parking facilities under an authorization concerning "public improvements" or "local improvements" generally. This may be the result of judicial decision or ordinance definition. In either case, the city could proceed with the establishment of parking facilities without specific legislation.

For example, a Wisconsin statute[5] provided that the governing body of any city might acquire property, real or personal, within or without the city, by gift, purchase, or condemnation, for public purposes; may improve the same, may construct, own, lease and maintain buildings thereon for public purposes; and may sell and convey such property.

(6) *Curb parking restrictions and police regulations.* Legislative and administrative regulations with respect to curb parking exist in practically every city in the United States. If parking meters are utilized, it is pertinent to know what their legal authorization consists of, and what regulations have been issued pursuant thereto. Since curb parking constitutes an element of the parking problem, it becomes important to know what curb parking restrictions exist, how

[5]Section 62.22, Wisconsin Statutes, 1943. This statute has been construed to authorize the condemnation of property for municipal parking lots. See THE MUNICIPALITY, March, 1946, page 62, "Land May Be Condemned for Parking Areas," by Robert J. Cunningham, League of Wisconsin Municipalities. Notwithstanding, Wisconsin authorities saw fit in 1947 to amend this section, substituting the specific phrase "vehicle parking areas" for the more general phrase "public purposes."

well they are enforced, and the extent of the violations.

(7) *Judicial decisions, and attorney general and city attorney opinions.* One or more of the laws contained in the above categories may have been challenged in court or may have been made the subject of an opinion by the city attorney or the State attorney general. A recent decision of the Court of Appeals in Kentucky, for example, would be of considerable significance to most cities in that State, and should be analyzed in connection with any city survey undertaken in Kentucky. In construing specific enactments of the legislature concerning the provision of off-street parking facilities, the court held that the provision of public parking lots for automobiles constitutes a legitimate municipal purpose.[6]

(8) *Use of power of eminent domain.* Sincere efforts to assist private enterprise in the provision of off-street parking facilities are being made in some cities in the United States. In this connection, possibilities should be examined as to whether the power of eminent domain can be utilized by the municipality in the acquisition of the necessary sites and properties for needed off-street facilities, and their subsequent lease or sale to private individuals or corporations, with appropriate restrictions to ensure their permanent use, etc.

Illustrative of action along these lines is a 1948 amendment to the District of Columbia Motor Vehicle Parking Facility Act of 1942, authorizing the Commissioners of the District to lease on competitive bids for terms not exceeding fifty years, property acquired pursuant to the act, subject to such terms and conditions as the Commissioners shall deem proper[7].

[6]See Miller et al. v. City of Georgetown; United Corporation, Inc., v. same, 191 S.W. (2d) 403, 301 Ky. 241, (1945).

[7]For the amendment in full, see Section 3 of the Act as amended by Public Law 728, Chapter 559, 80th Congress, 2d Session (S.2642), approved June 19, 1948.

(9) *Tax and other public concessions to private operators.* In futherance of the objective of assisting private enterprise to the maximum in the provision of needed parking facilities, the legal and administrative possibilities should also be explored as to the granting of tax and other special public concessions to private operators of off-street parking facilities, present and future. Any existing concessions, whatever their form should be noted fully. This might take the form of real estate tax exemptions, in whole or in part, public construction of entrances or exits or other auxiliary facilities, favorable leasing arrangements involving public lands or properties, etc.

A 50-year lease arrangement between the Union Square Garage Corporation and the city and county of San Francisco, through its Board of Park Commissioners, for example, stipulates among other things that the Corporation shall pay an annual rental of only $5,000 to the municipality, a sum that represents but a small fraction of the rental that Union Square could command on the open market.

ADMINISTRATION

An insight into the administrative aspects of existing parking facilities seems essential to an urban parking survey. This will reveal that governmental agencies or private operators are responsible for the planning. location, financing, establishment, construction, operation or maintenance of off-street parking facilities, and what their duties and responsibilities are.

The various types of parking facilities should be carefully distinguished, and the entire analysis should be made in light of the differences involved. The broad general classes of facilities might be grouped as follows: (1) *Curb parking facilities,* defined as accommodations provided by public authority for the parking of automobiles on the street, open to public use, with or without charge. (2) *Public off-street automobile parking facilities,* defined as accommodations provided

by public authority for the parking of automobiles off the street or highway, and open to the public, with or without charge. Such facilities may be publicly owned and publicly operated, or they may be publicly owned and privately operated. (3) *Commerical off-street automobile parking facilities,* defined as accommodations provided by private enterprise for the parking of automobiles off the street or highway, open to public use for a fee. (4) *Special-purpose off-street automobile parking facilities,* defined as accommodations provided by public authorities, private groups, or individuals, for restricted use in connection with public facilities, particular businesses, theaters, hotels and other private enterprises, or combinations thereof, or as adjuncts to housing developments or private residences. Such facilities may or may not be jointly established and operated. (5) *Cooperative off-street automobile parking facilities,* defined as accommodations provided by joint action of public and private interests.

Parking facilities may consist of lots, garages, or other structures and accessories; they may be surface facilities or facilities above or under the ground.

The following might well constitute lines of inquiry with respect to the mechanism of administration:

(1) Study should determine which State and local agencies are responsible, in whole or in part, for the planning, location, financing, construction, operation and maintenance of parking facilities in the particular city surveyed. It may not be at all unusual to find, upon inquiry, that ten or fifteen or more different agencies of government are responsible for some phase of the administration of parking facilities.

For example, in a given city, the police may have the responsibility, as they usually do, of enforcing curb parking restrictions; the traffic commission may have such responsibility with respect to the formulation of curb parking regulations including meter parking; the zoning commission, with respect to the provision of parking facilities for various property uses, under the zoning laws; the mayor and city clerk, with respect to the licensing and regulation of commercial parking facilities of designated capacities; the highway or public works departments, with respect to parking surveys and other aspects of parking or the provision of facilities; and so on down the line.

Additionally, it would be significant to know what efforts have been made to coordinate the activities of merchants, business groups, property owners, and commercial facility operators.

(2) If a special parking agency exists, it should be determined whether it is a special authority or an adjunct to some other larger department of government; what its powers and responsibilities are; how it is constituted; and what its accomplishments have been.

(3) With respect to private or commercial parking facilities, it is desirable to ascertain whether chains of parking facilities or independent establishments predominate; whether such facilities are established and operated by private individuals, partnerships or corporations; the accessory relationship of private parking facilities to individual businesses or activities, even though operated for profit; and other related facts.

(4) It is, of course, important to know all the facts concerning parking meters, i.e., their installation, regulation, enforcement of regulations, etc.

(5) Investigation should also be made of the provision, if any, for parking facilities in master or city plans, as such, and through the zoning mechanism. Any special conditions, restrictions, or related items, should be noted.

(6) Special charts or maps that designate the locations of existing parking facilities, rates charged, and so on, should be obtained, and their sponsorship explained.

(7) The present status of zoning restrictions should be noted, insofar as they permit or prohibit the establishment of off-street parking facilities, of whatever character, in the zones where they are likely to be needed. If prohibited, the report may want to recommend the relaxing of restriction sufficiently to

permit the establishment of needed facilities.

(8) Public relations are as important in solving the parking problem as in any other public improvement program. Whatever aspects of marshalling public opinion on the parking question have been dealt with in the particular city under survey should be recorded.

(9) Finally, the analysis should include a liberal number of photographs of present conditions in the city studied, and additional sketches and charts as well, illustrative of the facts. The financial analysis, suggestions for which follow, will also lend itself to this type of visual presentation.

FINANCING AND ECONOMIC ASPECTS

All phases of the financing and the economics of the provision of parking facilities should be investigated and reported upon, in any adequate survey for a particular city.

Parking meters. One of the most obvious first tasks concerns parking meters. In terms of the number and types of meters, it is important to know what the aggregate revenue is from this source, and its legal and administrative disposition. This information would be desirable on an annual basis, for every year of operation since original installation of the meters. In addition to original cost, it would be helpful to know the installation expense, if any; the maintenance costs, estimated or actual costs of enforcement; and costs of administration generally.

Beneficiary approach to assignment of cost responsibility. There is reason to believe that the unwillingness or inability perhaps of the appropriate authorities to assign cost responsibility for the provision of off-street parking facilities according to benefits received and ability to pay accounts for much of the present failure to provide facilities on a scale commensurate with the need.

With respect to off-street parking facilities, there are at least five major classes of beneficiaries that profit from the provision of such facilities, namely; (1) Property owners, particularly in the immediately affected areas; (2) business establishments, especially within reasonable walking distance of the parking facilities, (3) motorists or users of the parking accommodations; (4) the general community, because of its interest in the well-being of the central business district in its relation to the rest of the community; (5) the municipality itself, because of the public investment in public improvements of all kinds.

More precisely, how does each of these beneficiary classes profit from the provision of off-street parking facilities? With respect to property, it is elementary that accessibility constitutes one of the principal characteristics of value. The provision of parking facilities restores, stabilizes, or enhances accessibility. Conclusion: Parking facilities benefit property.

A striking illustration of the current market value placed upon accessibility factors is to be found in the vicinity of the Crenshaw Boulevard shopping development, in suburban Los Angeles. Two areas, one across the street from the other, were studied. One, the Crenshaw Boulevard shopping development, has adequate outer highway and parking facilities, and the current rental value of the land is $40 minimum per front foot, plus an additional one quarter of one percent of annual gross income, specifically charged for the parking facilities. The other area, directly across the street, and without outer highway or terminal facilities, lies idle at an asking rental of $25 per front foot[8]. Rental figures in the first block south of Santa Barbara Avenue (in the vicinity) to the Leimert Park shopping district range from $10.00 to $15.00 per front foot without outer highways or parking facilities. According to the investigation, the implication is strong that this differential in rentals, to a considerable

[8]For an excellent discussion of the matter see CALIFORNIA HIGHWAYS AND PUBLIC WORKS, May-June 1948, page 1 et seq., "Outer Highways" by Frank F. Marshall and Dexter MacBride.

extent at least, may be due to the lack of comparable access facilities.

Property ownership and business enterprise are frequently coexistent, and in such instances at least, it is difficult to separate benefits accruing as a result of the two different activities. Business enterprise, especially in the downtown area of a city, most certainly thrives on accessibility by pedestrian traffic. A substantial portion of pedestrian traffic is facilitated by motor vehicles, and the relative amount is increasing constantly. Accordingly, the provision of parking facilities by and for the benefit of business enterprise is obviously "good business."

The foregoing illustration of the Crenshaw Boulevard shopping development likewise applies in this instance. The persistent policy of such huge business concerns as Sears, Roebuck and Company, Kroger's, Safeway Stores, Ralphs Grocery Company, and many others, in providing substantial parking areas for their customers is further evidence of the value of such facilities as sales generators.

The benefits accruing to motorists or users of parking accommodations are obvious enough.

While gains are perhaps not as clear as in other cases, the general community also shares the advantages of adequate off-street parking facilities. This becomes apparent when we consider that

--the aggregate property valuation in downtown areas, particularly in the larger urban areas, has been decreasing in recent years;

--while variations exist, of course, the average central district, though but 5 to 10 percent of the total city area, generally contributes as much as 25 to 35 percent of the total city revenues;

--assuming a constant level and standard of municipal services rendered to the city as a whole, a decreasing tax base, due to a diminishing contribution of the central business district, will mean more tax dollars will need to be contributed by every taxpayer, especially those residing outside the central district;

--though the exact mathematical relationship between the decreasing assessibility and the decreasing tax base in the central areas, is unknown, the lack of adequate parking facilities, appropriately located and attractive in user cost, of necessity has an important influence on property values;

--and accordingly, every individual, within or without the central business district, whether a motorist or not, has a financial stake in the welfare of the downtown area. It might even be said that it would be more expedient for that individual to make a small contribution in general revenues, toward the establishment of parking facilities for the downtown area, to avoid making a relatively larger contribution later on, in order to sustain dwindling municipal revenues.

Finally, the municipality itself, in its governmental capacity, is a beneficiary of the increased accessibility resulting from parking facilities.

But what is the significance of such a beneficiary approach? In financing the provision of municipal off-street parking facilities, an ideal solution would assess costs in proportion to benefits to be received and ability to pay. Unfortunately, however, it is not a simple task to devise a satisfactory method of appraising such benefits. In the absence of a general guide, an acceptable solution may perhaps be found by assigning financial responsibility on the basis of such findings as may be made regarding the effective demand for parking relief on the part of the several beneficiary groups.

It may be found, for example, that land acquisition and other costs are so high that payment of the entire cost out of parking charges levied upon the individual vehicle would require fees so high as to discourage motorists from conducting their shopping and other business in the downtown area. Faced with such a contingency, the property and business interests in that area would find it to their advantage to participate in financing parking facilities in some proportion to the parking demand generated by the various business properties. Similarly,

the interest of the community at large in the preservation of the downtown area as a business, governmental, and cultural center may be evidenced by a strong public sentiment toward the appropriation of municipal funds for the purpose.

In working out such a solution, the optimum rates of parking charges to be assessed against the user would be determined by a study of both the local experience and that of other cities. Assignment of their respective shares of the remaining cost to the municipality and to the property and business interests, and determination of the method of assessment in the latter case, would have to be developed by negotiation and perhaps public hearings. Following the evolution of a generally acceptable plan by these means, action to put it into effect would be taken by the city government.

Such an approach to the problem of financing public parking projects requires, in addition to the analysis of data, the ability to gauge public sentiment and to lead conflicting interests toward an effective compromise. The solution will not necessarily be as complex as that indicated above. The more acute the situation, however, the greater the urgency for devising a plan which will draw support from all interested groups.

The divisions of the costs of establishing and operating parking facilities in this manner presumes a master plan and system of facilities.

To provide an insight into the possibilities of applying this approach on a scientific basis, let us consider, for the moment, some average figures derived from factual data of a number of municipalities. For example, it appears from studies of Public Roads Administration that shopper-parkers constitute approximately 27 percent in number and 16 percent in space-hours with respect to their use of parking facilities. Would not similar scientifically-derived data for a given city provide an equitable basis, among others, for assignment of costs to business establishments that benefit directly from this type of parking? The aggregate cost assigned this beneficiary class could then be apportioned in proportion to the amount of parking generated by each of the respective businesses or enterprises constituting the group, if such parking information were available.

Admittedly, the matter of assignment of costs on a benefit-received and ability-to-pay basis is very complex. But unless this approach is further explored and utilized, some believe that there can be little hope for an equitable solution to the financial aspects of the parking problem in urban areas.

Methods of financing. An analysis should be made of all existing methods of financing with respect to off-street automobile parking facilities in the city surveyed. For this purpose, it will be necessary, of course, to separate the various types of parking facilities, and particularly the public and commercial categories.

This should be followed by study of alternate financing methods in designing a plan for relieving the existing condition of inadequacy.

While financing by private capital has in the past accounted for a substantial portion of urban off-street parking facilities, there are apparent limitations to this method of providing funds on a scale commensurate with present need.

Public financing could employ bond issues (revenue or general obligation), or direct support out of current revenues, or a combination of both. Whether bond issues are used or not, revenue support may be found from one or more of the following sources: (1) General funds; (2) *ad valorem* property taxes, which in most cities are the chief source of general funds; (3) special or benefit assessments; (4) parking fees and charges derived from the facilities themselves; (5) *excess* parking meter revenues; (6) State aids; and (7) miscellaneous forms of public support, such as concessions or incentives to private enterprise in the form of reduced property taxes, assessments or license fees; or donations of real or personal property by private individuals or by government.

The choice of any of these revenue sources for supplying public off-street parking facilities would inevitably be

affected by the findings with respect to allocation of benefits, previously discussed.

An interesting cost comparison can sometimes be made of the costs of typical curb and off-street parking spaces in a downtown street in the city surveyed. Such a comparison may be made between the probable costs of widening a designated street to provide curb parking space and serve traffic movement, and the estimated costs of off-street facilities of similar capacity, etc. The necessity for the widening, is of course, assumed, and the facts must support this assumption for the comparison to be a valid one. The costs referred to are the annual costs, including amortization of the capital investment in right-of-way, other property, construction, maintenance, operating, and other costs. In most cases it will be found that the annual costs of off-street parking facilities of comparable character are substantially less than for curb parking accommodations.

The economics of parking facilities of various types should be studied, in terms of the city surveyed. Relative costs for land, improvements, maintenance and operation can be analyzed. The rate structures can be compared. Turnover and income studies might be made, and the probable effects of subsidies might be indicated.

Economic studies ought to take cognizance of the capacity factors of various types of parking facilities; of self vs. attendant parking; of public vs. commercial parking facilities; parking garages (of varying levels and designs) vs. parking lots; underground parking; merchant-operated facilities; fringe or perimeter parking plans; interior block parking; short- vs. long-time parking; and other similar matters.

In a recent inquiry on the matter[9], four financial alternative plans have been offered to the City of Vancouver for solution of the parking problem in the downtown area of that city, and their possibilities explored, as follows:

Plan A - Motorist pays full cost of the service.

Plan B - Motorist pays 5 cents per hour, municipality pays balance of cost out of general revenue.

Plan C - Motorist pays 5 cents per hour, downtown business interests pay balance of cost as a local improvement tax.

Plan D - Motorist pays 5 cents per hour, municipality pays balance of cost out of parking meter revenues.

A brief economic analysis of the downtown area is desirable in connection with a study of the parking problem. Present and past assessed valuations of the downtown areas, and decreases in such valuations ought to be noted, and related perhaps to the absence of accessibility. Decentralization of business in the last decade or so should be commented upon. Over-all tax significance of these facts should be noted. Perhaps the relation of mass transportation to the parking problem ought to be dealt with too. The problem of the great traffic generating capacity of the sky-scraper and the resulting parking difficulties, might be dealt with.

DEFICIENCIES AND RECOMMENDATIONS

The foregoing sections suggest the thorough assembly of the existing facts with respect to the legal, administrative, economic, and financial phases. In light of existing parking facilities, and present and anticipated demand therefor as evolved from the regular parking surveys, appropriate recommendations may be attempted. Determination as to the need for additional legal authority to deal adequately with the parking problem, proper administrative machinery, and possibilities for financing may also be made.

Some insight into such an approach to

[9] REPORT ON THE DOWNTOWN PARKING PROBLEM, City of Vancouver, British Columbia, March 1948, Office of City Engineer.

betterment is indicated as follows:

Legislation. Examination of existing general or special State enabling legislation may reveal that the city surveyed is not authorized to undertake the provision and fostering of off-street automobile parking facilities. Recommendations for such legisaltion would seem to be entirely appropriate.

The precise form of such legislation could be indicated. Comprehensive studies[10] of enabling legislation dealing with parking facilities indicate that general enactments, broadly applicable to all cities, counties, and other local units within the state are to be preferred over special or local acts that are enabling only for a particular city or special project.

Desirable local ordinances, for the city surveyed, could also be suggested -- ordinances that are necessary to further implement the State enabling act, perhaps spelling out some of the detail, especially those relating to finance.

Depending upon the local mores and other local factors, appropriate amendments to the zoning ordinance of the city surveyed could be recommended, specifically directed to the provision of off-street parking facilities (and truck loading and unloading facilities, for that matter) of varying amounts for the various property uses. Suggested legislative language could be included.

Because of the magnitude of the parking problem, every generator of parking demand should now make some contribution toward the provision of parking facilities.

If commercial parking facilities are not now licensed or regulated in the city surveyed, and if such public control seems desirable in the public interest and for the protection of the motorist, legislative implementation in that direction may be suggested.

Other legal phases may be explored and commented upon.

Administration. If the city surveyed does not now possess an adequate mechanism for the administration of a needed parking program, the essentials of such a parking facilities organization may be outlined. Unwarranted division of public responsibility for the various phases of the parking program may exist, and a consolidation of functions in a centralized body, whether it be a special authority, or a special branch of an existing government agency, may be desirable. Recommendations in this field should be quite specific, if that were deemed expedient. The various types of parking facilities should be taken into consideration, of course, in the formulation of any recommendations in the field of administration.

A public relations program, if one is needed, can be suggested.

Finance and economics. This phase of the study offers the greatest promise for the exercise of ingenuity and original thinking. All possibilities for financing the parking facilities needed should be explored boldly and imaginatively, yet with a calculating sense of realities.

For example, the issuance of identification tags for a designated annual sum, admitting the motorist desiring to park to any or to designated parking facilities, is one possibility still largely unexplored. The possible revenue to be derived from such fees might be estimated and capitalized, in terms of the parking facilities they would provide. Funds derived from this source might be added to contributions from general fund sources and from benefitting business enterprises, together constituting a formidable means with which to provide off-street parking facilities.

Moreover, there are a number of devices that the city surveyed might wish to recommend if it desired to assist private enterprise in the provision of needed facilities. These might include the fur-

[10] For a detailed discussion of the many advantages of general over special enabling acts, see "Administrative Authority and Jurisdiction," page 18, AN ANALYSIS OF GENERAL STATE ENABLING LEGISLATION DEALING WITH AUTOMIBILE PARKING FACILITIES, *Bulletin No. 2*, Revised 1947, Highway Research Board, and "Undesirability of State Legislation of Special and Local Character," page 2, AN ANALYSIS OF STATE ENABLING LEGISLATION OF SPECIAL AND LOCAL CHARACTER DEALING WITH AUTOMOBILE PARKING FACILITIES, *Bulletin No. 7*, Highway Research Board, 1947.

nishing of adequate street approaches, the enforcing of curb parking restrictions, the leasing of publicly-owned lands to private operators upon favorable terms, the public determination of the most desirable locations and designs for future parking facilities, and the acquisition and assembly, by government, of the properties needed for such facilities. Concessions in property taxes, assessments, or license fees might serve as partial incentives also.

Desirable methods of financing should be specifically recommended. The city surveyed may find it possible to allocate benefit-percentages to the various classes of beneficiaries of off-street parking facilities, and to allocate costs of providing the needed facilities to these classes in that ratio.

If parking meters exist in the city surveyed and if the revenues therefrom, over and above the costs of administration, are diverted to some use other than the provision of parking facilities, it may be desirable to recommend that hereafter, such net parking meter revenues should be devoted exclusively to the further alleviation of the parking problem by the application of such funds to off-street parking facilities.

POLICY CONSIDERATIONS

In the course of urban parking surveys, there are a few policy considerations that sponsors of the survey may hesitate to attempt to determine with finality. It may be felt that such matters should more properly be left to the local law-making bodies for adjudication. This attitude is a proper one.

But, even in such instances, it would seem desirable that the possibilities for action along several different courses might be sketched in the report, particularly in terms of the experiences of other places, leaving the final choice for those whose proper function it is to make one.

APPLICATION OF EXPANDED TECHNIQUE

At least four recent urban parking studies, undertaken by State highway departments with the cooperation of the Public Roads Administration, have included or are now including in varying degrees, legal, administrative and economic aspects of parking as suggested in this paper. The cities are Albert Lea, Minnesota, Toledo, Ohio, Seattle and Spokane, Washington.

Seattle, Washington. In addition to the regular survey data relating to the supply of and demand for parking facilities, and parking habits generally, the Seattle report[11] contains a discussion of certain economic aspects of a parking rate structure, as well as the advantages of a separate parking authority as a means of administration. The provision of parking facilities and truck loading and unloading facilities through the zoning mechanism is strongly recommended. Interim relief and long range improvement measures are indicated.

Spokane, Washington. The Spokane report now in the process of being published will contain some interesting materials related to the special aspects we are here dealing with. It contains discussions of the possibilities of a parking commission to develop private parking enterprise, municipal regulation of private enterprise, merchant parking corporations, municipal cooperation with merchants and property owners, municipal facilities, and a parking authority. An entire chapter deals with the economics of construction of parking facilities. Another section is concerned with the legal aspects, and suggestions for legislative action are made.

Albert Lea, Minnesota. The Albert Lea, Minnesota, survey will stress many of the same matters that have been dealt with in previous reports. The initial report on parking will also outline some legal problems specifically applicable to the city.

[11] A LOOK INTO SEATTLE'S PARKING NEEDS, Central Business District, 1947, reported in 1948, conducted by the Washington Department of Highways in cooperation with Seattle Governmental Agencies and the Public Roads Administration.

Toledo, Ohio. The legal, administrative and economic phases of the Toledo, Ohio, parking study are still being investigated and formulated.

WAYS AND MEANS -- PERSONNEL

One of the vexing obstacles that confront all surveys or research projects of this character is the lack of trained personnel to do the job. With respect to the legal, administrative and economic phases of urban parking surveys, no extensive staff of interviewers is necessary. In fact, a properly trained individual could adequately complete the assignment in two or perhaps three months, in the average city.

In Toledo, Ohio, the parking studies are being undertaken largely by the staff of the Toledo-Lucas County Plan Commissions. Where local planning bodies are not made active participants in these studies, it may be possible to effectuate the loan of technical services. Frequently, city and county attorneys or the office of the State attorney general will be helpful, particularly with respect to the legal phases of the studies. College professors in the field of economics or related fields can sometimes be interested in research of this type, particularly during the summer months. And, perhaps most desirable of all, the regular State or local highway department staff may be equipped sometimes to handle these aspects without any assistance from outside sources.

A willingness presumed, it would seem that the limited personnel needed to investigate and report upon these allied phases of parking surveys can be obtained.

CONCLUSION

The necessity for investigating the legal, administrative, and economic phases of the parking problem in connection with urban parking surveys is being increasingly recognized. A few cities that have sought to include these matters in their studies of the problem are finding that their ultimate objective of providing more parking facilities can be envisioned much more clearly than would otherwise be possible.

The conclusion seems clearly indicated: Those fostering and undertaking urban parking surveys should now bend every effort to promote a comprehensive study of the parking problem, extending their previous fact-finding effort to include the essential legal, administrative and economic aspects, thus assuring a well-balanced approach.

DISCUSSION

Mr. Jennings: Many downtown business men are reluctant to increase their cost of doing business by standing the expense or a portion of the expense of providing off-street facilities. If it resulted in a reduction in the cost of packaging, delivering or similar services they might be more favorable to the development of an off-street program.

Mr. Levin: If sales are increased by the usage of such parking facilities, it would appear reasonable to assume that the business men would be willing to pay a portion of the cost as "insurance" for the life of the business.

Mr. Marsh: Business men must believe that it pays to aid in development of parking facilities, otherwise they would not have made the financial outlays they have in many cities.

Mr. Lovejoy: Regardless of who finances the building of parking facilities, the city should be responsible for the development of the program for providing parking relief, otherwise no planned development will result.

Mr. Cherniak: Should parking meters be used as a means of producing revenue, and should the parker be allowed to stay in the space as long as he desires by simply putting enough coins in the meter to cover the length of time parked?

Mr. Levin: At least two court decisions (Albert Lea, Minnesota and Massachusetts) ruled that parking revenue could be used only for enforcement and administration and not as a revenue producing measure. Revenues in excess of those necessary for administration can be obtain-

ed if authority is specifically set forth by statute. This assumes that the city has the organic right to obtain revenue at the curb in excess of that needed for regulatory purposes. Multiple coin meters are on the market and if the curb area in question is not regulated to obtain turnover in the use of the space, then it should be possible to permit multiple coin operation within whatever time limit regulations are in effect.

Mr. Jennings: Can parking meter revenues legally be used for providing off-street facilities?

Mr. Marsh: Generally speaking parking meters bring in more revenue than is spent in the administration of the parking regulations. Some tolerance is permitted in exceeding costs and usually all meter revenues are turned over to the same fund. Proper legislative action should be taken to authorize the use of these excess revenues for financing off-street parking.

Mr. Matson: There are several points which have been developed in this discussion which deserve more complete treatment than we have been able to give them at this time. I should like to suggest, therefore, that the Committee consider them as part of their program for 1949.

1. Use of curb meter revenues for the financing of off-street parking facilities.
2. Authority of the city to regulate curb parking.

SOME TRAVEL AND PARKING HABITS OBSERVED IN PARKING STUDIES

R. H. BURRAGE, *Highway Engineer, Terminal Facilities Section* and S. T. HITCHCOCK, *Assistant Chief, Highway Transport,*
Public Roads Administration

The direct interview type of parking study, initiated in 1945[1], has now been made in more than 40 cities[2]. Other types of parking studies have previously been made in some of these same cities and in other cities, but prior to the use of the direct interview type of study it had not been possible to make any reliable generalizations about parking characteristics or trends. Procedures, scope, and objectives had been so varied as to preclude the establishment of common bases for statistical comparisons.

Reports have been developed in 24 cities of this group[2]. Since the same procedures were used in each case, it has been possible for the first time to observe some relationships of parking habits, travel habits, and traffic volumes. For those cities where the time periods studied were not identical, data were adjusted to a common 8-hour basis (10 a.m. to 6 p.m.).

In some cases it has been suspected that the indicated relationships or trends might exist, and personal experience may make some of these observations appear obvious, but they do substantiate many points which previously have been largely a matter of opinion or conjecture. Furthermore, the fact that these data and these derivations fall into a pattern indicates that the basic approach to this research problem, that is, the procedural technique, is soundly conceived. Although the number of reports analyzed so far has not been large (only 24), it should be remembered that from the analysis of the first 24 origin-and-destination reports a pattern in the travel habits of traffic approaching cities of different sizes was apparent, a pattern which has not changed materially by the addition of data from nearly 50 more reports.

In these cities, with the knowledge that the basic volumetric data have been obtained with reasonable accuracy, specific locations and designs for additional facilities may be planned with assurance. The data on parking habits, when correlated with location, may be used to advantage in revising parking time restrictions. The data as a whole, with their clearly established trends, representing conditions in cities which have recognized the existence of a parking problem, may also be of value in making comparisons in other cities where comprehensive studies have not been made and where complete data are not available.

These series of summaries should not be considered as being exhaustive. They are some of the more obvious relations which initial analyses have developed. More analyses should be made and material from similar reports should be added to verify and strengthen analyses already made.

[1]Described in 1945 *Proceedings* of the Highway Research Board.
[2]List of cities is attached.

THE CENTRAL BUSINESS DISTRICT

Area and Population Relations in Cities in Six Different Population Groups

Population group (thousands)	Number of cities (1)	Avg. Population metropolitan area (2)	Central Business Dist. Area in Square Miles		Number of blocks[1] (5)
			Total (3)	Per 100,000 population (4)	
Less than 25	6	16,900	0.12	0.74	27
25 - 50	3	32,300	0.11	0.36	35
50 - 100	2	66,550	0.22	0.27	36
100 - 250	9	131,750	0.44	0.26	76
250 - 500	6	280,700	0.46	0.12	97
500 and over	2	663,650	0.54	0.05	134
	28				

[1]Block dimensions vary from 150 feet to 600 feet.

The Central Business District is not a legal entity or a clearly defined area. In setting up the limits of such a district for purposes of a parking study the following considerations were used:

1. The area where land occupancy is almost 100 percent
2. The area where land use is principally business
3. The area where curb parking is crowded
4. The area to which transit lines converge.

Even though different engineers established the limits of the different Central Business Districts, it is significant to note that the limits of the districts have been uniformly recognized. The trend in size is to be expected perhaps, but confirmation of this trend lends assurance to further analyses in these cities. Where studies have not been made comparisons should indicate if a particular Central Business District constitutes a problem area greater or less than the average for cities of this size.

AVAILABILITY OF PARKING SPACE

Curb and Off-street Spaces Available in the Central Business Districts of Cities in Six Population Groups

Population group (thousands)	Number of cities (1)	Number of Parking Spaces: Total (2)	Curb total (3)	Off-Street total (4)	Per 1,000 population: Curb (5)	Per 1,000 population: Total (6)
Less than 25	5	1,649	981	668	54	90
25 - 50	3	2,061	1,286	775	41	66
50 - 100	2	4,089	1,688	2,401	23	57
100 - 250	8	6,449	2,684	3,765	17	42
250 - 500	6	11,093	2,961	8,132	7	28
500 and over	2	10,185(1)	2,510	7,675	3	12
	26					

[1]Providence, a city of 253,500 population, has a metropolitan area population of 711,500 with several other fully developed but smaller independent business districts.

These trends, perhaps suspected, lend assurance (1) to the soundness in definition of the Central Business District, (2) to the use of the data for comparative purposes in cities where extensive studies have not been made, and (3) to the methods of the making of the study.

It may be expected that the supply of curb spaces for parking in the Central Business District will continue to decrease as cities grow. Curbs are limited in physical extent and as the downtown area grows vertically more curb space is restricted for services in connection with the buildings and for the movement of traffic. Offstreet facilities are not developed in a compensating manner. Cities of more than 257,000 population have less than one-third as many total parking spaces per 1,000 population as cities of less than 25,000 population.

USAGE OF PARKING SPACE

Number of Vehicles Parked in the Central Business Districts of Cities in Six Different Population Groups

Population group (thousands)	Number of cities	Number parked in 8 hours[1]		Maximum number parked[2]		Percent commercial	Parking ratio peak hour to Avg. hour
		Total	Per 1,000 pop.	Total	Per 1,000 pop.		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Less than 25	5	7,905	432	1,141	62	14	1.22
25 - 50	3	7,378	239	1,350	43	13	1.13
50 - 100	2	11,866	164	2,185	30	11	1.15
100 - 250	7	20,156	112	5,168	28	13	1.15
250 - 500	5	32,436	83	8,245	21	13	1.15
500 and over	2	29,957	34	9,564	11	13	1.11
	24						

[1]Adjusted, where necessary, to a common period, 10 a.m. - 6 p.m.
[2]At any time during the eight-hour period.

This is the volume of parking under present conditions. It does not indicate in any sense what trends would be if better traffic service and parking facilities were available.

The volume of parking in the eight-hour period and maximum number parked at any one time in the period increases with the size of the city. When the population of the city is considered, however, the volume of parking per 1,000 population shows that the Central Business Districts in the smaller cities are bigger generators of parking than are the larger cities.

The proportion of commercial vehicles parking in the Central Business District apparently does not vary in cities of different size. These are the vehicles picking up and delivering goods in the downtown area.

There does not seem to be any appreciable difference in the ratio of the volume of vehicles parked in the hour of peak parking usage and the hourly volume parked in the average hour of the business day.

USAGE OF PARKING SPACES

Comparison of Overtime Parking at Metered Curbs and at Unmetered but Restricted Curbs

Zones	Number of cities	Percent parking overtime[1]		Percent of space hours Used by violaters[2]		Used in excess[3]	
		Unmetered	Metered	Unmetered	Metered	Unmetered	Metered
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
I All cities reporting							
All	18	29.2	-	53.1	-	35.4	-
All	10	-	15.3	-	35.2	-	19.4
II Cities with metered and unmetered spaces							
All	7	31.1	18.0	60.9	38.1	40.8	20.7
15 minute	1	59.6	59.4	89.0	87.2	76.4	60.0
30 minute	2	57.6	33.3	87.2	62.0	71.2	39.1
60 minute	5	33.4	17.3	67.3	40.3	47.3	22.3
90 minute	1	33.8	18.6	65.0	53.6	42.9	30.4
2 hour	3	22.8	11.2	50.3	28.3	26.7	12.0

[1]Percent of all curb parkers in zones indicated.
[2]Total usage including legal.
[3]Overtime usage only.

Group I includes some cities in which there were no parking maters and some time zone groups in other cities where there were no unmetered curbs. To present the data on a more nearly comparable basis Group II was analyzed. This group comprised only those cities where data were available in the same city and in the same time restriction class for both metered and unmetered but restricted spaces.

Data from each of seven cities, where curb parking was observed at both metered and unmetered but restricted spaces, indicate that violations in metered zones were less, both as to the numbers of parkers as well as length of usage of parking spaces.

This is also true when the data are segregated in time restriction groups. It is also apparent that the proportion of overtime parkers and overtime usage decreases as the length of the time restrictions increases. There is little difference in violations in metered and unmetered but restricted 15-minute zones. In unmetered 2-hour zones 22.8 percent of the parkers are overtime parkers and use 50.3 percent of the total time available of which almost 27 percent is overtime usage. In 2-hour metered zones eleven percent of the parkers exceeded time restrictions using 28 percent of the available time of which 12 percent of the time was in violation of restrictions.

PARKING SPACE SUPPLY AND DEMAND

The Usage of Space in the Entire Central Business District, and the Relation of Demand and Supply in the Core Area, in Cities of Six Population Groups

Population group (thousands)	Central Business District			Core[1]			
	Number of Cities	Present Usage space hours		Number of Cities	Space hours		Ratio demand to supply
		Number	Per 1,000 population		Demand[2]	Supply	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Less than 25	4	8,654	511	4	2,950	2,250	1.31
25 - 50	3	9,799	303	2	3,766	2,868	1.31
50 - 100	2	14,632	220	2	4,290	2,964	1.45
100 - 250	5	33,659	255	5	16,290	10,663	1.67
250 - 500	4	51,578	184	3	20,828	6,505	3.27
500 and over	2	65,846	99	2	28,590	6,649	4.67
	20			18			

[1]The core is that portion of the Central Business District where land values are generally highest, where in each block of several contiguous blocks, the demand for parking space in each exceeds the supply.

[2]Demand for space in core based on destinations of drivers who parked in the Central Business District.

This analysis applies only to those who park in the Central Business District. It does not include the "potential" demand of those who stayed away, did their shopping elsewhere.

The demand for parking space for those having destinations in the Central Business District shows a definite increase with the size of the city. On a per capita basis, however, the Central Business Districts in the smaller cities are greater traffic generators per 1,000 population than those in the larger cities.

For the Central Business District as a whole, supply of spaces is equal to the demand because the limits of the district are usually established to study the entire problem. Some of the central blocks in the district, however, create more demand than others and it is more than is available in the same blocks. The volume of this demand for spaces in the core increases in the larger cities whereas the supply, although increasing to cities of medium size, drops off in the larger cities where spaces in the core are sacrificed for other land uses.

TRAFFIC AND TRAVEL HABITS

Some Traffic Volumes and Ratios in the Central Business Districts of Cities in Six Population Groups

Population groups (thousands)	Number of Cities	8-hour volume inbound[1]	Avg. hour volume In & Out	Peak ½ hour vol. In & Out[2]	Ratio Peak to avg. hrs. In & Out	Volume per 1,000 pop. peak ½ hour	Vehicles passing thru C.B.D. - Percent[3] 8 hours	Peak ½ hr.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Less than 25	5	15,000	3,700	2,500	1.36	139	49	60
25 - 50	3	20,000	5,100	3,550	1.37	104	57	64
50 - 100	2	27,000	6,600	4,420	1.34	61	52	69
100 - 250	7	43,000	10,500	6,810	1.33	41	60	70
250 - 500	3	56,000	13,700	9,110	1.33	25	60	75
500 and over	2	72,000	17,600	12,000	1.34	14	58	91

[1] 8-hour period, 10 a.m. - 6 p.m. All vehicles.
[2] Peak ½ hour, for traffic movement generally between 5 and 6 p.m.
[3] Percent of vehicles entering the C.B.D.

The total 8-hour inbound volume, the average hourly volume in and out, and the peak one-half hour volume in and out of the Central Business District increase with the size of the city. When the population of the city is considered, however, the Central Business Districts of the smaller cities are bigger traffic generators per 1,000 population than are the larger cities.

The outbound 8-hour volume is almost equal to the inbound volume and the pattern with respect to population groups is the same.

Regardless of the size of the city, the ratio of peak-hour traffic and average hourly traffic in the 8-hour period is the same. Peak-hour volumes are about one-third again as large as the volumes during the average hour of the survey period.

The proportion passing through the Central Business District may more correctly be described as those who do not stop to park. It includes whatever "cruisers" there may be and those cars in service stations or in garages being serviced or repaired. These figures refer to vehicles entering the C.B.D. and not to vehicles leaving or to number of trips.

The proportion of traffic entering the Central Business Districts in the peak ½ hour of traffic movement (usually between 5 and 6 p.m.), which does not stop to park, increases as the size of the city increases. The development of employment centers in sections of the city, other than the Central Business District, creates a large movement of population twice a day going to and coming from work. Much of this movement is across town and through the district.

There does not seem to be much difference in the proportion of traffic passing through the Central Business District during the business day (10 a.m. to 6 p.m.) in cities of different population groups.

PARKING CHARACTERISTICS

Significant Data on Length of Time Parked and Distance Walked in Cities of Six Population Groups

Population group (thousands)	Number of Cities	Percent Parked		Percent Walking	
		Less than 30 Min.	4 hours and over	Less than 400 feet	800 feet and over
	(1)	(2)	(3)	(4)	(5)
Less than 25	5	56	8	69	9
25 - 50	3	53	10	78	5
50 - 100	2	52	10	77	7
100 - 250	5	46	14	65	14
250 - 500	2	34	20	63	19
500 and over	2	28[1]	25	46	30
	19				

[1]Estimated from different groupings of length of time parked.

These trends have been indicated in individual studies from time to time but this is the first time it has been possible to assemble the results of these studies in one summary.

The proportion of cars parked less than 30 minutes in the largest cities is only half of those parked for the same length of time in the smallest cities. The proportion parked four hours and over, however, is three times as large. The proportion parking less than 30 minutes decreases from 56 percent to 28 percent as the population of cities increases from less than 25,000 persons upwards to six- and eight-hundred thousand. The proportion parking four hours and over increases from 8 percent to 25 percent as population increases in the same population groupings.

Definite trends are apparent also in the distances people walk to their destinations after parking their cars. The lengths of blocks vary but generally speaking one block may be considered to be about 400 feet. In small cities three quarters of the people parking in the Central Business District park within one block of their destination. This proportion decreases to less than 50 percent in the largest cities.

The proportion walking more than 800 feet (2 blocks) is relatively small in the smaller cities, less than ten percent. In the largest cities, however, as many as 30 percent of the parkers walk more than 800 feet.

PARKING CHARACTERISTICS

Average Length of Time Parked for Each Purpose of Trip in Cities of Six Population Groups

Population group (thousands)	Number of Cities (1)	Average time parked for each trip purpose - Hours				
		Work (2)	Shopping (3)	Business (4)	Other (5)	All purposes (6)
Less than 25	5	3.1	0.7	0.7	1.1	1.1
25 - 50	3	2.9	0.7	0.8	0.9	1.3
50 - 100	2	3.3	0.8	0.7	0.9	1.3
100 - 250	5	4.0	0.9	1.0	1.5	1.7
250 - 500	3	4.5	1.4	1.2	1.5	1.8
500 and over	2	5.1	1.4	1.4	1.2	2.5
	20					

There are definite trends apparent for the average length of time parked for each trip purpose. Regardless of purpose the average length of time parked increases in the larger cities in comparison with that of the smaller cities.

There does not appear to be much difference in the length of time parked by shoppers or by those on business trips. In both instances the time parked increases with the size of the city.

Other trip purposes include meals, movies, doctors, dentists, social, and other recreational activities. There does not seem to be much difference in the length of time parked for these purposes in cities of different sizes.

CITIES IN WHICH DIRECT INTERVIEW TYPE PARKING STUDIES HAVE BEEN MADE

Footnote[2] for page 1. Direct interview type parking studies have been made in the following cities. Reports have been published for those indicated by (R). Populations shown are those for 1940, for the metropolitan area.

1945 (4)

Providence, R. I.	711,500 (R)	Denver, Colo.	384,400 (R)
Atlanta, Ga.	442,300 (R)	Pawtucket, R. I.	75,797 (R)

1946 (9)

Baltimore, Md.	1,046,700 (R)	Harrisburg, Pa.	173,400 (R)
Seattle, Wash.	452,600 (R)	Knoxville, Tenn.	151,800 (R)
Portland, Ore.	406,400	Walla Walla, Wash.	18,109
New Haven, Conn.	308,200 (R)	Portsmouth, N. H.	14,821 (R)
Nashville, Tenn.	241,800 (R)		

1947 (15)

Toledo, Ohio	341,700 (R)	Corpus Christi, Tex.	70,700 (R)
Honolulu, T. H.	245,000	Monroe, La.	28,309 (R)
Jacksonville, Fla.	195,600	Alexandria, La.	27,066 (R)
Chattanooga, Tenn.	193,200 (R)	Lake Charles, La.	21,207
Reading Pa.	175,300 (R)	Anderson, S. C.	19,424 (R)
Spokane, Wash.	141,400 (R)	Stevens Point, Wis.	15,777 (R)
Wichita, Kans.	127,300 (R)	Albert Lea, Minn.	12,200 (R)
Charlotte, N. C.	113,000 (R)		

1948 (17)

Cleveland, Ohio	1,215,000	Boise, Idaho	26,130
Allentown-Bethlehem,Pa.	325,142	Meadville, Pa.	18,919
Omaha, Nebr.	287,700	Huntington, Ind.	13,903
Richmond, Va.	245,700	Frankfort, Ind.	13,206
Muncie, Ind.	49,720	Columbus, Ind.	11,738
Lynchburg, Va.	44,541	Wabash, Ind.	9,653
Anderson, Ind.	41,572 (R)	Seymour, Ind.	8,620
Kokomo, Ind.	33,795	Decatur, Ind.	5,861
Easton, Pa.	33,589		

Total number of cities in which Direct Interview Type Parking Studies have been made - - - 45

DISCUSSION

Limitations to the paper by Mr. Burrage and Mr. Hitchcock.

Data are lacking on violations at the curb before meters were installed.

PARKING METERS NEED BETTER ENFORCEMENT

MATTHEW C. SIELSKI, *Director*
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Chicago Motor Club

An analysis of parking habits before and after the installation of meters to determine the effectiveness of meters to reduce over-time parking.

SUMMARY OF FINDINGS BEFORE AND AFTER INSTALLATION OF METERS

1. There was no appreciable change in the number of parkers remaining one-hour or less.
2. There was no appreciable change in the number of space hours used by parkers remaining one-hour or less.
3. Seven out of the ten cities studied showed an increase in the number of space hours used by long-time parkers after meters were installed.
4. Two out of the ten cities indicated a decrease in the number of space hours used by long-time parkers, and one city showed no change at all.
5. The number of available parking spaces was reduced due to the creation of stalls of uniform size adequate for the longest vehicle necessary for parking meters.
6. There is a definite need for enforcement based upon observation of vehicles through tire marking rather than upon examination of parking meters. Motorists are able to remain at the curb for a long time without detection by simply adding coins to the meters.
7. A study made in Evanston, Illinois revealed that an enforcement program which included tire marking and parking meter enforcement resulted in a lesser amount of long-time parkers.

Parking continues to hold its lead as a major traffic problem. More and more business men are becoming alarmed at the prospect of business decentralization resulting from a lack of proper parking facilities in their shopping district. Parking meters have mushroomed into many communities and by 1947, they were in use in 888 cities over 5,000 population[1]. Almost 70% of the cities in the 250,000 to 500,000 population group have installed meters. However, notwithstanding the tremendous increase in meters, widespread interest on the part of municipal officials and various organizations, most of our motorized cities still lack adequate parking facilities.

On the basis of these developments, are we to conclude that parking meters have been greatly overrated as a tool for curing our parking problems? Obviously, such a surmisal could not be made without the background of a thorough study. It is for that reason that this research project has been undertaken. A comprehensive study was undertaken in 10 midwestern cities of various population classifications, to ascertain the difference in parking behavior of motorists before and after the installation of parking meters. In addition, further factual information has been included in this re-

port obtained from studies in other cities.

What Constitutes a Good Parking Program

Obviously, those cities wishing to solve their parking problems must accomplish the following two objectives:

(1) The most efficient use of present curb parking spaces.

(2) The provision of adequate off-the-street parking facilities.

In regard to the first objective, an efficient use of curb parking space will meet at least these requirements:

(1) A rapid turnover of short time parkers.

(2) Proper time limits designed for the length of time the majority of the parkers choose to remain in respective business blocks.

(3) Long-time parkers are entirely eliminated.

The "before" and "after" studies were conducted in the 10 midwestern cities to determine how effective meters were in eliminating the objectionable overtime parkers. This study was not made to discredit the use of meters, but rather to determine what steps should be taken to improve upon their present operations. Meters are at the stage that traffic signals were some 20 years ago. The signals were rapidly replacing the manual police officer, but on the other hand, they required a vast amount of improvement in order to control the flow of traffic more effectively. Consequently, traffic engineers soon developed such devices as progressive systems, flexible synchronized signal systems, timing programs, turning arrows etc. So it is today with our parking meters. They have replaced the officer on the beat, but they require more research work in order to obtain better parking regulations. This conclusion is based on the following before and after study.

[1]The Municipal Year Book, 1948.

THE SCOPE OF THE STUDY

Before and after studies were conducted in the following cities:

City	Population	Parking Limits	
		Before	After
Princeton, Ill.	5,500	90 min.	1 hr.
Downers Grove, Ill.	10,000	2 hrs.	1 hr.
Dixon, Ill.	11,000	none	1 hr.
Streator, Ill.	15,000	90 min.	1 hr.
Mattoon, Ill.	16,000	2 hrs.	2 hrs.
Marion, Ind.	27,000	90 min.	1 hr.
Elkhart, Ind.	34,000	1 hr.	1 hr.
Moline, Ill.	35,000	1 hr.	1 hr.
Joliet, Ill.	42,000	1 hr.	1 hr.
Aurora, Ill.	47,000	1 hr.	1 hr.

In most cases, the "before" studies were made just prior to the installation of meters and "after" studies were taken from three to six months following the first use of meters. In this study, two different types of checks were made. In the first type of study, license numbers of parked vehicles were recorded every one-half hour of one day, starting at 10:00 a.m. and continuing until 3:00 p.m. The second type of study made on different days, was a sort of "case history" study on detailed parking habits of persons using metered parking spaces. In this study, checkers observed for each parking space studied, approximately twelve cars and recorded the exact time vehicles entered and left a parking stall. These observers would also indicate how many coins were deposited by these parkers. These two studies were conducted identically for before and after meter installations. In the ten cities studied, over 1700 parking stalls were observed and this work required approximately 300 man hours in the field. The entire study involved an analysis of the parking habits of some 25,000 motorists. The before and after studies where license numbers were recorded every one-half hour period, covered the major portion of the main business district where parking meters were installed. It will be noted that in most cities, there was no appreciable change in time limits before and after the installation of meters. Where changes have been made, the new limits were shortened which would help to create a faster turnover of curb spaces.

RESULTS OF STUDY

The chart "Tabulation of Results of Parking Habits Before and After the Installation of Parking Meters" summarized the before and after findings for the cities studied.

TABULATION OF RESULTS OF PARKING HABITS
BEFORE AND AFTER THE INSTALLATION OF PARKING METERS

CITY		Percent of Vehicles Parked 0-30	30-60	60-90	over	Percent Full	Percent of Space Hours Used 0-30	30-60	60-90	Over	Percent Full	Increase or Decrease in Parking Space Turnover
Princeton, Ill	Before	65	21	7	7	64%	41	33	18	8	61%	Slight Decrease
Pop 5,500	After	69	20	7	4		43	32	5	20		
Downers Grove, Ill	Before	81	14	3	2	67%	58	26	8	8	57%	Slight Decrease
Pop 10,000	After	71	21	4	4		42	31	10	17		
Dixon, Ill	Before	62	17	8	13	81%	24	23	13	40	67%	Increase
Pop 11,000	After	68	19	8	5		36	25	19	20		
Streator, Ill	Before	73	16	6	5	Not	42	23	16	19	65%	No Change
Pop 15,000	After	70	18	7	5	Known	39	25	17	19		
Mattoon, Ill	Before	59	22	9	10	82%	27	24	17	32	79%	Slight Increase
Pop 16,000	After	63	23	7	7		31	27	14	28		
Marion, Ind	Before	60	20	9	11	73%	28	21	18	35	90%	No Change
Pop 27,000	After	52	28	10	10		20	28	16	36		
Elkhart, Ind	Before	64	24	7	5	95%	32	30	15	23	86%	No Change
Pop 34,000	After	63	24	6	7		32	29	13	26		
Moline, Ill	Before	59	27	8	6	89%	30	34	17	19	91%	Decrease
Pop 35,000	After	62	24	7	7		29	28	14	29		
Joliet, Ill	Before	63	23	8	6	89%	34	31	16	19	91%	Decrease
Pop 42,000	After	55	29	8	8		25	33	15	27		
Aurora, Ill	Before	65	21	7	7	89%	32	27	15	26	90%	Slight Decrease
Pop 47,000	After	59	24	9	8		27	27	18	28		

Princeton, Illinois - 5,500 population - This was the smallest of the cities studied. The fact that parking spaces never exceeded 64 percent full, either with or without meters, indicates that this city never did have a serious parking problem. Before parking meters went into effect, 86 percent of the parkers remained one hour or less and used 74 percent of the available space hours, (one space hour is one parking space used for one hour). After the installation of parking meters, 89 percent of the parkers remained less than one hour. This increase in "curb parking availability" created by a slight increase in curb turnover was offset by lost space due to long-time parked vehicles. Before meters, 7 percent of the parkers remained over 90 minutes and used 8 percent of the total space hours. After meters were installed, 8 percent of the parkers used 20 percent of the available space hours. As a consequence, parking meters failed to provide more curb parking availability in this city.

It might be mentioned at this point of the report, that long-time parkers were recorded as those that had remained over 90 minutes. The parkers remaining 60 to 90 minutes were regarded as borderline cases and consequently were not mentioned in the study.

Downers Grove, Illinois - 10,000 population - This city maintained a good enforcement program before parking meters went into effect and consequently experienced a good turnover of parking spaces. Before meters, 95 percent of the parkers remained one hour or less and consumed 84 percent of the available parking space. Only 2 percent of the parkers remained over 90 minutes, which for all intents and purposes could be labeled as perfect observance of time limits. After meters were installed, the percentage of parkers remaining one hour or less decreased from 95 percent to 92 percent and violators increased to 4 percent, probably because of less effective enforcement. Thus parking meters did not create any additional curb parking availability and in reality decreased the amount of curb turnover.

Dixon, Illinois - 11,000 population - This city experienced a greater turnover of parking spaces as a result of parking meters. Before their installation, 79 percent of motorists remained one hour or less and used only 47 percent of the

available space hours. After meters went into effect, 86 percent of parkers remained one hour or less and consumed 61 percent of the available space hours.

Evidence of more parking accommodations created through meters lies in the finding that after meters were installed only 5 percent of parkers remained longer than 90 minutes and consumed 20 percent of the available space hours. This is in contrast to 13 percent of parkers using 40 percent of the available space hours before meters went into effect.

Streator, Illinois - 15,000 population - A study of parking conditions in this city revealed that no additional curb parking availability was created by parking meters. Before their installation, 89 percent of the parkers remained one hour or less and consumed 65 percent of the available space hours. Long-time parkers were kept down to a minimum of 5 percent. After the installation of meters, it was found that 88 percent of the parkers remained one hour or less and consumed 64 percent of the available space hours. Again, long-time parkers were held down to 5 percent.

Mattoon, Illinois - 16,000 population - Meters did not materially change the parking habits of the motorists in this community as is evidenced by the fact that 81 percent of them parked one hour or less before the installation of meters and in doing so consumed 51 percent of the total available space hours. Contrast this to 86 percent parkers remaining one hour or less in a metered area and consuming 58 percent of the total available space hours. It is interesting to note that in this particular study it was found that the number of available curb spaces was reduced by 17 percent due to the larger amount of curb space required with meters because each marked stall must be long enough to accommodate the longest passenger car.

Marion, Indiana - 27,000 population - Long time parking is just as much of a problem in this city today as it was before parking meters went into effect. Before meters, 11 percent of the parkers remained over 90 minutes and consumed 35 percent of the space hours. With meters, 10 percent used 36 percent of the space hours. Obviously, more rigid enforcement based on police observance of vehicles and not on examination of meters is essential. The number of short time parkers and the number of space hours used was almost the same with and without meters. (See Fig. 1)

Elkhart, Indiana - 34,000 population - Our study showed that very little space has been gained through the use of parking meters in this city. It is, however, important to note that after meter installation, 13 percent of parkers remained over the one hour limit and by so doing consumed 39 percent of the parking space. In this study, it was observed that the average time parker remained was 15 minutes. If this overtime parking were eliminated, an additional 276 average time parkers, or a net gain of 26 percent of average time parkers, could be accommodated. Before meters went in, 88 percent of the parkers remained less than an hour and consumed 62 percent of the available space hours. With meters, 87 percent stayed for an equal time and used 61 percent of the space, which is about the same as without meters.

Moline, Illinois - 35,000 population - Typical of cities over 25,000 population, the parking problem in this city is serious. Curb parking space is 90 percent full throughout the day and parking lots get their share of surplus parkers. Before parking meters were installed, 83 percent of the parkers remained one hour or less and consumed 64 percent of the curb availability. After meters, 86 percent parked one hour or less and consumed 57 percent of the space. The big difference in curb use resulted in a larger number of long time parkers after meters were introduced. Before studies indicated 6 percent of the parkers using 19 percent of the curb availability while after results indicated 7 percent of parkers using 29 percent of the space. Thus, the need for proper enforcement of time limits is very apparent.

Joliet, Illinois - 42,000 population - Before meters went into effect, 1408 downtown parking spaces were available in the day and were 89 percent full. After the installation of meters the number of spaces

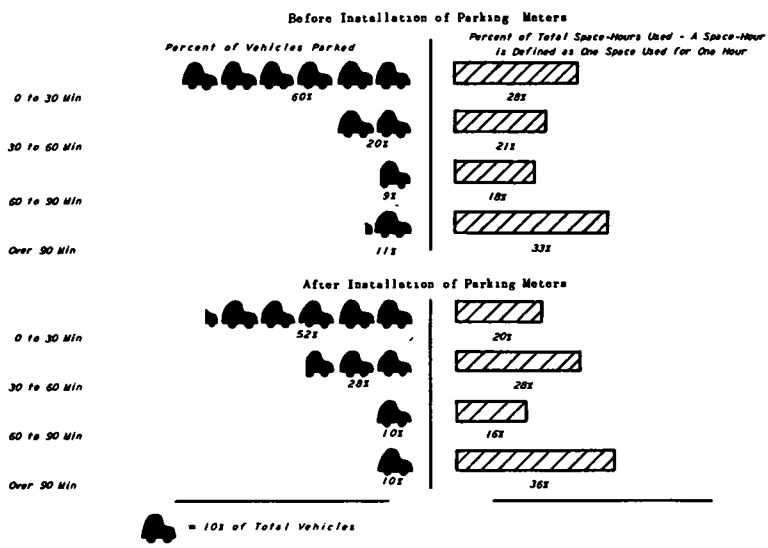

Figure 1. Use of Curb Parking Space in Business District of Marion, Indiana.

was reduced to 1376 and they were 91 percent full. 86 percent of the parkers stayed for one hour or less before meters and consumed 65 percent of the available space hours. After meters, the number of short-time parkers was reduced to 83 percent who consumed 58 percent of the available space hours. Thus it is apparent that no gain in "curb parking availability" was made through the use of parking meters. Further indication of this is evidenced by the increase in the use of space hours by long-time parkers from 19 to 27 percent an indication that proper enforcement certainly is desirable.

Aurora, Illinois - 47,000 population - In this study we found that 81 percent of the parkers remained at the curb one hour or less before meters, and consumed 59 percent of the available space hours. After parking meters were installed, 83 percent of the parkers remained one hour or less and consumed 54 percent of the available space hours. There was very little change in violations since 7 percent overstayed 90 minutes without meters and consumed 26 percent of the available space hours, while with meters 8 percent were violators, consuming 28 percent of the available space hours.

COMPARISON OF AVAILABLE PARKING SPACES BEFORE AND AFTER THE INSTALLATION OF PARKING METERS

This study was made to determine whether or not parking spaces were reduced as a result of creating parking stalls. Data obtained from five of the cities could not be used because in some cases parallel parking was substituted for angle parking. In other cases, parking was eliminated for moving traffic, and for the establishment of loading zones. The five cities eliminated are: Princeton, Dixon, Streator, Mattoon and Marion.

The five cities upon which data are based are: Downers Grove, Elkhart, Moline, Joliet and Aurora. All of the "before" and "after" studies, with the exception of Downers Grove, were made six months apart.

Downers Grove showed an increase of two parking spaces, from 111 to 113 stalls, but a decrease in the number of cars coming into the district from 595 to 516.

Elkhart has an increase in available spaces from 126 to 133, but a decrease in the number of cars coming into the district from 964 to 914.

Moline reduced its number of curb park-

COMPARISON OF AVAILABLE PARKING SPACES
BEFORE AND AFTER THE INSTALLATION OF METERS

City	Before Meters: Number of spaces	Before Meters: Number of vehicles[1]	Before Meters: Percentage Full	After Meters: Number of spaces	After Meters: Number of vehicles	After Meters: Percentage Full
Princeton[2]	181	939	64%	150	729	61%
Downers Grove	111	595	67%	113	516	57%
Dixon[2]	245	1589	81%	198	1066	67%
Streator			No study made			
Mattoon[2]	211	1386	82%	177	1081	79%
Marion[2]	135	794	73%	114	825	90%
Elkhart	126	964	95%	133	914	86%
Moline	175	1238	88%	164	1119	85%
Joliet	176	1254	89%	172	1259	91%
Aurora	303	2087	89%	288	2080	90%

[1]Number of cars parked throughout the survey.
[2]Angle parking eliminated or parking spaces removed for loading zones.

City	Percent of Overtime Parkers	Percent of Space Hours
Moline, Ill.	7%	29%
Joliet, Ill.	8%	27%
Aurora, Ill.	8%	28%

It can be seen that in the case of Evanston, more enforcement is necessary in order to cut down the percent of space hours that are used by long-time parkers. Since this enforcement program is relatively new in Evanston, even better results are expected as the enforcement program continues.

To further strengthen the belief that enforcement of vehicles is necessary to obtain proper use of curb space with meters, another study was made in Oak Park, Illinois. This municipality has a population of 66,000 and its characteristics, income of citizens, and general physical aspects are very similar. However, the enforcement of parking regulations comprises of the observation of parking meters rather than tire marking as in Evanston. Here are the results of that survey:

Time Parked	Percent of Vehicles Parked	Percent of Total Space Hours Used
0-30 min.	56%	26%
30-60 min.	27%	32%
60-90 min.	10%	19%
over 90 min.	7%	23%
	100%	100%

Why Street Enforcement is Necessary - By observing the charts illustrating the before and after curb use in the ten cities mentioned at the start of the report, it will be noted that the percentage of parkers remaining over the time limit is small. (about 7%) On the other hand, the amount of curb space used by this small number is worthy of consideration. (17-36%) (Fig. 2)

In the 47 curb spaces which were continuously observed, 20 parkers were found to reinsert coins after the one hour limit had expired. As a result of this practice, valuable curb space has been "hogged" by a relatively small number of parkers - space which could have been used by a large number of average time parkers.

Let us take, as an example, a typical study made in Moline, Illinois. In this check one observer constantly watched 10 parking spaces from 2:00 p.m. to 5:00 p.m. He recorded the exact time a car arrived and departed. He also observed the number of coins that were deposited by overtime parkers. In this particular check it was found that forty cars used the ten spaces. Of these, thirty-five or 87 percent parked one hour or less and consumed a total of 682 minutes or an average of 19.5 minutes per car. The overtime parkers, which constituted but five or 13 percent of the total consumed 502 minutes or an average of one hour and forty minutes per car. ing stalls from 175 to 164 and reduced the number of parkers using stalls from 1238 to 1119.

Joliet for all intents and purposes

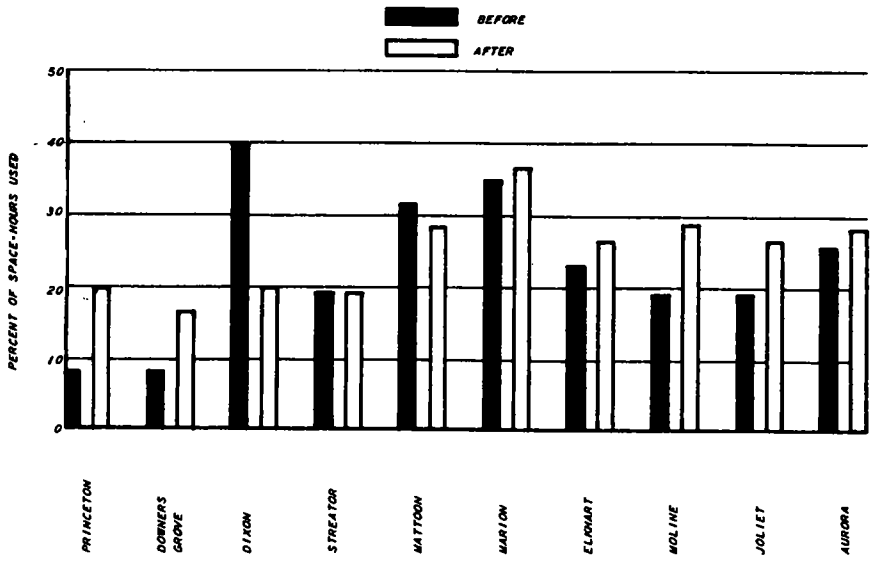

Figure 2. Comparison of Space-hours Used by Overtime Parkers Before and After the Installation of Parking Meters.

showed no change in the number of available spaces or number of parked vehicles.

Aurora, however, showed a decrease from 303 to 288 spaces after the installation of meters. Approximately the same number of cars came into the district and parked at the curb before and after meters. Combining the amount of spaces and vehicles entering the business district before and after in the five cities mentioned it was found that a 3 percent reduction in the number of spaces resulted and a 4 percent reduction in the number of cars coming into the business district. These comparisons are shown in the table "Comparison of Available Parking Spaces Before and After the Installation of Meters."

A BETTER ENFORCEMENT PROGRAM IS NECESSARY

On the basis of this study it can be concluded that parking limits cannot be enforced merely by the examination of the parking meters to determine when coins were last inserted. It must be based upon an inspection of the automobiles parked to determine whether or not they have been standing for longer than the permitted period. Proper enforcement under a system in which patrolling police officers would check the vehicles, rather than the meters, would add materially to the available parking spaces at the curb.

To demonstrate the effectiveness of such enforcing methods, a study was made in Evanston, Illinois population 65,000, to determine the number of space hours consumed by over-time parkers. This city has recently installed parking meters, but instead of checking the meters for violators, police officers stationed on three wheel cycles mark tires.

Here are the results of that survey:

Time Parked	Percent of Vehicles Parked	Percent of Total Space Hours Used
0-30 min.	57%	28%
30-60 min.	30%	36%
60-90 min.	9%	18%
Over 90 minutes	4%	18%
	100%	100%

Thus it can be seen that with such an enforcement program, only four percent of all motorists were found to remain

over-time at the curb. This is in sharp contrast to the experience found in other cities mentioned in this report. For example, here are the number of over-timed parkers mentioned earlier in the report having a population comparable to Evanston:

City	No. of spaces studied	Vehicles parked less than 1 hr			Vehicles parked over 1 hour			Additional cars that could have been accommodated
		No. of cars	%	Average time parked	No. of cars	%	Average time parked	
Moline	13	36	92%	30 min.	3	8%	90 min.	13
Moline	10	35	87%	19.5 min.	4	13%	100 min.	20
Elkhart	13	85	96%	14.7 min.	4	4%	89 min.	24
Elkhart	11	51	85%	24.2 min.	9	15%	95.5 min.	35

If these long-time parkers were eliminated, there would be space available for 25 additional average time parkers.

Here are some examples of other studies of this same abuse:

This study clearly demonstrates the need for rigid enforcement of parking limits if more parking space is to be found at the curb. As this study, and countless other parking studies repeatedly point out, the number of long-time parkers are few, but their violations are expensive to other motorists in terms of space "hogged" at the curb. As the table above points out, in just one section of a block, violators constitute but 15 percent of the total, yet, if these violators were eliminated, space could be provided for an additional 31 more average time parkers. Obviously, these overtime parkers will not be eliminated if officers confine their efforts to looking at the meters without noting the time individual cars remained at the curb.

CONCLUSIONS

The studies here reported lead to the conclusions that, as generally administered, parking meter ordinances have not aided in the creation of additional parking spaces and that, apparently, this shortcoming has been the result of imperfect enforcement, based upon examination of the parking meters to determine when coins were last inserted rather than upon inspection of the automobiles parked to determine whether or not they have been standing for longer than the permitted period. Proper enforcement under a system in which patrolling police officers would check the vehicles, rather than merely the meters, would add materially to the available parking spaces at the curb in the cities which employ these devices. (This has been demonstrated in Evanston, Illinois.) Apparently, enforcement through the actual checking of the vehicles has been lax within the municipalities studied because of the assumption by the enforcement officials that meters are self-enforcing because parkers would be deterred from overtime parking because of the necessity of inserting additional coins in the meters to obtain additional parking time. This assumption has been proved incorrect because the survey shows a marked increase in the number of overtime parkers who escape detection under the generally followed system of enforcement through checking the meters alone.

Proper enforcement alone will not provide a complete solution to the parking problem. With the present and the expected increase in the number of vehicles, adequate curb space for parking will not be available even under the most rigid enforcement of parking time limit restrictions. The use of parking meters can contribute to the ultimate solution of the problem because in addition to maintaining a rapid turnover of space, they can produce revenue which is generally more than adequate to defray the cost of parking regulation and the surplus revenue may be utilized for the purchase and construction of municipally owned off-the-street parking fac-

ilities. Municipalities commonly use such surplus parking meter revenue for a variety of purposes, such as street repair, the purchase of police and fire department vehicles and other expenditures not directly related to the parking problem. It is recommended that where existing laws do not authorize the use of parking meter revenue for the purpose of acquiring and constructing municipal parking lots, legislation should be adopted to permit this use of parking meter funds and that parking meter ordinances should be amended to provide for this expenditure.

DISCUSSION

Mr. Burrage: The cruising method of determining parking time as described in this study does not give accurate lengths of parking time. Usually it indicates only a portion of those overstaying a fixed parking time limit.

Mr. Sielski: The limitation on this type of study is recognized and by definition allowance is made. The interval in which parking checks were made is relatively unimportant in these studies because long time parkers only were considered. No overtime parkers were considered unless the vehicles had been in a space 90 minutes although the zones studied were one-hour zones.

Mr. LeVerne Johnson, American Automobile Association: Has any attempt been made to consider the amount of enforcement of time restrictions during the period of the studies?

Concensus of several replies: The degree of enforcement is difficult to appraise. Variation in amount of enforcement undoubtedly exists between different cities, within the same cities and even between metered and unmetered areas of the same city.

Several comments emphasized the limitations of this paper and of the paper presented by Messrs. Burrage and Hitchcock. These should be recognized in any comparison of the data presented in the two papers.

Limitations to the paper by Mr. Sielski.

All cities studied were less than 50,000 population.

Overtime usage is limited to drivers parking 90 minutes or more.

Overtime usage is expressed only in time and not numbers of parkers.

RESUME OF FRINGE PARKING PRACTICE

F. W. LOVEJOY, *Member*,
District of Columbia Motor Vehicle Parking Agency

At the 27th Annual Meeting of the Highway Research Board, held in Washington, D. C., December 2, 1947, the author discussed "Fringe Parking in Relation to Traffic Congestion" and Mr. Adrian Hughes discussed "Fringe Parking in Relation to Transit Operations." As a result of the discussion on the papers, the Committee included an item in its 1948 program of activity to develop a resume of fringe parking practice and any trends in its use.

The American Transit Association had obtained reports on the operation of transit companies with respect to fringe parking in 16 cities. To this Mr. I. S. Shattuck added information from three more cities. A questionnaire designed to obtain information relative to the operation of fringe parking operations was distributed by the committee to traffic engineers in 25 other cities. Replies were received from 19 of these. The coverage of this review includes 42 of the largest cities in this country and one large Canadian city.

The Committee acknowledges the cooperation extended to it by the American Transit Association and by Mr. I. S. Shattuck in making much of the information available. The replies received from individuals are also appreciated even where there was no fringe parking experience to report. The helpful comments, and opinions of those who discussed situations where fringe parking had been started and abandonded or where it is still being used are also appreciated.

FRINGE PARKING

Admittedly there is no generally accepted designation of what constitutes a Fringe Parking Facility. Perhaps, however, it could be considered that the most important characteristic of a fringe facility is its coordination with transit or mass transportation operations.

Function

Like all urban off-street parking facilities, fringe lots should function to relieve street traffic congestion, especially in the business sections. The development of such facilities must be coordinated with transit operations if automobiles are to be kept off the downtown streets.

Ordinarily, however, the expectation is that fringe parking in combination with transit will furnish a more or less satisfactory substitute for the privilege of driving a car downtown, and parking it there, at not too much expense.

It is possible to recognize some conditions which have been present in the operation of each fringe parking facility which has been abandonded. It is also possible to recognize some of the conditions which are present in those facilities which are continuing to operate as a fringe parking facility.

A resume by cities of the data collected follows:

DISCONTINUED FRINGE PARKING EFFORTS

City	Population
Denver, Colorado	322,412
Grand Rapids, Michigan	164,292
Pittsburgh, Pa.	671,659
Atlanta, Ga.	302,288
Norfolk, Va.	144,332
Richmond, Va.	193,042
Paterson, N. J.	139,656
Washington, D. C.	663,091
Hartford, Conn.	166,267

Pittsburgh, Pa. - Information from this city is not strictly comparable. The location was unfavorable (across a river) and the attempt was made several years ago before the last war.

Washington, D. C. - A shuttle service between two lots was discontinued March 31, 1949. Rates were relatively high - 25 cents, a token or 13 cents cash fare for bus ride each way. Downtown parking rates for two hours didn't exceed 50 cents at many locations and unrestricted curb parking was available near one lot at one end of the route.

Hartford, Conn. - Even with 5 cents parking and regular token fare with transfer privileges on regular transit busses, the attempt to develop a second fringe lot was discontinued. The first fringe parking lot is continuing to operate.

Certain generalizations are apparent in the remaining six cities. Fringe parking has been discontinued after attempts to install such operations in cities of less than 350,000 population. The maximum distances to be travelled in the smaller cities are not great enough to make two types of transportation to reach the downtown area sufficiently appealing.

Records of turnover in the use of space are low, slightly over 1.0. Most of the parkers who use these fringe facilities are all-day parkers, indicating few shoppers. It would seem that even with free parking at these fringe facilities shoppers having bundles to carry prefer parking closer to stores or if they must use a bus from the fringe, they may as well make the whole trip by bus.

CONTINUING FRINGE PARKING OPERATIONS*

Baltimore, Md.	(1)	Hartford, Conn.	(1)
Boston, Mass.	(28)	Philadelphia, Pa.	(2)
Chicago, Ill.	(2)	St. Louis, Mo.	(5)
Cleveland, Ohio	(2)	Toronto, Canada	(3)
Dallas, Texas	(1)	New York, N.Y.	(2)

*Number of fringe facilities in parentheses.

Baltimore, Md. - (Capacity 206 cars) 1940 population 1,046,692.

Lot operated by Baltimore Transit Company, which also furnished a loop bus service into the downtown area. The parking rate is 45 cents for all-day, including rides both ways on the loop buses.

The lot is 0.75 - 1.0 mile out, the bus headways 5 minutes on peak, 7.5 minutes on base day, the space turnover on the lot is 1.31.

Boston, Mass. - (Capacity 5,131 cars) 1940 population 2,350,514.

Twenty-eight lots, some operated by Metropolitan Transit Authority, some privately, some with parking fee, others without fee, all located along the transit lines.

Chicago, Ill. - 1940 population 4,499,126.

Monroe Street Lot - (Capacity 3,500 cars).

Lot operated by State Street Council, with loop bus service furnished by Chicago Motor Coach Company. The parking rate is 35 cents for all day, the bus fare 5 cents each way.

Practically any section of shopping district is less than a mile from the lot, which means a fairly short bus ride. Nevertheless, while the lot is usually pretty full, the space turnover is less than 1.0.

Soldiers Field Lot - (Capacity 6,000 cars).

Lot operated by State Street Council, with shuttle bus service furnished by Chicago Motor Coach Company. The parking rate is 25 cents for all day, the bus fare 5 cents each way. The lot is 1.5 miles outside the Loop, is used by only 400-500 parkers daily.

In both instances the payment of expense for operation of these lots is guaranteed by the State Street Council.

Cleveland, Ohio. - (Capacity 2,490 cars). 1940 population 1,214,943.

Private Lots - (Capacity 990 cars).

Two adjoining lots served by two bus lines to business district. Parking rates 25 cents and 35 cents all day, respectively, bus fare 5 cents each way.

The lots are 0.75 mile out, buses on 6-minute headway.

Municipal Lot - (Capacity 1,500 cars) Operated by City of Cleveland on Lake

Front 0.67 mile from business district, and served by two bus lines. No parking fee, bus fare 5 cents in each direction. Information concerning turnover is lacking.

Dallas, Texas - (Capacity 350 cars) 1940 population 376,548.

Lot owned and operated by a department store shuttle bus transportation downtown furnished by Dallas Railway and Terminal Company. The parking rates are 35 cents for three hours, 50 cents for all day.

The lot is 0.50 to 0.75 mile from downtown, while the buses run on a 6-minute headway, so the lot shows a space turnover of 1.57.

Hartford, Conn. - (Capacity 800 cars) 1940 population 502,193.

Lot operated by the Connecticut Company, which also furnishes loop bus service to downtown area. The parking rate is 5 cents for all day, the bus ride 10 cents in each direction.

The lot is 1.2 miles outside the business and shopping district, and the bus headway is 10 minutes.

New York, N. Y. - 1940 population 11,690,520.

Flushing Meadow (Capacity 3,000 cars)

Owned and operated by New York City at the terminus of subway to Grand Central Station. Parking is free. Subway fare is 10 cents. Lot is open 6 a.m. to 12 midnight. 7.8 miles to Grand Central Station. No attempt is made to make site self-supporting, costs of operation, including policing, are borne by the city.

Camden Plaza - (Capacity 700 cars)

Owned and operated by New York City at the Brooklyn end of the Brooklyn Bridge. Parking is free. Frequent trolley service across bridge, 1.5 miles to the City Hall. Fare is 7 cents. Short-time or all-day parkers no restrictions. City bears all costs of operation including policing.

Philadelphia, Penn. - 1940 population 2,898,644.

69th and Market Street Lot (Capacity 330).

Lot operated by Philadelphia Transportation Company, which also furnishes elevated and subway ride downtown. The parking rate, including subway ride in both directions, is 30 cents for all day.

The lot is 5 miles from downtown, but because of cheap combined rate for parking and subway ride, has a space turnover of 1.5 including some demand from local shopping center and movie.

Frankford Avenue and Bridge Street Lot - (Capacity 310 cars)

Lot operated by Philadelphia Transportation Company, which also furnishes elevated and subway ride downtown. The parking rate including subway ride in both directions is 30 cents for all day.

The lot is 7 miles from downtown, but because of cheap combined rate for parking and subway ride, has a space turnover of 1.22.

St. Louis, Mo. - 1940 population 1,367,977

Five lots in all, one municipally, four privately owned. St. Louis Public Service Corporation operates buses through the downtown area between these parking lots on the fringe. Parking rates vary from 15 cents all day to 25 cents first hour, some lots not being convenient to buses. Bus fares 5 cents each way.

The east and west fringe lots are 0.25 to 1.0 mile out, those on north and south fringes from 0.33 to 1.50 miles out.

Toronto, Canada - (Capacity 1,560 cars) population 667,457.

Three lots operated by the Toronto Transportation Commission, with bus loop into shopping district. Parking rates 15 cents all day, bus fare 5 cents each way.

The lots are 0.7 mile from downtown, the bus headway from 6 to 7.5 minutes, so the lots show a turnover of 1.31.

CONCLUSIONS

It appears that St. Louis has the best pattern of fringe parking facilities coordinated with transit. The lots are on all sides of the central business district, and serviced by buses running between them through the downtown section. Daytime curb parking is prohibited on a considerable proportion of downtown streets. The economics of the fringe lot service does not appear, however, nor the actual effect it has had in reducing downtown congestion, although the advantageous pattern of lot locations should permit important savings

in bus operations, and avoidance of too much traversing of the business center by cars seeking to park in fringe lots.

From this group of cities it appears that the operation of fringe parking facilities is continued even though the revenues from parkers, if any, are insufficient to finance necessary additional transit services.

In general the larger cities seem to accept fringe parking even at the expense of subsidizing transit service or of furnishing the parking facilities.

In general, however, the following conditions appear to be in common in cities where these fringe facilities are being conducted:

Large population centered in the area.

Large storage capacities in the lots.

Lot locations along arterial streets and at termini of express or rapid transit service.

Frequent transit service in rush hours (5 minute headway).

Purpose or Function

Fringe parking facilities may sometimes be provided at a railhead or bus terminus, for the accommodation of those driving cars in from outlying areas, then finishing their trips downtown by mass transportation. These fringe facilities may be at any reasonable distance from the center of town.

Location

Pattern: Where the size and shape of a city warrant it, there should be a complete pattern of fringe parking facilities surrounding the business and shopping center, so as to intercept parkers at the fringe, thus preventing the driving of some cars through the center to a facility perhaps on the far side.

Distance out: In this case, the distance of the fringe facility from the business district is of great importance. The distance from the center at which a fringe facility will best attract and serve the parker depends somewhat upon the parker's purpose in making his trip. If the parker has a job in town, for example, and wants to park all day, he can be served acceptably by a fringe facility a mile or so from downtown, or even further in some cases. But if the parker is a shopper or is making a business or professional call, he will want a fringe facility closer to his ultimate destination.

Transit

The proper coordination of transit with fringe parking is essential, most of all when the service accommodates the short time shopper or business parker. Headways then should preferably not be longer than 5 minutes right through the day. Indicentally, the fringe facility for the shopper and business parker should be so managed as to avoid the blocking out of short-time by too many all-day parkers.

Economics

The real over all economy of fringe lot operation is difficult to evaluate because of the tendency of transit to overlook losses for the sake of improved public relations, and more understandingly because of expected although not always apparent reduction of traffic on downtown streets, so buses and street cars can get through faster. This last again would tend toward improved public relations for transit.

Data should be obtained for making accurate determinations of over-all fringe facility economics, as well as a gauge of effects upon downtown traffic.

GROSS RETAIL SALES AND AUTOMOBILE PARKING REQUIREMENTS

FLOYD M. JENNINGS, *Director*
City Planning Commission
Grand Rapids, Michigan

An analysis of retail sales as a means of determining the number of spaces, distribution of spaces, and the design and function of the parking terminal is not proposed as a method to replace any of the techniques heretofore used. The origin and destination techniques which have been applied in the central business districts provide the overall analyses with valuable and contributing data. Retail sales as a source of data, when analyzed, provides a community with a true picture of parking requirements and not one of an existing parking pattern. This is the only contribution retail sales can make to the solution of the parking problem; however, these are important data upon which a parking plan is formulated. The location of existing parking lots does not necessarily represent centers of parking demand. An analogy to this is the origin and destination survey technique of traffic which has proven that the flow of traffic on a major thoroughfare does not necessarily represent the traffic demand characteristics of the area served by the thoroughfare.

The origin and destination parking study among other travel habit information obtains the following data: 1 - number of persons per automobile, age and sex; 2 - time duration parked; 3 - place where automobile is parked; 4 - destination of auto occupants.

FRAMEWORK FOR A PARKING-PLAN

The number of parking spaces required at any one point in the central business district is related to the drawing power of the traffic generator which the parking facility serves. The drawing power of a retail outlet varies during the week, the month, the season, and the cyclical periods. (See Figures 1, 2 and 3.) The table which follows shows the varying daytime peaks in the use of an attendant type parking terminal serving primarily a large department store in the central business district of Grand Rapids, Michigan.

Daytime Peaks	Volumes Parked
Nov. 15, 1946	105 automobiles
Nov. 20, 1946	110 automobiles
Nov. 30, 1946	135 automobiles
Dec. 7, 1946	150 automobiles
Dec. 9, 1946	150 automobiles
Dec. 14, 1946	155 automobiles

It will be noted that the use of the parking terminal increased as the Christmas buying period developed. A high daytime peak was experienced during the month of March of the following year (See Figures 4 and 5). These varying daytime peaks reflect seasonal fluctuations in retail sales.

The character of retail sales influences "total parking requirements". Together with destination data from parking studies "total parking space requirements" for any time during the seasons of the year can be developed.

In most central business districts there are a number of non-retail land and other structural uses. In terms of "net land area" the land in the central business district of Grand Rapids is used in the following manner:

Land Use (Figure 6)	Percent
Retail Sales	42.4
Parking areas (existing)	19.5
Industrial	13.1
Professional offices	9.7
Institutional	6.5
Hotels	3.2
Gasoline filling stations	2.4
Wholesale	1.6
Residential	1.6

CHARACTER OF RETAIL SALES

Before interpreting retail sales in terms of parking space requirements it is necessary to examine the character of retail sales. This examination falls into two parts: (1) an examination of the regional pattern of retail sales characteristics; and (2) an examination of the daily, seasonal, and cyclical fluctuations in retail sales.

The United States retail census in 1939

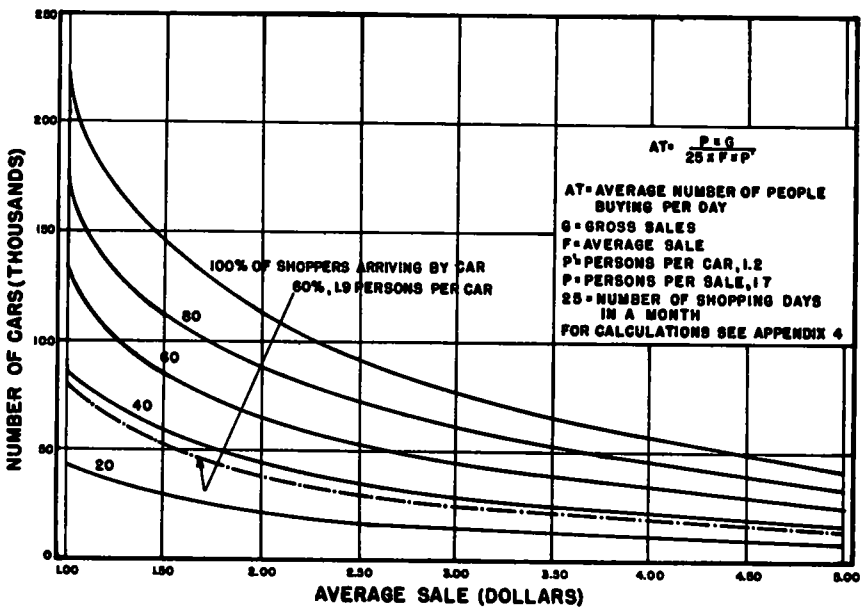

Figure 1. Parking Space Demand for Customers Retail Sales Central Business District, Peak, 1946.

The bulk of the "total parking space requirements" for the central business district are those required for retail sales, industrial, professional offices, and hotels (68.6 percent). The remaining uses are not major factors seriously affecting the "total parking space requirements" for the entire district.

If a graphic illustration could have been prepared showing floor area uses, the area for retail sales would have shown an even greater proportion of the total floor area usage. However, it is apparent even from scrutinizing the land area data that the retail sales function is the major factor in determining "total parking space requirements".

provided sales data in the following groups; Foods, general stores, apparel, furniture, household and radio, automotive, filling station, lumber, building and hardware, eating and drinking places, drug stores and other stores.

These groups except for a few insignificant exceptions can be categorically generalized: A - Convenience and soft goods; B - Style and hard goods.

Convenience and soft goods have, in most cities, become a sales function for neighborhood and community centers. Style and hard goods are predominately a central business district sales function. Style and hard goods lines require large inventories representing a relatively high

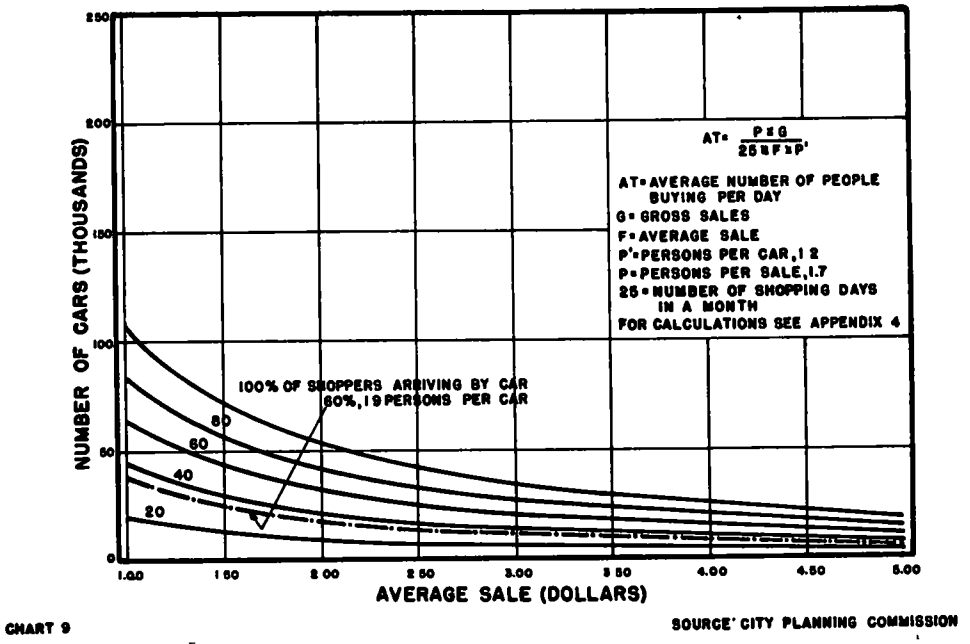

Figure 2. Parking Space Demand for Customers Retail Sales Central Business District, Low, 1946.

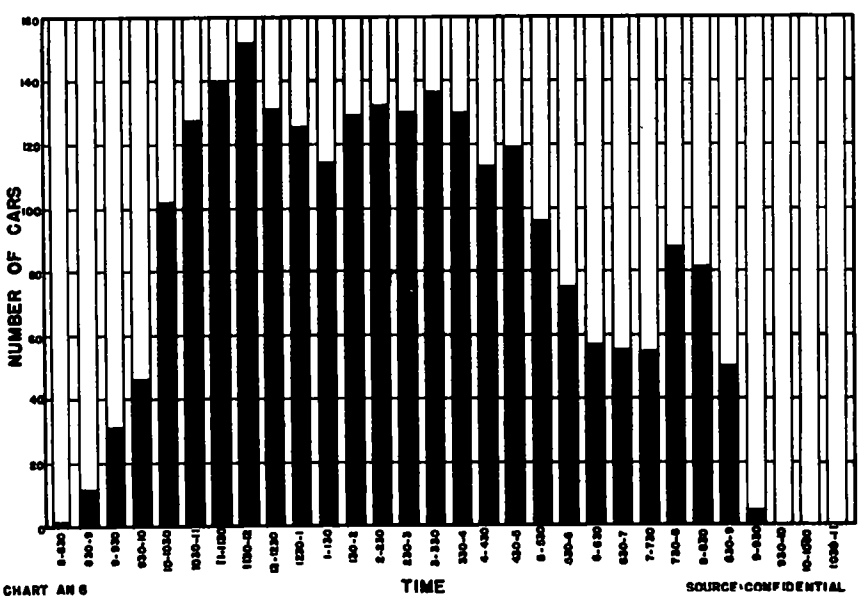

Figure 3. Net Cars Remaining on Downtown Parking Lot Saturday, December 14, 1946.

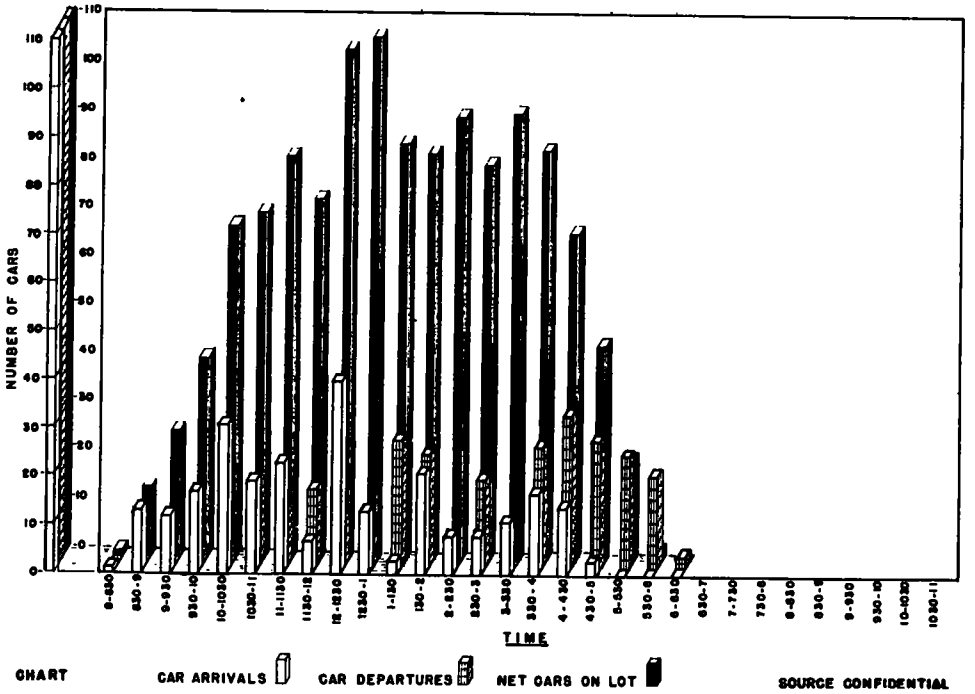

Figure 4. Operational Data - Downtown Parking Lot, Wednesday, March 12, 1947.

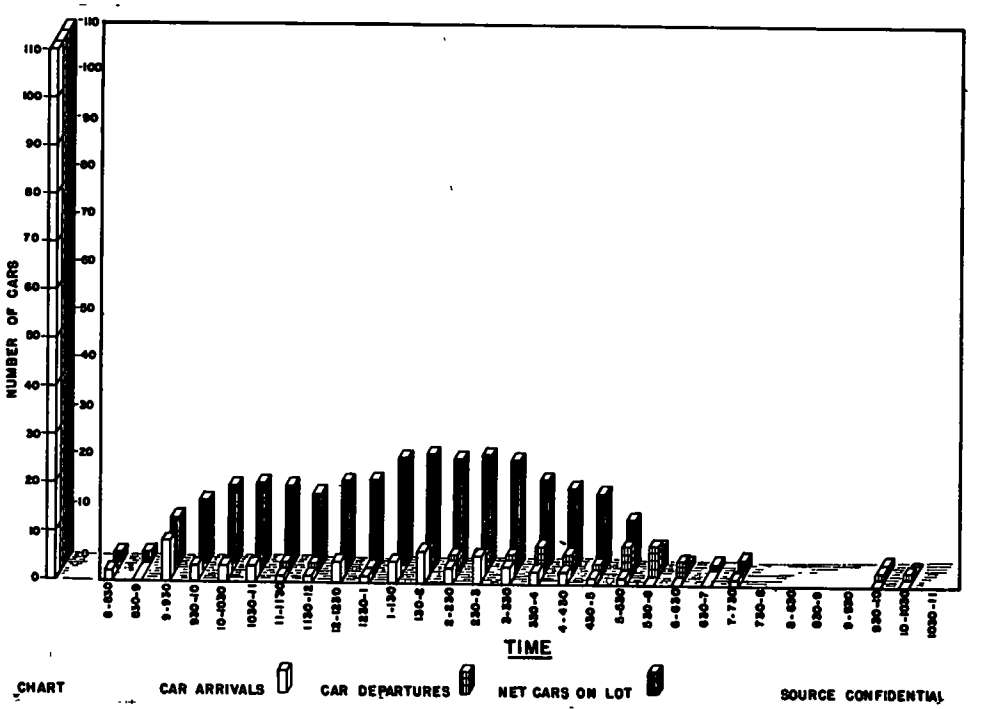

Figure 5. Operational Data - Downtown Parking Lot, Tuesday, March 25, 1947.

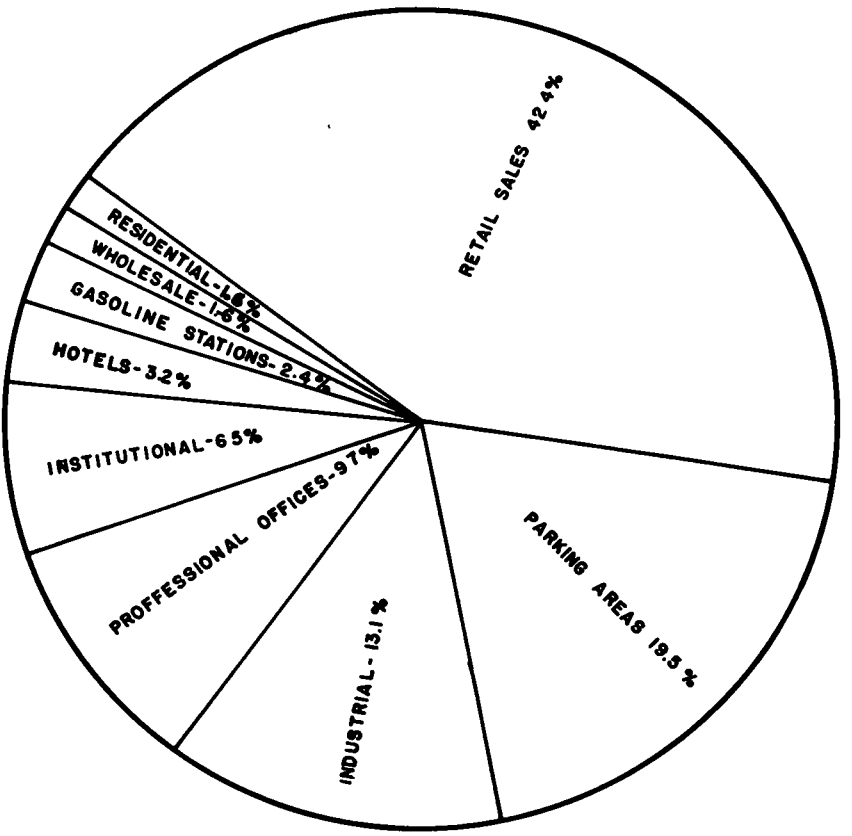

Figure 6. Types of Land Use in Downtown Area.

investment. These sales functions have not decentralized because of this retail sales characteristic. In urban places of one million people or more it has been economically feasible for some department store operations to decentralize. However, in urban places the size of Grand Rapids (250,000) decentralization of these sales functions would not be economically feasible.

In large metropolitan areas the regrouping of the central business district functions in one or more decentralized points has been planned. This process has become known as recentralization.

If there is any one predominate sales function and the centripetal force in the central business district it is the department store. The origin and destination study of Grand Rapids showed those blocks in which the 3 leading department stores are located to be the points of heaviest destination of trips to the business district.

In the central business district of Detroit an origin and destination parking survey showed the blocks in which the J. L. Hudson department store is located to be one of the heaviest points of destination (see Figure 7). It is revealing to note the correlation of the heavy points of destination and the places of high assessed valuation (see Figure 6 showing downtown property values in Grand Rapids). Although the O.D. study has not been completed[1] for Grand Rapids previews have shown a remarkable relationship between the two. Assessed valuations do reveal generalized data on economic rent. Economic rent is a product of the

[1]As of December 1, 1948.

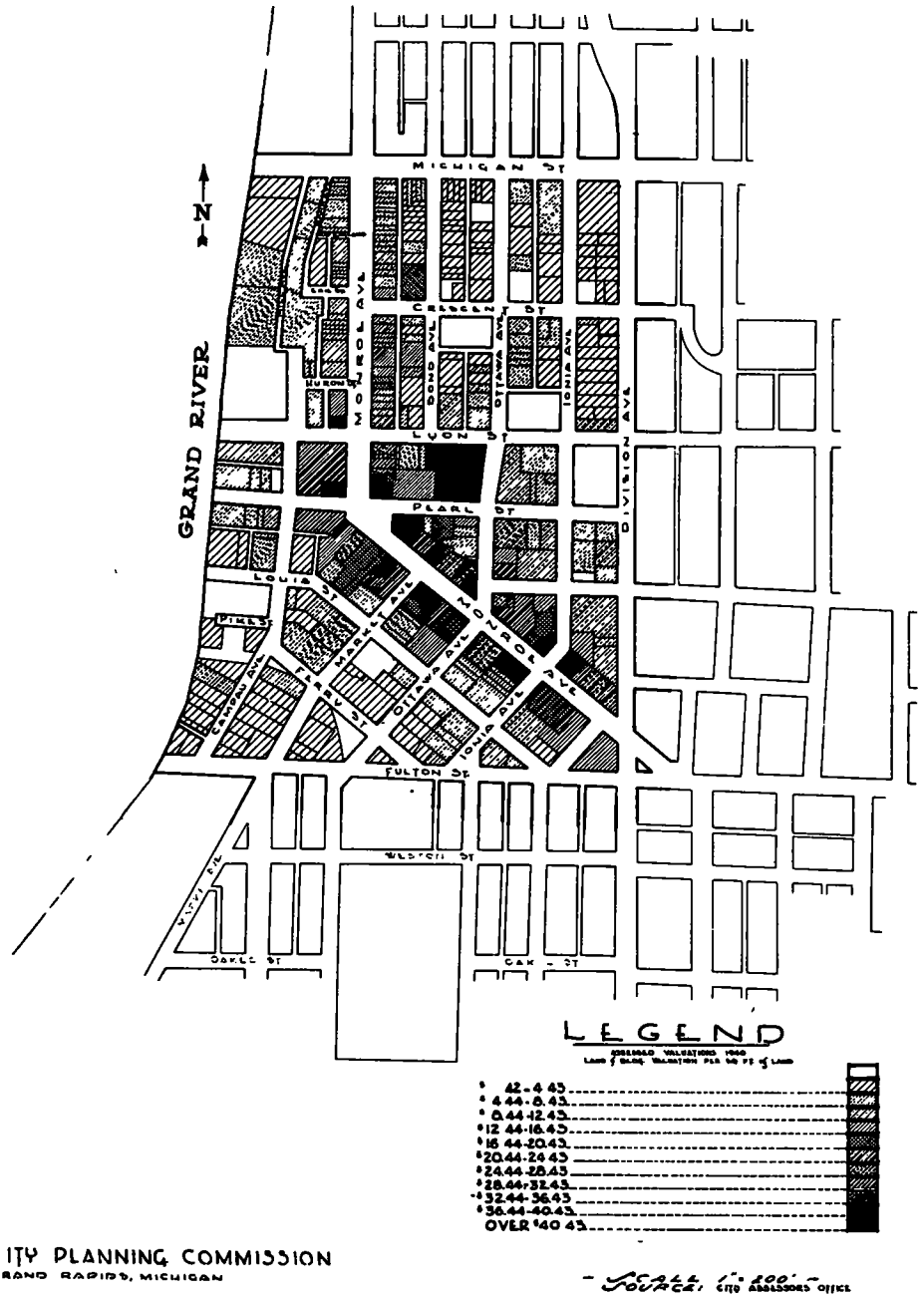

Figure 7. Downtown Grand Rapids Parking Study, General Property Values per sq. ft. of Land

total earning ability of land and reflects the relative number of customer destinations.

The retail business of the central business district is composed of sales in general merchandise (G), apparel (A), and furniture (F).

A comparison of the G.A.F. sales in each of the counties in the trading area tributary to Grand Rapids is summarized in Table 1.

TABLE 1

County Name	GAF Sales per capita
[1]Kent County (Grand Rapids)	$102. per capita
[3]Montcalm	28. per capita
[3]Isabella	34. per capita
[3]Clare	33. per capita
[2]Ottawa (Holland, Mich.)	48. per capita
[3]Newaygo	17. per capita
[3]Oceana	12. per capita
[3]Allegan	22. per capita
[3]Van Burean	30. per capita
[3]Wexford	24. per capita
[1]Grand Traverse (Traverse City)	92. per capita
[3]Ionia	34. per capita
[3]Clinton	24. per capita
[1]Saginaw (Bay City-Saginaw-Midland)	82. per capita

[1]Regional Shopping Centers.
[2]Secondary Regional Center.
[3]Neighborhood and Community Shopping Centers.

It will be noted that the per capita G.A.F. sales is high in Grand Rapids, Traverse City, and Saginaw, and the per capita sales of the same group in the neighborhood and community shopping centers, which fall geographically between these peak points, have very low comparative sales records in the G.A.F. group. Reasons for this difference is that the central business district is a regional shopping center and serves the people living in these areas of low recorded G.A.F. sales as well as the people living in the metropolitan district of Grand Rapids. These patterns can be developed for any of the regional areas in the United States.

In comparison, the convenience and soft goods per capita sales are relatively higher in the neighborhood and community shopping centers than is shown for regional cities.

An examination of the variations in retail sales is made to determine the stability of retail sales trends as a basis for studying parking needs.

During the past 8 years retail sales and costs of living indices have on the face of it reflected anything but stability.

Retail sales for Grand Rapids, as recorded by the 1939 United States Census of Retail Business, showed a gross volume of $80 million dollars. Recent estimates for the same city showed $222 million of gross retail sales. Reflected in this increase are increased cost of all items as well as an ever expanding regional service area of the central business district. Metropolitan population increases is one of the primary causes for these increases in retail sales.

The Bureau of Business Research of the Harvard University Graduate School of Business Administration has maintained a long time record of department store operations. This bureau has maintained a running record of the same thirteen firms from 1939 to the present time. These thirteen department stores represent typical operations and therefore are excellent examples to appraise in terms of stability. (See Figure 8.) It will be noted that the gross retail sales in 1939 was $240 million, and in 1947 the same stores did a gross of $570 million. If the annual number of purchases made and the average dollar value of the purchases had remained relatively the same, the gross retail sales for these stores would have represented approximately $450 million. (See Figure 9.) The difference of $120

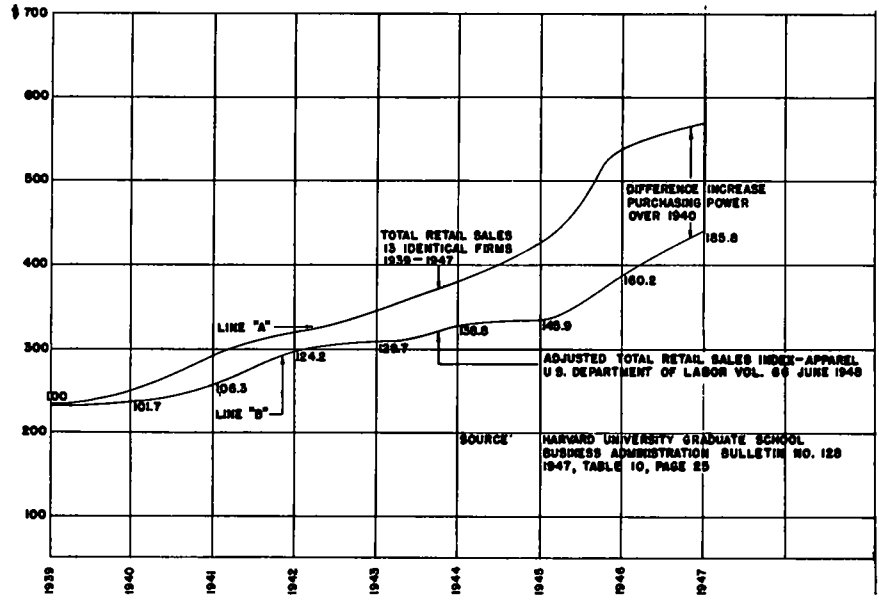

Figure 8. Characteristics of Retail Sales.

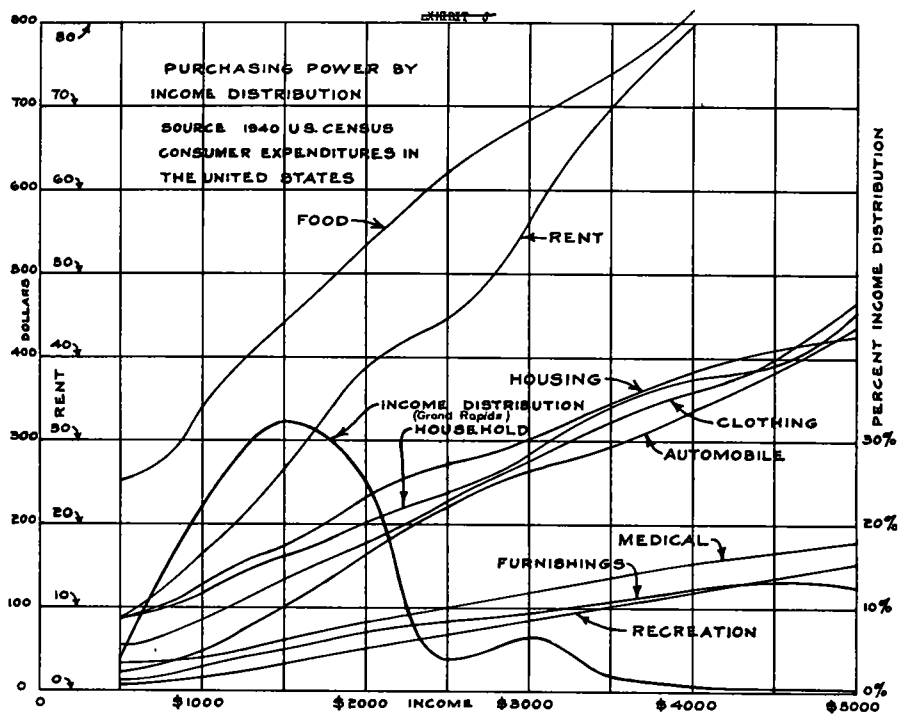

Figure 9.

million is a product of the increased dollar value of each purchase made and increased relative incomes of the consumer due to the tight condition of the labor market. Line A on Figure 8 shows actual gross retail sales; line B shows adjusted sales. Difference is increased purchasing power.

An examination of average gross sales, number of transactions per square foot of gross floor space, gross retail sales per square foot of selling space and gross retail sales of floor space. Kenneth C. Welch, Vice-President of the Grand Rapids Store Equipment Company and Chairman of the Grand Rapids City Planning Commission has conducted pedestrian traffic surveys of leading department stores for a period of more than 20 years and analysis of these data indicate there are .75 persons per transaction.

In Table 2 these retail sales data are listed to show changed by years.

The conversion of these data into a

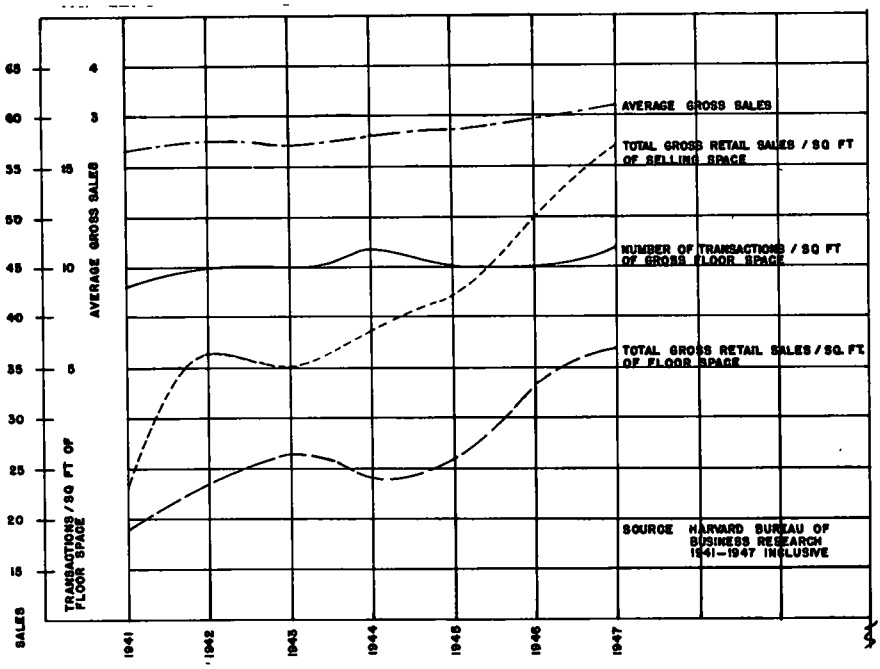

Figure 10. Productivity of Department Store Floor Areas.

area will reduce the total gross sales to a basis upon which stability can be observed. (See Figure 10.) It will be noted that graphic lines of gross retail sales per square foot of selling and gross floor areas are parallel. Authorities claim that these 2 sets of data are constantly changing due to interior renovation programs of department store managements. However, for purposes of determining parking requirements the floor area changes do not reflect any particular change in "total parking space requirements".

The significant characteristic of retail sales is the minor change experienced in number of transactions per square foot form for comparison by indices shows that the sales per square foot of selling space and total sales indices are almost identical, which indicates that the selling areas are adjusted to meet the needs of the sales pressures. Average gross sales index reflects the cost of living index more than it reflects increased purchasing power. Transaction index reflects only a minor change as was shown where the transactions per square foot of floor space changed from 9 to 11 over the inflationary years. The following Table 3 shows these indices by years. (See Figure 11.)

These adjustments of sales data show that, even though retail sales volumes

TABLE 2

Retail Sales - 2 million to 5 million[1]

	1941	1942	1943	1944	1945	1946	1947
Sales per sq. ft.	$19.00[2]	23.50[3]	26.50	24.00	26.00	33.00	37.00
Transactions per sq. ft. of total space	9	10	10	11	10	10[4]	11
Average gross sales	$ 2.31	2.45	2.40	2.60	2.75	2.85	3.20
Sales per total employees	$7,000		8,800	9,600	9,700	11,300	11,500
Gross floor space per employee sq. ft.	365		330	400	370	345	310
Sales per selling employees	$23.00	36.50	35.00	38.50	42.00	50.00	57.00

[1]4 million group included for years.
[2]Table 9 - page 18. Bulletin 115 - 1941 Harvard.
[3]Table 12 - page 17. Bulletin 119 - 1943 Harvard.
[4]Estimated by Author - 1945 Ratio - 14-10 Assumed same ratio for 1946.

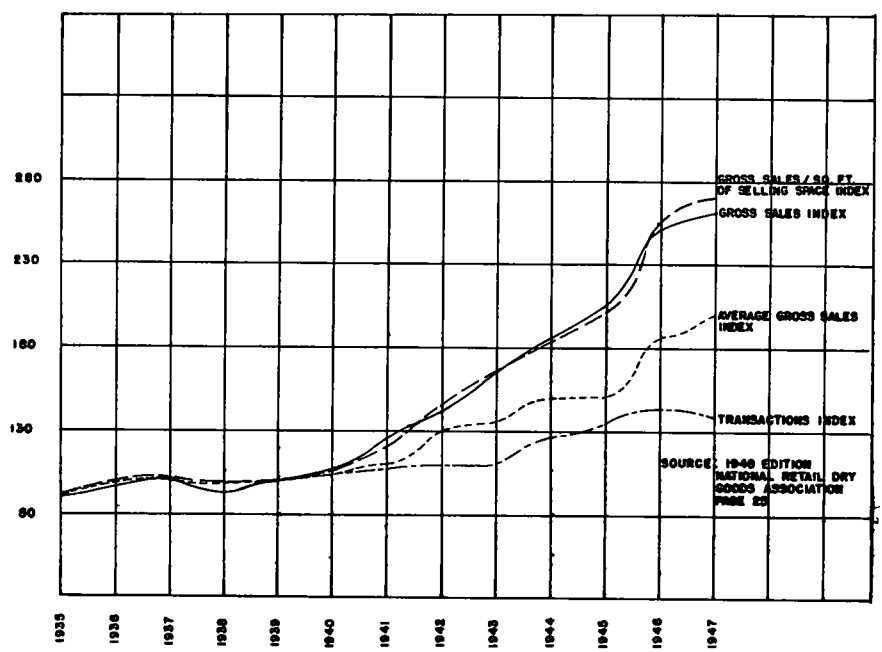

Figure 11. Total Store Data for Department and Specialty Stores.

have risen, the number of transactions have not increased to the same extent and of course the number of transactions is the factor related to total parking space requirements.

The second phase of retail sales characteristics, is an examination of the characteristics of seasonal changes in retail sales volume as a part of the necessary criteria upon which parking policy

TABLE 3

Sales Index 1939 equals 100	Average gross sales index 1939 equals 100	Transactions index 1939 equals 100	Sales per square foot of selling space index 1939 equals 100
1935 - 88	1935 - 88		1935 - 93
1936 - 97	1936 - 96		1936 - 100
1937 - 102	1937 - 102		1937 - 103
1938 - 95	1938 - 98		1938 - 100
1939 - 100	1939 - 100	1939 - 100	1939 - 100
1940 - 106	1940 - 104	1940 - 103	1940 - 103
1941 - 125	1941 - 116	1941 - 108	1941 - 123
1942 - 141	1942 - 131	1942 - 110	1942 - 145
1943 - 165	1943 - 137	1943 - 120	1943 - 165
1944 - 185	1944 - 150	1944 - 127	1944 - 194
1945 - 205	1945 - 153	1945 - 133	1945 - 200
1946 - 252	1946 - 187	1946 - 144	1946 - 255
1947 - 262	1947 - 200	1947 - 138	1947 - 270

may be formulated. Seasonal fluctuations in retail sales is very marked in its relation to parking requirements (See Figure 12). Seasonal fluctuations in food sales is less than in total sales. In consideration of the G.F.A. character of central business district sales the seasonal fluctuations would consequently be greater than exhibited by total sales tax collections.

Shall the total parking space requirements be determined based upon low, medium or high periods of retail sales volumes? The merchants' profitable business is a product of high periods of retail selling. Average sale periods provide for operational costs, the net profits are produced as a result of high efficiency, maximum sales, and complete use of all selling floor areas of the store during peak periods.

With proper recognition of the above facts "total parking space requirements" should therefore be planned for peak seasonal parking demand.

In summary, retail sales volumes present a basis upon which the entire problem of providing "total parking requirements" for a central business district can be examined. The cyclical and seasonal changes when reduced to number of customers form a dynamic base upon which both merchant and municipal policy can be predicated.

CONVERSION OF RETAIL SALES INTO PARKING REQUIREMENTS

Two methods are recommended for appraisal, examination, and improvement.

The first of these 2 methods was developed by Kenneth C. Welch, Chairman of the Grand Rapids City Planning Commission. The object of the first method is to ascertain the relationship of dollar sales to square foot area of parking required. (See Figure 13.) Assuming that a department store's annual retail sales volume in 1940 was $100,000, of which 10 percent was done in mail order business, the actual store gross sales was $90,000 or an average of $300 per day. The average gross sale in 1940 was $2.33, converting these figures we find an average of 129 transactions per day. There are 1.7 times more transactions on a peak day than on an average day, or 219 transactions on a peak day. There are .75 persons per transaction or 164 persons doing business in the store. Origin and destination surveys have shown that there are 1.6 persons per automobile for autos having their origin in the urban area and 2.2 in automobiles having origin outside the urban areas. Therefore, 164 persons represents 102 automobiles. Department stores generate a 3.5 average daily turnover requiring 29 spaces. 29 spaces at 300 square feet of area per space repre-

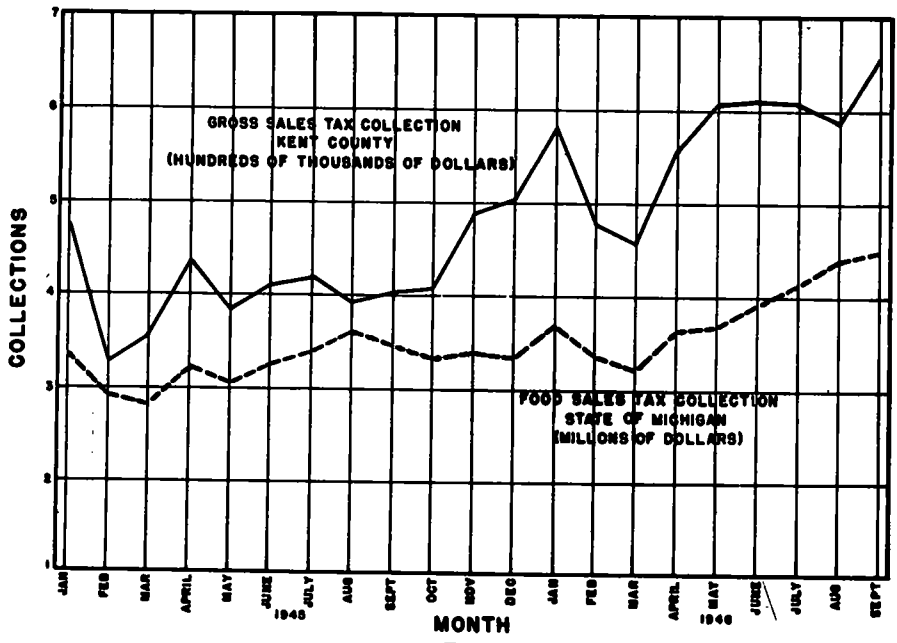

Figure 12. Sales Tax Collections.

$$R = \frac{\left(\frac{(V - MV)}{D} \div G\right) \cdot R_1 \cdot P}{P_1} \div T \; A$$

$$\frac{}{V}$$

R = .067 SQ FT OF PARKING TO $100 1940 RETAIL SALES

R = RATIO

V = ANNUAL GROSS RETAIL SALES VOLUME

M = PERCENTAGE MAIL ORDER SALES VOLUME

D = BUSINESS DAYS OF THE YEAR (300)

G = AVERAGE GROSS RETAIL SALE ($2.33)

R_1 = RATIO OF LOW SALES DAY TO PEAK SALES DAY (1.7)

P = PERSONS PER TRANSACTION (.75)

P_1 = PERSONS PER AUTOMOBILE (1.6)

T = TURNOVER IN USE PARKING SPACES

A = AVERAGE AREA PER PARKING SPACE (300 SQ FT)

SOURCE KENNETH C. WELCH, A.I.A
CHAIRMAN, GRAND RAPIDS
CITY PLANNING COMMISSION

Figure 13. Ratio-Parking Area to 1940 Retail Sales Dollar.

sents .087 square feet of parking per 1940 United States Census sales dollar of retail sales as related to the general merchandise, apparel, and furniture group. All of the floow areas devoted to retail sales in a central business district can be generalized into terms of productivity. On an overall basis the summation of these productivity calculations will prove out by using the United States Retail Census data for any community and categorically arranging these data in terms of regional, community, and neighborhood functions.

The factor of mass transportation should be applied in reference to its actual use. Care should be given in the application of any mass transportation factor due to this particular phenomena that, as parking spaces increase, it has been found that the use of automobiles increase proportionately, and it is possible that mass transportation volumes may be reduced in the same ratio.

The second method has its only value in overall determination of "total parking requirements". Average number of people buying per day equals persons per sale multiplied by the number of transactions for any day; the product of this is divided by the product of 25 (the number of shopping days in a month), average gross sale, and persons per car. The application of this formula in Grand Rapids was used to select parking requirements for low and peak sales periods for 1946. In multiplying the number of daily transactions by the persons per sale we arrived at the total number of persons shopping during the low period of the year or the high period of the year. The ratio of low and average persons per sale to high is 1.7 and .9 respectively. Converting the average number of people buying per day into automobiles we arrive at the number of cars coming to the central business district for shopping purposes.

The low and high retail sales periods were ascertained based upon United States retail census data and data from a local survey in which local businesses cooperated. The same procedure as outlined above can be used in other communities where the business men wish to participate. These types of data have their value as a preliminary basis upon which municipal policy can be determined and upon which administrators in line agencies of the municipality can decide upon the character of the action program used to approach the problem. (See Figures 1 and 2).

CONCLUSIONS

The use of retail sales volumes as a basis for determining parking requirements needs further appraisal and refinement than can be carried out by any one agency or any one city. It appears to be a method which will give the merchants and government officials a true picture of the proportions of the job to be done in solving a parking problem.

Retail sales data provides a community with a dynamic basis upon which total parking requirements can be ascertained and upon which a community or municipal policy relative to the problem can be developed.

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