

DEPARTMENT OF TRAFFIC AND OPERATIONS

Street Travel as Related to Local Parking

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Some percentage of travel on local urban streets is related solely to the time and distance expended in searching for a parking space. This paper attempts to measure the amount and characteristics of such "search" travel. Field interviews were conducted in New Haven and Waterbury, Conn. Each interview was conducted at the parking site (curb or off-street) as soon as the driver parked. The driver was asked to retrace the route he followed in going from his last origin to his parked destination. The usual information on sex of driver, trip destination, and trip purpose was also obtained. Comparisons of search patterns as related to type of parking (curb vs off-street), sex of driver, trip purpose and origin, are included. The influence of traffic volume and availability of spaces on search patterns are also noted. Finally, data that may aid in simulation of downtown traffic on electronic computers are presented.

• THIS STUDY sought to determine and measure the characteristics of search patterns by drivers seeking parking spaces at curbs or off-street facilities in the central business district (CBD). The relationship of terminal to expressway, the influence of demand and location on search patterns, and the magnitude of travel on streets by vehicles searching for parking were some of the items for which answers were sought.

STUDY METHOD

Locations Studied

The studies were made in the cities of New Haven and Waterbury, Conn.,

where all curb spaces were metered with limits ranging from 15 min. to 1 hr.

Off-street facilities in New Haven included two self-park municipal lots, a pigeonhole garage and a privately operated attendant parking lot. Waterbury off-street facilities included two self-park municipal lots and one privately operated attendant lot.

The curb spaces in both cities were those with the greatest turnover in the core of the CBD. The off-street facilities are located throughout the core area on various approaches to the two "downtown areas."

Waterbury had a population of 107,130 and New Haven a population

TABLE 1
SURVEY DATES AND TIMES

City	Day	Date	Time
New Haven	Thursday	July 7, 1960	1 PM—9 PM
	Friday	July 8, 1960	8 AM—5 PM
	Wednesday	Nov 2, 1960	9 AM—5 PM
	Thursday	Nov 3, 1960	8 AM—5 PM
	Monday	Dec 19, 1960	9 AM—5 PM
	Tuesday	Dec 20, 1960	9 AM—5 PM
Waterbury	Friday	July 15, 1960	9 AM—5 PM
	Thursday	July 21, 1960	12 NOON—8 PM
	Wednesday	Nov 9, 1960	9 AM—5 PM
	Friday	Nov 11, 1960	9 AM—5 PM
	Thursday	Dec 22, 1960	9 AM—5 PM
	Friday	Dec 23, 1960	8 AM—4 PM

of 152,048 in 1960. The metropolitan area populations were 141,626 and 278,794, respectively.

Date and Time of Study

The dates and hours of the parking study are given in Table 1. Three

seasons—the relatively quiet summer period, an average fall season, and the pre-Christmas rush—are included. During the summer, night shopping hours were surveyed; during the remaining periods, only daylight hours were included.

Sex of driver M F Date _____ Time _____

1. From where did you start this trip _____
2. Did you make any stops before coming here? NO YES, last stop: _____
3. On what street did you come into the downtown area?
(Show map to driver)
4. a) CURB Where did you begin looking for a place to park?
What streets did you follow while looking for a space?
- b) OFF-STREET Did you look for a place to park before coming to
this lot? YES NO
if YES (Where did you begin looking for a space?
(What streets did you follow while looking
for a space?
5. Before you came downtown, did you have a place in mind where you thought
you could find a place to park? NO if YES: _____
6. Where are you making your first stop now? _____
7. For what purposes did you make this trip?
Work Personal Business Shopping Sales & Service Other _____

REMARKS :

Figure 1. Questionnaire form.

Collection of Data

Information on parking search characteristics was obtained by interviewing the drivers as soon as they had parked. Data were collected for each driver on a questionnaire (Fig. 1).

A map of the CBD, with approaches, was included with each interview form. Information on the search pattern was obtained by asking drivers to trace their route to the actual parking space. Some help was required by drivers in orienting themselves on the map, but by knowing the interview location and the origin of this trip the interviewer was able to assist the driver in tracing his route. Most drivers were able to recall landmarks or particular intersections that served as a check on the route followed. Also, proper use of one-way streets was a further check on drivers' routes.

Questions 1 and 2 were intended to eliminate any confusion and ambiguity in defining the last immediate origin. Questions 3 and 4 required information on the routes followed.

Drivers identified the point where search began as "in this block" or "at the corner of Elm" or by some particular building. Of course there is no certainty that drivers would have accepted a parking space had there been one at the indicated start of search. This is a source of error in interpretation of searching distance. The questions on search pat-

terns were asked only of those off-street parkers who indicated they searched for curb space before entering the lot or garage.

Questions 6 and 7 were specifically related to trip purpose, and to get walking distance.

Definition of Terms

The following terms are used in this study:

Walking distance.—The distance, in feet, from the location at which the vehicle is parked to the driver's destination.

Search-walk distance.—The distance, in feet, from the point at which a driver begins to look for a parking space to the driver's destination.

Search distance.—The distance, in feet, along the route the driver travels between the point he begins to search and the point where he parks.

Total travel distance.—The distance, in feet, along the route the driver travels between the point the driver enters the study area and the point where he parks.

PARKING CHARACTERISTICS

Trip Purpose Distribution

The distribution of trip purpose by type of parking is given in Table 2 for New Haven and Waterbury and

TABLE 2
TRIP PURPOSE BY PARKING TYPE

Purpose	New Haven				Waterbury			
	Curb		Lot		Curb		Lot	
	No.	%	No.	%	No.	%	No.	%
Work	127	9	152	10	144	7	70	5
Personal business	664	48	375	25	596	29	252	19
Shopping	388	28	852	57	1036	51	901	67
Sales and service	126	9	61	4	102	5	28	2
All others	91	6	65	4	153	8	102	7
Total	1396	100	1505	100	2031	100	1353	100

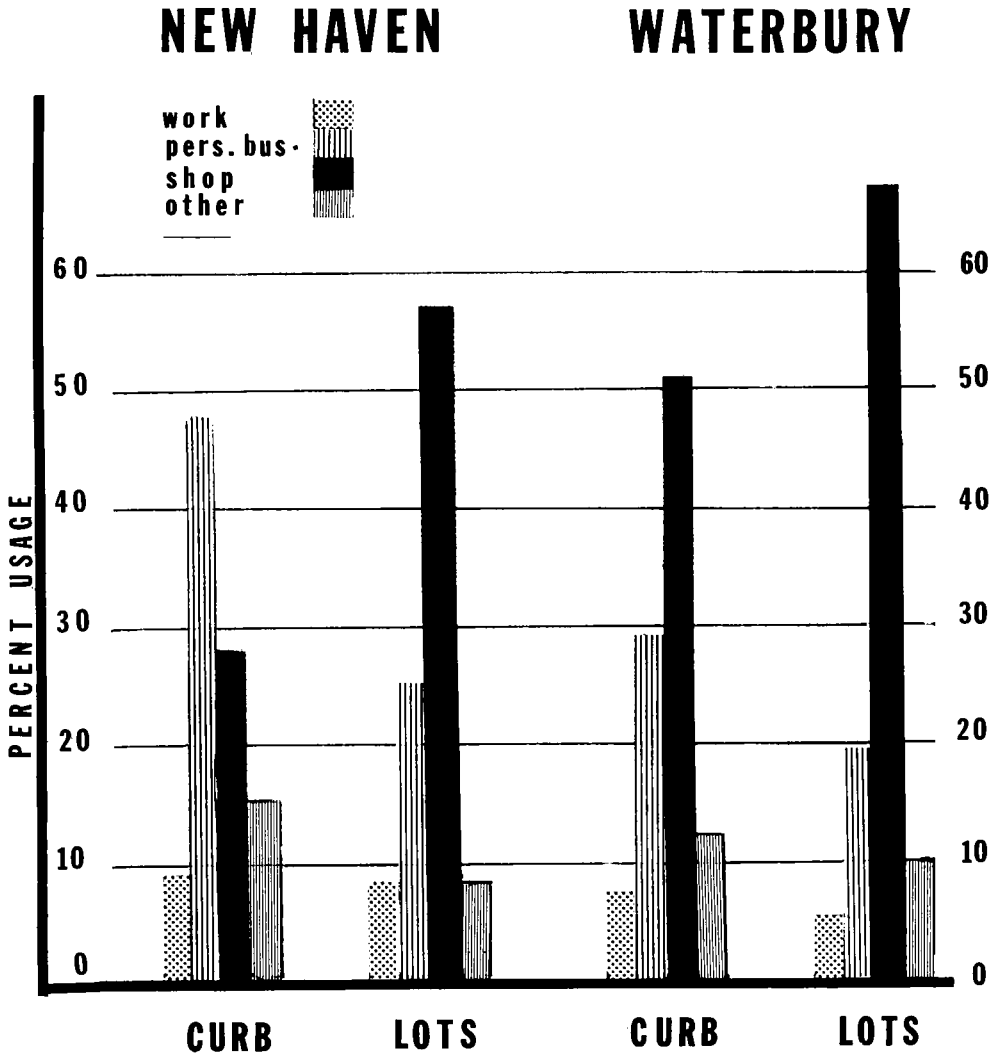


Figure 2. Trip purpose by location.

summarized in Figure 2. Shopping was the predominant trip purpose at off-street facilities in both cities and at curb sites in Waterbury. The principal trip purpose for curb parkers in New Haven was personal business. In both cities, on all dates, there was a greater percentage of shopping trips observed at off-street locations than at curb locations.

In order, the trip purposes were shopping, personal business, work, and sales and service. No other purposes were of great significance. The greater use of lots by women is shown in Table 3 and Figure 3. Approximately one-fourth of all parkers interviewed at curbs were women; the percentage of women parkers was over 50 percent in lots.

TABLE 3
USE OF LOTS AND CURBS, MEN AND WOMEN

City	Date	Curb				Off-Street			
		Men		Women		Men		Women	
		No.	%	No.	%	No.	%	No.	%
New Haven	July 7	181	76	57	24	54	49	56	51
	July 8	193	74	68	26	162	46	187	54
	Nov 2	158	76	47	24	85	46	100	54
	Nov 3	150	69	67	31	104	38	169	62
	Dec 19	147	79	40	21	132	49	140	51
	Dec 20	173	75	59	25	107	40	159	60
	All		1,002	75	338	25	644	44	811
Waterbury	July 15	315	78	87	22	46	43	60	57
	July 21	250	74	86	26	77	37	131	63
	Nov 9	127	72	49	28	83	37	144	63
	Nov 11	185	63	110	37	40	29	99	71
	Dec 22	222	73	81	27	98	38	157	62
	Dec 23	266	77	80	23	192	54	162	46
	All		1,365	73	493	27	536	42	753

TABLE 4
TRIP PURPOSE BY SEX OF DRIVER¹

Purpose	New Haven				Waterbury			
	Men		Women		Men		Women	
	No.	%	No.	%	No.	%	No.	%
Work	211	13	54	5	180	9	26	2
Personal business	723	44	269	24	621	32	175	14
Shopping	445	27	759	66	855	45	936	76
Sales and service	170	10	10	1	105	6	16	1
All others	93	6	51	4	155	8	86	7
Total	1642	100	1143	100	1916	100	1239	100

¹ Totals all dates.

Trip Purpose vs Sex of Driver

Trip purpose as related to sex of driver in the two cities is summarized in Table 4 and Figures 4 and 5. (Minor variations in total interviews were due to incomplete recording on the part of the interviewers, recording all but one item on the interview sheet. These incomplete interviews were retained in tabulations where the remainder of the data was valid.)

The principal trip purpose for women in both cities was shopping; the next category of importance was personal business. Shopping was also

the most important trip purpose for men in Waterbury but in New Haven the primary trip purpose was personal business. Work, sales, and service trips and all other trips were about one-fourth of all trips made by men in both cities.

Interviews were made on July 7 in New Haven and July 21 in Waterbury on shopping nights and influence the percentage of shoppers observed on the two dates. The high percentage of shoppers in both cities in December was a reflection of the pre-Christmas rush.

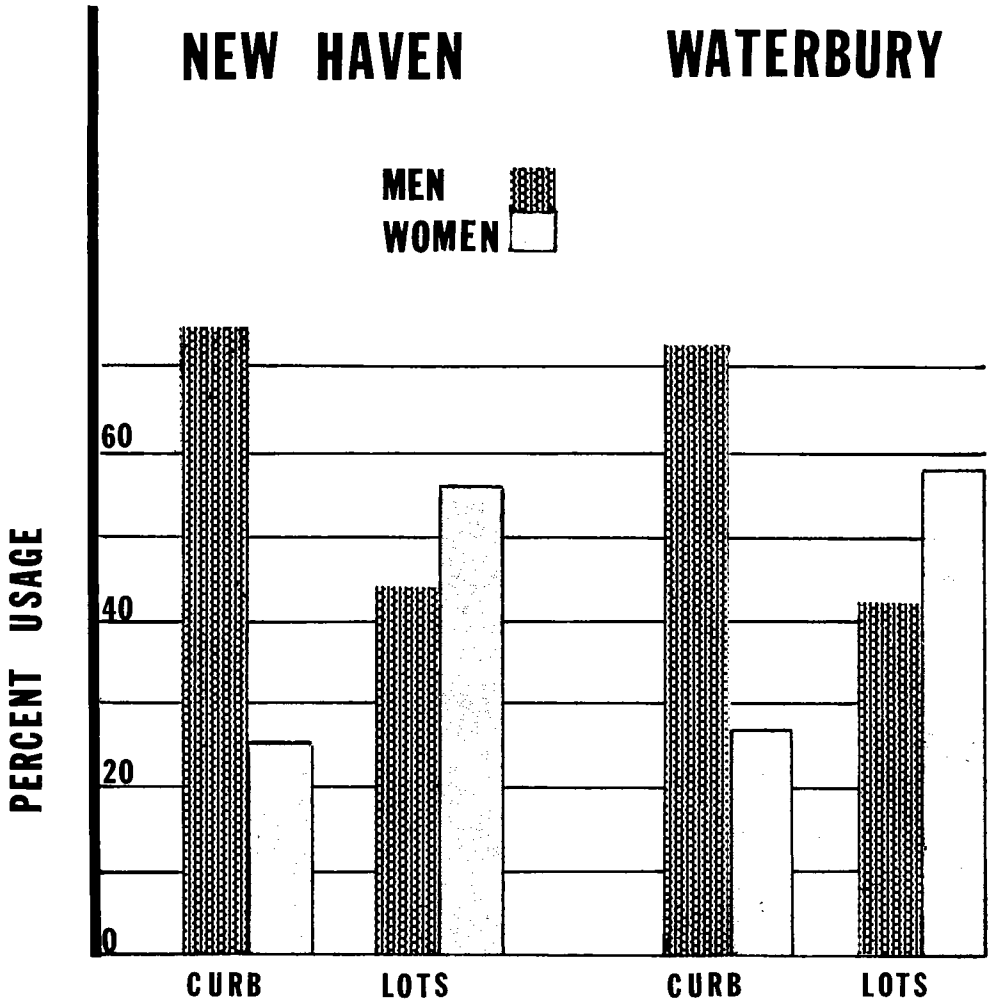


Figure 3. Curb-lot use by men and women.

Walking Distance

Walking distances, by sex and by location parked, are given in Table 5 and summarized in Figure 6.

Off-street walking distances were substantially greater than curb walking distances, varying from 212 ft for men in New Haven to 393 ft for men in Waterbury.

TABLE 5
WALKING DISTANCES

City	Parking	Walking Distance (ft)		Grand Avg.
		Men	Women	
New Haven	Curb	389.7	343.4	492.2
	Off-street	601.9	590.8	
Waterbury	Curb	307.8	323.1	474.2
	Off-street	701.7	684.0	

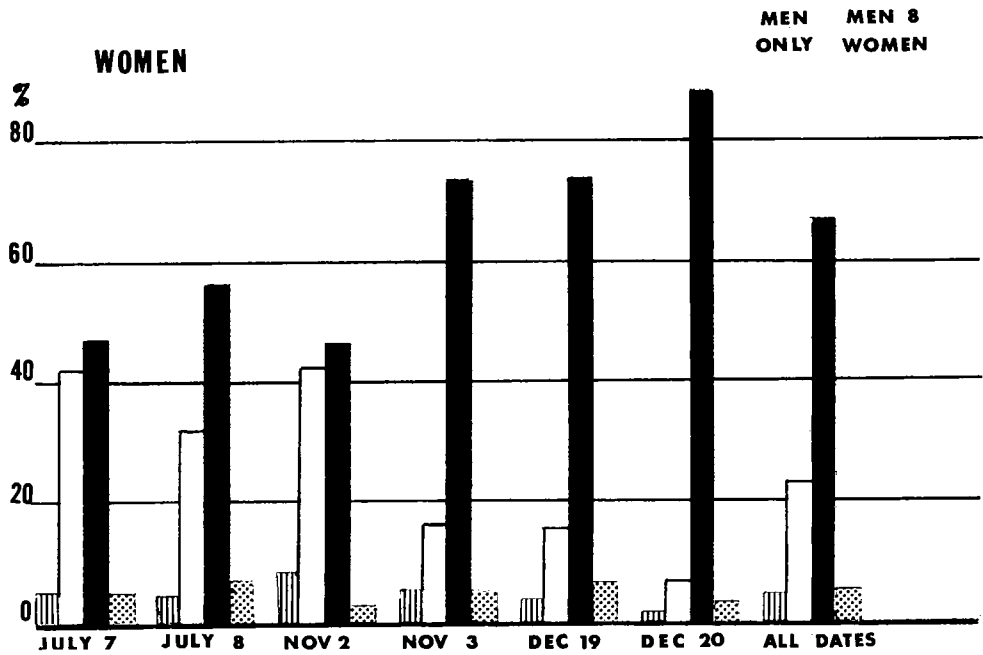
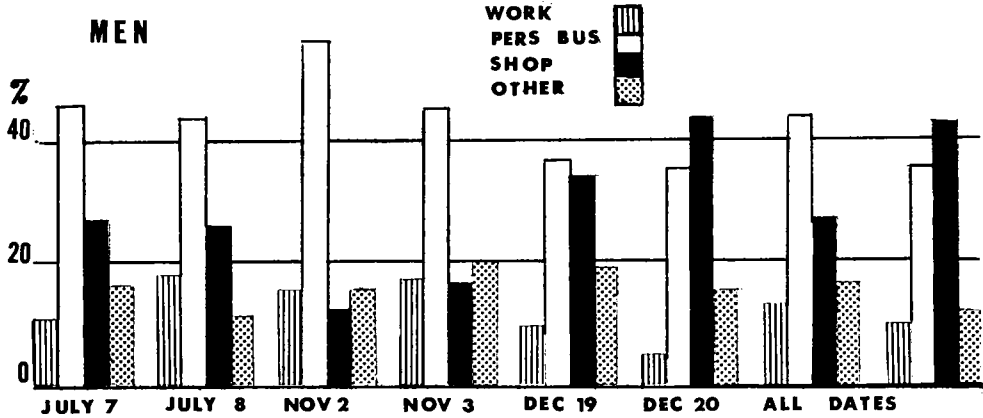


Figure 4. Trip purpose, New Haven.

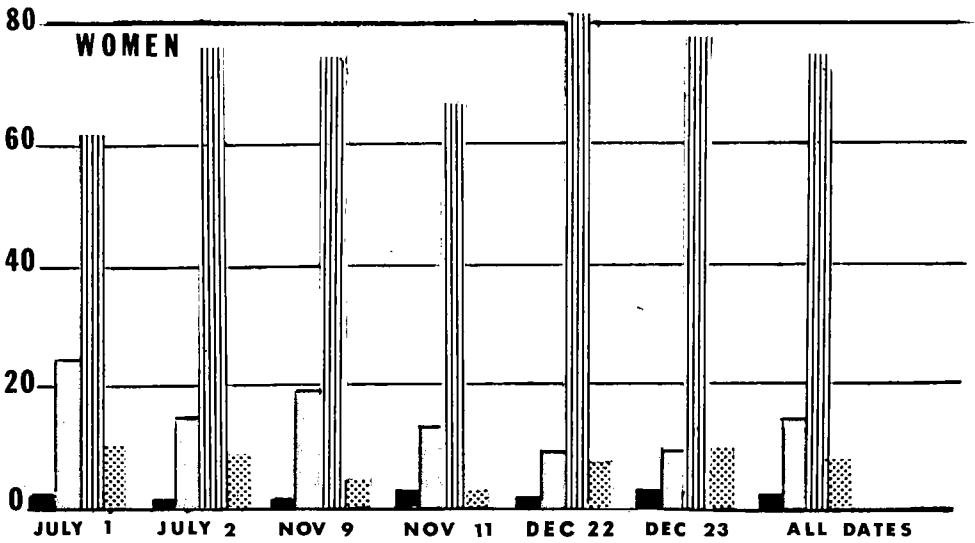
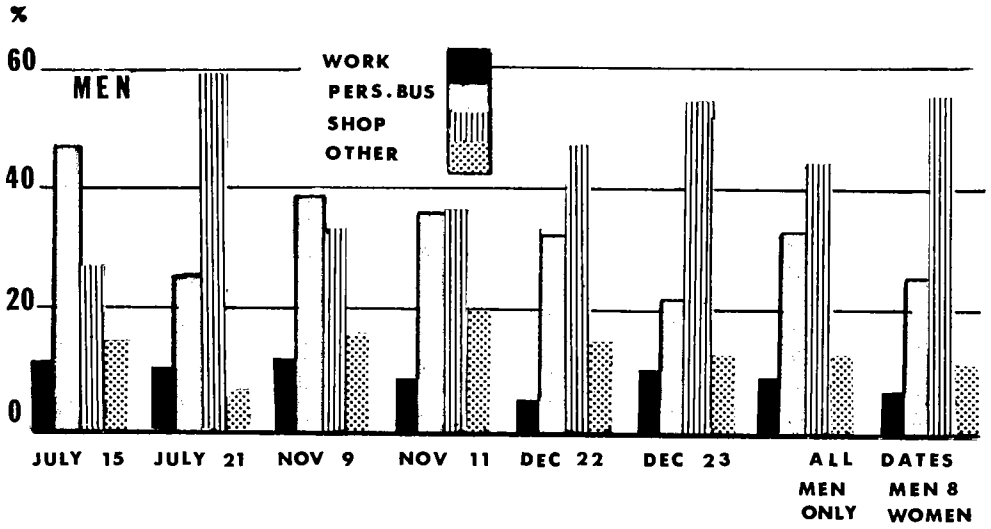


Figure 5. Trip purpose, Waterbury.

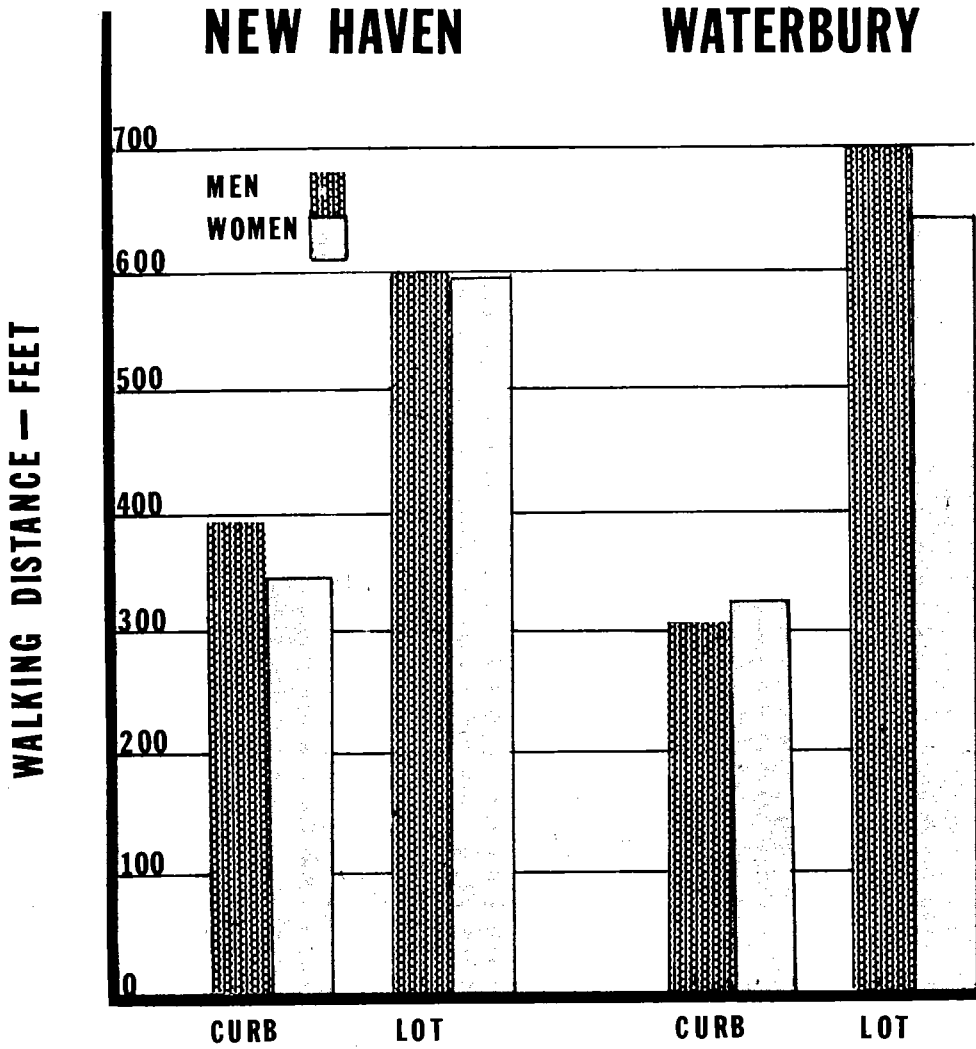


Figure 6. Walking distance.

Women, except at curbs in Waterbury, managed to park closer to their destination than men, but the differences are not statistically significant at the 0.05 level.

Finally, parkers at the curb in New Haven tended to have greater walking distance than curb parkers in Waterbury, though for off-street parkers New Haven walking distances were shorter. The shorter walking distances at lots in New Haven were a reflection of the large off-street facility very close to some of the prime generators.

Comparison to Previous Studies

Although no attempt was made to get a sample of all trip purposes and of all parking facilities in the two study areas, a comparison of the results with previously reported values may be of interest. Both communities had traffic and parking studies conducted by a firm of consulting traffic engineers during 1953. Table 6 gives the comparison for New Haven and Waterbury.

The difference in percentage of work trips between the two studies again reflected the type of interviews made for this project. Private lots or lots catering primarily to all-day parkers (workers mostly) were not included in this survey; therefore, more trips of the shopping and miscellaneous categories were observed.

Walking Distance

Average walking distances for the previous studies and the present study in the two cities were as follows:

	New Haven	Waterbury
Previous study	436 ft	471 ft
This study	492 ft	474 ft

There is no immediate explanation as to why the average walking distance in New Haven differed in the two studies or why they agreed so well for Waterbury.

SEARCH CHARACTERISTICS

Anticipation of Parking Location

One hypothesis of this study was that drivers who parked at curb locations were more likely to "take a chance" in finding a site at which to park. On the other hand it was reasoned that lot users tended to have a place in mind before starting and proceeded directly to that site. Furthermore, it was reasoned that persons with a particular curb site in mind were not as likely to be satisfied as those drivers who anticipated finding an off-street facility.

Drivers were asked, "Did you have a (parking) place in mind before you started this trip?" The results of the answers to this question are shown in Figures 7 and 8. Parkers using

TABLE 6
COMPARISON OF PRESENT AND PREVIOUS STUDIES OF TRIP PURPOSE

Purpose	Distribution (%)			
	New Haven		Waterbury	
	This Study	1953 Study	This Study	1953 Study
Work	9.6	30.4	6.3	16.7
Personal business	35.8	35.5	25.1	37.0
Shopping	42.7	30.4	57.2	27.5
All others	11.8	1.3	11.4	18.8

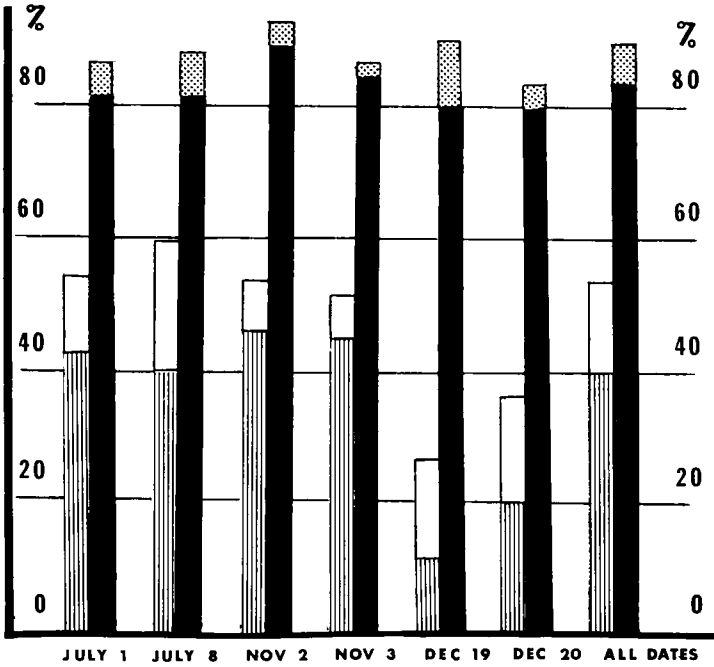


Figure 7. Place in mind, New Haven.

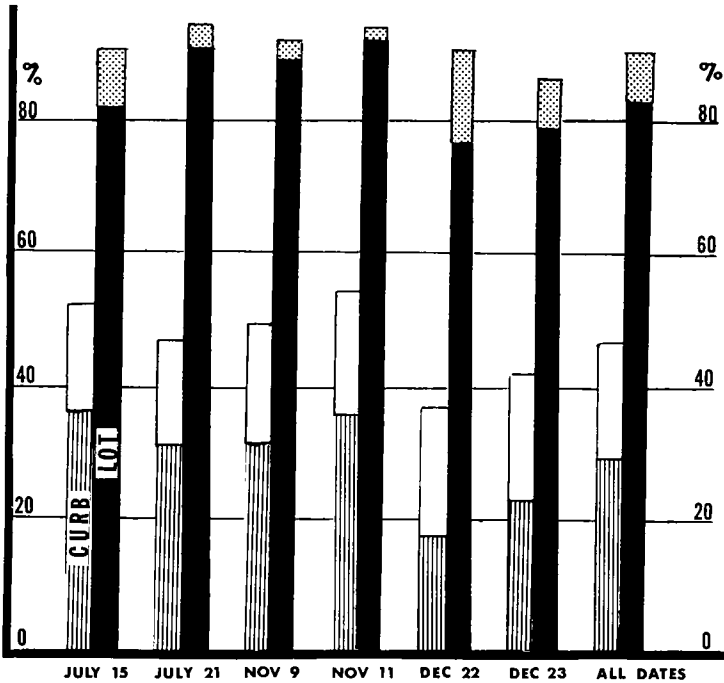


Figure 8. Place in mind, Waterbury.

lots consistently showed a high percentage with a place in mind as compared with those parking at curb sites.

For all dates in New Haven 89 percent of the lot parkers had a particular place in mind as compared to 53 percent of curb parkers. In Waterbury comparable percentages were 90 and 46 percent.

The percent of New Haven lot parkers answering Yes to this question varied from a low of 83 percent on December 20 to a high of 92 percent on November 2. Curb parkers answering Yes varied from a low of 26 percent on December 19 to a high of 59 percent on July 8.

The lowest percent of Waterbury lot parkers answering Yes was 85 percent during the pre-Christmas rush on December 23 and the highest was 94 percent on July 21 and November 11. For curb parkers the lowest percentage was 36 percent on December 22 and the highest was 54 percent on November 11.

In general, there was no great difference in the way men and women replied to these questions. Those parkers who replied Yes to the question about having a place in mind were then asked if the site of the interview was the site they had in mind.

Again, lot parkers outranked curb parkers, when measured in terms of percentage who were able to park at the particular site they had in mind. For all dates in New Haven 71 percent of curb parkers and 94 percent of lot parkers were able to park at sites of their own choosing; in Waterbury 61 percent of curb parkers and 92.5 percent of lot parkers were comparable figures.

Variations in percent of successful curb parkers ranged from a low of 43 percent on December 19 to a high of 86 percent on November 3 in New Haven and from a low of 48 percent on December 22 to a high of 68 percent on July 15 in Waterbury. For lot parkers the range for New Haven

was a low of 89 percent on December 19 to a high of 98 percent on November 3. Waterbury percentages ranged from a low of 85 percent on December 22 to a high of 98 percent on November 11.

The results of answers to the two questions "Did you have a place in mind?" and "Is this it?" indicated that when parking demand is great, in this case the pre-Christmas rush, fewer drivers had a pre-conceived idea of where to park and of those who had a site in mind fewer were successful. This was especially true for those parking at the curb.

Persons parking at the curb appeared to be ready, in about one-half of all instances, to accept whatever sites were available along a general route, without a specific block face in mind, and of those that did have a site in mind about one-third finally located at some other curb site.

About 85 to 90 percent of lot parkers, on the other hand, had a specific lot in mind and proceeded directly to that lot. In over 90 percent of the observations they were successful in this endeavor.

Relationship Between Parking Site and Destination

Curb parkers were asked to designate the point at which they began to look for a place to park. This location was then related to the final destination of the driver. The location where the driver parked was also related to the final destination. Drivers who passed their destination before searching or parking were classified as "Yes, did pass." This category included those drivers who were unable to park at their destination because of parking restrictions. Persons who began to search or who parked within 200 ft of their destination were classified as parking "at" the destination. Finally, those drivers whose routes did not pass their destination or began their search or

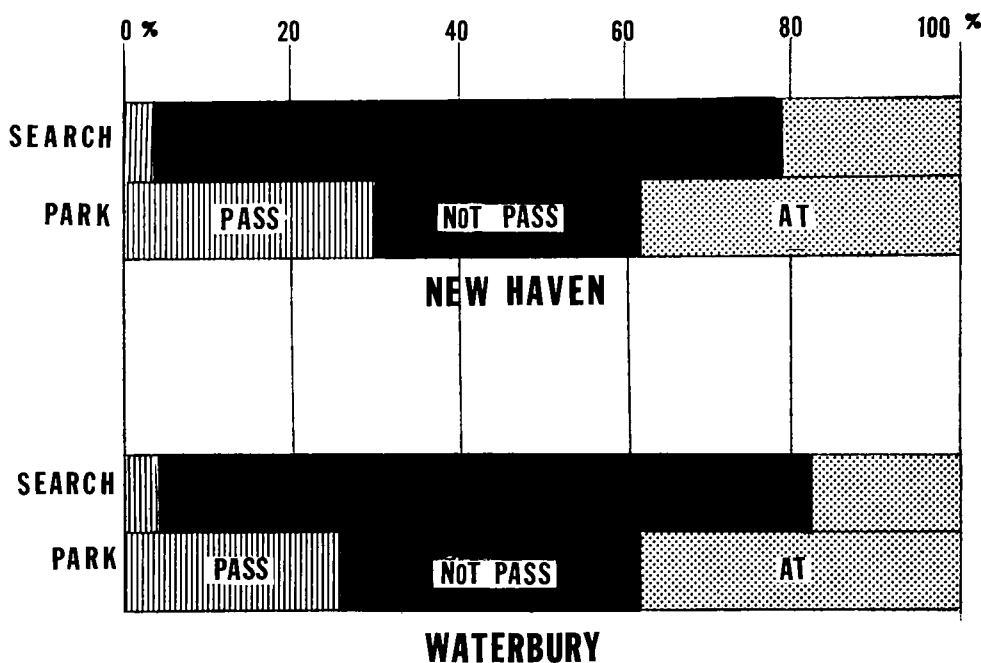


Figure 9. Destination and search-park.

parked before reaching their destination were classified as “No, did not pass.”

Results are shown in Figure 9. As might be expected, few drivers passed their destination before starting to look for a space. For all dates 4 percent of drivers in Waterbury and New Haven indicated they did pass their destination before beginning to search. Eighteen percent of drivers in Waterbury and 21 percent in New Haven began to search for a space within 200 ft of their destination. The greater numbers of parkers—78 percent in Waterbury, 75 percent in New Haven—began to look for a space before reaching their destination.

The relationship between the parking site actually used by the driver and the destination are also shown in Figure 9. Thirty percent of all drivers in both cities passed their destina-

tion before parking, 38 percent parked within 200 ft of their destination, and the remaining 32 percent did not pass their destination before parking.

No readily discernible pattern was seen in the day-to-day differences in destination as related to start of search or parking site. Even during the Christmas-rush period, over 30 percent of the drivers were able to park within 200 ft of their destination.

Search Distance

The distance between the point where the driver began to search and where he parked is given as the search distance in Table 7 and shown in Figure 10. The search distance for off-street parkers applied only to those drivers who looked for a space at the curb before entering the lot.

TABLE 7
SEARCH DISTANCES

City	Date	Men				Women			
		Curb Parked		Off-Street Parked		Curb Parked		Off-Street Parked	
		No.	Avg. Distance (ft)	No.	Avg. Distance (ft)	No.	Avg. Distance (ft)	No.	Avg. Distance (ft)
New Haven	July 7	177	1,181.5	10	1,980.0	57	1,050.6	8	4,008.7
	July 8	192	856.7	24	1,877.1	67	910.7	28	1,814.3
	Nov 2	156	1,194.4	15	1,123.3	47	1,159.1	15	1,620.0
	Nov 3	149	699.6	5	2,234.0	67	759.9	5	3,052.0
	Dec 19	143	1,132.4	20	2,500.5	40	1,644.5	37	3,202.2
	Dec 20	172	1,010.2	33	2,264.5	59	1,499.8	27	3,000.0
	All	989	1,010.9	107	2,033.7	337	1,129.2	120	2,682.6
Waterbury	July 15	303	1,038.2	17	1,447.1	83	1,078.2	12	1,565.8
	July 21	242	840.0	9	1,914.4	84	897.7	5	2,146.0
	Nov 9	140	477.5	14	1,293.1	49	675.5	11	976.4
	Nov 11	181	758.3	7	1,972.0	107	817.8	29	2,055.9
	Dec 22	220	1,154.0	38	1,535.5	80	1,379.2	41	1,503.7
	Dec 23	263	947.8	59	1,702.5	80	1,044.1	26	1,465.4
	All	1,349	908.2	144	1,614.8	483	992.5	124	1,609.9

Those drivers who searched at curbs before parking in lots tended to have the longest search distance. For the most part, these represented people who drove around the streets looking for a parking space without success and then entered lots. Average search distances for men at lots in New Haven exceeded search distances for men at curbs by 1,010 ft,

for women the excess search distance by lot parkers was 1,553 ft.

In Waterbury the search distance for men at lots exceeded search distance at curb sites by 706 ft and for women the excess search distance by lot parkers was 617 ft. Again, data on search distances at lots apply only to those relatively few parkers who entered the lots after attempting to find a curb space without success.

Women, in most instances, searched a greater distance than men, but the differences are not significant for the sample size measured.

Day-to-day differences in search distances were rather large when related to the mean search distance because of several factors. First, some evening shopping hours were included on one day of the July studies in both cities and had some influence on the results for those days. Second, the same sites were not checked on each day in each month, although in effect there were two sets of study sites in each city and these were studied during three periods—July, November, and December. Finally, such items as the increased shopping activity at Christmastime had an influence on results.

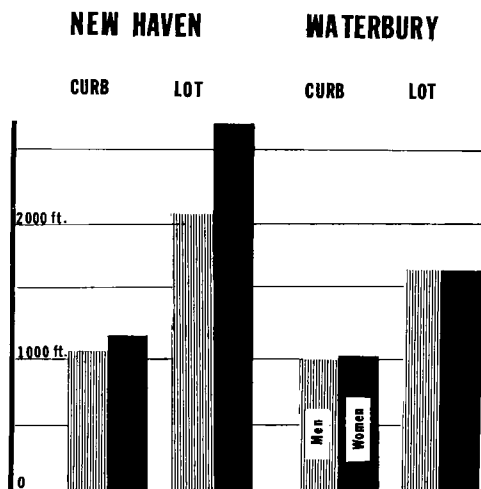


Figure 10. Search distance.

Walking Distance vs Search-Walk Distance

Table 8 compares walking distance and search-walk distance.

Drivers indicated a willingness to walk about 150 to 200 ft further than they actually did. Search-walk distances ranged from 455 to 631 ft in New Haven and from 407 to 569 ft in Waterbury.

If the days are ordered by magnitude of variable, the maximum walking distance and search-walk distance

TABLE 8
WALKING DISTANCE VS SEARCH-WALK DISTANCE (CURB PARKERS)

City	Date	Walking Distance (ft)	Search-Walk Distance (ft)
New Haven	July 7	371.2	550.8
	July 8	292.4	503.4
	Nov 2	312.8	454.7
	Nov 3	316.4	494.2
	Dec 19	404.9	630.6
	Dec 20	567.7	502.8
Waterbury	July 15	299.3	550.3
	July 21	278.6	462.1
	Nov 9	262.5	406.5
	Nov 11	357.1	464.8
	Dec 22	306.0	496.9
	Dec 23	346.2	568.6

are not coincidental. For example, the greatest mean walking distance in New Haven occurred on December 20 and the longest search-walk distance occurred on December 19. For Waterbury the longest walking distance occurred November 11 and the longest search-walk distance was observed on December 23.

Apparently days when drivers were unable to park close to their destination did not induce the individual driver to begin his searching at a greater distance from the destination than might otherwise be the case.

Walk Distance, Search-Walk Distance, and Search Distance

It was anticipated that those factors which influence walking distance would also influence search-walk dis-

tance and search distance. Analysis of the 6 days in the two cities for these relationships were not successful. The maximum walking distance did not necessarily occur on the same date as the maximum search distance or maximum search-walk distance. The same variables were grouped by the three months, rather than the 6 days, but there was not a consistent trend. Further analysis, with particular attention to locations, will be required to detect any common denominator for these variables.

Relationships to Volume and Parking Accumulation

Another assumption was that as vehicular volumes increased on the streets or as parking accumulation increased there would be an associated increase in walking distance and search distance.

Hourly volume counts were made at certain key locations in and around the study areas of the two cities. Parking occupancy counts on selected streets and in selected lots were made at 1-hr intervals. These data formed a basis on which checks could be made.

The search characteristics, walking distance, search-walk distance, and search distance were also calculated for each hour of the day. Hourly vehicular volumes and parking accumulations were then compared with the aforementioned search characteristics. The results to date have shown no consistent relationship. It does not follow that peak volume or parking accumulation occurs during the same time interval as maximum walking distance or maximum search distance. As for days or months, the search characteristics are not related to each other by hours of the day; the maximum walking distance does not occur at the same hour as the maximum search distance or maximum search-walk distance.

It is not surprising that vehicular volumes are unrelated to search characteristics. Relatively few parkers were located at the study sites during peak volume hours. Work trips contribute much to peak hour volumes and such trips were not a target of this study.

The poor correlation between parking accumulation and search characteristics was not anticipated. Perhaps the search characteristics observed at 10:00 AM, for instance, should be related to parking accumulation at 9:30 AM, because the space occupied at that time may have had some influence on the driver's search. This point is being explored.

Total Street Usage

The final measure of street usage was the total distance parkers drove

on city streets within the limits of the study area, including searching distance. Each trip was traced from the point it entered the cordon to the location of the parking site.

This section of the analysis is incomplete because proper computer facilities were not available, but data have been calculated for 3 days—2 days in New Haven and 1 day in Waterbury. Results are given in Table 9 and Figure 11.

On all 3 days, the over-all average total travel distance for off-street facilities was slightly less than the average travel distance at the curb. The difference was most pronounced in Waterbury, particularly because of the short travel distance to the private lot. Almost all users went directly to this lot along the main approach street to the town, and did

TABLE 9
TOTAL TRAVEL DISTANCE

City	Date	Parking	Men		Women		All	
			No.	Avg. Distance (ft)	No.	Avg. Distance (ft)	No.	Avg. Distance (ft)
New Haven	Nov 3	Off-street:						
		Private lot	33	3,465	54	3,362	87	3,401
		Municipal lot	63	3,142	105	3,268	168	3,221
		Total	96	3,253	159	3,300	255	3,282
		Curb:						
		Orange St.	83	3,317	31	3,334	114	3,353
	Chapel St.	26	3,419	26	3,847	52	3,633	
	Church St.	38	3,282	12	2,791	50	3,244	
	Total	147	3,353	69	3,378	216	3,379	
	Dec 20	Off-street:						
		Private lot	36	4,283	63	4,170	99	4,211
		Municipal lot	68	4,016	102	3,634	170	3,787
Total		104	4,109	165	3,839	269	3,937	
Curb:								
Orange St.		107	4,128	30	4,492	137	4,208	
Chapel St.	30	3,832	20	4,689	50	4,175		
Church St.	35	3,940	8	5,416	43	4,215		
Total	172	4,038	58	4,688	230	4,202		
Waterbury	Nov 11	Off-street:						
		Private lot	23	1,740	56	1,679	79	1,697
		Municipal lot	21	2,500	39	2,324	60	2,386
		Total	44	2,102	95	1,944	139	1,994
		Curb:						
		Bank St.	36	2,591	17	3,145	53	2,768
		S. Main St.	19	2,579	24	2,555	43	2,565
		Leavonworth St.	54	2,357	24	2,391	78	2,368
		Center St.	22	2,635	24	2,712	46	2,675
		W. Main St.	49	2,897	20	2,496	69	2,781
		Total	180	2,608	109	2,635	289	2,618

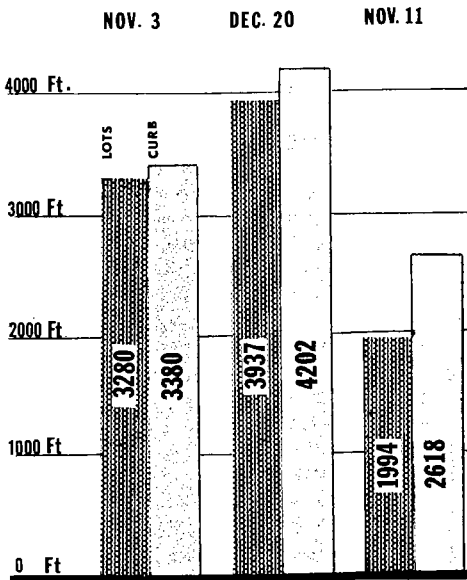


Figure 11. Total travel distance.

very little search driving before entering the lot.

The over-all differences—265 ft (December 20), 97 ft (November 3) and 624 ft (November 11)—represented the difference in street usage generated by off-street facilities vs curb facilities. The results suggest that off-street users generate less “street mileage” than curb users but further analysis is needed to prove if the difference is significant.

The results for New Haven were influenced by the location of the Oak Street Connector, an expressway leading from the Connecticut Turnpike to the CBD. Although the Connector is within the study cordon zone, travel distances were not included in this analysis because it is not a city street and vehicles cannot begin a parking search while on this expressway. Since users of the turnpike were more likely to use the municipal lot than other facilities, the exclusion of expressway travel distance had a greater impact on off-street-parker

travel distances than on curb-parker travel distances.

The difference between the November and December data for New Haven is of interest. Off-street parkers drove an average of 655 ft further in December as compared to November. For curb parkers the difference was 823 ft, a definite indication that parkers had to do more driving during the Christmas shopping rush period.

Some idea of the total magnitude of travel induced by this extra travel may be assumed as follows:

A 1953 study showed 31,750 vehicles with destinations in the New Haven CBD during a 10-hr period in July. Assuming that 70 percent of these might have been making trips of the type made for this study, allowing for no growth between 1953 and 1960, and making no correction for December over July, it can be assumed that there are at least 22,000 trips to the CBD that must search for a space. Assuming their trips are increased by 655 ft, as developed in this study, this is equivalent to an additional 14,410,000 ft or 2,729 mi of travel on the city streets.

Dividing the 14,410,000 by 3,379 (the average travel distance in November), this becomes the equivalent of adding 4,264 vehicles to the assumed 22,000 vehicles on shopping, personal business, or work trips.

Parking Location and Trip Origin

One method advocated for relief of congestion in the CBD is to supply parking facilities at locations that “intercept” trips at the edge of the congested area, before vehicles contribute to the congestion. If such a system were to work, there would be no trips that pass through the downtown area. Instead, each parking facility would receive traffic exclusively from origins located in the same direction from the downtown area as the facility itself.

At the other extreme, it may be assumed that each parking site is equally attractive to all origins. In this instance the number of parkers from each origin at any parking site will be present in the same proportion as that origin is to all origins. For example, if 10 percent of all origins come from direction A and 15 percent come from direction B, then 10 and 15 percent of all the vehicles at a given facility might be expected from direction A or B.

Table 10 gives the origins and destinations of the study data in New Haven. The figures in parentheses represent the number of parkers expected from each origin if it is assumed that each site is equally attractive to all origins.

A χ^2 test was applied to the hypothesis of equal attractiveness and the hypothesis was rejected. As

might be expected, certain origins are more likely to park at some destination than at others.

If the municipal lot located on Church Street in New Haven (Facility 9) is considered, all vehicles entering by way of the Oak Street Connector and Church Street (Origin 12-13) pass this facility when entering the downtown area. Most trips from the southeast side of the study area (Origin 14-18) are also funneled down Church Street and past the municipal lot. The result is that a disproportionate number of persons from these two directions parked in this lot. There were 208 destinations from the Oak Street Connector where 115.5 might be anticipated and 103 persons parking from the southeast as against an expected 76.

The most pronounced disparity on the negative side occurred for origins

TABLE 10
ORIGIN AND DESTINATION, NEW HAVEN¹

Destination	Origin								
	1-2-3	4	5	6	7	8-11	12-13	14-18	19-21
1	(97.8) 135	(34.8) 25	(40.3) 70	(27.1) 23	(16.1) 19	(19.2) 12	(63.2) 35	(41.6) 31	(44.8) 35
2	(78.2) 102	(26.1) 21	(30.1) 62	(20.3) 22	(12.1) 16	(14.4) 15	(47.3) 18	(31.1) 14	(33.5) 18
3	(67.1) 53	(23.9) 16	(27.6) 8	(18.6) 12	(11.1) 8	(13.2) 25	(43.3) 49	(28.5) 52	(30.7) 41
4-5-6	(48.0) 42	(17.1) 12	(19.8) 17	(13.3) 14	(7.9) 11	(9.4) 15	(31.0) 37	(20.4) 28	(220.0) 13
7	(36.6) 57	(13.0) 11	(15.1) 20	(10.1) 10	(6.0) 2	(7.2) 16	(23.6) 18	(15.6) 4	(16.3) 6
8	(77.5) 70	(27.6) 33	(31.9) 28	(21.5) 60	(12.8) 34	(15.2) 11	(50.0) 28	(32.9) 24	(35.5) 19
9	(179.0) 117	(63.7) 78	(73.7) 24	(49.8) 25	(29.5) 12	(35.2) 19	(115.5) 208	(76.0) 103	(81.9) 118
10	(74.2) 76	(26.4) 22	(30.6) 50	(20.6) 19	(12.3) 11	(14.6) 19	(47.9) 38	(31.5) 26	(34.0) 31
11	(24.4) 29	(8.7) 8	(10.0) 4	(6.8) 5	(4.0) 0	(4.8) 1	(15.8) 9	(10.9) 6	(11.2) 8
12	(18.5) 16	(6.6) 22	(7.6) 4	(5.1) 3	(3.1) 2	(3.6) 4	(12.0) 10	(7.9) 8	(8.5) 4

¹ Figures in parentheses are expected number of trips if all destinations are equally attractive to all origins.

² Destination Code:

1—Curb parking, east side of Orange St. from Elm to Court Sts.; 2—Curb parking, east side of Orange St. from Court to Chapel Sts.; 3—Curb parking, west side of Church St. from Chapel to Court Sts.; 4-5-6—Curb parking, both sides of Church St. from Court to Elm Sts.; 7—Municipal lot, Elm St. between Orange and State Sts.; 8—Pigeon-hole municipal garage, State St. between Elm and Court Sts.; 9—Municipal lot, Church St. between Crown and Chapel Sts.; 10—Private lot, Orange St. between Chapel and Center Sts.; 11—Curb parking, south side of Chapel St. between College and Temple Sts.; 12—Curb parking, north side of Chapel St. between College and Temple Sts.

³ Origin Code:

1-2-3—Broadway St., Ashmun St., and Prospect St.; 4—Temple St.; 5—Orange St.; 6—State St.; 7—Grand Ave.; 8-11—Chapel St., Court St., and Wooster St.; 12-13—Oak St. Connector (to Connecticut Turnpike); 14-18—Orange St., Congress St., and southwest New Haven area; 19-21—George St.

1-2-3 and 5. In the case of origin 5, a driver is on a direct route past curb sites and a private lot and must cross the CBD to arrive at destination 9. Though 73.7 destinations were expected there were only 24 observed at the subject lot. Persons from origin 1-2-3 do not pass any of the survey sites in taking the most direct route to destination 9, but they are required to follow a devious route (because of one-way streets and turn restrictions) that takes them across the CBD. By proportion, 179 trips were expected and 117 observed.

There were more trips than expected at destination 9 from origins 4, 12-13, 14-18, and 19-21. All but origin 4 are on the same side of the CBD as the facility. Origin 4 is on a one-way street that leads directly to lot 9. Those zones that had less than the expected parking volume were not on a direct route or were on the opposite side of the CBD from lot 9.

Parking locations 1 and 2 are curb sites on Orange Street, one of the important streets leading downtown. Persons entering the CBD on this street can be expected to pass these locations if they follow the most direct route. There were 132 drivers entering the area along Orange Street who parked along this same street as compared to 70.4 who were expected to park. Origin 1-2-3 contributed 237 parkers as against an expected 171. Drivers from this direction are required to make only one turn in order to get to a parking site and it is the most accessible facility of those covered in this study.

Greatest negative differences were contributed by origins 12-13 and 14-18. Drivers from these origins pass facilities 9, 3, 4, and 5 before arriving at destinations 1 and 2. Fifty-three drivers parked on Orange Street as against an expected 110.5 from the Oak Street Connector. The southeast area contributed 45 parkers against an expected 72.7. Origin

19-21 on the east side of the CBD also showed fewer than expected destinations (53 observed vs 78.3 expected).

Because of one-way streets and other restrictions destination 4-5-6 is not accessible without passing some other location and is not directly on any route. In this instance the assumption of equal attractiveness was borne out. The χ^2 test indicated that arrivals from all origins cannot be shown to be disproportionate. Only the private lot at location 10 approached the curb area 4-5-6 in being equally attractive to all parkers. The greatest source of disparity was the traffic entering along Orange Street directly on the route to the facility. From all other directions the arrivals were nearly in proportion to all origins from that direction.

All remaining facilities tended to be a "favorite" destination of one origin or another. The evidence of this analysis is that parking sites located on routes do tend to attract vehicles using that route and have a tendency to intercept trips bound for the CBD.

Those parking locations that are not on a direct route tend to attract vehicles from all directions and the influence of location is less pronounced.

CONCLUSIONS

1. Drivers who park at lots tended to have a particular location in mind when taking a trip to the CBD. Curb parkers were less inclined to look for a particular site, and more likely to "take a chance" in finding a parking location.

2. Parkers at lots were successful over 83 percent of the time in finding room at the facility of their choice. Curb parkers were successful only between 26 and 59 percent of the time.

3. The percent of drivers with a place in mind and the percent of drivers successful in their search

were at a minimum during the Christmas rush.

4. Approximately 75 percent of all curb parkers began to look for a space before passing their ultimate destination. Twenty percent began to seek a space within 200 ft of the ultimate destination and the remainder passed the destination before searching.

5. Before reaching their parking location 30 percent of the drivers passed the ultimate destination, 38 percent parked within 200 ft and 32 percent did not pass their destination before parking.

6. Persons who looked for spaces at the curb before entering off-street facilities tended to have longer search distances than people who were successful in seeking a site at the curb.

7. Drivers indicated they began searching for a space (search-walk distance) at a distance of 150 to 200 ft further than the distance actually walked.

8. Magnitudes of walk distance, search-walk distance, and search distance did not correlate by rank. Those days of maximum or minimum walk distance were not the same as days

of maximum or minimum search distance or search-walk distance.

9. None of the variables, walk distance, search-walk distance or search distance were correlated to volume or parking accumulation when measured by hours of the day.

10. Average total travel by curb parkers was slightly greater than for off-street parkers on the same date.

11. The influence of the Christmas rush period was to increase off-street parker average total travel by 655 ft and curb parker total travel by 823 ft over November measures. The net effect was equivalent to increasing vehicle travel—by about 20 percent even without the addition of further vehicles.

12. Parking facilities located on routes to the CBD tended to intercept trips entering along that route, both for curb and off-street locations. Drivers showed a preference for the nearest parking space and the most direct route.

13. Those parking locations not on a direct route tended to generate traffic from all origins in proportion to all vehicles entering at that origin.