PARKING

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THE ENO FOUNDATION FOR HIGHWAY TRAFFIC CONTROL
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FOREWORD

Progress in parking has been made in spite of discordance and difficult circumstances. From a broad outlook, most improvement has come from insistent pressures of the problem and from an increasingly realistic appreciation of probable consequences.

Widespread efforts of considerable financial importance have been made in areas where the problem became acute and could no longer be ignored. In some instances, parking has significantly influenced national trends in finance, business, marketing, industry, and living.

The problem continues to be of both local and national importance with manifold interlocking aspects, affecting our daily lives—in crowded centers of large cities, where parking inadequacy is most difficult to correct, and in smaller cities and towns, where there is a saving grace of time and opportunity to plan and provide for future situations.

For these reasons and the Eno Foundation's interest in all traffic problems, this publication is presented in the hope that it may contribute to continuing solutions, and that it may not only stimulate further studies of parking but form a basis for them.

THE ENO FOUNDATION

Saugatuck, Conn.

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CHAPTER ONE

THE PARKING PROBLEM

Increasingly congested traffic and inadequate parking seriously threaten the economic health of fine communities, halting their further progress. Yet our unavoidably growing use of motor vehicles, essential in our daily life, arises from inevitable changes in our past.

The experience of half a century now provides a more reliable view of the future than early estimates that went far amiss. Tardily foreseen problems hold back the motor vehicle's future usefulness. One is parking.

With our increased activity and mobility, people go largely when and where they want, but most frequently where travel facilities best meet their requirements and convenience. Obviously, the principal function of streets and highways is the efficient movement of vehicles and pedestrians. This simple truth should be the goal we try to reach.

Early, our use of streets for parking, loading, unloading and storage began to obstruct this primary purpose. Regulations and controls, though promptly recognized as necessary, came slowly. This unfortunate effect on the unplanned growth of our cities and towns, now confronts us with serious traffic problems. Today few roads or highways exist without aids and controls; yet often these are regarded as restrictions, though their real purpose is to provide safe, efficient highways.

Parking on streets and highways clearly obstructs travel. Until we widely recognize the importance of this basic principle, we shall continue to flounder in our confused predicament.

Parking will remain a problem as long as the public regards curb space as suitable and sufficient. This situation, now chaotic, requires unusual methods to correct it.

Not a city has fully solved the problem, though many, at long last making notable efforts, deserve credit for the professional manner of their procedure.

Small communities with time, space, and expert guidance—and alert administrations—can, with timely action and early planning, more easily relieve conditions than crowded cities. Yet it is unlikely that solutions will be found without radical departures from present methods.

Balance Between Movement and Parking

The broad objective is the development of a total free-wheel transportation system in which all components are in reasonable balance. Facilities for parking lag far behind facilities for movement. Congress in 1956 appropriated fifty billion dollars for an expanded highway system to be built within thirteen years.

During the last ten years, expressways in cities leading to central business districts have been built at the rate of hundreds of millions of dollars a year. Obviously, expenditures for parking facilities are not keeping pace with these advances. It is also clear that new facilities for movement will generate greater downtown traffic in central business districts whose present parking facilities fall short of present demands.

This lack of balance leads to the conclusion that greater effort and resources must be applied to the parking problem to bring parking facilities within reasonable balance with movement facilities already under construction, or for which financial commitments will be made.

Parking Problem Universal

The city problem is a shortage of parking accommodations—fewer spaces than drivers need—a lack detrimental to business.

Some physical factors make the downtown parking problem severe. Central business districts are limited in size, their boundaries often fixed by land use developed in a previous era. Tallest buildings are situated there in greatest number, anchoring street widths yet increasing the number of customers to be served. Another physical element is the automobile whose annual increase in ownership and use means that each year more people

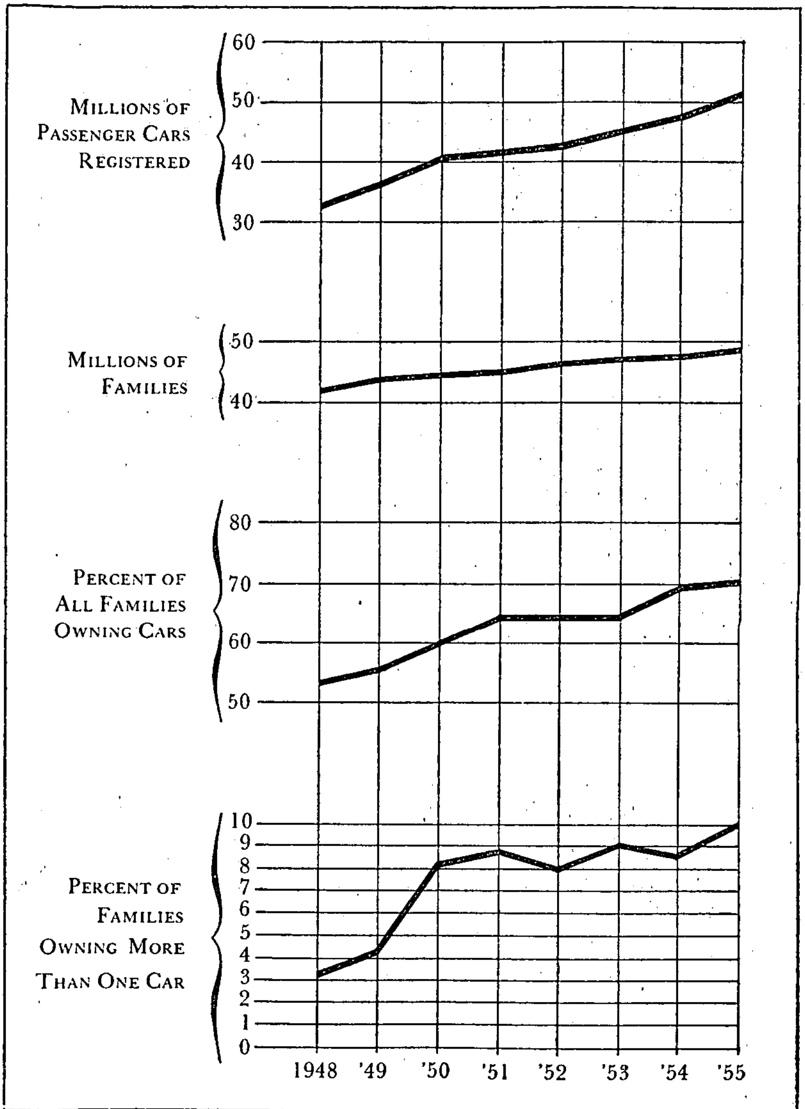


Figure I–1. Family Car Ownership.

can drive to the city center, and more drivers join in the competition for parking spots.

To improve the health of downtown business through relieving traffic congestion, curb parking will necessarily be gradually eliminated. Ultimately, whole blocks may have prohibited parking to gain greater use of traffic lanes. As these released pressures expand to other areas, prohibited parking may become the rule in most concentrated business areas.

Groups interested in the parking problem may readily visualize the solution of the parking problem as an orderly retreat from curb parking to off-street parking. Meanwhile, every curb space that congestions permit should be used effectively. Realistic measures now will be simpler and less expensive than when the problem becomes more complicated.

Groups and Interests Affected by Parking

Parking affects the competition between downtown business and that in outlying shopping centers or sub-business districts. It is not the sole cause of decentralization but it certainly has contributed to it. Customers have two transportation interests—convenience of travel to the place of business and convenience of parking when they arrive. Downtown merchants cannot afford further inconvenience to travel. Curb parking can be removed as fast as off-street parking equivalents are provided. The over-riding interest of merchants should be in the provision of more off-street facilities rather than in the perpetuation of existing curb parking.

The downtown parking problem exists in time, in space, and in people's minds—in varying degrees of concern that range from annoyance to worry over the safety of investments. This wide range of concern adds to the complexity of the problem and the reconciliation of differences.

Group discussions do not always lead to harmony, but they contribute to a better understanding of the problem. A brief consideration of conflicting interests illustrates why the parking problem is so difficult.

Trade is the focal point of downtown parking—an important generator of traffic movement and parking demand. Merchants suffer first when parking and congestion are not relieved. Unfortunately, many argue that their business is increased by curb spaces in front of their shops. Curb parking prohibitions receive their first organized opposition from this group.

Numerically the curb parker is unimportant compared with others customers. "Profit" from curb parking is outweighed by losses in traffic delay, interference with access to businesses, and by the reputation the city earns.

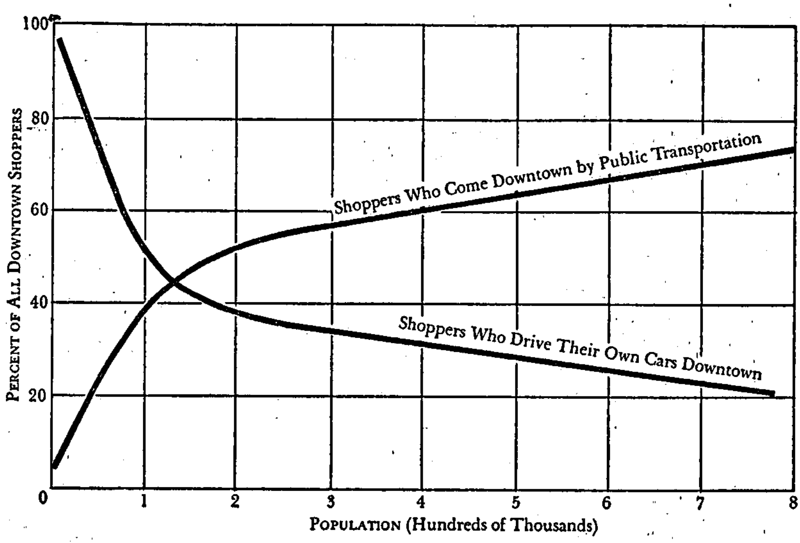


FIGURE I–2. Shopper Travel Mode.

A study of curb-parked customers in Philadelphia gained the full support of merchants for a ban on curb parking from 8 A.M. to 6 P.M. on nearly all the downtown one-way streets. It eased the general traffic flow and improved customer-access to stores. The ban covered 112 downtown blocks. After a year of operation, follow-up studies showed traffic movement speeded by 42 to 51 percent. Operating speeds for trolleys and buses had increased by 27 to 40 percent.

In Chicago's Loop, curb parking was eliminated after surveys determined the amount of retail business created—and deterred—by curb parking. A trial period proved the regulation a progressive step. Some merchants mistake traffic congestion as a sign of good business. They fail to foresee the consequences when access to an area is retarded by traffic and parking conditions.

Outlying shopping centers and suburban business areas typify such consequences and when those re-locations begin, it is expensive to correct the basic causes. Parking is a community problem. A healthy downtown area is important to the successful operation of the stores and businesses that create it.

Motorists

Where opposition to change arises, it is generally due to lack of reliable information or mistaken ideas. Where informed leadership has appeared, progress has quickly followed. Correcting or overcoming traffic congestion is difficult but not unlike solving other problems. Knowledge and experience are essential. Decisions and action should not be weakened by superficial understanding and false assumptions.

Parking needs of the motorist are natural and well-defined. They are the same as his needs in other phases of traffic operation. His car should provide its full advantage, including maximum of safety and minimum of delay.

Improvements in the downtown parker's future lies in off-street parking. He is at present undergoing a forced withdrawal from his false dependency on curb facilities. He is taught slowly, but necessarily, eventual and inescapable use of off-street parking.

Property Owners

Retail property owners look at the parking problem much the same as the retail merchant. The retailer sees his investment as dependent on free parking at the curb. Frequently he resists curb parking regulations. Yet few go to the expense of off-street spaces for their employees and patrons. In fairness it should be acknowledged that, in some central business districts, land values make it virtually impossible for the average individual merchant to develop off-street parking for his business. Such instances can be met, however, with concerted action.

Property owners are changing their parking attitudes. They appreciate that the success of their business and the value of their property depend upon greater accessibility for more customers than curb parking can provide. This simple fact has been conclusively proved and many seek advice on off-street spaces.

Commercial Fleet Operators

A primary purpose of streets in the central business district is to provide access to commercial activities in the area. This includes the movement of merchandise in and out of the central business district. These movements create involve parking conditions.

Motor shipments load and unload at the curb. Inefficient, compared with off-street loading and unloading, this operation frequently necessitates setting aside a disproportionate amount of curb space for delivery vehicles. In terms of total space, the spaces demanded by commercial fleet operators far exceed a reasonable apportionment of the available space.

Some progress appears in the voluntary installation of off-street loading and unloading berths in new industrial and commercial buildings. More progress shows in the compulsory provision of these facilities through zoning ordinances. (See page 000.) A parking program should take into account the need for convenient loading areas for trucks. Though some adequate and convenient off-street facilities may be provided, experience proves that part of these operations will always take place at the curb.

Taxis

Standing zones or loading areas are provided for taxis in the downtown sections of every city, some off-street, but most at the curb. In this respect the taxicab is important in the parking problem.

The principal opportunity for improved parking by taxicab control in downtown areas is in selecting efficient locations for cab stands and in the use of radio dispatching. As a by-product, the availability of well-located stands reduces "cruising."

Parking-improvement programs should include a review of taxi-stand location and use. Investigation of practices and plans used by other cities in accommodating and controlling the use of curb space by taxis can be helpful.

Emergency Vehicles

Police and fire departments are importantly concerned with curb parking conditions because curb-parked cars interfere with their duties. Adequate "no parking" protection in the vicinity of fire hydrants, sufficient street width for maneuvering over-sized public service vehicles, and space for laying fire hose are public safety requirements that must be considered when street parking revisions are contemplated.

It has been suggested that fire hydrants might be good sites for taxi stands. Such stands could use what is now dead parking space, and the curb at the hydrant could be readily cleared when necessary. Where hydrants are on the left side of the street, there might be some advantage in having the taxi stand directly across the street; then, all of the street near the hydrant could be cleared.

Mass Transportation

Efficient mass transportation can materially ease the city parking problem by serving downtown patrons who might otherwise drive private cars. Public transportation, with appeal to the customer, decreases the number of commuter cars in the city center but it encounters difficulty in replacing the flexibility and convenience of the private vehicle.

Well-designed and properly sited loading zones or stalls could remove the necessity of buses' having to load and unload in each block and probably improve their schedules and patronage.

Accidents Involving Parked Cars

Curb-parked cars, as well as cars in the process of parking and unparking, create accident hazards. Directional movement of parking and unparking cars is practically at a right angle with traffic in the moving lanes.

Studies show that accidents involving parking or parked cars account for approximately one-tenth of all accidents, and half of these involve parked cars. The next highest percentage of parking accidents involves cars moving from the curb. Cars slowing to park, double-parked, and backing into curb spaces account for most other parking accidents.

More accidents result from angle than from parallel parking. In leaving the angled stall, the driver is required to maneuver his car blindly into the traffic stream, often causing moving cars to swerve, inducing collisions with opposing traffic.

Curb parking too near an intersection creates traffic accidents. In San Antonio, Texas, right-turning buses were involved in five accidents within four months at a downtown intersection. Buses had difficulty negotiating the turn and caused congestion. Eliminating one curb parking space speeded the bus movements and eliminated congestion and accidents.

The parked car contributes to fatal pedestrian accidents. Regularly, eight to ten percent of the pedestrian fatalities involve persons entering the roadway from behind or between parked cars. Approximately the same percentage of pedestrian injury-accidents occurs under those conditions.

Because of the various ways of keeping city accident records, it is difficult to compile data illustrating the full importance of parked car accidents. However, the available records indicate that parked cars cause enough accidents to justify careful study of parking improvements from the standpoint of accident hazard. Because of the public's concern, it is often possible to enlist support for parking proposals on the basis of accident facts.

Commuters

In addition to shopper-convenience, parking facilities should be provided for employed persons who regularly commute by automobile. The classic conflict of interest between commuters and customers, as frequently shown by surveys, stems from business personnel cars parked all day at the curb.

Commuter demand is for all-day parking, and off-street parking can be provided farther away from places of employment than customers will accept. Adequate parking facilities for commuters are essential in making the central business district a desirable place to work as well as shop.

Economic Losses Due to Parking

Parking shortages hamper a city. Failure to provide parking in business areas denies access to motor-vehicle users. Inadequate parking space causes cruising and clogged streets; it results in excessive parking charges. Delay forces drivers to park far from their destinations and, like traffic congestion, interferes with a desirable pattern of city development.

Parking shortages and poor locations, combined with congestion, induce customers and business to drift from central business districts and their long-established commercial facilities. The drive to a shopping center and a place to park are more attractive to shoppers than cruising the central business district for a place to park. Though the shopper knows downtown may offer a greater selection of some types of merchandise, he will in the face of continuing parking difficulties finally prefer the convenience of outlying commercial centers and cease to patronize the central business district as frequently. This question of decentralization of retail trade has become a popular and much studied subject.

Customer convenience, mobility, inadequate parking, and shopping center development are cumulative influences threatening the attractiveness of downtown shopping. This phenomenon of decentralization results in loss of business, loss of capital value in that important but small fraction of city area which, although usually less than one percent in size, accounts for from 15 to 25 percent of the city's real property assessments.

Downtown business losses are most important to those whose livelihood originates in the central business district. But they further represent a financial loss to city inhabitants. Taxes on highly developed downtown properties have long provided much of the financial support for city operations. When businesses leave the city center, tax revenues decline. Central business district tax losses are not recovered by creating equivalent values at decentralized locations frequently beyond the city limit. Tax revenue declines are not accompanied by decreased city service needs. Eventually the tax rate is increased to maintain the tax yield.

Non-traffic reasons for downtown business decentralization most of our large cities are meeting include lower rentals, lower taxes and less restrictive building codes. In the outlying areas, however, the rate of that relocation—as reflected by declining tax revenues—is almost in direct ratio to the increased use of the automobile in the city. Poor parking and traffic conditions must rate as important factors in uncontrolled city decentralization.

Types of Parking Facilities

On-Street Facilities: On-street, or curb, parking can be divide into three classes developed as the parking problem became more critical:

1. Unrestricted Curb Parking
2. Restricted Curb Parking
   a. Police Controlled (through enforcing restrictions posted on signs)
   b. Meter Controlled

On-street parking is convenient only for the parker fortunate enough to find space reasonably near his destination. It is inconvenient, and to a degree unsafe, for the majority of motorists in moving cars.

In areas of concentrated land use, such as city central business districts, disadvantages far outweigh any advantages claimed for on-street parking.

Off-Street Parking Facilities: Two basic types of off-street parking facilities are:

1. Surface Lots
2. Multi-Floor Structures
   a. Ramp garages
   b. Mechanical parking devices

Off-street facilities, considered in terms of ownership and operation, develop other classifications:

1. Privately owned and operated
2. Publicly owned, privately operated
3. Publicly owned and operated

All types of off-street facilities have been operated successfully. No one type can be labeled the best. The success of each depends on local conditions, siting, operations, and other circumstances. Each city must decide which type will best serve its needs. Efforts can then be directed toward a specific goal rather than divided among conflicting approaches.

In succeeding chapters, details are given concerning each type of off-street facilities.

Administrative Approach to Problem

The parking problem stems from the fact that there is not sufficient curb space to accommodate all parkers. A first step in solving the problem is to learn whether the best possible use is made of existing facilities. Curb parking restrictions, adopted when traffic was considerably lighter, may still be in force. Slight changes will often help the situation.

Parking stalls in off-street lots may have been laid out without making most efficient use of the land; changing them from angle to perpendicular stalls may increase the number. Effective surface markings, better signing, relocation of entrances and exits, and use of one-way aisles are other ways to improve parking facility operation and attractiveness.

City parking administration is hampered from the outset; the more street space required for moving traffic, the greater the need for parking facilities. The problem becomes more complicated with lack of off-street berths for commercial loading and unloading, and the peculiar needs of transit and emergency vehicles. All these uses of the street are legitimate and necessary; and obviously all such uses should be considered in a complete parking program.

Costly and time-consuming off-street parking developments require important policy decisions. Some of the more important follow:

Elimination of Curb Parking

Many large cities have affirmatively decided whether or not curb parking should be abolished in the central business district. Effectively freeing parking lanes for traffic movement, such laws especially helped to relieve congestion.

The decision to eliminate curb parking if warranted, should be the result of careful study of local conditions and needs. On the basis of extensive parking information collected and carefully analyzed, a policy can be established and definite relief measures initiated.

Determination of a policy should be tempered by local considerations. Since many may consider prohibition of curb parking a drastic step, every effort must be made to balance conflicting interests and needs. An outline of recommended procedure for establishing a policy on curb parking restriction is given on page ooo.

Time-Limit Control of Curb Parking

Time-limit controls force sharing of curb parking spaces and afford the only fair way to use curb spaces when demand begins to exceed supply.

Time-limit controls should be installed only after careful study to insure that the regulations ultimately adopted are realistic, enforceable and productive of results.

Ways to examine existing curb parking time-limit controls and adjust them to current and projected needs are discussed in Chapter IV.

Enforcement

Parking restrictions are only as effective as the effort to enforce them. Regulations that cannot be enforced might better be rescinded. Regulations carefully related to parking needs and impartially enforced help to achieve the best use of existing facilities.

Parking Meters

The most important arguments favoring the use of parking meters are:

1. They make a set number of spaces available for more parkers, by encouraging a more rapid turnover in the use of parking spaces.
2. They simplify enforcement.
3. They produce revenue that may be used for off-street parking facilities.

Most downtown drivers wish to park for relatively short periods. Properly enforced parking meters reserve the space for short-time parkers and thus make the space available to more users. Scaling meter time-limits to area requirements is better than establishing a single time limit. Spaces near banks, offices, and similar spots where parkers need to stop only a few minutes, serve more effectively when parking meters have short limits. In other parts of the city center, where parking demand is not so concentrated, time limits can be extended for longer parking.

Meters aid enforcement by enabling officers to cover larger areas. But if meter limits are not enforced, violators will soon learn it is more convenient to "feed" the meter than to find a space elsewhere.

In the past, some cities channeled parking meter revenues into the city's general tax fund. Fortunately, this practice is on the decline. The logical and growing trend is to set those funds aside for development of off-street parking. If this trend continues, the ultimate step will be the removal of all curb parking when meter revenues can finance the purchase of sufficient off-street parking facilities.

A discussion of parking meters, presented in Chapter V, outlines factors to be considered by cities planning meters.

Off-Street Parking

Most cities are aware they lack sufficient curb space to satisfy current parking demands. Curb parking regulations juggle use of available space and temporarily help the parking situation. Permanent relief can come only from off-street developments. If a city undertakes such a program, some important policy decisions will include:

1. Administration of off-street parking program
   a. Place activity under an existing department, such as department of traffic engineering.

   b. Establish a separate city department for off-street parking.
   c. Appoint a parking committee, commission or board.
   d. Create a parking authority.
2. Acquisition of land for off-street parking facilities
   a. Gift.
   b. Purchase.
   c. Lease.
3. How is land acquisition and development financed?
   a. Use of general funds.
   b. Issuance of general obligation bonds.
   c. Sale of revenue bonds.
   d. Special assessments against benefited properties.
   e. Use of parking meter revenues.
4. Type of facilities
   a. Garages.
   b. Surface lots.
5. Operation
   a. City.
   b. Commercial operators.
6. Determining parking charges
   a. Operating costs, operations and debt retirement.
   b. Excess funds needed for developing new facilities.

These and other policy matters are discussed in Chapter Six.

General Problems of Finance

Inexpensive off-street parking is essential to a successful parking program. If the charge for off-street space is too great, drivers will cruise in search of curb stalls and off-street space will stand empty.

Major parking facilities involve large expenditures. Compared with other capital investments, the returns from parking investment may be small. This combination of high cost and uncertain revenues has caused private and public groups to hesitate in undertaking large-scale parking developments. Parking finance is a long-term proposition. This fact emphasizes the need for long-range decisions fixing municipal participation in the program.

It is essential to establish and make public a definite policy regarding the city's role in providing and maintaining off-street parking places. Obviously the city has a responsibility for providing and maintaining downtown streets. And all cities are in the parking business because of their regulation of curb parking.

But the main purpose of a street is to pass traffic, and parking must move off-street. As this relocation goes on, the city may assume responsibility for providing equivalent off-street space. It is important, however, to fix the limit of that responsibility specifically, and to define plans and policies for municipal activities in the field of off-street parking. Indecision or failure to state policy has proved an important deterrent to private extension of off-street parking in many cities.

Major difficulties are likely to be encountered if special assessment districts are set up for charging all or part of the cost of an off-street development against the benefited properties. The problem is to establish an equitable and acceptable ratio between assessments and benefits. Some of the knotty aspects of this seemingly straightforward financing plan are:

1. Exactly what constitutes a benefited property?
2. Is it fair to charge for benefits on the basis of assessed valuation? Or should the basis be assessed valuation modified by a factor that reflects the varying amounts of parking space different property uses require?
3. How does the degree of benefit vary with the distance between the taxed property and the parking development?

Theoretically, this plan distributes the cost of parking among the property owners who benefit from it. Practically, it is complicated and difficult to administer. Selfish viewpoints have retarded several badly needed parking programs which had anticipated using the benefited property assessment for financing. An example of how one city worked out a successful benefit assessment finance plan is given in Chapter Seven.

The comfort and convenience of the parker are of interest to others beside himself. Businessmen, merchants, professional men and others have an interest in seeing the parker accommodated. Often these groups can be persuaded to make contributions to help finance parking.

Because the provision of off-street parking is a comparatively new municipal activity, no one best way has yet developed to finance such facilities. In the past, cities usually paid for sewer, roadway, and water improvements by taxing the immediately benefited properties. General obligation bonds have long been favored for financing such general purpose improvements as parks, police stations and government buildings. However, no similar fixed pattern is yet noticeable in city financing of off-street parking. Different plans used successfullly in the past are detailed in Chapter Seven.

Future Progress

Delineation of the parking problem indicates that future progress hinges on resolving these dilemmas:

1. The parking problem is universal. It will *automatically* grow worse unless commitments are made to accelerate the provision of parking facilities to match at least the present commitments for expressways and highways (amounting to billions of dollars nationally).

2. Removal of curb parking to relieve congestion is inescapable but must be matched by equivalent off-street spaces in lots and garages.

3. To compete with outlying shopping centers and sub-business areas, central business district stores will need many more off-street parking spaces than those still remaining at the curb.

4. Short-range and long-range parking plans must be made now, based on surveys, using accepted techniques and programmed on a basis of stage development ranging from shorter curb parking limits to prohibited parking and prohibited stopping.

The parking problem is not hopeless. Full application of proved techniques can provide substantial improvements. But the more slowly the techniques are applied, the worse the problem will become in the meantime and the more expensive the capital investments required.

Downtown streets—which cannot be widened to create more moving lanes for doubling traffic volume—must ultimately have the parking lanes for movement.

CHAPTER TWO

PARKING HABITS AND CHARACTERISTICS

Most American motorists know that parking conditions grow worse as cities grow larger, that parkers are required to walk farther, and that curb parking spaces must be supplemented by lots or garages. Many believe that most curb spaces are taken by all-day parkers; that the majority of car-drivers on downtown streets seek parking places, and that a primary purpose of parking meters is to raise money. Parking studies have often been made, but until 1949 relatively little factual information was available.

Since World War II more than one hundred cities, with populations from eight thousand to a million, have authorized comprehensive parking studies by their state highway departments in cooperation with the Bureau of Public Roads. Since a uniform procedure was used throughout, analysis of the findings made it possible to make reliable generalizations on parking, travel characteristics, and trends. Data summarizing these relationships, made available by the Bureau of Public Roads, are used in this chapter.

Cities with completed studies have extensive data upon which to base a course of action. Where the existence of a problem is recognized but no study has been made, these generalized summaries should be of value; the data as a whole provide essential information for a broad study of parking.

The following summaries represent some of the findings in sixty-nine cities. They represent conditions in the central business district only. Since parking conditions downtown are contributed to by, and also concern, the people who live around the outskirts of a city as well as those who live inside the city limits, the figures represent the populations of the *urbanized areas*, according to the 1950 Census. Thus, a city having a *city* population of 85,000 but having an additional 25,000 living in the contiguous built-up areas, would be included in the 100,000–250,000 population group.

All summaries apply to the central business districts unless otherwise noted, and the figures represent averages for the population groups indicated. The term "vehicle" as used here, applies to passenger cars, taxicabs and trucks, but does not include buses and streetcars. The data represent conditions between 10 A.M. and 6 P.M.—peaks of traffic and parking.

The Central Business District

The parking problem first makes itself known in the central business district. In the larger cities it later appears in neighborhood shopping centers, at industrial plants, educational institutions, recreational centers, and other areas. This volume is primarily concerned with parking in the downtown area, and for that reason it is desirable to attempt a definition of just what that area comprises.

Central Business District Defined

The central business district is the heart of the city, and the main traffic arteries radiate from it. It is generally at the hub of the mass transit system, and is the focal point of the commercial activities of the urbanized area: retail trade, offices, light manufacturing, and commercialized recreational activities. It has few or no dwellings.

It is the area of traffic and parking congestion. It occupies a relatively small proportion of the city's extent and generally is irregular in shape, but more nearly rectangular than circular. More people are affected by parking conditions here than in any other area.

Area of the CBD

A statement of what and where the central business district is does not serve to determine its boundaries; yet that must be done before a study can be made and the problem resolved. The central business district is not a legal entity, nor is there any established rule for fixing its limits. However, from many parking studies made, more definitive criteria have emerged.

In small places, the central business district includes only two or three blocks of Main Street. As the town grows, the central business district grows around the corners of the cross streets. In cities between 5,000 and 10,000, it will include parts of one or two adjacent streets parallel to Main Street, or of the principal cross street. The area grows as the population grows, but not as fast, for its expansion is partly vertical, as much as or more than by horizontal or ground area growth.

Data compiled by the Bureau of Public Roads in sixty-nine cities are given in Table II–1. They show that as the average population increases from 8,000 to more than a million—163 times—the urbanized area increases 103 times; yet the area of the central business district serving that population increases only eleven times. Per capita, the largest cities have one-twelfth the downtown area of small cities (Figure II–1). It is evident that in the central business district the vertical growth creates a dense concentration of traffic and parking generators in a limited area.

The data in Table II–1 give some criteria for the size of the central business district in any given city and hence for approximating its boundaries. Actually, where comprehensive studies have been made following such an approximation, a final determination has been made by touring the suggested boundaries during peak hours to observe conditions inside and outside the tentative boundary.

The criteria used here are usually, (1) degree of occupancy of curb spaces; (2) nature of land use—business, industrial, or residential; (3) presence of nearby, rather than downtown, parking generators. When the boundary has finally been fixed, it usually will be found at the point where some residences appear, where there are fewer business establishments, where curb spaces are not fully occupied. In the smaller cities it is beyond the metered zone, in the area of two-hour or unrestricted parking. It is usually beyond any "pay" lots serving the central area.

The Core of the Central Business District

In every business district a central group of blocks represent the largest generators of parking demand and highest land values.

Table II–1

THE CENTRAL BUSINESS DISTRICT

1950 Urbanized Area Population			Average Area in Square Miles		Area of Central Business District		
Population group	*Average population*	*Number of cities*	*1950 Urbanized area*	*Central business district*	*Percentage of 1950 urbanized area*	*Per 100,000 population*	*Number of blocks**
5,000–10,000	8,000	2	2.2	0.09	4.0	0.97	10
10,000–25,000	18,000	16	4.9	.13	4.2	.71	22
25,000–50,000	36,000	16	8.7	.20	2.7	.58	39
50,000–100,000	80,000	5	21.8	.34	2.4	.42	45
100,000–250,000	167,000	14	38.6	.38	1.1	.24	60
250,000–500,000	366,000	8	79.5	.58	0.8	.16	99
500,000–1,000,000	549,000	5	125.4	.50	0.4	.09	139
Over 1,000,000	1,306,000	3	226.6	.99	0.4	.08	162
TOTAL		69					

*Block dimensions vary from 150 to 650 feet.

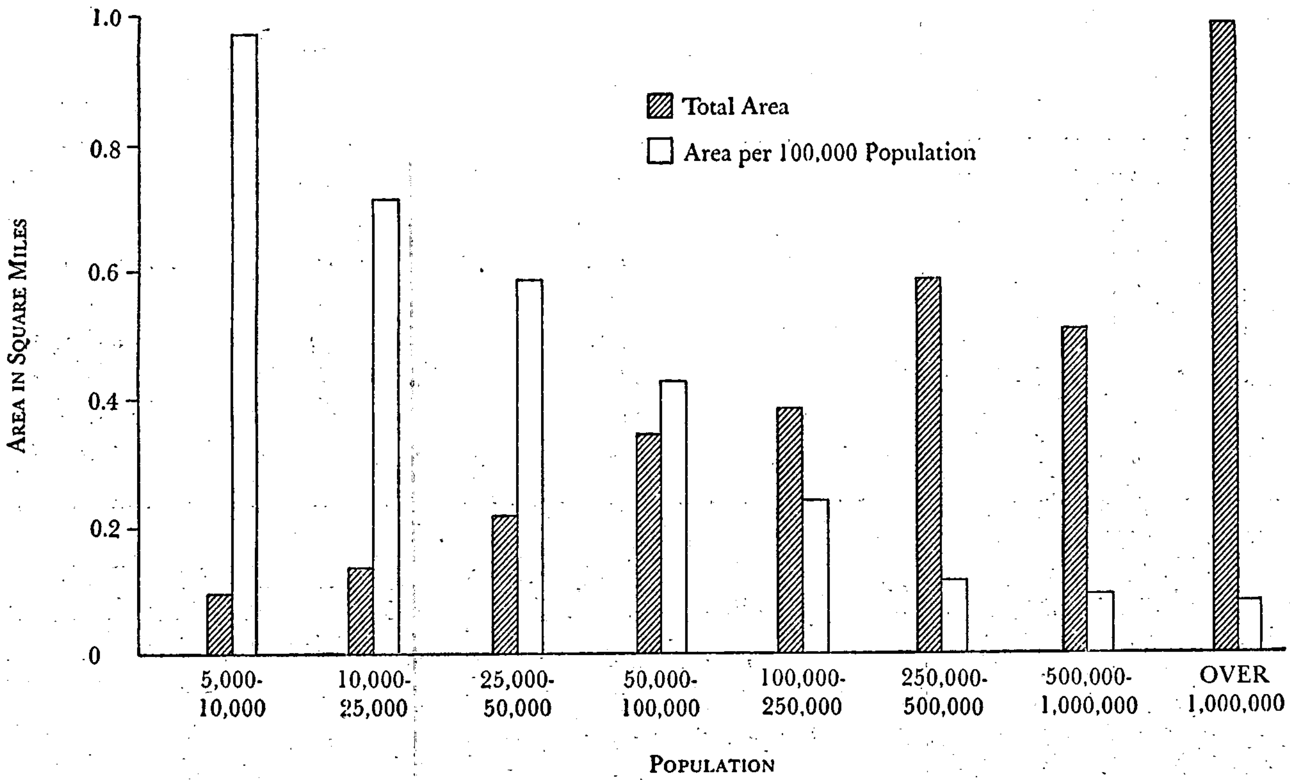


FIGURE II–1. Area of Central Business District.

In the comprehensive parking studies this area is defined as the group of contiguous blocks wherein the demand for parking space exceeds the supply of parking space, block by block.

Table II–2 shows that in the average city the core constitutes slightly more than one-quarter of the area of the central business district; it has only 20 percent of the parking spaces, but is the destination of more than two-thirds of the shoppers. The high

Table II–2

AREA OF THE CORE, AND ITS RELATIONSHIP TO THE CENTRAL BUSINESS DISTRICT

Population group	Number of cities	Core: Average area (Square Miles)	Core: Percentage of central business district: Area	Spaces	Shopper-parkers
5,000–10,000	2	0.02	23	21	—
10,000–25,000	15	.04	26	24	55
25,000–50,000	15	.05	24	21	57
50,000–100,000	4	.14	36	25	75
100,000–250,000	13	.09	24	21	68
250,000–500,000	7	.15	26	23	67
500,000–1,000,000	4	.11	23	10	69
Over 1,000,000	3	.22	22	12	76
TOTAL	63	—	26	20	67

land values in a limited area encourage the construction of taller buildings, which in turn generate still more traffic per unit of ground area, producing still higher values. Thus land uses in the core lead to high rentals, and increased commercial activity. Traffic demands in this area lead to the reduction or elimination of curb parking, while high land values increase the difficulty of providing off-street space.

These characteristics apply particularly to larger cities. In small cities there is less of a pattern to land uses because the downtown area is small, distances between points are short, and there is less competition for desirable sites.

As cities grow, land uses of similar character tend to congregate. In the core will be found the retail stores, office buildings and theaters. Toward the periphery of the central business district are wholesale and produce-market buildings, warehouses and trucking terminals. If the city is on a navigable body of water, its port facilities are apt to be in this area. Industry and manufacturing, demanding cheaper land, locate on rail and highway routes. Residences abandon the central area.

Traffic Volumes in the CBD

As the center of a city's retail, financial, business, administrative and entertainment activities, the central business district is the usual destination of the out-of-city traffic. As shown in Table II–3, the vehicular volume entering the central business districts of large cities is about ten times that in the smallest cities. In small cities almost all activity is confined to the central business district and important highways traverse it, while in large cities there are many other centers of activity and many heavily travelled streets outside the central business district.

On a per capita basis, the vehicular volume of small cities is fourteen times that of large cities. (Figure II–2). Responsible for this are the availability of mass transit; scarcity of parking space in large cities; ease and greater frequency of downtown trips in the small cities, and the greater proportion of other-than-downtown trips in large cities.

In cities with half a million population or more, the downtown area was thoroughly established long before the motor vehicle became an important factor. The central business district therefore inherited a system of streets incapable of handling the traffic it was to get. The number of vehicles entering a business district is limited by the capacity of the streets and by the number that can park. This is demonstrated by the data of Table II–2 which shows that in the large cities, with a business district eleven times that of the small cities, the peak accumulation of vehicles (moving and parked) per square mile is less than twice as large.

The greatest density of vehicles observed thus far in a parking survey was 34,000 per square mile, in Dallas, Texas. Although the population continues to grow and the central business district

Table II–3

TRAFFIC VOLUMES AND RATIOS

Population group	Number of cities	Number of vehicles entering*		Peak accumulation** of vehicles per square mile	Vehicles entering and leaving****			
		Total	*Per 1,000 Population*		*Average Hour*	*Peak half-hour****	*Ratio of peak to average ½-hour*	*Peak half-hour volume per 1,000 population*
5,000–10,000	2	8,100	942	15,100	2,000	1,480	1.49	171
10,000–25,000	16	14,900	837	12,400	3,800	2,570	1.38	145
25,000–50,000	16	22,100	627	14,300	5,600	4,000	1.40	113
50,000–100,000	5	37,400	476	15,300	9,600	7,600	1.56	96
100,000–250,000	13	36,500	236	15,300	9,400	6,570	1.39	44
250,000–500,000	7	60,300	168	20,700	15,600	11,550	1.45	33
500,000–1,000,000	5	73,800	135	27,400	19,100	14,470	1.49	27
Over 1,000,000	3	85,500	66	22,900	22,700	17,500	1.54	13
TOTAL	67						1.46	

* Excludes vehicles already inside the central business district at 10 A.M.
** Parked and in motion.
*** Peak half-hour for traffic movements generally 5:00 to 5:30 P.M.
**** Total inbound cordon count plus outbound cordon count.

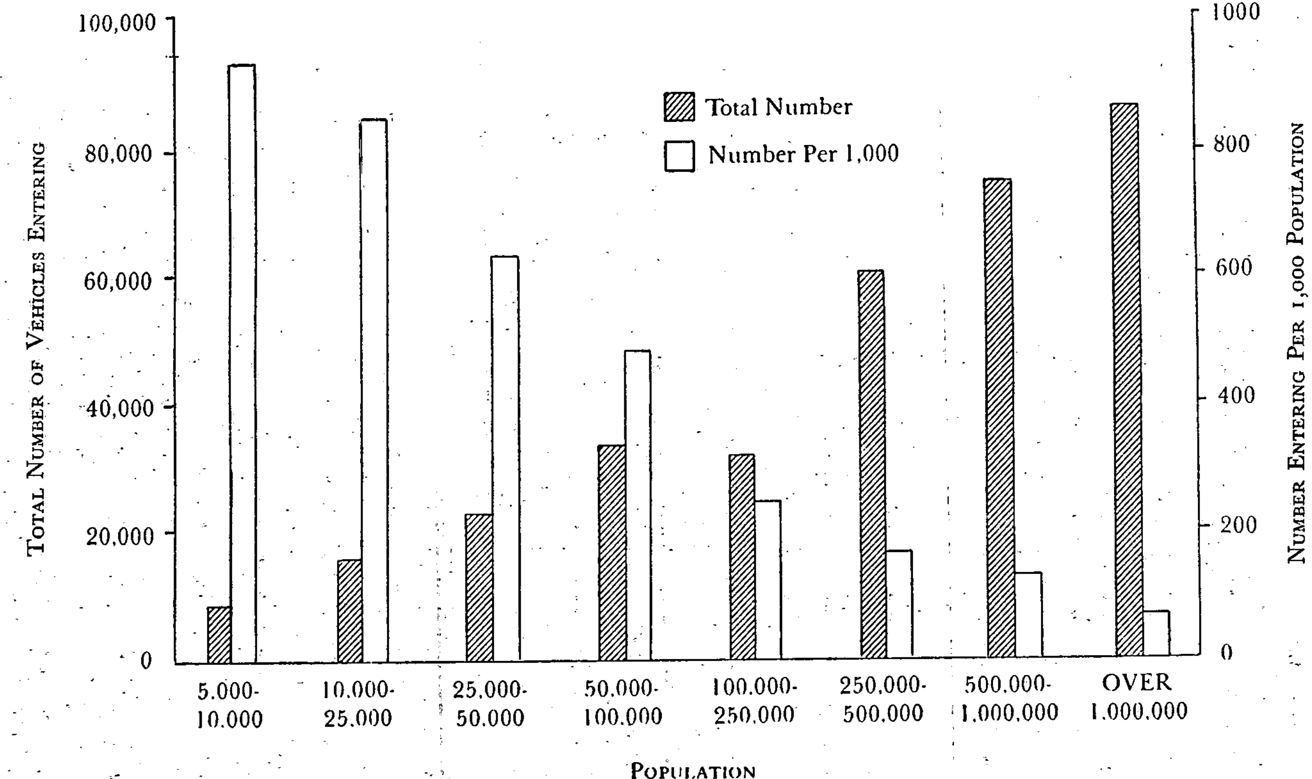


Figure II–2. Traffic volumes entering the central business district 10 a.m.–6 p.m.

to expand in ground area, the number of vehicles entering it increases at a slower rate. Another factor in part brought about by the congestion of the business district and in part responsible for its slower growth, has been the development, in and near many large cities, of neighborhood stores and shopping centers.

Truck Traffic

Trucks, as shown in Table II–4, comprise from 17 to 25 percent of all vehicles entering the central business district, the proportion being only slightly larger in the larger places.

Table II–4

INBOUND TRUCK TRAFFIC*

Population group	*Number of cities*	*Number of trucks*	*Percentage of all entering vehicles that were trucks*
5,000–10,000	2	1,810	21
10,000–25,000	15	2,940	19
25,000–50,000	12	4,150	20
50,000–100,000	5	6,570	17
100,000–250,000	11	7,280	21
250,000–500,000	5	14,500	23
500,000–1,000,000	5	14,760	20
Over 1,000,000	3	21,350	25
TOTAL	58	—	21

* Excludes all vehicles already inside the cordon at 10:00 A.M.

Traffic Passing Through Without Parking

Our cities, naturally enough, were born at the seaports whence highways would consequently radiate on the larger rivers, or along an important highway, often at the junction of another. It is not strange then that years later our arterial routes are found passing through the centers of these cities, even through the highly congested business districts, and that they carry many drivers who traverse the business district only because they are following a numbered route or because it offers the shortest or only path to their destinations.

Figure II–3 shows for cities of various population groups, percentages of traffic bound for the central business district, other points within the city, and points beyond the city. This refers to traffic approaching the city at points well beyond the city limits, not to traffic volumes at the edge of the central business district. As cities become larger, the proportion of "external-origin" traffic bound for the central business district becomes smaller; the proportion bound for other points in the city (part of it via the central business district) becomes larger, and the proportion bound for points beyond the city becomes smaller.

Small cities have few or no traffic generators except in the downtown area. But as cities grow, neighborhood stores, industrial establishments, schools and colleges, recreational centers, and residential areas generate traffic away from the business district.

Table II–5 refers to traffic entering the central business districts, traffic originating elsewhere in the city or at points beyond the city. The data were compiled from cities where comprehensive parking studies have been made, including counts of traffic enter-

Table II–5

TRAFFIC PASSING THROUGH CENTRAL BUSINESS DISTRICTS WITHOUT PARKING

Population group	Number of cities	Percentage of vehicles passing through without parking: 10 A.M.–6 P.M.*	Percentage of vehicles passing through without parking: Peak traffic half-hour**
5,000–10,000	2	61	68
10,000–25,000	16	53	60
25,000–50,000	16	54	60
50,000–100,000	5	48	61
100,000–250,000	13	54	65
250,000–500,000	7	55	69
500,000–1,000,000	5	59	83
Over 1,000,000	3	52	74
TOTAL	67	55	68

* Because of the lack of available data on trip origins, no correction was made for the trips originating within the central business district. Allowance for origins in the central business district would raise each of the above percentages a few points.

** Usually between 5:00 and 5:30 P.M.

DESTINATION OF TRAFFIC APPROACHING CITIES OF VARIOUS POPULATION GROUPS.

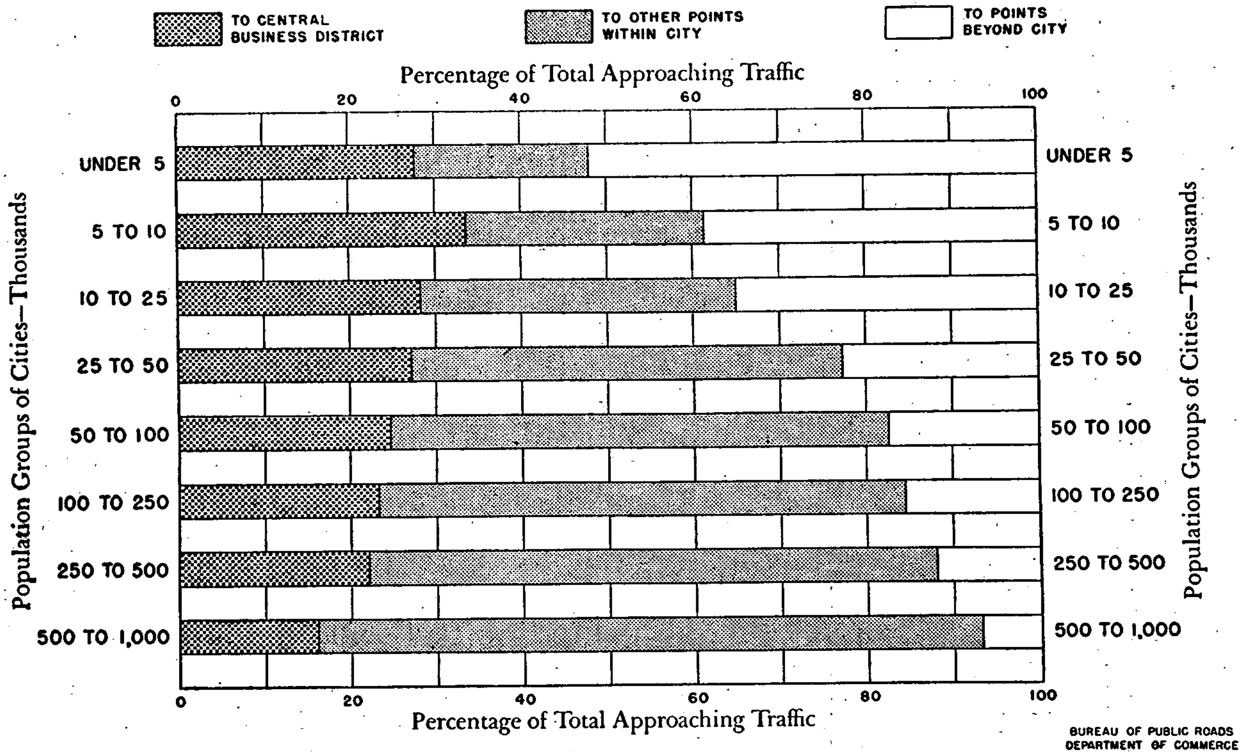


FIGURE II–3. Destination of traffic approaching cities.

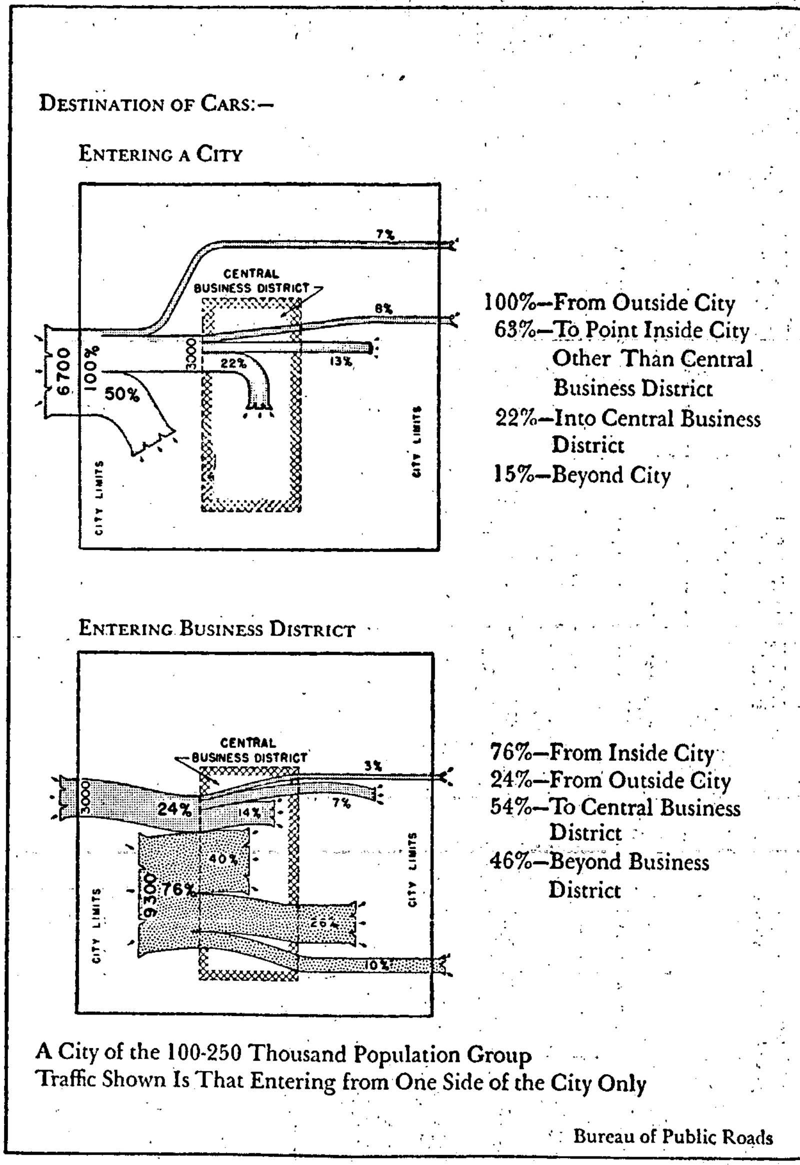


FIGURE II–4. Traffic entering a city and that entering the central business district.

ing and leaving the business district. Thus for these cities it was possible, by comparing the number of vehicles entering the district during a period with the number entering parking spaces during the same period, to approximate the number (hence the percentage) passing through without parking.

Allowance for the indeterminate small number of "cruisers" and cars being serviced in garages or service stations would reduce the number or percentage of those passing through; but this reduction is offset by the number recorded as parking whose trip origins were within the business district and so not included in the cordon count.

Figure II–3 indicates that as cities grow there is a definite decrease in the proportion of drivers from outside the city who pass through the *city* without parking. Table II–5 shows no significant difference between population groups in the proportion passing through the *business district.* While there is not necessarily a direct connection between the two sets of figures, it is possible that the decreasing proportion of exterior-origin vehicles passing through is offset by a larger number of internal-origins who pass through the central business district. In larger cities many cross-city trips are made from homes on one side to work or to schools on the other side.

Figure II–4 presents graphically, for one city in the 100,000–250,000 population group, the destinations of traffic entering the city, and of traffic entering the central business district.

The significance of Table II–5 is that notwithstanding the city's size, more than half the vehicles passing through the central business district have no purpose there other than to reach the other side. During the afternoon traffic peak a still larger proportion passes through without parking.

A large proportion of this through-traffic could be diverted around the district, to its own advantage and that of the district. It is evident that the need for this area is not for bypasses around the city but for an inner belt or bypass outside the business district.

In the same population groups, central business district through-traffic varies. Cities having the following characteristics are likely to have a smaller proportion of through-traffic:

1. Where the central business district is on the coast or a body of water without access to bridges, or at a dead-end. As an example, Key West, Florida can have little through-traffic.

2. Where a by-pass has been provided around the central business district.

3. Where the city is isolated in sparsely settled territory, remote from other cities. Many motorists who normally would go through stop for meals or rest.

4. A state capital, university city, or sightseeing center.

5. Where the city is a retail and wholesale trade center or a county seat in an agricultural area.

Cities can expect a larger proportion of through-traffic:

1. Where the location is at the hub of a network of roads, with U.S. numbered routes and other principal state highways passing through the central business district.

2. Where the city is on a river with bridges in the business district.

3. Where the location is in a valley in mountainous country.

4. Where the city is near a larger city and on a direct route between two larger cities less than one hundred miles apart.

Supply of Parking Space

Tables II–6 and II–7 and Figure II–5 furnish data on the supply of parking space in the central business districts of several population groups; Tables II–8 and II–9, data on curb footage and its availability for parking.

Table II–6

SUPPLY OF PARKING SPACES

Population group	*Number of cities*	*Average number of parking spaces**				
		Curb	*Lot*	*Garage*	*Off-street*	*Total*
5,000–10,000	2	710	87	0	87	797
10,000–25,000	18	1,012	613	54	667	1,679
25,000–50,000	16	1,598	983	121	1,104	2,702
50,000–100,000	5	3,018	1,687	380	2,067	5,086
100,000–250,000	13	2,475	2,350	728	3,078	5,553
250,000–500,000	8	3,324	6,760	1,849	8,609	11,933
500,000–1,000,000	4	2,933	6,564	3,834	10,398	13,331
Over 1,000,000	3	3,335	14,785	5,457	20,242	23,577
TOTAL	69					

* Excluding permit spaces, loading zones, and taxi stands.

Table II–7

RELATION OF PARKING SPACE SUPPLY
TO AREA OF CENTRAL BUSINESS DISTRICT AND TO POPULATION

Population group	Number of cities	Average number of parking spaces* per		
		1,000 Population	Square Mile	Square mile per 1,000 population
5,000–10,000	2	93	10,800	1,357
10,000–25,000	18	94	13,300	761
25,000–50,000	16	76	13,600	382
50,000–100,000	5	64	15,600	205
100,000–250,000	13	38	14,800	100
250,000–500,000	8	31	20,600	56
500,000–1,000,000	4	24	25,100	45
Over 1,000,000	3	18	23,000	18
TOTAL	69			

* Excluding permit spaces, loading zones, and taxi stands.

In cities with more than 10,000 population, curb spaces are insufficient to accommodate all vehicles demanding space, and as a city grows from 50,000 to more than a million population, its business district gains practically no curb spaces.

Comparison of smallest and largest cities reveals that the footage of curb space increases sixteen times, but the part available for curb parking (only 62 percent even in small cities) is gradually taken over by truck loading zones, bus stops, taxi stands and building entrances—as well as by fire hydrants, crosswalks, and "no parking" zones—until, in the large cities, only 30 percent is left for parking.

In the meantime, with the curb entirely unable to carry the parking load, lots appear and later garages. Table II–6 shows that while curb spaces do not increase appreciably as cities grow beyond the 50,000 population, lot and garage space increases steadily, but at a much slower rate than the population. This is reflected in Figure II–5, indicating that the space supply per capita declines rapidly.

Thus, as shown in Table II–10 and Figure II–6, the proportion of curb space to the total supply of space decreases with increasing population. In the largest cities, curb spaces are only 16 percent

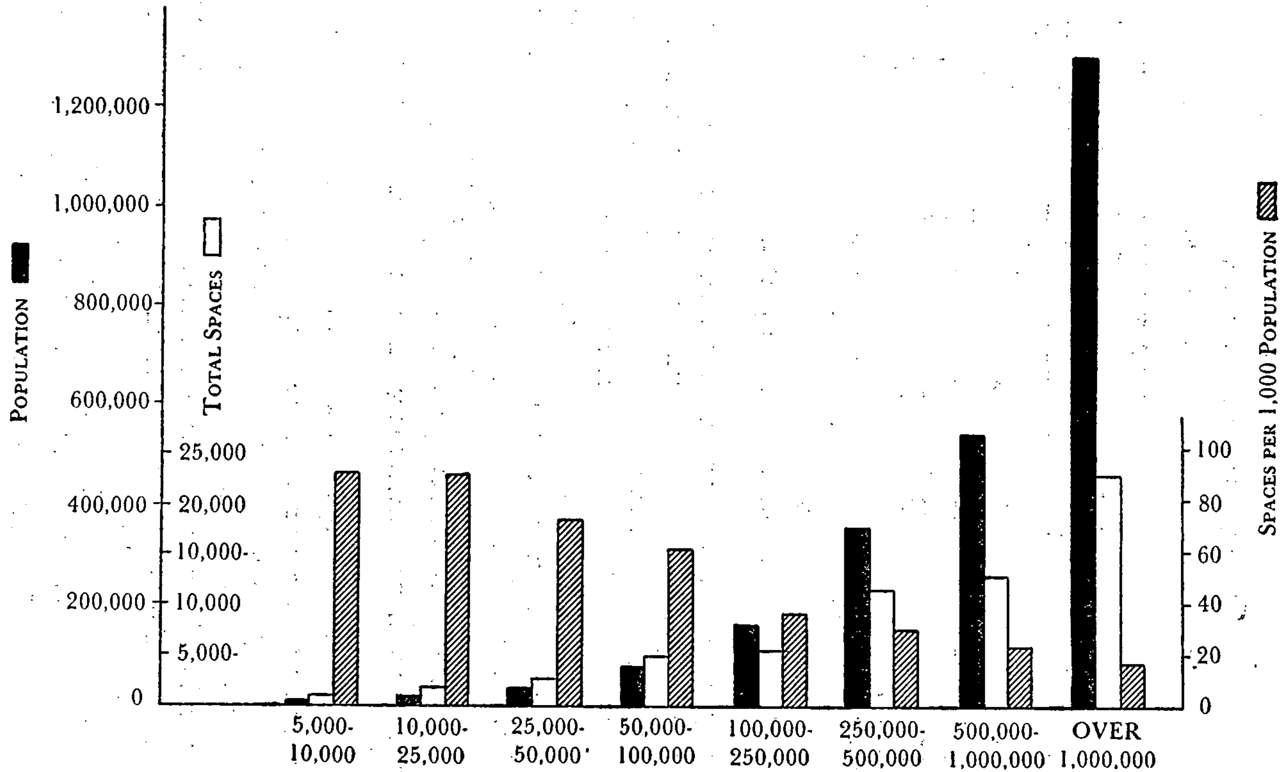


FIGURE II–5. Population, number of parking spaces and number per 1,000 population.

Table II–8

PHYSICAL CHARACTERISTICS OF THE CENTRAL BUSINESS DISTRICT

Population group	*Number of cities*	*Area of central business district (Square Miles)*	*Total ground area occupied by all parking facilities (Square Miles)*	*Percent of total central business district ground area occupied by*					*Total length of curb (Miles)*	*Percentage of street area occupied by curb parking space*
				Curb parking spaces	*Lots*	*Garages*	*All parking facilities*	*Streets*		
5,000–10,000	2	0.09	0.01	5.8	1.2	0.0	7.0	31	3.4	18
10,000–25,000	13	.12	.01	5.6	3.0	0.2	8.8	32	5.7	18
25,000–50,000	11	.18	.02	5.2	3.2	0.4	8.8	31	8.4	17
50,000–100,000	2	.29	.03	5.9	3.7	0.5	10.1	28	15.8	21
100,000–250,000	12	.37	.03	3.9	4.4	0.6	8.9	27	17.3	15
250,000–500,000	3	.54	.06	4.6	6.2	0.7	11.5	29	24.8	16
500,000–1,000,000	4	.53	.08	3.5	9.2	2.2	14.9	31	29.6	11
Over 1,000,000	3	.98	.13	2.1	10.3	1.7	14.1	25	54.4	8
TOTAL	50							29		

Table II–9

CURB SPACE LIMITATION AND USAGE

Population group	Number of cities	Ratio of the maximum number of vehicles parked* to the total number of public curb spaces	Number of cities	Total length of curb	Percentage of curb space used for			
					Public parking	*Special parking***	*Prohibited parking****	*Truck loading zones*
5,000–10,000	2	0.8	2	17,900	62	3	35	2
10,000–25,000	17	1.2	5	24,400	60	4	36	2
25,000–50,000	16	1.2	4	42,700	60	5	35	2
50,000–100,000	5	1.5	3	104,000	58	7	35	3
100,000–250,000	13	1.7	4	78,600	57	9	34	3
250,000–500,000	7	2.7	4	150,200	43	12	45	6
500,000–1,000,000	5	4.6	2	156,400	38	11	51	6
Over 1,000,000	3	7.5	1	287,100	30	18	52	11
TOTAL	68		25					

* At all parking facilities, at one instant.
** Special parking includes truck loading zones, bus zones, theater and hotel entrances, special permit spaces and taxi stands.
*** Prohibited parking includes curb space at fire hydrants, driveways, entrances (other than at theaters and hotels), corner clearances, crosswalks, and curb with "no parking permitted" signs.

Table II–10

PERCENTAGE DISTRIBUTION OF AVAILABLE SUPPLY OF PARKING SPACES

Population group	Number of cities	Percentage of total parking spaces* at			
		Curb	Lot	Garage	Offstreet
5,000–10,000	2	88	12	0	12
10,000–25,000	18	64	32	4	36
25,000–50,000	16	61	35	4	39
50,000–100,000	5	55	38	7	45
100,000–250,000	13	44	42	14	56
250,000–500,000	8	30	54	16	70
500,000–1,000,000	4	23	51	26	77
Over 1,000,000	3	16	60	24	84
TOTAL	69				

* Excluding permit spaces, loading zones, and taxi stands.

of the total, but nevertheless (as will be shown) accommodate half of all the parkers.

Garage spaces are relatively rare until cities reach 100,000 population. In the largest cities they provide one-quarter of the space supply, but handle only 12 percent of the parkers.

Parking Volumes

As cities increase in population, more traffic generators appear outside the central business district; mass transit develops, and, as a consequence, private cars are used less and less, per capita, for going to the central business district. Table II–11 points out that while the population increased 163 times, the total number of vehicles parking from 10 A.M. to 6 P.M. increased seventeen times, but the number parking per capita was only one-ninth as many.

Parking Accumulation

While the total number parking from 10 A.M. to 6 P.M. grew seventeen times, the peak accumulation of parked vehicles increased fifty-one times. The average vehicle parks much longer and the average turnover is much lower in the large cities, which means that more parking acts overlapped each other, hence the larger accumulations. There is little difference between popula-

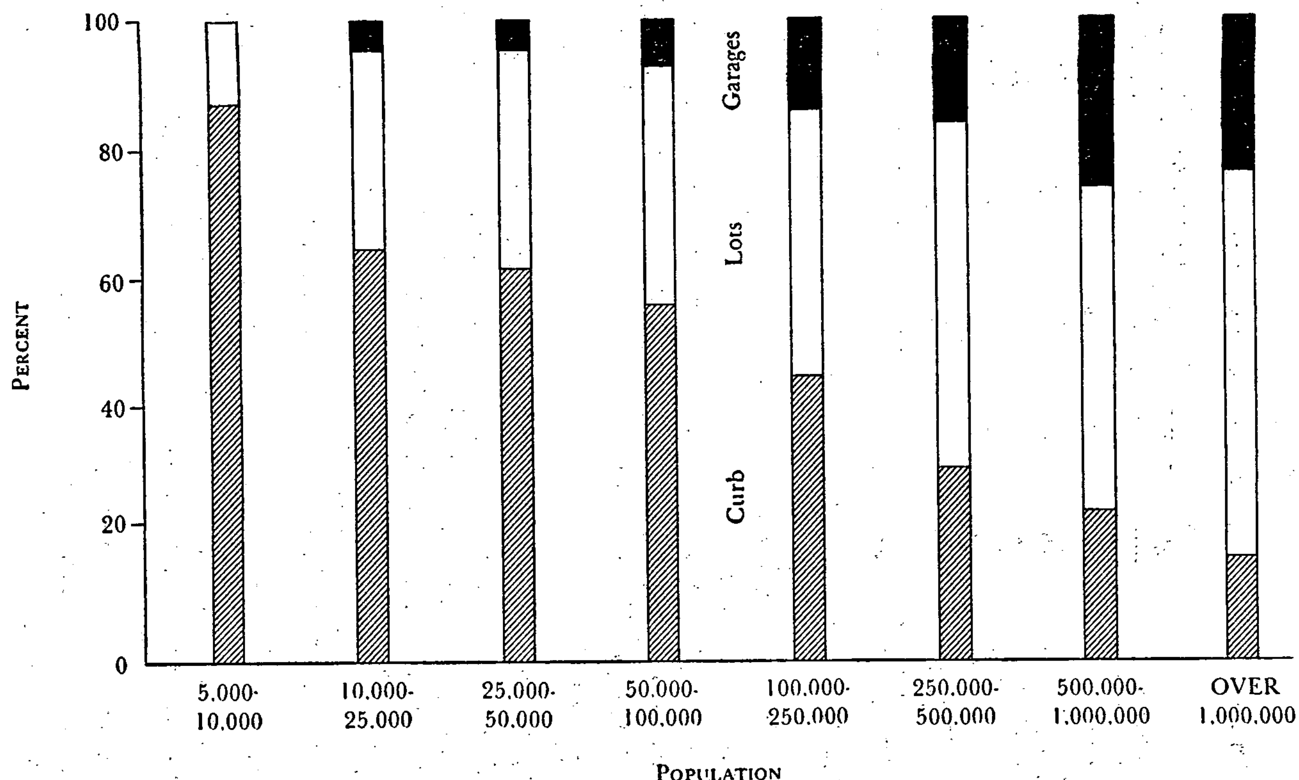


FIGURE II–6. Percentage distribution of parking spaces.

Table II–11

NUMBER OF VEHICLES PARKED 10 A.M.–6 P.M. AND PARKING ACCUMULATION

Population group	Number of cities	Average number of vehicles parked[1] Total	Per 1,000 population	Number of cities[2]	Vehicle parking accumulation Average	Peak[3]	Ratio of peak to average
5,000–10,000	2	3,500	413	2	450	490	1.10
10,000–25,000	17	7,940	449	14	1,038	1,180	1.14
25,000–50,000	16	11,860	340	15	1,720	1,950	1.14
50,000–100,000	5	23,600	293	5	3,990	4,450	1.12
100,000–250,000	13	20,670	134	10	3,660	4,130	1.13
250,000–500,000	7	34,810	99	7	7,920	9,140	1.16
500,000–1,000,000	5	41,260	75	3	12,070	13,590	1.13
Over 1,000,000	3	58,640	44	2	21,680	25,160	1.16
TOTAL	68			58			1.14

[1] Including 10 A.M. inventory of parked vehicles.
[2] The same cities upon which Figure 7 is based.
[3] Represents the average of the peaks in the cities of each population group and varies somewhat from the composite peaks shown in the accumulation curves in Figure II–7.

tion groups in the peak and average parking accumulations, the peak amounting to 14 percent more than the average.

Since the peak parking accumulation grows faster than the area of the central business district (fifty-one times as compared to eleven times), the peak density triples and becomes as high as 23,000 per square mile (Table II–12). If to this is added the number of vehicles in motion on the streets, the total is enough to fill nearly 12 percent of the ground area of the central business district in the large cities.

Figure II–7 is based on fifty-eight cities and shows the parking accumulation from 8 A.M. to 6 P.M. and parking spaces available in the average city of each population group. In every group the number of spaces exceeds the number of vehicles parked at any one time, but as will be pointed out later, an apparent excess of space does not necessarily mean that no more parking spaces are needed.

Table II–12

PEAK PARKING ACCUMULATION

Population group	Number of cities	Peak parking accumulation* Total***	Peak parking accumulation* Per Sq.Mi. of central business district	Peak parking accumulation* Per 1,000 population	Percentage of all vehicles parked between 10 A.M. and 6 P.M. present at the** Average moment	Percentage of all vehicles parked between 10 A.M. and 6 P.M. present at the** Peak moment of parking accumulation
5,000–10,000	2	490	7,160	59	13	14
10,000–25,000	16	1,170	9,270	63	13	14
25,000–50,000	16	1,900	9,540	54	14	16
50,000–100,000	5	4,450	13,350	55	16	18
100,000–250,000	13	4,310	11,240	28	18	21
250,000–500,000	7	9,140	15,390	25	22	26
500,000–1,000,000	5	11,260	23,290	21	24	28
Over 1,000,000	3	21,200	20,980	16	31	36
TOTAL	67					

* Passenger cars and trucks.
** Includes vehicles parked at 10 A.M.
*** Based on 67 cities. Those in Table 11 are based on only 58 cities.

In the smaller cities the accumulation curves show peaks at about 11 A.M. and 3 P.M., with a dip during the noon hour, undoubtedly due to the use of cars during the lunch period. For population groups under 500,000, there was relatively little fluctuation in the accumulation between 10 A.M. and 4 P.M., but in larger cities the pattern is different, with the daily peak accumulation around 1 P.M.

Type of Parking Used

Table II–10 gives data on the division of parking space at the curb and in lots and garages. Table II–13 shows the corresponding distribution of parked vehicles, a quite different pattern, because parking durations increase and turnover rates decrease as cities grow. In the smallest cities, 93 percent of the parking is at the curb and there are no garages; in the largest cities 50 percent park at the curb and 12 percent in garages.

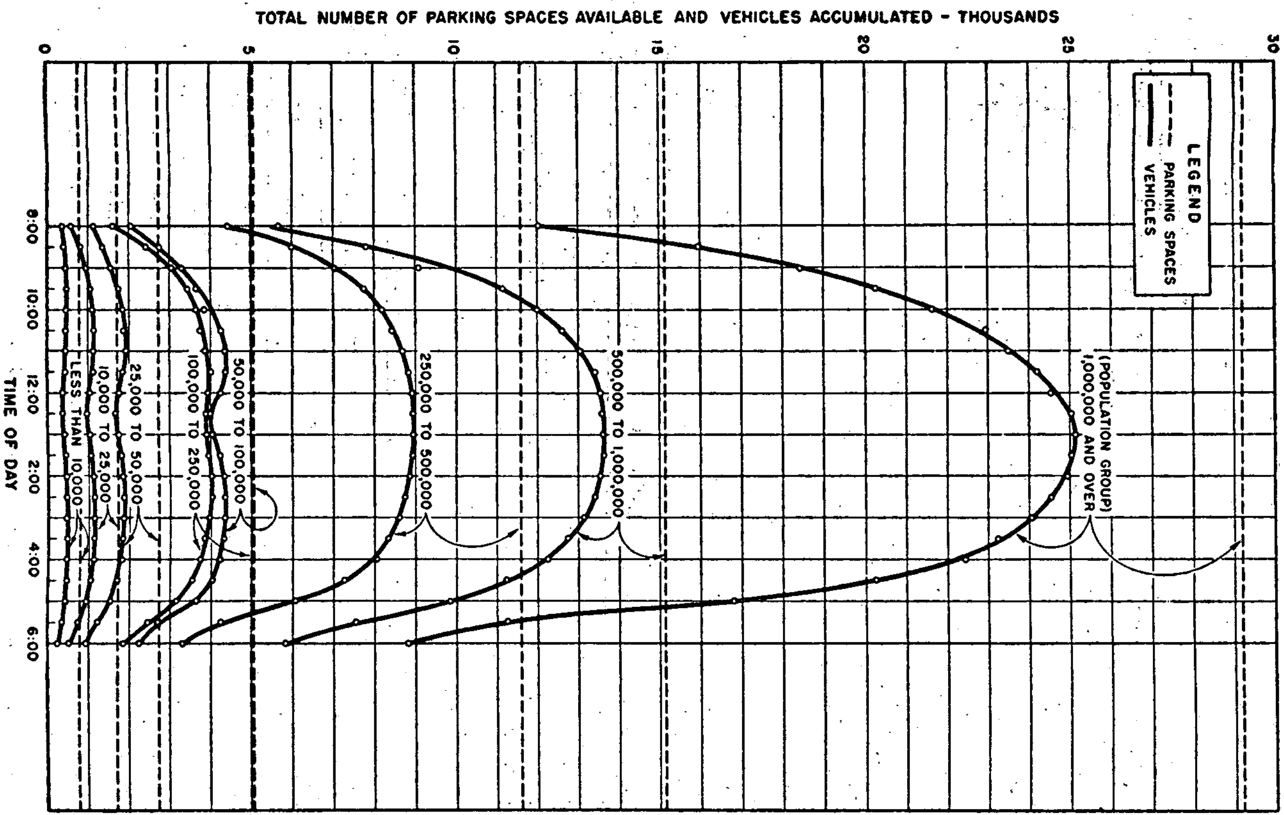


FIGURE II–7. Time distribution pattern of vehicle parking accumulation by half-hour periods 8 a.m.–6 p.m. and the corresponding number of parking spaces available.

Table II–13

PERCENTAGE DISTRIBUTION OF PARKERS BY TYPE OF PARKING

Population group	Number of cities	Type of parking used			
		*Curb**	*Lot*	*Garage*	*Offstreet*
5,000–10,000	2	93	7	0	7
10,000–25,000	17	85	14	1	15
25,000–50,000	16	84	15	1	16
50,000–100,000	5	79	19	2	21
100,000–250,000	11	76	20	4	24
250,000–500,000	7	66	28	6	34
500,000–1,000,000	5	63	26	11	37
Over 1,000,000	3	50	38	12	50
TOTAL	66				

* Including illegal parkers.

Truck Parking

Table II–14 shows that in all population groups trucks comprise about 15 percent of all the vehicles that park between 10 A.M. and 6 P.M., but that they form only about 7 percent of the vehicles parked at any one time. The average parking duration for trucks is usually quite short, less than half that for the average passenger car. Hence there is less overlapping of individual truck parkings and a lower accumulation.

Table II–14

PERCENT COMMERCIAL VEHICLES PARKED

Population group	Number of cities	Percent of commercial vehicles	
		*Parking-in**	*Average parking accumulation*
Under 25,000	9	15	9
25,000–50,000	12	14	8
50,000–100,000	4	13	7
100,000–250,000	11	13	6
250,000–500,000	7	15	5
Over 500,000	4	17	6
TOTAL	47	15	7

* Includes 10 A.M. inventory of parked vehicles.

Demand for Parking Space

The comprehensive parking studies which provided the data in this chapter, included a record of where each driver parked, how long he parked, and his destination after parking. Thus it was possible to determine the demand for every block in the central business district, both in number of vehicles and in space-hours needed.

Comparison of the number of parkers over a period and the number of spaces does not permit an evaluation of usage. For example, the fact that thirty vehicles were parked in an eight-hour period in a lot having twenty spaces does not give any measure of the extent to which those spaces were used. If each of the thirty vehicles parked for only ten minutes, the usage would be very small; if each parked for five hours, the lot would be practically full all day long.

It is necessary, therefore, to compare supply and demand in terms of space-hours. Thus, in the example given above, the space supply was 160 space-hours, the thirty vehicles parking for ten minutes each would use five space-hours, while each parked for five hours would use 150 space-hours.

Supply and Demand in the Central Business District

Table II–15 compares, in space-hours, the supply of parking space in the central business district with the demand. This demand is that expressed by those drivers who actually parked downtown, and does not include the potential demand of those who stayed away, parked elsewhere, or who would park downtown if conditions were more to their liking.

The total demand increases as the population increases, but at a very much slower rate, as shown by the decline in per capita demand. The larger cities, with mass transit available, have many attractions outside the central business district.

In every population group there is an apparent excess of parking space in the central business district as a whole. The actual excess or surplus, however, is not as large as it appears to be. Because of the time used by vehicles entering and leaving spaces,

Table II–15

DEMAND FOR AND SUPPLY OF SPACES

Population group	Number of cities	Supply, space hours	Demand, space-hours: Number*	Demand, space-hours: Per 1,000 population
5,000–10,000	2	6,376	3,600	426
10,000–25,000	17	13,200	7,970	451
25,000–50,000	16	21,400	13,430	372
50,000–100,000	5	39,970	31,880	397
100,000–250,000	13	44,200	30,520	189
250,000–500,000	7	94,960	63,340	175
500,000–100,000	5	104,740	79,670	145
Over 1,000,000	3	185,510	146,660	112
	68			

* Adjusted to a 10 A.M. to 6 P.M. basis.

the time spaces are empty until parkers find them, and because the arrival rate is not uniform throughout the day (see Figure II–7), it is not possible to get 100 percent use of the space-hours theoretically available.

Studies in many cities indicate that rarely, even in the presence of heavy demand, have any curb spaces, lots or garages achieved better than 85 percent usage of their theoretical capacity. It is necessary, accordingly, to discount the apparently available supply. Also, while the space-hours shown represent existing spaces, many of these are in private lots or garages restricted to the use of certain persons or groups, so that any vacant space in them is not available to the general public.

In five of the cities studied, the number of parkers at the peak parking accumulation exceeded the number of parking spaces available—possible only through a large number of drivers parking double, at fire hydrants, or in other illegal places.

The actual surplus of space in the average city of each population group refers to the central business district as a whole, and does not necessarily mean that no additional spaces are needed. As cities grow, the central business district spreads out until, in cities of a million population, it has an area of a square mile or more, and the distance from the center to the outer edge of the downtown area may be half a mile or more.

Ground space in the core is almost entirely preempted by department stores, retail shops, banks, office buildings and other uses normally found where land values are highest. Rarely are many parking facilities available in the center of the core and, equally logically, and ironically, the farther one goes from the core, the more easily is parking space found. Near the outer edges of the central business district there is more space than is needed. But this surplus, unfortunately, is much too far from the center of demand to attract drivers bound for destinations many blocks away. Most business districts have enough parking space, but not where it is needed.

Supply and Demand in the Core

It is the presence of retail stores, banks, and office buildings in the core that causes the high land values which prevent the establishment of parking facilities, and at the same time generates the demand for them.

Although the core of large cities occupies only about one-fifth of the CBD area and about a tenth of its parking spaces, it is the destination of three-fourths of all the shopper-parkers. This is emphasized by Table II–16, showing that in cities of more than 500,000 population the demand for parking space in the core is four times the available supply.

Table II–16

SUPPLY AND DEMAND IN THE CORE

Population group	*Number of cities*	*Demand, space-hours*	*Supply, space-hours*	*Ratio: demand to supply*
Under 25,000	17	3,930	3,050	1.4
25,000–50,000	15	7,040	4,280	1.6
50,000–100,000	4	22,670	11,730	2.0
100,000–250,000	13	14,460	8,850	1.8
250,000–500,000	7	37,400	19,950	2.2
500,000–1,000,000	4	45,500	11,040	4.5
Over 1,000,000	3	83,380	22,940	3.8

63

Space Deficiency in the Central Business District

It was the practice in the comprehensive parking studies to compare demand and supply block by block, with consideration given to acceptable walking distances. These vary from 300 feet in the small cities to 800 feet or more in the cities with more than a million population. On that basis it was possible to determine the location and extent of space shortages and to make recommendations for the addition of needed spaces.

Table II–17 shows, for the average city of each population group, the number of additional spaces recommended in the study reports, usually including a small allowance for the additional demand expected to be generated by the provision of better parking facilities.

Table II–17

NUMBER OF ADDITIONAL PARKING SPACES RECOMMENDED IN REPORTS OF PARKING STUDIES

Population group	*Number of cities*	*Number of additional parking spaces recommended**
5,000–10,000	2	70
10,000–25,000	15	157
25,000–50,000	14	350
50,000–100,000	5	826
100,000–250,000	12	830
250,000–500,000	8	2,287
500,000–1,000,000	4	3,265
Over 1,000,000	2	6,404
TOTAL	62	

* As reported at the time of the study.

Walking Distances in Parking

The location of additional spaces is of primary importance, and in any decision on location the factor of walking distance is introduced. Indeed, if walking distance is not a factor, then there is no parking problem in any city, for space can always be found by walking far enough.

Tables II–18, II–19 and II–20 give data on the walking habits of parkers. It is clear that the distances people walk after parking their vehicles become larger as the population increases. In cities under 25,000 population the average distance was only 223 feet and 77 percent of the parkers walked less than one block. In the largest cities the average distance was 549 feet and only 45 percent walked less than a block.

Table II–18

DISTANCE WALKED FROM PARKING PLACE TO DESTINATION

Population group	Number of cities	Percentage of parkers walking* less than 350 feet	750 feet	1150 feet	1550 feet	over 1550 feet	Average distance walked feet
Under 25,000	17	77	94	98	99	1	223
25,000–50,000	16	76	92	97	99	1	293
50,000–100,000	5	68	88	95	98	2	353
100,000–250,000	13	63	85	93	97	3	397
250,000–500,000	6	58	79	89	95	5	502
500,000–1,000,000	5	57	80	91	95	5	523
Over 1,000,000	3	45	68	81	89	11	549
	65						

* Passenger cars and trucks.

Table II–19

AVERAGE DISTANCE WALKED FOR VARIOUS TRIP PURPOSES

Population group	Number of cities	Average distance walked for Work	Business	Shopping	Sales and service
		Feet	Feet	Feet	Feet
Under 25,000	2	–	–	234	226
25,000–50,000	3	408	297	295	216
50,000–100,000	4	483	327	391	218
100,000–250,000	4	539	416	539	221
250,000–500,000	3	728	606	824	415
Over 500,000	3	698	528	656	419
TOTAL	19	571	435	489	286

Table II–20

AVERAGE DISTANCE WALKED BY LENGTH OF TIME PARKED

Average distance walked in feet for each length of time parked

Population group	*Number of cities*	*Less than 15 minutes*	*15–29 minutes*	*30–59 minutes*	*1–2 hours*	*2–3 hours*	*3–4 hours*	*4–5 hours*	*5–6 hours*	*6–7 hours*	*7–8 hours*	*8 hours and over*	*All parkers*
Under 25,000	2	195	220	248	291	328	347	337	253	244	278	327	233
25,000–50,000	3	244	298	330	371	408	407	411	386	383	416	386	303
50,000–100,000	4	238	304	374	425	471	523	532	592	587	661	623	369
100,000–250,000	4	276	403	491	552	598	606	592	591	610	580	480	440
250,000–500,000	3	392	526	580	688	768	801	747	767	766	828	787	614
Over 500,000	3	350	451	508	571	633	673	677	694	729	778	646	560
TOTAL	19												

This difference is intensified when it is realized that in small towns practically all parking is free, while in the largest cities about 47 percent of all parkers (curb and off-street) pay for the privilege.

Motorists parking for sales and service walk shorter distances than those having other purposes. Workers walk the longest distances, but no conclusive trends appear, in part because sharp distinctions cannot be drawn between trip purposes. One man whose job is reading meters, for example, may consider his purpose as "service," while another on the same job might class it as "work" since he earns his living that way; a third might call it "business."

Table II–20 indicates that parkers tend to accept greater walking distances as their parking durations increase, although that trend is less distinct for durations of more than four hours. It is a logical conclusion that parking facilities intended primarily to serve short-time parkers such as shoppers, should be located within one to two blocks, depending upon the size of the city.

Table II–21 summarizes data on average walking distances by population groups for parkers using the several types of parking facilities.

1. Illegal parkers have the shortest average walking distance, particularly in the larger cities.

2. Since free off-street spaces are usually those provided by parking generators on their own or adjacent properties, for use by their tenants or customers, these afford the lowest walking distances of the legal spaces.

3. Since the most-centrally located curb spaces are usually metered, the meter parkers usually walk shorter distances.

4. It is perhaps commonly believed that the patrons of commercial or pay lots and garages, since they pay for the privilege, will not walk as far as other parkers. Actually they walk much farther. It may seem incongruous that off-street pay-parkers walk farther than free curb parkers, but this is probably because most of the curb space (in the central business district) has time restrictions, and those requiring more time must park off-street.

5. A common misconception is that walking distance summaries show how far people *will* walk, whereas the summaries actually represent only how far parkers did walk or had to walk under the existing circumstances. The matter of *acceptable* walking distances is discussed in the chapter on off-street parking.

Table II–21

AVERAGE WALKING DISTANCES FROM VARIOUS TYPES OF FACILITIES

Population group (urban area)	Number of cities	Curb			Off-street			All legal curb and off-street	Illegal curb	All parkers	Percent illegal	Percent using pay off-street
		Free	*Pay*	*Legal*	*Free*	*Pay*	*All*					
Under 25,000 (Average 13,332)	4			215	158		158	208	139	201	11.2	
25,000–50,000 (Average 33,388)	8	421	306	338	266	491	315	311	184	285	8.0	3.9
50,000–100,000 (Average 82,083)	3	454	307	354	255	588	358	355	202	344	6.2	5.2
100,000–250,000 (Average 164,545)	6	428	387	395	283	660	521	438	192	426	7.0	8.9
250,000–500,000 (Average 399,043)	4	482	527	512	365	851	715	614	270	581	9.3	29.9
Over 500,000 (Average 880,145)	7	612	516	543	352	799	720	621	204	564	13.6*	24.8

* 19.4 for cities over a million population.

Trip Purposes of Parkers

Replies of parkers as to trip purpose were the basis of data in Table II–22. The proportion of shopper-parkers decreases with the city's growth because of the development of neighborhood and other shopping centers. The proportion of worker-parkers increases, partly from the greater use of private cars by workers moving to the suburbs. The greater proportion of workers contributes to the longer average parking durations.

Table II–22

TRIP PURPOSE

Population group	*Number of cities*	*Percentage distribution of parkers* for*			
		Shopping	*Business*	*Work*	*Other*
5,000–10,000	2	27	32	15	26
10,000–25,000	16	33	30	16	21
25,000–50,000	16	29	32	17	22
50,000–100,000	4	30	30	17	23
100,000–250,000	13	25	38	16	21
250,000–500,000	8	17	42	23	18
500,000–1,000,000	5	18	44	22	16
Over 1,000,000	3	13	31	41	15
TOTAL	67				

* For passenger cars and trucks with known trip purposes.

Parking Durations

Table II–23 shows the length-of-time-parked habits of parkers using all types of facilities, its especial significance being that from 40 to 74 percent of parkers park for less than one hour.

From Table II–24 is seen that as cities grow, the average length of time parked increases, no matter what the trip purpose of the parker may be. The shortest durations result from parkers on sales and service calls; stops for shopping and business calls average slightly under an hour, and parking-time of workers is the longest.

In small towns a trip downtown often requires no more than a few minutes, and parking is simple; many trips are made on

Table II–23

LENGTH OF TIME PARKED

Population group	*Number of cities*	*Percentage parked** Less than *15 minutes*	*30 minutes*	*1 hour*	*2 hours*	*3 hours*	*3 hours and over*
5,000–10,000	2	47	58	74	84	88	12
10,000–25,000	16	43	58	74	85	89	11
25,000–50,000	16	40	56	71	82	87	13
50,000–100,000	5	34	51	68	81	85	15
100,000–250,000	12	29	47	63	77	83	17
250,000–500,000	6	24	39	55	70	77	23
500,000–1,000,000	5	20	34	54	69	75	25
Over 1,000,000	3	13	28	40	55	64	36
TOTAL	65						

* At curb and off-street. For passenger cars and trucks with known parking durations.

Table II–24

AVERAGE LENGTH OF TIME PARKED FOR VARIOUS TRIP PURPOSES

Population group	*Number of cities*	*Average length of time parked in hours* for* *Shopping*	*Business*	*Work*	*Sales and service*	*Other*	*All*
5,000–10,000	2	0.5	0.5	2.8	0.5	0.7	1.0
10,000–25,000	14	.6	.6	3.1	.6	.9	1.1
25,000–50,000	16	.6	.7	3.4	.6	1.0	1.3
50,000–100,000	5	.7	.7	3.8	.6	1.1	1.4
100,000–250,000	13	1.0	.9	3.8	.5	1.3	1.6
250,000–500,000	6	1.3	1.1	4.8	.7	1.4	1.9
500,000–1,000,000	4	1.3	1.3	4.8	1.0	1.4	2.2
Over 1,000,000	3	1.8	1.5	5.6	1.0	1.9	3.0
TOTAL	63	0.98	0.91	4.1	0.69	1.2	1.8

* Passenger cars and trucks.

impulse, perhaps several trips a day. As cities increase in size, the drive becomes longer and parking more of a problem; as a result fewer trips are made and more is accomplished on each trip.

The influence of the type of facility on parking durations is shown in Table II–25. The average stay at the curb is of course

Table II–25

AVERAGE LENGTH OF TIME PARKED AT VARIOUS TYPES OF PARKING FACILITIES

Population group	*Number of cities*	*Length of time parked in hours* at*				
		Curb	*Lot*	*Garage*	*Offstreet*	*All spaces*
Under 25,000	17	0.9	2.1	5.2	2.2	1.1
25,000–50,000	15	1.0	2.5	4.3	2.6	1.2
50,000–100,000	5	1.1	2.5	5.1	2.7	1.4
100,000–250,000	12	1.0	3.2	4.9	3.5	1.6
250,000–500,000	8	1.1	3.7	4.5	3.9	2.1
500,000–1,000,000	5	1.0	4.0	4.5	4.4	2.1
Over 1,000,000	3	1.3	4.5	4.6	4.5	2.9
TOTAL	65	1.1	3.2	4.7	3.4	1.8

* Passenger cars and trucks.

much shorter than the durations off-street, both because the curb is the most attractive to short-time parkers and because a large proportion of the curb space is restricted to short-time parking.

Population has little influence on length of time parked at curbs or in garages; but at lots the average durations definitely increase as the city enlarges. Curb durations are held down by restrictions, and it appears that as cities grow and greater numbers of parkers require more than an hour, those needing from one to three hours prefer lots, leaving the garages for the long-time parkers.

Duration habits of *curb* parkers are summarized in Table II–26, which also shows the average turnovers. By applying the turnover figures for each time-restriction group, it is possible to determine the percentage distribution of spaces needed to serve these parkers, discussed in Chapter IV.

Turnover in the Use of Parking Space

Turnover is the rate of usage of a facility. It is the number of vehicles parking in a stated time divided by the number of stalls. In this chapter the turnover period is the eight hours from 10 A.M. to 6 P.M.

In every population group the curb spaces have the highest turnover, lots next, and garages lowest, with curb turnover three

Table II–26

PARKING DURATIONS OF CURB PARKERS

Population group	Number of cities	Percentage parked at curb for: Less than 15 minutes	15–30 minutes	30–60 minutes	1–2 hours	2–3 hours	Over 3 hours	Total
Under 25,000	18	47	16	16	10	3	8	100
25,000–50,000	16	45	16	16	11	4	8	100
50,000–100,000	5	40	19	17	12	4	8	100
100,000–250,000	11	36	20	19	13	4	8	100
250,000–500,000	7	35	19	20	13	4	9	100
Over 500,000	7	27	22	23	15	5	8	100
TOTAL	64	38	19	19	12	4	8	100
Average turnover		27	14	10	9	3.4	1.6	

times that of off-street. Table II–27. As population increases, turnover at all facilities decreases.

Shopper Parkers

While populations increased eighty-six times, parking spaces increased twelve and a half times, and the number of all parkers grew eight times. Yet according to Table II–28, the number of

Table II–27

TURNOVER* IN THE USE OF PARKING SPACE

Population group	Number of cities	Turnover at: Curb	Lot	Garage	Offstreet	Total
Under 25,000	17	5.7	2.3	0.9	2.1	4.3
25,000–50,000	16	5.6	1.9	1.3	1.8	4.1
50,000–100,000	5	5.7	2.2	1.0	2.0	4.0
100,000–250,000	13	5.8	1.6	1.0	1.5	3.3
250,000–500,000	7	5.5	1.5	1.2	1.5	2.6
500,000–1,000,000	4	6.9	1.6	1.2	1.5	2.9
Over 1,000,000	3	4.4	1.7	1.3	1.6	2.0
TOTAL	65	5.7	1.8	1.1	1.7	3.3

* Adjusted to a common 8-hour basis, 10 A.M. to 6 P.M. for passenger cars and trucks. Turnover is the number of legal parkers divided by the number of spaces.

Table II–28

NUMBER OF SHOPPER-PARKERS AND SUPPLY OF PARKING SPACE

Population group	Number of cities	Total number of Shopper-parkers*	Total number of Available parking spaces
Under 25,000	15	2,770	1,890
25,000–50,000	12	3,370	2,850
50,000–100,000	4	5,520	5,900
100,000–250,000	12	4,140	5,210
250,000–500,000	6	5,191	12,010
500,000–1,000,000	4	6,290	13,380
Over 1,000,000	3	5,330	23,580
TOTAL	56		

* Including those already parked at 10 A.M.—includes passenger cars and trucks.

shopper-parkers barely doubled, indicating that after a city reaches 100,000 the number of parkers stabilizes. In larger cities, strong generators of shopping trips—grocery and meat markets—have moved out of the central business district, and shopping centers have provided convenient parking facilities. Another factor is the availability of mass transit in large cities.

Table II–29 presents data usable in planning parking facilities intended primarily for shopper-parkers, by showing the daily peak accumulation, the average half-hourly rate of arrival and the peak rate, and the relation between the total number parked (10 A.M. to 6 P.M.) and the peak accumulation.

In small cities the peak accumulation of shopper-parkers is one-twelfth of the total parking between 10 A.M. and 6 P.M.; in large cities it is one-third of the total; that is, in the largest cities one-third of all the shopper-parkers are present at the peak. This reflects the longer parking duration of shoppers as population increases and also the decreased proportion of shopper-parkers (to all parkers) as cities grow.

According to Table II–30, the parking durations of shopper-parkers increase as the population increases. In the smallest cities 55 percent park for less than fifteen minutes and only 2 percent

Table II–29

SHOPPER-PARKERS: TOTAL NUMBER PARKED 10 A.M. TO 6 P.M.* PEAK ACCUMULATION, AND ARRIVAL RATE INTO PARKING PLACES

Population group	*Number of cities*	*Total number parked 10 A.M. to 6 P.M.*[1]	*Peak accumulation*	*Ratio of total number parked 10 A.M. to 6 P.M. to peak accumulation*	*Number parking-in per half-hour*		
					Average	*Peak*	*Ratio of peak to average*
Under 25,000	10	3,036	259	12	180	249	1.39
25,000–50,000	8	3,719	300	12	220	318	1.46
50,000–100,000	4	5,523	558	10	320	426	1.33
100,000–250,000	5	3,839	544	7	222	293	1.32
250,000–500,000	4	5,055	1,068	5	297	393	1.34
500,000–1,000,000	2	6,331	1,259	5	352	417	1.20
Over 1,000,000	1	5,167	1,555	3	295	473	1.60
TOTAL	34						

* Including those parked at 10 A.M.

Table II–30

LENGTH OF TIME PARKED BY SHOPPERS*

Population group	Number of cities	Less than 15 minutes	Less than 30 minutes	Less than 1 hour	Less than 2 hours	Less than 3 hours	3 hours and over
5,000–10,000	2	55	70	88	96	98	2
10,000–25,000	10	50	69	87	96	98	2
25,000–50,000	14	44	64	82	94	97	3
50,000–100,000	5	37	59	79	92	96	4
100,000–250,000	8	30	51	72	87	93	7
250,000–500,000	7	23	40	61	80	89	11
500,000–1,000,000	5	18	37	59	80	89	11
Over 1,000,000	3	12	26	44	66	80	20
TOTAL	54						

* At all types of parking facilities.

for more than three hours; in the largest cities only 12 percent park for less than fifteen minutes while 20 percent remain longer than three hours.

Illegal Curb Parking

From 10 to 18 percent of all parkers park in illegal places, or, since most illegal parking is done at the curb, 37 percent of all curb parkers in the largest cities. Table II–31. An excessive amount of illegal parking indicates inadequate enforcement, but also, because of excessive walking distances to available space, many parkers prefer to park illegally and assume the risk of being fined.

Curb Characteristics

The curb is in demand by parkers, and in large cities half of all parkers park at the curb. But it cannot accommodate the demand. From Table II–9 it is evident that at the time of peak-parking accumulation in cities of more than a million, there are seven times as many parkers in the central business district as as there are curb spaces.

In small cities 62 percent of the curb footage is available for public parking. But as cities grow, truck and bus loading zones,

Table II–31

ILLEGAL CURB PARKING*

Population group	Number of cities	Percent of all: Curb parkers	Percent of all: Parkers in central business district
5,000–10,000	2	12	10
10,000–25,000	17	12	10
25,000–50,000	16	11	9
50,000–100,000	5	16	12
100,000–250,000	11	14	10
250,000–500,000	7	18	11
500,000–1,000,000	5	16	9
Over 1,000,000	3	37	18
TOTAL	66	17	11

* Passenger cars and trucks combined.

taxi stands, theater and hotel entrances use from 3 to 18 percent of the total. From 35 to 52 percent is taken for fire hydrants, driveways, cross-walks, corner clearances and "no parking" zones. The growth in traffic volumes makes it necessary to prohibit parking on many streets.

Garage Characteristics

Analysis of eighty-eight individual garages operating in twenty-two cities, each garage having a capacity of 100 vehicles or more, and two-thirds of the cities having populations exceeding 250,000, produced the following facts:

Average turnover	1.1
Range of turnover*	0.2 to 2.8
Average occupancy**	60 percent
Range of occupancy	11 to 100 percent
Average parking duration	4.9 hours
Range of parking duration	2.3 to 7.9 hours

* Between 8 or 10 A.M. and 6 P.M.

** The percentage of available space-hours used.

Garages usually cater to long time parkers consequently their turnover is lower than that in lots and at the curb. Most garages, even those with a high degree of occupancy, have unused space, particularly from 8 to 10 A.M. and from 4 to 6 P.M., because of the arrival-pattern of parkers illustrated in Figure II–7.

While examples exist of garages showing 100 percent occupancy (averaging full from 10 A.M. to 6 P.M.), it is accomplished only by crowding in more cars than the garage has spaces—by parking in the aisles and on ramps. The only way a garage could achieve true 100 percent occupancy would be for it to fill up before 10 A.M. with all-day parkers, all of whom remained until 6 P.M., a practical impossibility.

In New York City, one garage which caters almost exclusively to all-day parkers and has a waiting list of monthly-rate applicants, records for a typical day show that the garage's 507 transient spaces were completely filled from 9:15 A.M. until after 4:15 P.M. Of these parkers 63 percent remained for more than eight hours, 86 percent for over four hours; yet for the period from 8 A.M. to 6 P.M. the occupancy was 91 percent.

Parking Fees in Garages

Fee schedules in forty-nine garages having 100 spaces or more, between 1947–1954, in cities from 100,000 to more than 500,000, showed fees as follows:

	Range	*Average*
1 hour	$ .10–.50	$ .29
2 hours	.20–.60	.37
3 hours	.25–.75	.42
4 hours	.25–1.00	.45
Day	.25–2.00	.72
Week	3.50–7.00	4.78
Month	7.50–22.50	13.00

Fees for the first hour tend to increase as population increases; rates for additional hours differ little. The highest rate for the first hour in these garages is fifty cents. In New York City the prevalent fee in 1955 for the first hour was one dollar.

In the twenty years since their first appearance in 1935, parking meters have become an important factor. Chapter V is devoted to the many aspects of their use, including their effectiveness.

CHAPTER THREE

PARKING NEEDS SURVEY

Many cities with a population over 1,000 state their parking problems in "letters to the editor." Somebody "should do something about it," but rarely is there a clear picture of the problem or of what can be done.

Facts are needed. An engineer experienced in traffic and parking matters can usually suggest simple professional recommendations. But without substantiating facts his report and advice may get scant attention.

Many cities have made parking studies, but many have been poorly planned and incomplete. The objective is not the collection of "interesting data," but the determination of facts that clarify the problem and indicate a solution. Whether the city is small or large, the essential elements of needed information are much the same. They are:–

1. The pattern of traffic flow; its fluctuations throughout the day; evidences of congestion.
2. Capacity, location, type and characteristics of existing facilities.
3. Use of existing facilities; parking characteristics of motorists; violations and enforcement; peak concentrations.
4. Location and extent of demand for space and its relation to supply; the influence of large generators of demand; areas of present and future need or deficiency; site availability.
5. Adequacy of existing laws and ordinances.
6. Status of local administrative responsibility.
7. Adequacy of existing signs and markings.
8. Possible financing methods.

A Study Need Not Be Complex

Facts may be obtained by a carefully planned and organized study, neither complex nor expensive. A comprehensive study in a large city may be costly, yet not expensive in terms of information gained and benefits derived.

In a majority of cities, parking is an "orphan child." Every city has agencies or officials responsible for police work, sanitation, fire protection, education, water supply. In few cases is any city department or individual charged with responsibility for providing parking facilities. There is no one whose duty it is to undertake a parking survey; there are many interested and concerned —the driving public, the merchants, the transit company, the truckers—and all agree that something should be done.

Responsibility Must Be Assumed

A study must have a sponsor, either an official commission or agency, a chamber of commerce, board of trade, civic organization or automobile club; and the more who participate and contribute, the greater likelihood that findings of a study will be translated into action. Except for the simple study, a full-time staff is important, though it be only one person. The guidance of an experienced traffic engineer will be of great value, and for comprehensive studies in larger cities, services of such an engineer or specialist are essential in analyzing and interpreting data and preparing recommendations.

The essential elements of a parking survey have been stated and each should be examined in the study of a city. The list of essentials may appear formidable, and for a large city it requires a considerable undertaking in both effort and time. Some of the needed information is simple to obtain; in a city of 10,000 to 20,000, for example, one qualified person should be able in a short time to get complete data on existing local ordinances concerning parking, on the status of local administration of parking, and on adequacy of existing signs and markings.

The important phases from a manpower point of view are the field work steps: counts of traffic volumes, determination of parking-space supply, and then of use and demand. In these statistics the labor is in direct proportion to the city's population and to the activity of its business district. In smaller cities, it is possible for civic organizations to contribute this manpower. The remaining elements of the study include office work, carried out (in smaller cities) with limited assistance.

The scope and conduct of a thorough parking study may best be shown by outlining procedures for a full-scale study in a large city; modified or simplified forms of studies for smaller cities, and finally by certain special-purpose or spot studies designed to meet particular situations.

The Full-Scale or Comprehensive Study

When World War II motor vehicle travel restrictions were removed, city authorities were confronted with increasing problems of congestion and parking. Many inquiries were received by highway and traffic authorities on parking, how to study it, what to do about it.

Although development of parking facilities is not part of the Federal-aid highway program, the close association between terminal points of trips and routes of travel indicates a need for integrated planning of parking facilities and arterial highway routes to achieve their most effective use. The Bureau of Public Roads and state highway departments reviewed several methods and procedures, and after trials, developed a manual for a comprehensive study of central business districts. The Bureau has ruled that funds apportioned to the states for engineering and economic investigations may, at the election of the states, be used in part for parking surveys. These surveys make it possible to study the parking problem on a nation-wide basis and to examine and evaluate procedures, an undertaking hardly feasible for an individual city or state.

Since World War II more than 100 cities, ranging from 7,000 to 1,000,000 population, in 35 states, have made this thorough type of study. The majority of studies have been cooperative projects between the city, state highway department, and the Bureau of Public Roads. In most cases these studies have been initiated by the city's request to the state highway department. Usually half the cost has been met by federal funds, with the city and state sharing the balance and the state providing technical guidance. Often the city's contribution has been shared by local civic organizations. The procedures set forth in the manual are available, and in some cases have been used with no state or federal participation.

Comprehensive or Direct-Interview Procedure

The scope and general procedures may be described as follows:

1. *Supply.* A physical inventory of existing facilities in the central business district, at the curb and off-street, lists their location and capacity (in numbers and space hours), physical features, operating features, regulations, and fee schedules. Included also are data on land use and assessed valuations, as well as areas suitable for additional facilities.

2. *Use.* The driver of practically every vehicle parking in the area is interviewed. Answers to certain questions permit determination of turnover, violation of space and time regulations, and use of loading zones and other special privilege facilities.

3. *Demand.* The information on where drivers park, coupled with their destinations and duration of parking, gives a reasonably accurate measure of where they would like to park and for how long.

4. *Traffic.* A schedule of traffic counts on a cordon surrounding the area determines the volume of traffic entering and leaving the business district and permits an estimate of the by-passable portion. This information is an essential part of a parking study. The parking problem cannot be divorced from that of congestion.

5. *Building Use.* Influence on parking demand of large generators—stores, office buildings, hotels and places of amusement—is important. This can be determined from the data on location of demand.

6. The parking habits of motorists: trip purposes, duration of parking, walking distance to destinations.

7. Adequacy of existing laws and ordinances.

8. Limitations of existing administrative responsibility.

9. Financing methods.

10. Adequacy of signs and markings.

The basic phase of the study — interviews with parkers — is usually confined to the central business district, and the traffic count cordon surrounds the same area. Interviews generally are limited to business hours, 8 or 10 A.M. to 6 P.M., and hence include the peaks of parking accumulation and traffic movement.

Questioning is done by a small crew of trained interviewers and is spread over an appreciable period. This affords operating advantages and produces a composite sample, more representative of an average day. Interviews are made only on weekdays unless Saturdays are believed to be peak days. The cordon count is also a composite sample, spread over the same period as the interviews, and includes continuous machine counts at control stations to permit expansion to 24-hour volumes or other periods.

The actual interview with each driver requires about thirty seconds and includes inquiries to determine trip origin, home address, purpose of the stop, and destination to which he is going to walk. Observed data include parking location, times of arrival and departure, type of vehicle, and whether parking is at an unrestricted curb, a metered space, an illegal place, a fee lot or garage.

Inventory and cordon count data are summarized and tabulated by manual methods. Interview data, because of the number of information items involved and the correlations desired for analysis, are adaptable to machine tabulation. The study of legal, administrative, and financing aspects of the problem is a staff responsibility, properly integrated with findings and recommendations from other phases of the study.

Surveys Furnish Essential Data

The inventory, in tabular and map form, furnishes complete data on number and location of parking spaces at curbs, in lots and garages; classifies them by time and use restrictions and as public spaces, truck loading zones, special permit spaces, taxicab stands, etc., showing fees or rates.

Figure III–1 presents a typical inventory or supply map. It also lists quantitative data on the proportion of curb space not available for parking. A complete inventory will include a reconnaissance of vacant or other areas suitable for developing into additional facilities. This information rarely is a matter of record until such a study is made.

The cordon count shows the distribution of traffic by vehicle type on each street entering the business district for time-of-day

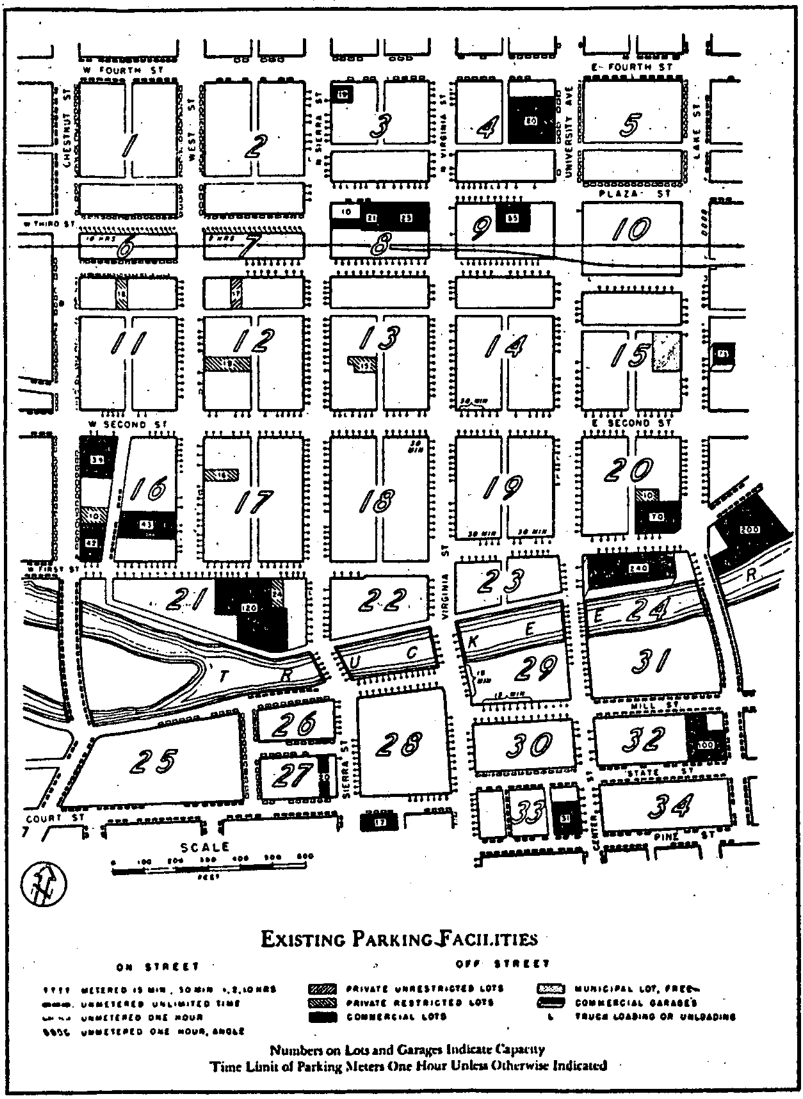


FIGURE III–1. A Typical Inventory Map.

intervals; proportion of entering traffic which parks; proportion of entering traffic which passes through, and the accumulation of parked vehicles in the area at each hour.

Vehicles Entering or Leaving the Central Business District and Vehicles Parked in that Area

Parking and Traffic Data Cover a Weekday Between 10 a.m. and 6 p.m.

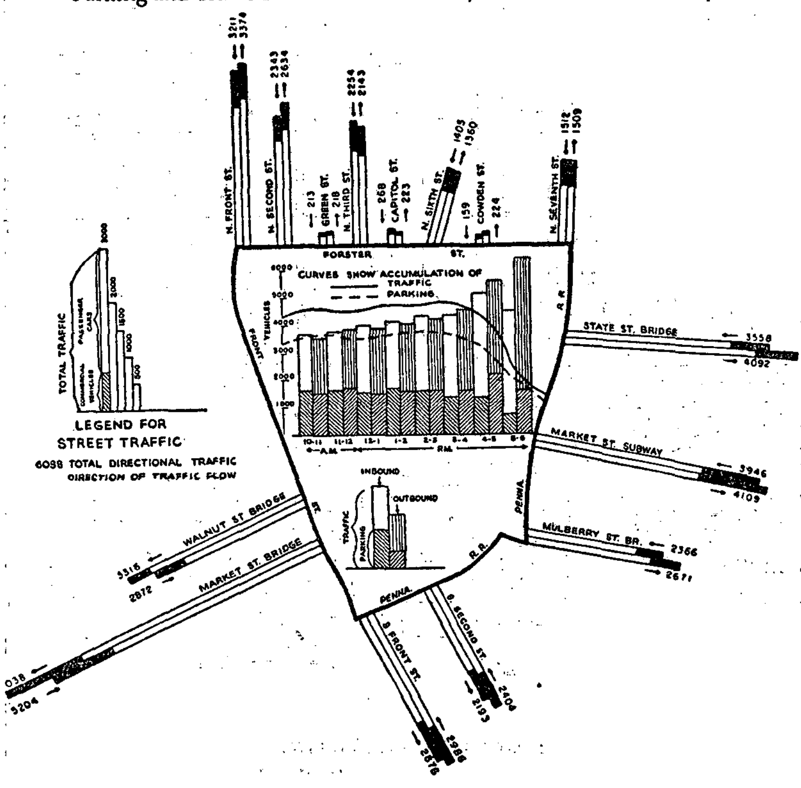


Figure III–2. Traffic Volume Chart.

These data help in determining street capacities and in preparing desire-lines of flow to, from, and within the business district. They are necessary in selecting one-way streets, in planning traffic control signals, and in deciding on partial or entire parking bans on arterial streets. Additional parking facilities must be planned to fit into the traffic pattern, where their influence is important at both morning and evening rush periods.

The cordon count data, in combination with the parking interviews, are useful in determing internal by-pass routes for through-vehicles.

Parking interviews record trip purpose, origin, and ultimate destination of parkers—the location of demand. Figure III–3 shows forms for interviewing parkers. Recorded at the same time, from observation, are the location of parking (including illegal use), and length of time parked. Distances walked by parkers are calculated, and the volume of vehicles is accumulated by half-hourly periods to obtain the total parking load.

The study of legal, administrative, and fiscal considerations reveals present administrative organization and responsibilities, existing fiscal and financial policies, and scope of existing legislation and ordinances. Presented in a series of tabulations, some data have obvious direct significance; others require comparisons, further calculations, analysis, interpretation, and presentation in graphic form.

In a comprehensive study an endeavor is made to interview every person parking in the central business district between 8 or 10:00 A.M. and 6 P.M. Results may average from 3500 interviews in a city of 8,000 to as many as 70,000 in a large city. Since each interview includes some fifteen items, correlation of the data requires machine tabulation procedures.

Data on Demand and Supply

Perhaps the most valuable information is the supply of and demand for parking space in each block of the central business district. Expressed in space-hours rather than in numbers of vehicles, and presented both in map form and figures, these findings show clearly the areas of parking congestion and of surplus space, and permit a quantitative evaluation of deficiencies.

Any determination of spaces required, however, must involve certain basic assumptions; among these, a decision as to the dis-

TRANSPORTATION STUDY
CITY OF ____________
PARKING SURVEY

DATE | NO. OF CARDS
DAY | HOURS

FACILITY NAME
LOCATION

MAP NO.	BLOCK NO.	FAC. NO.

CONTROL ☐	BLOCK ☐☐☐	FACIL. ☐	DAY ☐

INTERVIEWER

CODED BY	DATE
CHECKED BY	DATE

SUPERVISOR

	TYPE PARKING	
LEGAL CURB	10 CURB, UNRESTRICTED 11 CURB, 2 HOURS 12 CURB, 1 HOUR 13 CURB, 30 MINUTES 14 CURB, 12 MINUTES 15 CURB, 1 HOUR, METERED	16 CURB, 30 MINUTES, METERED 17 ALLEY (BY TRUCK) 18 SPECIAL PERMIT (LEGAL USE) 19 TRUCK LOAD ZONE (BY TRUCK) 20 LOADING DOCK (OFFSTREET) 21 INFORMAL PARKING
ILLEGAL PARKING	30 THEATER OR HOTEL ENTRANCE 31 DOUBLE PARKING 32 BUS STOP, TAXI STAND (BY CAR, TRUCK) 33 PROHIBITED CURB 34 DRIVE, CROSSWALK	35 PAINTED CURB 36 FIRE HYDRANT 37 ALLEY (BY CAR OR TAXI) 38 SPECIAL PERMIT (ILLEGAL) 39 TRUCK LOAD ZONE (CAR, TAXI)
LOTS	40 LOT, PUBLIC, FREE 41 LOT, PUBLIC, PAY 42 LOT, PRIVATE, FREE	43 LOT, PRIVATE, PAY 44 LOT, MUNICIPAL, FREE 45 LOT, MUNICIPAL, PAY
GA-RAGES	50 GARAGE, PUBLIC, FREE 51 GARAGE, PUBLIC, PAY 52 GARAGE, PRIVATE, FREE	53 GARAGE, PRIVATE, PAY 54 GARAGE, MUNICIPAL, FREE 55 GARAGE, MUNICIPAL, PAY

SUGGESTED FORM FOR COVER SHEET FOR EITHER INDIVIDUAL INTERVIEW SLIPS OR INDIVIDUAL INTERVIEW-TABCARD FORMS

TRANSPORTATION STUDY
CITY OF
PARKING STUDY

LICENSE NO. ....
VEH. TYPE P.C.(1), TRUCK(2), TAXI(3) ☐
TYPE PARKING (SEE COVER) ☐☐
TIME IN .... ☐☐☐
TIME OUT .... ☐☐☐
CLASS ☐
HRS. 8-6 ☐☐☐
HRS. AT PEAK ☐☐
ORIGIN ....
.... ☐☐☐☐
DESTINATION ....
.... ☐☐☐☐
FT. WALKED ☐☐
PURPOSE: SHOP 1 SERVICE, SALES 4
BUSINESS 2 TRK. LD. OR UNLD. 5
WORK 3 OTHER 6 ☐
HOME ADDRESS ....
.... ☐☐☐☐

SUGGESTED FORM FOR
INDIVIDUAL INTERVIEW SLIP.

FIGURE III–3. Parking Interview Forms.

tance parkers might be expected to walk, and whether, as a policy, short-time parkers should be given preference over long-time parkers. One index may be the proportion found to be walking considerable distances; certainly conditions cannot be serious in a city where 95 percent of the parkers walk less than a block. Congestion is apparent if, for example, 25 percent have to walk more than a thousand feet.

Figure III–4 shows graphically the relation of supply, use and demand in a typical city.

Figure III–5 shows areas of net deficiency based upon an assumed acceptable walking distance.

Parking Habits

The tabulated material includes data on distances actually walked by parkers having various purposes; those using curb and off-street facilities; those parking for short and long periods, and those parking legally and illegally. Comparison of these data in one city with similar data from comparable cities is significant.

Tabulations giving parallel data for the peak hour of parking accumulation establish a relationship between that and average conditions. The accumulation curve enables planners to decide whether to base an estimate for improvement on the peak, the average conditions, or on some intermediate parking volume.

Similarly, since the recorded data give information only on the demand at the time of the study, it is desirable to project the data into the future, to allow for anticipated losses of curb and off-street space and for probable increase in demand because of expected increases in traffic volume. Although "generated demand" cannot be forecast precisely, allowance must be made for it. Additional demand will be brought forth by any substantial improvement in facilities.

A common complaint is that workers, arriving first in the business district, preempt desirable parking spaces. This charge may be brought out by comparison between purposes, times of arrival and distance walked. Data on curb space often will involve existing time restrictions, their appropriateness and degree of observ-

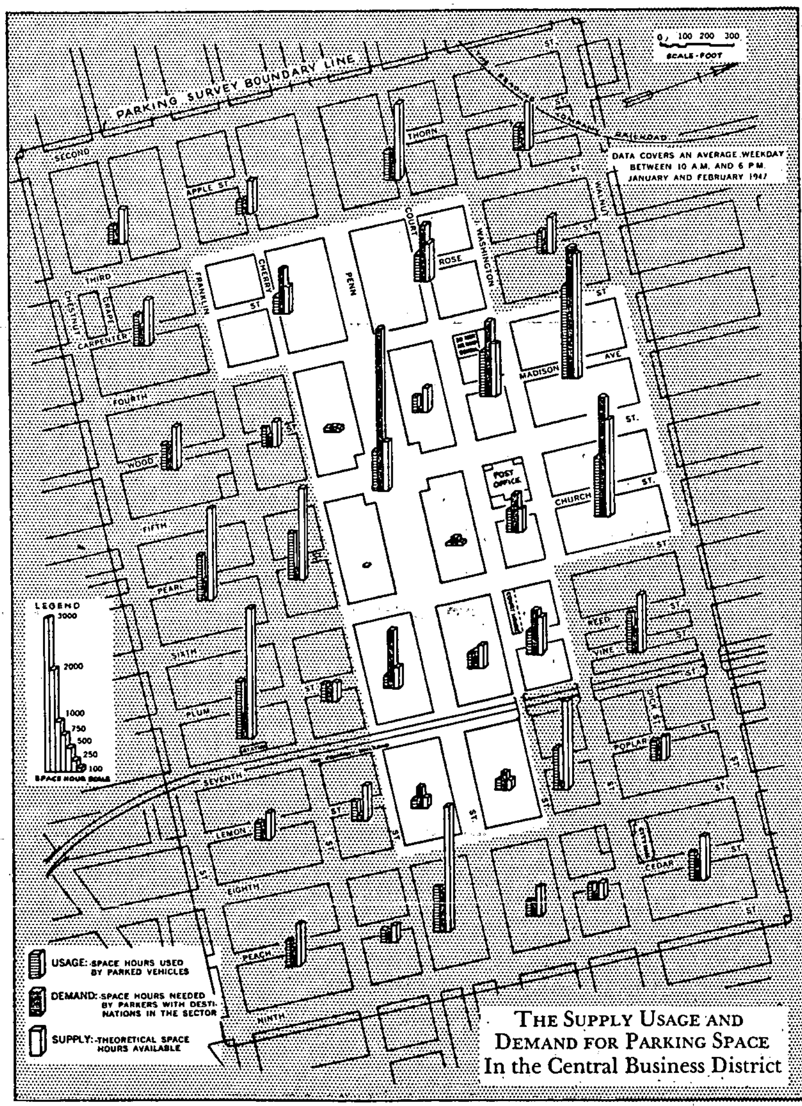


FIGURE III–4. Comparison of Supply, Use and Demand.

ance or compliance—all available from the comprehensive study.

Observance of restrictions on the place and duration of parking is evidence both of the degree of enforcement and of the deficiency of convenient space. Examination of these records may indicate the need for adjusting or extending time restrictions. Areas showing excessive space violations are usually coincident with those having deficient space. A comparison of parking durations in metered and nonmetered areas, or before and after meter installation, will demonstrate the effectiveness of meters as regulators, although their effectiveness depends on the degree of enforcement. The records of legal and illegal parking in any special permit spaces should determine whether their establishment is justified.

A long range approach toward meeting deficiency in parking space lies in zoning ordinances requiring provision of off-street space in connection with any new construction, the amount being based upon the demand expected to be generated by the intended use of the building. Ordinances established thus far have had only a meager factual basis. The parking study data give the currently expressed demand (in space-hours) for all the principal buildings.

Mention has been made of the part played by trucks in parking and traffic congestion. A tabulation presenting information by type of vehicle and type of parking facility used, when compared with the inventory data, will show generators of truck parking demand and the use of loading zones and alleys by trucks. Conversely, the extent of truck use of normal curb space, particularly the use of double parking and other illegal space, will indicate the need for additional loading zones, off-street berths or alley facilities.

These examples indicate specific ways in which the parking study data may point out and support a program of physical improvements. Integrated with these steps, the staff studies of the legislative, administrative and financing aspects of the problem should suggest the means for initiating action and implementing the program.

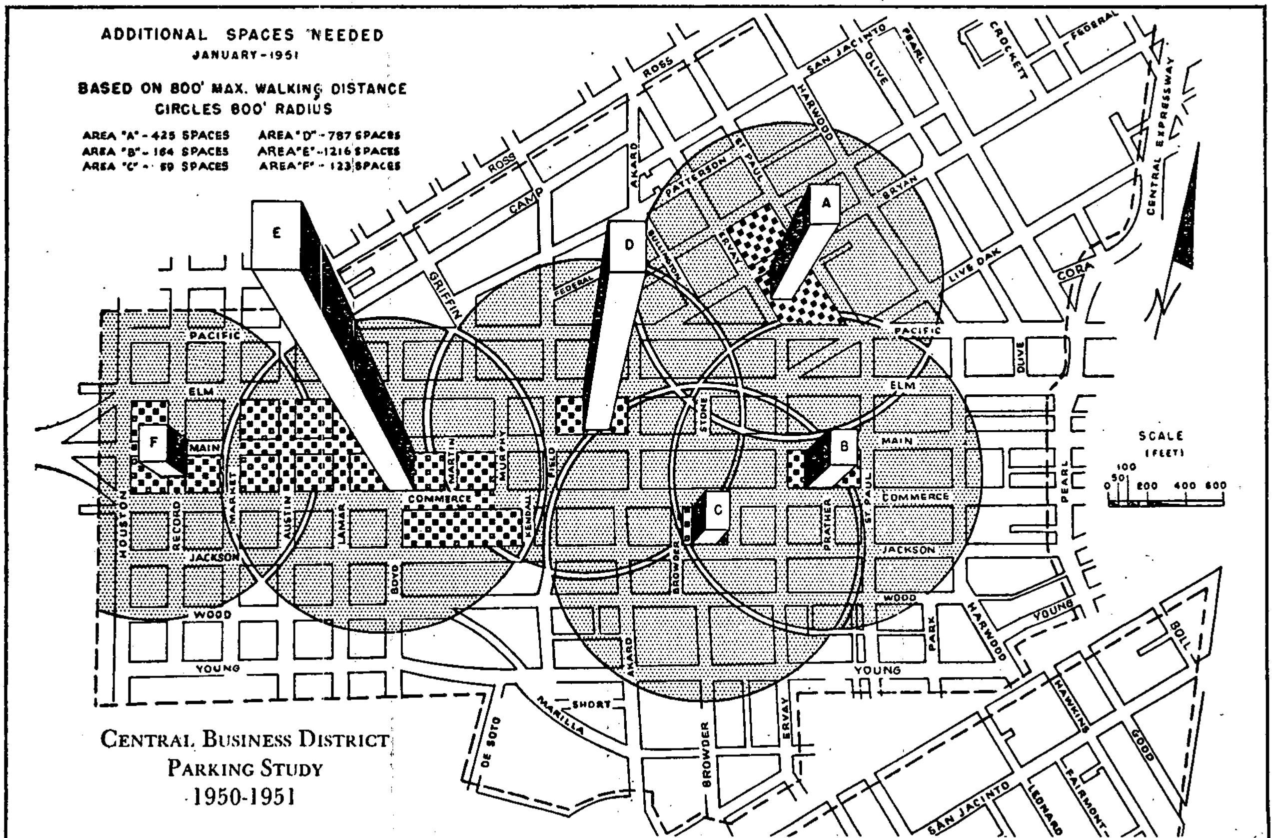


FIGURE III–5. Net Deficiency in Parking Space.

Information for a Bond Prospectus

A bond prospectus is essentially a selling document, intended to satisfy prospective investors that the proposed project will be profitable. It must then include estimates of revenue and expense; in a parking improvement program, these must be based upon anticipated use of the new facilities under the proposed fees, and usually, upon probable accessory revenue from curb parking meters.

The comprehensive parking study provides the basic data required to support these estimates: location and extent of existing space deficiencies, use of existing pay facilities, and use of existing metered spaces, with additional information on the principal generators of parking demand, location of available sites, the local traffic pattern, etc.

In some cases it may not be possible to finance the cost of the comprehensive study described above, and especially in a small city, a limited or less extensive procedure may serve the immediate need. This is frequently true.

The "Peak Moment" Parking Study

The comprehensive study involves interviewing practically every person parking a vehicle in the central business district during business hours. This method requires at least one man-day of labor for each block face in the area and for each off-street facility, and is responsible for about 40 percent of the cost of the study.

The "peak moment" study procedure confines its concern to those parked in the area at the time of its greatest accumulation of parked cars, usually at 2:00 P.M. or later. Interviewers are placed at that time, make a list of all parked vehicles, and remain only as long as necessary to interview those particular parkers, disregarding later arrivals, but including all vehicles then parked, whether legally or not. The interviews are conducted as in the comprehensive study, recording the same data.

Depending upon the durations of the parkers, an interviewer might complete his assignment in less than an hour, or might have to remain until 6 P.M. A controlling feature, therefore, is the availability of part-time help (four hours per day). Coding (expressing the data in code or numerical form for use in machine tabulation) may be carried on all day, and it may be feasible to use some interviewers each morning as coders. Coding usually requires less than half the man-hours needed for interviewing.

In this type of study the cost of interviewing should not exceed half that of a comprehensive study. If machine accounting analysis is used, the cost of coding, punching and tabulating should be much less because the number of cards (one per interview) should be only about 20 percent as great, there is no calculation of elapsed time, and there are fewer tabulations to make. Actually, manual tabulation might be used. The study involves only the situation at the peak moment, hence no consideration of space-hours; and the principal result is a comparison of the number of parkers demanding spaces in each particular block, at the peak, with the spaces available in that block.

This procedure, although much less complex and expensive, obviously will not produce all the valuable data of the comprehensive study. It should be entirely satisfactory in determining the extent of the need for space, and where spaces should be provided—the primary function of a parking study. But it does not give representative data on illegal parking, overtime parking, trip purposes, or truck requirements for loading zones.

Where it is believed that this peak moment type of study is appropriate, information and possibly assistance in its conduct may be obtained as for the comprehensive type of study, through state highway departments with reference to the Bureau of Public roads.

A Simplified Study for Small Cities

In larger cities where walking distance is a factor, it is necessary to consider the destination of parkers, obtainable only through interviewing them. In small cities under 15,000, the central business district with relatively few blocks does not usually involve walking distances of great length.

In such a city it is possible to obtain reasonably satisfactory information on parking habits and needs without the expense of conducting interviews. For detailed instructions, see Appendix.

Sampling Procedures Not Satisfactory

The comprehensive type of study gives excellent results but is not inexpensive. To retain its advantages and at the same time reduce its cost, many attempts have been made to decrease the manpower involved, both in field work and subsequent computation, by sampling procedures. Instead of attempting to interview all parkers, tests have been made by interviewing at one or at two faces of every block, alternate block faces on each street, or at one-fourth of the spaces in each time-restriction area.

By making these tests on data from studies using the comprehensive procedure, it is possible to compare results of fractional samples with results of a nearly 100 percent sample. For information on parking habits—trip purpose, parking duration, and distance walked—results have been reasonably accurate. But for data on location of demand, based on the destinations of parkers, the samples (even 50 percent samples) have been far from satisfactory. Samples have not been representative of the whole—and the location and extent of demand is the heart of a parking study.

Similarly, attempts have been made to use data from origin-and-destination studies for determining parking demand. These studies usually involve interviews at no more than ten percent of the homes in the city, and have proved satisfactory for origin-and-destination use. But here too the data have been found not representative for parking information.

In parking studies, where walking distance is an important factor, it is desirable to pinpoint destinations to a particular block or even closer, much closer than for travel destinations. And it is a statistical axiom that the smaller the area involved, the larger the sample (in percent) must be, to be representative.

CHAPTER FOUR

CURB PARKING

In any city the parking problem makes its first appearance in the central business district when the curb is no longer able to accommodate parking demand. Most parkers would prefer to park at the curb if space were available. The following table, based on data in Chapter II, indicates that the total demand for curb space exceeds the regulated curb supply in the average city before its population reaches 10,000. In the largest cities seven or eight persons seek to park, at the peak, for every curb space available.

Table IV–1

Supply of Curb Space

	Number of cities	*Average number curb spaces*	*Peak parking accumulation**
5,000–10,000	2	710	490
10,000–25,000	18	1,012	1,188
25,000–50,000	16	1,598	1,950
50,000–100,000	5	3,018	4,450
100,000–250,000	13	2,475	4,130
250,000–500,000	8	3,324	9,140
500,000–1,000,000	4	2,933	13,590
Over 1,000,000	3	3,335	25,160
	69		

* At all types of spaces.

A shortage of parking space in the central business district not only creates parking congestion of its own, but available curb space creates competition and contributes heavily to traffic congestion. At the same time, divergent interests conflict: shoppers, workers, and many of the merchants have a direct interest in curb parking; transit operators, fleet owners, highway officials and others are primarily interested in expediting traffic.

Traffic Must Have Priority over Parking

Whenever demand for public service becomes greater than the supply, priorities must be established. Business cannot exist without transportation, and transportation requires movement. But movement needs terminals, places to park at destinations. Streets are primarily intended for travel, and a basic policy should be that whatever part of the street is needed for free movement of traffic must not be used for parking.

Of equal importance with traffic in regulating curb parking are public safety requirements, expressed in the Uniform Vehicle Code and the Model Traffic Ordinance. The Code has certain minimum standards designed for incorporation into state law, requiring a clear view for the passage of other vehicles, prohibiting parking on crosswalks, beside fire hydrants or loading islands, and in other places where parking would create a hazard.

The model ordinance contains other provisions, some applicable to all cities, and some needed in relatively few. These include Sections 129–Parking in alleys; 130–All night parking prohibited; 132–Parking near schools; 133–Parking prohibited on narrow streets; 146–Parking prohibited at all times on certain streets; 149–Parking time limited on certain streets, and so on.

However, no reasonable use of streets for parking should be prohibited or restricted until traffic demands become pressing, and parking should be permitted and regulated wherever and for as long periods as is equitable. Traffic and parking are in the public welfare and neither should be swayed by group or private interests.

The amount of curb space in any city is limited and decreases as the city grows. The use of space for parking should be distributed to benefit the greatest number. Excess parking demand must be provided for by offstreet facilities. In the application of this theoretical approach, it should be remembered that the first purpose of streets is to move traffic, not hinder it.

Business in the Downtown Area

Since World War II, unprecedented growth in size and number of neighborhood and suburban shopping centers, usually with generous provision of parking space, has focused considerable discussion on "decentralization," decay of downtown areas, and decline in property values. Much of this trend is ascribed to the inadequate supply of parking space. But H. E. Evans, then of the United States Chamber of Commerce, inclined to the view that much of this move of business has been not entirely a flight from city congestion but partly to get nearer to new population centers in suburban areas.

Downtown stores are losing some business to shopping centers, and are not gaining business as fast as the suburbs, but they are gaining. They need better parking facilities, but will find it difficult to match suburban stores in that respect. A large proportion of downtown shoppers come by transit, and some of the downtown rejuvenation may come from new ideas in mass transit facilities.

Curb Spaces Are Expensive

As far back as 1933 it was estimated that the cost (to New York City, perhaps an extreme case) for providing one parking space at the curb was $1700 per year.[1]

The cost of high-type city paving in 1948 was about $4 per square yard, so that one curb space 8 by 20 feet would cost about $71 to pave. This does not take into account the reduction in capacity of adjacent traffic lanes. The 1948 cost of adequate off-street lot paving was about seventy-five cents per square yard or about $20 per car space. Curb parking is not economical use of valuable travel space.

Parking Spaces Are Valuable to Merchants

It appears that downtown parking spaces are worth from $15,000 to $20,000 each in annual retail sales in cities from 10,000 to 100,000 population. Many examples indicate that added parking spaces have a beneficial effect on downtown property values.

In Quincy, Massachusetts, the city built a parking lot with more than 500 spaces, in the rear of stores in the center of the business district in 1950, and reports that in neighboring stores retail sales increased as much as 80 percent, and that store personnel more than doubled. One store reported a 60 percent increase in personnel and a 158 percent increase in sales.

[1] *Engineering News-Record*, Feb. 9, 1933.

San Bernardino, California, reports on two general merchandise stores, competitive, handling the same lines and similar in every way except that one has a 1,000-car adjacent parking lot and the other has not. The store with no parking space averaged less than $40 sales per square foot of sales area, while the store with good parking space averaged more than $90.

Curb Parking Hurts Traffic

Highway capacity studies, reported by the Highway Research Board and the Bureau of Public Roads, provide specific data on the effect of curb parking upon highway capacity for handling moving traffic, as shown in the following table:

Table IV–2

PRACTICAL CAPACITIES FOR DOWNTOWN STREETS

(TOTAL VEHICLES PER HOUR)

	Curb parking allowed*		*Curb parking prohibited*	
Street width between curbs	*Left turn allowed*	*Left turn prohibited*	*Left turn allowed*	*Left turn prohibited*
30 feet	450	500	900	1000
40	750	850	1400	1500
50	1000	1100	1800	2000
60	1250	1350	2200	2400
70	1400	1550	2500	2800

* Parallel parking.

These data are based on time signals showing green 60 percent of the time, with commercial traffic averaging from 5 to 15 percent of the total volume.

Capacities without parking are double the capacity when parking is allowed. A 40-foot street without parking can accommodate as much traffic as a 70-foot street with parking.

Onstreet parking is a major factor in accidents. Vehicles entering or leaving curb spaces, vehicles improperly or illegally parked, and persons entering the street from between parked vehicles are serious and prevalent causes of accidents. Curb parking constitutes a serious fire hazard by obstructing apparatus and fire hydrants.

The Curb Is Important to Parkers

The following data by the Bureau of Public Roads are compiled from many studies:

Table IV–3
CURB SUPPLY AND USAGE

Population group urbanized area	*Number of cities*	*Percent curb spaces of total*	*Number of cities*	*Percent curb parkers of total*
5,000–10,000	2	88	2	93
10,000–25,000	18	64	17	85
25,000–50,000	16	61	16	84
50,000–100,000	5	55	5	79
100,000–250,000	13	44	11	76
250,000–500,000	8	30	7	66
500,000–1,000,000	4	23	5	63
Over 1,000,000	3	16	3	50
	69		66	

The curb's proportion of total spaces dwindles rapidly as the city grows, and offstreet spaces accommodate an increasing proportion of parkers. In smaller cities, curb spaces are 88 percent of the total supply and take 93 percent of the parkers; in the largest cities curb spaces are only 16 percent of the supply, but, because of tighter time restrictions and higher turnover, take care of 50 percent of the parking demand.

The Situation at the Curb

In evaluating a city parking situation, it is desirable to consider other cities of comparable size. Similarly, information and guidance can be obtained from knowing trends or characteristics of cities as they grow, to aid in planning and controls.

The comprehensive type of parking study, made in more than a hundred cities, provides valuable data as shown in Chapter II.

In cities over 25,000 population curb spaces cannot accommodate all vehicles demanding space. Table IV–1 shows that at the peak, in cities over a million, the demand is seven times greater than spaces available. Table IV–4 shows that in small cities only

Table IV–4

RESTRICTIONS ON USE OF THE CURB

Population group	*Number of cities*	*Ratio**	*Number of cities*	*Total length of curb in feet*	*Percent of curb space used for*			*Truck loading zones*	*Percent of street area used for curb parking*
					Public Parking	*Special Parking***	*Prohibited Parking****		
5,000–10,000	2	0.8	2	17,900	62	3	35	2	18
10,000–25,000	17	1.2	5	24,400	60	4	36	2	18
25,000–50,000	16	1.2	4	42,700	60	5	35	2	17
50,000–100,000	5	1.7	3	104,000	58	7	35	3	21
100,000–250,000	13	2.0	4	78,600	57	9	34	3	15
250,000–500,000	7	3.3	4	150,200	43	12	45	6	16
500,000–1,000,000	5	3.7	2	156,400	38	11	51	6	11
Over 1,000,000	3	6.6	1	287,100	30	18	52	11	8
	68		25						

* Ratio of maximum number of vehicles parked (at any one instant) to total number of public curb spaces.
** Includes truck loading zones, bus zones, theater and hotel entrances and special permit spaces.
*** Space for fire hydrants, drives, crosswalks, corner clearances and "no parking" zones.

62 percent of the curb space is available for parking, and this decreases to 30 percent as the cities grow. Special curb uses—taxi stands, truck and bus loading zones, theater and hotel entrances—require from 3 to 18 percent of the curb.

Parking needs at the curb, and various restrictions against curb parking, claim from 35 to 52 percent of the space, increasing with the size of the city.

Table IV–5

LOSS OF CURB SPACE IN 5- TO 9-YEAR PERIOD

Population group	*Number of cities*	*Percentage loss*
Under 25,000	10	14
25,000–50,000	10	14
50,000–100,000	1	31
100,000–250,000	6	11
250,000–500,000	2	15
500,000–1,000,000	5	13
Over 1,000,000	3	41
	37	

In 1954–55 re-inventories of parking space supply were made in thirty-seven cities which had completed comprehensive parking studies from five to nine years previously. In thirty-six of these cities a definite net loss in curb space occurred, as indicated in Table IV–5, because of increasing demand for street space for traffic movement or safety requirements. The heavier loss in the largest cities reflects the prohibition of curb parking on entire streets to relieve traffic congestion.

Illegal Parking

In smaller cities one parker in ten parks in an illegal space. Until enforcement becomes efficient there always will be violators. The proportionate increase after the population passes the half million mark suggests that in large cities walking distances are becoming so great that more and more parkers prefer to risk a fine.

Another type of illegal parking, overtime parking, is closely allied with the subject of parking meters, and is discussed in another chapter.

Design of Curb Space

It has been stated as doctrine that the demands of traffic, together with safety considerations, have priority over parking in the use of street space. Table IV–4 shows that a large proportion of curb space has already been claimed for other-than-parking purposes; and that the supply of curb spaces is dwindling rapidly. On the other hand, it is clear from Table IV–3 that the curb is being used by well over half of all downtown parkers.

Aside from the question as to whether, where, or when angle parking should be permitted at the curb, there are times and places when it is used. Examination of Figure IV–1 makes it clear that both the curb footage needed for each curb space and the width of street space needed for maneuvering are affected or controlled by the width of the parking stall. As in offstreet parking, the trend in automobile body design—wide doors—and the fact that practically no curb parking is done by attendants, makes wider spaces desirable. Table IV–6 shows the essential data for some conditions.

Angle Parking vs. Parallel Parking

The Uniform Vehicle Code prescribes parallel parking, but authorizes local authorities to permit angle parking, with the proviso that it shall not be permitted on any federal-aid or state highway without prior approval of the state highway authorities. Subject to this proviso and the further one that angle parking will not necessitate driving on the left side of a street or on car tracks, the Model Traffic Ordinance authorizes the city traffic engineer to determine on what streets angle parking shall be permitted. Signs or markings must indicate such permissible angle parking. The Ordinance also authorizes the city traffic engineer to issue special permits for backing to the curb to unload merchandise or materials.

Angle parking accommodates more vehicles per unit of curb space than parallel parking. This advantage increases as widths of the angle increase, until at ninety degrees nearly two and one-half times as many spaces are possible. But as the angle increases, so do requirements of roadway width used for parking and additional width needed for maneuvering into and out of spaces.

Ninety-degree parking at the curb is rarely permissible and only under special conditions, as in wide market-district streets where small trucks back to the curb for the sale or delivery of produce. Usually sixty degrees is the maximum practicable, and the forty-five-degree stalls generally give best results. Steeper angles require more maneuvering space, while flatter angles use nearly as much curb space as parallel parking.

An interesting variation of angle parking is used in Alliance, Nebraska, where stalls at an angle of thirty-seven and one half to thirty-nine degrees provide two definite advantages. When cars are parked at this angle, the left rear door can be opened behind the car at the left, while the right front door can be opened ahead of the car on the right, simplifying exit by passengers and minimizing damage to cars. At the same time, with the door problem

Table IV–6

STREET SPACE USED FOR VARIOUS PARKING POSITIONS*

Stall width	*Position at curb*	*Width of street used when parked*	*Street width needed for parking plus maneuvering*	*Length of curb per car*	*Cars parked per 100 feet*
7 feet	Parallel	7 feet	17 feet	22 feet	4.5
8 feet	45	18.4 feet	30.4 feet	11.3 feet	8.2
	60	19.6 feet	38.6 feet	9.2 feet	9.5
	90	18.0 feet	46.0 feet	8.0 feet	12.5
8 feet 6 in.	45	18.7 feet	29.7 feet	12.0 feet	7.8
	60	19.8 feet	37.8 feet	9.8 feet	9.5
	90	18.0 feet	43.0 feet	8.5 feet	11.5
9 feet	45	19.1 feet	30.1 feet	12.7 feet	7.37
	60	20.0 feet	37.0 feet	10.4 feet	9.0
	90	18.0 feet	41.0 feet	9.0 feet	11.1

* Based on stall widths as shown, including lines
No overhang of curb
Car length 18 feet
width 6 feet 6 inches
wheel base 10 feet 6 inches
overall turning diameter 23 feet 3 inches

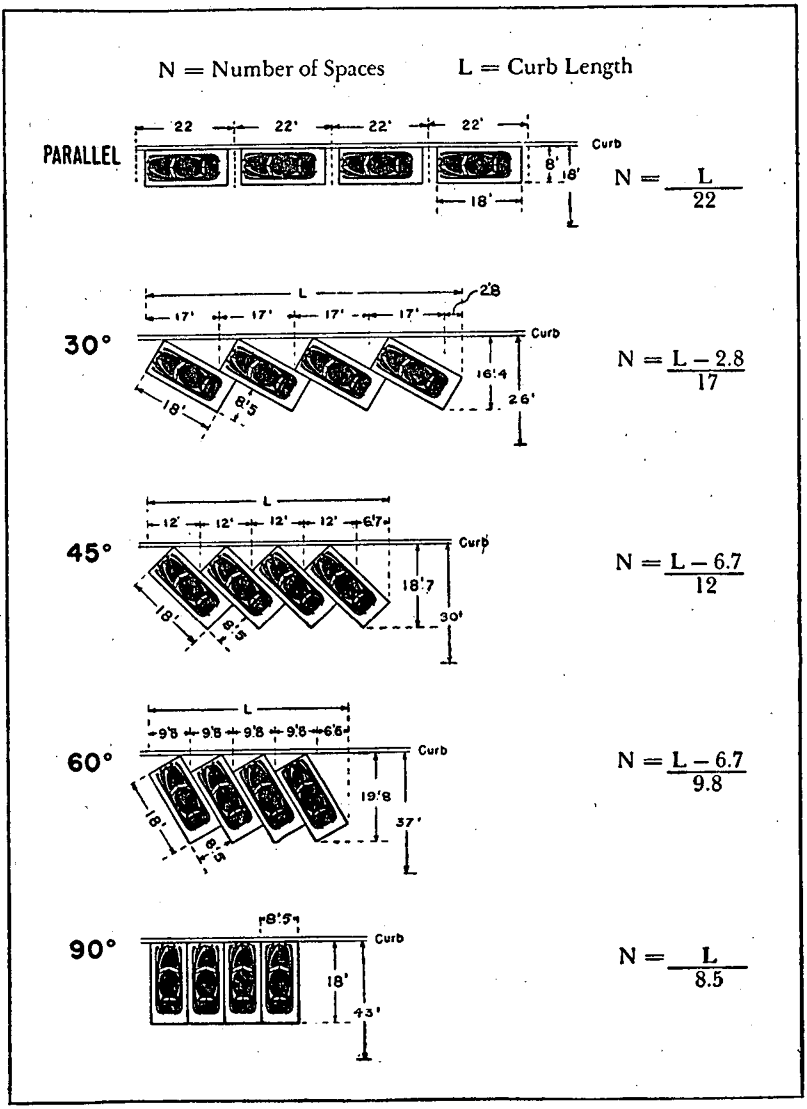


FIGURE IV–1. Street space used for various parking positions, using stalls 8 feet, 6 inches wide.

removed, the individual stalls can be reduced to seven feet six inches width, requiring twelve feet of curb per stall.

Angle parking simplifies and speeds up the act of parking. The driver can head directly into a stall with no lost motion and a minimum of interference with moving traffic. Parallel parking involves a backing maneuver, which delays moving traffic and is difficult for many drivers to perform without repeated and time-consuming attempts.

On the other hand, while angle parking is almost ideal in causing a minimum of interference during the act of parking, the act of leaving an angle stall is more dangerous than unparking from a parallel stall. Many drivers back excessive distances when leaving an angle stall, others back too suddenly for the short distance needed to gain visibility; consequently moving traffic is forced to swing out, often across the center line and partly into an opposing line of traffic. Hence the result that several feet of roadway adjoining the angle spaces become No-Man's-Land, avoided by moving traffic as dangerous.

Many studies, of the "before-and-after" type, have shown that angle parking at the curb is a common factor in accidents and a change to parallel parking brings a definite reduction.

Minor disadvantages of angle parking are that cars so parked often overhang the curb, with the consequent loss of sidewalk space a hazard to pedestrians; and angle parking forces parkers to debark in the street and walk through the gutter to reach the sidewalk.

A decision as to whether angle parking may be permitted at a given curb must be based upon the width of the street, the volume of traffic, the type of Traffic or vehicles, the type of parking to be expected (turnover), and the nature of the neighborhood.

For the central business district, because of the nature and volume of the traffic movement on most downtown streets, it is recommended that angle parking be generally prohibited, and permitted only where the roadway is exceptionally wide (over 70 feet), or on short dead-end or stub streets with negligible traffic movement.

The only advantage of back-in parking is that the subsequent unparking is simpler and less hazardous. But the backing-in maneuver is difficult for the average driver, who greatly prefers to head into narrow spaces and to have room for backing.

Marking Curb Stalls

Parking stalls outlined or indicated on the pavement or curb are valuable in promoting orderly parking. It is necessary to mark angle-parking stalls, and the practice of marking parallel stalls has grown rapidly since the installation of parking meters demonstrated the advantages of clearly indicated space limits.

The American Automobile Association made a study of the time required to park in uniformly marked 20-foot stalls, as compared with parking at entirely unmarked stretches of curb. The findings strongly favored the marked stalls, where the average parking time was 21.7 seconds, while the average time at the unmarked curb was 38.4 seconds.

This 43 percent saving in time resulted from the greater average space available. Random and indiscriminate parking sometimes allows more cars to crowd into a given length of curb, but invariably leads to longer parking and unparking times and irritation to parkers.

The test mentioned above was made with 20-foot parallel stalls, at that time an acceptable standard. That distance should be used as a minimum. In any zones where parking is restricted to thirty minutes or less and the resulting turnover will be high, stalls should be from 22 to 24 feet long, to minimize maneuvering delays.

An important point, often overlooked, is that of tailoring the length of a parallel stall (or the width of an angle stall) to fit the circumstances and so provide extra stalls or more comfortable ones. For example, since the two end stalls of each block face have plenty of maneuvering space, they may be reduced in length to 18 or even 17 feet. Dead space in many blocks, created by alleys, fire plugs, driveways and other restricted zones offers opportunities for more short stalls because of the maneuvering space provided.

Similarly, these restricted zones are apt to leave curb stretches of odd lengths which will not divide exactly into 20- or 22-foot spaces, and the surplus length, if distributed among the several stalls, will speed parking maneuvers. A curb from an alley to a driveway might measure 105 feet; here it would be reasonable to have two end spaces of 18 feet and three intermediate ones of 23 feet each.

Pair Parking

A means to speed parking and unparking maneuvers at parallel-parking curb spaces is "pair-parking" or "twin-stall" technique, in which two cars are parked bumper to bumper in two 17- or 18-foot stalls, separated from adjacent two-car units by 8- or 10-foot intervals. The open intervals are plainly marked as prohibited for parking. This arrangement uses twenty-two feet per car stall, but insures that each car will have the maximum space for maneuvering. Pair parking may be used either with or without meters, but clear pavement marking is essential. It has not been accepted for general use.

Center Street Parking

Parking is permitted in the center of extremely wide streets in some smaller cities. It is not a satisfactory solution and has not grown in favor. Parallel parking may be used, but the use of angle stalls is more common. It is suggested that center parking be used only when the street width permits the addition of a center island for use as a walk.

Curb Truck Loading Zones

Analysis of many comprehensive parking studies shows that about 15 percent of all vehicles parking in the central business district are trucks, and that trucks play a major part in double parking and obstructing the flow of traffic. A car driver or passenger can walk several blocks to his destination if necessary; a truck handling merchandise must as a rule be parked nearer its destination. This practice has lead to excessive parking violations by truck and delivery-vehicle drivers, and the habit has been abetted by the tolerance of police.

Rarely have business and industrial establishments in downtown areas provided offstreet loading facilities; few cities have alleys in sufficient number to handle normal truck demands, and few cities having alleys have developed their usefulness to the maximum. Practical zoning ordinances are a long-range approach to the development of offstreet facilities. But meanwhile, although alley use may be increased, the bulk of loading requirements must be met at the curb through the use of loading zones.

The comprehensive parking study records data on the kind of vehicle, the type of parking used, the duration of parking, and the destination. It can also provide information (regarding trucks) on the location and extent of double parking and other illegal practices; on the use of alley and off-alley spaces and of loading docks; on the location and extent of demand for loading zones, and on the use of existing loading zones. It provides the information for an equitable distribution of these spaces.

Parking studies have revealed that many loading zones at first justified are no longer needed, but that there is a demand for loading space on some block faces where none exists. In areas of heavy commerce or industry a single generator may require several contiguous loading zones, or several generators may call for two or more separate zones in one block face.

There is no established standard or limit on the number of loading zones to be permitted in a block face. The 1949 Municipal Year Book reports that of 225 cities which do limit the number, 89 allow one; 74 permit two; 12 permit four. Eight cities allow up to half the block, five allow three zones; one city allows five zones; another, one quarter of the block, while 35 cities have a limit but do not specify the number of zones.

There is a similar lack of unanimity as to zone lengths, but a common figure is from 20 to 25 feet. A longer zone (30 feet) is recommended as a minimum, together with restriction on vehicle length, and a prohibition on backing to the curb except by special permit.

If metered spaces are designated for truck use, it is desirable to allow at least two such spaces per loading zone. The usual meter space of twenty feet is too short for most truck operations.

Curb Bus Loading Zones

The American Transit Association recommends that bus curb loading zones have minimum lengths as indicated in Table IV–7, to permit bus drivers to pull in and out with reasonable ease and to park parallel to the curb, out of the flow of traffic, with the center door not more than one foot from the curb. Traffic movement will be improved by increasing these distances somewhat.

Table IV–7

CURB BUS LOADING ZONE LENGTHS IN FEET (MINIMUM)

Approx. Bus Seating Capacity	*One-Bus Stop*			*Two-Bus Stop*		
	Near side	*Far side*	*Mid-block*	*Near side*	*Far side*	*Mid-block*
25 and less	60	50	85	90	80	115
30	70	50	95	100	80	125
35	75	55	100	110	90	135
40–45	80	60	105	120	100	145

The location of bus stops, whether near side, far side or mid-block, is affected by several factors, including the presence or absence of street cars; turns at the intersection; curb radius; angles at intersections; transfer points; availability of channelizing islands; incidence of turns by other vehicles; proximity of large generators of passengers, and condition of sidewalks or presence of grades.

Truck Loading Docks and Berths

Though located offstreet of the establishment they serve, truck loading docks or berths usually are adjacent to the property line, sidewalk or alley, and often make use of street or alley space for necessary maneuvering.

The American Trucking Association recommends that the total dock area be at least double the total body floor area of the number of trucks that can be docked at one time. Freight may be tiered six feet high in trucks but not usually as high on the dock. With dock areas of this size, elevator capacity of the building may be a critical factor.

A simple rule for maneuvering-area in front of a dock for back-in parking, is that the distance from the edge of the dock to the limiting boundary should be not less than twice the over-all length of the truck. On heavily traveled streets this area should be entirely within the property lines; in alleys or on minor streets, part may be in the alley or street. Ten or twelve feet along the edge of the dock should be allowed per vehicle.

Specifications suggested by the Subcommittee on Truck Loading Facilities of the Institute of Traffic Engineers are:

Truck Berths	
Depth behind property line	40–50 feet
Width	12–14 feet
Vertical clearance	12½–14 feet
Freight Platforms	
Depth	12–15 feet
Height	40–50 inches

Signs and Markings

The necessity for marking angle stalls and desirability of marking parallel stalls, particularly when parking is restricted to one hour or less, was pointed out earlier. Properly used signs and pavement markings will improve parking behavior, add safety, and ease the movement of traffic.

But to serve their purpose fully, markings should be visible, properly located, simply worded, unmistakable in meaning and strictly enforced. Their effectiveness is greatly increased by following standards of size, shape, lettering, colors, and messages. The earmarks of a good sign are that it is clear, concise and legible. Both signs and markings should be properly maintained if their usefulness is to be preserved.

Signs and markings are notices to the driving public of restrictive or permissive rules, regulations or ordinances; if they are to be effective, they should be supported by legally enacted ordinances, enforced, and maintained. Deviations from these principles are more widespread in the field of parking than in other phases of traffic regulation. It is common to find:

1. Homemade "no-parking" signs and curb painting by merchants in front of their stores.

2. Non-uniform, confusing, illegible or conflicting signs erected by the city, sometimes based on some official's opinion and without necessary legal authorization.

As policy, it is recommended that all regulations applying to parking be properly posted, that all signs and markings accord with standard practices, and that curb markings be maintained at "no parking" zones and at prohibited areas. Nationally recommended standards for parking signs and markings are contained in the "Manual on Uniform Traffic Control Devices for Streets and Highways."[2] Specific references are:

Section	47	Parking and Stopping Signs
	48	Placement of Parking Signs
	49	Parking Signs in Rural Districts
	123	Colors of Pavement Markings
	147	Parking Space Limits
	149	Curb Markings for Parking Restrictions
	329	Parking Prohibitions at Islands

Control and Enforcement of Curb Space

In discussing design of curb spaces, consideration was given to location, number, type, size and arrangement. To meet the demands of traffic and safety, the spaces provided should serve their purpose efficiently. It is essential to determine where spaces should *not* be allowed, the times of day when they should or should not be used, and the length-of-time periods to be allowed. This control is effected through various types of restrictions and degrees of prohibition.

Time restrictions may range from none at all, in the smallest of towns where existing space meets the demand, through gradually tightening time limits as the city grows, to the other extreme in largest cities, where it has become necessary to ban all curb parking in the core of the central business district during peak or

[2] Obtainable from the Superintendent of Documents, Washington, D.C. $1.00.

business hours. It is not unusual that where demand for space is greatest, least room is available. Also it is true that where restrictions are lax, long-time parkers use a disproportionately large share of the time available.

Use of the curb must be evaluated not only in numbers of vehicles but also in the length of time parked. The unit of measure is the space-hour, one space-hour being one parking space used for one hour. For example, four space-hours may be used by one vehicle parking for four hours, two vehicles for two hours each, four vehicles for one hour each, or sixteen vehicles for fifteen minutes each.

Table II–26, taken from data compiled by the Bureau of Public Roads, shows the percentage of *curb* parkers in each time restriction group for each population group, and the resulting average turnover. Turnover is the number of parkers using a space in a given time—in this case during the eight-hour study period.

In the sixty-four cities reported upon, an average of 57 percent of the curb parkers stayed for less than thirty minutes; but because of high turnover in this group, required only 23 percent of the curb space-hours. On the other hand, 12 percent of the parkers stayed for more than two hours and used 51 percent of the space-hours.

Warrant for establishing time limits where there have been none are suggested by the Institute of Transportation and Traffic Engineering of the University of California. These presumably are applicable in smaller cities:

1. There must be existing demand for additional short-time parking in the immediate area of the block in question. This might be indicated by

a. Turnover study of nearby time-limit spaces showing nearly 100 percent occupancy at times other than peak hours, with good enforcement.

b. *Or* more than 50 percent of merchants on a street, which is predominantly business, signing a petition favoring time restrictions.

c. *Or* residents in an area petitioning for time-restrictions to provide short-time space monopolized by long-time parkers.

2. Study also showing high occupancy of block now having no time limit.

3. Reasonable enforcement.

4. Also desirable:

a. Other curb space, lots or garages where displaced long-time parkers may park.

b. Good mass transit service to encourage long-time parkers to use transit.

It has been suggested that when curb parking becomes congested, duration of parking should be so reduced that in a given block at least one parking space will always be available. This procedure would have to be limited to locations where the demand is extremely high, or the allowed durations might be reduced to absurdly low values, making enforcement difficult.

In setting up time-limiting procedures, the average number of vacant spaces throughout the day, or the vacancies in any block at times throughout the day, may be obtained from data of the simplified study described in the Appendix.

Length of Time Limits

In most cities one hour is the normal time limit for the central part of the downtown area, with a two-hour limit in the fringe areas and some twelve- or fifteen-minute spaces at post offices, banks, and other "errand-type" places. Smaller cities may have some unrestricted spaces at the limits of the central business district.

Parking studies described in Chapter III provide data on the numbers and percentages of curb parkers (and of all parkers) parking from fifteen minutes to eight or more hours, and on the turnover to be expected at each type of space. These data are based on present parking habits and may be influenced by existing time limits and the degree of enforcement. But they form an acceptable basis for adjusting current restrictions.

In the absence of a recent local study, the appropriate data from Table IV–8 may be used in applying the allocation of time restrictions. Whatever the source of data used, consideration must be given to probable turnover. Because 50 percent of parkers park for less than fifteen minutes does not indicate that 50 percent of the spaces should be limited to fifteen minutes. The turnover at a fifteen-minute space may be several times that at a one-hour space; hence the proportion of such spaces needed will be smaller than the proportion of parkers needing them. A fifteen-minute parker may park in a one-hour space if available, and many will do so.

Table IV–8 compares the proportion of curb spaces needed by each length-of-time group (calculated by applying turnovers to actual usage) with the proportions of the corresponding types of spaces currently available.

Table IV–8

NEEDED CURB SPACE, AND AMOUNT AVAILABLE, FOR EACH TIME-RESTRICTION GROUP

Population group	*Number of cities*	*Percentage of spaces needed and percentage available*					
		10–15 minutes	*30 minutes*	*1 hour*	*2 hours*	*Un-restricted**	*Total*
Under 25,000	18						
Needed		14	10	14	10	52	100
Available		2	0	16	19	61	98**
25,000–50,000	16						
Needed		14	10	14	10	52	100
Available		2	0	30	18	50	100
50,000–100,000	5						
Needed		12	12	14	11	51	100
Available		3	0	22	27	48	100
100,000–250,000	11						
Needed		10	12	16	11	51	100
Available		4	1	41	15	39	100
250,000–500,000	7						
Needed		10	11	16	11	52	100
Available		5	3	44	11	36	99**
Over 500,000	7						
Needed		8	11	18	13	50	100
Available		3	4	50	18	25	100
All groups	64						
Needed		12	11	15	11	51	100
Available		3	2	33	18	43	99**

* Including small proportion of 3-hour spaces.
** Balance unusual periods.

In every population group there is need for a larger proportion of fifteen- and thirty-minute spaces. Most cities have a few fifteen-minute spaces, usually near the postoffice, but many shoppers and persons on errands require less than thirty minutes. Additional short-time spaces might well be converted from one- and two-hour spaces, which are in excess in most cities.

A reasonable compromise in the average city is to limit about five percent of all curb spaces to fifteen minutes, placed near the postoffice, banks and public utility offices, and to limit another five to eight percent to thirty minutes, at block ends in the retail area.

Table IV–8 is based upon the needs of those parkers now using *curb* spaces. If the needs of *all* parkers (curb and off-street) were considered, more fifteen- and thirty-minute spaces would still be needed, plus a greater surplus of one-hour spaces, and (in the larger cities) more long-time spaces. Needs of present off-street parkers, however, have not been considered, since there would be no advantage in providing curb space for parkers now using off-street facilities.

Where fifteen-or thirty-minute spaces are placed at mid-block curbs, stalls should be from 22 to 24 feet long to expedite the turnover. Obviously, these short duration spaces, to be effective, will require constant enforcement. Any program for changing current time restrictions, particularly when limits are shortened, should be accompanied by appropriate publicity with supporting data to explain the necessity. Parking meters and their use in time-restriction zones are discussed in a separate chapter.

Time Limits Need Enforcement

No better procedure has been developed than tire-chalking by enforcement officials on frequent but irregular schedules. A recent innovation, the use of women foot-patrols, has been successful in a number of cities.

Total prohibition of parking, standing or stopping on certain streets (or on one side) is warranted when traffic volume exceeds the practical capacity of the street or of its intersections. Any such prohibition must be based upon studies of the street's traffic volumes and turning movements during peak hours, and of the signal system.

The "Highway Capacity Manual" published by the Highway Research Board, is useful in this field, but studies and observations must be made by qualified personnel. Inexperienced personnel cannot make investigations and decisions. Cities that do not have competent technical personnel may obtain advice and assistance from consultants, or from their state highway departments.

Warrants for Prohibiting Curb Parking

Affecting the regulation of curb parking are the requirements of public safety, expressed in the Uniform Vehicle Code and the Model Traffic Ordinance (Appendix I). The code has minimum standards for incorporation in state law, requiring a clear view for the passage of other vehicles, prohibiting parking on crosswalks, near fire hydrants or loading islands, and in other places where parking would create a hazard.

The Model Ordinance contains other provisions. These include Sections 129—Parking in alleys; 130—All-night parking prohibited; 132—Parking near schools; 133—Prohibited on narrow streets; 146—Parking prohibited at all times on certain streets; 149—Parking time limited on certain streets.

Prohibition of Parking During Certain Hours

Many cities find that traffic volumes become extremely heavy during morning and evening peaks and that curb parking must be prohibited on major highways at these times. Section 147 of the Model Traffic Ordinance meets this condition, and Section 148 imposes more drastic restrictions by prohibiting momentary stopping except as necessitated by traffic or signals. These prohibitions, usually confined to the major arteries in or close to the central business district, have proved their effectiveness.

A secondary benefit of rush-hour parking prohibition is that it discourages all-day parking at the curb.

The following summary shows the extent to which 597 cities have accepted some form of curb parking bans:

Table IV–9

Population group	Number of cities in study	Cities reporting some parking prohibition on main street downtown — All day: Number	All day: Percent	Rush hour: Number	Rush hour: Percent
10,000–25,000	293	193	66	34	12
25,000–50,000	133	87	66	21	16
50,000–100,000	82	56	68	26	32
100,000–250,000	42	38	91	24	57
250,000–500,000	32	28	88	27	85
Over 500,000	15	14	93	14	93

Total Prohibition of parking in CBD

Some large cities have found it advisable to eliminate curb parking in the core of the central business district, at least during the business day, to expedite traffic movement. These cities have extensive mass transportation facilities, and some have fringe parking lots with shuttle-bus or other transportation to the business district.

Philadelphia, in 1952, placed a strict ban on curb parking in more than one hundred downtown blocks, effective six days a week from 8 A.M. to 6:30 P.M. Bus speeds rose 7.5 percent, accidents decreased 10 percent, and private car speed increased nearly 50 percent in the area.

All-night Curb Parking Bans

To permit the removal of snow in winter and to facilitate street cleaning some cities prohibit all-night curb parking. Many cities lack adequate off-street parking space and a complete ban would be severe. A possible compromise is to allow parking on even-numbered sides of the street, on even days of the month, and on odd-numbered sides on odd days. The parking prohibition usually is from 2 A.M. to 6 A.M.

The Model Traffic Ordinance (Section 130) allows parking only for thirty minutes, between 2 A.M. and 5 A.M., except for physicians on calls.

All-night Rental of Curb Space

A different procedure, aimed at the ultimate improvement of parking conditions, has been legalized in Milwaukee, allowing all-night residential street parking for motorists who cannot secure off-street facilities.

The city council repealed a two-year old ordinance that prohibited all-night parking on city streets. Instead the city substituted a system of special permits for street parking where garage space is unobtainable.

Lack of offstreet parking spaces in the residential areas made it necessary in post-war years to grant numerous one-night special permits to persons unable to obtain garage space. Calls from persons seeking special permits each night flooded police department telephone switchboards. Six thousand automobiles were being parked on public streets every night.

The new ordinance[3] provides that permits will be granted when the police department ascertains that parking lot or garage space cannot be obtained within two blocks of a residence. Permits are issued monthly for a fee of $4 a month. Different colored stickers are used each month. Special privilege permits are issued to night workers for parking during the period of their employment.

No permits are permitted for parking on arterial highways, fire lanes, and streets with public transportation lines. The revenue from fees is used to provide public offstreet facilities.

No Standing During Rush Hours

The New York City Department of Traffic made available all possible road space for moving traffic in congested areas by prohibiting standing, loading or unloading during peak periods (8 to 9 A.M. and 4 to 6 P.M.) on several major crosstown arteries in midtown Manhattan. This restriction has been successful in virtually eliminating double-parking during these hours and in reducing congestion of moving traffic.

Existing taxicab stands were abolished for these periods, and taxicabs were required to use other established stands in the area.

3 Courtesy, Public Administration Clearing House.

FIGURE IV–2. Before a no-parking, no-standing ban on a New York City crosstown street.

Many bus stops were relocated from the near to the far side of intersections.

Figures IV–2 and IV–3 are views on a New York cross-street before and after this ban, in December, 1953.

Alternate Side Parking

Another New York City regulation, inaugurated in 1950 on the lower East Side, instituted "alternate side" parking. This had marked success in facilitating street cleaning and by the end of 1953 the system was in effect on a total of 620 curb miles throughout the city.

This regulation prohibits parking on alternate sides of the street (where so signed) on alternate days of the week including Saturdays. The prohibition covers two-or three-hour periods varying from 8 to 11 A.M. and from 11 A.M. to 2 P.M.

Cars parked on the wrong side of the street are towed away to a pound and owners are fined $15, plus $10 to reclaim the car, and $1 a day storage fee. Towing is done by Sanitation Depart-

FIGURE IV–3. Congestion caused by commercial vehicles eliminated by a ban on standing, loading and unloading.

ment wrecking trucks, and traffic wardens are assigned to check hours and notify police when motorists fail to abide by the restrictions.

Effect of Parking Prohibition on Business

Following the total prohibition of business-hour parking in a large area of downtown Philadelphia, the Federal Reserve Bank reported an increase in sales in city stores, and the Chamber of Commerce stated that the ban had benefited a large number of people. It appears that loss of a small amount of curb space is more than compensated by gains in traffic movement.

One-way Streets and Business

Few today question the benefits to traffic flow of properly planned one-way street systems, but early installations aroused strenuous objections, particularly by commercial interests. In many cities, after a fair trial, there was general agreement that the system was not detrimental but actually aided business.

In Sacramento, California, a 2.4-mile stretch of a main business street was converted to one-way operation; after the first year under the new system a study was made, based on the sales tax returns of retail business establishments. The findings were as follows:[4]

1. Traffic volumes increased 14 percent on the pair of one-way streets as compared with the same streets when two-way.
2. Speed averaged 24 percent higher in the peak hour and 41 percent in other hours.
3. Vehicular accident rate was reduced 16 percent.
4. Pedestrian accident rate was reduced 62 percent.
5. Retail business increased 27 percent over the previous year under two-way operation, 5 percent better than the 22 percent increase for Sacramento County as a whole.
6. *Corner*-location retail business increased 26.9 percent as compared with 25.4 percent at between-corner locations, and the gross business at corner locations represented 78 percent of all business on the street.

Loading Zones

A Public Administration Service study of twenty-two cities with more than 300,000 population showed that in sixteen, alleys were inadequate for truck loading and unloading; three cities had only partially adequate alleys, and three, fully adequate. Trucking in and out of central business districts is a necessity; where alleys or loading bays are not available, streets must be used, but their use can be regulated.

Practically all local city deliveries are made by trucks. Food and perishable goods are delivered daily. Heavy merchandise requires large trucks, close access, and time to handle. Requirements for loading space vary throughout the day.

Trucks unable to find curb space are conspicuous obstacles as double parkers—yet they must be accommodated. The natural tendency is to limit the periods of such use for loading and unloading. This is usually resisted. Trucking and businesses oppose night deliveries because they require night crews and create other problems.

[4] California Highways and Public Works, March 1953.

The whole pattern of moving goods into and out of the central business district is a special problem. A really comprehensive parking study will supply useful data that may be supplemented by an analysis of truckers' operating schedules, the numbers and types of vehicles used, the business establishments involved, and the hours when the drivers need either delivery or shipment service.

Findings can lead to a program designating the location and size of zones and time periods for their use. Obviously, such a plan must be integrated with and reconciled to peak parking and traffic demands and capacity, and developed with the cooperation and support of the various groups concerned.

In Spokane, Washington, following studies by a representative committee, seventy-seven zones were designated and marked as special loading zones for use from 7:30 to 9 A.M. At the same time a vigorous educational campaign was conducted among truckers and businessmen, to obtain their cooperation in speeding deliveries and rearranging schedules so that downtown deliveries are made early in the day and suburban deliveries later. A 30 percent reduction in afternoon deliveries was achieved, with a corresponding improvement in traffic flow.

Some cities prohibit truck loading at the curb during rush hours anywhere in the central business district, but a more common practice is to confine this prohibition to major arterials, with "No Parking 7–9 A.M. and 4–6 P.M.—One Hour Parking 9 A.M. to 4 P.M."

If, as is frequently the case, the rush-hour traffic is heavy in only one direction, it may be necessary to impose loading and parking prohibitions on one side of the street, alternating for morning and evening peaks.

Lesser restrictions may require that heavy shipments be handled at off-peak periods, may allow no backing-to-the-curb, or may require parallel parking of trucks, and parking for not more than three minutes, during the rush hours.

Loading zones should be clearly marked with a yellow painted curb and by signs at each end stating days and hours when regulations apply.

Permits for Loading Zones

In administration and use of loading zones it is essential that some permit system be used, as provided in Section 138 of the Model Traffic Ordinance, which authorizes the city traffic engineer to determine the need for zones and issue permits for them. Section 139 limits occupancy of a *passenger* loading zone to three minutes, and Section 140 limits *freight* zone use to thirty minutes; in each case use is permitted only for loading or unloading.

There has been much misuse of truck loading zones, and issue of a permit should not grant or imply that the holder may keep trucks there continuously, or use the zone for parking passenger vehicles. It is important that the use of existing loading zones be reviewed periodically.

Curb Loading Zone Fees

The 1949 Municipal Year Book reports that only about 3 percent of the cities charge application fees and only 8 percent charge annual fees. One argument in favor of free zones is that loading zones often are intended to serve several or all adjacent buildings without domination by any one user, and that when a zone is free, the city is at liberty to establish or remove zones as it deems necessary.

The Use of Alleys

Some cities have no alleys, and many have incomplete or inadequate alley systems. Many parking studies show that few cities having alleys make good use of them. Frequently, buildings backing on alleys have no rear freight entrance; many have back yards with ample room for loading and parking, yet allow the area to become littered and useless.

Too often, when alley facilities are available, front-door pickups and deliveries are permitted; large trucks back to the curb, and clutter the sidewalk with freight. Actually, it is the city government's responsibility to prohibit such parking; to restrict the use of alleys to loading and unloading; to control the positioning of trucks; and through zoning ordinances, to require full use of back yards and offstreet berths. Such a campaign requires the cooperation of business establishments and truckers.

Special, Temporary or Part-time Loading Zones

In metered zones it is occasionally necessary to restrict certain spaces temporarily for special purposes, such as the delivery of construction materials, or to prohibit their use entirely for a period. This may be done by the use of meter hoods. Appropriately marked hoods may similarly designate selected metered spaces as truck loading zones during certain hours.

There are few municipal regulations the public seems to regard less than those governing curb parking, and this attitude must be changed if any proposed regulation is to be effective. The American Automobile Association expresses the opinion that widespread violation of a city's curb parking regulations usually is traceable to (1) unreasonable restrictions; (2) regulations neither clear nor well posted; (3) a serious deficiency of parking space; (4) poor enforcement, or (5) inadequate fines.

It is of primary importance that parking and loading regulations be carefully drawn so that they are consonant with public safety and public convenience and are in keeping with available enforcement strength. Good regulations can be nullified by confusing signs, or by lax enforcement.

Any proposed change in parking regulations should be preceded by convincing publicity to explain its operation and necessity for the benefit of the community.

Handling Violations

The apprehension of parking violators is inevitably linked with ticketing, a procedure familiar to many drivers. At one time it was necessary in most cities, and still is in some, for the traffic officer to notify or arrest the driver or owner *in person*, obviously impracticable. The procedure now largely used, as exemplified by Sections 160–162 of the Model Traffic Ordinance, requires only that the officer affix the ticket to the vehicle, with the prima facie presumption that the registered owner was the person responsible for the violation.

Tickets are associated with violation in the minds of drivers, and "fixing" is associated with tickets. It appears that many drivers, otherwise law-abiding, have no conscience about efforts to have parking tickets fixed. In recent years, an almost fix-proof "quadruplicate ticket" system has been adopted in many cities.

Fully described in Sections 157–163 of the Model Traffic Ordinance, the method uses books of serially-numbered citations in quadruplicate; one copy for the offender, one for the traffic court, one for the police central records section, and one copy (retained in the book) for the city financial officer who is required to make periodic audits and reports.

Under this system tickets can be cancelled only by the court; possibilities for fixing are greatly reduced by the knowledge that every ticket is accounted for and becomes a matter of public record. City officials prefer the method since it provides them means for a polite refusal, if approached.

Traffic Violations Bureau

Where the growth of traffic volumes has brought a corresponding increase in parking violation tickets, a traffic violations bureau may be established to ease the burden upon the courts. Bureaus are established by the courts, often in the police department, and are authorized to accept payments from those offenders not wishing to contest the summons or appear in court. In support of this system, fines should be meaningful.

A car parked in violation on an arterial street is no less of an obstruction because it has been ticketed. An impounding ordinance empowering police to remove the car provides an effective deterrent to violators, since the driver is not only subject to a fine but also to the expense and nuisance of having to locate and claim his car.

Baltimore, Maryland has had an impounding law since 1948; applied to specified important through-streets, it has brought effective results and little objection. Twelve miles of one-way and three miles of two-way arterials between the central business district and the northern residential area are patrolled by three impounding or service trucks.

The impounding law supplements the parking regulations on these streets. Baltimore does not use "No Stopping" regulations, and permits vehicles to stop to take on or discharge passengers. But on one-way streets, parking is prohibited from 7:30 A.M. to 6 P.M. on the right side. Loading and unloading trucks are prohibited on both sides during the morning peak and on the right side during the afternoon peak. Parking is allowed from 10 A.M. to 4 P.M. on the left side.

When a cruising tow-truck observes or receives a radio report of a violating car, it proceeds to the scene; a summons is prepared, the car is inspected for damage, and then taken to a central pound where a full record is made, including a description of any damage and of all articles found in the car.

On discovering his loss, the driver telephones the police to learn where his car has been impounded. He must appear at the pound, identify himself, prove ownership, identify the car, and pay a $5.25 fine, plus a $5 towing charge, and $1 a day for storage exceeding forty-eight hours.

Since impounding was put in effect in Baltimore, benefited streets have carried 650 cars per lane per hour. These streets have all intersections at grade and have only half of the green time-cycle; hence this represents a volume rate of 1300 cars per lane per hour, which is reasonably close to an expressway capacity of 1500 cars. The public has reacted favorably, recognizing that streets are cleared for moving traffic. The ordinance has been extended to cover additional streets.[5]

Program for Improving Curb Parking

1. Inventory all curb space and its classification. Study present usage. See Chapter III for procedures.

2. Review existing ordinances concerning curb parking. Use the Model Traffic Ordinance as a standard in making indicated revisions and additions.

3. Compare existing time restrictions with current usage. Revise them to force the long-time parkers farther out or offstreet.

[5]Section 166 of the Model Traffic Ordinance gives essential elements of an impounding ordinance.

Provide more 15- and 30-minute spaces in the retail area. Use tire-chalking to enforce regulations.

4. Study truck loading and unloading. Review loading zones. Study alleys and require capacity use of them for loading and unloading.

5. Change angle parking to parallel wherever congestion is indicated.

6. See that regulations are properly posted, that signs are legible and understandable in accordance with the "Manual on Uniform Traffic Control Devices." Have curbs properly painted and marked. Have all curb spaces (especially if unmetered) marked on the curb or (preferably) on the pavement. Remove unauthorized signs and markings.

7. Enforce regulations. Eliminate ticket fixing. Give police adequate personnel.

8. Keep the public informed of changes, giving reasons, remedies, and expected benefits.

CHAPTER FIVE

PARKING METERS

Parking meters, originating in Oklahoma in 1935, are firmly established as a permanent part of a city's traffic control system. They have proved their value in effective control of time-limit parking. They tend to reduce overtime parking and increase turnover. They simplify and reduce the expense of enforcing time limits. More and more cities are wisely earmarking meter revenue for providing offstreet parking facilities and for traffic improvement.

While there is no disputing the widespread use of parking meters and their beneficial use in the control of curb parking, there is a tendency in many cities to regard meters as a panacea for all parking ills. Actually it is inevitable that more and more street space must be used for the moving traffic for which the street was created and that the goal in every city must be adequate offstreet parking.

In 1952, a factual study on parking meter use in the United States was made, based upon a comprehensive questionnaire sent to the cities. Much of the material in this chapter was taken from the report of that study.[1]

The study was purely factual, showing existing practices. The data indicate only what was being done, and should not be interpreted as suggesting or implying that such practices are necessarily the best.

Extent of Parking Meter Use

The Municipal Year Book for 1942 reported that 347 cities were then using curb parking meters. By the end of 1951 this number had grown to more than 2,800, using more than one million meters. In spite of this growth, only 16 percent of urban places

1. Joint study undertaken by the Highway Research Board, the Bureau of Public Roads, and the American Municipal Association. The report of the study was published as Bulletin 81, Highway Research Board.

were using meters. Of cities with more than 2500 population, 38 percent were without meters.

At the same time, these cities reported having an additional 18,626 meters in offstreet facilities, and were proposing the installation of 90,757 more at the curb and offstreet.

New York City's use of meters did not start until late in 1951 and is not fully reflected in the study; but in 1953 the city had more than 21,000 meters in operation in sixty-eight areas, and expected to have 26,500 by the end of 1954.

Table V–1

Parking Meters in the United States

Population group	*Total number of places (1950 Census)*	*Places having curb meters*		*Estimated * number of meters in places having curb meters*		*Places reporting*
		*Number ** of places*	*Percent of total places*	*Number ** of meters*	*Percent of all meters*	*Number*
Under 2,500	13,235	385	2.9	48,117	4.3	86
2,500–5,000	1,557	616	39.6	114,259	10.3	217
5,000–10,000	1,093	707	64.7	196,630	17.7	300
10,000–25,000	752	639	85.0	258,585	23.2	311
25,000–50,000	249	236	94.8	144,823	13.0	128
50,000–100,000	126	120	95.2	123,325	11.1	61
100,000–250,000	65	61	93.8	87,761	7.9	37
250,000–500,000	23	22	95.7	62,995	5.6	13
500,000–1,000,000	13	12	92.3	59,705	5.4	8
1,000,000 or over	5	5	100.0	16,964	1.5	4
TOTAL	17,118	2,803	16.4	1,113,164	100.0	1,165

*By expansion of data from cities reporting.
**As of January 1, 1952—Data from "Parking Meters," Bulletin 81, Highway Research Board.

Public Attitude Toward Meters

Table V–2 summarizes replies from nearly 1100 cities concerning the attitude of the public, merchants, businessmen and farmers, before and after meter installation. Results demonstrate clearly the widespread acceptance of parking meters, with a favorable vote by nearly 96 percent of the cities. It is apparent that "before" attitudes were influenced by uncertainty or fear of the unknown, which disappear once the advantages of meter use are demonstrated. One noteworthy finding was that opposition to meters by farmers was less than expected, and although large cities are the strongest supporters of meters, there was little difference in the attitudes of any of the population groups.

Table V–2

PUBLIC ATTITUDES TOWARD PARKING METERS BEFORE AND AFTER INSTALLATION, AS OF JANUARY 1, 1952*

Population group	*Percentage of places with indicated attitude*							
	Substantial opposition		*Some for Some against*		*Generally favorable*		*Attitude unknown*	
	Before	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*
Under 2,500	37.4	1.2	37.3	6.4	25.3	92.3	—	—
2,500–5,000	34.0	2.0	34.0	2.5	31.5	95.0	0.5	0.5
5,000–10,000	36.7	3.1	32.3	1.0	28.9	95.5	2.1	0.4
10,000–25,000	36.7	1.2	27.0	2.6	35.3	96.2	1.0	0.0
25,000–50,000	34.0	2.7	33.9	—	30.4	96.4	1.7	0.9
50,000–100,000	37.5	5.1	19.6	—	42.9	94.9	—	—
100,000–250,000	29.7	—	48.7	—	18.9	100.0	—	—
250,000–500,000	54.5	—	18.2	—	27.3	100.0	—	—
500,000–1,000,000	—	—	80.0	—	20.0	100.0	—	—
Over 1,000,000	—	—	25.0	—	75.0	100.0	—	—
TOTAL	35.6	2.1	31.6	2.0	31.6	95.6	1.2	0.3

*Data from "Parking Meters," Bulletin 81, Highway Research Board.

Advantages and Disadvantages of Meters

The parking meter, when accompanied by adequate-length stalls, time restrictions appropriate to the demand, and proper provision for loading zones, produces the following benefits:

1. Provides an accurate time check on parking, simplifying detection of overtime parkers, and discouraging all-day parkers.

2. Reduces overtime parking, increases turnover and makes parking available for more motorists.

3. Aids merchants in metered areas by increasing turnover.

FIGURE V–1. Double parking before installation of parking meters on a New York street. *Courtesy New York City Department of Traffic*

4. Reduces the police personnel required for parking enforcement by nearly 50 percent.

5. Reduces double parking.

6. Aids traffic flow by reducing congestion caused by cars maneuvering into unmarked spaces. See Figures V–1 and V–2.

7. Finances the enforcement of parking, of traffic control, and often the provision of offstreet facilities.

However, to provide these advantages and to be fully effective, meters must be reasonably used and thoroughly supervised and enforced. Some possible disadvantages are:[2]

1. If used where not warranted, they arouse resentment and result in nonobservance.

2. Unless properly enforced, motorists learn that they can park overtime with impunity.

3. Unless frequently checked, some motorists will park overtime for long periods by "feeding" the meters.

4. After meters have been installed, the desire to continue the

2. *Traffic Engineering Functions and Administration,* Public Administration Service.

FIGURE V–2. Double parking eliminated and traffic flow expedited, after installation of parking meters. *Courtesy New York City Department of Traffic*

revenue may prevent elimination of curb parking when traffic demands indicate a need for it.

5. On streets where parking is prohibited during rush hours, the presence of meters increases the difficulty of enforcement.

Legality of Parking Meters

Those who have studied the subject, as reported by the League of Minnesota Municipalities, agree that a parking meter ordinance raises the question of whether such an ordinance is a proper exercise of municipal police power. This question is then resolved into others:

1. Does it unduly restrict the public's right to use the street?

The weight of opinion has been that the right to free use of the street implies only such use as is necessary to travel, and does not include the right to park. Parking meters provide a reasonable method for providing the regulation or enforcement needed, and cities are empowered to collect fees necessary to cover the cost of installation and regulation.

2. Does it unconstitutionally deprive abutting property owners of their right of ingress and egress to and from the street?

Similar reasoning applies here. In the case of Kimel v. the City of Spokane (Wash., 1941) the court stated:"Under the exigencies and complexities of modern life, it is impossible to guarantee to respondent free and uninterrupted access to his property at all times. The use of streets and highways for the parking of motor vehicles has been too long and too well established by custom to now be denied because of the theoretical right of the occupant of abutting property to free and uninterrupted access to his premises at all times . . .

"On the other hand, the power of the state and of the municipalities to regulate the parking of cars on the streets and highways cannot be doubted . . . with the exercise of that power, the courts will not interfere so long as it is invoked with reasonable regard for the rights of both the traveling public and the occupants of abutting property."

3. Does the large amount of revenue which the parking meters yield require the ordinance to be regarded as a tax measure or as a police or regulatory measure?

In a Minnesota case the court said that the ordinance in question declares the amount of fee to be "levied and assessed as a fee to cover the cost of inspection and regulation, control and operation." From this the court concluded that it was an attempt to exercise the police power.

"The ordinance must fail if there is a lack of proportion between the cost of the service rendered and the fee actually charged. The city may intend by this means to pay for the whole cost of the regulation of parking – cost of machines, their repair, the pay of the policemen who will be required to enforce the ordinance, and generally the expense of providing and keeping clear places in which drivers may park."

The principle is that a municipality, as an incident to its general police power, may charge a reasonable license fee to defray the expenses of the police regulation or supervision; but a specific enabling act is required to empower the municipality to impose a special tax for revenue-producing purposes.

Most of the decided cases hold that the fees involved were justified as incident to the general police power. It has been said that "it is conceded that the income from license fees need not equal exactly the costs of supervision. A substantial surplus will be disregarded unless the surplus becomes so great as to make the charge so disproportionate to the cost that it can be classed as nothing but a revenue measure."

Administration of Meter Program

The administration of a meter program may involve several major functions: (a) selection of meter locations; (b) enforcement; (c) repair and maintenance; (d) collection of revenues, and (e) miscellaneous functions. The study shows a wide diversity of executive agencies responsible for this administration.

Selection of Meter Locations

According to 48 percent of more than 1100 returned questionnaires, location is determined by the local legislative body itself, very likely from a belief that this function should accord with the will of the people. In about 18 percent of the places, police have the function, and in 12 percent it is assigned to the chief executive officer of the locality.

Strangely enough, only six percent of the places makes the traffic or transportation agency responsible, although that would seem to be the most logical choice, where such an agency exists. The remaining 16 percent of the places assign the duty to one of twelve miscellaneous agencies – street or highway department, parking commission, board of public safety, public service commission, city clerk, finance commissioner, and in one place, the merchants of the city.

The parking meter program in many cities has become big business. Its administration should be in the hands of the city department best qualified and most capable of handling it.

Enforcement of Meters

In more than 75 percent of the places reporting, the police department very properly has this function. In 12 percent the legislative body has the responsibility, but some of these cooperate with the police. The remaining 13 percent assign the function to the mayor, the traffic department, or other agency.

In the cities where enforcement is by full-time policemen, the average number of meters served per policeman ranges from 88 in the smaller cities to more than 300, averaging 277 per policeman for all cities.

An interesting feature in enforcement of meter regulations is the use of women by the police department. Charlotte, North Carolina, for example, set up a twelve-woman patrol to check meter violations in the downtown area. These policewomen have no police power other than to issue citations, but a number of cities have reported them to be efficient in these duties.

Repair and Maintenance of Meters

In 54 percent of more than 1100 cities reporting, the police department has this responsibility. Eight percent assign it to the parking-meter department, most logical where such an agency exists. In five percent of the cities, the legislative body itself retains the function. In the remaining 33 percent it is scattered through a variety of sixteen other agencies, including only five percent where the traffic department assumes the duty.

Collection of Meter Revenues

Here again the police department is most often charged with this function – in 59 percent of the cities. But in the 1108 questionnaires returned, thirty other agencies were designated. Many of the smaller places, as a matter of economy, use policemen. However, it would seem entirely logical that collection of revenues should be assigned to an agency having some functional relationship with the meter program: the traffic department, police, parking-meter department or parking agency, or treasurer's office.

Miscellaneous Functions

Other functions essential to a parking meter program include counting, sorting and depositing revenues, keeping records, and mailing delinquency notices. The agencies most frequently named are the city clerk's office, 28 percent, and city treasurer, 26 percent. Of lesser importance, in order of their frequency, are the chief executive officer, finance department, police department, banks, city controller, and others.

Other duties are performed by the agencies indicated: (1) overall supervision and answering of complaints, by the motor vehicle parking agency in one place and by the traffic engineering division in another. (2) Studies of meters and development of an offstreet parking program, by the planning department, police department, and service department, each in one city. (3) Rental of meter hoods by the city treasurer in one place. (4) Purchasing of meters by one city purchasing department, by the parking meter department of another, and by the department of public works in a third.

Ordinances Concerning Meters

Ordinances relating to parking in many cities reveal deficiencies which would render portions of them invalid if challenged in court. A common circumstance is to find meter installations placed by the police or by authority of some city official but without the enacted and recorded ordinance required to give them legal status. Frequently, an ordinance intended to prohibit "meter feeding" fails, by its wording, to do so.

Any city would be well advised to review its parking ordinances. An excellent model is available, published in the 1953 Model Traffic Ordinance and included in Appendix I of this volume.

Types of Meters

Meters are small weathertight metal boxes mounted on a post near the forward end of a curb parking space. The post is usually set in the sidewalk about one foot from the edge of the curb.

There are two basic types, manual and automatic. A clock mechanism is set in operation when the meter is used, either by turning a crank or moving a lever after inserting the proper coin (manual), or by insertion of the coin itself (automatic). The manual clock mechanism is wound each time it is used, by turning the crank or pushing a lever. In the automatic meter, the clock mechanism is wound periodically, usually when coins or coin boxes are collected.

Some meters are adapted for the use of one coin only, others for more than one coin or denomination of coin. The clock mechanism moves a dial or a pointer across the face, indicating elapsed time or time remaining after the fee is paid. Some later models do not show time remaining. The dial or pointer is usually of distinctive color when permissible time limits are exceeded, to emphasize overtime parking.

When coins are inserted, they fall into sealed containers which are collected and then opened only by an authorized official. Other sealed containers are used as replacements permitting meters to be used continuously.

The study revealed that 55 percent of the 512,853 meters reported upon were automatic. There appears to be a relationship between the type of meter and size of the city; in general, the larger the city the higher the percentage of automatic meters.

Features to consider in selecting a meter other than whether it is automatic or manual, include:

1. A register or coin counter to record deposits, to provide a control of collections.

2. A visible window showing the last coin deposited, with the purpose of reducing use of slugs.

3. A violation signal to show time used. Visibility of these signals from a distance on either side of the meter is important for law enforcement.

4. Coin slots are located differently on various types of meters; some have two coin slots, one for pennies and one for nickels.

5. There are single coin meters, multiple, and combination meters which permit the use of both pennies and nickels. Obvious advantages of the many types may be observed by a demonstration of meters.

Purchase of Parking Meters

The Highway Research Board study reported sixty different plans used in purchasing meters. Some cities pay cash, with short trial periods before the purchase, and often receive cash discounts. In some cases when the city pays cash, the company assumes the cost of maintenance for the first year. Other cities arrange to pay at the rate of 25 percent of the revenue (or 50 or 75 percent), but assume title immediately; in some instances, the company retains ownership until the meters are paid for.

Four different plans, however, account for 69 percent of the places reporting; (1) company retains ownership until meters are paid for, 21 percent; (2) company retains ownership until meters are paid for, at the rate of 50 percent of revenue received, 19 percent; (3) company receives 50 percent of revenue until meters are paid for, 19 percent; (4) city pays cash, with no restrictions, 10 percent.

Specifications for Parking Meters

The Massachusetts Institute of Technology in 1947 published an appraisal of various types of parking meters. The points covered:

A. Reliability of operation
  1. Simplicity of design
  2. Ruggedness of design
  3. Susceptibility to improper usage
  4. Resistance to weather and shock
  5. Ease with which unit may be removed for servicing

B. Convenience to User
  1. Ease of operation
  2. Clear and simple directions
  3. Protection against loss of coin if operating instructions are improperly carried out
  4. Overtime record

C. Visibility
  1. Coin slot
  2. Directions
  3. Scale reading
  4. Violation signal

D. Protection against dishonesty
  1. Sealing of coin box
  2. Counter
  3. Slugs
  4. Detection of slugs

A subcommittee of the Institute of Traffic Engineers further recommends that the following points should be covered:

E. Exterior design
   1. Appearance
   2. Absence of corners or projections
   3. Finish
   4. Resistance to weather and shock
F. Cost of operation
   1. Spare parts furnished without charge
   2. Cost of replacement parts
   3. Length of guarantee period.
G. Method of installation and installation materials
   1. Simplicity of design
   2. Ruggedness of design
   3. Resistance to weather and shock
   4. Uniformity of height of meters and distance from curb

A set of model specifications for parking meters, as recommended in 1948 by a committee of the Institute of Traffic Engineers, is presented in Appendix II, page 000.

Cost of Parking Meters

The weighted average cost per meter for 416,151 meters purchased from 1935 through 1951, was as follows:[3]

1935	$52.50	1941	$59.54	1947	$65.32
1936	61.49	1942	62.40	1948	64.71
1937	59.97	1943	65.68	1949	64.79
1938	62.20	1944	60.25	1950	62.25
1939	57.81	1945	68.85	1951	61.08
1940	54.61	1946	66.06		

After World War II the average price of parking meters decreased from $68.85 in 1945 to $61.08 in 1951 (the study year). This was during a period of rising prices.

Municipal officials concerned with parking programs may use

[3] Highway Research Board Study.

the average costs indicated with some assurance, for budgeting, financing and planning purposes. However, individual technical differences between the various brands should be taken into account.

Meter Fees at the Curb

More than fifty different combinations of cost and time periods are used with curb meters, but for 87 percent of all meters the most frequent rate is five cents per hour. Some also allow 12 minutes for one cent, 24 minutes for two cents, etc.; others allow parking for more than one hour at the same rate—two hours for ten cents, and up to ten hours for fifty cents. The lowest rate reported was ten hours for five cents and the highest, sixty cents an hour (applying to only one meter).

Although in the majority of cases meters are intended to foster short-time parking, some exceptions permit ten hours for twenty-five cents. There is a growing tendency to charge more than five cents an hour, by raising the rate to ten cents an hour, five cents for thirty minutes, or twenty cents for two hours.

When New York City first installed 1500 parking meters, late in 1951, the fee was fixed at ten cents for the prescribed time limit of one hour or less.

The survey merely reported existing practices, with no necessarily logical justification for many of the unusual rate and time combinations. Probably the needs of most cities could be served satisfactorily if curb meters were made available only for periods of twelve, fifteen and thirty minutes and one, two and three hours. Perhaps in some cases eight- or ten-hour meters may be warranted for all-day parkers in fringe areas. In general, time periods should be closely tailored to the needs of parkers and traffic conditions, with priority given to short-time parkers.

Sometimes special types or classes of vehicles are exempted from paying the regular meter fee but are subject to an alternative method of paying for use of the space. This may be by placing a hood over the meter or a windshield sticker, on payment of an annual fee.

In Fort Worth, Texas, when a metered space is used as a special zone, the charge is fifty cents per day if it is a two-hour meter, seventy-five cents at a one-hour meter, or a dollar per day at a twenty- or thirty-minute meter.

Meter Fees Offstreet

Contrary to common belief, metered offstreet facilities generally do not have higher rates than curb space and do not cater to long-term rather than short-term parkers.

The most prevalent fee for offstreet meters is one hour for five cents, at 47 percent of the 18,626 meters reported upon. The next fee schedule (at the same rate) is two hours for ten cents, 41 percent of the total; third, two hours for five cents, 30 percent of the total; fourth, three hours for fifteen cents, 25 percent of the total. Eliminating the overlapping of meters of the same rate, more than three-fourths of all offstreet spaces have relatively low rates and serve short-time parkers.

Alhambra, California (population 51,000) has nine metered lots with 396 metered spaces, all at five cents for two hours or twenty-five cents for ten hours. Businessmen who were regular users of these lots requested that a monthly rate be established. Because of charter provisions and enforcement difficulties, a plan was adopted to rent meter hoods (with lock and key) for a $5 deposit and $3.50 per month in advance.

Possession of a hood does not entitle the holder to use a particular space or lot, but permits the use of any space in any of the nine lots. Hoods are not transferable, are good only for the car for which issued, and may not be left on a meter when the space is vacated. A renter who fails to use his hood is ticketed.

Erasing Unused Meter Time

In Chapter Two it was pointed out that in spite of the fact that many parkers park overtime, the average user of a two-hour metered space parks for about fifty-four minutes, and the average user of a one-hour metered space parks for about forty-two minutes. Since more than 90 percent of all meters are in these two classes, it is clear that a great amount of paid-for but unused time at metered spaces is appropriated by subsequent parkers.

The *Kansas Governmental Journal* (January, 1952) reported that Denver experimented with a device designed to "erase" unused time. The device had a bar or treadle set into the pavement, parallel with the curb and approximately in the middle of the parking space. This bar makes an electric contact with the meter as a vehicle leaves the space, lowering the red flag and resetting the meter.

Middletown, Connecticut obtained parking meters with a dial visible from only one side, and then installed the meters facing the stores (away from the street). The chief of police reports these advantages:

1. It permits the foot patrolman to watch the meters on his beat.
2. Motorist-shoppers can come to the store door or window to check their remaining time. The meters have large dials.
3. Motorists are prevented or deterred from cruising to find free unexpired time on meters.

Meter Rates and Major Generators

It is evident that a tendency is developing in cities to graduate meter-fee schedules so that spaces closer to major generators of parking would have higher rates or shorter time limits.

Of 1160 cities reporting, 62 percent indicated no graduated fees or time, regardless of the location. But 21 percent reported that although rates were the same on all meters, the permissible time was shorter at meters nearer important generators. And 16 percent reported rates higher and time shorter near major generators.

Special types of generators often are the reason for different rates or shorter allowed times. In this class are postoffices, banks, utility offices, and drug stores. The larger the city, the more probable is the use of short-time meters in these areas.

The few fifteen- and thirty-minute spaces are generally located at postoffices and banks; one-hour spaces are on the main street (and core area in the larger cities); two-hour spaces form a ring around the one-hour spaces, and spaces on the fringe of the central business district are unrestricted. This is almost invariably the pattern, except that in some smaller cities the shortest restriction is two hours. Thus whether cities have meters or not, the tendency definitely is to graduate time restrictions (inversely) according to the intensity of demand.

Meter Revenues

Parking meter revenue is shown by the following data:

Table V–3

ESTIMATED ANNUAL REVENUE OF CURB PARKING METERS*

Population group	*Estimated total number of curb meters*	*Estimated average annual revenue per meter*	*Estimated total annual revenue from all curb meters*
Under 2,500	48,117	$42.28	$2,034,387
2,500–5,000	114,259	48.73	5,567,841
5,000–10,000	196,630	55.62	10,936,561
10,000–25,000	258,585	67.43	17,436,387
25,000–50,000	144,823	74.80	10,832,760
50,000–100,000	123,325	77.25	9,526,856
100,000–250,000	87,761	82.92	7,277,142
250,000–500,000	62,995	89.67	5,648,762
500,000–1,000,000	59,705	82.34	4,916,110
Over 1,000,000	16,964	86.78	1,472,136
Total or average	1,113,164	$70.48	$75,648,942

*As of January 1, 1952. "Parking Meters," Bulletin 81, Highway Research Board.

Amounts of revenue collected by curb meters may be emphasized or given more local significance by the data in Table V–4.

While the figures in the above table represent average cities, there were wide ranges in the number of meters in cities of any one group and hence in the revenues. For example, Marysville, California, with a population of 7,826, reported an annual revenue of $50,212; Rockford, Illinois, population 92,927, reported $194,445. The largest annual gross revenue reported for a single city was $763,291, for San Francisco.

Table V–4

ANNUAL METER REVENUE IN THE AVERAGE PLACE* OF EACH POPULATION GROUP

Population group	*Number of places having curb meters*	*Average annual gross revenue per place having meters ** *
Under 2,500	385	$5,284
2,500–5,000	616	9,039
5,000–10,000	707	15,469
10,000–25,000	639	27,287
25,000–50,000	236	45,902
50,000–100,000	120	79,390
100,000–250,000	61	119,297
250,000–500,000	22	256,762
500,000–1,000,000	12	409,676
Over 1,000,000	5	294,427
	2,803	

*Average city having meters. As of January 1, 1952.
**Based on data from Highway Research Board Bulletin 81.

New York City's use of curb meters did not begin until 1951 and was not included in this study; but in 1954 it was estimated that by the end of that year New York City would have more than 26,500 meters in operation. All are on a ten-cent basis, and average $180 to $200 per meter per year. The annual gross revenue to New York City is estimated at more than $5,000,000.

In general, the larger the place, the greater was its annual average gross revenue per meter, ranging from $42.28 in places under 2,500 population to $89.67 in cities from 250,000 to 500,000 (with a preponderant rate of five cents an hour). The record annual revenue reported (*American City*, June 1953) for a single five-cent meter was $256.65, at a fifteen-minute meter near a public utility collection office in Toledo, Ohio.

Use of Meter Revenues

In 1951, curb meter revenues, as reported by 1,152 places, were used as follows:

Table V–5

DISPOSITION OF GROSS CURB PARKING METER REVENUES IN 1951*

Purpose for which revenues were expended	*Percentage of gross revenue*
Curb and offstreet parking	
Parking meter program	
1. Amortization of curb parking meters	7.5
2. Police enforcement	6.2
3. Meter repair and maintenance	3.9
4. Collection of meter revenue	2.0
5. Combination of two or more of 2, 3, 4	2.9
6. Miscellaneous expenses, meter program	0.6
Total parking meter program	23.1
Parking meter fund	3.2
Offstreet parking facilities	8.6
Total curb and offstreet parking	34.9
Related purposes	
1. Traffic control	5.1
2. Street or highway improvement	2.5
General city purposes	
1. General fund	38.1
2. Police department	2.4
3. Miscellaneous purposes	1.7
Total general city purposes	42.2
Combination of two or more of above purposes	3.8
Disposition not indicated	11.8
Gross revenue for year	100.0

*Data from Bulletin 81 of Highway Research Board.

In New York City, the largest user of meters, the fee was fixed at ten cents for the prescribed time-limit; and the law prescribes that all meter fees be paid into a special "traffic improvement" fund. The need for parking accommodations is so great that any diversion to nonparking purposes is beginning to be looked upon as undesirable in the public interest, as well as conflicting with the legal justification for parking meters.

It is noteworthy that at least 20,315 spaces and 165 lots were provided by 1951 through parking meter funds in 167 places in twenty-six states. It is in this direction that meters are making a real contribution.

Fines for Violating Meter Restrictions

The scale of fines for these violations, as reported for 1951 by more than 1,100 cities, ranged from five cents to a maximum of $3. The most common flat-rate fines were $1, levied in 569 cities in forty-two states; and fifty cents, in 124 places in twenty-five states. Among the fines varying with the number of offenses or the time elapsing before payment is made, the most common ranged from a minimum of $1 to a maximum of $2 to $100.

There appears to be significance in average revenue from fines per meter in use.

Table V–6

Average Annual Amount of Fines Collected per Meter

Population group	*Average amount of fines per meter*
Under 2,500	$2.61
2,500–5,000	3.00
5,000–10,000	4.14
10,000–25,000	6.92
25,000–50,000	11.94
50,000–100,000	15.71
100,000–250,000	40.61
250,000–500,000	58.57
500,000–1,000,000	31.66
Over 1,000,000	23.62
Average	$12.33

Based upon the estimated total number of curb meters in use in the United States in 1951 (1,113,164) and upon the above fine collections per meter, total fines for all meters in 1951 were estimated at more than $16,000,000, equal to about 21 percent of the amount collected from the meters themselves.

Memphis, Tennessee formerly imposed a $1 fine for any length of overparking time and found that many motorists took advantage of this leniency by using the curb for all-day parking. Now, a fine of $1 is imposed for each hour of overparking.

Pittsburg, Kansas has had good success with the use of collection boxes for overtime parking fines. Motorists find it more convenient and less embarrassing to put fifty cents into the envelope left by a patrol officer and drop it into a nearby collection box, than to hunt up the police station.

Collection boxes are mounted on steel posts set back a few inches from the meter line and slightly lower. The top of the box is rounded to shed rain, and extends like a visor over a deposit slot in the front; the bottom of the box is tapped for mounting on the post with a lock-on device. Boxes are locked with the same key that fits the meters, and, complete with lock and post, cost $17.35 each. Pittsburg has a penalty box for each eight meters.

Service Life of Meters

When the Highway Research Board study was made it had been only eighteen years since the first parking meter was installed, and the great bulk of meters in use today have been installed since World War II. Consequently, only limited experience data are available, and estimates of meter service-life by various municipal officials should be judged accordingly.

As a general summary, for the majority of meters reported on, without regard to type of meter, the estimated life was between six and fifteen years. By five-year classes, the following percentages were found:

Table V–7

SERVICE LIFE OF METERS

Average service life	*Percentage of total number of meters for which data were reported*
(years)	
0–5	9.7
6–10	55.2
11–15	22.7
16–20	6.0
Will last indefinitely	6.4
	100.0

It may be presumed that cities reporting an indefinite service life expected that adequate maintenance and repair would make that possible.

Analysis of the reports indicated that any differences in the service life of automatic and manual meters were so slight as to be negligible for all practical purposes. The evidence also indicates no significant relationship between the size of the city and the service life of meters.

Effectiveness of Parking Meters

It is usually stated that the objective in using meters is to reduce overtime parking and increase turnover at the curb. Frequently it is assumed that increased turnover, following the installation of meters, is proof per se that the meters have brought a benefit.

However, it has been demonstrated that the significant factors or criteria in assessing meter benefits are: (1) proportion of overtime parkers; (2) proportion of avilable time used by them; (3) average parking duration of these violators; (4) the turnover, and (5) any improvement found in the first three of these factors may be credited to the meters, but unless accompanied by improvement in the others, may not constitute any net improvement in conditions.[4]

An improvement in turnover alone should not necessarily be credited to the presence of meters, but an improvement in all four factors is reasonably conclusive evidence of meter effectiveness.

Table V–8 presents data comparing the performance of parkers in unmetered (posted) and metered zones of various time restrictions in fifty-eight cities throughout the United States. In most of these cities, enforcement of meter regulation was slight, usually confined to tagging only the violators indicated by red flags, with little attempt to catch the meter feeders.

In these cities the metered spaces show markedly better performance in percentage parking overtime in three of the four zones; in proportion of time used by violators in two of the four;

[4] *Traffic Quarterly,* April 1955.

Table V–8

COMPARISON OF OVERTIME PARKING AT POSTED AND METERED SPACES [1]

Zones	*Number of cities having*		*Total number of cities*	*Percent parking overtime*		*Percent of space hours used in excess*		*Average hours overtime parkers*		*Turnover*		*Percent of difference in turnover*
	posted spaces	*metered spaces*		*posted*	*metered*	*posted*	*metered*	*posted*	*metered*	*posted*	*metered*	
15-minutes	14	7	21	31.2	25.2	36.7	40.9	1.10	0.80	12.5	27.3	118
30-minutes	19	2	21	30.8	41.0	37.7	50.7	1.70	1.22	9.5	13.8	47
1-hour	12	11	23	22.3	18.2	27.5	23.8	2.49	2.16	7.7	9.9	29
2-hour	10	16	26	24.0	6.1	26.5	9.9	4.17	3.71	4.2	8.8	110
All zones	35	23	58	24.3	13.4	28.6	17.3	2.50	2.32	7.1	9.6	35

[1] Cities having only posted spaces or only metered spaces (in each time restriction class).

in average duration by violators in all zones, and in turnover in all zones. For the group as a whole, metered spaces were 45 percent lower in percentage of overtime parkers; 39 percent lower in proportion of overtime used; 7 percent lower in average duration of violators, and 35 percent higher in turnover. Benefits in the 15- and 30-minute zones are not conclusive, but in the one- and two-hour zones, which include 96 percent of all metered spaces, there can be no question.

Meters have undoubtedly brought definite benefits, whether enforced or not, but enforcement increases these benefits in proportion to its thoroughness. A corollary benefit is that regular meter-spacing eliminates the crowding and congestion found at unmarked and unmetered curbs. Also, double parking is much less prevalent at metered curbs, perhaps because they suggest the presence of enforcement (See Figures V–1 and V–2).

The task of checking parking time is much easier with meters, since violations can be detected from a moving police vehicle and the laborious process of chalking tires is greatly reduced. It is reported that only one-third to one-fourth the time formerly required is needed to patrol the same area after meters have been installed.

Warrants for Parking Meters

In determining when or where parking meter-installation may be warranted, it is essential that the decision be based upon established criteria or policies and not upon the desires of revenue-minded officials. When used at the curb, the sole function of a meter is to monitor the use of parking space to provide the best possible use of that space.

Such a policy or set of warrants follows:[5]

1. The installation should be based upon and aimed at an equitable apportionment of the available space-hours and not on the raising of revenue.

2. There should be ample evidence that, at the proposed location, the demand for curb space exceeds the supply. The supply is not adequate unless, at most times of the day, a small percentage, perhaps ten percent, of the spaces are open and available for use.

[5] Burton W. Marsh, of the American Automobile Association, in a paper presented at the 1948 annual meeting of the Institute of Traffic Engineers.

3. It should be determined through study and analysis that it is reasonable to have time-limited parking at the location and that from a traffic standpoint it will continue to be justifiable for some time in the future.

4. Meters should be installed only where parking is otherwise legal and advisable. In some cities the desire for extra revenue has led to encroachment on parts of the curb where parking should be prohibited – too near intersections, or where loading zones are needed.

5. The location of meters and their time limits should be integrated with the areas of demand, ranging from 15-minute meters at the heaviest demand spots in the core of the central business district to two-hour meters at its fringe.

6. Meters should be installed only to the extent that will permit good enforcement by the police power available.

7. Meters should be used only where it is possible to get full-size stalls, preferably twenty-two feet.

8. There should be assurance, preferably by ordinance, that meter revenues in excess of costs be devoted to betterment of the parking situation. While it is true that this warrant has no direct relationship to the apportionment or control of curb space, it seems wise, from the public-acceptance viewpoint, to assure official sanction and support of the policy that net meter revenues be used to help finance offstreet parking. In fact, the availability of such revenues greatly eases the financing of revenue bonds for that purpose.

9. Meters should be installed only after approval of the city traffic engineer, if there is one, or by the city engineer, to avoid installations which might produce bad traffic results.

An unusual installation of curb meters is used on Gulf Avenue in Passe-a-Grille Beach, Florida. Gulf Avenue has no business establishments, but borders a long strip of bathing beach on the Gulf of Mexico; and meters are used to allocate time for the bathers. The single row of meters is nearly a mile and a half long and has 395 meters. The fee is five cents per half hour and the allowed time limit is two hours. Meters are in effect from 8 A.M. to 7 P.M. every day in the year.

The Parking Meter and the Parking System

In addition to its usefulness in monitoring time restrictions and promoting increased turnover at the curb, the parking meter is becoming an important member of a partnership or system combining the legal, functional and financial aspects of curb and offstreet facilities. According to the Highway Research Board's study of meters, at least 212 municipalities in thirty states are integrating their curb and offstreet facilities.[6] This practice is usually evidenced through allocation of all or part of the meter revenues to an offstreet parking program, or through a pledge of the revenue in a bond issue for that purpose.

The essential elements of this concept of a parking system are:

1. A parking problem must exist.

2. A system mechanism, under whatever name, must be authorized in its essential features in state enabling legislation and in local ordinances.

3. All parking facilities under public control, at the curb and offstreet, must be pooled.

4. All financing and revenue operations must be pooled.

5. The system as a whole should be planned as self-liquidating.

6. Management of the system, acquisition, construction, operation and maintenance must be lodged in a responsible and qualified public body.

7. Need for parking facilities must be so urgent, authorizing legislation so sound, operating plan so reasonable, and financing proposals so equitable, that the judiciary will approve of the whole program as legal and constitutional.

Commercial Advertising on Parking Meters

A movement has been growing in metered cities to place private advertising matter on parking meters, the municipalities involved sharing in the profits. In 1951, forty-nine cities in twenty-three states reported they had such advertising, or had contracted for it, on their meters. The rates vary widely, from fifty cents to $20 per meter per year.

The legality of this practice and its wisdom from the standpoint of public policy are yet to be determined, but it is clear that it is not legal at least on the rights-of-way of the federal-aid systems.

In one city (Philadelphia), where property owners on certain city streets have title to the fee of the sidewalks and brought suit to enjoin meter advertising, the court ruled that "The city, in the exercise of its police power, has the right to regulate and control the said sidewalks for public uses and purposes only, and that, per contra, has no right to use or permit the use of said sidewalks

6 Bulletin 81, Highway Research Board.

for private purposes; and that therefore, the private use which the city and the intervening defendant propose to make of the said sidewalks would constitute a trespass thereon, and would result in taking of property of plaintiffs without due process of law."[7]

It is suggested that those contemplating an authorization for commercial advertising matter on parking meters read this decision in full.

Policy Concerning Use of Meters

Installation should be made only after a study to determine the need for meters.

An installation should be given sufficient publicity to acquaint the public with the proposed change.

An installation, particularly the first in an area, should be for a trial period. Meter revenues should not be looked upon as fees or a tax, but as incidental to regulation.

Enforcement should be uniform, thorough, and impartial, but reasonably tolerant.

Net meter revenues should be earmarked for offstreet parking or items related to traffic control.

As matters of operational policy, parallel parking curb spaces should be no less than twenty-two feet long; time limits should be set to meet the demands of parkers having destinations in the vicinity, with priority given to short-time parkers.

The use of metered spaces without charge should be permitted for delivery and pickup stops, for emergency service stops, and for loading and unloading if that privilege is not abused.

Meters should be inspected regularly, faulty mechanisms reported at once, and repairs made promptly.

[7] Chestnut Hill and Mt. Airy Business Men's Association et al v. The City of Philadelphia et al. Decision filed January 5, 1954, reported in *The Legal Intelligence*, January 13, 1954, Philadelphia, Pennsylvania.

CHAPTER SIX

OFF-STREET PARKING

Introduction: From 1940 to 1956, U.S. motor vehicle registrations rose from 30 million to 65 million. Vehicle miles increased from 302 billion to 814 billion. This constant growth intensified the downtown parking problem. The glut magnifies the need for parking space and creates more congestion downtown on streets.

While the curb supplies 88 percent of the parking space and takes care of 93 percent of the parkers in small cities, curbs in large cities provide only 16 percent of the space for about 50 percent of parkers. More and more street space must be reserved for moving traffic, and parking must be entirely prohibited on many principal streets. And notwithstanding how efficiently officials regulate curb-space to increase the turnover, the solution in larger cities lies in two approaches: lessening the need by using mass transit and fringe parking, and by adequate off-street space.

This chapter outlines the types of off-street facilities; types of facilities in terms of ownership or sponsorship; the setup of facilities; design; operation, and cost.

Location of Off-Street Facilities

The central business district: Lots and garages serving parkers of a central business district, seldom situated on Main Street, become more numerous as the fringe area is approached.

A specialized type of downtown parking area now appearing in many cities is the "drive-in," commonly found at banks; though some banks have provided space for a teller in a basement beneath the sidewalk, to serve patrons at a specially reserved curb space, a more recent trend is to install a side or rear-window in the bank wall, using side-yard, back-yard or alley space for cars to approach the teller's window.

A bank in Austin, Texas, occupying the ground floor of a large office building, has installed in the basement four teller's windows served by a special ramp from the street.

Neighborhood centers: Small facilities, usually lots, are found beside or behind small groups of stores on main traffic arteries in areas outside the central business district, in cities of more than 50,000 population.

Fringe lots, used largely by long-time parkers, are found at or beyond the fringe of the central business district. In small cities they are reached only by foot. In large cities, usually over 500,000 population, they are served by shuttle buses or nearby transit routes. A further discussion of fringe lots is included in a later section of this chapter.

Commuter lots, developed at the terminus, or at suburban stations of rapid transit lines, were installed by the Philadelphia Transit Company at the city limit as a self-parking 310-car lot. In the same category is the large lot developed by the New York, New Haven and Hartford Railroad twelve miles south of Boston, where its main line intersects Route 128, a freeway-type of circumferential highway around Boston. All trains, express and local, stop at this station.

Shopping centers usually are near or beyond the city limits, in cities of 100,000 or more, and are situated on large tracts adjacent to large apartment developments or in the suburbs remote from mass transit. Part of their attraction depends upon provision of ample and convenient parking space.

Airport carparks serve the major airports, and in large cities are highly profitable.

Industrial parking: Large industrial plants are usually situated in suburban or rural areas not served by mass transit, and require large parking areas for employees.

Types of Space Available

A parking study should produce an inventory and map-record of existing facilities, a determination of space deficiencies and available or potential locations for new facilities.

Vacant lots: Most parking lots first appearing in a city resulted from razed buildings. Often such lots are small, and of shape or dimensions that make efficient use difficult. Their haphazard location may have little relation to the demand. They do provide added space until a more profitable use for the property appears, usually one that will add to the parking demand.

City-owned land: Frequently, through obsolescence of a public building, by tax foreclosure, or by reclamation of property acquired for other purposes, a city owns potentially vacant land in the central business district.

In Temple, Texas, a Carnegie library occupying an entire block next to the City Hall was destroyed by fire. Temporarily the site was used as a drive-in market for farmers. Later it was developed into 278 metered parking spaces. With fees of five cents for two hours or thirty cents for twelve hours, the lot averaged a turnover of 2.1, plus heavy evening use.

Outstanding examples of the use of city property are the underground garages built under city parks in Union and St. Mary's Squares in San Francisco, Pershing Square in Los Angeles, and Grant Park in Chicago. In each case, the park and landscaping were restored, and the high construction cost justified by the "hot-spot" location and consequent heavy usage.

The question of city subsidizing is not necessarily involved. A project may be turned over to private enterprise for construction and operation for years. If operation is by the city, the fees may be adjusted accordingly.

Blighted areas: These may call for extensive demolition. Such property, usually low-priced, may lead to larger, more efficient facilities. Development of an attractive parking area may result in rehabilitating adjacent property.

In Quincy, Massachusetts (population 83,000), city-owned marshy land behind stores on the principal business street was filled and developed into a parking area with 560 metered spaces. There was an immediate increase in business. Income from the meters totalled $51,000 in the first year of full operation. Retail sales personnel and the sales volumes per square foot doubled.

Interior block space: A study of the business district of a typical city revealed these facts:[1]

1 "An Economic Study of Interior Block Parking Facilities," C. S. LeCraw, Thesis, Bureau of Highway Traffic, Yale University.

1. In city blocks with separate interior-block land parcels, there is a differential in assessed valuation between street-front and interior property.

2. The value of both front and interior property decreases as the location increases in distance from the center of the city.

3. Savings in initial cost of land as high as $20 a square foot resulted from using interior property instead of street-front lots for off-street parking.

4. Street-front property will, on the average, return six times as much taxes as interior parcels of similar size and location.

5. Land values on streets with high traffic volumes tend to be lower than values where less traffic exists.

6. Land values were high on streets with high *pedestrian* volumes.

7. Entrances to interior-block parking generally provide accessibility to maximum traffic and minimum interference with pedestrians.

8. It is possible to locate entrances and exits to interior facilities on the ground level of buildings without interfering with the use of upper floors.

Downtown interior property is the area behind stores and office buildings. It is often blighted with outbuildings and rubbish, yet within a hundred feet of valuable frontages. In older eastern cities where blocks average from 150 to 300 feet square, rear areas are small. In many midwestern or western cities, with blocks approximately 600 feet square, there may be two or three more acres interior space in one block. This may be purchased for far less than the cost of curb frontage. Where property owners cooperate in a joint development, the added facilities provide a valuable asset. In Quincy, Massachusetts, merchants installed attractive rear entrances off the parking.

An example of interior-block development is the 510-space ramp garage of the Zion Cooperative Mercantile Institution in Salt Lake City. (Figure VI–1.) The only front property used is for combined entrance and exit.

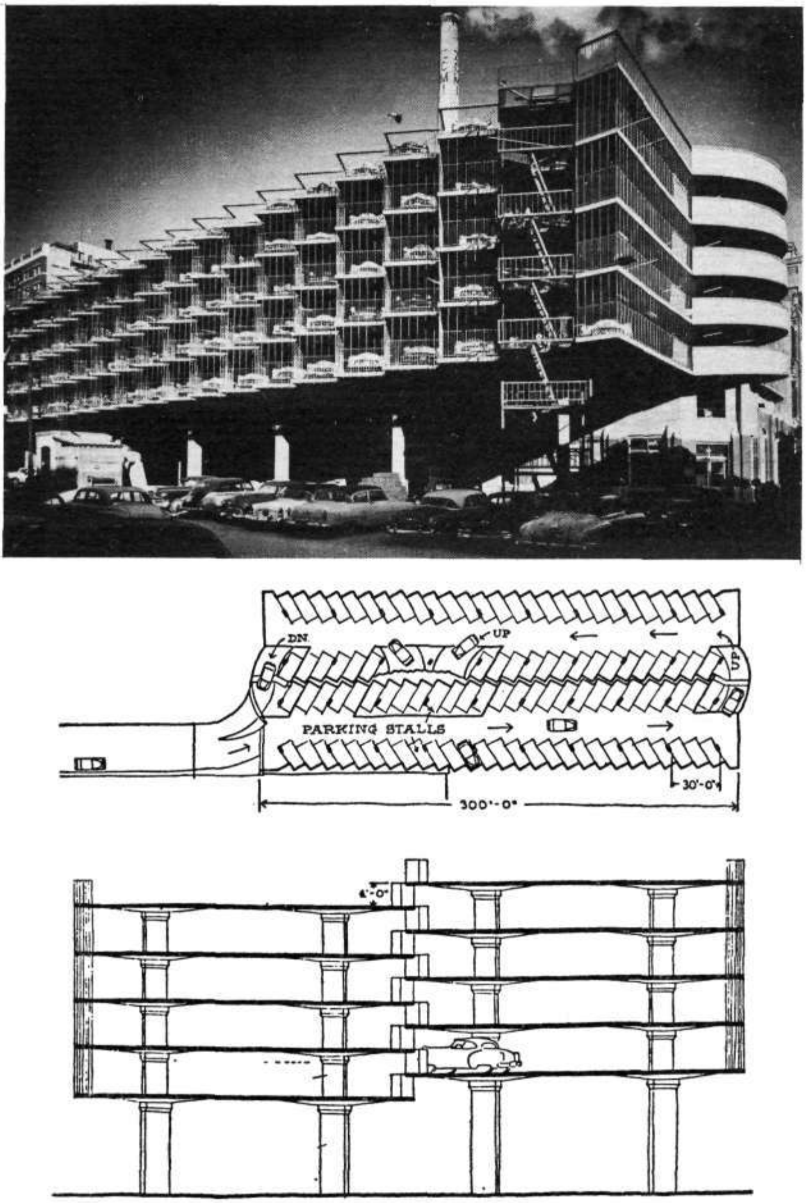


FIGURE VI-1. Interior-block garage of Zion Co-operative Mercantile Institute, Salt Lake City, Utah.

Commercial Facilities: Of more than a million spaces in lots and garages in the United States, about eighty percent have been provided by commercial operators. They rent vacant lot land to organizations with chains of lots and garages.

Types of Off-Street Facilities

Merchants or Customer Facilities: These facilities as provided by merchants primarily for their customers, may be owned and operated by the merchants, or owned by them and operated by a professional operator. They may be owned or leased by a merchant group or landlord. They may be free or fee facilities. Merchants are more aware that an important factor in sales volume is moderately-priced parking within a reasonable distance from their stores.

Operating costs of merchant-owned facilities are often lower than the cost of commercial facilities. Frequently they form an accessory to a business, and because of increasing the sales volume, parking is offered free. A few years ago, the American Automobile Association reported that space provided and operated by merchants cost only half as much per car parked as the cost for private facility parking.

Merchant-owned and operated—free: Typical of this merchant-operated class are the free self-parking customer lots. The Hecht Company at Arlington, Virginia, operates a free customers' garage adjacent to its suburban branch store. One of the largest garages in the world, it has four levels, 1500 spaces, easy ramps, one-way aisles, and self-parking. Each level connects directly with the store.

Merchant-owned and operated—fee charged: An example is the 510-space self-parking garage of the Zion Co-operative Mercantile Institution in Salt Lake City. Rates are 30 cents for the first hour and 20 cents for each additional hour, with a $1 maximum. Customers' tickets are validated for one hour's free parking for a purchase of one dollar or more.

Merchant-owned, professionally operated—fee charged: In Richmond, Virginia, the 516-space Grace Street garage is jointly owned by the two largest department stores—within half a block of both.

It is operated by a professional operating chain, with attendant parking—and no customer-ticket validation.

Validation: Stores not large enough to provide parking facilities of their own arrange with a nearby commercial operator to accept their customers at a predetermined rate, allowing an hour's free-parking for a store-validation. Some stores validate whether or not a purchase is made. Some validate for any purchase, but often a minimum is stipulated. Validation is commonly used at facilities operated by merchants.

Many merchants realize that competitively it is wise to make parking available. One merchant, computing the average purchase amount, the average number of purchases per person, and the average car occupancy, calculated that new customers cost him only three percent of the customer's gross purchase.

A validation plan started in 1954 at Washington, D. C., by the "Downtown Park and Shop" organization is participated in by 98 percent of the downtown parking facilities and 225 business establishments. These include stores, banks, beauty parlors, building and loan associations, restaurants, opticians, stationers, repair shops, and collection agencies. Each business, regardless of size, pays $5 weekly per place of business, payable quarterly in advance. This entitles it to display the Park and Shop insignia and to be listed in the Park and Shop newspaper advertising. A member business may purchase printed gummed validation stamps at thirty cents each. When a customer or client presents a parking ticket, the member firm pastes a stamp on it, for one hour's free parking. Each business sets its own requirement for validation, and there is no rule on the amount a customer must purchase for validation stamp.

Tenants' facilities: Similar to merchants' or customers' parking are those provided by property owners for their tenants or employees. These differ from customers' facilities in that they are not usually open for public use. Their space is largely rented on a monthly basis or the charge included in tenants' rent. An unusual example is the "park at your desk" structure in Washington, D. C., a complete ramp garage occupying the central core of a twelve-story office building. A tenant may drive directly to his floor.

Merchants' cooperative action: Merchants and property owners not in a position individually to provide parking facilities may increase their incomes by joint action—pooling separate interior-block parcels or by purchase or lease.

In Danbury, Connecticut (population 22,000), a merchants' association owns and operates a 250-car parking lot in the downtown area, open twenty-four hours a day at no charge. There are no attendants except for routine policing by the city police. The cost is met by small assessments within the organization, and occasional aid from the city.

The Downtown Merchants Parking Association of Oakland, California (population 385,000), was formed in depression years by far-sighted merchants and property owners. By 1954 the association operated six lots. These ranged from sixty to 242 spaces, and a 570-space garage, within 600 feet of the principal generators. Although the properties are leased, six are owned by merchants or property owners who benefit by their existence. The garage is owned by a subsidiary or affiliate of the association, which financed the land purchase and garage construction by selling shares of stock to merchants and owners. The garage is leased to the association for operation.

The facilities of the Association totaled 1344 spaces in 1954. Current charges were fifteen cents or one validated ticket for the first hour and fifteen cents each hour thereafter, with night parking (at two stations only) at 35 cents. In 1953, the combined facilities parked nearly 1,300,000 day cars (84 percent validated) with an average daily turnover of 3.9, and 71,000 cars at night. The average cost to members was about three cents per validation.

Another type of cooperative effort is a commercial garage in Sioux City, Iowa, where the normal parking fee is twenty-five cents an hour from 8 A.M. to 6 P.M. By arrangement with a group of merchants and professional men, shopper-parkers visiting any of their establishments are given a coupon good for one hour of parking for each purchase of $5 or more. A customer having several coupons may park for as many hours, or may collect a refund of twenty-five cents at the garage for each unused coupon if presented on the day of issue. At the end of each month the garage bills each merchant for the number of coupons used, at twenty-five cents each. Merchants say the system is both effective and inexpensive. The 400-space garage has a daily turnover of better than 3.5.

Even strictly private facilities help to relieve congestion. They are provided by business establishments, office buildings and industries for the exclusive use of their own personnel, sometimes for a small fee but usually free. The distinction between these and customers' facilities is that they are strictly reserved for certain persons and not available to the public. Common examples are the spaces reserved for officials at public buildings and the area for doctors at hospitals. An extreme case is the Pentagon in Washington, D. C. with some 9,000 reserved spaces.

Municipal Facilities

It is sometimes urged that municipal provision of off-street facilities has succeeded only in a few cities and by spectacular means. Actually, municipal parking facilities are widespread. In 1946, some 280 cities, over 10,000 population, reported having 570 municipal facilities with 75,000 spaces. In 1955, there were 685 cities, over 10,000 in population, with 2179 municipal facilities totaling 229,000 spaces. While there have been noteworthy projects in some of the largest cities, fifty-two percent of the facilities were in cities of less than 25,000 population.

Parking was free in forty-three percent of the facilities (principally under 25,000 population), fifty-two percent were metered and five percent unmetered charged a fee. The median number of spaces, by size of city, was:

Population	*Spaces*
10,000– 25,000	194
25,000– 50,000	272
50,000–100,000	411
100,000–250,000	300
Over 250,000	1,037

In 1950, the Regional Plan Association surveyed accomplishments in the New Jersey-New York-Connecticut metropolitan region.[2] Eighty-four municipalities were questioned. Of these, sixty-two places (74 percent) had established, authorized, or had in process municipal parking facilities.

Among the significant findings of this survey:

The average city had a population of 24,337.

Fifty-seven of the 62 places were under 50,000 in population.

The average number of municipal facilities per city was 6.8.

The average number of municipal parking spaces per city was 445.

The average number of municipal spaces per 1,000 population was twenty.

Eighty percent of the facilities charged no fee.

Seventy-two had no time limits.

The average city invested $6.64 per capita on offstreet parking.

Lots built between 1945 and 1950 had an average capacity of 148 spaces. The land cost was $326.50 per space, the improvement cost $192 per space. The total cost $518.50 per space. Land cost ranged from 6c to $6.20 per sq. ft.

Municipally owned and operated facilities: Since parking is free in forty-three percent of the municipal lots and is metered in fifty-two percent, it is obvious that nearly all such lots are entirely under city operation. The number of municipal *garages* is relatively small. City-owned and operated are the 500-space garage in Bridgeport, Connecticut, and the 320-space continuous-ramp self-parking garage in Grand Rapids, Michigan.

Municipally owned, privately operated: Some cities, although building and owning their garages, prefer to have the operation handled by experienced operators. In this class are the 1050-space municipal garage in Hartford, Connecticut, and the Boulevard and Third Avenue garages in Pittsburgh, Pennsylvania.

Joint or Cooperative Action

There have been many instances of parking space cooperation between municipalities and merchants or private enterprise, to the advantage of all concerned.

2 "Adequate Parking in Business Areas," F. P. Clark, *Traffic Quarterly*, April 1951,

The Telegraph Avenue business district, close to the University of California in Berkeley, had a serious deficiency in parking space. Merchants in the area approached the city council for assistance, but found that curb parking meter funds were inadequate, and that use of municipal credit was impossible (since the proposal was not city-wide), so a joint arrangement was suggested.

When a 100-space lot was found, the city agreed to finance one-half, the merchants one-quarter, and nearby property owners one-quarter, since all would benefit.

A "contribution district" was established by the Department of Public Works, to include all merchants and property within 800 feet of the site. The cost was $127,750 ($1,277 a space). The twenty-five percent share of the merchants was proportioned according to gross income, ranging from $12 a year to $240 a year for ten years. The twenty-five percent share of the property owners was proportioned according to assessed valuations, over a ten-year period.

The total cost, including meters, was $160,800. Based on the first six months of operation the receipts and expenses were:

Meter revenue			$8,000
Expenses:	Meter collection	$ 87	
	Enforcement	1,418	
	Electricity	420	
	Taxes	528	
	Maintenance, etc.	247	2,700
Annual net revenue			$5,300

The advantages of the Berkeley plan are that the city has title to the property, insuring its continued availability for parking, the property remains on the tax rolls and the meter revenues pay the taxes, and reasonable fees are assured.

Citizens and city cooperate: When the need for more off-street space became evident in East Lansing, Michigan, the city purchased two parcels of land and opened a small lot, financed from curb meter revenue.

The meter revenue was not sufficient to finance an expansion. A group of businessmen purchased or leased three additional lots for $200,000 providing 173 more spaces. The city council pays a monthly rental, payable solely from meter funds, for a five-year period, during which time it may purchase the property at the same price. With the cost of the property fixed, the city council plans to sell revenue bonds to enable purchase of the lots, reimbursing the businessmen.

City cooperates with a merchant: The Fox Company at Hartford, Connecticut, leased the land from the city, built a 650-space self-parking garage, deeded it to the city, and then took it back on a twenty-year lease, at the end of which it will revert to the city. Because of its location at one edge of the business district, the garage is used primarily by Fox customers. About fifteen percent of the users have other destinations. The fees are comparable with other facilities, and there is no validation.

Los Angeles Pershing Square garage: An example of cooperative effort is the 2000-space underground garage in Los Angeles. Pershing Square is a park occupying an entire block in the heart of the city's retail area, where the demand for parking space is critical and land values extremely high. The city was unwilling to sacrifice the attractive park, but leased the underground rights to private operators who built and operate the garage and pay yearly rental to the city under a fifty-year lease. The park was fully restored and landscaped.

Location of Parking Facilities

Ideally, every driver could park near his destination. In some cities there are cases where all persons bound for one large building—perhaps a hotel, department store, or theater—can park in an adjacent lot or garage—a difficult standard to meet on either a physical or an economic basis in crowded cities.

In Miami, Florida, a large department store is, on an average weekday, the destination of more than 3700 drivers with an average parking duration of more than two and one half hours. These parkers would require a garage of 1500 spaces, a structure of four levels filling a block situated on the most highly assessed land in the city, occupied by activities creating heavy parking demand.

Comprehensive parking studies, of the type described in Chapter III, have been made in more than 100 cities in the United States ranging from 10,000 to more than 1,000,000 in population. Figure III–4 (Chapter III) shows the space deficiency in a city of 100,000 population. In a large part of the central business district there is more parking space than needed. Space deficiency occurs in only twelve of the thirty-nine blocks, but these form the core of the district.

In the core of many cities, traffic demands have caused the removal of nearly all curb parking spaces, and the land values are usually too high to permit off-street parking.

Space deficiencies are in the core: That is the situation, in the central business district of nearly every city—a core where there is a deficiency of parking space, surrounded by a fringe that has more space than needed. Also in most cities the surplus space in the fringe is more than enough to balance the deficit in the center. The central business district as a whole has enough parking space but not where it is needed. In small cities there may be a space shortage along Main Street, but space enough on the side streets, not far from most destinations. But as cities grow the core grows also. In St. Louis, it is about 1400 feet from the core to an area where there is surplus space. The factor of walking distance is perhaps the most critical factor in locating a facility; for if walking did not have to be considered, selecting lots or garages would be no problem.[3]

No flat statement can be made as to how far people will walk after parking. As cities grow larger, parkers accept greater walking distances, and no matter what the size, there are parkers unwilling to walk more than a block; others will walk 1500–2000 feet if necessary.

Table VI–1 summarizes data on average walking-distances in cities of several population groups. Table II–18 shows that in each population group the majority of parkers are in the shorter distance groups.

These figures show how far parkers *are walking*, the distances

[3] "Walking Distances in Parking," R. H. Burrage, 1954 Proceedings Highway Research Board.

Table VI–1

AVERAGE WALKING DISTANCES OF PARKERS AT VARIOUS TYPES OF FACILITIES, THE PERCENT PARKING ILLEGALLY AND THE PERCENT USING PAY OFF-STREET FACILITIES

Population group (urban area)	*Number of cities*	*Type of parking:* *Curb*			*Off-street*							
		Free	*Pay*	*All legal*	*Free*	*Pay*	*All*	*All legal curb & off-street*	*Illegal curb*	*All parkers*	*Illegal parking*	*Parkers using pay off-street facilities*
		Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Percent*	*Percent*
Under 25,000 (Avg. 13,332)	4			215	158		158	208	139	201	11.2	
25,000–50,000 (Avg. 33,388)	8	421	306	338	266	491	315	311	184	285	8.0	3.9
50,000–100,000 (Avg. 82,683)	3	454	307	354	255	588	358	355	202	344	6.2	5.2
100,000–250,000 (Avg. 164,545)	6	428	387	395	283	660	521	438	192	426	7.0	8.9
250,000–500,000 (Avg. 399,043)	4	482	527	512	365	851	715	614	270	581	9.3	29.9
Over 500,000 (Avg. 880,145)	7	612	516	543	352	799	720	621	204	564	13.6*	24.8

* 19.4 for cities over 1,000,000.

becoming greater as conditions become more severe with increasing population. It might be argued that since people do walk these distances they are acceptable. But these data come from studies of cities dissatisfied with existing parking conditions, and with evidence of much illegal parking by motorists who risk fines rather than walk several blocks.

Better enforcement will increase the load on legal spaces, and stricter time-checks will increase both the turnover and the total users of curb-parking. Yet additional spaces must be off-street, and these, to improve parking conditions, must have shorter walking distances.

In most cities, added lots or garages are planned as *pay* facilities, and it is therefore advantageous to examine parkers' walking habits.

The *average* distance ranges from 491 feet to about 851 feet, becoming greater as the city grows. Table II–18 shows that the majority walk less than the average distance. A more realistic figure to use, therefore, would be the median distance (fifty percent walking further, fifty percent walking less).

These median distances in Table VI–2 are suggested as starting criteria but not to be used arbitrarily. Their application requires judgment. A greater distance may be acceptable because of other favorable factors, such as a wish to accommodate long-time parkers, the frequency of other generators between the facility and the core's demand-center, or a low-fee schedule. At a municipal parking lot in Providence, Rhode Island, the average walking distance is 1,590 feet. The explanation lies in the low fee—five cents for two hours, fifteen cents for four hours.

A walking distance of *less* than the median is desirable if the service is for shoppers and other short-time parkers; if pronounced grades come between the facility and the center of demand; if much of a gap intervenes between the facility and the nearest generators, or if there are poor crossings, busy intersections, railroad grade-crossings, bridges or similar psychological barriers along the pedestrian paths. Walking distances must be measured as the parkers would walk from the facility to entrances of the generators.

Table VI-2

AVERAGE AND MEDIAN DISTANCES WALKED BY OFFSTREET-PAY PARKERS IN SEVERAL POPULATION GROUPS

Population group (urbanized area)	*Range* by cities* Feet	*Average distance* Feet	*Median distance* Feet
Under 25,000	—	—	—
25,000– 50,000	112–756	491	345
50,000–100,000	482–725	588	490
100,000–250,000	339–858	660	530
250,000–500,000	716–895	851	740
Over 500,000	726–929	799	730

* Range of average among cities of each group. Data from U. S. Bureau of Public Roads.

Origins of parkers an influence: In some cities it is found that a preponderance of the shoppers and other short-time parkers come from a few parts of town, or directions. A facility situated on the side of the business district toward their origins will have more attraction and make less congestion than a location requiring trips through the district and a walk back.

Street-traffic pattern an influence: When a city has a belt highway skirting the business district, a parking may logically be placed between the belt and the core of the district, preferably on an important connection between the two, on its right-hand side inbound. It is desirable to have entrances and exits for right turns into traffic. A location running through a block between a pair of one-way streets will permit cars from either direction to enter and leave without crossing traffic. Access to a rear alley may accomplish the purpose.

In many cities, expressways or freeways are being built that skirt the core of the central business district to expedite the through-traffic, to serve the core, or both. These arterials generally have grade separation structures.

Construction of these highways often presents an opportunity to include parking facilities and their integration with the traffic plans. Examples are parts remaining from right-of-way takings, areas within large interchanges (requiring additional separation structures), space beneath elevated structures, and covered space over depressed routes. It is desirable to build parking facilities adjacent to and directly connected with the arterials or expressways. In this case it is necessary to have deceleration and acceleration lanes and ample reservoir space, to prevent backup on the highway.

Mid-block location best: Corner parcels in blocks are highly desirable for merchants, and consequently carry higher assessments. Mid-block locations are best for parking facilities, preferably at least 150 feet from intersections, to avoid interference with or from the intersection traffic control. An entrance or exit near an intersection can easily be blocked by back-up traffic at a stop light.

Pedestrian volume is a factor: High pedestrian volumes are a better index to high-value areas than high traffic volumes—and the high-value areas are generators of heavy parking demand.

Topography has a bearing: In a business district situated on level ground, a garage or lot on a steep grade is at a disadvantage because of extra walking effort required. But in a city where residents are accustomed to grades, as in Seattle or San Francisco, a sloping location may be an advantage to a garage or lot, in that direct access may be possible at different levels without ramps or elevators.

Interior-block and rear lot parcels: Advantages of these areas have been stated earlier. Such locations require only enough street frontage for an entrance drive or arcade, provide minimum interference with the continuity of store frontage.

In much the same class and equally desirable are block-rear parcels in rear of stores, especially when abutting stores have rear entrances. An outstanding example of this type of development is that of Garden City, New York, which has perhaps the best planned, most convenient and most lavish provision of parking space. Every store or business establishment has a parking area abutting in the rear, and the majority have rear-door access and show windows. Figure VI-2 is a typical example.

Multi-purpose locations: A parking facility convenient to the retail area may enjoy an excellent turnover, but its use may be largely confined to business hours. A location serving stores but

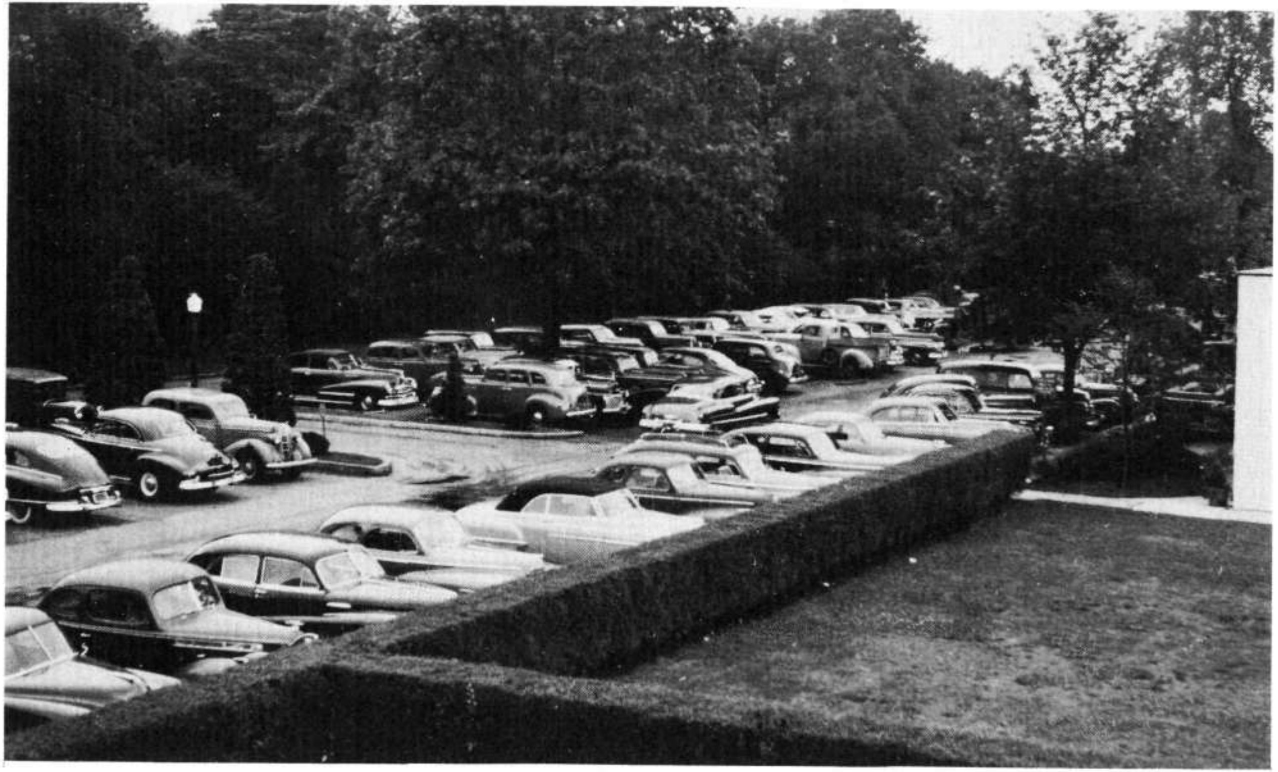


Figure VI–2. Municipal Parking Lot, Garden City, N. Y.

convenient to a theater, hotel or restaurant can increase its income through evening and overnight uses.

Size, shape and dimensions of available parcels: A parking lot has in theory no minimum size. Any vacant space or back yard may be so used. Many small, irregular areas are used for private parking, but areas intended for public use, free or fee, are not normally considered as parking lots unless they accommodate a minimum of ten cars. Records from a number of cities indicate the average public lot has about eighty-two spaces (20,000–25,000 square feet) and the average private lot about half that number.

Rectangular areas are preferred, irregular areas avoided if the area is small. Many layout designs are suitable to an area of 5000 square feet with normal proportions.

For ramp garages, it is generally agreed that, because of the space required for ramps, an area 100 by 120 feet is the minimum. Some mechanical garages can be used on a plot as small as twenty-five by eighty feet.

Capacity limitations: Some locations in larger cities justify large facilities. Yet there is general agreement that it is desirable to have several smaller facilities strategically distributed through an area. Self-parking ramp-garages should usually not be more than five levels above ground.

A 1200-space self-parking garage, opened in San Francisco in 1955, has eleven levels, ten above ground. When this volume was written, no definite conclusion could be reached on the use of its upper levels. Where demand is heavy enough, other space scarce, and rates low, parkers will likely accept the added height.

Larger garages, under attendant-parking, often are slow on deliveries because of the travel time involved, and contribute to traffic congestion when accepting or discharging peak volumes of patrons. Smaller facilities, better distributed, involve shorter walking distances.

Character of neighborhood: Many facilities have failed in their objective simply because the only apparent reason for their location was cheap land. Parkers avoid run-down or slum areas because of the danger of theft or vandalism, and they dislike walking through such areas to or from a facility.

The primary criterion in selecting a location is proximity to large generators of parking demand, but other things equal, a location is better if its patrons walk past other generators on their way to the center of demand.

Fringe lots: A fringe parking lot is one not in the central business district, but at its fringe or farther out. In small towns, such lots may be a block or two from the main street, while in large cities they may be beyond usual walking distances and linked by mass transportation. They are located with the idea of relieving both traffic and congestion by intercepting parkers before they reach the business district.

Types of fringe parking have been tried in some cities, and although successful in some cases, acceptance has not been widespread. More and more persons in postwar years depend upon the automobile for travel exceeding a quarter of a mile. They depend less upon mass transportation unless induced to by a considerable advantage – a substantial saving in cost, a prohibition, or another compelling circumstance.

A study of case histories of fringe parking shows the factors involved. It appears to have been demonstrated that success for a fringe-parking-plus-transit operation may be expected only in the presence of a combination of favorable factors:

(a) There must be a large population centered in the area. The ventures which have survived are almost entirely in cities with populations over 500,000.

(b) The lot should be located on and have direct access to a major artery leading to the business district, or at a terminus of a rapid transit line.

(c) The lot should be far enough out to be situated on low-cost land, yet close enough for the transit travel time to be no greater than by private car. If the lot is to serve all-day parkers, it can be a mile or more from the center, but a lot to serve shoppers must be nearer or have good rapid transit service.

(d) The parking fee plus the two-way transit fare must be appreciably less than the cost of parking downtown for an equivalent period.

(e) Usually the parking fee at fringe lots is either low or free.

In some large cities it has been found worth while either to furnish free parking or to subsidize the transit service.

(f) If the lot is near any local generator of parking demand, the fee schedule should give preference to the customer using the parking and transit combination.

(g) The transit service must have a stop in or immediately adjacent to the lot, and must offer fast and frequent service during rush hours – and all day if the lot is for shoppers. Only a large lot can support special, frequent and all-day bus service. If the lot adjoins a regular transit line with good service, it may be made to serve all-day parkers by a few special rush-hour buses.

One of the oldest, largest, and perhaps the best known fringe lots is the 2400-space municipal lot at Lake Erie, less than a mile from the central business district in Cleveland. Parking is free, and the bus fare ten cents or six for fifty-five cents. The lot is served by three loop bus lines, with three to five minutes headway in rush hours, and six to nine minutes in off-peak hours, from Monday to Saturday from 6:30 A.M. to 6 P.M. (9:40 P.M. on Mondays).

Design of Parking Facilities

The usefulness and success of a parking lot depend largely on various factors that enter into its design. The principal factor, location, has been discussed in the preceding pages. Consideration must also be given to the boundary conditions, entrances and exits, geometric layout of stalls and aisles, operating plan, topography, drainage, surfacing or paving, lighting, enclosure, pedestrian walkways, local zoning ordinances and landscaping.

Types of parking lots: Lots may be classified as to

1. Topography
   a. One-level flat lots. Most are in this class
   b. Multi-level
2. Operation
   a. Attendant-parking
   b. Self-parking
   c. Mechanized. Devices, found in some attendant-operated commercial lots, similar to hydraulic car lifts,

which permit lot capacity to be increased by using multiple levels

3. Fee Practices
   a. Free
   b. Pay
      (1) Collection by attendant
      (2) Metered
      (3) Honor system (fees deposited in box)
      (4) Toll gate

Boundary conditions: Lots and garages in built-up areas must usually be built on parcels of land as they are found. In nearly every case there must be some adjustment of the ideal lay-out to make the most of available space and shape.

It is necessary to determine the points where pedestrian access may be permitted to adjacent property, abutting stores, streets and alleys, and other points or areas where vehicular access must be available to store delivery entrances or loading docks. *Topography* of the parcel may require excavation or grading to a level surface, or it may permit terracing and the use of multiple entrances, or, if used "as is," it may require some adaptation of the layout plan. Drainage should be provided, and a plan for snow removal where necessary.

Surfacing or paving: Drainage, grading and dust-prevention are the minimum requirements.

Marking and signing: Proper signing and marking have an important influence on efficient operation. Stall-marking lines should be used for any pattern and are essential for any angle-parking other than 90 degrees. It has been found that double lines between stalls—two 3-inch or 4-inch lines with diagonal striping or cross-hatching between, forming bands two feet wide—are more effective than single lines in inducing orderly parking. In large lots, directional arrows are necessary wherever there is one-way travel, and signs indicating exits.

Illumination is a requisite when a lot is to be used after dark, to prevent damage to vehicles, pilfering and vandalism, and injury to pedestrians.

Landscaping: Border strips should be provided for screening in the form of hedges or fences, particularly where lots border

FIGURE VI–3. Pedestrian walkway adds safety.

residential areas, and dividing or channelizing islands may be used for ornamental planting and shade trees.

Local zoning ordinances should be examined. In many cities these include provisions or restrictions concerning curb cuts, driveways, set-backs, fencing, surfacing, illumination, even landscaping. Parking areas may be subject to the same setbacks as buildings on the street, particularly in residential areas.

Pedestrian walkways require additional space, but are desirable for safety and in bad weather they provide a dry and protected pathway. Figure VI–3 shows the excellent walkway provided in a Davenport, Iowa municipal lot.

Where a walkway has parking on one side only, a minimum width of five-and-a-half feet is desirable, or six feet if between two rows of parking.

Operating plan: The parking or operating characteristics that have a definite influence on the design of a facility include:

1. Choice between attendant-parking and self-parking. Where cars are to be parked by attendants there are several factors which enter into space requirements.

   a. Attendants are skillful at parking in close quarters.

   b. Attendants customarily back cars into spaces, this maneuver requiring less aisle width than head-in parking.

   c. Attendants can get out of cars parked in narrower spaces than self-parkers readily accept.

   d. With attendant-parking, cars may be parked two or more deep—"stacked."

As a result an area laid out for attendant-parking requires only sixty to eighty percent as much space per car as self-parking. A more extended discussion of attendant-parking vs. self-parking is included in a later section of this chapter.

2. Length of parking times.

   a. In high-turnover lots, such as those catering to shoppers, attention must be given to fast handling and easy circulation; hence, wider aisles, one-way movement, easier turns, less "stacking."

   b. With attendant-parking, cars likely to be parked all day can be parked two-deep.

There is a belief, among some operators, that a full lot or garage or a high degree of occupancy through the day is an ideal condition for "good business." Actually, since a great majority of pay facilities charge a higher rate for the first hour than for additional hours, a high turnover is more lucrative than a high occupancy.

For example, assume two facilities each charging thirty-five cents for the first hour and ten cents an hour thereafter:

Facility No. 1		*Facility No. 2*	
Usage 200 for 4 hrs., 65c	$130	Usage 400 for 1½ hrs., 45c	$180
Cost 200 @ 20c	40	Cost 400 @ 20c	80
Net	$ 90	Net	$100
Occupancy *800/1600=50%		Occupancy *600/1600=37½%	
Turnover **200/200 = 1		Turnover **400/200 = 2	

*Open for 8 hours.
**Capacity 200 spaces.

3. In metered lots, space must be allowed for meters and comfortable access to them. Where fees are to be collected manually, either the entrance and exit must be together or an extra attendant will be required.

The geometric layout: The basic unit of design for any parking facility is the parking space or stall. Based upon today's cars, the minimum size of a space can be no smaller than the overall dimensions of a car, about six feet four inches x seventeen feet nine inches or 112 square feet. Using a unit only slightly larger than this, it is possible to pack a lot, but it is unnecessary to comment on the undesirability of such a practice.

There is a minimum turning radius for every car, ranging from twenty-one feet to thirty feet, although sharper turns may be negotiated by repeated maneuvers. This affects the width of aisle required.

The establishment of criteria for the details of design must include consideration of space needed to permit opening car doors, of the human equation, the relative skill of attendants in comparison with that of self-parkers, the likes and dislikes of the average driver, and a "margin of safety."

Good design should recognize that true efficiency is by no means measured by the number of cars that can be packed into a given area. Satisfactory operation and financial success require that consideration be given to every factor which can improve the speed and quality of service, the internal movement, the ease of access to and from the street, the amount of car maneuvering, the turnover, the convenience of the parkers, and the security of the cars.

Design

This volume has been prepared primarily as a guide. The design criteria shown are considered suitable and desirable under normal conditions for an average lot.

It is realized that in some types of special use facilities, for lack of space or economic reasons it may be desirable and justifiable to resort to special measures to meet special or unusual requirements. Such steps are not desirable in normal type facilities, particularly those catering to the public.

The unit space: Because of the extra space required by the wide-opening doors on modern cars, the unit space for self-parking has become at least eight feet six inches wide by eighteen feet long, although this width may be reduced to eight feet with attendant parking.

Aisles: Aisles should have sufficient width to permit parking or removing a car without forward-and-back maneuvering. The space required depends upon (1) size of the car, (2) dimensions of stall, (3) type of parking, (4) turning characteristics of car, (5) direction of parking (head-in or back-in) and (6) necessary clearance between the car being parked and cars in adjacent or opposite stalls.

The most authoritative reference on this subject is the *Traffic Design of Parking Garages*,[4] the figures and recommendations given here are largely based upon that text and do not represent the minima under attendant-parking or by professional operators; that text should be consulted if greater detail is desired.

Entrances and exits: To reduce interference with sidewalk and

[4] 1957 edition, by E. R. Ricker, Eno Foundation.

street traffic, the number of entrances and exits should be kept to a minimum, but sufficient to accommodate peak hour requirements, and it is desirable that entrances and exits be separated. In many cities local ordinances include regulations concerning curb cuts and driveways. Figure VI–4 shows entrance and exit dimensions as suggested in the *Traffic Engineers Handbook.* A combined entrance and exit should be at least 26 feet wide at the property line.

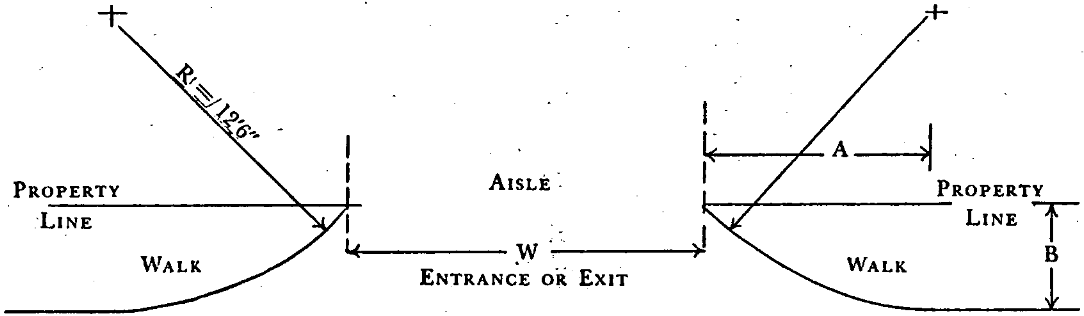
Design vehicle: The design data herein are based upon the performance characteristics of a "design vehicle," which is not an average vehicle, but one with dimensions at least as great as those of the majority of cars being manufactured in 1956. The critical dimensions of the design vehicle are shown in Figure VI–5.

Table VI–3

Symbol	*Dimension*	*Value*
L	Over-all length	18′
W	Over-all width	6′6″
B	Wheel base	10′6″
Of	Front overhang	3′
Or	Rear overhang	4′6″
Os	Side overhang	9″
tr	Rear tread	5′
tf	Front tread	5′
r	Min. turning radius, inside rear wheel	13′8″
r′	inside front wheel	17′3″
R	outside point, front bumper	23′3″
R′	outside point, rear bumper	19′9″
bf	Bumper depth from maximum turning point, front	12″
br	Bumper depth from maximum turning point, rear	8″

Angle of parking: Spaces in a lot or in a garage may be parallel to the wall, curb or aisle, at an acute angle to it, or at a right angle, and the choice made will depend largely upon the shape and dimensions of the available area. Figure VI-1 gives the data for parallel spaces, and Figure VI–6 and Table VI–4 show the space requirements for various angles of parking, and make it evident that the more acute the angle of parking, the greater the proportion of space wasted.

Direction of parking: Cars may be either headed-in or backed-in



A	B	Exit W	Entrance W
9'9"	4'6"	11'6"	14'9"
10'6"	5'6"	10'9"	14'0"
11'0"	6'6"	10'0"	13'6"
11'6"	7'6"	9'6"	13'0"
12'0"	8'6"	9'3"	12'6"
12'3"	9'6"	9'0"	12'3"
12'4"	10'6"	8'9"	12'2"
12'5"	11'6"	8'6"	12'1"
12'6"	12'6"	8'3"	12'0"

NOTE: Table gives curb returns required to permit a car traveling one foot from the curb to make the turn into the parking lot aisle and miss any parked cars by one foot. Exit dimensions permit the reverse of that movement.

Figure VI–4. Exit and Entrance Curb Returns for Lots.

Table VI–4

RECOMMENDED STALL AND AISLE DIMENSIONS

Angle of parking	*Direction of parking*	*Width of Stall*	*Depth of stall perpendicular to aisle*	*Width of aisle*	*Unit parking depth*	*Width of stall parallel to aisle*	*Number of stalls in distance*	*Area* per car sq. ft.*
30°	Drive in	8′	15.9′	11′	42.8′	16′	L–3.6/16	356
45°	Drive in	8′	18.4′	12′	48.8′	11.3′	L–7.1/11.3	305
60°	Drive in	8′	19.6′	19′	58.2′	9.3′	L–6.7/9.7	325
90°	Drive in	8′	18′	28′–32′	64′–68′	8′	L/8	283
90°	Back-in	8′	18′	22′	58′	8′	L/8	242
30°	Drive in	8′6″	16.4′	10′	42.8′	17′	L–2.8/17	428
45°	Drive in	8′6″	18.7′	11′	48.4′	12′	L–6.7/12	346
60°	Drive in	8′6″	19.8′	18′	57.6′	9.8′	L–6.6/9.8	320
90°	Drive in	8′6″	18′	25′–29′	61′–65′	8.5′	L/8.5	296
90°	Back in	8′6″	18′	21′	57′	8.5′	L/8.5	259
30°	Drive in	9′	16.8′	9′	42.6′	18′	L–2.5/18	426
45°	Drive in	9′	19.1′	11′	49.2′	12.7′	L–6.4/12.7	352
60°	Drive in	9′	20′	17′	57′	10.4′	L–6.4/10.4	317
90°	Drive in	9′	18′	23′–27′	59′–63′	9′	L/9	286
90°	Back in	9′	18′	20′	56′	9′	L/9	255

* Based on the number of whole spaces in an aisle 100 feet long. Thus for a forty-five-degree drive-in plan with eight-foot six-inch stalls, the number of stalls is 100–6 7/12 or 7.78 stalls on each side, or 14 whole stalls. A 100-foot aisle 48.4 feet wide has 4840 square feet or 4840/14 or 346 square feet for each stall provided.

to spaces for 90-degree parking. Practically all commercial attendant-parking facilities use back-in parking because of the space economy resulting from narrower aisle-widths, but self-parkers, particularly women, generally prefer head-in parking. For angle parking at less than ninety degrees, head-in parking is usually the rule. A further discussion of self-parking versus attendant-parking will be found later in this chapter.

Aisle width: Figure VI–6 and Table VI–4 give the recommended aisle widths for various parking angles and stall widths, based upon the performance characteristics of the design vehicle together with reasonable clearance from adjacent parked vehicles and an allowance for safety and the human equation. As stated previously, layouts for self-parking should use stall widths no less than eight feet six inches.

In Table VI–4 for the ninety-degree head-in stalls, a range of aisle widths is shown, this being twenty-five feet to twenty-nine feet for the eight foot six inch stall. The twenty-nine-foot width is recommended wherever space will permit, but it may be reduced somewhat in garages if the column spacing is favorable or where spaces are normally filled in succession.

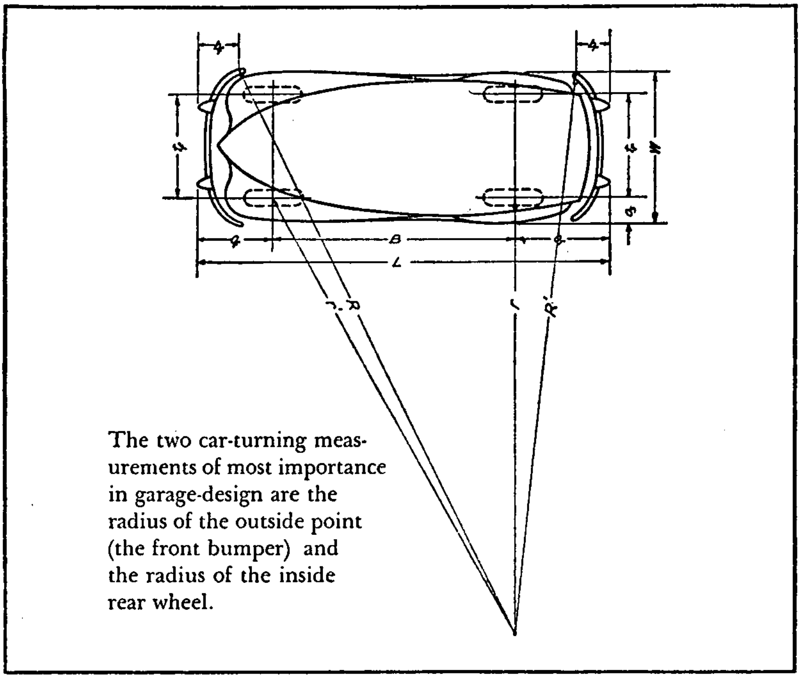


FIGURE VI–5. Vehicle Dimensions Necessary for Computing Turning Movements.

Space layout: The normal practice in large lots and usually the most effective, is to use ninety-degree parking for as much as possible of the available area. This rectangular arrangement not only fits better into rectangular areas with minimum space wastage but also permits the aisle to be used for travel in either direction, thus allowing the use of dead-end aisles, which may permit a more economical design.

Acute angle-parking gives fewer spaces for any length of aisle, requires deeper stalls and at the same time, because of the triangular areas at each end of each car and each row, is relatively

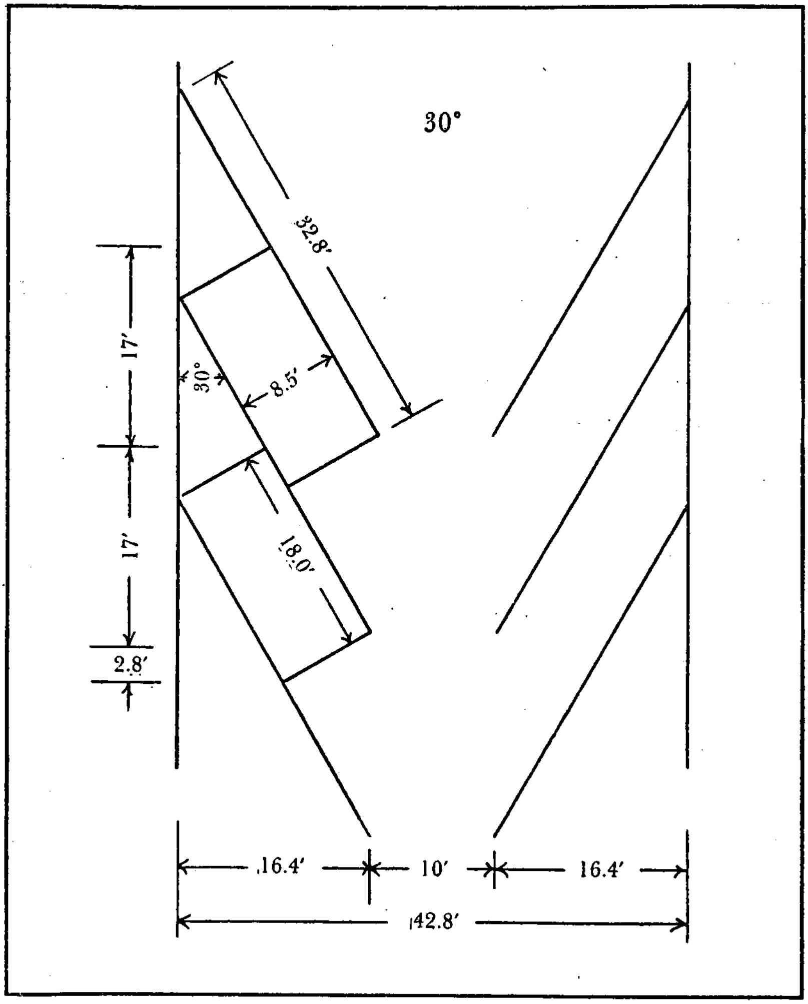


FIGURE VI–6a. Space and Aisle Dimensions for Parking at Various Angles.

wasteful of space. Normally it requires one-way aisles, so cannot be used in dead-end aisles. But angle stalls are much easier for drivers to enter and are preferred by them and (more so with the flatter angles) require narrower aisles. Where space economy is not a prime consideration and convenience is, as in many suburban customers' lots, forty-five-degree or sixty-degree parking

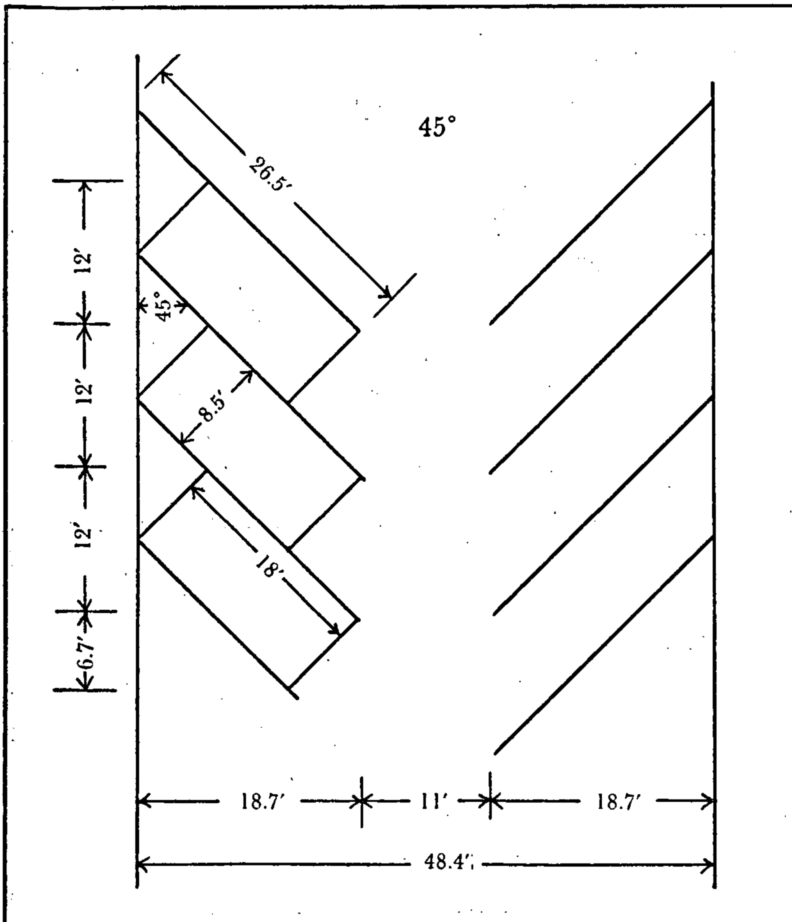


FIGURE VI–6b. Space and Aisle Dimensions for Parking at Various Angles.

is commonly used. Frequently, available areas or portions of areas are too narrow to permit the use of ninety-degree stalls, but are wide enough for one of the acute angles.

A variety of angle-parking is illustrated in Figure VI–7, showing two types of the "herringbone" pattern. This uses only the forty-five-degree angle and, by intermeshing the two rows of stalls not only eliminates two sets of triangular waste-areas, but at the same time reduces the width of the double row by six feet (37.4′–31.4′).

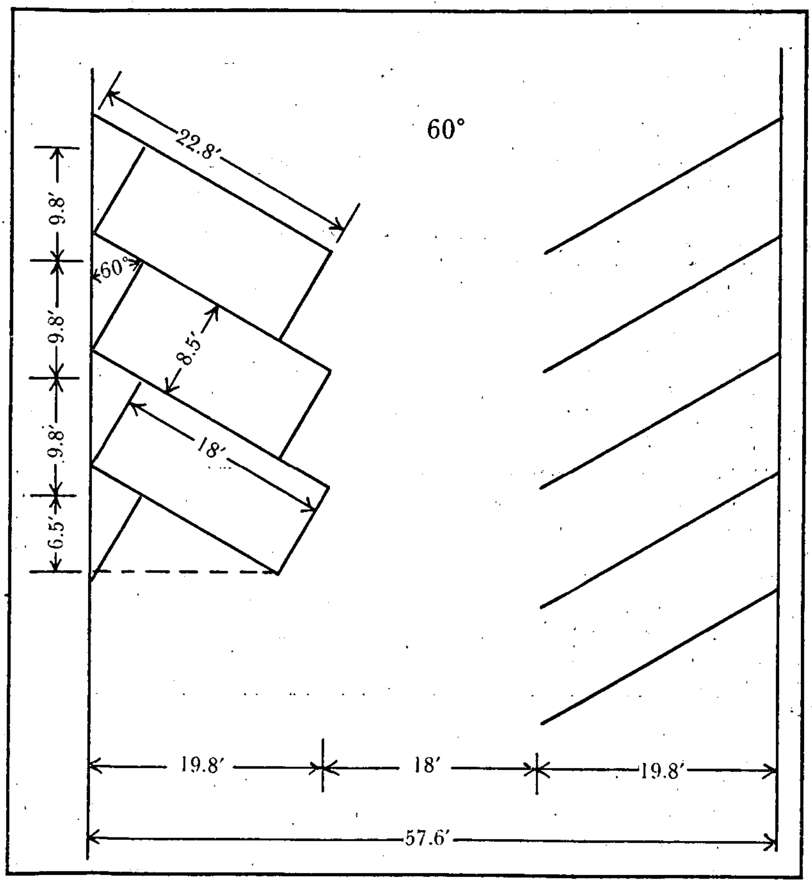


FIGURE VI–6c. Space and Aisle Dimensions for Parking at Various Angles.

Both patterns require the use of one-way aisles, but Type A requires the same direction of travel in all aisles, while Type B calls for opposite directions in alternate aisles.

For further discussion, see Chapter Eight.

Stall bumpers: The addition of stall bumpers compared with painted end lines, increases the construction cost of a parking facility. The advantages are:

(1) The possibility of damage to cars in opposing stalls is minimized. Figures VI–8 (A, E).

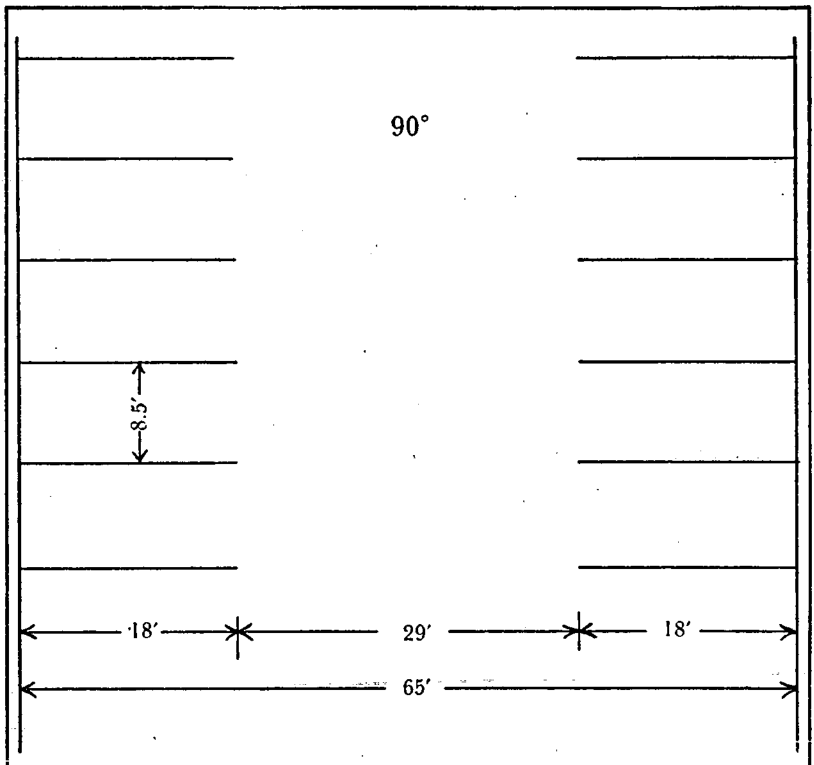


FIGURE VI–6d. Space and Aisle Dimensions for Parking at Various Angles.

(2) A more uniform parking depth is induced, leading to less aisle encroachment. Figures VI–8 (B, E).

(3) Because of more orderly parking, vacant stalls are more easily found.

(4) The presence of stall bumpers encourages and eases the centering of cars in stalls.

(5) Bumpers prevent driving and leaving through the next

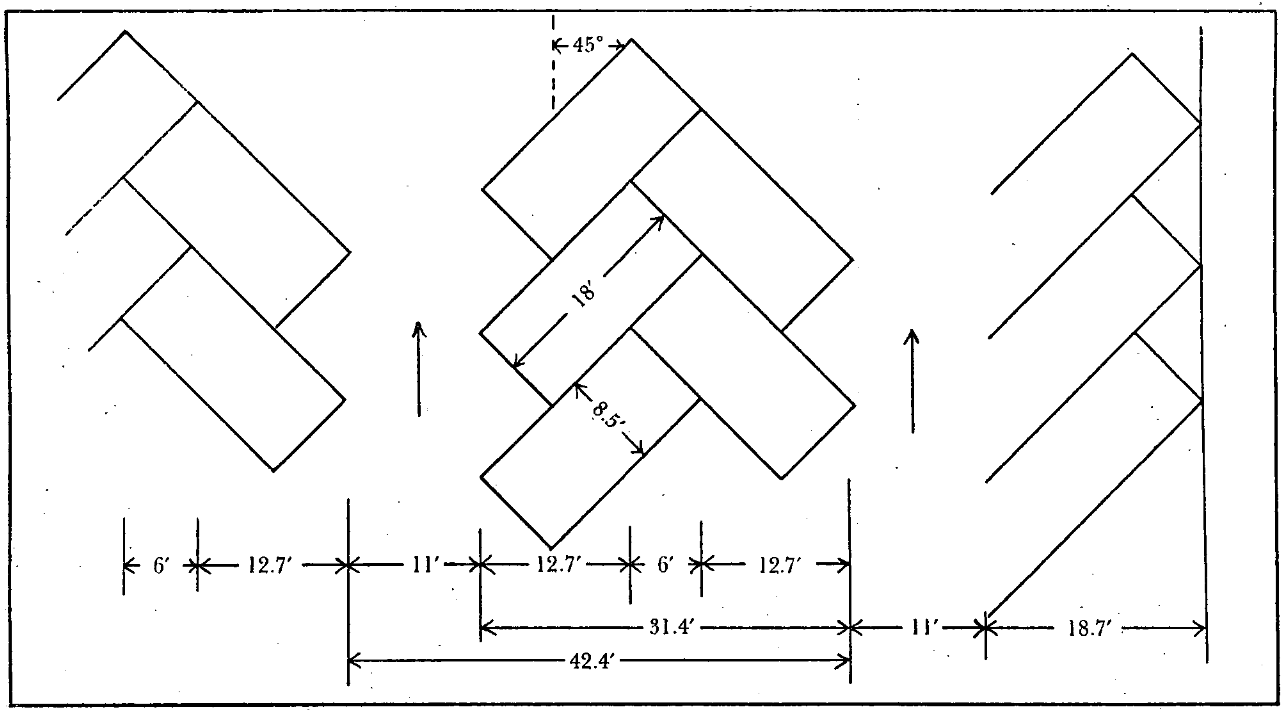
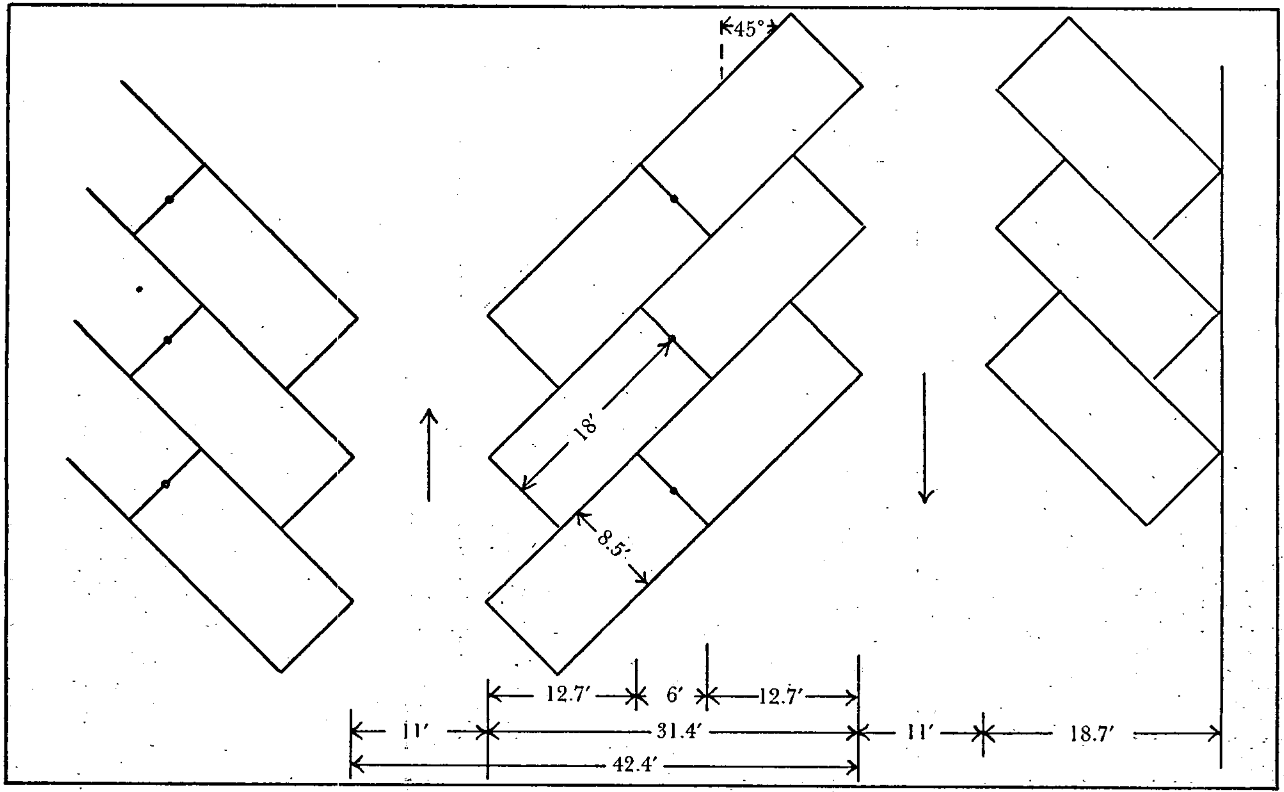


FIGURE VI–7a. Type A Herringbone Patterns.



PARKING

Figure VI–7b. Type B Herringbone Pattern.

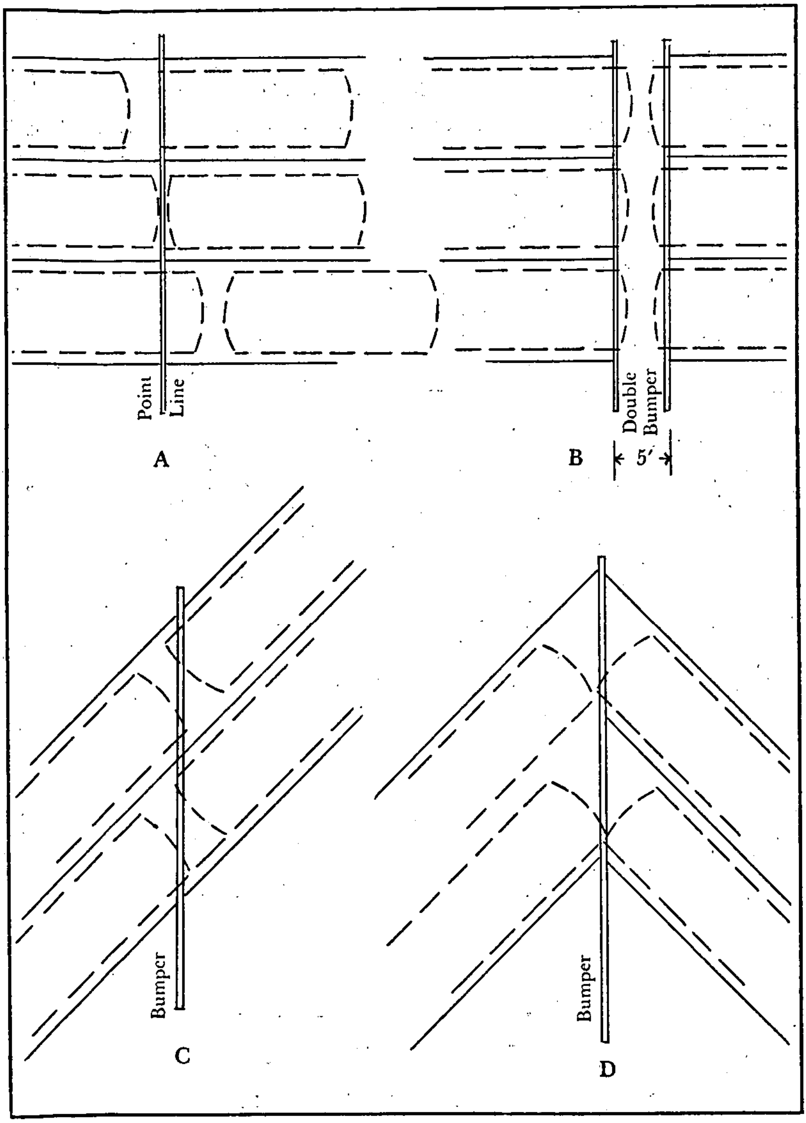


FIGURE VI–8a. Bumper Layout.

bay, which cause serious traffic conflicts, particularly in a one-way circulation system.

A minor disadvantage of bumpers is that they may be a hazard to pedestrians, and may interfere with snow removal.

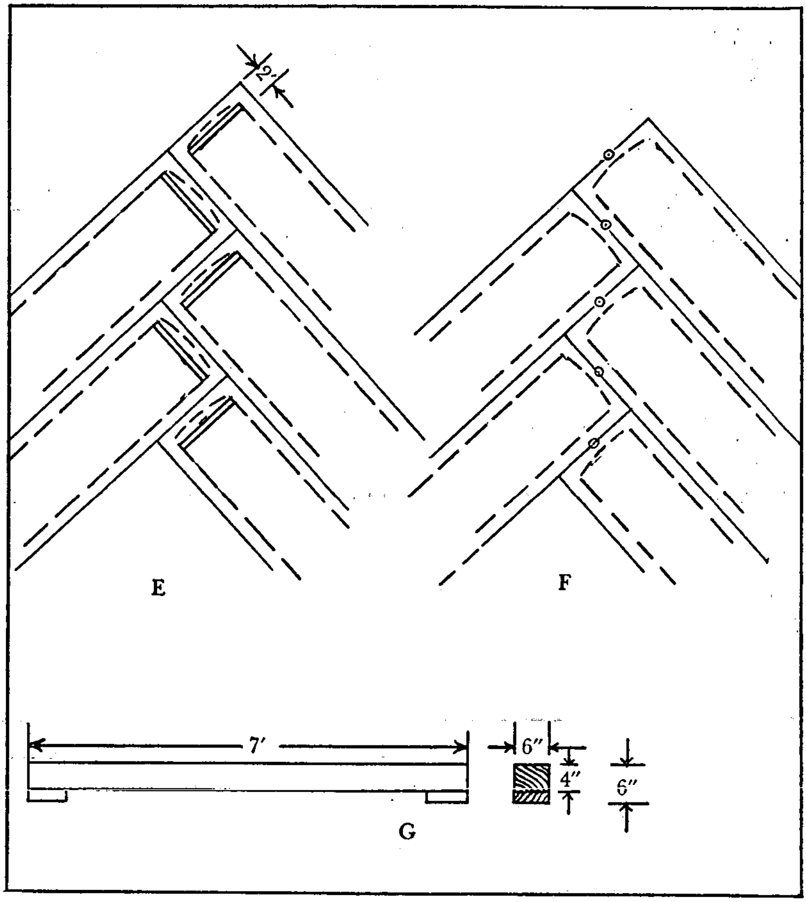


FIGURE VI–8b. Bumper Layout.

There are several types of bumper layouts:

(1) Bumpers set at a right angle to the angle of parking. See Figure VI–8 (E). An advantage of this layout is that the stalls are more clearly defined, hence easier to center cars in. Disadvantages are that snow removal is more difficult, and that double bumpers would be required in the case of Type B herringbone parking.

(2) Straight-line bumpers. See Figures VI–8 (B, C, D). Advantages are ease of installation and some simplification of snow removal. A single bumper will serve to separate cars parked at forty-five degrees about two feet, somewhat less at sixty degrees. Disadvantages are that double bumpers are needed for ninety-degree parking (separated more than four feet) and that a single bumper will not separate cars parked as in Figure VI–8 (D).

(3) Vertical posts in a straight line. See Figure VI–8 (F). These are especially applicable to the two types of herringbone parking shown in Figure VI–7, and it will be noted that the spacing for Type B is double that for Type A. The advantages are the low cost, the ease of layout, and the simplification of snow removal. Disadvantages are the possible need for frequent straightening of the posts, and a less attractive appearance than bumpers. An excellent and sturdy bumper may be made by using five-foot lengths of four-inch boiler tube set in concrete twenty-four to thirty inches below grade and filled with concrete.

(4) Use of a central island or pedestrian walkway provides a bumper effective for both forty-five-degree and ninety-degree parking. A possible disadvantage is the greater cost and greater use of space. To give minimum walking space, the walk must be at least four feet wide for forty-five-degree parking and five to six feet wide for ninety-degree parking. See Figure VI–3.

Bumper size. See Figure VI–8 (G).

Note that the bumper is raised by blocks to ease drainage. For further discussion, see Figure VIII–5.

Aisles and travel directions: In any facility the aisle and travel pattern as well as the parking pattern must be tailored to the dimensions, area and shape of the facility available, with consideration of the position of the possible points of entrance and exit and a pattern which will minimize the number of turns and crossing movements and the distance to the average stall.

In large lots it is desirable, where possible, to restrict parking to transverse aisles, keeping the main aisles clear for movement. Dead-end aisles have a minor disadvantage in that the end stalls are more difficult to use. The normal pattern of acute-angle-parking requires one-way aisles, which do save some width, and one-way aisles may promote speedier movement by reducing interference and confusion. When the size and shape of the area permit, the aisles of a parking lot serving a single generator should be at right angle to the generator, so that the walkways will give the most direct access.

Combination patterns: In theory it would be desirable to combine all these criteria into a standard design including all the desirable features. Usually, however, it is necessary to fit a facility into an area restricted by adjacent and sometimes irregular property lines. The ideal is rarely possible except in the instance of an industry or generator in an isolated location where the economics are relatively unimportant. Any particular design will call for compromises or adjustments. The temptation is to attempt to provide more spaces by reducing standards for stall or aisle widths. Deviation from the standards may be necessary, but in that event the deviation should be through *raising* the standards.

As a general rule a rectangular layout using ninety-degree, eight-foot-six-inch stalls in unit (aisle plus two rows) widths of sixty-one to sixty-five feet are desirable, but rarely will the available area fit exactly that unit or a multiple of that unit. To make the most efficient use of the area, another pattern may be used, if multiples of it will fill the space, or two patterns may be combined.

Table VI–5 gives the unit or bay widths of a number of possible combinations with a range in bay width from sixty-five feet to twenty-six feet. As an example, assume an area is 100 feet by 300 feet. Four units of ninety-degree parking would use 244 feet, leaving fifty-six feet, which is not enough for another ninety-degree unit. A fifty-six-foot space will accommodate either a sixty-degree to forty-five-degree (No. 4) unit, a sixty-degree to thirty-degree (No. 5) unit, or a ninety-degree—Parallel (No. 6) unit. Of these three, the ninety-degree—Parallel (No. 6) unit will give the most spaces and will also permit two-way travel.

In a multiple-unit layout it is of course desirable to use a uniform parking angle throughout, so far as possible, and any necessary deviation should be confined to one unit or to one row at one end of the area.

Table VI–5

WIDTH OF UNIT (2 ROWS, 1 AISLE), USING COMBINATIONS OF ANGLES
(For stalls 8′6″ wide only)

	1st row angle	*Feet*	*Aisle feet*	*2nd row angle*	*Feet*	*Total feet*
1	90°	18	25–29	90°	18	61–65
2	90°	18	25–29	30°	16.4	58.4–63.4
3	60°	19.8	18	60°	19.8	57.6
4	60°	19.8	18	45°	18.7	56.5
5	60°	19.8	18	30°	16.4	54.2
6	90°	18	25–29	Par.	8	51–55
7	45°	18.7	11	45°	18.7	48.4
8	45°	18.7	11	30°	16.4	46.1
9	60°	19.8	18	Par.	8	45.8
10	90°	18	25	—	—	42.0
11	45°	18.7	11	Par.	8	37.7
12	30°	16.4	10	Par.	8	34.4
13	45°	18.7	11	—	—	29.7
14	Par.	8	10	Par.	8	26

NOTE: Certain combinations have been omitted as less efficient than others requiring no more space. Thus two rows at thirty degrees with a unit width of 42.8 feet has been omitted since a single row at ninety degrees, having a unit width of forty-two feet, will provide more spaces.

Further, the use of angle parking in any aisle (usually) requires one-way travel in that aisle, and the entire pattern must therefore consider the position of entrances, exits and the desired travel paths to produce the most efficient design.

Figure VI–9 shows several alternative layouts for a lot 100 feet square, assuming various entrance or exit restrictions.

Reservoir space: If parkers arrived and departed at a uniform rate throughout the day, it would be a simple matter to design a facility and plan operation to handle them efficiently. But they don't either arrive or depart at a uniform rate, and the patterns at two facilities may be very different. Figure VI–10 demonstrates the wide dissimilarity between the arrival patterns of a shoppers' garage and one used by long-time parkers.

If a facility is to use attendant-parking and provides enough attendants to store the absolute peak flow as fast as it arrives, then it is very apt to have much too large a force for the rest of the day, greatly increasing the cost. If the staff is just enough to handle the

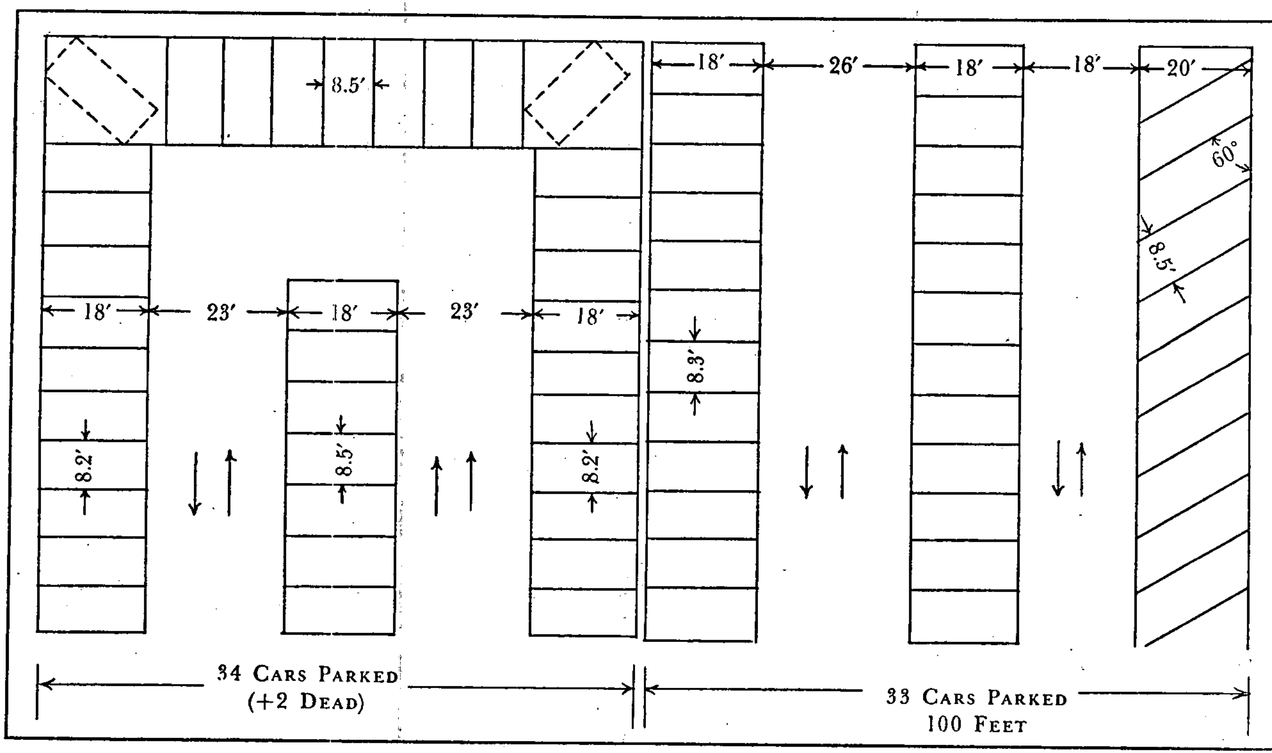


Figure VI–9a. Alternative Layouts for a Lot 100. x 100..

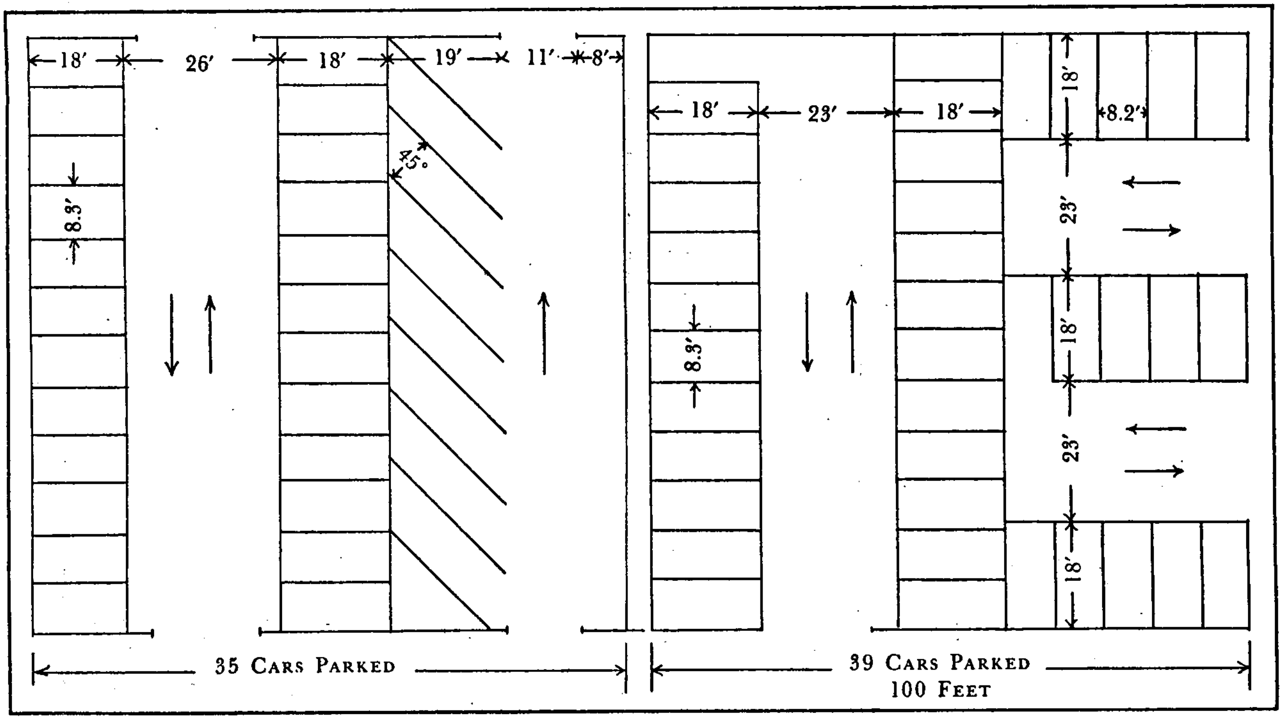


Figure VI–9b. Alternative Layouts for a Lot 100. x 100.

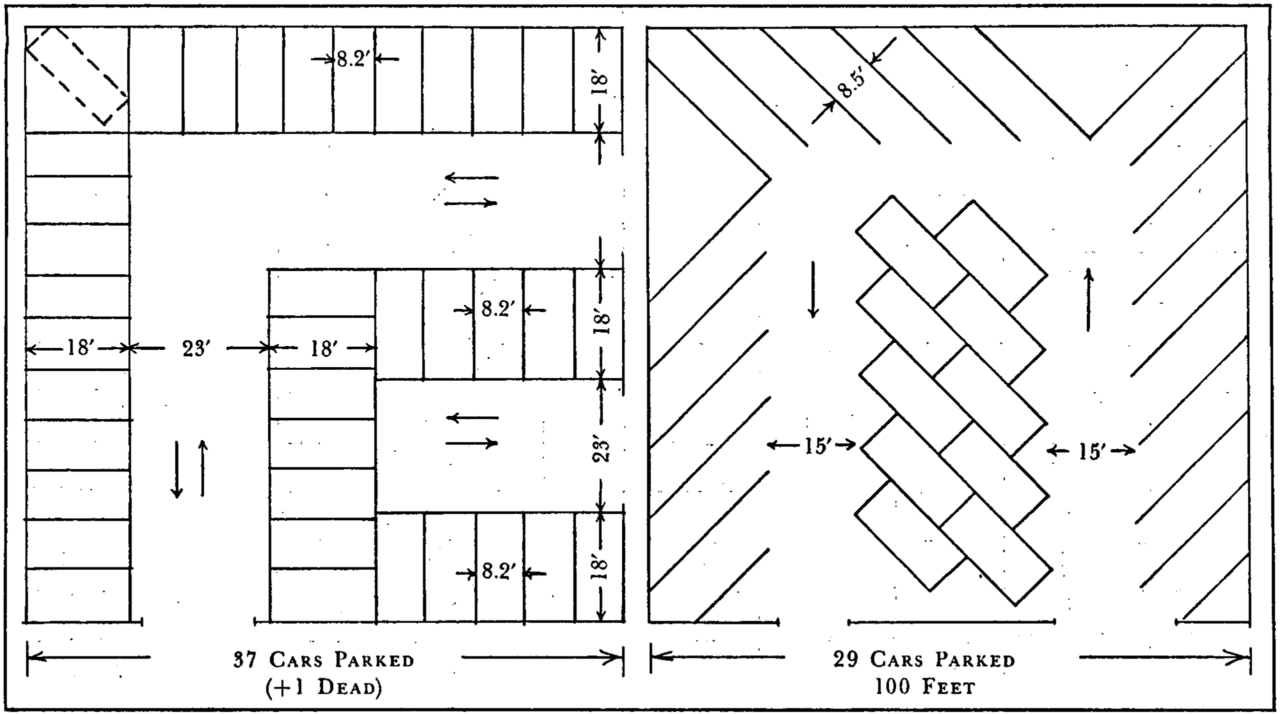


Figure VI–9c. Alternative Layouts for a Lot 100. x 100..

average load, then either adequate reservoir space must be provided, or there will be serious back-ups and delays at the peak.

The purpose of a reservoir is to absorb temporary surges that exceed the capacity of attendants. There is a definite relation between the time required to store the average car, the number of attendants, and the size of needed reservoir space.

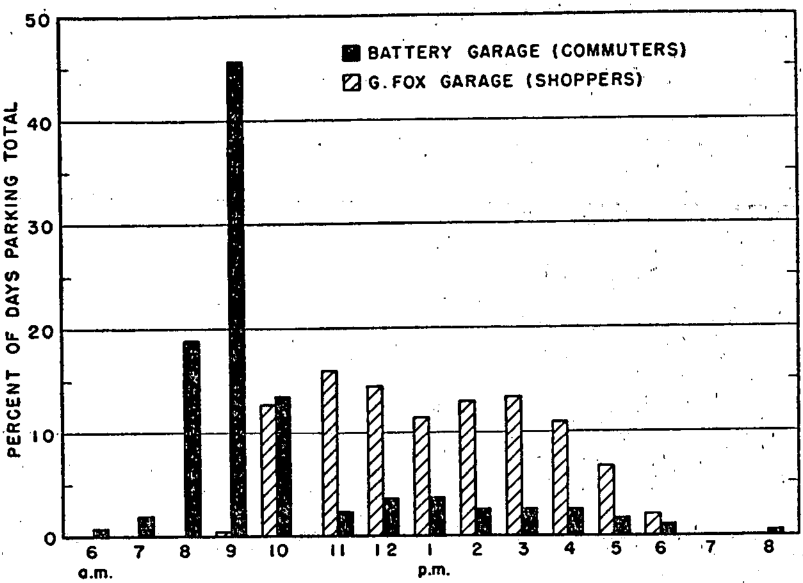


FIGURE VI–10. Contrasting arrival patterns for commuters and shoppers' garages.

The storage rate varies directly with the number of attendants, and varies inversely with the single-car storage time. Thus if it takes an attendant five minutes to make a round trip, storing a car and returning to the entrance, he can store twelve cars an hour, and the storage rate will be the number of attendants multiplied by twelve.

The storage rate on the average should equal or be greater than the rate at which cars arrive during the peak *hour*. There will be, however, definite surges even during that hour. At the Battery Garage, a commuters' facility in New York City, there have been 377 arrivals in the peak hour, but the fifteen-minute period volumes varied from 69 to 125.

Because of the several variables involved, it has not been possible to formulate a flat rule for the capacity needed for reservoir space, but in "The Traffic Design of Parking Garages,"[5] which includes a full discussion, E. R. Ricker has developed a graph, shown in Figure VI–11, from which the required capacity may be closely approximated, assuming that the rate of storage must equal the *average* rate of arrival during the peak hour and that the peak hour arrival rate can be estimated, either from a parking study or from examination of data from similar facilities. An arrival rate of 180 cars in the peak hour, for example, indicates a reservoir of thirty-two to thirty-three spaces, and the number of needed attendants as fifteen (based on a storage time of five minutes a car).

To serve its purpose, a reservoir area in an attendant-parking facility must of course be at the point at which the patrons surrender their cars. In a lot this always is just inside the entrance and in a garage it usually is so, although in the case of a few underground garages the patron is required to drive to a reception level where more space is available.

The reason for the inadequate provision of reservoir space in many facilities is, obviously, the high value of the ground area, making it attractive for other and more profitable uses such as service and accessory sales, or rental to retail stores dependent upon street frontage. These other uses may contribute additional income and naturally often lead to insufficient reservoir space and consequent entrance and street congestion.

The best arrangement for a reservoir area is to provide several parallel lanes leading from the entrance toward the parking aisles or (in a garage) to the ramp, the capacity of the several lanes being the reservoir capacity. Entering cars are directed into these lanes to fill them successively, the drivers are given claim checks, and the attendants clear each lane in turn. Four such lanes are commonly provided.

Since the reservoir of an attendant-parking facility is its public reception area, it should be signed, well-drained, well-lighted, clean, and include provision for safe pedestrian movement.

[5] 1957 edition, Eno Foundation.

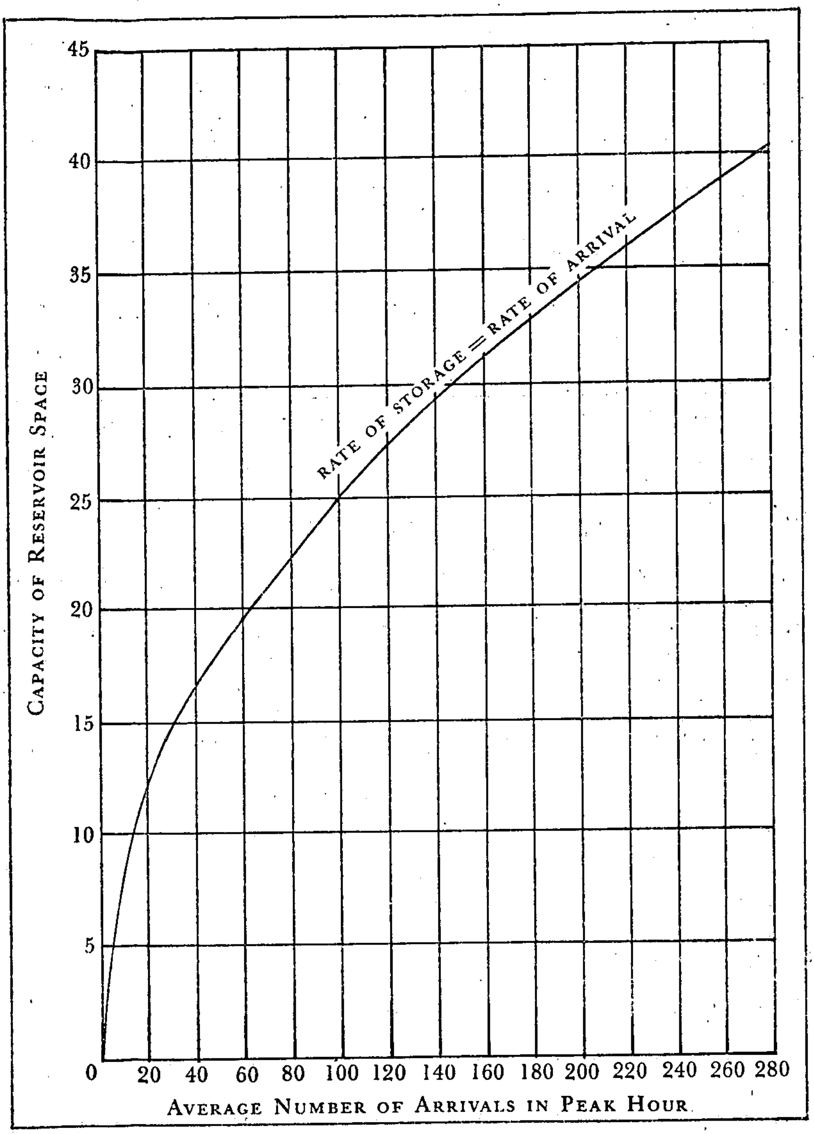


FIGURE VI–11. Reservoir space required for various arrival rates.

An *outbound* reservoir will be necessary in a large attendant-operated facility, for delivering cars to patrons and for loading passengers and bundles. The area may be much smaller than for a reception reservoir, but should be at least two lanes wide, to permit by-passing a slow-loading or unclaimed car. In facilities where the exit and entrance are side by side, it may be possible to use an "unbalanced" design, i. e., to use a central lane in the morning for part of the inbound reservoir and in the afternoon as part of the outbound reservoir.

The foregoing discussion of reservoir space has concerned *attendant-parking* facilities. Customer or *self-parking* facilities require some but relatively little reservoir space. A later section of this chapter discusses self-parking versus attendant-parking.

Space Layout Planning

The following notes summarize the suggestions discussed at greater length in this chapter. They are intended to assist in the geometrical or physical design or layout of an area to be used for parking, and are confined to self-parking, one-deep operation, using stalls eight feet six inches wide.

Preliminary steps: (1) Make an accurate drawing of the area on *tracing paper*, at a scale of twenty feet to one inch, including

(a) Outline and use of abutting properties, buildings thereon and vacant areas.

(b) Abutting sidewalks, streets and alleys, with direction of traffic flow on *each*.

(c) Points where access to abutting properties must be preserved (such as for truck loading, etc.).

(d) Location of any fixed obstacles which cannot be removed.

(e) Setbacks required by local building codes or ordinances.

(f) Location of nearest intersection in each direction.

(g) Space needs for any required or desired screening (fences, walls, hedges, landscaping) around the border.

(h) Location of any nearby important generator which the facility is intended to serve.

(2) Determine the possibility of acquiring any small abutting

parcels which would give access to a second street or to an alley and permit a better circulation pattern.

(3) Consult local building codes and zoning ordinances for any possible restrictions or requirements as to size, curb-cuts, fencing or screening, drainage, lighting, hours of operation, signs, etc.

(4) If the lot is not to provide free parking, determine whether collection is to be by meters, a toll-gate, or attendants, since this can affect location of entrances, and since space must be provided for meters.

Space layout principles: The ninety-degree parking system is the most economical of space where it is feasible, but there are advantages and disadvantages in the use of it or of each of the other angles or combinations. See pages 000.

For example, ninety-degree parking permits aisle travel in either direction, and will allow the use of dead-end aisles, sometimes a convenience, while angle parking limits travel to one direction and hence requires transverse aisles or more than one exit, but usually permits the use of narrower aisles. The Type B herringbone pattern reverses the travel direction in alternate aisles, permitting freer circulation by persons seeking a space, while the Type A pattern requires the same direction in all aisles.

While the ninety-degree pattern is the simplest to lay out, the forty-five-degree and thirty-degree angles are more easily maneuvered by self-parkers and are more commonly used for customer lots or where space is freely available. The herringbone patterns are more economical of space than other angle patterns, but are not applicable where pedestrian walkways are to be used.

Where entrance to only one side of the lot is possible, a ninety-degree pattern (permitting travel in both directions) may be used without transverse aisles, or an angle pattern with transverse aisles to permit circulation.

One-way circulation is desirable for a busy lot, although not essential. Two-way, main travel, or transverse aisles should be at least fifteen feet and preferably twenty or more feet wide. Where possible, especially in larger and active lots, distribution should be accomplished by main travel aisles (with no parking) and parking confined to transverse parking bays, to reduce interference.

Space economy often results from placing bays parallel to the longest dimension of the lot, but walking distances for the parkers may be reduced by directing the bays toward the exit or entrance side. Thus where a lot serves a particular store or building, the parking aisles or bays (and walks if provided) should lead toward that destination.

Where space is ample, or left-over space permits, it is highly desirable to provide pedestrian walks, usually between bays, as illustrated in Figure VI–13a and b. Similarly, islands between bays may serve not only as walkways but also to place meters, to serve as bumpers for orderly positioning, to place lighting standards, and to place trees or screening. See Figure VI–3.

Entrances and exits should be placed as far as possible from street intersections (to avoid traffic backups) and so placed as to avoid left turns or crossing movements when possible. Thus a location having access to two streets may have right-turns-only at both exit and entrance. Where the only access is to and from a two-way street, the exit and entrance should be separated as far as possible, to minimize confusion, and so placed that inbound cars will not cross outbound cars.

The pattern for a particular lot or area is best selected by a cut-and-try process, on paper, tailoring the pattern to the dimensions, area and shape of the parcel available, with consideration for the various controlling factors which have been listed above. Ideal layouts are rarely possible, and compromises may be necessary.

It has been suggested that an accurate drawing of the area be made at a scale of twenty feet to one inch, *on tracing paper*. This will permit use of the templates or patterns attached as in Figures VI–12, a–c (at that scale), by placing any one of them on a table or drawing board underneath the drawing. These are based on the data given in Figures VI–6 and 7 and Table VI–4, and from these it is possible to select, for each of the four angles (thirty-degree, forty-five-degree, sixty-degree, ninety-degree) a single row sloped in either direction or a unit (two rows with aisle), with the appropriate aisle width, to mark the required space on the drawing, and to determine the number of spaces.

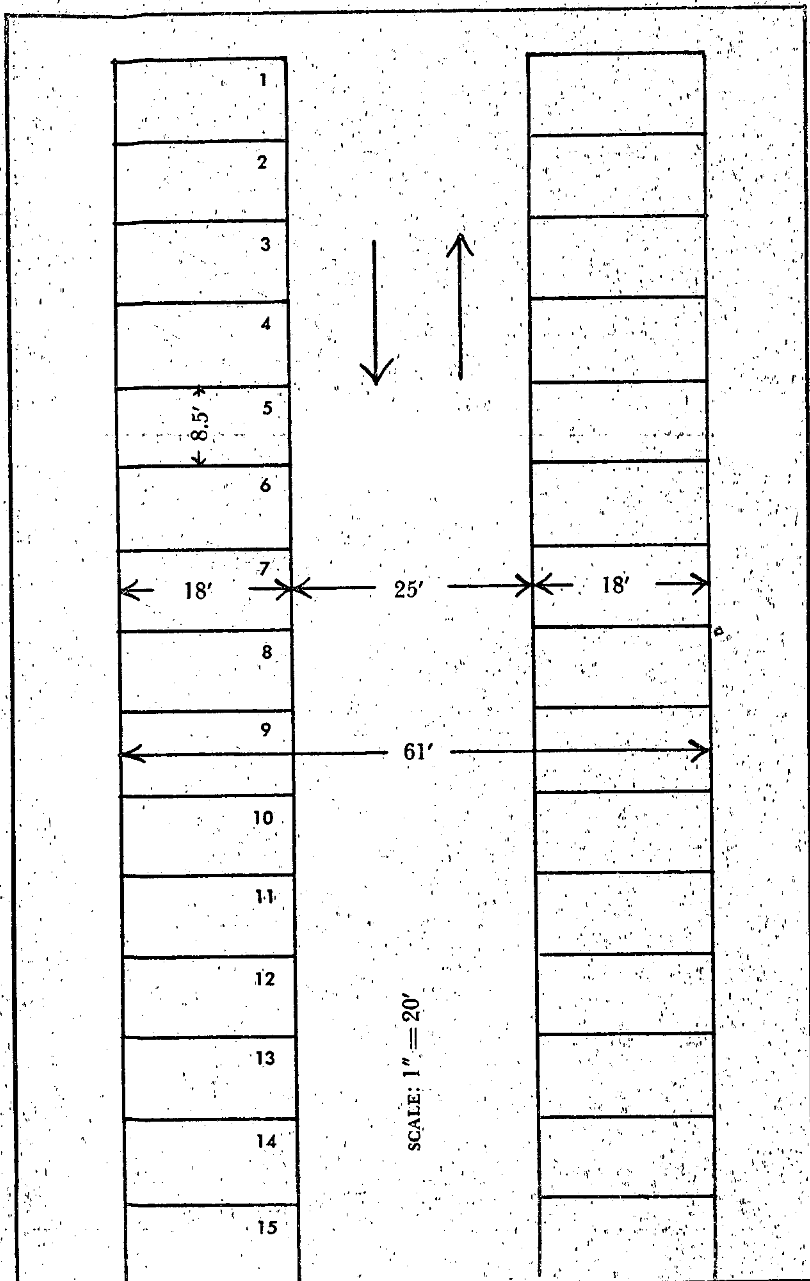


FIGURE VI–12a.

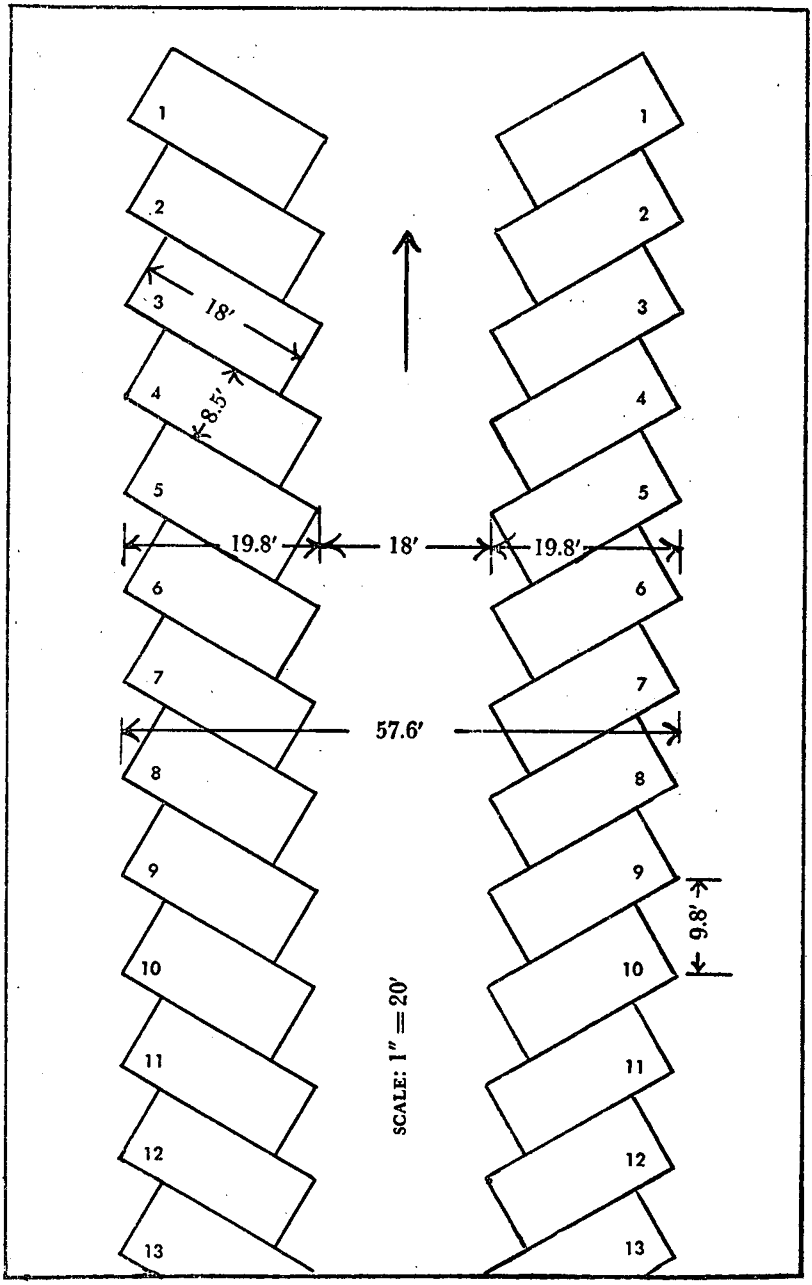


FIGURE VI–12b.

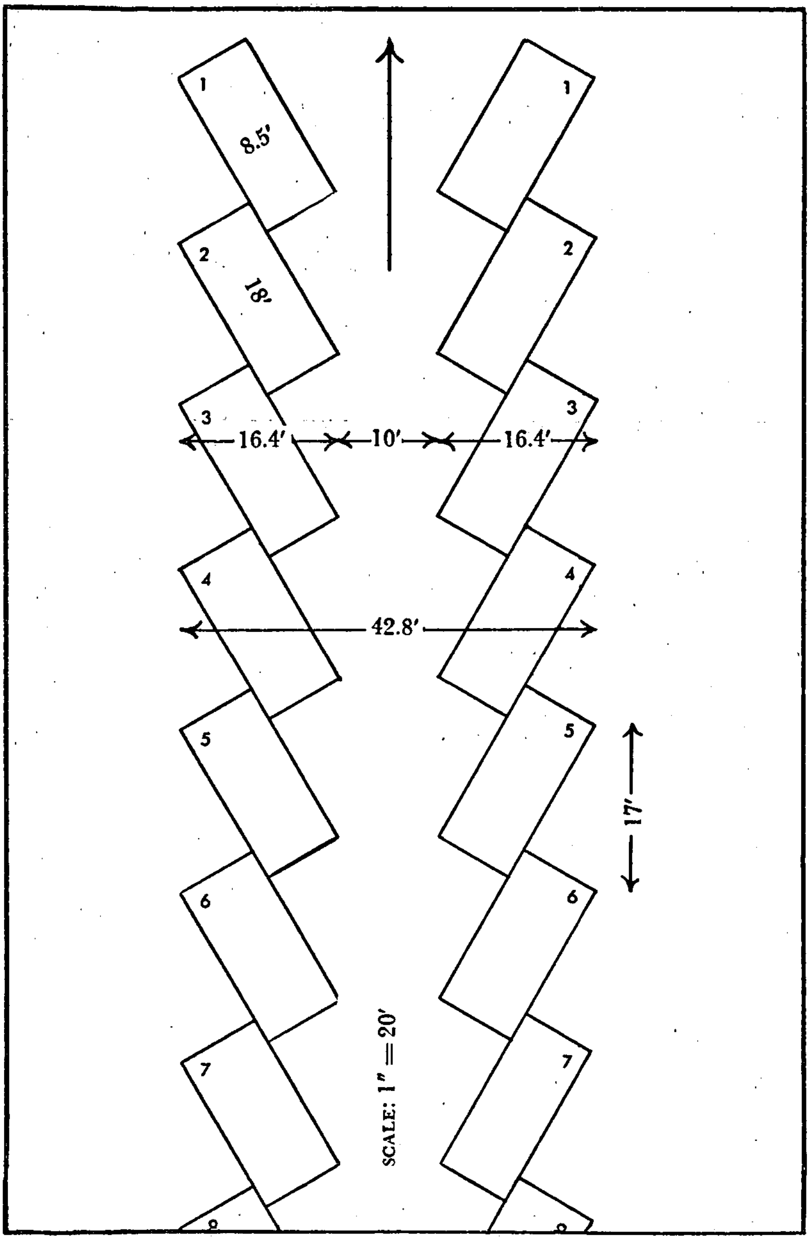


FIGURE VI–12C.

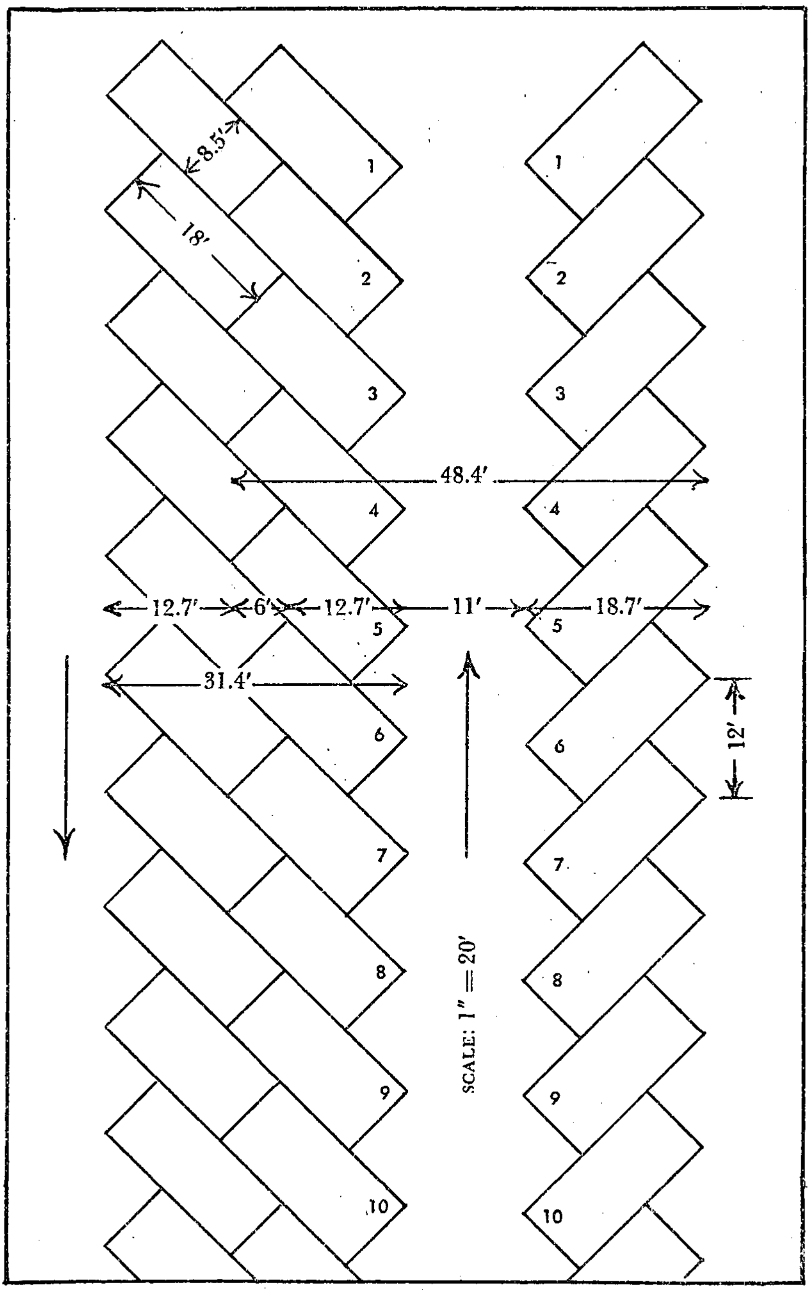


FIGURE VI–12d.

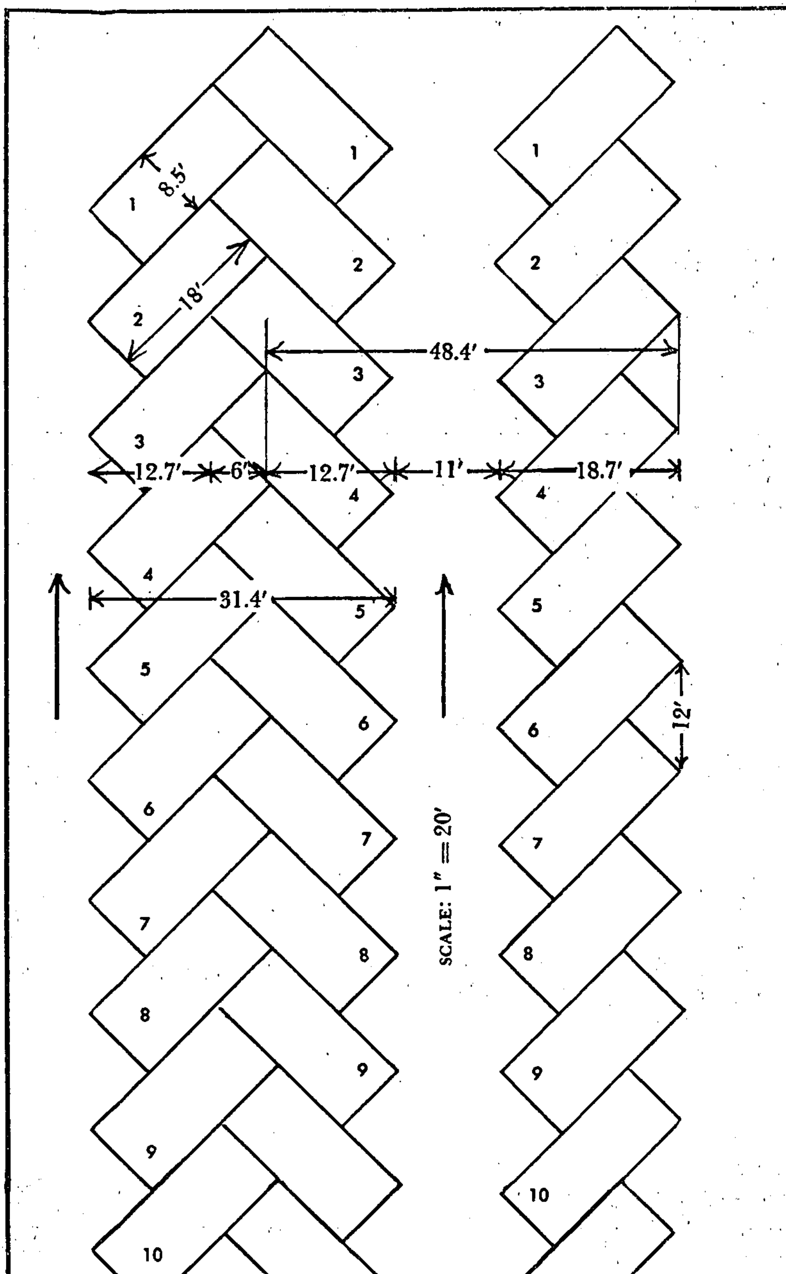


FIGURE VI–12e.

By shifting or "stepping along" the pattern, its suitability for the whole area may be determined. For a large area, a preliminary step might be to compare the total length available with the unit widths of the patterns (42.8 feet for thirty-degree, 48.4 feet for forty-five-degree, 57.6 feet for sixty-degree and 61 feet for ninety-degree, etc.).

Where a "combination" unit is used, the aisle width must be that required by the steeper angle. Thus if a unit has forty-five-degree stalls on one side and ninety-degree stalls on the other side, the aisle must be at least twenty-four to twenty-five feet wide.

The procedure is perhaps best clarified through several examples:

(1) A small parcel sixty feet frontage by eighty feet deep is obviously well adapted to the ninety-degree pattern, using a combined entrance and exit in the middle of the frontage. The eighty-foot depth will allow eighteen stalls and leave three feet for fence or screening.

(2) A parcel with a fifty-six to fifty-seven foot frontage and eighty feet deep would not permit comfortable use of a standard ninety-degree unit but could accommodate one unit at sixty degrees and allow fourteen stalls, but would require an exit at the rear, because of the necessary one-way travel.

(3) The same parcel, fifty-six to fifty-seven feet wide and eighty feet deep could accommodate one row at sixty and one at forty-five, with a total of thirteen stalls, less than in example (2).

(4) An alternative for the same parcel might be to use ninety-degree stalls, making them ten feet wide instead of eight feet six inches. This would permit use of the narrower twenty-foot aisle, and would provide sixteen spaces, more than in (2) or (3).

(5) Figure VI–9a shows six alternative layouts for an area 100 feet by 100 feet, dependent upon possible points of entrance and exit.

(6) Figures VI–13a, b shows eight possible ways of laying out an area 140 feet by 225 feet, under various controlling conditions.

Plan A. The 140-foot width permits two ninety-degree units of sixty-one feet each with three six-foot pedestrian paths, and provides ninety-two spaces.

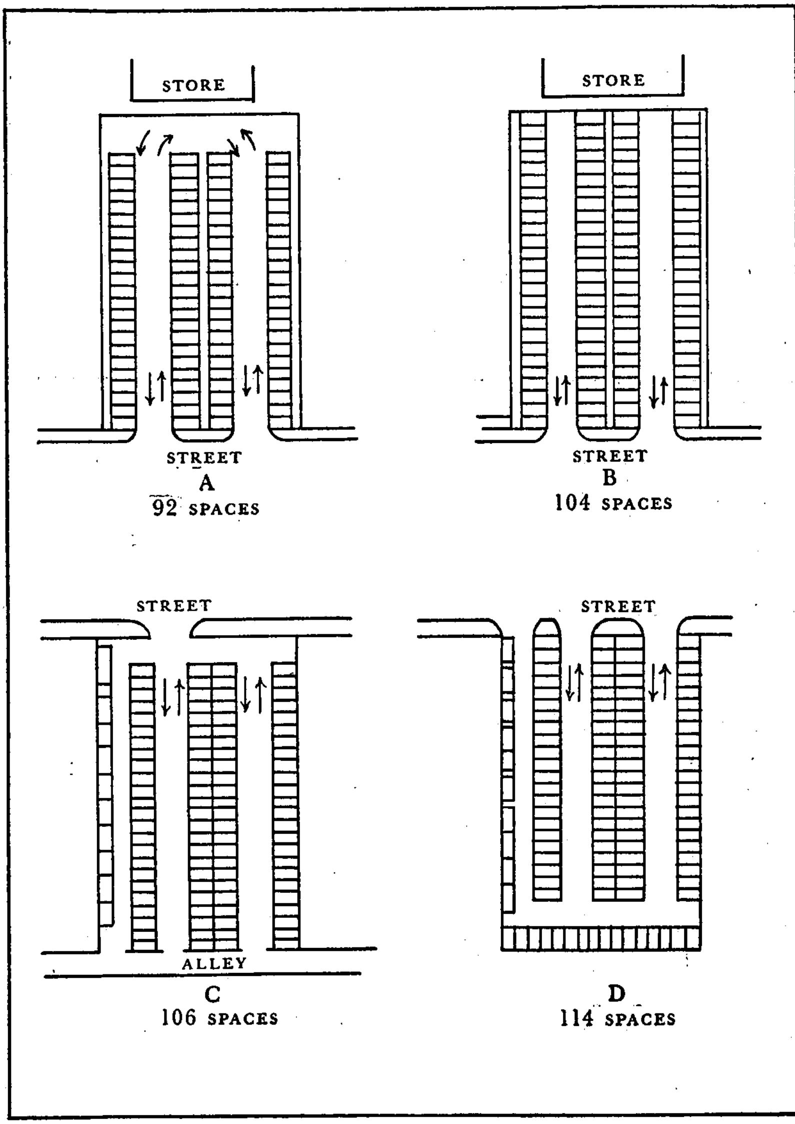


FIGURE VI–13a.

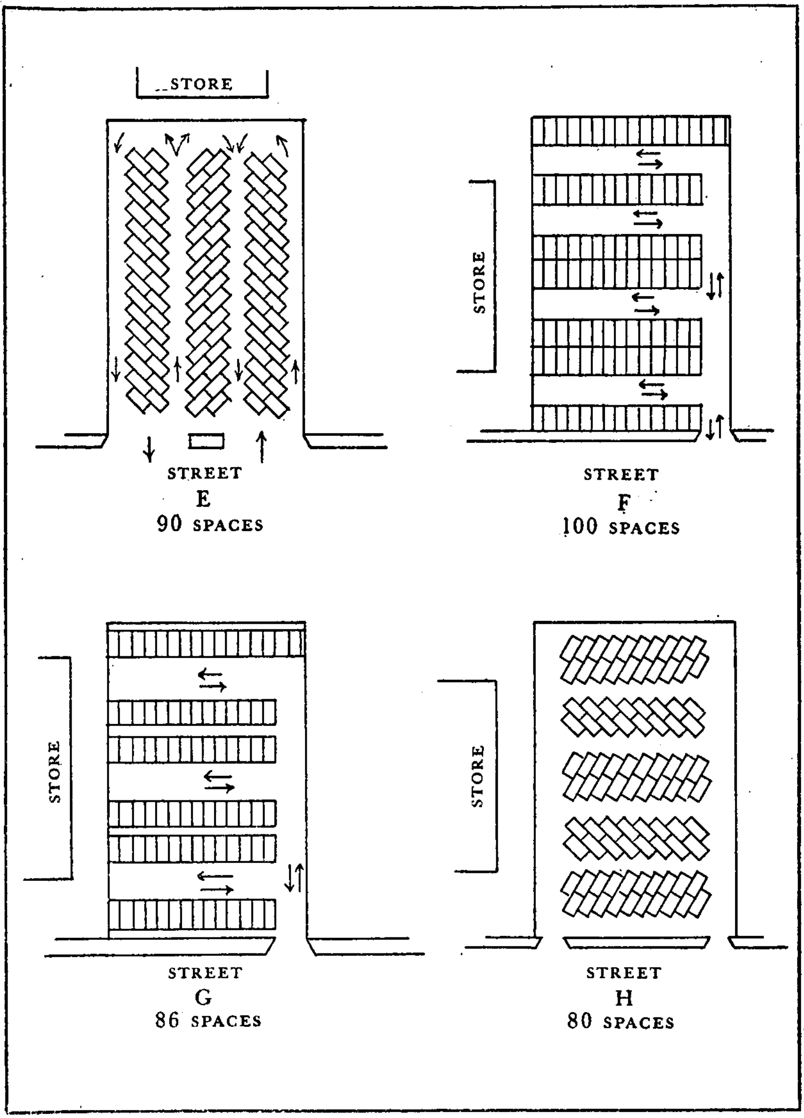


FIGURE VI–13b.

Plan B uses a similar layout to provide 104 spaces, but omission of the transverse aisle prevents passage from one unit to the other.

Plan C. By omitting the pedestrian walks, space is gained for ten parallel stalls, possible only because of availability of an alley for exit.

Plan D. Without benefit of an alley this provides 114 spaces and still has a transverse aisle for easier circulation and to permit use of the parallel stalls.

Plan E. This offers the easier parking afforded by angle stalls, and has one-way circulation, but provides only ninety stalls. This could be served by a single entrance-exit.

Plan F. By using the ninety-degree pattern this provides 100 stalls and needs only one entrance-exit. This pattern might be improved by placing the main travel aisle in the center, with parking aisle branching to each side.

Plan G. This uses a pattern similar to that in F, but sacrifices one row or fourteen stalls to provide pedestrian walkways.

Plan H. This provides fewer spaces than for G but affords the easier parking of angle stalls.

It cannot be assumed that the layout which provides the largest number of spaces is thereby the best, even for a commercial lot operated by attendants. A lot provided by a store to attract customers usually sacrifices some capacity to give convenience and comfort. Where meters are to be used, or where screening or landscaping is desired, space must be allowed, and so on.

Figure VI–14 gives examples of the adaptation of standard patterns to irregular areas in several self-parking metered municipal lots in California cities.

Offstreet Truck-loading Docks or Berths

Figure VI–15 shows suggested layouts for docking facilities for tractor-trailer combinations, as listed in Table VI–6.

For general use, the stalls, doors, etc. should be at least twelve feet wide, and overhead clearance fourteen feet. Dock heights vary from forty-four inches for smaller trucks to forty-eight to fifty

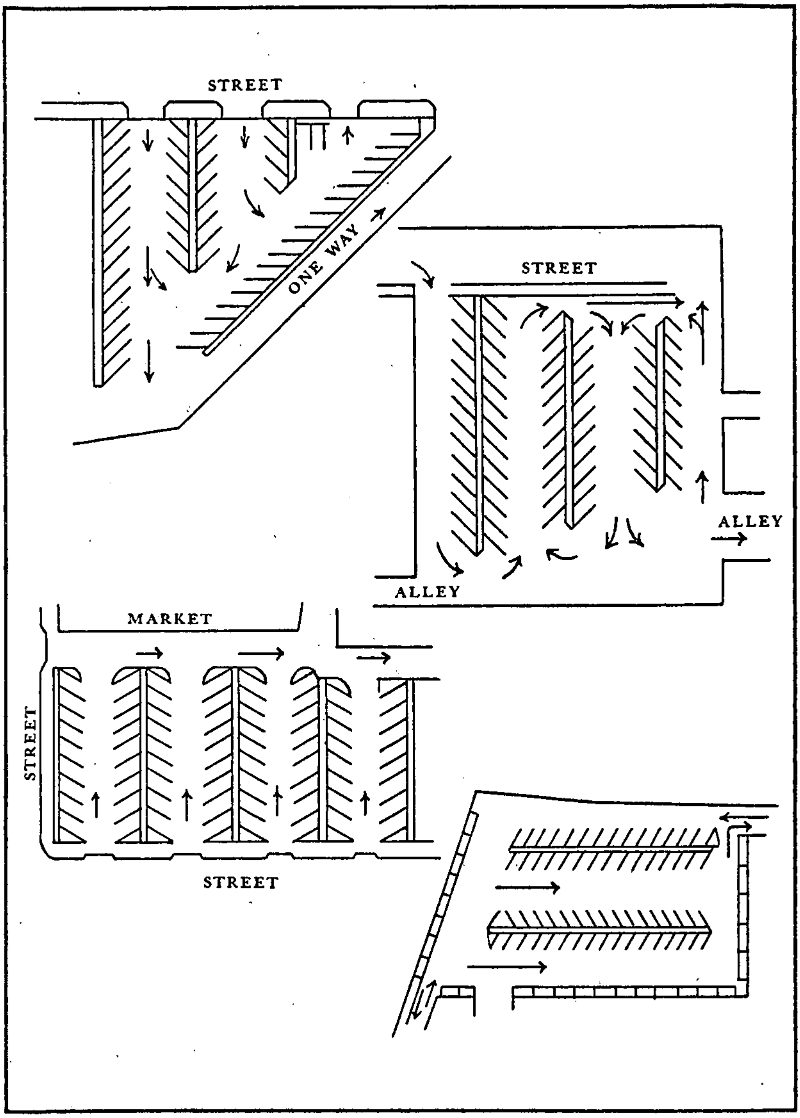


FIGURE VI–14. Layouts of Municipal Lots in Four California Cities (Not to Scale).

Table VI-6

APRON SPACE REQUIRED FOR SINGLE-MANEUVER POSITIONING OF TRACTOR-TRAILER COMBINATIONS

Overall length of tractor-trailer ft.	*Width of stall* ft.	*Apron Space* ft.
	10	46
35	12	43
	14	39
	10	48
40	12	44
	14	42
	10	57
45	12	49
	14	48

SOURCE: Fruehauf Trailer Co., published in *Architectural Record,* October, 1947.

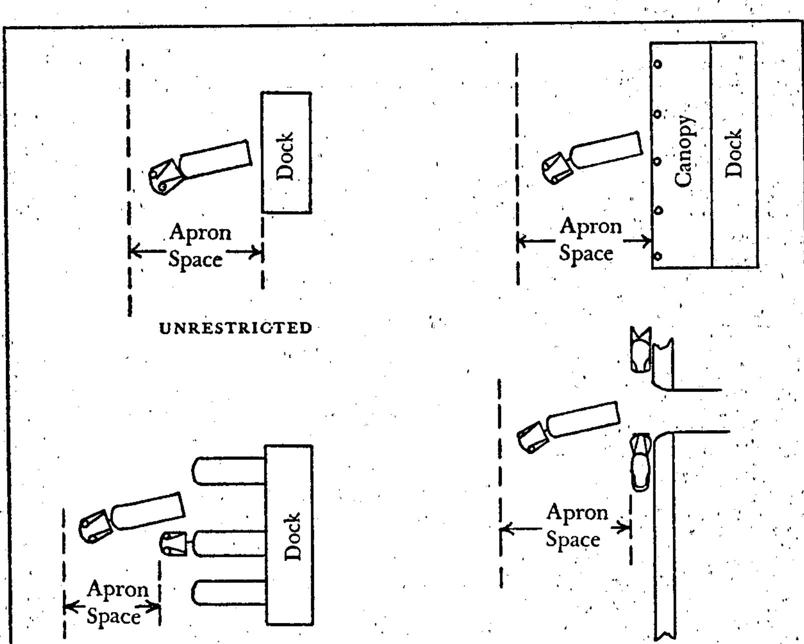


FIGURE VI-15. Loading Dock Layouts.

inches for heavy-duty units, and ramps or jacks often are used to adjust differences in levels of truck beds and dock height.

The dock area needed for each stall depends upon the capacity of the units being served, the height to which tiers may be stacked upon the dock, the elevator or other service available for clearing the dock, and the frequency of arrival of trucks (i. e., the tonnage per dock per day).

Costs of Parking Lots

The first cost of a parking facility includes (1) the land cost and (2) the cost of improvement or construction. With the land cost there usually is included any cost of clearing or demolition of existing structures, and obviously there can be a very wide range in values. Similarly improvement costs may range from simple grading of a vacant lot to the construction of a multi-level garage, and here too costs are affected by such factors as topography, nature of the soil, local labor rates, degree of improvement, etc.

Parking lots: An excellent study of the development of municipal offstreet parking activity in the New York City Metropolitan area, published in 1951[6] reviewed the progress in sixty-one municipalities ranging from 1,600 to 152,000 in population, with an average population of 23,600. These sixty-one places provided, very largely in the years 1945–1950, a total of about 27,000 *municipal* offstreet spaces in 230 lots. It should be borne in mind that fifty-seven of the sixty-one places have less than 50,000 population and that in such places there are apt to be few if any commercial offstreet facilities.

The supply of these spaces ranged from one to 161 per 1000 population, the average being nineteen. The range was from one to ninety-two in all but two places. Garden City, on Long Island, with 161 spaces per 1000 population, has perhaps the most generous supply and best arrangement.

The average lot provided 148 spaces and had a land cost of $326.50 per space (ranging from $18 to $2,021 per space) at an average of about $1.05 a square foot.

[6] "Adequate Parking in Business Areas," F. P. Clark, *Traffic Quarterly*, April, 1951.

The average improvement cost was $192 a space, ranging from zero to $1432, and the total cost averaged $518.50 a space.

The investment in these lots per capita of population averaged $6.28, the maximum being $66.80. In Garden City, which has the best supply, the investment was $23.50 per capita. That this investment has brought direct and material benefits is demonstrated by the fact that in Garden City, since the creation of its parking system, the total assessed valuation of the business area served has more than doubled, notwithstanding the withdrawal from taxable valuation of an area of land greater than the present total area of business property. This doubling of business valuation came during a period when the assessed valuation of land in the village as a whole increased only seventeen percent.

Two parking lots for neighborhood shopping centers in Detroit, Michigan, constructed in 1953, provide the following data:[7]

	Costs per stall			
	Lot No. 1		*Lot No. 2*	
Land		$761.34		$570.52
Improvement				
Tree removal	$ 2.20		—	
Grading, paving	182.92*		204.98	
Water and drainage	15.27		18.42	
Curbing, block wall	27.55		16.22	
Illumination	22.68		29.80	
Shelter, signs	11.63		37.43	
Landscaping	7.57		—	
		274.82		306.85
Total cost per stall		$1,036.13		$877.37
Number of stalls		360		128

* 6″ base course, 1½″ asphalt penetration course.

Three municipal parking lots in Lansing, Michigan, constructed about 1950, involved costs as follows:[8]

7 "Parking Lots for Secondary Shopping Centers," H. M. Batts, Jr., *Traffic Engineering*, January, 1955.

8 *Traffic Quarterly*, July 1950.,

	Costs per stall *Lot No. 1*		*Lot No. 2*		*Lot No. 3*	
		$845.98		$729.45		leased
Improvement						
Grade and base	$46.20		$59.50		$10.57	
Black top	35.60		28.90		29.80	
Meters	66.00		66.00		62.50	
Bumper posts (1 each)	.77		1.29		1.68	
Install meters, bumpers	8.75		6.20		4.13	
Paint for posts and signs	.42		.55		.59	
Regulatory signs	1.30		1.08		1.51	
Flood lights	9.00		2.92		1.38	
Top and remove trees	.60		.71		—	
Fence	.50		—		—	
Plans	.24		.27		.30	
		169.34		167.50		112.55
Total Cost per stall		$1,015.32		$896.95		
Number of stalls		105		93		96
Gross sq. ft. per stall		309		280		407
Land cost per sq. ft.		$2.74		$2.61		leased
Construction cost per sq. ft.		$0.548		$0.598		$0.276

In 1946, Miami Beach, Florida began a program of parking lot construction in an attempt to meet the demand of its tourist season, when the normal population of about 46,000 is swollen to nearly 200,000. By 1949 four lots had been completed.[9]

Number of spaces	962	168	323	76
Land cost per space	unknown	$5030*	$1550*	$435
Improvement				
Construction per space	$140	204	124	122
Landscaping per space	15	74	36	—
Total cost per space	unknown	$5308	$1710	$557

* City land, assessed valuation.

All lots are metered, yet despite the fact that the tourist season lasts only about five months, the meter income is such that the entire improvement cost for the average lot should be amortized in less than four years.

[9] "City-owned Parking Lot Experiences in Miami Beach, Florida." *Traffic Quarterly*, April 1950.

Improvement (only) costs for the parking lots for a chain of grocery stores were as follows:[10]

Unit costs:	
Black top	20c per sq. ft.
Asphalt	25c per sq. ft.
Concrete approaches and curb cuts	50c per sq. ft.
Grading and sewer	7½c per sq. ft.
Lighting:	
Underground wiring	5c per sq. ft.
Poles	$50 each
Flood lights	$22 each
Typical costs for a lot 100′ x 120′, having 45 spaces:	
Asphalt, 12,000 sq. ft.	$3,000
Fences, 250′ @ $2.00	500
4 lights @ $50	200
12 reflectors @ $25	300
Underground wiring	600
	$4,600

or $102.20 a space, or 38.35 cents per sq. ft.

In a study made by the City Administrative Officer of Los Angeles in 1955, sixty-two California cities reported having 259 municipal parking lots with an average capacity of ninety-six spaces per lot. Costs per space ranged from $197 to $2329. Approximately fifty-four percent of the spaces were metered, and

Cost of Municipal Lots
Janesville, Wis.*

Lot No.	1	2	3
Year	1951	1952	1953
Type of parking	Self	Self	Self
No. of stalls	136	101	51
Gross area per stall, sq. ft.	297	344	384
Land and clearance cost per stall	$143	$660	$257
Improvement cost per stall	$ 47	$149	$168
Total cost per stall	$190	$809	$425

* "Parking Programs," American Automobile Association, 1954.

10 *Appraisal Journal*, October, 1950, page 434.

Cost of lots and garages (municipal)

Ann Arbor, Michigan*

Project No.	1	2	3	4	5	6	7
Type of facility	Lot (metered)	Garage	Lot	Garage	Lot (metered)	Lot	Lot
Type of parking	Self	Self	Self	Self	Self	Self	Self
No. of stalls	125	422	39	235	28	70	120
Date acquired	1951	1948	1948	1946	1951	1952	1953
Gross area per stall, sq. ft.	279		301		279	301	340
Land and clearance Cost per stall	$196	$332	$1622	$259	$1429	$1429	$625
Structure or improvement Cost per stall	$10	$1126	$6	$1370	$100	$205	$4
Total cost per stall	$206	$1458	$1628	$1629	$1529	$1634	$629

*"Parking Programs," American Automobile Association, 1954.

the average meter return was $50.64 a year. One large city reported one lot having sixty meters with an average return of $1 a meter a day.

Cost of Municipal Lots
Silver Spring, Md.*

Lot No.	1	2	3	4	5	6	7	8
Type of Parking	Self	Self	Self	Self	Self	Self	Self	Self
No. of stalls	211	641	144	300	160	75	380	253
Gross area per stall square ft.	413	328	468	283	271	333	422	362
Land and clearance cost per stall	$677	$135	$626	$114	$1240	$469	$152	$357
Improvement cost per stall	$263	$106	$141	$135	$ 89		$101	$219
Total cost per stall	$940	$241	$767	$249	$1329	$469	$253	$576

*"Parking Programs," American Automobile Association, 1954.

CHAPTER SEVEN

OFF-STREET PARKING: FINANCE AND REGULATION

The basic need in city parking is effectively distributed offstreet facilities. They offer a real solution to full street use and a free flow of traffic.

A useful way to classify offstreet parking is by type of ownership and operation: (1) privately owned and operated; (2) publicly owned, privately operated, and (3) publicly owned and operated.

All three have been used successfully and none should have preferential consideration. Any choice should be determined by local circumstances.

Privately Owned and Operated Facilities

Private enterprise *contributes* invaluable *aid* to the parking problem, with thousands of efficiently operated, privately owned facilities. Yet in few cities have private interests *fully* met parking demands.

Private facilities are usually situated in areas of maximum demand. The basic difficulty in relying wholly on private investment is that the community obligation and the private investor's highest-profit motive do not coincide.

Privately developed offstreet parking often arises from pressure, competition, and the desire to assure continued successful operation. In some cases both driver and business share the cost.

Countless attractive offstreet parking facilities are provided by individual stores or groups of businessmen and merchants. In some places, parking is free. Others require validation, or combinations of validation, purchase, and time parked.

Allentown, Pennsylvania devised a highly successful plan for a co-operative attack on the parking problem. Her downtown parking situation was acute before World War II. During the war, parking demands dropped sharply. Car registrations slumped and gas rationing curtailed car use. Parking lots in the heart of the city were doing a poor business. Property owners reduced lot rentals when property values generally were on the upswing.

A far-sighted group of businessmen realized that the post-war downtown parking situation was serious. Consequently an organization was formed and chartered as Park and Shop Inc., with these aims:

1. To prevent land used for parking from being put to other uses.

2. To plan so existing lots would be more attractive, physically and financially.

3. To acquire additional properties for parking.

4. To encourage better enforcement of curb parking laws so on-street spaces in the business center could serve efficiently.

The corporation issued 2500 shares of capital stock among its thirty original participating members. At $100 a share, the initial stock provided $250,000 working capital. Allocation of the stock was on the basis of:

1. Total first floor area.

2. Type of business, with reference to its ability to concentrate sales in a given unit of floor area.

Stock quotas in the original issue varied between $300 and $40,000. Some were paid in cash, others over a five-year period. It was agreed that profits would be used to extend the facilities.

Upon subscribing to stock, each merchant entered into a contract with the Park and Shop Corporation. The contract stipulated that the merchant could offer his customers free parking at any of the corporation facilities with a minimum purchase of one dollar. The contract permitted members to establish higher minimum purchases before validation.

In its first year of operation, the corporation acquired four parking lots. These were facilities already in use. They formed the nucleus of the chain of facilities envisioned. Today, the corporation has more than one hundred members, and its assets total more than $800,000. It owns or controls nine parking lots and one garage that can park 800 cars. It has been a successful and widely discussed operation.

All lots are leased to commercial operators at an attractive rental, since the aim of the corporation is to provide parking. The annual rental is 10 percent of the purchase price of the property. One of the lots costs Park and Shop $600 a car space. The operator of that lot pays the Corporation $60 a year for each car space—a reasonable return to the corporation and a good profit for efficient operation.

Upon entering a Park and Shop lot the driver receives a standard parking check for twenty-five cents. The fee covers two hours of parking. If he shops at a member store and has his parking check stamped, the fee is returned when he leaves the lot. Two validations give four hours of free parking.

Monthly, the lot operators send validated tickets to Park and Shop. For each, they receive fifteen cents. Park and Shop in turn bills its members twenty cents for each ticket validated the previous month. The difference covers administrative expenses of the corporation. One member store, after a careful study, discovered they were getting an average purchase of $4.60 from each parking validation. Another reports his parking costs to be three-tenths percent of sales. An indication of the parking plan's success is the growth of Allentown's retail sales—$59,000,000 in 1940 and $160,000,000 in 1950. Allentown merchants devised a positive plan to develop permanent, convenient parking near their stores.

A Parking Authority has been established by the City of Allentown to work with Park and Shop in providing spaces for all-day parkers. A well-balanced city-wide, offstreet parking layout is their aim.

In Hollywood, California, the Chamber of Commerce joined with merchants in a unique parking validation scheme. The Chamber of Commerce sells parking stamps to participating lot owners by placing parking stamps on their backs for purchasers of one dollar or more. To complete the circle, the stamps are redeemed by the Chamber of Commerce for the lot owner.

Minneapolis, Minnesota, has a merchant-parking corporation. A Chamber of Commerce committee undertook to sponsor a city-owned and operated series of parking facilities. They participated in the preliminary surveys and co-operated with the City Council in its feasibility studies. As they progressed, they accumulated considerable data on what facilities would be needed and their probable effectiveness.

State law limited financing of city parking facilities to assessments against benefited properties or the use of revenue bonds. When financing decisions were being made to determine a suitable method, the Chamber of Commerce suggested an organization of downtown business interests. Downtown building owners, retailers, and bank officials readily agreed. They demonstrated their interest by promptly raising $600,000. A prominent insurance company lent $1,500,000 to provide enough money for the construction of two parking structures.

The new corporation, Downtown Auto Parks, Inc., formed in 1950, immediately started construction of the two garages. The corporation is operated by officers and a board of directors, selected from the stockholders, who serve without compensation.

Management of the parking facilities is by commercial operators. Rates are twenty-five cents for the first hour and fifteen cents an hour thereafter. The maximum rate is $1.50 for twenty-four hours of parking. Some monthly parking is permitted. Rates vary from $12 a month for roof parking to $23 for basement parking.

Despite the success of merchant parking operations, some merchants object to providing facilities. They often object on the grounds that their stores and businesses do not create the entire parking problem, and they, therefore, should not be required to furnish the solution. By providing offstreet spaces they contend they are freeing the curb for parkers who may not be shoppers. This type of opposition does not prevail and in most cases participating merchants have found it a profitable venture.

Merchants may find offstreet parking a costly venture. Yet, failure to participate may be more costly in the long run, because of traffic congestion, absence of parking space, and competitive disadvantages. If merchants are unable to contribute to a solution of their problem, they should co-operate with the city in its efforts to do so.

Merchants and groups providing parking accommodations look on them as a reasonable way to bring customers to their stores.

Although a recent trend has been toward increased municipal offstreet parking, *private enterprise* occupies an important place. In some cities it is the dominant force. Substantial improvement in parking conditions can be achieved by encouraging private enterprise to expand their operations.

The complete physical and financial figures on the two decks of Downtown Auto Parks are:

	Fourth and Marquette Ave.	*Ninth and LaSalle Ave.*
Ground Dimensions	156′x 157′	180′x 167′
Ground Area	24,492 sq. ft.	30,060 sq. ft.
Number of floors:		
Below ground	1	2
Above ground	5	5
Total building area	147,000 sq. ft.	210,400 sq. ft.
Number of car spaces	535	819
Square feet per car space	274.7	256.8
Construction cost	$560,414.88	$792,080.98
Architectural, Engineering, Consulting and Miscellaneous costs	$32,100	$49,140
Total construction cost	$592,514.88	$841,220.98
Construction cost per car space	$1,047.50	$967.13
Construction cost per square foot	$3.81	$3.76
Land cost	$269,747.39	$170,132.12 (part leased)
Total cost, land and construction	$862,262.27	$1,011,353.10
Total cost, land and construction per square foot	$5.65	$4.57
Total cost, land and construction per car space	$1,551.70	$1,174.86
Number of stalls set aside for monthly parkers	100	260
Remainder for transients	435	513
Size of reservoir space	17 car spaces	16 car spaces
Rates—Transient	25¢ first hour	25¢ first hour
Rates—Transient	25¢ first hour 15¢ each add'l hour	25¢ first hour 15¢ each add'l hour
Rates—Monthly	$12 to $23 per month	$12 to $23 per month
Approximate number of employees required:		
Peak days	20	30
Off-Peak days	10	15
Operating Hours	24 hours	24 hours

Some cities encourage this by reducing taxes for several years on parking properties. Others aid in planning private lots. One city permitted its department of streets to grade private lots and provide them with proper drainage.

Arguments for these public subsidies are:

1. Widespread municipal benefits.

2. Uncontrolled decentralization of the Central Business District is prevented or retarded.

3. Whatever the cost of assistance by the city, the improvement proves worth it.

Objections come from owners of parking properties not enjoying such favor. If municipal aid tips the balance of legitimate competition objectors have a valid complaint—and the city should re-examine its program. Government subsidy in parking should alleviate the problem, not aggravate the difficulty.

Publicly Owned, Privately Operated Parking: This combined ownership and operation furnishes an appreciable part of the parking capacity in downtown areas. It is a form of municipal subsidy. Examples range from the city-owned lot leased to a private operator at a nominal rental to the city-financed multi-story parking structure given over to highest-bidding commercial operators on a long lease with varying types of financing.

This plan for developing offstreet parking combines the advantages of private enterprise with those peculiar to municipal participation. The land remains on city tax rolls with no drain on public funds. Private enterprise solves public problems.

City participation means that facilities can be effectively distributed as part of a general plan. They need not be limited to areas where parking shortages are so severe that immediate financial success is assured. It adds a greater degree of permanency to parking gains achieved. It is a means of self-preservation for the city.

Richmond, Virginia, owns a 240-car parking lot operated by a private operator on a sharing basis.

The lot, covering a block, is within 800 feet of the city's two largest downtown department stores. Acquisition and improvement costs totaled $345,000, or about $1,400 a car space. They were paid out of a general improvement fund.

With the city setting parking rates, the method of operation, distribution of revenues, and requiring that bidders have parking management experience, operation of the lot was awarded by competitive bid. The city's share is forty-five percent of the gross revenue with a guaranteed minimum of $20,000 a year. The first year of operation netted the city $23,985. The city expects to recoup its original investment within ten years.

Des Moines used revenue bonds to finance the construction of two parking structures promptly leased to experienced private operators. One is a ramped garage, the other mechanical. Their combined capacity is 780 cars.

The bond issue, for $1,250,000, was sold at public auction. The city pledged 75 percent of the income from 1700 curb parking meters and all revenues from the parking structures, as well as the promise of a general tax of up to one half mill if necessary to insure orderly liquidation of the revenue bonds within their 19-year term.

The first unit completed was a five-story continuous ramp building, 132 feet square. It can accommodate approximately 350 cars. Cost of the structure, including architectural and engineering fees, was $408,000; land cost, $118,000; cost per car space, roughly $1,500.

The second unit is a mechanical garage, elevator type, carrying cars vertically and horizontally in front of the parking stalls racked to nine stories. The elevator attendant drives the cars into the parking slots. The Des Moines structure uses three elevators to service the 430 car-spaces, on an 88 by 132 foot plot.

Total cost of the second parking structure was $526,755. The mechanical device cost $146,000; land, $110,000; cost per car space, $1,421.

Parking rates set by the city:

	Continuous Ramp Structure	*Mechanical Structure*
First hour	25c	30c
Each additional hour	10c	10c
Maximum—12 hours	75c	$1.00
Monthly	none	none
Hours of operation	7 A.M.–Midnight	7 A.M.–Midnight

Both facilities are managed by private operators. The city receives $35,000 annual rental plus a percentage of the gross receipts in excess of $7,200 a month. The mechanical garage nets the city $50,000 annual rental.

To facilitate financing, the city obtained special state legislation authorizing assessment of a city-wide one-half mill property tax, if necessary, to retire the revenue bonds.

Publicly Owned and Operated Parking Facilities: Municipal acquiring and operating of offstreet parking developments has largely resulted from a failure by private enterprise to solve the problem satisfactorily. The main argument to justify this course is that parking facilities for the public should be furnished by the public. Further support is gained for the plan because the city often has usable land. If not, it can usually acquire land. It can finance land purchase and development costs. Usually, street department personnel and equipment are available to prepare the lots. Most important, the city can offer minimum-cost parking. It need not be a profitable undertaking. Isolated break-even or reasonable deficit-parking operations are easily justified on the basis of their being part of a planned parking system.

Replies to this:

"The city has been in parking business since meters were installed at the curb."

"Offstreet parking is an extension of public responsibility to develop and maintain public ways for travel."

"If the city prohibits curb for parking, it should provide comparable offstreet facilities."

Other arguments against city parking operations center around the right of private enterprise to conduct business without competition from government. Opponents of municipal parking programs contend it is unfair for the city to participate in offstreet parking activities where private capital has heavily invested.

Despite arguments, offstreet parking is a community problem. Citizens, adversely affected by parking *shortages*, find that their city is often the only agency able to acquire proper offstreet locations. The more suitable the location, the more difficult, the more expensive it is to acquire. And unlike the private property owner, a city has authority and resources to erect suitable parking structures.

In most cities, private operators have turned available land to parking use. But leases often discourage expansion. Many aspects of private operation show the tenuous nature of both leases and operational methods.

Evanston, Illinois, decided that private parking facilities were not solving the problem. Officials launched a municipal program that developed within three years eleven parking lots. Six are in or near the principal shopping area; three, in secondary business districts, and two, in apartment neighborhoods.

Experience proves that small lots appropriately distributed help to ease parking problems, and distribute traffic movement. Six of Evanston's eleven lots charge for parking. They are metered with a three-hour limit at five cents an hour. The remaining five have free parking.

Parking meter revenues have paid the cost of Evanston's program. Additional lots and two garages are contemplated.

Administration of the City Offstreet Parking Program: In four ways, city governments have assumed the responsibility of administering their offstreet parking:

1. Placing the function in an existing department such as Streets or Traffic Engineering.

2. Setting up a separate municipal department of offstreet parking.

3. Appointing a parking board or parking commission to coordinate the offstreet efforts of other city departments.

4. Creating an autonomous Parking Authority.

Each plan has advantages. One that best suits one community is not necessarily best for another. Local conditions and factors affect the choice. Variables are population, public attitude, political character, administrative precedent, and governmental custom.

Advantages and weaknesses of the four plans are:

Sub-department: The simplest way for a city to assign responsibility for offstreet parking meters is to create a sub-department of offstreet parking within an established department. Unfortunately, offstreet parking activities, thus becoming an added function, are often subordinated to the department's primary activities. Parking activities can under such circumstances be obscured from public view and review. Offstreet parking is important to the public. It requires aggressive management. The executive ability for successful offstreet parking facilities is hard to find at the sub-department level.

Separate department: Problems involved and abilities required in the administration of parking are sufficiently unlike those in other city units to justify a separate department. Capable management personnel can be attracted by prestige, salary and authority of a city department head. A separate department has direct lines of authority, its duties and responsibilities clearly defined.

Creation of a department of offstreet parking, however, does not remove the matter from political pressure. Change in political control of the city government makes it impossible to assure continuity of departmental management. That uncertain tenure does not contribute to the acquiring of capable personnel or to the efficient administration of offstreet parking projects.

Parking Board or Commission: This agency type is often composed of civic-minded citizens who serve without compensation, their function advisory. Advantages claimed are:

1. Appointment to a non-salaried, civic-betterment body appeals to the higher-type, experienced businessman. His administrative decisions will be motivated by the *public* interest.

2. Because commission and board members are usually downtown business and professional men close to the parking problem, the city benefits from their talents and collective judgment in the consideration of administrative decisions often outside the normal concern of city government.

3. The commission or board gives a voice to representative members of local groups interested in improving parking conditions.

One of the defects of the commission administration is the limit on powers to act. Their authority rests in the mayor. He controls commission activities, either directly or by appointments. Regardless of the merits of commission proposals, their implementation depends on another group of men. The separation of planning and execution functions does not facilitate offstreet parking activities or the acquisition of facilities.

Other disadvantages are:

1. It may become a body more interested in gaining recognition than in service.

2. It may become a buffer between the public and the city with responsibility for offstreet parking policy passed from one to the other while parking attrition continues.

3. Important decisions required in the administration of offstreet parking can be cumbersome and time-consuming, if left to a large group.

Parking Authority: Many cities in recent years have adopted the device of a parking authority to administer the parking program. The Authority is a separate, legal entity, completely autonomous in planning, financing, construction and operation of a city offstreet parking program. Created by the city, it combines public responsibility of government with business initiative and the efficiency of private enterprise.

City parking authorities have two primary identifying characteristics:

1. Sufficient independence from direct city control to permit autonomous operation with appropriate corporate powers to function.

2. Power to finance operations by revenue bonds. (See pages 216–219.)

Parking authority proponents say that powers granted to parking authorities provide flexibility and responsiveness for prompt, businesslike decisions. Revenue bonds balance this management flexibility. Bonds are attractive to potential investors when sound decisions are apparent.

Purposes of parking authorities outline a development of logical action for a good offstreet parking agency. Those purposes are:

1. Conduct detailed factual studies to locate site and determine suitable size and type parking facilities to meet requirements.

2. Make the results of those studies and conclusions available to private individuals as a means of stimulating their interest and investment activity.

3. Assist organized groups of merchants, businessmen, and others in offstreet parking activities.

4. Acquire property, finance, construct, and operate offstreet parking facilities.

5. Control the location, operation, servicing and maintenance of parking meters at curb and offstreet locations.

6. Administer minimum operating regulations for both public and privately owned parking facilities.

7. Prepare a rational master plan of offstreet facilities to meet present and probable future parking needs.

8. Periodically re-evaluate parking needs to up-date the master plan for changing parking needs and desires.

Parking authorities are controlled by a governing board, appointed by the mayor. Generally there are five board members. For continuity of management, tenures of members are staggered. One is replaced each year. Careful selection of board members is the key to successful parking authority operation. Such success is a direct measure of the business ingenuity and resourcefulness of the men entrusted with its management.

The primary advantages of the authority-form of offstreet parking administration are:

1. It provides an agency of size and power comparable to the problem.

2. Its powers are broad and flexible. It can plan and pursue a suitable course advantageous to the problem and the city.

3. It is self-sustaining, its operation does not increase the taxpayer's obligation.

Briefly, parking authority provides businesslike development and management of an essential municipal service.

Critics point out that the parking authority plan has disadvantages. One is its separation from city government and the immunity that separation provides from easy municipal supervision. Co-ordination of parking authority work with other city activities related to traffic and parking is also minimized by the independent character of authorities. That the authority duplicates much of the work of existing city departments is another criticism.

Actually, it too soon to judge the value of parking authorities versus other plans for administering a city's offstreet parking program. The concept is young, the experience, limited. About forty-five such agencies have been created.[1] Of those not entirely

[1] Modesto, San Francisco, San José and Santa Monica, California; Norwalk, Connecticut; Wilmington, Delaware; Joliet and LaGrange, Illinois; Indianapolis, Indiana; Augusta, Maine; Baltimore, Maryland; Detroit, Flint, Grand Rapids and Lansing, Michigan; Hackensack, Jersey City, New Brunswick, Paterson, Passaic and Trenton, New Jersey; Elmira, New York City, Peekskill, Syracuse, and White Plains, New York; Charlotte, Raleigh and Wilmington, North Carolina; Cincinnati and Columbus, Ohio; Portland, Oregon; Johnstown, Lansdale, McKeesport, New Kensington, Philadelphia, Pittsburgh and Uniontown, Pennsylvania; Knoxville, Tennessee; Norfolk, Virginia; Madison and Milwaukee, Wisconsin.

successful it is not clear that their ineffectiveness was caused by—or was in spite of—their being authorities.

The parking problem continues to grow in seriousness. It exerts a tremendous effect. Many cities consider it of public importance to continued growth of the city and a direct threat to city centers. Offstreet parking should be the concern of both the municipal authorities and private operators. But that does not invite open warfare between the two groups. Long range and early action should be part of every city's parking program. Every city should have a live program. A city offstreet parking program should produce as much or as little parking as private enterprise demonstrates it is unable or unwilling to provide.

Methods of Finance

Private financing of parking developments is little different from private financing of other business. Parking facilities are not always costly to provide. Orderly liquidation of the investment depends on the continuous balancing of a financing operation that leaves little room for inefficient management.

Successful city parking programs indicate that many different financing plans are workable, and are geared to meet varying conditions. Several proved methods of financing parking projects, including land acquisition, facility construction and operation are:

1. Current budget expenditures.
2. General obligation bonds.
3. Revenue bonds.
4. Benefited district assessments.
5. Parking revenues.
6. Co-operative measures between city and private enterprise.

Current Budget Expenditures: Some cities have financed parking projects from current budgets—particularly, a few years ago, when city participation in offstreet parking was new and projects were small. In recent years, this plan has been augumented by growing measures of parking control and the spreading of financial burden more directly on those benefiting most from parking improvements.

Early city-owned offstreet parking places were modest developments. They cost relatively little. Rapid increases in the size of the parking problem, particularly since World War II, has required a comparable expansion in programs to meet it.

Current budget financing of parking continues to be used in cases where suitable land is city-owned, or can be reasonably acquired.

Over the past fifteen years, Hampton, Virginia, has used current budget expenditure to build a system of seven parking lots. They contain more than 1,000 spaces. All the lots were acquired and improved with money from the city's general funds by carefully working the costs into the city budget over the period.

This foresight of Hampton officials has produced much-needed parking space at minimum cost. Other benefits were achieved during the process. Several blighted areas were replaced by attractively finished parking lots. The need for expensive street widening was eliminated. And the trend of slumping business, as reflected by decreases in applications for business licenses, was reversed.

Summit, New Jersey, developed its entire offstreet parking system by current budget appropriations. In twelve years, Summit spent $63,000 to acquire and improve four parking lots for 448 cars. Only one of the lots has pay parking. Revenue from it, as well as that collected from curb parking meters, goes into the general fund.

Tax foreclosure proceedings gave Teaneck, New Jersey, four parking lots. Twelve thousand dollars of the current budget provided improvements. The four lots accommodate 346 cars.

General Obligation Bonds: Where the city's debt limit permits, general obligation bonds prove workable for offstreet parking. The annual debt retirement is spread equally over property on the city tax rolls.

General-obligation bonds are subject to charter limitations on indebtedness. Many cities have small amounts of unobligated funds but set up limited programs.

Debt-service charges and amortization of the bonds are paid through general taxation. Opponents argue that downtown merchants receive benefits out of proportion to their taxes—an often short-sighted view.

Port Chester, New York, used general obligation bonds. In 1930, a 100-car lot was built downtown for $50,000. That development and a recent $100,000 project for 160-cars, was financed with general obligation bonds. Such bonds were used also by Kansas City, Kansas, to pay twenty percent for its offstreet parking program. The remaining eighty percent was paid by special assessments on directly benefited property owners over a ten-year period. The Kansas City program provided nine attractive lots—capacity, 1,065 cars. The lots serve every part of the central business district.

The initial phase of that program involved acquisition and progressive improvement of six lots for 765 cars. Acquisition costs were $233,000, improvements $196,000—a car-space cost of $560. The second part of the program developed three additional lots for 300 cars. Development costs were $255,000 for acquisition, $255,000 for improvements—a car-space cost of $1600. Total costs of the program have been $912,000. The city's share was $182,000 and the share of benefited properties, $730,000.

Revenue bonds are becoming a popular way to finance offstreet parking. Income from the facility retires the bonds—a retirement dependent on earnings of the facility, not constituting an obligation of the city.

A drawback to revenue bond financing is the higher interest rate because of their speculative nature. Some cities have convinced merchants that they lose sales through parking shortages, benefit from parking improvements, and should buy up the entire bond issue at *reduced* interest, or interest-free.

The salability of revenue bonds improves as the interest rate decreases. Another way to obtain lower interest rates, in addition to the plan outlined above, is pledging other income sources, such as returns from curb-parking meters. Consideration by the city of revenue bond financing should include careful investigation of possibilities to improve the marketability of the issue.

Revenue bonds have proved particularly useful to parking authorities. Such municipal corporations, lacking the city's legal borrowing power, are confined in most cases to the use of self-liquidating revenue bonds for financing. The legality of revenue-bond financing for parking has been established. The investment market has demonstrated its faith in this type of bond. The revenue bond places responsibility for financing on those directly aided by the improvement. In the face of continuing and mounting offstreet parking needs, the revenue bond will probably be more frequently used.

Ann Arbor, Michigan, has a successful parking program financed with revenue bonds. Some $630,000 in these bonds were sold to finance development of the Ann Arbor Automobile Parking System. Four sites were purchased for $241,000. Three were made into parking lots. The fourth, because of its topography, was selected as the site for a ramped, three-level parking structure. Cost of construction was $315,000.

Fees at all the city-owned facilities are ten cents for the first two hours, five cents for each additional two-hours. Drivers park their cars; attendants collect the fees.

All parking revenues, including curb-meter money, go into the Parking System fund to retire bonds and pay debt-service charges. In its first year of operation, the Parking System netted $75,000. Further expansion, using funds remaining from the initial issue, should return $100,000 yearly to the city. This will retire the bonds within their fifteen-year term.

A $1,600,000 revenue-bond issue financed the beginning of the Sacramento, California, offstreet parking program. The bonds were marketed in July, 1951. Two large parking lots began operating in May, 1952, less than ten months after the bond sale. Land for a third lot was acquired, improved, and put into operation by June, 1954. This property was developed with the unused balance of the original bond issue plus the operating surplus accumulated by the first two lots.

All three Sacramento lots have a three-inch asphaltic concrete pavement on a six-inch crushed stone base, a complete drainage system for storm water runoff, mercury vapor luminaires for night time operations, and perimeter landscaping. Entrances and exits are safe, attractive and functional. Cost details of the three projects:

	Lot A	*Lot B*	*Lot C*
Size	320′ x 340′	320′ x 340′	160′ x 320′
Number of car stalls	346	358	160
Gross area per car stall	314 sq. ft.	304 sq. ft.	320 sq. ft.
Costs			
Land	$604,000	$624,800	$202,100
Clearing, grading, drainage, paving	32,000	32,000	20,000
Entrance and exit structures	11,350	11,350	1,000
Striping and stall bumpers	3,500	3,500	1,500
Fencing	1,850	1,850	1,000
Landscaping	1,000	1,000	500
Lighting	7,600	7,600	3,000
Total	$660,700	$682,100	$229,100
Cost per car stall	$ 1,912	$ 1,905	$ 1,432
Parking charges			
First hour	10¢	10¢	—
Second hour	10¢	10¢	—
Each additional hour	15¢	15¢	—
All day	—	—	40¢
Evenings	25¢	25¢	35¢
Monthly	—	—	$7.00

The Sacramento offstreet facilities have exceeded predictions in the revenue forecast. Financial statistics of the first two years of Lots A and B are shown in Table VII–1.

Table VII–1

"Sacramento's Offstreet Facilities Exceeded Predictions."

	Lots A & B, 1952–54
Operating Revenues	
Parking fees	$339,250
Interest on investments	3,960
Pay telephone, etc.	581
Sub-total	$343,791
Operating Expenses	
Salaries and Wages	$ 88,860
Repairs, maintenance, utilities	10,453
Tickets and miscellaneous supplies	2,822
Sub-total	$102,135
Net Operating Revenue	$241,656
Debt Requirements	
Interest	$100,442
Principal payment	
Fixed maturity	30,000
Sinking fund (minimum)	20,000
Sub-total	$150,442
Net Operating Profit	$ 91,214
Pledged Parking Meters Revenue	$100,000
Net Profit and Other Income	$191,214
To Sinking Fund (for accelerated bond redemption)	$ 83,897
To Surplus	$107,317

One of the Sacramento city officials responsible for developing this highly successful revenue bond program has outlined points, which if stipulated in the resolution of bond issuance, can aid the marketing.[2]

1. That the issuing entity establish and collect charges and tolls for use of the facilities being financed which, together with any other revenues pledged to bond service, will be equal to at least the minimum "coverage" (estimated net revenues pledged to the payment of the bond principal and interest in excess of actual requirements).

2. That the pledged revenues when collected be deposited with a fiscal agent (a bank or trust company) who shall distribute the same to the various funds and make payments on the bonds as provided in the resolution of issuance.

3. That a bond reserve fund equal to about one year's bond service requirements be established and maintained during the life of the bonds to assure prompt payment in the event the necessary revenues are not realized.

4. That the fiscal agent apply the revenues in approximately the following order of priority:

   a. To the bond interest fund.
   b. To the bond principal fund.
   c. To the bond reserve fund (if required).
   d. To the operation and maintenance fund.
   e. To a bond sinking fund.
   f. To a fund which may be used at the option of the city for various purposes.

5. That additional bonds having an equal lien status and secured by the same revenues may be issued only when certain conditions are complied with.

6. That a portion or all of the bonds be subject to call and redemption prior to their respective maturity dates at certain prefixed prices.

7. That proper records of accounts will be maintained and that an annual financial statement applicable to the project be made available each year.

8. That no competitive projects be established by the city that would tend to reduce the revenues pledged to bond service, and that sufficient on-street meters be maintained to produce a designated minimum revenue (if any parking meter proceeds are pledged to bond redemption).

9. That adequate insurance and fidelity bonds applicable to the project and its employees be maintained.

10. That the project will be operated and maintained in an efficient manner, and proper enforcement measures be taken to assure collection of parking charges.

11. That other covenants having to do with events of default, sale or condemnation of property, amendments to the resolution, and other matters be adopted to safeguard the interests of the bondholders.

[2] Faustman, D. Jackson, "The Sacramento Municipal Off-Street Program," *Traffic Quarterly*, Vol. VIII, No. 4, October 1954, page 397.

Benefited District Assessments: This system of financing tries to proportion parking development costs among properties that benefit from it. Obviously the degree of benefit varies. Some of the bases used in determining each property's share of costs are assessed valuation, front-footage, area, and anticipated benefits.

In theory, the benefit-district-assessment method of financing parking is attractive. Good parking has wide community benefit, but attempts to fairly determine the benefits to specific properties and land uses are difficult. The difficulty of establishing equitable assessments makes it one of the less favorable financing plans.

In Kalamazoo, Michigan, a 400-car, $60,000 lot was paid for by benefited district assessments. The principal reason for success in Kalamazoo was active, interested participation by a committee of affected property owners in establishing district limits and assessment rates.

Three benefited districts were defined. The smallest, made up of the most favorably affected properties, was assessed forty percent of the total. The next benefited area was also assessed forty percent —a considerably larger area making individual levies less. The least benefited and largest area was assessed the twenty percent. Assessments were based on a combination of property area and assessed valuation.

Silver Springs, Maryland, taking advantage of a 1946 law permitting meter revenues and assessments on benefited properties to finance parking, developed nine lots—2,200 spaces. Eight of the lots were improved with grading, drainage, and surfacing. Approximate car-space cost was $500.

Two bond issues, totaling $1,000,000, paid all acquisition and improvement costs. A tax of forty cents for $100 of assessed valuation on business and industrial properties, plus a tax of twenty cents for $100 of assessed valuation on undeveloped properties in the area, plus the net earnings of more than 200 curbside parking meters should retire both bond issues by 1975.

The Silver Springs zoning ordinance requires provision of offstreet parking in conjunction with various types of land use. Land owners who comply with those requirements and provide their own offstreet parking are exempt from the special assessment.

Parking Revenues: Many cities provide offstreet parking projects with funds from other parking operations. Usually with this financing method, the net revenues, or a fixed percentage of the gross revenues, of all curb-parking meters and existing offstreet parking facilities are set aside for acquisition of additional off-street space. Such funds are often used to give additional support to a revenue bond issue. Sometimes offstreet sites are not acquired until parking receipts are sufficient to complete financing. The weakness of this pay-as-you-go plan is the time. During those long delays, public sentiment can turn to resentment while the parking problem continues apparently unattended.

While one city believes that setting aside twenty-five percent of parking revenues will be sufficient, another, regarding the parking need as more critical, earmarks all parking revenues. Some cities delay offstreet parking action until funds are accumulated to cover acquisition and improvement of an offstreet development. Others purchase properties and improve them on a ten-year basis, meeting each debt with parking revenues.

Lansing, Michigan, developed five metered parking lots with curb parking revenue. Now, all parking revenues, curb and off-street, are earmarked for a reserve fund to continue acquisition of properties to complete the original program that contemplated ten lots.

The Lansing lots have graded, black-topped surfaces with each stall marked in herringbone pattern. Stall-bumper posts encourage orderly parking; flood-lights promote night use. Fencing affords protection. To minimize congestion, traffic enters and leaves by separate drives. Costs of the first three lots opened are tabulated in Table VII–2.

Other Methods of Off-Street Parking Finance: A few cities have used income from city-owned public utilities to finance offstreet parking. The best known of this method is Ottumwa, Iowa. The one-year receipts of city-owned water and power plants were enough to reclaim a swamp area on the banks of the Des Moines river. Today almost 1,000 cars can be parked on the lighted, well-surfaced lot on the made land.

While not actually a financing method, Coral Gables, Florida, has adopted a leasing arrangement. The city leases for twenty-five years property suitable for parking. Terms provide for the city to improve the areas and install parking meters, with rental set at thirty-five percent of gross revenues. The city retains sixty-five percent for maintenance, operating expenses, and taxes. Excess revenues are used to improve the lots and build a fund for additional facilities. The city has an option to purchasing the property during the twenty-five years, purchase price determined by negotiation. Coral Gables has established three small well-sited lots under this plan. Their capacities are 28, 95 and 114 cars. Meter rates are reasonable—one-half hours for five cents to nine hours for thirty cents.

Table VII–2

"LANSING, MICHIGAN, DEVELOPED ATTRACTIVE PARKING LOTS WITH FUNDS ACCUMULATED FROM CURB PARKING METER REVENUES."

	Lot 1	*Lot 2*	*Lot 3*
Size	198′ x 165′	87′ x 299′	110′ x 186′ and 145′ x 185′
Number of car stalls	105	93	116
Gross area per car stall	311 sq. ft.	279 sq. ft.	408 sq. ft.
Costs			
Property	$88,825	$67,839	Leased
Grading, gravelling and base preparation	4,850	5,539	1,229
Black-topping	3,737	2,690	3,466
Tree removal	63	66	—
Parking meters	6,930	6,138	7,250
Bumper posts	81	120	195
Installation of meters and posts	918	576	481
Paint	44	51	69
Signs	137	100	176
Lights	946	272	155
Fences	52	—	—
Plans	25	25	35
Total	$106,608	$83,416	$13,056
Cost per car stall			
less property cost	$ 169	$ 167	$113
including property cost	$ 1,015	$ 897	—

Selecting the Best Financial Method: The three most important factors affecting the city's choice of a plan for financing offstreet parking are:

1. State limitation on authorized financing methods where it has been previously determined that city participation in offstreet parking is permissible.
2. Extent of the proposed parking program.
3. Determination of the fairest distribution of offstreet parking costs according to which group or groups should pay those costs.

Since city powers come from the state, the first step in a parking finance program is to examine state law to see how cities are authorized to participate. In some cases, the law is specific; in others, the law goes into considerable detail without prescribing financing methods.

Oregon with a broad enabling law, gives to Oregon cities complete freedom in selecting a financing plan for financing:

> Section 2. Any incorporated city or town may establish one or more offstreet motor-vehicle parking facilities for the general use and benefit of the people of said city or town, or for one or more special classes of vehicles, as shall appear necessary, proper or beneficial in the public interest. To that end said city or town may:
>
> a. Plan, design and locate such facilities.
>
> b. Finance such facilities by any one or any combination of the following methods: *General obligation bonds* within legal debt limitations, or *revenue bonds* payable primarily or solely out of revenue from parking facilities in such amounts, at such rate of interest, and upon such conditions as may be prescribed by the legislative authority of such city or town; *special or benefit assessments* equal to the total cost of land and improvements, or to any portion thereof, such assessments to be levied against property benefited in proportion to the benefits derived, the amount of such assessment to be determined in accordance with special assessment practices for local improvement as prescribed by the ordinances or charter provisions of such city or town; *parking fees and special charges* derived from the use of offstreet parking facilities by motorists, lessees, concessionaires or others; *general revenue appropriations*; state or federal grants or local aids; parking meter revenues, general property taxes or gift, bequest, devise, grant or otherwise.

Other provisions of the Oregon law require operation of city-developed offstreet facilities to be placed by private lease granted under public bid. Apparently the Oregon legislature believes that private operation and management, under suitable contract, will best use technical know-how for efficient operation and service to the parking public.

Cities planning to develop offstreet parking should carefully check the extent of their legal powers before acquiring land. They should not start condemnation proceedings, enter into contracts of purchase until they have carefully examined the statutes.

Legal Aspects of City-Developed Parking Facilities

Legislation varies considerably. In some states the legality and limitations for city offstreet parking is a part of the state constitution. Elsewhere the activity is covered by legislative acts, or by municipal charters containing the offstreet parking conditions.

Right of Assessment Questioned: In two states, court-action on the right to assess benefited properties for parking facilities upheld the cities.

Special assessment is a form of taxation levied on the benefit from the operation of the taxing body. The special development should benefit the taxed property to a substantially greater degree than property not so assessed.

The special benefit element depends on the location and purpose of the parking facility. Fringe parking lots operating in conjunction with some form of shuttle bus system would not qualify as special-assessment developments. The lots would not be of special benefit to adjacent properties. Special assessment for a parking lot or garage in or next to a commercial area, where benefit is clearly present, would probably not be questioned.

Location of Facilities

In most cities, a single offstreet parking facility, regardless of size, would prove inadequate. A proper distribution of parking developments to provide a balanced system of parking areas is essential. Location of offstreet facilities has much to do with their effectiveness. As bad as the downtown parking problem is, mere provision of offstreet space may not give full relief. Facilities developed on poor sites will prove useless if they do not attract parkers.

Parking demand should determine location. Engineering studies, cordon counts, parker-destination surveys, and other established traffic and parking studies should indicate the capacity and site of new facilities. Sites should be selected for suitability for later construction of garages. This will provide a continuing flexible program. Current parking demands may not support a garage; future ones may.

Offstreet parking should be located to intercept traffic so a minimum number of cars need to travel into congested areas. In general, this indicates a distribution of facilities on all downtown quadrants, taking into account the sources of heaviest traffic flow. Traffic surveys will show how much traffic enters downtown on each of the feeder routes. Such information must be modified by studies of the destination of parkers.

The location of proposed facilities should be examined for its traffic effect on adjacent streets. Capacity of streets should be ample to handle the added load the parking facility might generate. The expense of increasing the capacity will have to be reviewed and compared with the benefit derived from the added facilities.

Location and arrangement of buildings and businesses that create parking demand should be considered. A comparison of parking-demand generators and available parking accommodations will indicate the location and size of offstreet parking needs. It will also delineate the area within which effective parking facilities can be developed.

Studies Relative to Location: A combination of parking studies are needed to give accurate information on the best location for a parking development. Action taken on hit-and-miss studies will not provide appreciable relief. Carefully executed technical studies are required to evaluate needs and insure a proper approach. Cordon counts provide the total demand for parking at any one time. Origin-destination surveys pinpoint parking demand centers. Parker interviews develop valuable information on where the parker desires to park, how long he wants to stay, and how much he thinks he should pay. There are numerous small communities where reasonable judgment and minimum technical assistance can fully serve the initiation of a modest program. Such technical assistance frequently can be obtained from the state or other nearby competent source.

These studies develop facts. They cannot indicate potential parking demands, but can provide guidance for the future, plus data necessary to develop an effective program.

Off-Street Parking Ordinances

Zoning ordinances for offstreet parking with certain types of property help the parking problem. Zoning regulations for parking are advantageous in growing cities in areas outside the central business district. It is a long-term solution.

In some cities, this legal method of requiring offstreet parking has been broadened to include *reconstructed* or substantially *altered* buildings. Requirements differ with building types and land uses. The ordinance, making the facilities a part of land development, provides permanent parking. It guides land developers by informing them of requirements.

Zoning for parking takes into account the new traffic generators. The regulations are not in themselves a solution. Yet, properly drafted and administered they can be a valuable aid.

The city council or other agency becomes the administrative or regulatory force. Usually it maintains a close working relationship with another city department that serves in an advisory capacity. Often this responsibility falls to the city planning board or city plan commission. The plan commission provides investigative and technical aid in writing the ordinance. Once adopted, provisions of the zoning ordinance for parking are often enforced by the building inspector.

There are no scientific bases on which to prescribe parking requirements for various types of land and building uses. Notwithstanding, the requirements of the zoning ordinances adopted are similar—evidence that careful study of a common problem by independent groups will develop agreement. The similarity of requirements suggests their reasonableness. Unanimity bespeaks agreement as to what are practical and reasonable requirements.

Buildings Affected: In the early days of zoning for parking, the regulations were applied to few building types. As acceptance of the technique became prevalent, the breadth of ordinances and building types it encompassed became more inclusive. Continued activity in this field of zoning has seen continued expansion of building types and land uses coming under zoning requirements. Today most ordinances require that offstreet parking be provided with many types of buildings. Requirements are not unseemly, because few buildings do not attract automobile traffic. A list of the specific building types covered by the typical zoning-for-parking ordinance follows:

Single family dwellings
Multiple-family dwellings
Hotels
Hospitals
Theaters
Restaurants
Places of public assembly
Retail stores
Office buildings
Wholesale establishments
Industrial buildings

Single Family Dwellings: Residential neighborhoods are not free from the growing need for reserving streets for the use of moving traffic. By requiring that new single-family residential buildings provide an offstreet parking space, the zoning ordinance prevents traffic congestion in residential areas. In large-scale housing developments, it prevents a problem from ever developing. In recently built-up sections of towns and cities, it permits effective enforcement of bans against overnight curb parking. Fire fighting and other emergency equipment, delivery and home-service vehicles can serve the area. Snow removal and street cleaning are easier. The likelihood of accidents is decreased.

All zoning ordinance requirements for single family dwellings stipulate that one offstreet car space shall be provided. Few ordinances specify an enclosed garage.

The West Palm Beach, Florida, zoning ordinance has a section dealing with the offstreet parking required of single-family dwellings. It reads in part:

. . . no residence shall be erected, and no major repairs made to an existing residence, unless there already be in existence upon the lot, or unless provision is made for the location on the lot concurrently with such erection or repairs, of a vehicular driveway space leading from the street serving such premises to an auto storage space on such lot consisting of one of the following:

a. A porte cochere
b. A carport
c. A garage
d. A car parking space with a minimum size of 200 square feet

Such auto storage space, whether or not covered, shall be considered as an occupied space . . . and likewise such space, if not covered shall not be included in computing rear, front or side yard space as defined and required in the chapter.

The "major repairs" referred to are defined in the ordinance thusly:

Major repairs shall be deemed to be involved when the cost thereof, including all material and labor as determined by the city building inspector is found to be in an amount equal to, or in excess of, 25 per cent of the last city valuation for the building in question.

There is no mistaking the intent or extent of the West Palm Beach ordinance as it affects single-family dwellings.

Multiple-Family Dwellings: Apartments and other multiple-dwelling-unit structures, unless they provide off-street parking accommodations, cause severe "spot congestion." It is not unusual that practically all cities using the zoning ordinance for parking include such buildings under their requirements. The space requirements in those ordinances vary considerably. They range from three parking spaces for each two dwelling units to one space for each three dwelling units. The usual requirement is one parking space for each dwelling unit.

Ordinances that require one space for each unit are generally found in cities of the western states. Eastern cities with their lower car-ownership-population ratio use less stringent requirements.

The car-space for each single unit is the most realistic requirement. It will come closer to meeting future parking needs of multi-family buildings.

Apartment buildings often include retail stores on the ground floor and professional offices on the lower floors. The Birmingham, Michigan, ordinance anticipates this dual development in the part of its zoning for parking ordinance that reads:

> If a building in a multiple-family residence district shall have therein business establishments . . . there shall be provided in addition to the parking spaces required . . . for the residential units in such building, one parking space for each 300 square feet or major fraction thereof of floor area available to customers of such establishments.

Hotels: In most zoning ordinances, new hotels are required to provide offstreet parking space in ratio to the number of guest rooms. A common requirement is one space for each three guest rooms. Smaller cities usually have higher requirements.

The Birmingham, Michigan, ordinance has special parking space requirements for the apartment building that might have retail stores on the ground and lower floors. (See page 000.) No known ordinance anticipates this same type of dual use in hotel structures, although it is probable that more hotels than apartment buildings have ground floor retail establishments. Parking needs of drug store, gift shop, florist, and haberdasher, often found on the street floors of hotels, should be taken into account.

The Pasadena, California, ordinance anticipates the possibility of restaurants and bars operated in hotels, as follows:

> For Hotels, Residential Hotels, Clubs and Fraternal Organizations, Charitable or Welfare Institutions sold for dwelling purposes and other similar structures, at least one (1) parking space for every three (3) guest rooms, dwelling units or suites. If assembly or lecture halls or ***public eating or drinking facilities*** are provided in such structures, additional parking will be required in accordance with the provisions of subparagraphs (8) or (12) whichever pertains.

Subparagraphs 8 and 12 cover the parking space requirements for assembly halls, theaters, general auditoriums, exhibition halls and similar places of assembly, as well as commercial buildings, business and professional offices.

With slight revision, along with the general lines of the Pasadena ordinance cited above, all the ancillary activities in hotel and similar structures can be acknowledged for increased parking needs.

Hospitals: Ordinances requiring new hospitals to provide offstreet parking are country wide. The common basis is the number of beds. Most ordinances require one car space for four beds. The range is one space for one to ten beds.

Substantial peaks of parking demand occur during hospital visiting hours. Where offstreet facilities are not provided curbs of nearby streets become jammed to the detriment of moving traffic and convenience of hospital visitors. Offstreet space should be made available to doctors and hospital staff members.

Theaters: Theaters in downtown areas served by mass transit find half their patrons arriving by private car. Space requirements of ordinances provide one space for each ten theater seats. Obviously this is not a realistic estimate. Most newly erected theaters have a higher proportion of parking spaces. The aggressive businessman most often provides more than the minimum. He knows the value of offstreet parking to successful operation.

Peak of theater parking is during evening hours. The zoning ordinance can recognize this by permitting a portion of theater parking requirements through a co-operative use of parking lots developed primarily for daytime use.

Restaurants: Probably because of the wide range of establishments covered by the word "restaurants," less than a fourth of existing zoning-for-parking ordinances cover them. Most base requirements on the total floor area instead of the more practical figure of how many persons can be accommodated. Seating capacity should be the criteria.

Floor-area requirements vary from one space for each forty square feet to one space for 1,000. Based on seating capacity, requirements range from one space for each three seats to one for twenty. Other ordinances compute spaces by employees, restaurant frontage, or total lot area. It is difficult to relate the last three to parking needs.

Places of Public Assembly: Places of public assembly are considered separately from theaters for parking, because of irregular use: auditoriums, stadiums, community center buildings, sports arenas, and similar places. Requirements for this type of parking vary from a minimum regulation for one space for each twenty seats to one for each three. Many ordinances, anticipating areas without permanent seats, worded requirements this way: "One parking space shall be furnished for each ten seats or fraction thereof, *or*, one space for each one hundred *square feet* or fraction thereof used for public assembly but not containing fixed seats."

As with theaters, a few cities permit *part* of the parking for privately owned places of assembly to be nearby facilities that serve daytime business. For these cases the ordinance spells out special requirements.

Retail Stores: Existing ordinances use twenty bases for retail stores. Parking-space-floor ratios predominate. In the absence of dependable data, no criticism can be made of the parking-space-floor area ratio. Justifiable criticism *can* be made of ordinances using employees as a basis. It has slight relation to customer-parking.

Strength of the framework of zoning lies in requirements based on logical reasoning, backed by factual data.

For retail establishments, parking requirements vary. Few reliable studies have been made to determine their needs accurately. Some indication can be derived from the experience of shopping center developers.

Shopping center developers generally agree on a two-to-one ratio. One authority in the shopping center field concludes[3] that the two-to-one proportion meets only the essential minimum, even with sixty percent of the shoppers arriving by public transportation or on foot. In centers more dependent on the driving shopper, three-to-one is desirable.

Such ratios, easy to apply, obviously are not the final answer. They provide a qualified *suggestion* for parking needs of retail establishments, but much depends on the nature and location of the business.

Office Buildings: Modern multi-storied office buildings contribute to downtown traffic. Ordinances, recognizing this, include office buildings in their parking requirements, using total floor area to compute parking needs. The minimum requirement is one car-space for each 3,000 square feet of floor; the maximum is

[3] Baker, G., and Funaro, B., *Shopping Centers—Design and Operation*, Reinhold Publishing Corporation, New York City, 1951, page 36.

one space for 150 feet. The wide spread probably is due to lack of data.

Wholesale Establishments: Often wholesale houses are located in sparsely built sections. This removal from the center of parking shortage may be why less than half the ordinances include buildings used for wholesale business. Where they appear, the car-space-floor area ratio is used, ranging from one space for 150 square feet to one for 5,000. Ineffectual requirements that bear little relation to parking needs, such as one space for each ten feet of building frontage, or a parking area thirty-five feet deep along the entire front, are found.

Industrial Buildings: Like the wholesale establishment, industrial buildings are infrequently mentioned. About half base requirements on employees: one parking space for five employees. Ordinances stipulate use of the maximum number of employees that may be employed to determine the number of parking spaces required. Obviously this provision can be easily sidestepped, though it guides a far-sighted developer.

With more than one working shift, the overlapped parking needs aggravate the problem—particularly troublesome where continuous plant operation is necessary during shift changes. Suggested solutions would stagger arrival-and-departure times, and base parking on the maximum employed on consecutive shifts. None of the ordinances so far have such provisions.

Building height, number of floors, and total floor area, coupled with the character and operation affect the parking needed at office buildings, wholesale establishments, and industrial buildings. Public interest requires that these details be considered in planning industrial structures. Zoning provisions afford a way to obtain adequate space for users of adjacent streets as well as for other property owners in the vicinity.

Location of Parking: Zoning ordinances are usually specific about the location of parking. For residential structures, the parking space is most often required to be on the same, or an abutting plot.

Distances at which parking facilities may be situated vary from 200 to 500 feet from the building. Some stipulate a "reasonable" distance.

Factual surveys determine the distance parkers will park from their destination. Parkers will walk farther for long stops than for short ones. This information can establish "reasonable distances" for various building types. Obviously the parking area provided for a residential building should be on the same lot or one immediately adjacent.

Muskegon, Michigan, has a concise paragraph on the allowable distance for parking:

> In all districts, in connection with every industrial, commercial, business, trade, institutional, recreational or dwelling use, and similar uses, parking spaces for . . . parking or storage of vehicles shall be provided either within three hundred (300) feet of the building, structure or premises they are intended to serve, except in the case of dwellings, where parking spaces shall be provided on the same lot as the dwelling, in accordance with the following schedule.

Space Requirements: Zoning ordinances specify dimensions for *offstreet parking space*—usually "200 square feet," or "one offstreet car space, at least eight feet wide, eighteen feet long, vertical clearance, seven feet." Virtually all zoning ordinances require that the parking area have adequate interior drives, entrances and exits to connect with a public street or alley.

Colorado Springs prefers to use the specific area requirement. There, an offstreet parking space is designated as being an area eight feet wide and twenty feet long. Adequacy of the spaces for their intended purpose is provided by this section:

> *Plan of the Parking Area:* For the purpose of converting parking space into the required parking area, plans must be submitted to show how the required parking spaces shall be arranged in the area supplied for that purpose, and to indicate sufficient space for turning maneuvers, as well as adequate ingress and egress to the parking area.

Morristown, New Jersey, prefers the specific area requirement, but only passenger cars. The zoning ordinance leaves judgment of space for parking commercial vehicles to the discretion of the Board of Adjustments:

> For the purposes of this section, a "Parking Space" shall mean an area of not less than 200 square feet, exclusive of drives or aisles giving access thereto, accessible from streets or alleys or private driveways or aisles leading to streets or alleys and usable for the storage or parking of passenger vehicles. A parking

space intended for the storage of commercial motor vehicles may be increased to more than 200 square feet by the Board of Adjustment whenever in its judgment a larger area is required solely to serve the intended use.

Arrangement has much to do with the effectiveness of any parking facility. Good design can enhance the appearance and utility of the building served, as well as increase the attractiveness to parking customers. Poorly designed parking may meet the car-space requirements of the ordinance, but it can be a detriment to the building. Good parking design is discussed in Chapters IX and X.

Municipal Regulation of Commercial Parking Facilities

Commercial parking facilities are found in practically every city, many on unimproved lots, or developed on vacant land, distributed through the downtown area with little relation to parking needs. Rates vary, frequently established on the maximum figure parkers will pay, not on a measure of their service or convenience.

Many downtown parking lots occupy land on a *temporary* basis—until real estate and economic conditions justify permanent development. Land owners are therefore reluctant to finance improvements. This type of operation results in the development of poor layout, overcrowding; delays in delivery; damaged cars, and generally inefficient operation.

Municipal regulation through licensing can control parking facility appearance, require design features that minimize car damage and pedestrian injury, require financially responsible operators, and apply other reasonable regulations in the public's interest.

City ordinances permitting this type of regulation have gained considerable prominence recently. One of the first, enacted in Pasadena, California, in 1926, bore little resemblance to the present idea of licensing and regulation. Its only requirement was that lot surfaces should be of cement, crushed rock, or sand, "laid in such manner that said premises shall be free of dust."

Other regulatory ordinances followed as more cities recognized the need for control of parking lot operation. One of the first comprehensive ordinances was enacted in Royal Oak, Michigan, in 1928. Highland Park, Michigan; Toledo, Ohio; East Orange, and Atlantic City, New Jersey; and Washington, D.C. were other pioneers. Today, most large cities and many small ones have such ordinances. Requirements vary. Some merely *license* for a *fee*. Others prescribe standards that cover all aspects of physical design and operation. Most ordinances have in common an enthusiastic public reaction.

Licensing Practices: Most ordinances designed to regulate parking facility operations require filing a written application before issuance of a license. Items of information generally required on license application forms are:

a. Name of the person or organization requesting the license.
b. If the license is requested by a corporation, the names of all officers and directors, as well as the amount of capitalized stock.
c. If the license is requested by a partnership, the names and addresses of the partners.
d. Complete legal description of the premises intended for the parking development.
e. One-time capacity of the proposed facility.
f. Planned hours of operation.
g. Complete schedule of the rates to be charged.

License Fees: Many ordinances require payment of a license fee—the same as for other businesses in that licensable class. Other ordinances consider the parking development as a business apart from those for which the fee is based on physical or operational features. License fees for commercial parking facilities are established on one of four bases: fixed fee; variable with facility area; variable with facility capacity, and variable with gross receipts.

Most cities prefer the fixed fee. It is simple, and requires little effort or expense to administer. Annual fixed fees for licensing range from $2 in Highland Park, Michigan, to $45 in Macon, Georgia. Cheyenne, Wyoming, charges $250 for the first year's license and $25 for yearly renewal. Five dollars per year is usual.

Small cities charge as much as large ones for licensing. Los Angeles and Long Beach, New York, both charge $5. Macon, Georgia, with a population of about 60,000, charges $25. Other large cities—Milwaukee, Minneapolis, St. Paul, and Seattle—charge less.

Land area of the parking development is used by a number of cities for determining annual license fees. Jacksonville, Florida, and East Orange, New Jersey, both use one-half cent per square foot. Newark, New Jersey, uses a penny. Other cities favor a sliding scale based on land area. Toledo, Ohio, charges $5 for all lots with areas up to 1500 square feet. Shorewood, Wisconsin, and Rockford, Illinois, charge $5. There, the $5 fee covers lot up to 5000 square feet. Augusta, Georgia, has the highest land area charge—$21 for lots up to 4,000 square feet. For each additional 4,000 square feet, or fraction thereof, the fee is $26. The license fee for a parking facility developed on one acre of land in Augusta is $246. Fresno, California, uses a similar scale but with different rates. There, $50 is charged for lots up to 7,500 square feet in size; $75 for lots from 7,500 to 15,000 square feet; and $100 for all larger lots. One city uses the lot area scale but sets a maximum of $15 as the annual license fee. Two other cities charge up to $25, depending on lot size. Toledo, Ohio, has a maximum fee of $35 for all lots more than 6,000 square feet in area.

Cities that vary license fees on car capacity range from Greenwood, South Carolina—population 13,000—to New York City, with more than eight million. Jackson, Michigan, charges 50¢ per car space used for transient parking and 25¢ for each car space used for monthly rental.

Boston, Massachusetts, charges a licensing fee based on sliding scale of car spaces. Small lots pay an average $3 a car space annually. The unit assessment decreases as the capacity increases until a fee of $1 a car is charged for each car space in excess of 500. A few cities base their fee on the basis of car spaces, but modify it by establishing a maximum license fee. For example, Orange, New Jersey, charges an annual license fee of $2 each for the first five car spaces and $1 for each additional space with a maximum fee of $50.

Philadelphia uses a sliding scale of car spaces for determining annual license fees. Commercial parking developments there pay fees ranging up to $20. The Philadelphia ordinance is careful to distinguish between commercial facilities and those operated privately in conjunction with a specific business of building. These latter, "not for hire" facilities pay an annual fixed fee of $2.

Regulation of Rates: Apparently rate regulation through licensing is questionable from a legal point of view. None of existing ordinances seem to exercise any control in this direction. Licensing laws do, however, encourage standardization of rates by requiring that rates be stated on the license application and a new application be submitted if the rates are changed.

Further encouragement for lot operators to use uniform rates is the license condition that requires that they be continuously and conspicuously posted at the facility entrance. In order to regulate the manner in which parking rates shall be advertised, a number of city ordinances prescribe the minimum size lettering that may be used. Most of those ordinances require the use of letters at least six inches in height.

While requiring that rate schedules be posted in letters of a size that will insure their legibility, many city ordinances regulating commercial parking developments also have esthetic provisions that set *maximum* dimensions for signs that identify properties as parking facilities. Detroit limits those signs to fifty square feet, Maplewood, Missouri, twenty square feet, and Atlantic City prescribes the parking facility sign can be no larger than two feet by two feet. Some cities even prescribe heights at which signs must be mounted. Detroit prescribes only a *minimum* height—six and a half feet. Maplewood, Missouri, prescribes only a maximum height of ten feet. Both Orange, New Jersey, and Toledo, Ohio, prescribe minimum *and* maximum mounting heights. Both have a minimum mounting height of eight feet; and maximums that vary with the letter size. For five-inch lettering the maximum height is ten feet. For six-inch letters, twelve feet.

Physical Requirements: To prevent poor layout, unsuitable surfacing, inferior drainage and other undesirable conditions, many ordinances regulate physical development of commercial parking facilities. A frequently used physical restriction is that a barrier be provided between the parking and adjoining properties. Such requirements are aimed at protecting pedestrians and providing a "buffer" between parking and nearby residences or other non-commercial properties. A secondary purpose of this requirement is to prevent encroachment on adjoining lots. A few cities specify height of the required barriers. Others specify no dimensions but require that "suitable" barriers be installed. In cities that specify barrier height, requirements vary considerably. In East Orange, New Jersey, and Canton, Ohio, barriers must be at least eighteen inches high. In Detroit, Michigan, at least three feet. Phoenix, Arizona, is more explicit; there the barrier must be "a solid wall of wood or masonry, not more than five feet nor less than four in height."

The Portland, Oregon, ordinance will permit a yellow paint line barrier on paved parking lots, unpaved lots must have a barricade or fence, a barrier maximum height of five feet is authorized unless the fence is within three feet of the street line, in such case maximum height is 20 inches. This requirement is aimed at preventing parking lot barriers from impairing the sight distance at the exit.

Surface Standards. As commercial parking lots become more prevalent, city ordinances are attempting to encourage developers to make them attractive by setting standards for their surfacing and, in some cases, landscaping. Practically all ordinances require dust abatement at unpaved lots. The Paterson, New Jersey, ordinance says:

> Persons operating open-air parking stations shall keep same free from dust by frequent sprinkling or the use of calcium chloride or other means so that the same shall not become a nuisance to adjacent property owners or others.

Other cities go further and set minimum standards of surfacing. Kansas City, Missouri, specifies that the City Traffic Engineer shall inspect parking properties and see that "ground surfaces are paved or adequately treated to keep dust, dirt and mud at a minimum." Baltimore, Maryland, requires that the entire parking area be "paved with a hard or semi-hard dustless surface." Some cities specify a variety of surfaces and permit the operator to choose. Los Angeles requires a dust-proof surface on all lots within twenty-five feet of a dwelling.

Shelters: In the past, shelters to house parking lot employees have often been ramshackle structures. Some existing ordinances are attempting to correct this by including sections regulating minimum design standards for such buildings. Detroit requires that parking lot shelters containing more than fifty square feet must be of masonry construction or frame construction covered with asbestos shingle, stucco on metal lath, or comparable material. Sheet metal construction is expressly forbidden. Heating of shelters is restricted to electricity, gas or oil.

The Washington, D.C. ordinance only limits the size of shelters. None larger than forty square feet is permitted. A special permit must be obtained for its construction. Certain minimum design standards must be satisfied in order to obtain the special permit.

Lighting: One of the most important aspects of parking lot operation is the amount and type of lighting used. Experience has shown there is a direct relation between lighting and the safety of vehicles and their contents at night.

Kansas City, Missouri, requires that parking lots operated during the hours of darkness shall provide not less than two-tenths lumens of light per square foot of surface. Phoenix, Arizona, and Maplewood, Missouri, are concerned only that the parking lot illumination shall not be bothersome to nearby residences. Their ordinances require that the parking lot lighting "be so arranged as to reflect the light away from adjoining property in residential districts." Philadelphia prescribes that parking lots install "shielded floodlights" in such a way "as will permit owners of cars to have reasonable access to all portions of such space during the hours of darkness." All parking lot lighting installations in the city of Philadelphia must secure the approval of the Electrical Bureau of the Department of Public Safety.

Entrances and Exits: Parking lot entrances and exits are often regulated by city ordinance separate from the parking lot licensing rules. The typical driveway regulation requires that applications be submitted for any curb cut, be it for a parking lot or drive-in bank, complete with accurately drawn plans. Most existing driveway ordinances limit the number and width of openings. Rangeof allowed widths is sixteen to thirty-two feet.

Often investigation by the street or traffic engineering department is a condition of driveway approval. In order to minimize drainage difficulties the modern driveway ordinance requires that the land developer reconstruct the existing curb and gutter as an integral part of his new driveway. Compliance is determined by field investigation usually by the city engineer's office.

CHAPTER EIGHT

PARKING LOTS

Parking lots often are designed with little other consideration than to crowd onto them the greatest number of cars—usually as a temporary means of deriving income from a property. Others are developed with considerable thought and detail as an investment or municipal project.

A good parking lot should meet certain standards of design, location and serviceability.

1. It should not detract from the attractiveness of the surrounding area. It should harmonize with adjacent land developments.

2. It should have utility or "workability" and attract customers. If the lot is operated by attendants, the motorist should expect courteous and efficient service. If the lot offers self-parking, parking stalls should be comfortably large, plainly marked and easily accessible.

3. It should be designed to co-ordinate its use with nearby traffic flow. Entrances and exits should be on minor streets or in alleys.

Most cities and commercial developers of parking properties realize that parking is a profitable and important business. They appreciate that it is sound business practice to provide some amenities of convenience, safety, comfort and appearance to make their parking lots attractive. Wide aisles, ample stalls, protected walkways, weatherproof surfaces and adequate lighting are some of the design features that result in greater ease, efficiency and safety.

Parking Lot Design

Some parking lots permit self-parking, others have attendant-parking. Attendant-parking is used at most commercially operated lots because it permits more efficient use of space. A commonly used plan of attendant-parking is shown in Figure VIII–1.

A self-parking lot offers a minimum of inconvenience and a maximum of ease. Although the following principles of parking lot design and operation pertain largely to self- or customer-parking, they apply also to the development of attendant-parking lots.

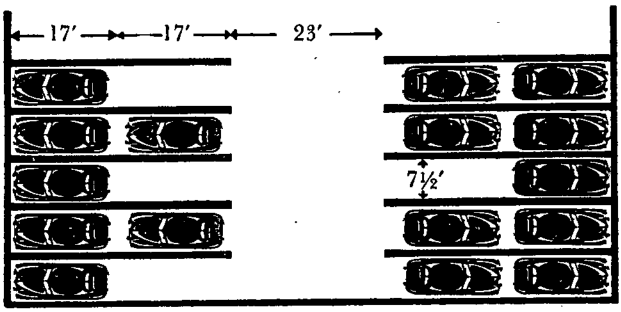


FIGURE VIII-1. Ninety degree double-stall attendant-parking uses about 170 square feet per car. It is often the only feasible parking plan where land cost is high.

Size of Lots

Parking lot sizes, measured in terms of cars accommodated, generally range from twenty-five to five hundred or more. Lots that accommodate from one hundred to two hundred cars are efficient and practical. A few small lots, strategically sited, will usually serve better than a single large one.

Parking lots of large capacity can cause congestion on bordering streets, especially during peak-traffic hours. If capacity is small and the number of lots large, the potential traffic congestion tends to spread over several areas and thus minimize its effect.

If attendant-operated, moderately-sized lots develop better operational efficiency than large ones. Parking and unparking of cars are accomplished much more rapidly in lots of low capacity. The distance traveled by attendants is shorter, service is faster.

For efficient land use, the self-parking lot should provide three hundred square feet for each car space. Depending on design features, three hundred square feet is an acceptable standard for quickly estimating capacity for possible development of a convenient parking facility. A smaller per-car space area will necessitate narrower stalls and aisles. A higher figure will allow wider stalls and aisles, more maneuvering space, greater safety and convenience, and simpler, faster operation.

The size and capacity of a parking lot should be tailored to the area it is to serve. Some indication of parking space requirements for various building types and land use is given in zoning for parking space requirements discussed in Chapter VII.

Entrances and Exits

To minimize conflicts with street traffic, parking lot exits and entrances should be well-defined and as few in number as practicable to provide for peak-hour operation. They should be at least fifty feet from intersections. When the lot fronts on a heavy-traffic street, separate entrances and exits are best.

Where possible, parking lot openings should be oriented to favor right-hand turns for entering and exiting traffic. Where such design is not possible and there is considerable street traffic, it may be necessary to prohibit left turns into and out of the parking lot.[1]

Reservoir space at entrances and exits is of particular importance in lots on busy traffic streets. Space to accommodate accumulation of incoming cars prevents back-ups into traffic lanes if claim-ticket issuance delay, a confused driver, or other condition temporarily block entering lanes. Area within the parking lot to accommodate some cars at the exit permits groups of leaving cars to take advantage of gaps in traffic.

Single-lane entrances to parking lots should be at least fourteen feet wide. Exits should be a minimum of ten feet. A combined entrance-exit should be not less than twenty-six feet wide. All should have suitable curb returns.

Grading and Surfacing

If a parking lot is to offer year-round service it should be pleasing in appearance and completely finished. Grading should

[1] See Figure VI–4.

provide good drainage, surfacing should abate dust. Inadequate drainage and inferior surfacing will discourage parking lot use and increase the difficulty of aisle and stall marking.

Gravel or crushed stone paving give satisfactory service if adequate drainage is provided. Concrete is expensive for parking lot surfacing. Blacktop pavement has been used extensively as a satisfactory all-weather surface. It should be applied with the same care used in city street work or highway construction.

Lot Enclosure

For safety and aesthetic value, lots should be fully enclosed by a fence, guard rail, wall or hedge. This precaution adds to the lot appearance as well as insuring that vehicle movements are kept within the lot.

In designing lot enclosures, allowance should be made for the overhang of car bumpers over the parking curb. With head-in parking, the overhang will average about two and one-half feet. With back-in parking, the average overhang will be about four feet. (Figures VIII–2 and VIII–3.)

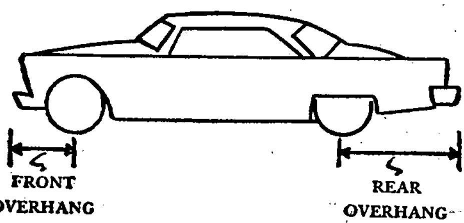


FIGURE VIII-2. In designing parking lots, allowance should be made for the overhang of car bumpers over the parking curb.

Signs

Signs identifying the lot as a parking facility should be posted at all entrances. If adequate in size, and lighted at night, they speed up the entry of cars and thus minimize interference with traffic on adjacent streets. Signs should be used to indicate one-way aisles, location of exits, pedestrian walkways and other helpful information.

Parking Stall and Aisle Dimensions

The minimum area required to park a car is one hundred and forty-four square feet—a rectangle, eighteen feet long, and eight feet wide. These dimensions are minimum size for self-parking lots. Stalls eight and one-half feet wide are preferable. Most shopping centers use nine-foot widths as a concession to the woman shopper and driver. No reduction in the eight-foot stall is recommended because of the trend toward wider frames and doors.

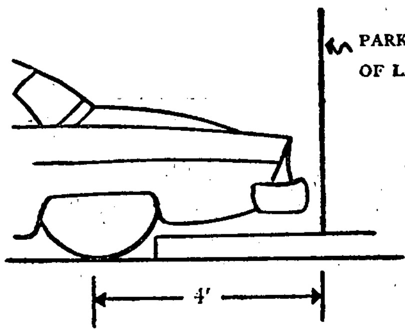


FIGURE VIII-3. With back-in parking, the average overhang will be about four feet.

Comparison of per-car area required in lots using self-parking, and those using attendant-parking shows that driver-parking requires almost twenty-five percent more space. Tables VIII–1 and VIII–2 give this comparison for a number of lots. Table VIII–1 shows the area per car for eleven parking lots that use driver-parking. Area requirements vary from a maximum of three hundred and seven to a minimum of one hundred and ninety-six square feet, with an average of two hundred and forty-three square feet.

Table VIII–2 shows similar information for twenty-four lots employing attendants. The per-car areas vary from two hundred and fifty-one to one hundred and twenty-seven square feet, averaging two hundred square feet per car.

Varying the angle of parking changes the length of curb and width of aisle required for each car. The parking angle determines the efficiency of lot design because it governs the car space area.

Table VIII–1

AREA PER CAR IN LOTS EMPLOYING CUSTOMER-PARKING

Parking area in square feet	*Number of cars*	*Area per car in square feet*
20,000	65	307
30,000	100	300
39.360	137	283
33,550	121	277
32,800	128	256
60,000	251	239
61,224	260	235
14,644	65	225
23,834	110	216
27,780	130	213
44,160	225	196
	Average	243 square feet

Table VIII–2

AREA PER CAR IN LOTS EMPLOYING ATTENDANT-PARKING

Parking area in square feet	*Number of cars*	*Area per car in square feet*
24,645	98	251
25,725	110	234
11,620	50	232
16,200	70	231
17,925	78	229
19,236	85	226
33,575	147	221
29,335	133	220
27,109	128	211
15,500	75	206
32,640	163	200
12,780	65	196
15,225	78	195
13,800	73	189
16,900	85	187
25,320	135	187
17,289	95	182
15,380	86	178
12,000	70	171
9,900	58	170
10,150	60	169
19,792	118	167
8,180	55	148
7,656	60	127
	Average	200 square feet

Table VIII–3

DIMENSIONS FOR PARKING ANGLES WITH VARYING STALL SIZES

α	W and L	N	N_{100}	Wa	Wa_i	Wa_h
Parking angle	*Width and length of stall*	*Number of car stalls per unit length of parking line (PL)*	*Number of car stalls per 100 linear feet of parking length*	*Wasted area (in square feet) at each end of single parking line*	*Wasted area (in square feet) at each end of a pair of interlocked parking lines*	*Wasted area (in square feet) at each end of a pair of herringbone parking lines*
30°	7′6″ x 18′	$n=\frac{PL-4'4''}{15'0''}$	6.4	207.8	336.0	—
	8′ x 18′	$n=\frac{PL-3'7''}{16'0''}$	6.0	219.1	341.8	—
	8′6″ x 18′	$n=\frac{PL-2'10''}{17'0''}$	5.7	230.3	343.1	—
	9′ x 18′	$n=\frac{PL-2'1''}{8'0''}$	5.4	244.2	344.3	—
45°	7′6″ x 18′	$n=\frac{PL-7'6''}{10'7''}$	8.7	162.0	311.2	311.2
	8′ x 18′	$n=\frac{PL-7'1''}{11'4''}$	8.2	169.5	310.7	322.1
	8′6″ x 18′	$n=\frac{PL-6'9''}{12'0''}$	7.8	176.0	306.9	333.1
	9′ x 18′	$n=\frac{PL-6'4''}{12'9''}$	7.3	182.5	303.1	344.3
60°	7′6″ x 18′	$n=\frac{PL-6'10''}{8'8''}$	10.7	107.4	202.4	—
	8′ x 18′	$n=\frac{PL-6'8''}{9'3''}$	10.1	110.8	195.2	—
	8′6″ x 18′	$n=\frac{PL-6'6''}{9'10''}$	9.5	113.1	189.9	—
	9′ x 18′	$n=\frac{PL-6'4''}{10'5''}$	9.0	116.6	180.4	—
90°	7′6″ x 18′	$n=\frac{PL}{7'6''}$	13.3	0	—	—
	8′ x 18′	$n=\frac{PL}{8'0''}$	12.5	0	—	—
	8′6″ x 18′	$n=\frac{PL}{8'6''}$	11.7	0	—	—
	9′ x 18′	$n=\frac{PL}{9'0''}$	11.1	0	—	—

$$n=\frac{PL-[W\sin\alpha+L\cos\alpha-l]}{l}$$

$$wa=\frac{d^2}{2\tan\alpha}$$

$$wa_i=\frac{2d_i^2}{\tan\alpha}-\left[WL+\frac{W^2}{2\tan\alpha}\right]$$

$$wa_h=\frac{L^2}{2}+\left[\frac{1.414\,L+2d_i}{2}\right].707\,W$$

l = curb length of car stall measured parallel to parking line $=\frac{W}{\sin\alpha}$

d = depth of car stall (single parking line) measured perpendicular to the parking line $=L\sin\alpha+W\cos\alpha$

d_i = average depth of car stall (interlocked pair of parking lines) measured perpendicular to the parking line $=L\sin\alpha+\frac{W}{2}\cos\alpha$

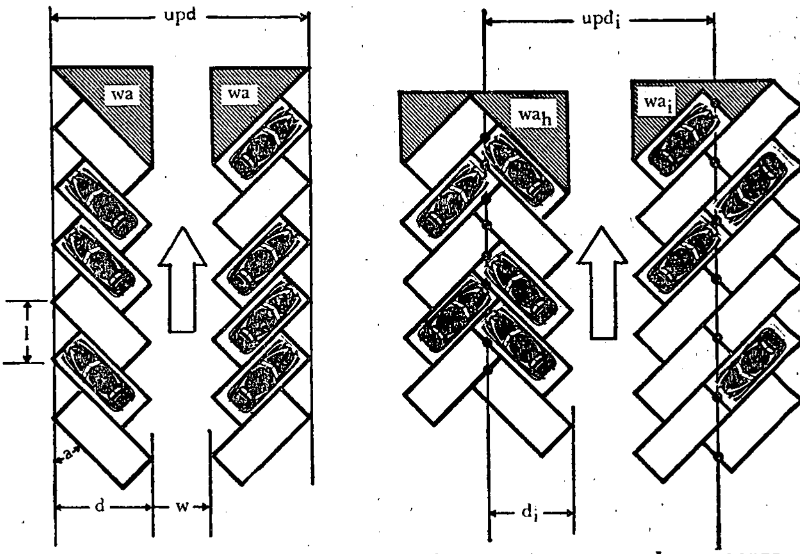
The angle of parking affects the dimensions of a parking layout that contemplates stalls eight and a half feet wide and eighteen feet long as shown in Figure VIII–4, in which "l" is the curb length required per car for various parking angles. Ninety-degree parking requires the least—eight and a half feet; parallel parking requires the most. Although eighteen-foot stalls are long enough for angle parking, twenty-two-foot stalls are needed for parallel parking to permit reasonably easy entrance and exit.

Depth of the parking stall, "d," is measured perpendicular to the aisle. Parallel parking requires the least depth; seventy-degree parking requires the most—almost two feet more than ninety-degree stalls.

Under "w" is width of aisle needed to maneuver into and out of stalls with reasonable ease and convenience. Aisle-width shown for the parking angles from zero to fifty degrees is greater than that required for the parking and unparking maneuver. With shallow parking angles, minimum aisle-width is based on the needs of cars moving in the aisles. Two-foot clearance between parked and moving cars should be provided along parking-lot aisles. Minimum aisle-widths thus become ten feet for one-way, and twenty feet for two-way aisles. The minimum *desirable* aisle-widths are twelve and twenty-four feet respectively.

"A" is the average gross area required per car. It varies for different angles of parking because of the parking angle-aisle width interrelationship. Angled parking permits narrower aisles than perpendicular parking; flatter angles allow narrower aisles than do wider angles. Aisle-widths must be considered to get an accurate comparison of area requirements for parking at different angles. Thus, the average area per car space listed in column five of Table VIII–4 is the area of a parking stall plus one-half the area of aisle in front of it. Waste space at the end of parking lines and the area of circumferential access roadway space are not included. However, the figures listed provide a reasonably accurate basis for comparison.

Unit parking depth, "upd," is a convenient unit of measure for quickly determining the best parking layout for a lot. It is the width of a parking aisle plus the perpendicular depth of a stall



SINGLE LINE PARKING HERRINGBONE PARKING INTERLOCKED PARKING

FIGURE VIII-4. Changing the angle of parking affects the dimensions of a parking layout.

Table VIII–3a

PARKING LOT CAPACITY (8½-FOOT x 18-FOOT STALLS)

Width of area	*Parking plan*	*Number and width of aisles*	*Car capacity per* 100 *feet of lot length*
40 feet	1 row of 90° stalls	1—22 feet	12
50 feet	2 rows of 45° stalls	1—12 feet	14
60 feet	2 rows of 90° stalls	1—24 feet	24
70 feet	1 row of 90° stalls	1—24 feet	23
	2 rows of 30° stalls	1—12 feet	
80 feet	1 row of 60° stalls	2—12 feet	24
	2 rows of 45° stalls	2—12 feet	
90 feet	1 row of 45° stalls		
	2 rows of 45° stalls, interlocked	2—12 feet	28
	1 row of 45° stalls		
100 feet	2 rows of 90° stalls	1—24 feet	38
	2 rows of 45° stalls, interlocked	1—12 feet	
	1 row of 60° stalls		36
110 feet	2 rows of 60° stalls, interlocked	2—14.5 feet	36
	1 row of 60° stalls		
120 feet	4 rows of 90° stalls	2—24 feet	48

on each side. It is a definite value for each angle of parking. The unit-parking-depth values in column six of Table VIII–4 were used to obtain the typical parking lot capacity figures shown in Table VIII–3.

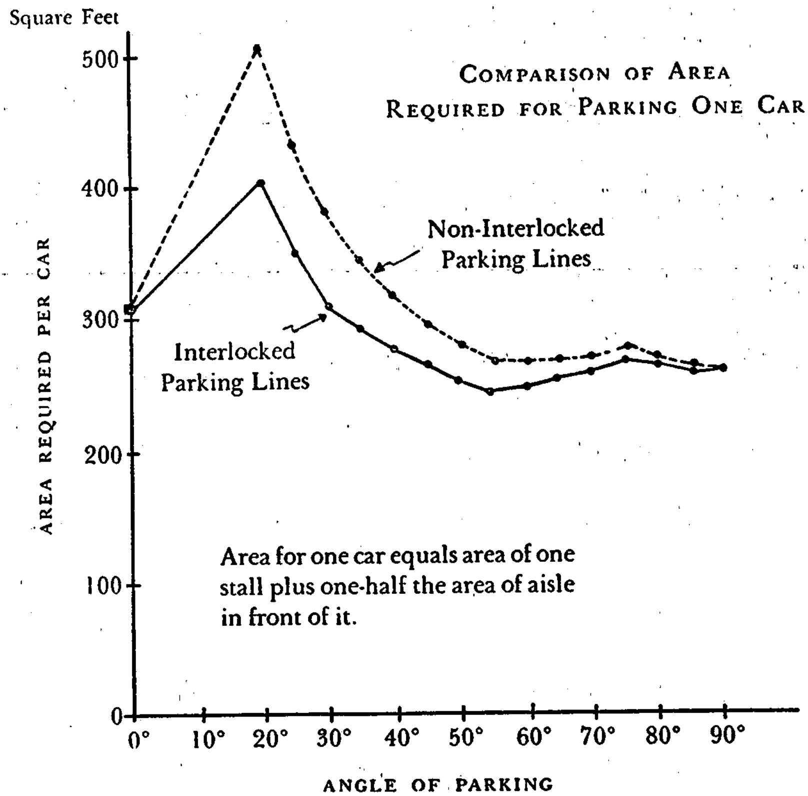


FIGURE VIII-5. The average gross area per car varies for different angles of parking because of the parking angle-aisle width relationship.

Table VIII–3 compares the dimensions associated with different parking angles when the basic size of the stall is varied. It shows the number of parking stalls that can be laid out in a space one hundred feet long, using various size stalls at different angles. Included are formulas for computing the number of different size stalls that can be placed in a parking length of known dimension.

Table VIII–3 also shows the non-productive waste space at each end of a single parking line and its variation with the angle of parking. The figures show that aisle-end waste-area is reduced when double parking lines of angled stalls are laid out in interlocking and herringbone patterns.

Table VIII–4

Typical Parking Lot Capacity Figures

	Single Parking Lines						Intermeshed Multiple Parking Lines			
∝	L	D	W	A	upd	N	D_i	A_i	upd	N_i
Parking Angle	*Curb Length per Car*	*Depth of Stall*	*Width of Aisle*	*Gross Area per Car*	*Unit Parking Depth*	*Approximate Number of Cars per Acre*	*Depth of Stall*	*Gross Area per Car*	*Unit Parking Depth*	*Approximate Number of Cars per Acre*
0°	22′	8′	12′	308□′	28′	141	8′	308□′	28′	141
20	24.9	14.2	12	502.9	40.4	87	10.1	400.9	32.2	109
25	20.1	15.4	12	430.1	42.8	101	11.4	349.7	34.8	125
30	17.0	16.4	12	380.8	44.8	114	12.7	309.8	37.4	141
35	14.8	17.3	12	344.8	47.6	126	13.7	291.6	39.4	149
40	13.2	18.1	12	318.1	48.2	137	14.8	274.6	41.6	159
45	12.0	18.7	12	296.4	49.4	147	15.8	261.6	43.6	167
50	11.1	19.2	12	279.7	50.4	156	16.6	250.9	45.2	174
55	10.4	19.6	12	266.2	51.2	164	17.2	241.3	46.4	181
60	9.8	19.8	14.5	265.1	54.1	164	17.8	245.5	49.6	177
65	9.4	19.9	17	267.0	56.8	163	18.2	250.9	53.4	174
70	9.0	19.8	20	268.2	59.6	162	18.4	255.6	56.8	170
75	8.8	19.6	23	273.7	62.2	159	18.6	264.9	60.2	164
80	8.6	19.2	24	268.3	62.4	162	18.4	261.4	60.8	167
85	8.5	18.7	24	260.9	61.4	167	18.3	257.6	60.6	169
90	8.5	18.0	24	255.0	60.0	171	18.0	255.0	60.0	171

Determining the best parking angle depends on the size and outline of the parking lot. It may be necessary to use two or more parking angles in the same lot to make best use of the space. Another space-saving method uses the herringbone and interlocking patterns of angle parking, illustrated in Figure VIII–4, and tabulated in the last four columns of its explanatory data. This intermeshing, or fitting together, at adjacent parking lines is also illustrated in Figure VIII–6.

The herringbone pattern is most efficient with forty-five-degree parking. Made up of complementary thirty- and sixty-degree stalls, it is a means of gaining more car spaces. It is not an efficient or particularly space-saving method of angle parking. The inter-

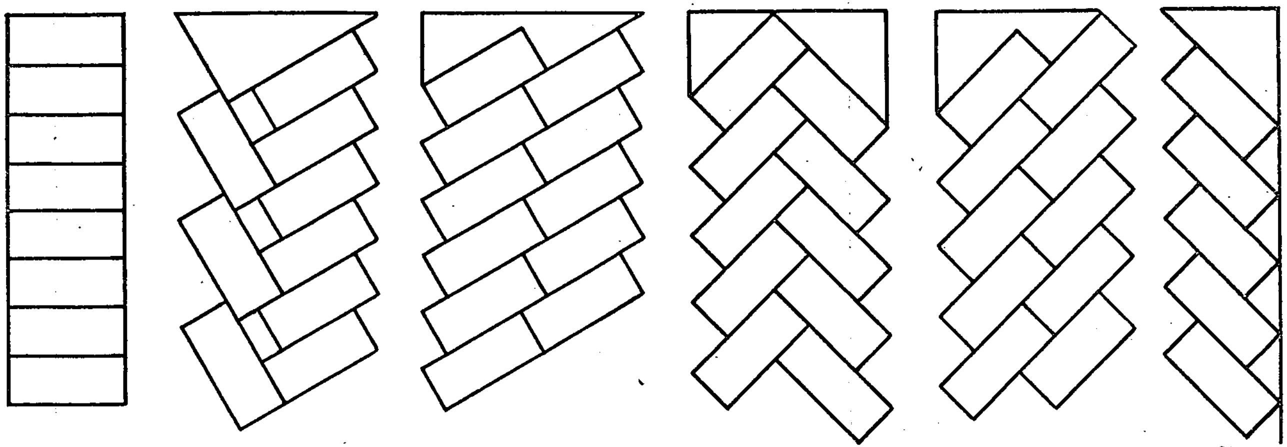


FIGURE VIII-6. Selection of the best parking angle depends primarily on the size and outline of the parking lot.

locking parking pattern is equally effective at any angle of parking.

Normally the most efficient use of space is obtained when parking stalls are laid out perpendicular to the aisles. This plan provides more stalls per unit area and permits parking and unparking in either direction. Angled parking yields fewer stalls for a given length of parking curb (see column four, Table VIII–3a) and permits parking and unparking in one direction only. However, angle parking is more convenient. Drivers find it easier to maneuver in and out of angled stalls; also it is easier to spot empty spaces.

Back-in parking requires narrower aisles than drive-in, but backing in requires more maneuvering ability than drive-in angle parking and takes more time. Most designers are reluctant to use back-in parking in customer-parking facilities because its difficulty may neutralize the driver-convenience that so often motivates parking lot development.

For space-saving, however, back-in parking is often used in lots with parking attendants. Twenty of the twenty-four attendant-operated lots reported in Table VIII–2 use back-in parking. The average area per car of these twenty lots is one hundred and ninety-seven square feet. The average area of the remaining four lots that employ head-in attendant-parking, is two hundred and twenty-four square feet per car.

Stall Markings:

Parking stalls should be marked by surface paint lines. Where stalls head into a wall or fence, it helps the driver if stall markings are extended up the wall or fence.

Stall markings are particularly important on self-parking lots. They minimize inefficient space-use caused by straddling of stalls, and encourage orderly parking where attendants are used.

Circulation:

Lots with angled stalls require continuous aisles because unparking cars are always headed in their original direction. The best aisle-plan for such lots is a series of continuous one-way aisles that alternate in direction. This requires that the angled stalls be laid out in an interlocked rather than herringbone pattern. See Figure VIII–7. One-way aisles are desirable because they are most economical of space and eliminate head-on and side-swipe accidents.

When ninety-degree parking is used, cars can unpark to the right or left and may use the aisle in either direction. Two-way aisles reduce travel distance—parking and unparking cars can take the most direct route to their destinations. Some lots may necessitate a few dead-end aisles to use all available area. In those cases, ninety-degree parking must be used.

Circulation aisles within the parking lot should be laid out to reduce travel distance and the number of turns. A poorly designed system of aisles, requiring excessive travel and turning for drivers to find an empty stall, develops confusion and hazard. Directional signs, prominently displayed, can help create orderly and safe inter-lot circulation.

Parking lot aisles should be as wide as practical. Wide aisles permit the entering driver to spot empty stalls quickly and encourage quick, easy parking. The faster an entering car is parked, the less it contributes to congestion. In larger lots, especially during peak entering hours, if drivers cannot find their way quickly to an empty stall, it may be necessary to install some means of guiding them. An unusual method is the posting of a spotter where he can oversee the lot and, through manually operated traffic lights or broadcast instructions to attendants, direct parkers to an open space.

Illumination:

Lighting should be provided where conditions indicate a reasonable amount of night-time parking. Illumination will discourage thievery and minimize pedestrian and property-damage accidents.

If the parking lot borders a residential neighborhood, landscaping, underground wiring and attractive lighting standards may be justified on aesthetic considerations. For a lot surrounded by business property, these may be considered extravagant, but nevertheless desirable.

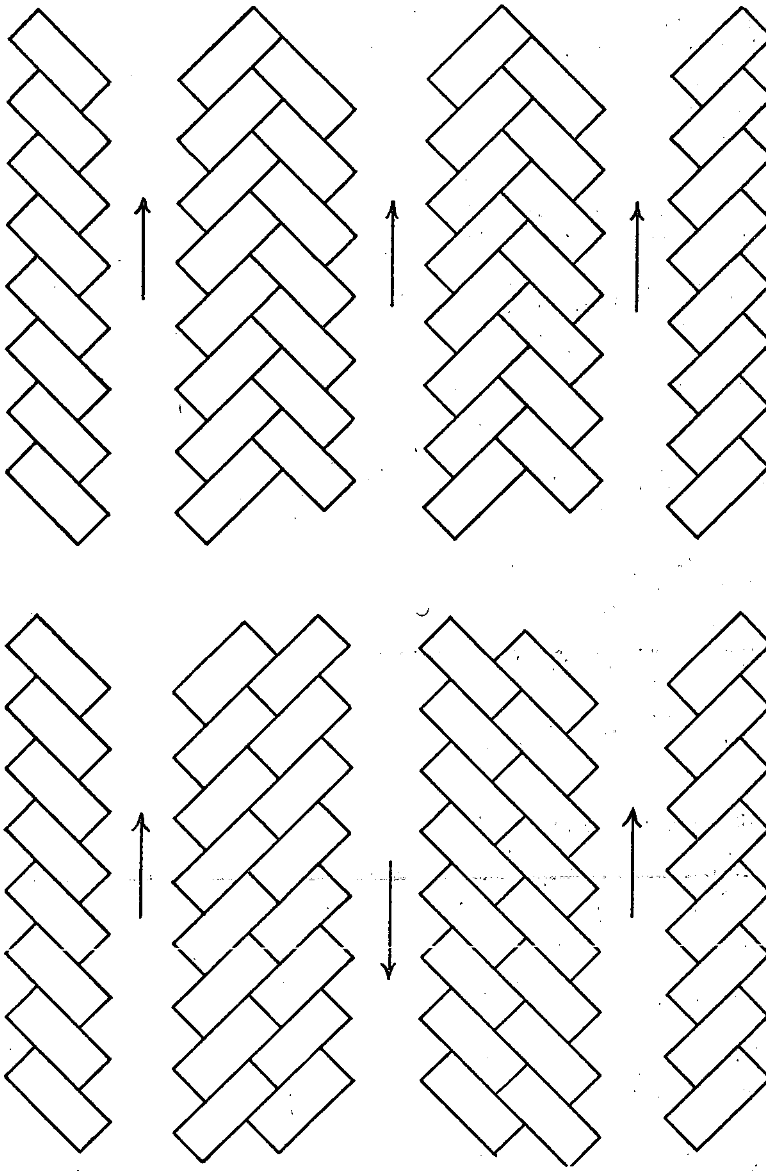


FIGURE VIII-7. The 45-degree interlock layout allows driver to return via the adjacent aisle if all stalls are occupied in an aisle. Stall-bumper layout is fairly simple; even if the bumpers are not especially effective, there is little chance for collision damages.

Pedestrian Safety:

Walkways within the parking lot are not essential, but their advantages often outweigh the additional space they require. Pedestrian walkways—never less than four feet wide—should be protected by a fence or barrier, and properly identified by guide signs.

Proper orientation of parking lines can promote pedestrian safety. If they are set at right angles to the major destination of most parkers, pedestrians are provided with direct access and are not required to cross aisles.

Where it is impractical to align parking stalls perpendicular to the most important pedestrian objective, raised pedestrian walkways between adjacent parking lines may be used. A raised pedestrian walk should have a clear width of four feet after allowing for the overhang of cars parked against it.

Stall Bumpers:

Stall bumpers are desirable aids for quick, safe parking. They encourage drivers to pull all the way into a parking stall and prevent them from over-running the stall. Because of the difference in bumper overhang in various makes and models of cars, stall bumpers high enough to meet the car bumper are more efficient than low curbs that stop the car wheels. They also prevent encroachment on pedestrian walkways, and areas where parking meters may be installed.

Lansing, Michigan, used vertical five-inch cedar logs for bumper posts but found them unsatisfactory because cars striking the posts loosened and split them. On later lots, four-inch boiler tubing in five-foot lengths was used for bumper posts. These were placed in concrete twenty-six inches below the parking lot surface and filled with concrete.

Parking Lot Costs

Principal costs of parking lots are for land and operation; development costs are relatively low. Land costs are difficult to evaluate and vary over a wide range for numerous reasons. They cannot be compared with reliable accuracy.

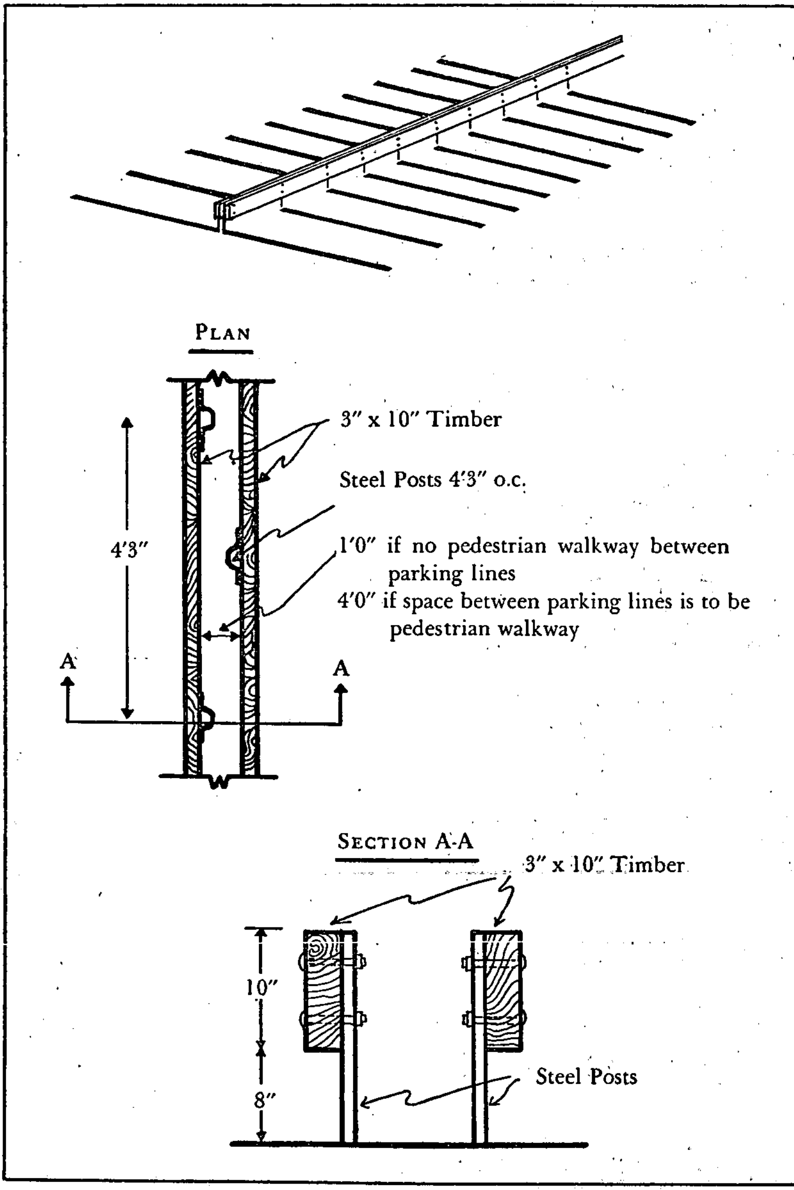


FIGURE VIII-8. Stall bumper high enough to meet the car bumpers are more efficient than low curbs that stop the car wheels.

Parking lot operating costs, however, can be analyzed. One study analyzed information collected from thirty-seven facilities.[2] Some of the salient figures revealed in that survey are discussed in the following paragraphs.

To provide a limited breakdown, operating expenses were grouped in six classifications:

1. Rental or interest on investment, liens or mortgages
2. Salaries of parking attendants, service attendants, clerical workers and management personnel
3. Insurance
4. Taxes
5. Maintenance
6. Utilities and miscellaneous expenses.

Rental or Return on Investment:

Many properties used for parking lots are leased. Their annual rentals vary considerably. The variation in annual rental per square foot is from ten cents to $1, as shown in Figure VIII–9. About one-fourth of the lots operating on a rental basis pay ten to twenty cents per square foot annual rental. Two lots reported their rental depended on gross receipts. In both cases the amount was pegged at forty percent of the annual gross receipts. Rental amounted to $12,000 for one lot that parked 75,000 cars during the year; the other paid $7,696 and parked 55,000 cars.

For parking lots operated on owned land, it was necessary to estimate a fair return on investment that would be comparable to the rental value. To provide a uniform comparison, a fixed net return on investment was assumed and used throughout to calculate the interest charges on investments in land and improvements. These values are shown in Table VIII–5. On an annual basis, this item varies from $894 to $6,740; on a per square foot basis it varies from two cents to twenty-five cents. It is interesting to compute the gross income necessary per car parked to provide this fixed return on the total investment. Using the number of cars parked per year, column seven of the Table was prepared.

[2] LeCraw, C. S., Jr., and Smith, Wilbur S., *Parking Lot Operation*, Eno Foundation for Highway Traffic Control, Saugatuck, Connecticut, 1948.

The income required to provide this return varies from 2.7 to 12.2 cents for each car parked.

Salaries:

Total salaries paid to parking lot employees were found to be between twenty-five and seventy-nine percent of the total operating expenses. The lot reporting the minimum figure provides no

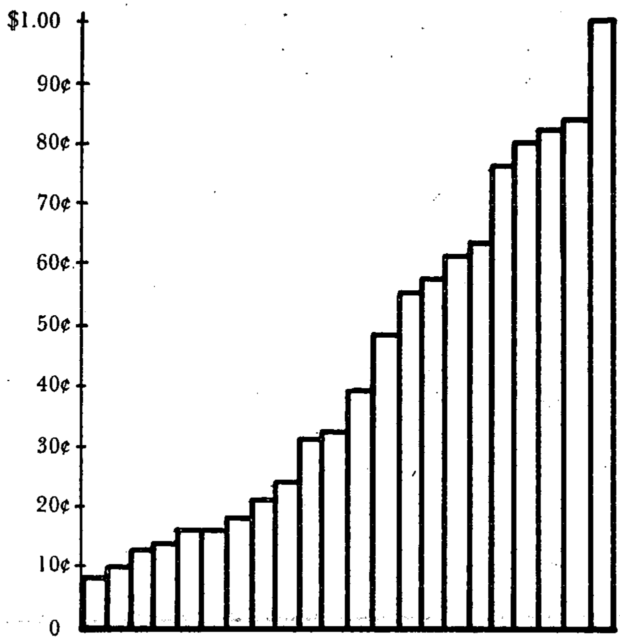


FIGURE VIII-9. Parking lot annual square foot rentals.

automotive services and listed no salaries for administrative or managerial personnel. The lot reporting the high figure offers complete automotive services. Its seventy-nine percent of operating expenses for salaries represents the total paid to all employees —skilled, unskilled, managerial and clerical.

A comparison of salaries paid to lot employees, excluding management and clerical personnel, is shown in Figure VIII–10. The lowest average monthly salary reported was $83. The highest was $275.

There was little difference between individual salaries of employees. At lots with customer-parking, the range was $94 to $275; average, $165. For lots with attendant-parking, the range was $83 to $270; average, $174.

Table VIII–5

INVESTMENT COSTS FOR PARKING LOTS OPERATING ON OWNED LAND

Land Purchase Price	*4 percent Return on Land*	*Improvement Cost*	*4 percent Return on Improvements*	*Total Return*	*Return per Square Foot*	*Return per Car Parked*
$19,000	$ 760	$9,000	$360	$1,120	$0.146	*
20,000	800	2,350	94	894	.020	$.028
22,000	880	1,825	73	953	.082	.032
56,000	2,240	**	**	2,240	.226	.027
62,000	2,480	225	9	2,489	.082	*
80,000	3,200	2,400	96	3,296	.212	.055
121,000	4,840	1,000	40	4,880	.224	*
153,500	6,140	15,000	600	6,740	.109	.041
154,300	6,172	5,200	208	6,380	.252	.122

* Number of cars parked annually not reported.
** Improvement costs not reported.

The "salaries" column of Table VIII–6 relates the number of cars parked in each lot per year to the total annual salaries of all employees. A salary cost of 1.1 cent per car parked was reported by one customer-parking lot that accommodated 43,000 cars for the year, using only part-time employees. The highest salary cost per car parked was eighteen cents, reported by an attendant-operated lot that handled 52,000 cars in the year.

For the group of lots using self-parking, salary costs ranged from 1.1 cents to 16.7 cents per car parked. The largest group had costs of less than ten cents per car parked. The average was 7.1 cents.

In lots using attendants, salary costs were higher. The range was 2.7 to 18 cents; average, 11.2 cents.

Insurance:

Only one in ten of the parking lots polled carries no insurance. Seventy-eight percent carry public liability insurance. Sixty-three percent carry employee liability or compensation insurance. Forty-seven percent carry fire and theft insurance on patrons' cars, and three percent carry insurance to cover loss of contents of patrons' cars.

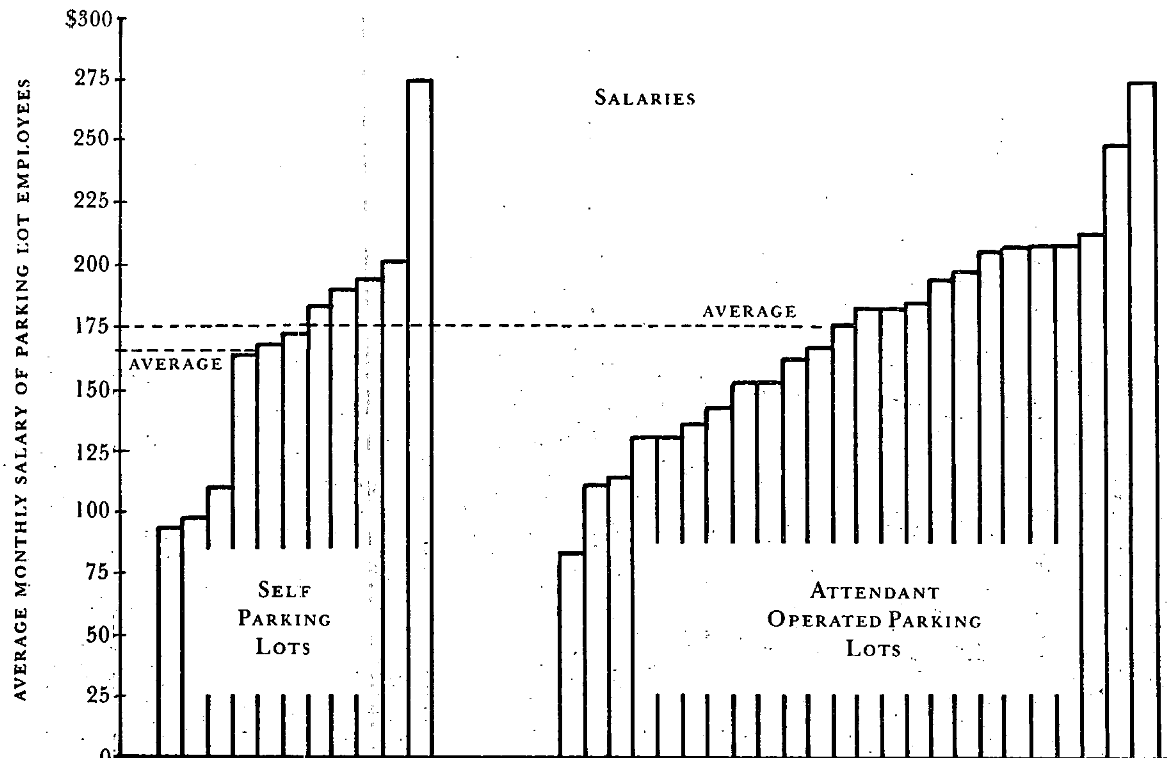


FIGURE VIII-10. Salaries paid to lot employees, excluding management and clerical personnel.

Insurance costs as high as $2500 a year were reported, but the average is considerably lower. Eighteen lots reported their annual insurance costs at less than $100. Twenty-two percent pay $100 to $200 a year; another twenty-two percent, $200 to $300; seven percent, $300 to $400; eleven percent, $400 to $500; eleven percent, $500 to $100; eight percent pay annual premiums in excess of $1000.

In terms of cars parked per year, insurance costs are a fraction of the total operating costs. It exceeded one cent per car in only two cases. The lowest insurance cost was .08 cent. The average annual unit cost of insurance for customer-parking lots was .14 cent per car parked. Workmen's compensation insurance for attendant lots averaged .61 cent for each car parked.

Property Taxes:

Tax-rate comparison is of limited value. For the properties examined, the tax rate per $100 of assessed valuation ranged from $1.40 to $6.89, and included both city and county taxes. The average rate was 36 mills on appraised valuation; half of the lots reported tax rates of less than 40 mills.

Taxes on one parking property were $115 a year; on another, more than $15,000. Tax costs per square foot were found to vary from .5 cent to 37 cents.

Maintenance:

Many operating costs go into maintenance, though in most lots this item included resurfacing, stall and aisle markings, snow removal, general repairs and upkeep. Average annual maintenance costs varied from $25 to $3200. From that wide range, obviously expenses charged to maintenance at one lot are charged to "other expenses" or "miscellaneous" at another lot.

Related to cars parked in a year, maintenance expenses ranged from .03 cent per car to 1.9 cents. The pride of ownership is reflected in the average maintenance costs reported for owned and rented lots. An average of $721 was spent to maintain the owned lots; $297 for maintenance at rented lots.

Utilities and Miscellaneous Expenses:

Some lots charge to "other expenses" items that might more accurately be classed as maintenance. Without great detail it was not possible to adjust this difference in analyzing data. The costs shown under columns headed "Other Expenses" in Table VIII–6 are varied. In addition to miscellaneous items, other expenses include electricity, utilities and license fees. License fees are generally small, ranging from $10 to $25 a year. The highest reported was $100 a year.

For the lots covered by this survey, other expenses ranged from $30 to $7,000.

Total Operating Expenses:

Total operating expenses in terms of gross revenues provide some idea of the size of parking-lot operations. Operating expenses in terms of costs per car space are of more significance. They provide a basis for comparison of parking lot operations of different sizes. They are a direct value for relating the physical and financial features of parking lots.

But even with this elementary unit of comparison, operating costs vary. One lot reported total operating expenses of $10.42 a car space. From this minimum, the cost rises to a high of $494.06 per car space per year. The average for all the lots was $206.25.

The most accurate picture of parking lot operating expenses is obtained when they are related to the number of cars that daily use each car space. This is commonly referred to as turnover. Some operating expenses will remain constant—regardless of the total number of cars parked. One of these is rental. However, most other operating expenses vary with the number of cars parked.

Table VIII–6 shows that the total annual operating expenses ranged from five cents per car to forty-three cents. The average for all lots was found to be twenty-four cents. Three lots reported annual operating expenses of less than ten cents per car parked. Only two reported expenses in excess of forty cents per car. The greatest number—about one-third of the lots—found their annual

Table VIII–6

Parking Lot Annual Operating Cost

Charge for Land Use			Salaries			Insurance			Taxes			Maintenance			Utilities and Other Expenses			Total Expenses	
Per Car Parked	*Per Car Space*	*Percent of Total*	*Per Car Parked*	*Per Car Space*	*Percent of Total*	*Per Car Parked*	*Per Car Space*	*Percent of Total*	*Per Car Parked*	*Per Car Space*	*Percent of Total*	*Per Car Parked*	*Per Car Space*	*Percent of Total*	*Per Car Parked*	*Per Car Space*	*Percent of Total*	*Per Car Parked*	*Per Car Space*
.028	3.97	38.1	.011	2.13	20.4		None Carried		.010	1.92	18.4	.0069	1.33	12.8	.0055	1.07	10.3	.06	10.42
.007	8.63	15.2	.039	44.53	78.3	.0008	.88	1.5	**	**	**	.0012	1.43	2.5	.0012	1.43	2.5	.05	56.90
.073	30.77	53.8	.060	25.64	44.8		None Carried		**	**	**	0	0	0	.0019	.83	1.4	.13	57.24
.110	51.56	75.9	.027	12.65	18.6	.0039	1.84	2.7	**	**	**	0	0	0	.0039	1.86	2.8	.14	67.91
.054	25.20	34.8	.086	40.00	55.3	.0016	.74	1.0	**	**	**	.0054	2.50	3.5	.0084	3.90	5.4	.15	72.35
.160	49.59	64.1	.088	27.27	35.2		None Carried		**	**	**	.0010	.33	0.4	.0008	.25	0.3	.25	77.44
*	23.07	28.8	*	52.03	65.1	*	1.77	2.2	*	**	**	*	1.83	2.3	*	1.23	1.6	*	79 93
*	19.14	20.8	*	70.00	76.1	*	.28	0.3	*	1.63	1.8	*	.57	0.6	*	.34	0.4	*	91.96
.145	33.25	35.2	.167	53.27	56.4	.0062	1.97	2.1	**	**	**	.0028	.91	1.0	.0140	4.95	5.3	.33	94.35
.041	25.92	26.5	.072	46.15	47.2	.0012	.82	0.8	.010	6.40	6.6	.0192	12.30	12.6	.0096	6.15	6.3	.15	97.74
.032	19.06	17.8	.104	62.40	58.7	.0015	.90	0.9	.030	18.12	17.0	.0013	.80	0.9	.0166	5.00	4.7	.18	106.28
*	52.63	47.4	*	52.63	47.4	*	4.70	4.2	*	**	**	*	0	0	*	.97	1.0	*	110.93
*	46.15	37.2	*	72.00	58.2	*	2.25	1.8	*	**	**	*	1.53	1.2	*	1.92	1.6	*	123.85
.008	11.36	9.0	.068	92.72	73.7	.0060	8.18	6.5	**	**	**	.0033	4.54	3.6	.0066	9.08	7.2	.09	125.88
.220	90.41	63.5	.114	46.85	33.0	.0058	2.42	1.7	**	**	**	.0040	1.64	1.2	.0020	.82	0.6	.34	142.14
.122	47.26	31.2	.180	61.92	40.8	.0064	2.64	1.7	.083	32.00	21.1	.0096	3.70	2.4	.0109	4.22	2.8	.41	151.56
*	56.74	35.6	*	57.67	36.2	*	5.09	3.2	*	31.36	19.6	*	2.91	1.8	*	5.82	3.6	*	159.59
.159	112.94	67.9	.066	47.05	28.3		None Carried		**	**	**	.0052	3.71	2.2	.0037	2.65	1.6	.23	166.25
.172	122.61	73.7	.055	39.70	23.8	.0016	1.15	0.7	**	**	**	.0007	.55	0.3	.0035	2.54	1.5	.23	166.55
.162	124.61	66.2	.073	56.00	29.7	.0020	1.54	0.8	**	**	**	.0010	.77	0.4	.0070	5.39	2.9	.24	188.31
.040	35.29	18.4	.155	137.24	71.5	.0033	2.91	1.5	**	**	**	.0034	3.03	1.6	.0154	13.61	7.0	.21	192.08
.027	38.62	19.9	.152	121.00	62.3	.0035	2.82	1.4	.032	25.95	13.4	.0012	1.72	0.9	.0028	4.07	2.1	.21	194.18
*	52.57	25.1	*	38.28	18.3	*	3.06	1.5	*	111.71	53.4	*	0	0	*	3.68	1.7	*	209.30
.055	43.94	20.3	.140	112.00	51.7		None Carried		.055	44.40	20.5	.0033	2.67	1.2	.0171	13.75	6.3	.27	216.76
.215	135.33	57.4	.143	89.72	18.0	.0043	2.69	1.1	**	**	**	.0070	4.81	2.0	.0055	3.49	1.5	.37	236.04
.139	128.26	48.4	.118	108.33	40.9	.0072	6.66	2.5	**	**	**	.0054	5.00	1.9	.0181	16.66	6.3	.28	264.91
*	18.66	6.9	*	242.66	90.6		None Carried		*	6.60	2.5	*	0	0	*	0	0	*	268.01
.160	171.43	53.7	.115	123.94	38.7	.0120	12.85	4.0	**	**	**	.0020	2.14	0.7	.0085	9.14	2.9	.29	319.50
.222	212.24	50.9	.178	170.07	40.6	.0178	17.00	4.1	**	**	**	.0057	5.45	1.3	.0136	12.90	3.1	.43	417.66
*	171.43	40.7	*	205.71	48.7	*	17.15	4.1	*	**	**	*	2.92	0.7	*	24.25	5.8	*	421.46
.148	205.12	41.5	.139	192.30	38.9	.0023	3.20	0.6	**	**	**	.0027	3.84	0.8	.0647	89.60	18.2	.35	494.06

Average Operating Cost

	Per Car Parked	*Per Car Space*	*Percent of Total Cost per Car Space*
Charge for Land Use	$.109	$ 69.93	38.0
Salary Cost	.102	80.77	43.8
Insurance Cost	.0049	4.22	2.3
Tax Cost	.037	18.01	9.8
Maintenance Cost	.0044	2.81	1.5
Cost of Utilities and Other Expenses	.0105	8.39	4.6
Total	$.267	$184.13	100.0

* Number of cars parked annually not known.
** Rented lot, taxes paid by owner.

operating expenses ranged between twenty and thirty cents per car parked.

To point up the difference between public and private ownership, as well as the difference between attendant- and driver-parking operation, the lots were divided into four classifications: publicly owned, commercially owned, attendant-parking, and self-parking. Lots operating on rented land were treated separately from those on owned land. And lots offering automotive services were set apart from those that do not. These classifications are shown in Table VIII–7.

Table VIII–7

AVERAGE ANNUAL EXPENSE FOR DIFFERENT TYPES OF LOTS PER CAR PARKED

		Expense per Car		
Classification	*Type of Lot*	*Average*	*High*	*Low*
Owner or operator	City-owned	$0.16	$0.33	$0.05
	Commercial	0.21	0.44	0.06
Type of parking	Customer	0.11	0.33	0.05
	Attendant	0.29	0.44	0.14
Services offered	Parking only	0.17	0.41	0.05
	Parking and services	0.34	0.44	0.09
Land ownership	Owned	0.17	0.41	0.06
	Rented	0.27	0.44	0.05

Privately operated lots on city-owned land reported expenses approximately twenty percent less than other lots. This saving is probably because taxes are not usually imposed on city-owned land, and city-owned parking lots offer a minimum of service. Drivers generally park their own cars, and automotive services are not provided.

Lots that permit drivers to park their cars reported average operating expenses of eleven cents per car. The average for lots with attendant-parking was twenty-nine cents. The range in self-parking lots was from five to thirty-three cents; in attendant-operated lots, the range was from fourteen to forty-four cents per car parked.

The trained personnel at lots that provide automotive services increases expense. Operating costs are about twice those of lots that do not offer automotive services. In this survey the ratio was exactly two to one. Lots providing automotive services averaged thirty-four cents per car parked; lots without those services reported seventeen cents per car.

The expenses of lots operating on rented land run higher than those of lots on owned land. Average expenses on operator-owned property was seventeen cents per car. For lots on rented land, the average was twenty-seven cents. The range on owned lots was six to forty-one cents; on rented lots, five to forty-four cents. The operating expenses of owned lots included charges on investment.

Parking Lot Income

The important figure in discussing parking lot earnings is *income per parking space*. Gross income has little meaning; it varies over a wide range and for many reasons. Some of the factors that make gross income a poor figure to use in comparing financial operations of a group of parking lots are:

a. Parking lot size and capacity
b. Parking durations
c. Parking rates
d. Extent of automotive services offered.

For example, in the parking lot study, the smallest gross income was \$7,000, reported for a small-town lot that provided no automotive services. The largest gross income reported was \$131,000. The lot reporting the largest gross income contained 35 percent fewer parking stalls than the lot reporting the lowest annual income.

The annual gross income per car space varied between \$31.13 and \$908.75. See Table VIII–8. The lot reporting the greatest per car space income was one of the smaller lots studied. It had only seventy car spaces, but fifty-seven percent of its annual income was derived from automotive services.

Forty-eight percent of the lots reported gross incomes of less than \$200 per car space; twenty-one percent earned less than \$100; twenty-seven percent claimed their earnings at between \$100 and \$200. Sixteen percent had incomes between \$200 and \$300, while eighteen percent fell in the \$300 to \$400 range. The remaining eighteen percent reported varied amounts ranging as high as \$900 per car space. The average for all the lots was \$252.15.

Table VIII–8

PARKING LOT ANNUAL GROSS INCOME

Parking Income			*Service Income*			*Total Income*	
Per Car Space	*Per Car Parked*	*Percent of Total*	*Per Car Space*	*Per Car Parked*	*Percent of Total*	*Per Car Space*	*Per Car Parked*
31.13	0.16	100.0	—	—	—	31.13	0.16
41.66	*	97.0	1.42	*	3.0	43.08	*
77.48	0.25	100.0	—	—	—	77.48	0.25
82.50	0.18	100.0	—	—	—	82.50	0.18
79.80	0.25	90.5	8.38	0.03	9.5	88.18	0.28
90.38	0.21	100.0	—	—	—	90.38	0.21
93.05	0.25	100.0	—	—	—	93.05	0.25
97.57	0.09	100.0	—	—	—	97.57	0.09
104.00	0.27	100.0	—	—	—	104.00	0.27
117.11	0.25	100.0	—	—	—	117.11	0.25
150.13	*	100.0	—	—	—	150.13	*
150.99	*	100.0	—	—	—	150.99	*
157.04	0.38	100.0	—	—	—	157.04	0.38
114.93	*	70.6	47.86	*	29.4	162.79	*
183.06	0.253	97.1	5.47	0.007	2.9	188.53	0.26
192.30	0.25	100.0	—	—	—	192.30	0.25
194.81	0.308	99.3	1.37	0.002	0.7	196.18	0.31
203.12	0.29	100.0	—	—	—	203.12	0.29
222.66	0.14	100.0	—	—	—	222.66	0.14
224.00	0.15	100.0	—	—	—	224.00	0.15
235.54	0.33	100.0	—	—	—	235.54	0.33
240.00	0.36	100.0	—	—	—	240.00	0.36
244.00	0.31	100.0	—	—	—	244.00	0.31
306.90	0.35	100.0	—	—	—	306.90	0.35
76.75	*	25.0	230.25	*	75.0	307.00	*
314.34	0.22	100.0	—	—	—	314.34	0.22
322.51	0.35	100.0	—	—	—	322.51	0.35
367.74	0.586	99.3	2.59	0.004	0.7	370.33	0.59
389.83	0.34	100.0	—	—	—	389.83	0.34
428.57	0.40	100.0	—	—	—	428.57	0.40
362.37	*	73.0	134.03	*	27.0	496.40	*
442.91	0.33	81.2	102.54	0.07	18.8	545.45	0.40
775.39	0.56	90.0	86.15	0.06	10.0	861.54	0.62
802.04	0.84	90.0	89.11	0.09	10.0	891.15	0.93
908.57	*	100.0	—	—	—	908.57	*

AVERAGE INCOME

	Per car parked	*Per car space*	*Percent of total income per car space*
Parking Income Only			
All lots	$.34	$252.15	
Lots that provide parking only	.26	224.32	
Lots that provide automotive services and parking	.45	312.86	
Parking Income and Income from Services at Lots that Provide Both			
Parking income	.45	312.86	82.9
Income from services	.04	64.50	17.1
Totals	.49	377.36	

* Number of cars parked annually not known.

Turnover:

To point out the importance of turnover in parking lot operation, the reported annual incomes were related to the total number of cars parked. The lowest annual gross income per car parked was nine cents, reported by a city-owned lot that handled 150,000 cars during the year. Parking rates were five cents for the first two hours and five cents for each additional hour.

The largest average income per car parked was ninety-three cents, reported by a lot that parked 140,000 cars in the year—approximately ten percent fewer cars than the lot having the lowest per car income. The difference was of course in the rate schedules. The high-income lot charged twenty-five cents for the first hour of parking and ten cents for each additional hour.

The average income per car parked for all lots studied was thirty-four cents.

Table VIII–9

Annual Income for Different Types of Lots per Car Parked

Classification	*Type of Lot*	Income per Car *Average*	*High*	*Low*
Owner or operator	City-owned	$0.206	$0.28	$0.09
	Commercial	0.340	0.93	0.14
Type of parking	Customer	0.212	0.31	0.09
	Attendant	0.361	0.93	0.15
Services offered	Parking only	0.263	0.40	0.09
	Parking and services	0.484	0.93	0.26

Largely because of rate differences, city-owned parking lots averaged about forty-one percent less income per car than commercially-owned facilities. Each car parked in one of the city-run lots returned twenty cents of gross income. Each car in a commercial lot paid an average of thirty-four cents. The range in income per car parked varied from nine to twenty-eight cents for city lots and from fourteen to ninety-three cents for all others.

Lots with attendants reported an average of thirty-six cents earned on each car parked. At lots with driver-parking, the average income per car was twenty-one cents. The lowest income per car space reported by an attendant-operated lot was fifteen cents; for a self-parking facility, nine cents.

Lots that offer automotive services earn almost twice as much per car parked as those not offering such service. Lots with service reported an average gross income per car parked of forty-five cents; those without service facilities, twenty-six cents. The lowest per car income reported by any lot providing services was twenty-six cents—nearly three times the lowest amount reported by non-service lots. In evaluating these figures, proper account should be taken of the increased operating expense in providing services and attendants.

Parking Income vs. Service Income:

Some of the lots gave a breakdown of income detailed enough to allow a comparison of parking income and service income. They showed that income from automotive services accounted for 38.7 percent of the average parking lot's total income. The smallest figure reported was 9.5 percent; the largest, eighty-two percent. These and the other reported values are shown in Table VIII–10.

Table VIII–10

COMPARISON OF ANNUAL GROSS INCOME FROM PARKING, AUTOMOTIVE SERVICES AND AREA USAGE

Lot Capacity (Car Spaces)	*Cars Parked per Year*	*Area Usage*		*Percent of Gross Income:*		*Relative Gross Income**
		Percent Parking	*Percent Services*	*from Parking*	*from Services*	
147	140,000	90.0	10.0	88.6	11.4	100
78	108,000	90.0	10.0	53.5	46.5	51
70	**	76.0	24.0	43.0	57.0	48
110	150,000	81.2	18.8	63.3	36.7	46
260	166,405	99.3	0.7	90.5	9.5	39
133	83,381	99.3	0.7	67.1	32.9	38
65	**	86.9	13.1	25.0	75.0	15
85	60,225	97.1	2.9	89.0	11.0	12
110	35,000	90.5	9.5	75.0	25.0	7
121	37,500	73.0	27.0	18.0	82.0	7
Average 118	97,564	88.3	11.7	61.3	38.7	

* Lot with maximum gross income regarded as 100 percent.
** Number of cars parked annually not known.

In considering the portion of gross income derived from automotive services, the ratio of land used for parking and that used for automotive servicing can be related to income. Table VIII–10 gives a percentage comparison of income derived from parking and services for a group of lots. It also shows the percentage of land area devoted to each use. It is obvious that space devoted to automotive servicing returns a greater proportional gross income than area used for parking.

The percentage of total income produced from parking is lower for each lot than the percentage of total area devoted to parking. The greatest unit return from a service area was at a lot reporting that 32.9 percent of its gross income came from servicing activities on 0.7 percent of its total land area. Averaging all lots in the group shows that about twelve percent of the land area devoted to automotive services develops thirty-nine percent of the gross income.

CHAPTER NINE*

GARAGES

Chapter VIII dealt largely with design elements affecting parking lots. Since garages may be looked upon as multi-story lots, design principles apply equally but with reservations.

The structural design of parking garages is far beyond the scope of this volume, which attempts only to *summarize* the most important aspects of parking needs, characteristics, and practices. An excellent and complete discussion of these elements may be found in "The Traffic Design of Parking Garages" (1957) edition.

There is no one best garage type, ramp system, floor layout or method of operation. The determination of each of these may be influenced by the area and dimensions of the site, the street traffic pattern, the topography, the needed or desired capacity, the nature of the expected patronage and hence the turnover, and various economic considerations.

Practically always compromises will be necessary, for some of the items of design which, for example, bring space efficiency may at the same time decrease the speed or smoothness of operation, and features which lower operating costs may involve a high construction cost. The best design and plan represents the best adaptation to the particular circumstances existing.

Classification of garages: Garages may be classified by their general type—above ground, underground or integral, by their means of interfloor travel—elevators or ramps, or by their method of operation—attendant-parking, self-parking, or mechanical. As with lots, they may be either pay or free facilities, operated as commercial or municipal businesses; for customer or employee parking.

Types of garages: All but a few of today's garages are *above-ground*, usually constructed of reinforced concrete, although steel-frame and bare steel structures are becoming more common.

Underground garages: Since the advent of the Union Square

* *Editor's Note:* Both chapters IX and X deal with garages.

underground garage in San Francisco, followed by those in Pershing Square, Los Angeles, St. Mary's Square in San Francisco, Grant Park in Chicago, and Mellon Square in Pittsburgh, there has been a misconception that some sort of magic about an underground garage answers all parking problems.

Actually an underground garage, with no operating advantages over a surface structure, has disadvantages in costing more to build and requiring more light and ventilation. The reason for the appearance of underground garages has been that in each case subsurface space could be acquired, in a high-demand area, under more favorable conditions than for comparable surface property in an equally desirable location.

However, while it is true that in every case a surface structure would cost much less to build and somewhat less to operate, there may be compensating circumstances. When an underground garage is built under a city-owned park or street and the surface is restored to its previous use, it is reasonable to consider that the land cost (for the garage) was zero, and that the construction cost is the whole cost. Conversely, if land is bought for a surface garage, or land already owned is used, then the land cost must be included in the total cost.

The following summary is based upon data on the construction costs of various garages built in 1954–55:[1]

	Average underground garage (of 2)	*Average ramp garage (of 6)*
Number of spaces	1,624	1,008
Construction cost per space	$3,630	$1,510
Square feet of land per space	114.0	70.2

The underground construction cost per space was $2120 higher than that for a surface open-deck ramp garage. Since the surface garage requires 70.2 square feet of land a space, the underground garage would be less expensive, unless land equally desirable could be bought for $2120/70.2 or $30.20 a square foot or less.

The best known of the underground garages, the Union Square in San Francisco, Pershing Square in Los Angeles, Mellon Square

[1] Reprinted from *Engineering News-Record*, Copyright 1955, McGraw-Hill Publishing Company.

in Pittsburgh and Grant Park in Chicago, are all surrounded by very highly assessed property. Based upon known values of comparable properties, it hardly would be possible to acquire an equivalent location for a land cost of $30.20 per square foot—and such a location would undoubtedly also be encumbered by very expensive improvements above the land value.

A logical conclusion is that the field for underground garages is largely restricted to public park land in the most highly assessed areas of large cities.

Integral parking: Among the first examples of the provision of parking facilities in connection with a structure intended primarily for other purposes, were the roof-parking areas such as those found on some Sears & Roebuck stores, and the basement and sub-basement parking areas more recently provided in large office buildings and auditoriums. A more modern example, expanding the principle is the Cafritz "Park-at-your-Desk" office building, in Washington, D.C. In this 8-story office building the entire central core is a ramp and parking system permitting each tenant to park his car within a few feet of his office.

Elevator garages: Elevator garages are relatively few—carry-overs from the 1920's, usually on narrow-frontage sites where ramp structures would not be feasible. The disadvantage or handicap in the use of elevators is, of course, the necessarily intermittent or cyclical type of operation (as opposed to ramp garages), wherein one storage or delivery must be completed before another can begin—hence an inability to speed up under a peak situation. Initial cost and maintenance are both high.

In Ramp Garages: Interfloor travel is by the ramps or sloping drives, the ramp system including also floor aisles connecting the ends of ramps. Ramps may be classified in several ways:

1. *Alignment:* Ramps may be either curved or straight. In curved ramps the turns are usually either a half-circle or a full circle, and with straight ramps the turning movements are made on the garage floors or decks.

A full-circle ramp has the minor disadvantage of losing the waste space in the core of the ramp, but a great advantage is the high level of speed possible. Straight ramps usually have the disadvantage of requiring abrupt turns at each end.

2. *Continuity:* A continuous curved ramp is in effect a spiral, with the entire ramp system in one unit of the structure. A non-continuous curved ramp usually consists of half-circle sections which are connected by level sections of garage floor. Curved ramps may or may not be banked.

The semi-circular or arc-shaped ramps eliminate most of the sharp turns which accompany straight ramps, and also permit use of much of the core space wasted in full-circle ramps.

3. *Capacity:* Ramps may be one-lane or two-lane and may have one-way or two-way travel. Although one-lane ramps are used in a few small garages for two-way travel, such practice is undesirable, even with signal-control, and two-lane two-way ramps are dangerous unless the two lanes have a median separation.

4. *Direction:* In a *parallel* system the up-ramp and the down-ramp slope in the same direction, on the same plane. Opposed ramps slope in opposite directions.

5. *Relative position:* Up and down ramps may be adjacent (side by side) or separated. If two one-way ramps are parallel and adjacent, they form a two-way ramp. Whether ramps are straight or curved, the ramp system, if the garage has three or more levels, may be considered as forming a spiral, even though it may be a "rectangular spiral." If the up-and-down ramp systems form about the same center, the ramps are concentric. If not, they form a tandem.

6. *Separation of ramp from parking areas:* In some garages the ramp system is a unit, separated from the parking aisles and stalls, hence permitting safer and more efficient movement. In other garages the aisles connecting the ends of ramps also serve parking stalls, hence are more efficient in space usage, although interfering somewhat with free movements.

7. *Number of ramp systems:* Most garages have two ramps, one up and one down, and since even a single ramp system has a very high capacity, additional ramps are needed only to save travel distance if the garage covers a very large area. An example is the huge underground garage in Grant Park in Chicago, with a ramp system at each end.

8. *Outside-ramps:* In some long garages the several levels are

served by long straight ramps on the outside of the structure, as shown in Figure IX–1, the Hecht Company department store customers' garage in Arlington, Va.

The ramp at the right is a two-way divided ramp, the up half serving all levels and the down half serving the top level only. Beneath it are several down-ramps, one for each level. This garage uses self-parking, charges no fee, and each level connects directly with the adjacent department store.

9. *Sloping-floor or spiral-floor:* A garage of this type consists almost entirely of a rectangular spiral ramp, the ramp being wide enough (usually about sixty feet) to accommodate a two-way travel aisle plus a row of stalls on each side. Since travel must be two-way, the stalls are at 90 degrees, and since parking maneuvers are executed directly from the travel aisle, the ramp or sloping floor is held to a very flat slope, usually four degrees or five degrees. This requires a relatively long building site and leads to longer car-travel and driver-walking distances.

A different type of sloping floor garage is represented by the three-level, 1179-space garage of the May Company's Wilshire branch store in Los Angeles. Each floor is flat but sloped three degrees to four degrees, the three floors are parallel and there are no ramp connections between floors. The lower floor is largely underground, and is entered where its higher end reaches ground level. The second floor is entered at the other end of the structure, where it meets ground level, and the top floor is entered by a short ramp from the street at about midpoint on one side. Each floor is about 232 feet by 513 feet and uses the herringbone Type B layout pattern.

10. *Staggered-floor garages:* Whatever the slope of a ramp, it is obvious that at that slope it must have a certain length in order to reach the next floor level. Thus a 10-percent grade (which rises ten feet in a length of one hundred), must be 80 feet long if the floor levels are spaced at eight feet (seven feet six inches is the recommended minimum *clearance*). This means that an appreciable portion of the garage storage capacity must be sacrificed to provide access.

The staggered-floor type of garage such as the one illustrated

FIGURE IX-1. Outside ramp, Hecht Company garage, Arlington, Virginia.

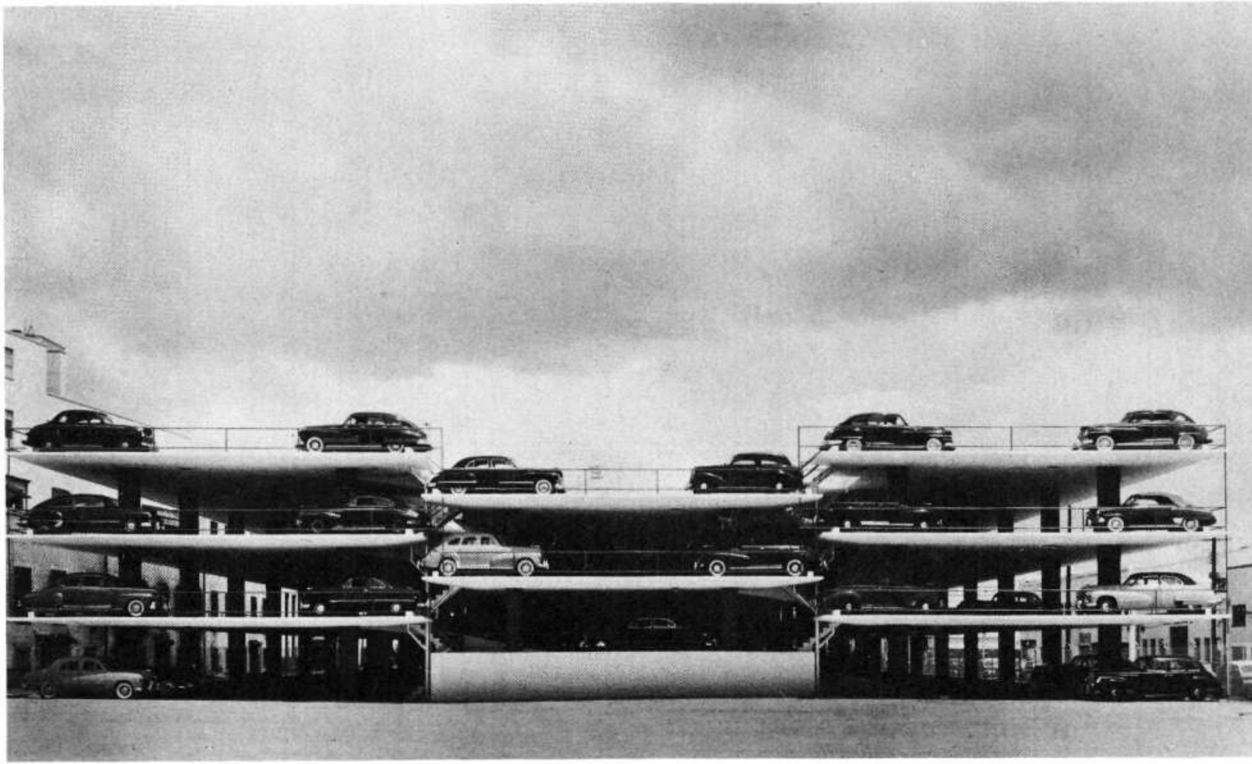


FIGURE IX-2. Staggered-floor garage, Miami, Florida.

in Figure IX–2 (Miami, Florida), has two or more adjacent sections, with the levels of each section midway between the levels of its neighbor. Successive levels, therefore, are at vertical intervals only half as great as in a normal structure. Thus in a structure having the minimum vertical clearance, a ramp would have to rise only four feet between levels, reducing the ramp length by fifty percent. Furthermore, steeper grades are acceptable where the ramp length is short. A further advantage of the staggered-floor design is that, by cantilevering, the floors of adjacent sections may be overlapped as much as five or six feet, with a consequent gain in space efficiency. This low-ceiling added space is fully usable if parked cars are headed into the stalls.

Staggered-floor garages may use either straight or curved ramps. An example is the large self-parking customer garage of the Zion Cooperative Mercantile Institution in Salt Lake City, which has curved ramps both in the interior of the structure and at each end.

11. *Hillside garages:* A special situation, wherein the need for ramps in a garage may largely be eliminated, is illustrated in a hillside garage in Bluefield, West Virginia. Here it is so located that access direct from street level is possible for all four levels.

A complete discussion of the geometrics and characteristics of the many ramp systems and combinations is included in the "Traffic Design of Parking Garages," 1957.

Other design details: Although the basic principles of aisle and stall layout apply equally to both lot and garage design, the addition of a third dimension introduces other factors which must be considered.

It should be noted that the herringbone layout pattern is not usually practicable in garages because of the interference of columns.

Space taken by ramps: In most garages a large part of the space taken by ramps represents lost area, space which in a lot could be used for stalls. An exception is the sloping-floor type of construction, in which the continuous ramp serves both two-way travel and a double row of parking stalls.

Ramp grade: Ramps used purely for travel range in gradient from ten to fifteen percent, with a maximum of twenty percent on short ramps, such as those between levels in a staggered-floor garage. The ramps in sloping-floor garages are usually held to four or five percent.

Transition grades: Since a sharp break where the top or foot of a ramp intersects the level floor would tend to scrape or damage the underbody of cars, the ramp and floor surfaces at these points should be joined by an easement or transition grade. This may be accomplished either by a gradual warping of the surface or (as illustrated in Figure IX–3) by a straight grade ten to twelve feet long, at a grade half that of the ramp, "eased" or "feathered" at each end.

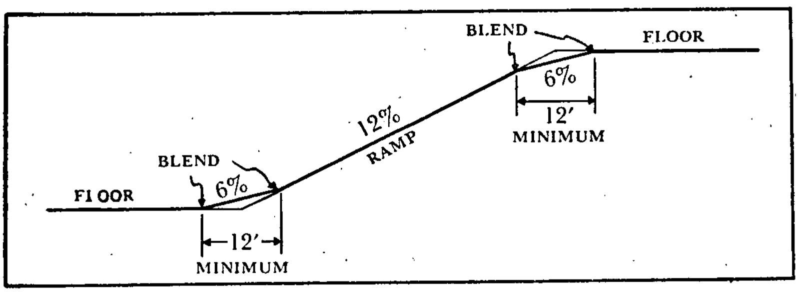


FIGURE IX-3. Transition grades for ramp ends.

Ramp width: One-lane straight ramps should have a minimum width of ten feet between curbs, flared at each end. Where up and down straight ramps are adjacent there should be a separating median curb at least one foot six inches wide and not more than six inches high.

On curved ramps, it is recommended that the inner curb have a radius of at least eighteen feet, the inner lane a width of twelve to fourteen feet. If the ramp is two-way, two-lane, there should be a medial curb at least one foot six inches wide.

Number of stories: When nearly all garages operated with attendant-parking, there was a generally followed principle that there should not be more than five parking levels about ground, because of the travel time and hence the delay to customers.

Under self-parking the situation is different. Drivers parking themselves do not think of their own driving time as a delay, particularly so if the fee is lower. A greater number of floors, hence, is less of a handicap. That this is so is demonstrated by the Battery Garage in New York City, where all-day parkers drive as high as seven levels, and the Downtown Center garage in San Francisco, catering to many shoppers, and rising eight levels.

Basements: The addition of a basement costs a little more than the addition of an extra deck, but will involve much shorter travel-distance in operation, may permit the use of under-sidewalk space, and provides one level of space rarely below freezing, hence attractive to particular parkers.

Story or level height: Not only are modern cars nearly a foot less in height than the models of thirty years ago, but the trend is toward still lower heights. Also, the modern parking garage is usually built for that purpose alone, with no reason to provide floor heights adaptable for other uses. The upper levels, therefore, need not exceed seven feet six inches in clear height, although ground floor heights are usually greater, to permit partial use for stores.

Column spacing: The position of columns is obviously an extremely important item in garage design because of its inter-relationship with the layout of aisles and stalls. Just as car heights have decreased nearly a foot, so have car widths increased by six to ten inches. Similarly, many garages designed with narrow stalls for attendant-parking, have found that a conversion to self-parking and wider stalls brought a reduction of twenty-five to thirty-three percent in capacity because of the fixed and no longer suitable column spacing.

It is desirable, therefore, to use long spans to give clear areas equal to the unit parking depth or an aisle plus a stall on each side, hence about sixty feet (with ninety-degree parking). This gives great flexibility in varying stall widths as vehicle widths or operating practices change. The unit depth cannot be changed if car lengths change, but this can be compensated for to a large degree by changing stall widths.

Vertical transportation facilities for patrons and for attendants must be provided in garages having more than two or three levels. In an attendant-parking garage the ideal situation is to have the flow of arrivals and departures so evenly distributed that every trip by an attendant may be two-way, storing one car and delivering another, but even under the best of conditions that rarely happens more than half or two thirds of the time.

For attendants, fire poles have been used in older garages, but the usual means today is by man-lifts, or endless belt vertical conveyors about one foot wide, having steps to stand on and handles to grip. The speed is about ninety feet a minute and the lift may be ridden in either direction.

In self-parking garages the facilities for patrons must be convenient and attractive. Pushbutton (self-service) elevators are commonly used, with escalators in some larger facilities. In either case the location should be as close to the waiting room and to the center of the storage floors as possible and the capacity ample for peak conditions.

In one large recently-constructed self-parking garage, having a concentrated discharge surge, the bottleneck has proved to be not the capacity of the ramp system or the nearby streets, but the inadequacy of the passenger elevators to handle the patrons arriving to claim their cars. Stairways should always be provided for emergency use.

Bumpers are desirable at stall ends, to prevent over-run and damage to walls and parapets. Wheel stops may be insufficient where cars are backed into stalls, because of the varying rear overhang of cars.

Ventilation is essential for enclosed and underground garages, the latter requiring extensive exhaust and intake systems and automatic devices for the detection of carbon monoxide gas. Most modern garages are of the open deck variety and need no ventilation.

Heat and light: Heat is required only for waiting rooms, rest rooms, attendants' rooms and offices in open-deck garages. Good lighting is essential in self-parking structures.

Fire protection: The extent will be prescribed by the local building code, and in a modern steel or reinforced concrete structure may be no more than portable chemical extinguishers placed as required, although some cities may require sprinkler systems and even fire walls.

Drainage and snow removal: A good drainage system is a *must* for every garage, because of the water and snow dripping from cars, and requires thorough water proofing of all floors and pitching the floors at least one-eighth inch per foot, from the center of the aisle to the rear of the stalls, where a shallow gutter should lead to drains behind or beside the columns.

In snow country where roof-parking is used, provision should be made for plowing the snow to a chute, either through the building or over the side to an alley, and into trucks.

Markings and Signs: Good stall marking is very important in self-parking garages. Visibility is inferior to that in lots, and the presence of columns, usually spaced to allow bays of three spaces, often means that any line-straddling by one car will result in a wasted space. Where the type of construction permits, the painted stall lines should be continued for several feet up the wall or parapet at the back of the stall, as a more visible guide. It has been found that a wide crosshatched line or bar, about two feet wide (as described under Design Factors earlier in this chapter), is more effective and a better guide than a single line, for floor marking.

It is also important, particularly so where self-parkers select the stall in which they park, to provide means of identification for the stall location, using stall numbers which will designate the floor, aisle and stall, even using a distinctive color for each floor. In many garages it is also necessary to indicate travel directions and the location of up and down ramps and of passenger elevators.

Communications: In attendant-parking garages it is desirable to have a means of quick communication between the ground floor control point and all storage floors, and for this an interoffice two-way system is best, with loudspeakers. In the currently operating mechanical parking garages, one is entirely automatic (with no need for communication), one uses loud speakers, and one uses electrically operated panel boards, in the cashier's office and in the elevators.

Service facilities: In many garages it is the availability of facilities for car washing and servicing which represents the profit margin, and in any garage these services are an important source of income as well as convenience for the customers. The location of the service area must be carefully planned to avoid conflict with the storage and delivery movements.

Similarly, the renting of first floor street-frontage space may be a most important producer of revenue and make the project a more attractive investment.

Waiting, rest and check rooms: In both attendant and self-parking garages an attractive waiting room should be provided, located beside and giving a clear view of the outbound reservoir space, with rest-rooms adjacent. Employees' wash rooms and lockers may be located in waste space wherever convenient.

A check room is desirable, for patrons who do not wish to leave articles in their cars, and in small garages this may be in charge of the cashier. In garages operated by or for a department store, a service very attractive to shoppers is a check room with delivery from the store of purchases by patrons.

Building codes: Many of the foregoing items such as ventilation and fire protection are specified in local municipal building codes, together with requirements as to floor loadings, screening, appearance, stairways, elevators, etc.

Operating Methods

Attendant-parking is familiar to all who park in cities over 25,000 in population, and *self-parking* (at least in parking lots) is the rule in smaller cities. The appearance of self-parking in pay facilities and even in garages in large cities in recent years has aroused considerable discussion of its pros and cons.

Self-parking: Self-parking in lots has been common practice for many years, as exemplified by the small free lots for the customers of grocery and chain stores, and more recently in the majority of municipal lots, particularly in the smaller cities. In most of these cases the land cost involved has not been high, so that space arrangements have been generous.

There was little or no question as to the acceptability of self-parking on the part of the drivers in these lots, since there was usually no charge for the privilege and they offered an easier alternative to hunting for and perhaps paying for a curb space.

Today's discussions or controversies have arisen since the large-scale introduction of self-parking in pay facilities in larger cities, which heretofore have almost traditionally been associated with attendant service, and even into high turnover facilities in the central business districts, including multideck garages.

Even there the idea is not entirely new, for there were a few self-parking garages as early as the twenties, up to ten or more levels, with tight corkscrew ramps, but they were used only by experienced and relatively intrepid drivers.

In many of the older garages, attendant-parking was practically a "must" because of their steep ramps and sharp turns and the need for two-deep (or more) parking. In more modern garages, the case for attendant-parking has been based largely upon two theories, (1) that because of the high land cost it is essential to cut down the area used per car, by "stacking them up," and (2) that attendants can handle cars much faster (in lots and garages) than the owners can.

While there is a certain amount of truth in each of these theories, the differences are not so great as they appear at first glance. There is no doubt that attendant-parking is more economical of space, but (a) "stacking" cars reduces the ease and fluidity of movement and hence involves delay to the customer, particularly on deliveries, and reduces turnover, the most important element in profit-making, (b) if sufficient reservoir space is provided to take care of the peak surges of arriving parkers, this will cancel much of the space-saving of "stacking", and (c) there is no need for stacking until a facility reaches its peak capacity without "stacking"—a condition which many garages never reach. Many garages achieve an excellent turnover without ever being completely filled.

It is also true that an attendant can stow or deliver a car faster than the average customer—but ten attendants (for example) cannot park forty cars, or deliver them, as fast as the forty drivers of those cars. And even though it may take the customer ten minutes to park while an attendant could do it in five minutes, the customer has only that one car to handle, and the stowage or delivery of other cars is affected little or none by his slowness. Also, a customer will be irritated if he has to wait ten minutes to have his car delivered, but will not notice the time if he goes for the car himself.

On the other hand, the advantages of self-parking are substantial:

1. The operating cost of a self-parking facility is only about one-fifth that of using attendants. One authority reports that the operating cost per car (in 1954) in attendant-parking garages was from twenty-four to twenty-six cents, while in self-service garages it was as low as four cents.

2. The owner may leave his car locked and know that it will not be handled by others. The danger of wear on rubber and damage to fenders is almost entirely eliminated.

3. Much less reservoir space is needed for self-parking, since there is a minimum delay at the entrance and cars may proceed as fast as they arrive. In one 1100-space garage, entirely self-parking, there was no back-up or delay observed under an arrival of 145 cars in fifteen minutes, or one for each 6.2 seconds.

4. Particularly so where there are surges in the demand for deliveries, delivery times will be more satisfactory to the customers.

In self-parking, the customer pauses at the entrance only long enough to accept a ticket, then drives on. With attendants it requires at least ten seconds for the owner to get out and the attendant to get in and away. If no attendant is ready, every following car is delayed accordingly, and when a peak flow exceeds the capacity of the attendants, a back-up quickly accumulates.

As for receipt and storage of cars, the difficulty could be obviated by the provision of a larger reservoir or of more attendants, but both procedures are usually avoided or held down because of their expense. The provision of extra attendants for an hour or two is not usually practicable, and the provision of reservoir space would take ground floor space, which usually is taken over for more profitable uses, on high-value land.

Studies at two modern department store customer garages permit some comparison of attendant-parking and self-parking:

	Attendant-parking garage	*Self-parking garage*
Capacity, spaces	516	650
Number of levels	5	6
Reservoir capacity, spaces	24	26
Number of entrances used	2	3
Number of cars parked, 8 A.M.–6 P.M.	894	991
Number of attendants serving cars	12	7
Peak accumulation, cars	371	355
Percent accumulation was of capacity	72%	55%
Peak 2-hour inbound volume	294	323
Peak 1-hour in and out volume	221	280
Average entrance delay, 2-hour period	6.8 min.	0
Maximum entrance delay, 2-hour period	21.5 min.	0
Maximum number cars in line in street	20	0
Average length of time parked	2.8 hrs.	2.2 hrs.

The two garages are quite similar in size, capacity, number of levels, the arrival pattern, the day's load, and the peak accumulation. The reservoirs are about equal, but in the attendant-operated garage, although it has six lanes, it is necessary to remove all the cars in any one lane before another can enter, while in the self-parking garage, all cars move forward with the front car.

In the example above, the inbound flow during the peak period was ten percent higher at the self-parking garage, yet there were no delays or back-ups, while at the attendant-parking facility there was an average delay of 6.8 minutes, a maximum delay of 21.5 minutes, and a street waiting line of from six to twenty cars. Yet the self-parking garage used only seven attendants as compared to twelve at the other.

It is of course not to be inferred that self-parking is appropriate for every situation. There are many lots and garages, especially older garages, where the dimensions or nature of the structure require that cars be parked two or more deep, or where narrow aisles, sharp turns, or steep and tight ramps prohibit self-parking.

An important factor influencing the decision as to the type of operation, if a facility is adaptable to either self- or attendant-parking is the nature of the probable demand, in terms of times of arrival and length-of-time-parked.

Figure VI–10 demonstrates the wide difference between the arrival patterns of the users of a long-time facility (the Battery Garage, in New York City, serving commuting office-workers) and a short-time facility (the shoppers' garage of the G. Fox department store in Hartford, Connecticut). The Battery Garage had received 67 percent of its day's load by 9 A.M.; compared to less than one percent at the Fox Garage. The average durations were seven and a half hours at the Battery Garage and two hours and eleven minutes at the Fox Garage. The Battery Garage received fifty-three percent of its day's total in one hour, the Fox Garage sixteen percent.

To handle the peak volume at the Battery Garage would require thirty-two attendants and also a forty-one-space reservoir. Under self-parking, only six attendants are used and fewer than ten reservoir spaces are needed.

Where area and dimension conditions permit, the ideal self-parking facility is probably one where the travel aisles are one-way with no parking off them, and all parking is done off transverse parking aisles, also one-way. Ninety-degree parking is preferred, but angle-parking may be used with one-way aisles. Good directional signing and marking is essential, as is the marking of stall boundaries, and the provision of a small reservoir space at the entrance. In a self-parking garage the ramps must have a gentle slope, ample width, as large radius curves as possible, and be one-way where possible. It is probable that an important part in the acceptance of ramp driving by parkers has been played by the advent of automatic transmission in cars, which has simplified their handling on slopes.

Consideration must be given to the safety and comfort of parkers in their pedestrian travel, and elevators or escalators must be provided if there are more than two levels.

Where a self-parking facility is to be of the pay type there are further desirable features. If the volume is such that one attendant can both issue and receive claim checks, the entrance and exit should be at one point, with a two-lane opening and the gatehouse and time clock within a few feet. With a large facility and heavy volume a separate exit and attendant may be desirable at peak periods.

Self-parking facilities may fall in any one of several classifications:

1. *Free and unattended:* The garage of the Hecht Company department store in Arlington, Virginia, one of the four or five largest garages in the world, provides nearly 2000 spaces free for the use of store customers. The garage abuts the store, and each level connects directly with the store. No attendants are required except during the Christmas peak.

2. *Unattended, pay:* Many municipal lots and some commercial lots are in this class. An example is the 278-space metered lot in Temple, Texas.

Other lots in this class make use of various other control devices for the collection of fees from parkers.

(a) Honor systems, under which the parker is expected to deposit the stated fee in a locked box.

(b) The entrance to the lot has a platform onto which the parker drives. Further progress is prevented by a barrier, but when a coin is deposited the platform and car are shifted a few feet to one side, permitting the car to proceed. A similar device is at the exit, requiring a second coin before the car is released.

(c) Each stall has a treadle in the ground, which, actuated by the entrance of car, starts a timing mechanism and raises the treadle in such a way as to prevent removal of the car until coins have been deposited to pay for the time consumed.

(d) The entrance to the lot is blocked by a gate or arm similar to a railroad crossing gate. The control, which may be reached from a car-window, may be actuated either by a coin or by a special metal card or token (issued to regular users). The control raises the gate, the parker drives through, and the gate, actuated by a treadle, closes behind the car. The same procedure applies on departure.

(e) A coin device at the entrance to the lot issues tickets which the parker leaves in plain sight on the front seat, locking the car. With one ticket good for a unit period, additional tickets may be used to cover as long a period as desired. Only occasional checking by an attendant is needed.

3. *Attended, pay,* with the attendants serving only to issue tickets

and collect payments and, in some large lots and garages, to direct the customers. An example is the 510-space customer garage of Zion Cooperative Mercantile Institution department store in Salt Lake City, Utah (Figure VI–6).

4. *Semi-self-parking* facilities are exemplified by the Union Square underground garage in San Francisco. In these the customer does not actually park his car, but the entrance congestion and reservoir problems are avoided by having the customer drive to a designated level before releasing his car.

Fees at self-parking facilities: Although there have been occasional parking facilities operating with attendant service where some regular customers were allowed to park themselves, there were few lots or garages prior to 1954 which gave customers a choice between attendant-parking and self-parking. The availability of such an option in a single facility, with some customers getting more service than others, makes obvious the need for a fee schedule recognizing that fact.

One of the first large facilities to offer both types of service was the 2359-space Grant Park underground garage in Chicago, which opened in September, 1954. All customers approach the same checking station, the self-parkers using one pair of lanes, and those wishing attendant service using others. The fee schedules are as follows:

Period	*Self-parking*	*Attendant-parking*
0– 1 hour	$0.40	$0.65
1– 9 hours	.15 each additional hour	.15 each additional hour
9–10 hours	.10 additional	.10 additional
11–24 hours	.05 each additional hour	.05 each additional hour

On an average weekday (Mon.-Fri.) in January, 1955, 86.7 percent of the users of this garage elected self-parking and 13.3 percent attendant-parking. Indicative of the capacity of the garage to handle large and concentrated volumes, the peak hour of arrivals on an average Saturday showed 588 self-parkers and seventy-four using the attendant service, a total of 662, or eleven a minute.

A garage in Miami, Florida, has a monthly rate of $25 for attendant service but charges only $10 per month to patrons willing to park their own cars on the top (fourth) floor.

Mechanical garages: Study of a map of the central business district of a large city, showing property valuations, will almost invariably show that the most valuable properties are those in the central core of the district, the usual location of the largest stores and office buildings. These are the generators of the heaviest parking demand, the magnets which attract great numbers of people—the fact which leads to their high valuation.

Yet this area, which has the greatest need for parking spaces, has the lowest supply of any part of the central business district. The data in Chapter II show that in the larger cities fifty percent of all parkers in the central business district are found for this core, which has only twenty-six percent of the area and twenty percent of the parking spaces. The land values here are so high that a parking lot cannot earn enough to pay its way, except as a temporary use pending its use for a new building.

A ramp garage, which can put three or four times as many cars on the same ground as a lot, requires land parcels at least 120 by 120 feet, because of the extra space required for ramps. Parcels that large often are difficult to acquire. Also, because of the driving time involved and the consequent labor cost, ramp garages have in general been limited to about five floors above ground.

The development of modern mechanical parking devices has undoubtedly been brought about by the indicated need for a means of making use of small land parcels, and for increasing the number of vehicles that could be stored per unit of ground area—and hence reducing the cost per space.

The first mechanical garages appeared many years ago, but only since 1950 have better designs shown possibilities of meeting the requirements of speed, economy and efficiency needed to meet today's heavy parking demand.

At the time this text was prepared, there were three new types or designs of mechanical garages in operation in the United States, with several others of apparent merit about the enter the field.

The Park-O-Mat in Washington, D. C., occupies a plot only twenty-five by sixty feet, and has two fixed elevators, each of which serves two stalls on each floor, one at its front and one at its rear. The customer leaves his car with wheels in guiding channels in front of an elevator, locking the car but leaving the brakes released. The single attendant remains at the ground floor control point, where he operates both elevators. By pushbutton control a car-positioner is extended from the elevator platform and raises arms which push or pull the car into the elevator. Another button closes the gates and sends the elevator to a designated floor, where the car-positioner pushes the car forward or back into an empty stall.

For efficient operation it is desirable that a Park-O-Mat installation be so located that cars being discharged may leave at the rear, or opposite the point of entrance.

This Park-O-Mat has sixty-eight stalls on the fifteen levels above ground and two levels below, and can if necessary accommodate four more cars on the ground level. The entire operation is automatic and has an elaborate system of electronic controls.

Each elevator with its stalls is an independent unit about ten feet wide by sixty feet deep, and units may be combined to fit the area available. The Washington Park-O-Mat is a reinforced concrete structure. The current cost of a Park-O-Mat, above the ground, is estimated to be more than $2,000 a stall.

A very different device is the Pigeon Hole system, of which at least thirty-six were in use or under construction in 1955. A Pigeon Hole garage is a steel framework, providing two tiers of parking bins separated by a central aisle. The Pigeon Hole garages built thus far have usually been skeleton steel structures, but ornamental facing may be added when desired for appearance or required by building codes. The stalls are about nineteen feet deep and the aisle twenty feet wide, making a unit width of about fifty-eight feet. The stalls or bins are each fifteen feet wide, holding two cars, and units may be combined as the area permits. The Harrisburg garage has four levels above ground and is twelve units (24 stalls) long, so has a nominal capacity of 240 including the ground level.

The parking bins are served by an hydraulic elevator which moves both vertically and horizontally, traveling on rails along the central aisle. The elevator carries a cantilever type of dolly that lifts the car and moves it forward or backward into a bin, or vice-versa. The customer leaves his car in any one of several entrance stalls on the ground floor, locking it and setting the brakes. The elevator and dolly are controlled by an operator, who rides the elevator. Although the frontage required for the Pigeon Hole is only fifty-eight to sixty feet, it is necessary that either the structure be on a corner parcel, that one side be adjacent to a curb, or that extra space be provided for approach to the entrance stalls.

A recent installation of a 240-space Pigeon Hole cost about $1,190 a stall for the structure and mechanism and about $155 per stall for decorative facing on the front.

The Bowser system is structurally similar to the Pigeon Hole, with two tiers of bins, a central aisle and a two-direction elevator. The structure is enclosed, the elevator is suspended from above, and no dolly is used. Standard, electrically-operated elevator equipment is used, and cars are driven on and off the elevator by the attendant, who operates the elevator by push-button controls reached through the car window.

The fact that no dolly is used permits parking cars two-deep on either or both sides of the elevator. This slows delivery times when extra depth is used. This extra width of the structure allows space on the ground level for an aisle parallel to the elevator shaft through which cars may enter from the front of the garage and turn into an entrance stall.

Another feature of this system is that elevators are counterweighted so if power fails, the elevator will rise until stopped at any floor by manual controls; with the weight of a car added, the elevator will descend by gravity. The system has an electric signal system for indicating empty stalls, keeping track of the location of cars, and calling for desired cars. There were fourteen or more Bowser installations in operation or under construction in 1955, and construction costs were reported to be from $1400 to $2000 a stall.

In either the Pigeon Hole or the Bowser systems, a number of elevators may be used, depending upon the capacity, each serving a section of the structure, with some overlap possible in case of a breakdown of one. It has been reported that a Pigeon Hole garage to be constructed in San Francisco is to have nine elevators and 900 spaces.

Mechanical garages vs. ramp garages: Well-designed ramp garages have been widely accepted. Their outstanding advantages are that, when properly staffed, they can offer very rapid acceptance and delivery of cars, and that they are adaptable to self-parking. Some of their less desirable features are that they may be under-staffed and hence slow in service, that there is danger of damage to cars from careless handling, that the labor cost is high, that they are not adaptable to small land parcels, and that their height and hence their capacity is restricted.

Mechanical garages may be erected on very small parcels of land, with frontages of sixty feet or less, and have great flexibility in depth. They may be built to much greater height than ramps, and so may achieve a much higher capacity per unit area of land. Because of this, they may be located on high-value parcels.

In some of them there is no driving by attendants, eliminating the damage factor and making it possible for the customer to lock his car and keep the keys. They require a very much smaller labor force, hence have a lower operating-labor cost than ramp garages. At least one type is prefabricated, so may be dismantled and moved if desirable.

The mechanical garages also have some disadvantages. Some of them have a high first cost and must have heavy patronage at relatively high prices, restricting the locations where they may be used. All the mechanical systems claim an average delivery time of about one minute. Those observed have not achieved this, but there is no doubt that single storages and deliveries are much more rapid than in ramps. Their operation, however, is intermittent, in that each cycle must be completed before another can begin. The handling operation for any one elevator cannot overlap, as they can in a ramp, and each car must be disposed of before another can be cared for, although a receipt and a delivery can overlap partially.

The service which a garage can give is not measured in individual delivery times, but in the number of cars handled an hour. Thus even though an elevator can deliver a single car in a minute and a half, it cannot deliver more than forty an hour. Ramp garage deliveries may take four or five minutes each, but the delivery rate per hour is limited only by the number of attendants or drivers. A reasonable conclusion is that if it is to meet concentrated demands, a mechanical garage should not require one elevator to serve more than perhaps eighty stalls.

Another disadvantage of mechanical garages is that the intermittent type of operation indicates a need for ample reservoir space at the reception point, while the provision of such space at ground level is hardly likely when the location is a small parcel in a high-value area. Also, the use of a reservoir requires that the cars be driven by attendants, increasing the cost, and that the cars be left unlocked.

There is no intent here to minimize the value of mechanical garages, and it is believed that their use will spread rapidly. Their advantages have been recognized and the manufacturers are constantly making improvements. Ramp garages and mechanical garages are competitive in some locations, but it also is true that there are locations or conditions favorable to each and unfavorable to the other.

A publication on "Parking in the Air with Structural Steel," published in August, 1955 by the American Institute of Steel Construction, proclaims the advantages of constructing garages as open steel frame structures.

Until very recently, most building codes have required that steel frames be fully enclosed by concrete. Where that is not required and a minimum of screening is called for, a considerable reduction in costs is possible, as evidenced by the following reports:

1. In Omaha, Nebraska, a three-level 200-space steel frame deck with exposed steel members and reinforced concrete slab floors, cost $930 a stall (exclusive of land).

2. In Greensboro, North Carolina, a staggered-level ramp garage was erected for $535 per stall, the steel erection taking only thirteen days and the entire job only thirteen weeks.

3. In Savannah, Georgia, a 367-space exposed steel frame staggered-level garage, having steel beams at 8-foot centers and 4-inch concrete slab decks, cost only $582 a space.

Costs of parking garages: The *Engineering News-Record* in 1955[2] published a most comprehensive listing of recently-constructed garages, from which the following summary has been made:

Table IX–1

COMPARATIVE DATA ON GARAGES BUILT IN 1954–55

(*Construction Cost Only*)

		Ramp garages			
		Walled-in	*Open-deck*	*Underground*	*Mechanical*
No. structures reported		7	25	2	5
No. stalls	min.	350	172	890	240
	max.	800	1230	2359	715
	avg.	461	636	1624	487
No. levels	min.	4	2	2	5
	max.	7	12	6	14
	avg.	4.7	5	4	10
Floor area per stall, sq. ft.					
	min.	193	225	373	232
	max.	469	400	373	362
	avg.	334	307	373	311
Land area per stall, sq. ft.					
	min.	41.7	31.5	53.9	29.4
	max.	238	183	136	70
	avg.	93.4	73.5	114	35.8
Cost per sq. ft.	min.	$3.35	$2.59	$9.42	$6.31
	max.	6.29	9.99	10.57	7.43
	avg.	5.21	4.69	9.99	6.67
Construction cost per stall					
	min.	$1111	$693	$3518	$1458
	max.	2740	2821	3932	2317
	avg.	1775	1435	3632	2156

The Carport, Inc. garage in Oklahoma City, Oklahoma, built in five months in 1954, uses attendant-parking and has a capacity of 675 by parking two-deep in certain aisles. The reported construction cost was $800 per space, one factor in the low cost being the use of expanded steel plate mesh, in sheets eight feet by sixteen feet, as reinforcement. The floor slabs are cantilevered and taper from nine and a half inches at the center to three inches at the edge.

In the review of the costs of any lot or garage it should be borne in mind that the reported cost per stall is derived by dividing the total cost by the number of stalls, and that the number of stalls may not be firm or entirely reliable.

[2] Reprinted from *Engineering News-Record*, Copyright 1955, McGraw-Hill Publishing Co.

One large modern garage reports a construction cost of $2,000,000 and a capacity of 1200 spaces, or a per space cost of $1667, while an actual count indicates a maximum capacity of about 1000, making a cost of $2,000 per space. Similarly, construction costs may be reported on the basis of the estimated capacity based on attendant-parking, while the actual use may be with self-parking, which may permit a capacity only seventy percent as large.

CHAPTER TEN

GARAGE CRITERIA

In smaller cities and towns, parking *lots* can accommodate current parking needs. Larger cities increase the capacity with multi-level garages. Some cities have too little suitable space in downtown areas for adequate off-street parking lots. In high land cost areas where parking is essential, the facilities are financially successful only with multi-level garages.

The first garages were built in the 1920's, some continue to provide parking though many have been converted to other uses.

Practically all earliest parking garages were fully-enclosed, above-ground with ramps or elevators. They had solid walls, lighted and heated. Their exteriors were in keeping with the design of nearby properties.

As a group they made a poor financial showing. The best contribution was in the object lesson.

There were other reasons for the failures. Many earlier garages were poorly situated for present traffic needs. They were constructed without regard for efficient space-use, and were designed to accommodate cars of dimensions and operating characteristics different from those of subsequent years. The ratio of storage capacity to space in the older structures declined steadily. Operating costs remained *reasonably* constant. As parking capacity diminished, it became necessary to increase parking rates to meet costs. As rates increased, parker resistance grew and some were converted to other uses. The early failures undoubtedly retarded new construction.

Location is the most important factor in successful garage building and operation. Siting a parking garage requires that careful consideration be given to the amount and type of service it should provide, estimated revenues, return on the investment, type of operation, and estimated parking demand. Any site, because it is in a congested area, may not support a parking structure. In the

Editor's Note—**Both Chapters IX and X deal with garages.**

past, some well-built and well-managed garages have operated at a loss, while others no better built have prospered.

Location principally determines whether a parking facility will attract drivers; next, efficiency of operation. And that depends on management, layout, and the ease with which cars can enter and leave the garage.

The parking survey methods discussed in Chapter III evaluate parking demand and yield important information on location. With that information, parking demand centers can be spotted—and available land parcels rated for value as parking sites.

Features of land that best suit development of a ramped parking garage are:

1. Rectangular shape.
2. Minimum dimensions approximately 120 x 120 feet.
3. Direct access on two or more streets.
4. Location on or within one short block of major feeder street.
5. Location on side of the central business district from which most parkers approach.
6. Oriented to the main traffic flows so most parkers can enter and leave by making right-hand turns into and out of the facility.

Physical design is important. It affects both the economy of construction and the efficiency of operation. The functional value of the open-deck ramp-type has made it popular. With self-parking, this structure has four or five levels. Drivers are reluctant to drive higher. With attendant parking, open-deck garages are built with more levels.

Basically, each level of a parking structure is a parking lot with means added for floor-to-floor travel. The choice in multi-level garages lies in the means for inter-floor travel. Elevators and ramps vary in type, cost, arrangement, reliability, capacity, and speed. In any structure, the type selected should give maximum capacity in turnover, low cost, and customer-satisfaction.

The underground parking garage is growing in favor. The successful example of San Francisco's Union Square Garage is one reason. Built in 1942, it has exceeded expectations and was the forerunner of a number of sub-surface parking facilities.

Traffic Characteristics

Successful garages have designs developed with attention to traffic operations peculiar to a parking structure: entrance, storage, delivery, and exit. Entrance includes entering of the car, the checking procedure, and the change of drivers. Storage includes travel of incoming cars from entrance to parking space and the parking maneuver, unparking, and travel to an exit. "Exit" is the car's movement in entering the traffic stream.

Proper design can facilitate all steps. Poor design invites failure. Character and dimensions of design features as they affect the movement of cars and drivers are discussed later. They are summarized on page 161.

Parking Demand: A problem is reliable determination of patronage. The method frequently employed is to analyze parking needs and habits through a survey. Studies give information on the location and extent of potential parking demand. Other important information can be obtained through analysis of parking garages—on the rate of inbound and outbound movements, peak hours, parking durations, facilities and variations in parking needs by day, month, and season.

The peak occurs during the Christmas shopping period. The remainder of the annual cycle ranges from the low point during mid-winter (usually February) to a secondary peak in late spring (usually April). Early spring (March), mid-summer (June), and early fall (September) are average seasons. Variation of activities by seasons and months is illustrated in Figure X–1.[1]

Differences in climate, metropolitan activities, type of patronage and other local variables will cause some departure from the pattern shown.

Within the variations of parking need, there is a shorter need cycle on different days of the week. Within short periods of the seasonal and monthly cycle, daily variations repeat themselves from week to week.

Sunday is the low parking-demand day, Saturday the high. For the remainder of the week, demand is uniform. Some garages

[1] Adapted from *Traffic Design of Parking Garages*, E. R. Ricker. The Eno Foundation for Highway Traffic Control, Inc., 1957.

reflect local activities such as week-day shopping nights. The weekly pattern for a large customer-parking garage averaged over three months is shown in Figure X–1.

The weekly pattern is valuable in estimating probable revenue of a new facility as well as determining work schedules.

To the garage operator, the most significant parking demand variations are the daily ones. These are sensitive to local conditions and difficult to predict. Two of the ways to chart this information are shown in Figures X–2 and X–3. From these types of charts, the time of occurrence and extent of peak flows can be evaluated. The level of activity at different hours can be judged by total movements. The accumulation curve indicates the use.

Daily variations in parking demand can be charted by arrival and times parked. See Figure X–4. This series of bar-graphs measures garage patronage by arrival time but is not as easy to interpret as the facility-use chart. The group of bar-graphs represents one-hour differences in length of time parked—the percentage of inbound movements during each half-hour. Figures in the right-hand margin show the percentage for each hourly change.

The three illustrations, Figures X–2–3–4, show an important characteristic of garage operation—the extent and time of peak flows. Information on average flows would help if parker-arrivals took place at a uniform rate. But studies show that garage traffic changes sharply. Parkers arrive in short-peak periods and leave in shorter, more sharply accentuated peaks. To retain patronage, the garage operator should take care of peak movements *promptly.* Slow operations drive patrons away and the dissatisfied parker neither knows, nor particularly cares, what conditions the sluggish operation. He seeks another facility where the operation suits him.

Figure X–5 shows a mid-week-day's movements in a garage. The peak accumulation occurred between 1:30 and 2:30 P.M. This coincides generally with the peak accumulation in a downtown district.

Figure X–5 shows inbound movement in mid-morning—shoppers arriving downtown. The outbound peak is in the late afternoon. The inbound movement is neither as concentrated nor as

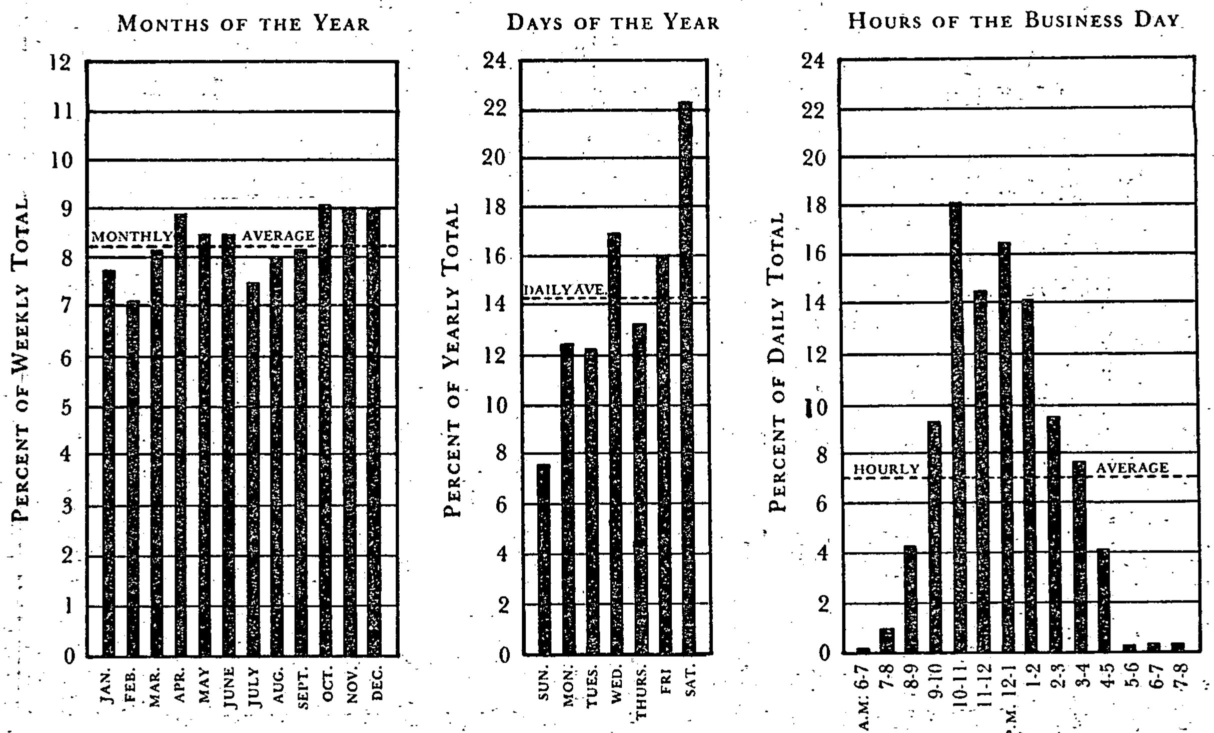


FIGURE X-1. Variation in Parking Garage Use.

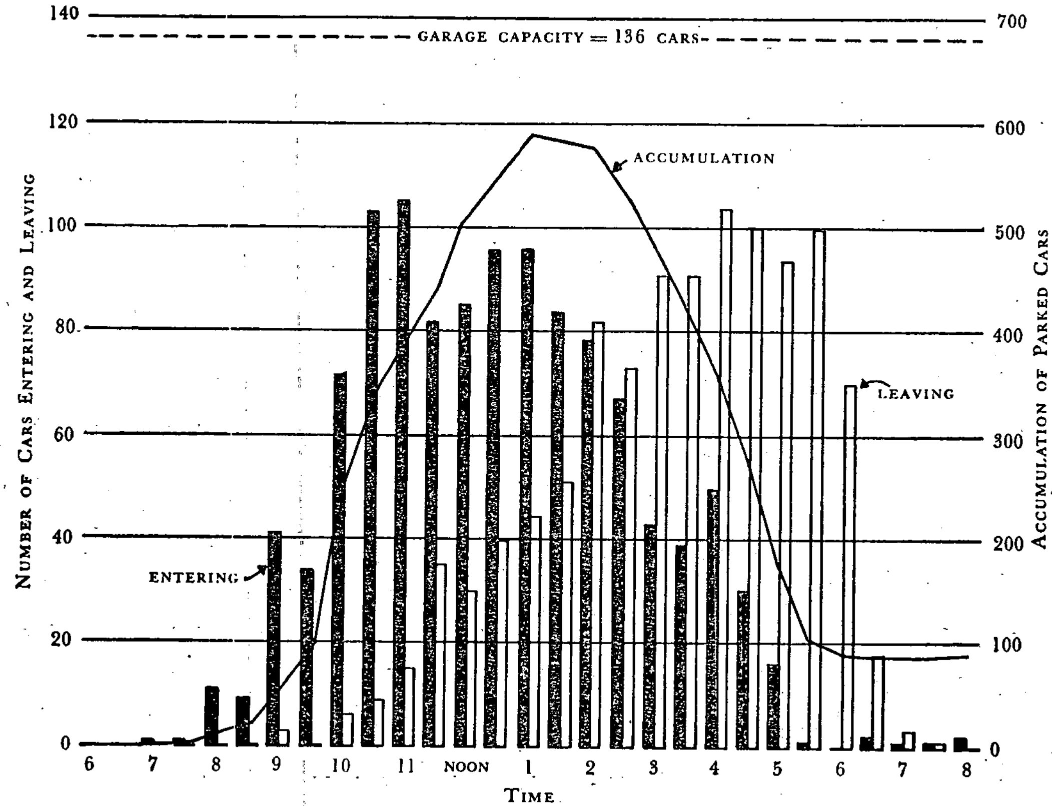


FIGURE X-2. Accumulation of Parked Cars.

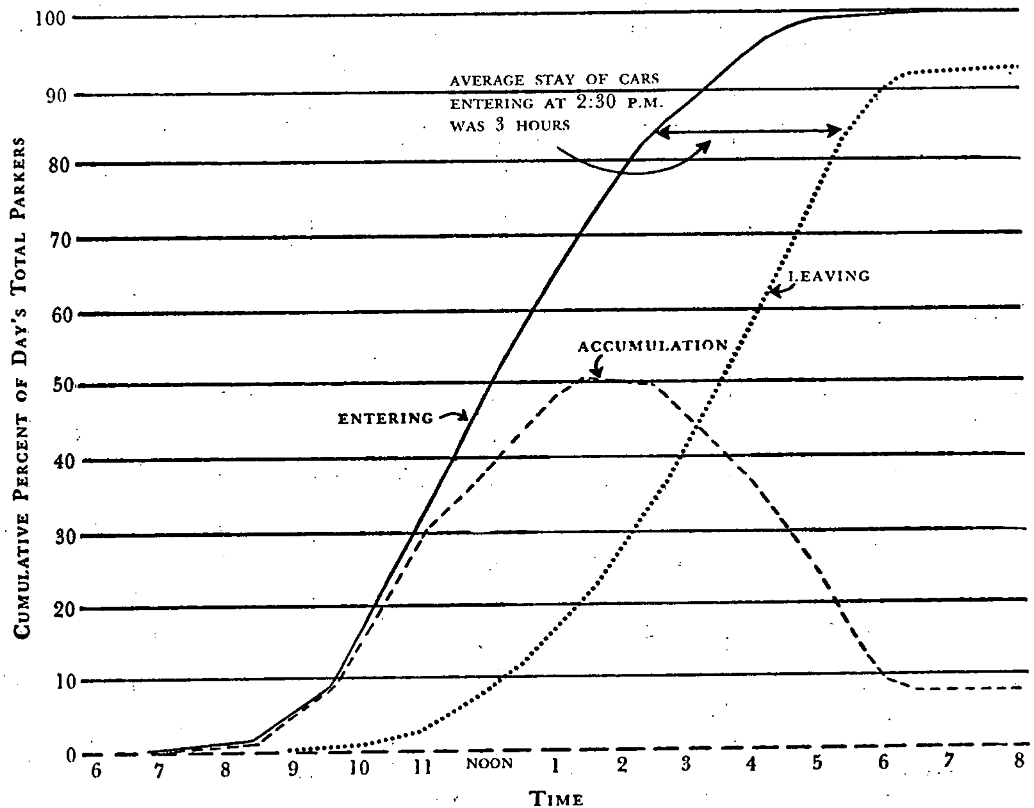


FIGURE X-3. Arrival and Duration.

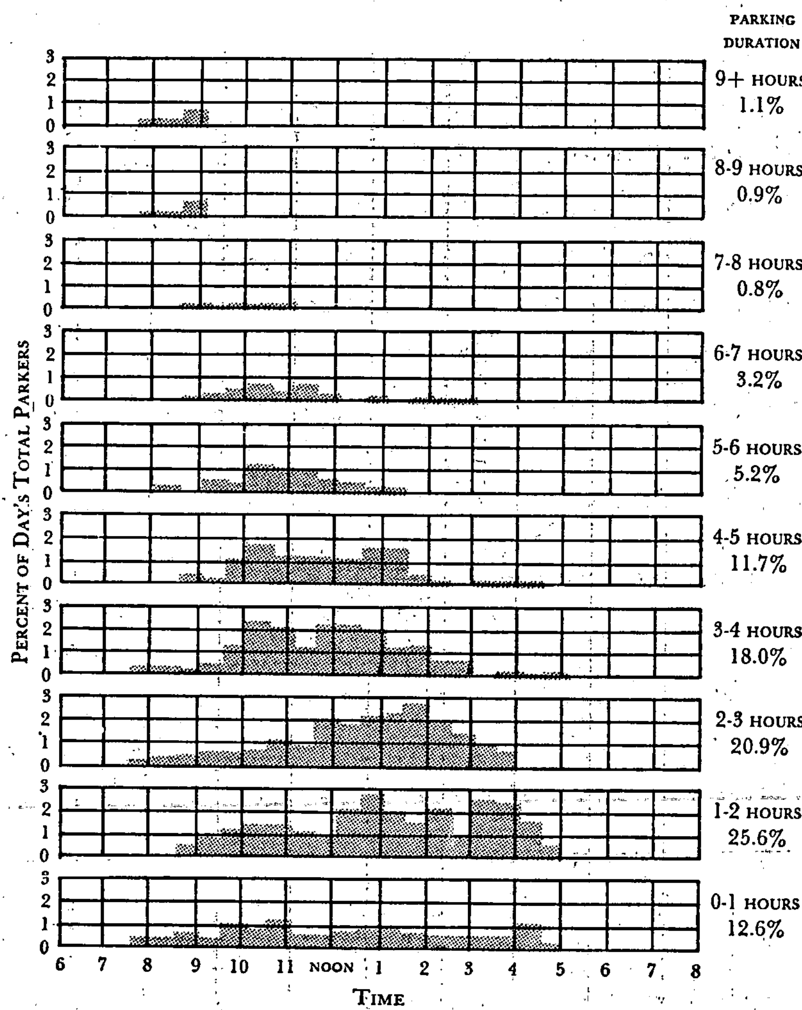
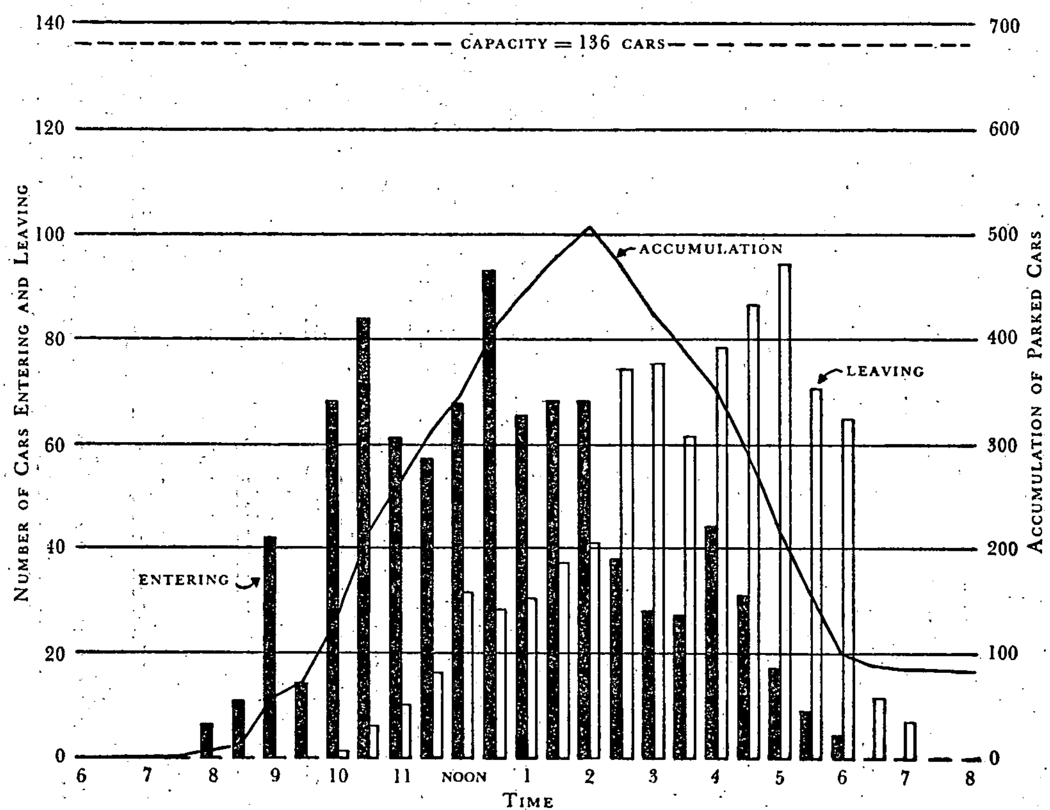


FIGURE X-4. Daily variations in parking demand can be charted by times of arrival and length of time parked.



FIGUNE X-5. Mid-week-day's movements in a typical parking garage.

consistent as the outbound. It often lasts into the early afternoon while the outbound movement peak builds up quickly in the late afternoon and quickly declines by 6:00 P.M.

Figure X–4 shows a graphic analysis of parker-arrival times and the duration of parking. The long-time parker, arriving earliest, is a small part of the parkers. Arrival times of the short-time parker are spread over a greater part of the day. Short-time parkers (three hours or less) represent almost two-thirds.

Garages develop patterns of inbound and outbound movements by their location. An example is the garage situated near the central business district's theater area. During the day, it has the familiar inbound and outbound peaks and accumulation curv eof the garage patronized by downtown workers, visitors, and shoppers. In addition, it enjoys a secondary inbound peak and upswing of accumulation as the evening theater-goers arrive. The operational graph of one such garage is shown in Figure X–6. The theater rush inbound takes place from 8 and 8:30 P.M.; the outbound movement between 11 and 11:30 P.M. The product of the two movements is represented by a corresponding hump in the accumulation curve.

A conditions that varies the normal pattern of garage operation is the late opening or closing of stores. This is illustrated in Figure X–7. Most stores in the vicinity of that garage open and close later on Wednesday than on the other days of the week. The morning inbound movements build up more gradually, over a longer period, and reach a daytime peak two or three hours later than normally. A second greater inbound peak develops as evening shoppers park between 6:30 and 7:30 P.M. There is a moderate outbound flow in the late afternoon. But the real outbound peak takes place between 8:30 and 9:30 P.M., before and after the stores close.

Demand for Delivery of Cars: The garage operator is interested in the rate of inbound and outbound movement. It represents revenue. The degree to which he can meet both demands is important to the success of his operation. The foregoing charts of garage operation give an indication of delivery demand, though they are usually developed to present a picture of total patronage and arrival rates.

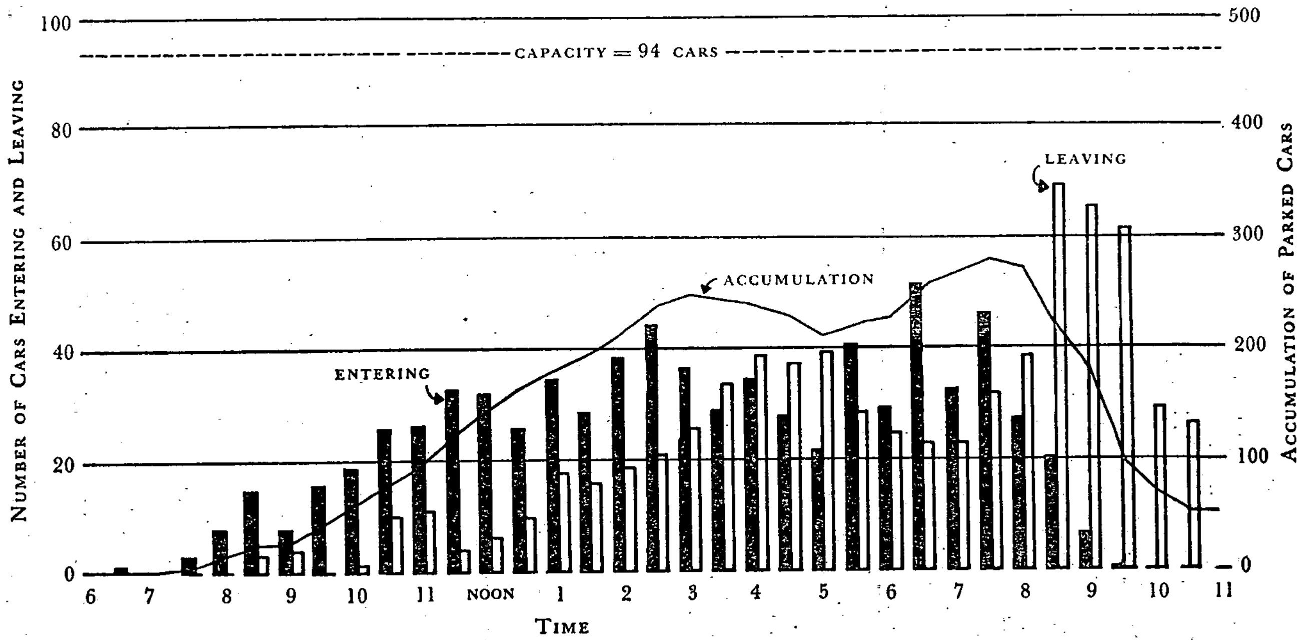


FIGURE X-6. Garage in Theatre Area near business district.

The principal function of a garage's main floor is acceptance and delivery of cars. Usually the main floor is at ground level. Occasionally it will be one story above or below. The street-level is often used for store space. As logical as this seems, its financial advantages do not always offset operational disadvantages. When the acceptance area is not at the ground level, drivers often stop on the ramp and return by elevator or stairs.

Design of Main Floor

The reservoir area is actually a facility area and temporary storage space—between the cashier's office and the ramps. This space serves the important function of absorbing peak inbound flows that enter the garage at a higher rate than can be sorted. The number of attendants, the time needed to park cars, and the size of the reservoir are closely related. Their important effect on each other is discussed.

In customer-parking garages cars go directly to storage floors. Main floor delays are negligible. The reservoir can be used at peak and rush hour operations.

The main floor contains the cashier's booth. The booth, small as practicable, should be used only to issue parking tickets and collect fees. Bookkeeping and personnel administration should be housed in less valuable space. In a busy garage, the cashier should not check packages. This can be done with lockers.

A customer facility on the main floor should be an attractive waiting room near the outbound delivery point. It should have a public telephone. Public rest rooms should be provided nearby.

Other main floor features are manager's office, service and repair facilities, check room, and sales room. The extent of these features varies from garage to garage depending on types of service and patronage.

Entrances and Exits: Garage entrances should conform to local curb-cut requirements. By location and number they should provide safe, convenient connection with the street as required by local regulation. They should be attractive to parkers.

Entrances and exits should be as far as possible from street intersections. The slow movement of entering and leaving a

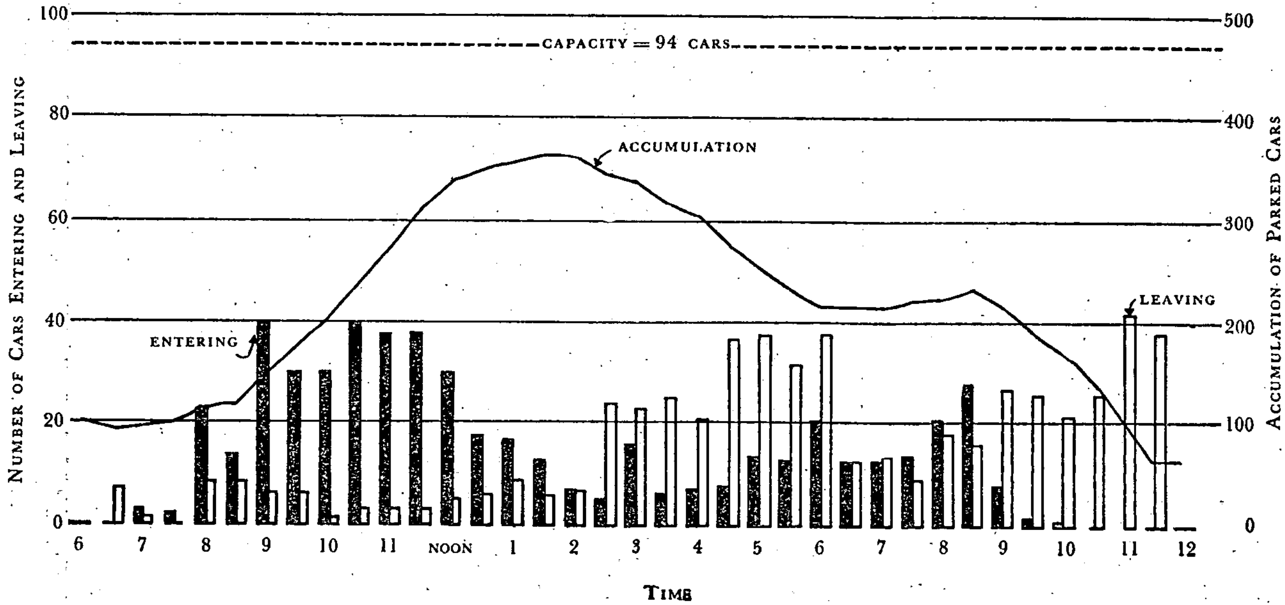


FIGURE X-7. Late Opening and Closing Stores.

garage should not add to the normal congestion of intersections. Special attention should be given to the street system that will serve it and the traffic flows affected. It will be profitable to have the advice of counsel from the local traffic authority in preliminary planning of garage openings.

Entrances and exits should embody principles of intersection design. Cars should enter and leave the garage at right angles to street traffic lanes. They should diverge from and merge with street traffic at a relatively low speed. Entrances and exits should admit cars easily without danger of collision. Double or triple lane entrances are most desirable. Lanes should be at least twelve feet wide. Exits should have ample sight distance at sidewalk crossings.

Reservoir Space: The reservoir is space at the entrance and exit for acceptance and delivery of cars. Lack of sufficient inbound reservoir space creates "back-up" into the street, causing congestion and the need to turn away potential parkers. In attendant-operated parking facilities, cars are usually checked in at the inbound reservoir area and later moved to stalls. There are no general rules for the reservoir space required. Seven to ten spaces for hundred-car capacity has been suggested; also that "ten or twelve car spaces are adequate for *any* size garage." Neither is entirely correct, as reservoir space requirements are based on movement rates that vary considerably among garages. A garage serving short-time parkers who arrive in peak movements will require more reservoir than another of the same capacity which serves long-time parkers who arrive in evenly distributed flows.

For satisfactory garage operation, the rate of storage should equal, or exceed, the rate of car arrival. To meet these conditions, the size of reservoir space can be determined by equating several known or assumed traffic-operating values. These are rate of arrival of cars during peak parking periods, the average time for parking a car, and number of attendants.

Studies of car arrivals indicate that the probability with which a given number of cars will arrive in excess of the average rate may be estimated with reasonable accuracy by application of Poisson's Theory of Probability. Applying this, it is possible to compute the size and occurrence of short surges of parking demand. The difference between those short surges and the average arrival rate is equal to the amount of reservoir space needed. The formula,

$$X = 2.4\sqrt{A}$$

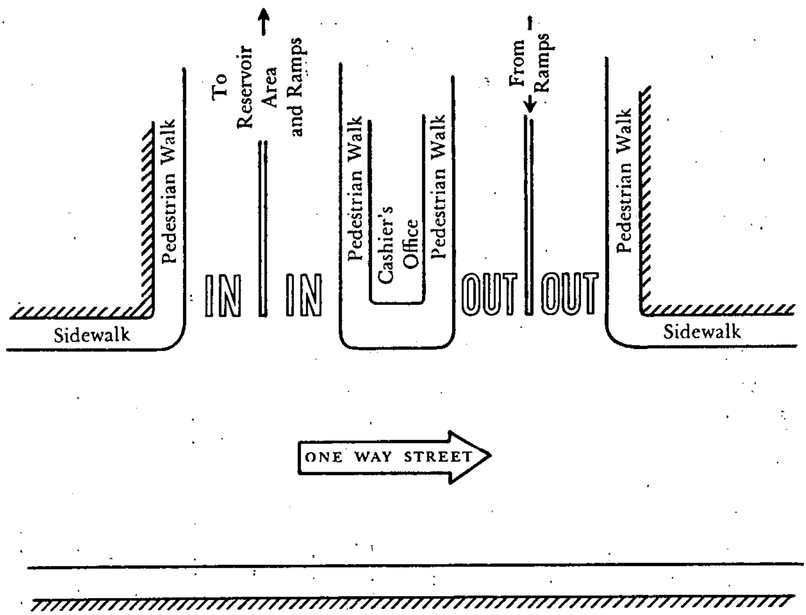


FIGURE X-8. One-Way Street Design.

gives an approximation of the number of arrivals at one time that will not be exceeded 99 per cent of the time.[2] X equals the number of cars that will arrive in excess of the average. A is the average rate of arrival in cars an hour. The resulting value of X is the reservoir capacity needed when the average rate of parking equals the average rate of arrivals. Figure X–9 shows the relationship of reservoir capacity to average number of cars arriving during the peak hour when the rate of parking them is less than, equal to or greater than the average rate of arrival.

[2] For development of formula see Ricker, E. R., *Time Motion Relationship in Operation of Garages*, Highway Research Bulletin No. 19, July 1949, page 14.

The average time required for an attendant to park one car and return to the reservoir area for another is the rate of storage of rate of parking. It can be computed from the formula,

$$P = \frac{60N}{T}$$

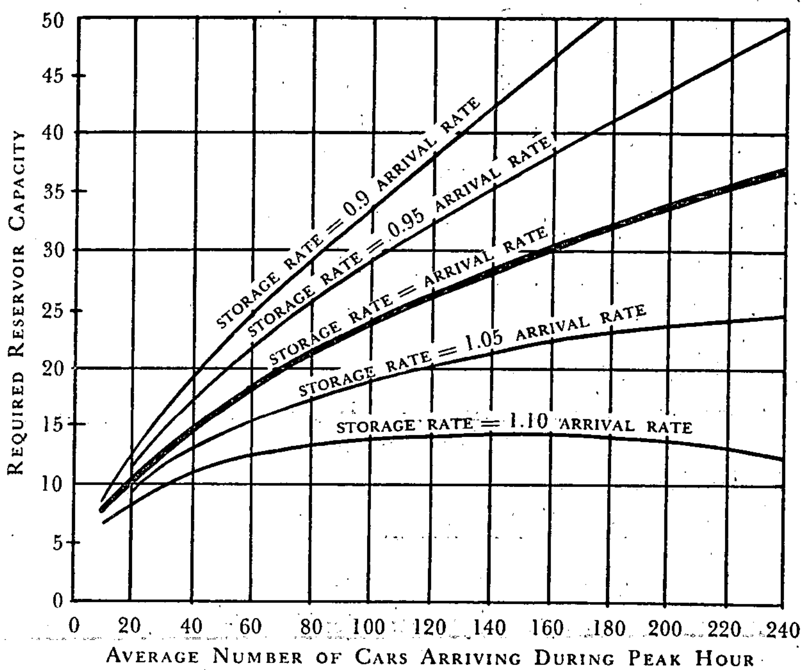


FIGURE X-9. Reservoir Space.

P is the parking rate in cars an hour. N is the number of attendants. And T is the average time in minutes required by an attendant to park a car and return to the reservoir area for another.

The best physical arrangement of reservoir space is in the form of lanes leading from the entrance to the ramp. As cars come into the garage, they are directed into successive lanes. Drivers are asked to drive into the garage as far as possible, thus filling the reservoir area one lane at a time. After cars are ticketed, they are moved out of the reservoir area to storage floors in order of arrival, one lane at a time, where several lanes are used.

Appearance of the reservoir area in an attendant-operated garage is important. It, the cashier's booth, and the waiting room are the only parts of the garage that customers see. The reservoir lanes should be kept well-cleaned and properly lighted. They should also provide adequate space for safe pedestrian movement.

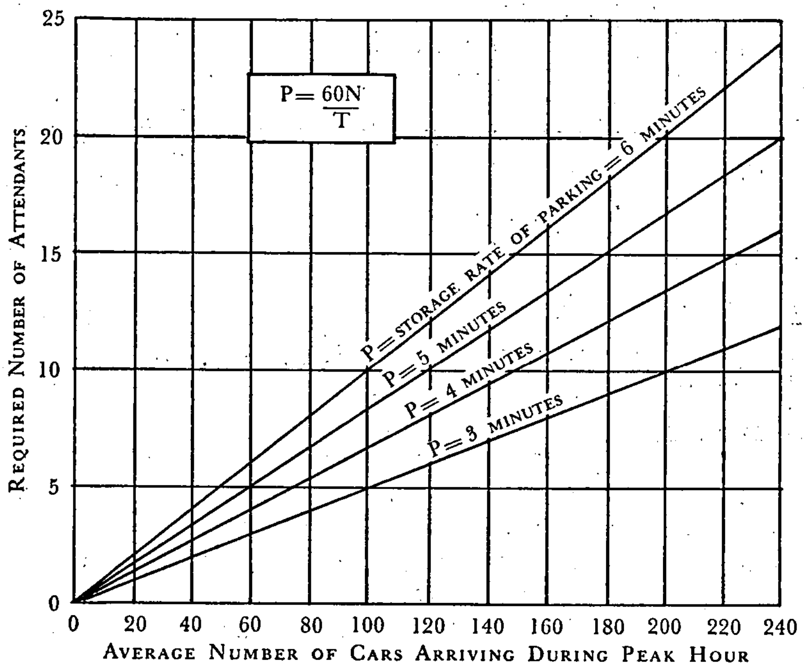


FIGURE X-10. Storage Rate.

Width of reservoir lanes should be enough to permit customers to get out of their cars comfortably and without danger from moving cars in the adjacent lane. Twelve-foot lanes are recommended. White-painted walkways will serve the dual purpose of directing pedestrians along the safest path and adding to the well-kept appearance.

A small number of neat, legible, concise signs in the reservoir area will facilitate entrance operations. At least three messages should be shown:

1. Direct drivers to go into the garage as far as possible.

2. Direct drivers to turn off the ignition and leave the keys in the car.

3. Complete schedule of the parking rates.

Outbound reservoir space is needed for delivery of cars and for loading drivers, passengers, and packages. The outbound reservoir need not be as large as the inbound one, but it should have at least two twelve-foot lanes to permit passing so that one slow-loading customer will not block all outbound operations. Two exit lanes also permit a left-turning and a right-turning car to take advantage of the same gap in traffic in leaving the garage. Part of the inbound reservoir space is often used for peak outbound movements.

Ramp Location: Most efficient main floor operations are achieved if the ramps or other means of interfloor travel feed directly from the reservoir area. This arrangement saves difficult and time-consuming movements that decrease the rate of receiving customers.

Where shape of the land parcel will permit, the ramps should be as far as possible from the main entrance to increase the effectiveness of reservoir area. However, shape of the land parcel as well as ramp requirements should be taken into consideration. Often they make it necessary to locate ramps in other than the most ideal spot. The important considerations in placing ramps from the main floor, in order of their importance, are:

1. Oriented to lead directly from the reservoir area.

2. Located so their termination on storage floors will permit efficient parking and travel arrangement.

3. Far from main entrance to permit development of maximum reservoir facilities.

Pedestrian Paths: In attendant-operated garages, pedestrian movement is a problem on the main floor only. Customers walk from the reservoir area to the exit after leaving their cars for parking. On their return, they walk from the pedestrian entrance (often a raised walk along the vehicle entrance) to the cashier's office and then to the delivery point outside the cashier's booth. Additional pedestrian safety can be gained if the point at which returning customers should enter is clearly marked on the outside of the parking structure. It will also guard against unnecessary and dangerous foot traffic in the garage service lanes.

Layout of Storage Floors

The car stall and access aisle are basic design units in storage floors. Structural columns add complication. Optimum operation requires that floors be planned to yield the greatest number of parking spaces with least interference and restriction to car movements. Maximum practical capacity requires careful design of stalls and aisles balanced with an equal amount of attention to freedom of movement.

Each stall is usually marked by paint lines on the floor or walls, a low dividing bumper, or by its location between supporting columns. Car stalls are arranged on either side of a parking aisle, usually at right angles to it. Often a single row of car stalls is on either side of an aisle so all cars have direct accessibility to it. Occasionally stalls are arranged in double rows for greater capacity.

Stall Dimensions and Parking Angle: Parking stall length is determined only by the length of cars that will use it. Parking stall width is determined by width of car and the extra space required for cars to turn into the stall as well as that required to get into and out of the car. (See Chapter VI, page 135 for critical dimensions in parking lot layout).

A stall length of eighteen feet will accommodate more than ninety-five percent of all cars. There are a few models that exceed that length but it would be uneconomical to design for extreme models.

Most cars do not exceed six and one half feet in width; they can move in and out of stalls with a one-foot clearance on each side. That would indicate that a seven and one-half stall width might do. However, an eight-foot minimum width is more effective and should be used in attendant-parking garage design.

In self-parking garages, a more generous stall width (eight and one-half foot width recommended) will produce faster and safer parking. It will also avoid customer dissatisfaction from having to struggle through narrow door openings.

Between-car space limitations are somewhat less critical in attendant-operated parking facilities. Attendants are usually adept at parking and getting in and out of cars. In that type of operation, an eight-foot stall width should be used. It is slightly greater than the minimum needed but it will allow for speedier operations and for some further increases in car body widths.

Because it is the most economical of space, ninety-degree parking is practically the only scheme used in garages. See Table X–2. Ninety degrees back-in parking is used in attendant operated parking facilities because of the smaller aisle and narrower stall it requires. Ninety-degree drive-in parking is used in self-parking operations because the average driver has difficulty backing into restricted spaces. They do not have the same difficulty driving into restricted spaces. They do not have the same difficulty in performing the backing maneuver required to unpark from a drive-in stall.

Other advantages that make ninety-degree parking the most used in garage facilities are:

1. Rectangular stalls can be better fitted into buildings between their supporting columns and into corners.
2. Access aisles can be used for two-way movement. Cars can be unparked to the right or left and reach the exit ramp by the shortest, most direct route.
3. Dead-end aisles can be employed to gain the best use of space. The two-way aisles associated with ninety-degree parking allow entrance and exit to dead-end aisles.
4. Stall marking is more easily designed and maintained.

Aisles: Aisle dimensions and layout depend on the direction and angle of parking. The forward minimum turning radii (either left or right) of cars is an important factor in establishing aisle dimensions. The minimum turning radius is less for backward movements than for forward movements. Back-in parking is not convenient so the greater of the two forward turning radii are used in developing suitable aisle dimensions. Thus the recommended dimensions serve back-in parking facilities and have a built-in factor of safety.

Stall and aisle dimensions vary with angle of parking. See Chapter VIII. The following information in Table X–1 is recommended as suitable for stall layouts.

Table X–1

SUGGESTED DIMENSIONS FOR LAYOUT OF PARKING GARAGE STORAGE FLOORS

Stall Width	*Parking Angle*	*Type of Parking*	*Aisle Width*	*Perp. Depth of Stalls*	*Parallel Width of Stalls*	*Unit Parking Depth*	*Area per Car*
	Degrees						
8′0″	30	Drive-in	12′6″	15′1″	16′0″	42′8″	341.6
8′0″	45	Drive-in	12′6″	18′0″	11′4″	48′6″	274.4
8′0″	60	Drive-in	21′0″	19′8″	9′3″	60′5″	278.4
8′0″	90	Drive-in	25′0″	19′0″	8′0″	63′0″	252.0
8′0″	90	Back-in	22′0″	19′0″	8′0″	60′0″	240.0
8′6″	30	Drive-in	12′6″	15′1″	17′0″	42′8″	363.0
8′6″	45	Drive-in	12′6″	18′0″	12′0″	48′6″	292.0
8′6″	60	Drive-in	20′0″	19′8″	9′10″	59′5″	292.0
8′6″	90	Drive-in	24′0″	19′0″	8′6″	62′0″	263.5
8′6″	90	Back-in	22′0″	19′0″	8′6″	60′0″	255.0

The ninety-degree parking dimensions given in the above table are the most significant. They permit shallower stalls, narrower aisles, the greatest number of car spaces for each 100 feet of aisle. The values for angled parking stalls are useful when dimensions of the storage floor cannot be a multiple of the ninety-degree unit parking depth and an extra row of angles stalls is all that can be developed in the storage floor area that remains.

Floor Markings: Parking stalls are usually marked by paint stripes, four to six inches wide, on the floor, or high on the wall in the same width. Another effective method of marking stalls is to paint the entire between-cars space. This aids the driver in parking in the center of his stall and adds speed and safety in garage operations.

As an economy, stall markings need not be as long as the design dimension of the stall. A fifteen-foot marking will usually be sufficient for an eighteen-foot stall, and may provide a twenty percent saving in paint.

In interfloor travel, usually by elevator or ramp, most garages have ramps. Many elevator parking devices are available. It is claimed they make efficient use of space. It is not the purpose here to make comparisons.

Interfloor Travel

They can be developed on land parcels too small for ramp garages or in higher multi-level garages because of their faster rate of vertical travel. Because they require fewer attendants, all but the smallest of mechanical garages can be operated more economically than ramp garages of comparable capacity.

In the earliest mechanical garages, elevators were used only to transport cars between the main and storage floors. In more recently developed types, the entire parking operation is handled by elevators that can move vertically and horizontally, or vertically and diagonally. In the newer, completely automatic type, power dollies move the car from the entering lane onto the elevator and into parking cubicles.

The main disadvantage of elevator parking is their slower rate of handling cars. Ramp garages provide practically continuous movement of cars. If there are sufficient attendants, cars can be operated on ramps almost bumper-to-bumper.

The ramped, open-deck form of parking garage design evolved from the financial failure of the early, ornate garage. It is a structural design that retains many of the operational advantages of parking lots and combines them with the added capacity of multiple levels.

Open-deck construction refers to a multi-level parking structure without side walls. Cars are stored on each of several decks or levels, including the top one that would be the roof of an ordinary building. This type of garage is basically a stack of parking lots, one above the other, with a low retaining wall or railing around each. Travel between levels is by ramp.

The open-deck garage is the most inexpensive. Because of design and operating economies, it costs less than one-half the cost of building and operating an enclosed garage. Many economical design features of the open-deck apply to other garage types—

minimum ceiling heights, absence of interior detail and cheap, durable building materials.

Yet the open-deck has features that minimize construction and operating costs. The absence of walls eliminates heating, ventilating, and daytime lighting. Its basic form makes stage construction and the addition of parking levels as needed a practical matter.

Parking-garage ramps are sloped floor drives for travel between levels. Design and placement of ramps is one of the most important considerations in a garage floor layout.

A complete system includes ramps as well as floor aisles that connect ramp-ends. With few exceptions, ramp systems follow a rotary path to connect parking levels.

Clearway ramp systems provide a path for the inter-floor travel completely separated from parking aisles. With them there is no conflict between parking and unparking cars, and those traveling on the ramps.

Systems in which a part of the ramp-travel takes place along parking aisles are called *adjacent parking ramps*.

The *clearway* system permits the safest and quickest ramp travel. The adjacent parking ramp system requires less area per car parked because of the dual use of some of the parking aisles. More delays result and more accident possibilities exist in adjacent parking ramps, but in some smaller garages or those developed on odd-shaped properties, they may have some advantages.

Drivers using a two-way individual ramp tend to swing wide at restricted turns or cut corners at liberal ones. In large garages, one-way ramps are necessary to provide ramp capacity required for peak hour movement. The one-way ramp is more common than the two-way in today's garages.

One-way ramps are preferred to two-way ramps, except in small garages. Clearway ramps are most desirable in *self*-parking facilities. They produce speedier operations in *attendant*-parking garages. They do not, however, use space as economically as the adjacent-parking system. Curved ramps require more space than straight ramps, but permit easier, more comfortable handling of cars.

Ramps are further classifiable by whether their alignment between floors is straight or curved. With straight ramps, all turns are made on parking floors that connect them. With curved ramps, some or all turns are made on the ramp.

Straight ramps are easiest to build and require less space than curved ones. Operationally they are less desirable than curved ones, requiring drivers to make sharp turns at the ends, a condition requiring extra floor area kept clear to permit them.

Curved ramps usually have a uniform radius. They are more difficult to build and require more space than straight ramps, but permit quicker, more comfortable and safer interfloor travel. Their regular curvature and superelevation provide gradual turns that are easy to negotiate.

Straight one-way ramps are classed as *parallel* or *opposed*, and *adjacent* or *separated*. If the up and down ramps between pairs of floors are in the same sloping plane, they are *parallel*. If pitched in opposite directions, they are *opposite*. If the up-and-down ramps between pairs of floors are immediately next to each other, they are *adjacent*; if separated by floor area, they are *separated*. Thus a two-way divided ramp is properly classed as Adjacent Parallel. This is by far the simplest and most widely used system.

Disadvantages of the *adjacent-parallel* ramp system are the difficult turns to enter and leave ramps, the hazard, congestion, and delay from opposing traffic.This disadvantage may be overcome by placing the two some distance apart.

Adjacent-opposed ramps require as much space as *adjacent-parallel* but result in a different traffic-circulation pattern within the garage. Travel on the parking levels can be performed side by side in a two-lane, one-way aisle. Thus the possibility of conflicts is reduced, though not comparable to *separated* ramps.

Opposed ramps may be placed with their up-and-down lanes a distance apart. They make up a *separated-opposed* system. With more expensive construction, this arrangement provides positive separation of up-and-down movements for increased safety and shorter travel.

The ends of parallel ramps, as they reach the main floor, point in the same direction. So either *adjacent-parallel* or *separated-parallel* ramps are best for the garage with entrance and exit on the same street. The *adjacent-opposed* or *separated-opposed* systems suit the garage with its entrance and exit on different streets. Either of these types can be adapted for entrance and exit on the same street, with a 180-degree turn on the main floor.

Curved ramps can be continuous or non-continuous. The continuous curved ramp is often called a spiral. It is a complete uninterrupted sloping floor drive with entrances and exits onto the various parking levels. The up and down lanes may be opposed or parallel; entrance and exit may be on the same or opposite sides of the spiraling ramp.

Parallel-curved ramps are a single sloping surface on which the up and down movements are separated by a low median. For best operation, the outer lane is used for up travel. It has the larger turning radius and lowest grade. Also for best and safest operation, *parallel-curved* ramps are usually oriented to require the up-movement counter-clockwise; the down movement is clockwise, and cars pass each other on the right.

Opposed-curved ramps have up-and-down lanes on opposite slopes. It is the curved ramp version of *adjacent-opposed* straight ramp system discussed earlier. It is difficult to build, and offers little operational advantage over *parallel-curved* ramps.

Recommended minimum design dimensions for parking garage ramps are:

Grade	10 to 15%
Width	
Straight ramps	10 to 12 feet
Curved ramps	12 to 14 feet
Curvature	30 foot radius to inside curb
	55 foot radius to outside curb
Median	
Width	18 inches
Height	6 inches

In the half-story, or *staggered floor ramp* principle, the structure is built in two sections vertically offset, one-half story. Straight ramps connect the staggered levels. Because of short length, ramps in this type may be steeper than the longer ramps in other designs.

Half-story ramps are usually separated horizontally by the distance cars need to make an 180-degree turn between ramps. Any of the straight ramps discussed earlier may be used with the *staggered floor* principle.

An *open-deck*, staggered-floor garage was built by a department store in Detroit. It accommodates 850 cars on five levels. It occupies a city block of approximately 55,000 square feet. It took the place of a three-level half-block garage. In addition to parking, it houses fourteen retail shops on the first floor.

The *sloping-floor* design has a ramp passing along a series of planes in a continuous slope through the height of the structure. Cars are parked on each side of the ramp—in effect, a single, coiled parking aisle. Such garages use a shallow grade that permits higher speeds offset by greater travel distances. Movement is generally two-way with parking transversely to the slope on both sides. The congestion associated with two-way ramp travel adds to the congestion of the adjacent parking feature.

A Los Angeles *sloping floor* garage—"one story parking building six stories high"—built in 1949, consists of a single continuous ramp that winds around a rectangular center shaft at a four percent grade. On two sides, the ramp is sixty feet wide; on one forty-five feet, and on the last thirty feet wide. Parking is on *both* sides of the sixty-foot section, and on *one* side of the narrower sections. About 480 cars can be accommodated. Parking and unparking is by the driver; elevators and stairways in the center shaft transport him between his car and the street. Although drivers park their cars on the ramp, attendants turn them around during the day to reduce congestion. Most cars park for the day.

Techniques of Operation

Offstreet parking, essentially a materials-handling problem, depends as much on operation as on the design. Good management can minimize *poor* design; poor management can minimize *good* design.

Time is the common denominator in evaluating all garage operations. While the customer is actually paying for car storage, his satisfaction depends on the speed and dispatch with which his car is received and delivered.

Handling Cars: It should be based on experience in other parking facilities modified to suit design and type—long-time, short-time, transient-contract. This operating procedure varies among garages. The most suitable one will be the one best adapted to conditions and circumstances.

In attendant-operated parking facilities, cars should be removed from reservoir space to storage floors in an orderly manner so attendants can move to the next car without confusion. Satisfactory results are obtained when reservoir lanes clear one at a time in rotation: fast service, best use of the reservoir, and time for entering drivers to unload.

Time-values for the various steps in a parking and unparking operation at an attendant-parking facility follow:

Parking

Attendant accepts car, gets in and starts it	8 seconds
Drives on main floor to ramp	4 seconds
Drives on ramps (average of 2 levels at 12 seconds a level)	24 seconds
Average delay on ramps	15 seconds
Drives on storage floor	6 seconds
Maneuvers into parking stall (back-in)	18 seconds
Stops car and gets out	6 seconds
Notes location of car on office portion of identification ticket	31 seconds
Walks to elevator (plus 6 seconds average wait for elevator)	45 seconds
Rides to main floor in elevator	20 seconds
Walks to Cashier's booth to deliver identification ticket	8 seconds
	185 seconds

Unparking

Attendant accepts identification ticket at Cashier's booth	5 seconds
Walks to elevator	8 seconds
Rides to storage floor in elevator	20 seconds
Walks to parking stall	45 seconds
Checks identification of car	20 seconds
Gets in car and starts it	8 seconds
Unparks and drives on storage floor	8 seconds
Drives on ramps	24 seconds
Average delay on ramps	15 seconds
Drives on main floor	6 seconds
Stops car in delivery area and gets out	6 seconds
Accepts customer's ticket and delivers car to him	10 seconds
	175 seconds

Totals for the time-steps in parking and unparking are about equal. Dissimilar operations about offset each other. Parking (back-in) requires more time than unparking, but the process of finding a car has no matching step in the parking operation. In line with these considerations, parking and unparking times may vary between two and six minutes—between three and four minutes.

Where there is a demand for simultaneous parking and unparking, attendants drive one car to the parking floor and another back to the main floor. Their round-trip time will be increased, but the time per car handled will be reduced. A combined parking-unparking trip usually takes about fifty percent more time than a single purpose trip. An attendant who can park or unpark a car in four minutes can park one and unpark another in about six minutes.

Orderly garage operation requires an orderly system of identification on parking checks. A good system can speed car handling and make maximum use of space. A poor system slows garage operations, alienates customers, and increases the cost of doing business.

Identification tickets serve as:

a. a receipt to the driver indicating acceptance of his car for parking and identifying him as the owner when he returns for it

b. a means of identifying and locating the car for unparking

c. a bookkeeping record, on which the date, duration of parking and parking changes are noted

Size, color, and format of identification tickets vary with size of the facility, extent of the service it offers, the bookkeeping method employed, and the procedure of operation. Some tickets have as many as five sections. Some as few as two.

Five-section tickets are usually made up as follows:

Section 1. Customer Claim Check

Given to the customer when he delivers his car for parking. It identifies the parking facility to the customer. It identifies the parking customer with his car. Its usual contents are:

a. Name and address of the parking facility

b. A serial number which appears on all sections of the ticket

c. Schedule of parking rates

d. A quasi-legal statement setting forth the extent of liability of the garage
e. Date and hour at which car was received for parking

Section 2. Car Stub

Placed on the car (most often under the windshield wiper) to identify it. Contains only the ticket serial number in print large enough, so attendants can read it easily from the parking aisle.

Section 3. Office Stub

Primarily for bookkeeping. It is used to keep a record of the parking duration, car location and amount of money collected. Its usual contents are:

a. Ticket serial number
b. Time In and Time Out of car parked
c. Amount of charges (itemized if other than parking service is furnished)
d. Location of car

Section 4. Location Stub

Used by attendant to locate and identify car for unparking. Remains attached to Office Stub until customer calls for car. Contains ticket serial number and location information.

Section 5. Release Stub

Used by customer to identify himself with car when it is delivered at outbound reservoir. Remains attached to Office Stub and is given to customer when he pays parking charges. Surrendered to attendant upon delivery of car. Contains ticket serial number only.

Four-section tickets have no *release stub*. Sometimes they have no *location stub*. The *office stub* replaces either, and the *customer's claim check* is retained for accounting.

Three-section tickets have neither a release stub nor location stub. Either the office stub or customer's claim check is used for car location and release; the other, for accounting.

Two-section tickets have only a customer claim check and car stub; the customer claim check retained for accounting.

Self-parking facilities use a three-section identification ticket consisting of a customer claim check, office stub and release stub. Location systems consist of a regular method of identifying individual car stalls or small groups of stalls by placing information on the location stub that will identify the stall in which a car is parked or the car itself.

In the individual-stall location system, each stall is identified by a combination of numbers and letters that indicate the floor and specific location on that floor. A regular, easily-remembered system assigns a letter to each parking row, and a consecutive number to each stall in the row from one end of the parking floor to the other. If each floor is laid alike, stalls having the same location code (except for floor designation) will be in the same location with respect to stairways, elevators and ramps. Stall numbers are marked on the floor, overhead beams, or supporting columns. This number is marked on the location stub by the attendant when he parks. Sometimes, car-license numbers are put on the location stub. The individual-stall marking system is most accurate. It is difficult to use, however, in double parking rows or where the overflow of cars is regularly parked in the aisles.

In the area-marking system of stall location, parking floors are divided into sections, such as the bays between columns, holding from three to ten cars. Each area is identified by a combination of numbers and letters as in the individual-stall marking system. Cars within the separate areas are identified on the Location Stub by make or license number, or both. This system is best when double-row parking is used. It permits cars to be moved within the area without losing their identification and without having to adjust the office record of locations.

Simple operating rules within the garage will prevent accidents and speed operations. Two examples of such rules are cars traveling down-ramp have the right of way over those going up; a horn warning should be given by cars as they approach blind turns.

Cars known to be stored for a long period should be placed in the rear of double rows, in stalls adjacent to ramps or in difficult stalls. This leaves the most accessible stalls for short-time, high-turnover parking. At all times, the parking activity should be reasonably well spread throughout the garage so as to reduce interference between cars.

Quite often when a car is delivered to the outbound reservoir area, the customer will not be there to claim it. A separate to-the-side space should be provided.

Number of Attendants is a variable in garage operation directly under management. Other factors are total parking demand, rate of customer arrival, demand for car delivery. Management must accept these considerations and adjust to them.

Figure X–11 shows the rate of customer-demand and rate of car delivery during the evening outbound peak period for an attendant-operated garage. Plotted as it is, it provides a quick picture of the average length the customer waited for delivery of his car (nearly thirty minutes) as well as the number of customers waiting car delivery at any moment (between twenty and almost eighty).

The *rate of delivery* curve has two distance slopes. The shallower (longer delivery time) preceding 9:15 is explained by the fact that inbound cars were still arriving—part of the attendant's activities were taken up in parking entering cars. After 9:15, when the operation was almost entirely outbound, the slope deepens. The slope of the latter part of the curve is equal to a delivery rate of four minutes per attendant per car. During that time there were eight attendants on duty. Their overall average in handling cars, after the extreme delays of lost cars and other causes had been eliminated was three minutes, twenty-one seconds—a reasonably fast average.

In this operation, if a total of ten attendants had been used, and if they could have maintained the four minutes per attendant per car rate of delivery, 100 cars could have been delivered every forty minutes—almost exactly the rate at which customers arrived to claim their cars. And there would have been no large accumulation of waiting customers. The average wait would have been reduced to less than ten minutes.

Customers arrive to park and return later to call for their cars at random. However, careful measurement of these characteristics for any garage over a period of time will usually show patterns that tend to repeat regularly. This information is invaluable for adjusting the number of attendants on duty at any or all times.

The car delivery rate of attendants tends to be fairly uniform. Depending on design and the efficiency of attendants, it will vary between two and six minutes. Figure X–12 shows the relation between rates of delivery, number of attendants and number of cars handled per hour. In actual practice it has been well established that attendants have difficulty in averaging more than fifteen cars per hour.

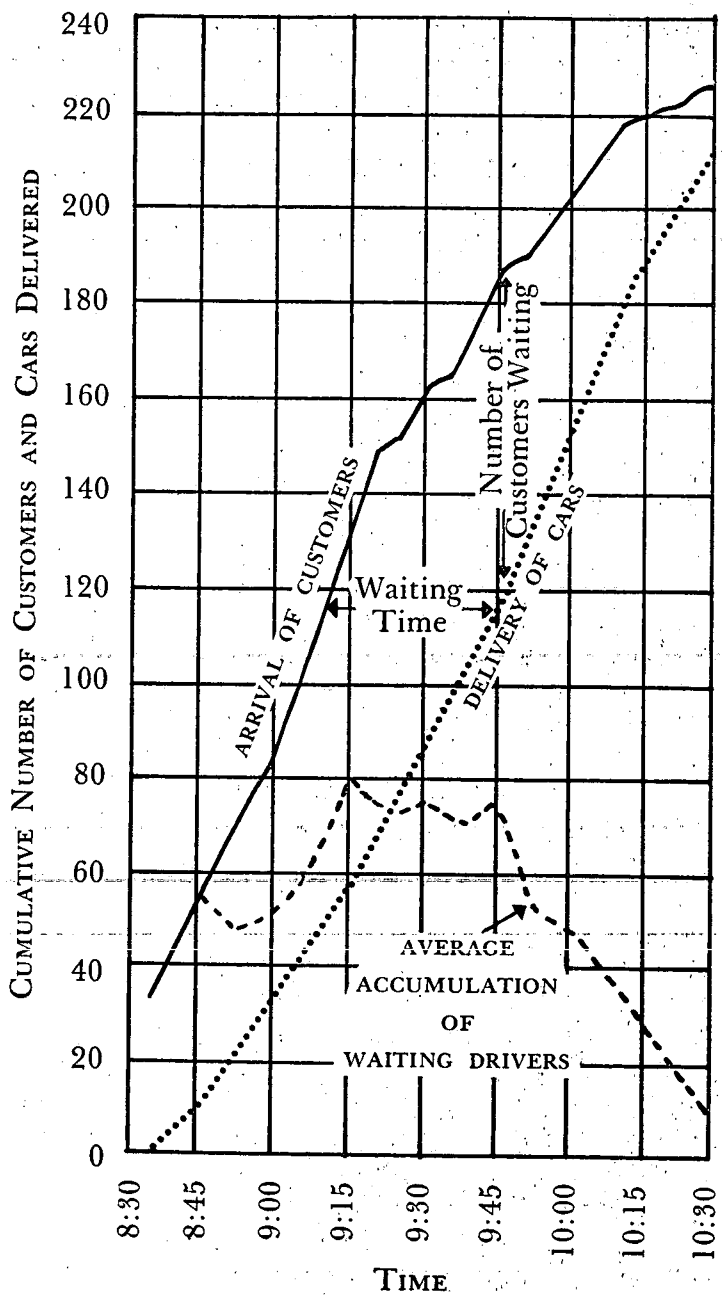


FIGURE X-11. Customer Demand and Car Delivery.

Peak hours make or break the garage operator. They are the times when customers form their judgments of garage operation. Ideally that rate should equal the rate of customer arrivals (for either parking or pick-up) for the average peak hour. During off-peak periods, the excess of attendants may be given other

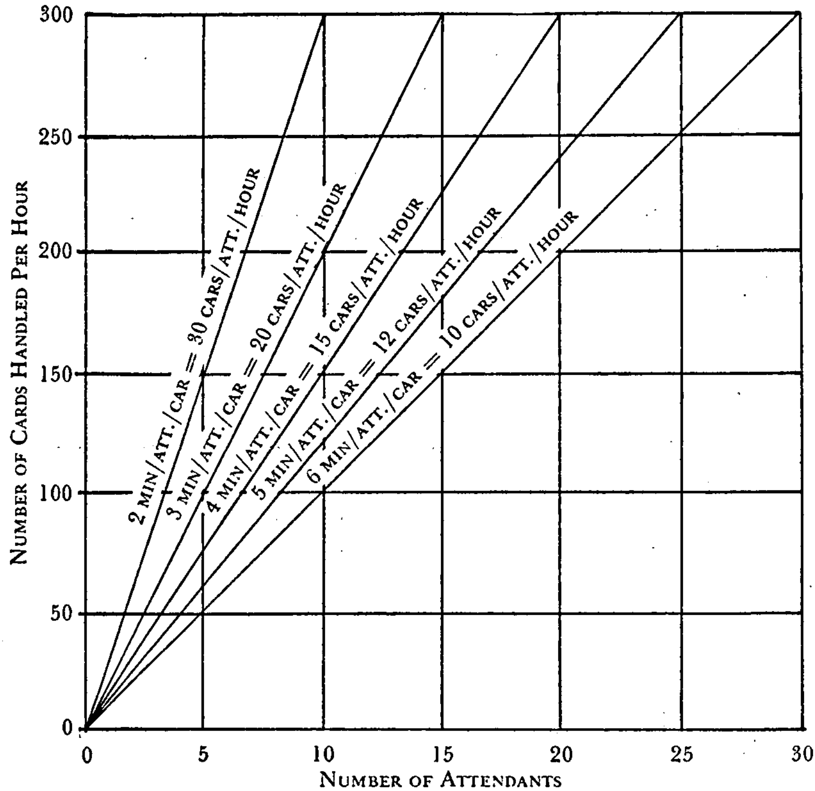


FIGURE X-12. Attendant Rate of Delivery.

duties having to do with maintenance and servicing of the parking facility. And working schedules may be overlapped so as to have two shifts of attendants during peak periods.

To the parker, the usefulness and adequacy of a parking garage is measured by the time he must spend in obtaining parking service. Unless careful attention has been paid to the garage design and its functional operation the customer waits, what seems to him, an unduly long while for car delivery. This waste of time is important to him. He often withdraws his patronage. The waste of time is important to the facility *operator* because of lost business and high cost.

Time-saving in garage operation does not mean that cars must be driven fast or that the attendants must run. Significant savings can be realized by the physical design of the facility and by efficient, well-supervised operation.

Recommended Design Values

The various design features and dimensions discussed are summarized:

Facility Size	
Minimum Capacity	200 cars
Maximum Capacity	500 cars
Maximum Number of Levels	5
Entrances and Exits	
Number	1, with multiple lanes. As far from street intersections as possible, oriented to favor right turns.
Width of Lanes	12 feet
Reservoir Space	
Inbound	
Capacity	Fraction of average peak inbound flow as determined from Figures X-9, X-10, Pages 310, 31
Lane Width	12 feet
Number of Lanes	4
Outbound	
Lane Width	12 feet
Number of Lanes	At least 2
Reiling Height	
Main Floor	12 feet
Storage Floors	7 feet, 6 inches
Camps	
Slope	15 per cent maximum
Width	
Straight Ramps	11 feet
Curved Ramps, inside lane	12 feet
Curved Ramps, outside lane	10 feet, 6 inches
Curvature	32 foot diameter to inside lane edge

Parking Stalls	
Type	
Attendant-parking	back-in
Self-parking	drive-in
Angle of Parking	90 degrees
Length	18 feet
Width	
Attendant-parking	8 feet
Self-parking	6 feet, 6 inches
Access Aisles	
Width	
Attendant-parking	22 feet
Self-parking	24 feet
Curbs	
Height	6 inches, maximum
Width	18 inches, mimimum

Mechanical Garages

In the last thirty years, systems for parking cars mechanically aimed at doing away with ramps to save space and manpower. In the simplest of these facilities, a heavy-duty freight elevator replaced the ramp. Cars were driven onto the elevator, carried to parking levels, parked by attendants. There was a saving in space, but none in manpower.

Sine those first attendant-operated elevator garages many more elaborate mechanical parking systems have been proposed. They show promise of developing the speed and economy of service so important to successful garage operation.

Mechanical garages do not have the economical and operational height limitations of ramp garages. They can achieve a much higher parking capacity per square foot of area. Mechanical garages do not have the relatively large rectangular site requirements of ramp garages. They can be developed on small, high-value land parcels. And, mechanical garages do not require as many attendants as ramp garages. So, their greater initial cost can be justified on the basis of their lower operating cost.

Park-O-Mat: makes maximum use of limited space. Its developers claim the device can be used to advantage on larger sites as well. A wider site would permit more elevator units. A deeper site would permit setting the parking structure back to provide reservoir space in front of each elevator as well as more adequate exit space out the rear. An eight-elevator installation on a plot 100 feet wide and 150 feet deep could accommodate 250 cars in a fifteen level structure only 120 feet high.

Other modern mechanical parking garages use elevators that move horizontally as well as vertically. They normally have tiers of parking cubicles facing each other across a well in which the elevator travels. Two different designs of this type are in use today. One is the Bowser Garage. The other is the Pigeon Hole Garage.

The first *Bowser Garage*, built in Des Moines, Iowa, in 1951, is a nine-story building, 124 feet wide and 78 feet deep with space for 430 cars. It has two opposed tiers of parking stalls served by three elevators suspended in the center well separating the parking tiers. Fifteen entrance lanes occupy the full 124 foot width of the building. Drivers enter these lanes and leave their cars. Attendants drive the cars onto one of the three combination elevator-cranes that serve all the stalls in the structure.

After driving the car onto the elevator platform the attendant reaches through the car window to actuate the push button controls associated with parking stall selection. Upon the push button operation the elevator moves vertically and horizontally, at the same time, to the selected parking stall. The attendant drives the car backward or forward into the space and rides back to the ground level.

Rates at the Des Moines Bowser facility are thirty cents for the first hour and ten cents for each additional hour, with a maximum parking charge of $1 for twelve hours.

Chicago has a Bowser Garage too. There, the rates are sixty-five cents for the first hour and twenty cents for each additional hour, with a maximum parking charge of $1.95 for twenty-four hours. Contract parking is $35 a month.

The Chicago Bowser facility was put into operation in October, 1954. It parks 495 cars on eleven levels. Each level has thirty-six front row and nine back row stalls. The street-floor incoming-reservoir is seventeen lanes that can accommodate thirty-four cars at one time. To make entering and exiting easier, the approach lanes, elevators, parking stalls, and exit lanes are skewed about seventy degrees from the entrance aisle.

Friday is the peak parking day. Almost eighteen percent of the week's parkers are accommodated then. Parking on the rest of the days of the week vary between a Sunday low of 12.2 percent of the average week's total, to a secondary peak of 17.4 percent on Wednesday. Saturday night is the peak parking night. Almost thirty-three percent of the average week's entire evening parking activity takes place then. Parking on the other evenings ranges from 17.7 percent of the weekly night total on Monday to 17.2 percent on Friday.

A detailed study has been made of one day's operating performance of the Chicago Bowser facility.[3]

On the day of the Chicago study, a total of 830 cars were *parked* between 9 A.M. and 5:15 P.M. (a turnover of 1.68); 719 were *unparked*. The maximum accumulation was 328 cars, or sixty-six percent of the garage capacity, at 2:30 in the afternoon.

The *pigeon hole garage* is somewhat similar to the Bowser in that it consists of two opposed banks of parking stalls separated by a center well in which an elevating mechanism functions. As in the Bowser garage, the *pigeon hole* elevators move horizontally and vertically. The difference in the two structures is that the Bowser elevators are suspended from the roof of the garage and the pigeon hole elevators are hydraulic and operate from below. This difference in elevating machinery gives the two garages a different outward appearance. The Bowser is always partly enclosed to protect the elevators from weather. The pigeon hole garage elevating device, not requiring covering, is often a completely open-framework structure.

Pigeon hole garage elevators have a dolly device for parking and unparking cars. Manned by an attendant who rides the elevator platform, the dolly device extends from the elevator to pick up cars and to park them.

Advantages claimed for the pigeon hole garage are its reasonable cost, fast operation, utility on narrow land plots, and pre-

[3] Zralek, Robert L. and Burrage, Robert H., "A Study of a Bowser Mechanical Garage," *Traffic Engineering*, Vol. 27, No. 5, February 1957, page 218.

fabricated construction that permits quick erection and easy disassembly if the facility must be moved. Its apparent disadvantages are moderately noisy operation of the elevator equipment, the continuous maintenance it requires and its practical limitation of a maximum of ten parking levels.

Both the Bowser and pigeon hole structures require minimum frontage. It is necessary that each structure be situated on a corner plot, the other side next to an alley, or driveway; or that space be provided on both sides of the structure of the driveways needed by arriving and departing cars.

The first pigeon hole garage, erected in Spokane in 1950, has three levels above ground and parks 142 cars on a 55 by 142 foot plot. The land is leased but construction costs were reported as $43,000, or about $300 per car space. Parking rates are twenty-five cents for one hour, thirty-five cents for two hours, and five cents for each additional hour. Monthly parking is $12 when the car is left in a stall all day. Daily in and out parking costs $12 a month. Day and night parking costs $15 a month. This first Pigeon Hole installation is about three blocks from a large department store and about half-a-mile from Spokane's shopping center. Nevertheless, it is reported to be filled to capacity frequently.

The New Haven Parking Authority pigeon hole garage is in the heart of the retail district. The shape of the land plots available for the New Haven downtown parking development was such that the most effective installation is a combination of small parking lots fitted onto the irregular plot around a pigeon hole garage. The entire site accommodates 468 cars. 164 in two parking lots. And, 304 in the pigeon hole facility. Occupying the only large rectangular part of the site, the pigeon hole structure is fifty-eight feet wide and 143 feet long.

It provides eight parking levels in its fifty-six foot height. Its location permits direct entrance from the street on which it fronts as well as from the interior drives of the parking lots that make up the balance of the development. All entrance to the New Haven pigeon hole garage is on the north side of the structure. Exit is to the south. Rate schedule at both the lots and garage is twenty-five cents for the first hour, forty cents for two hours and ten cents for each additional hour. The maximum charge for twelve hours of parking is seventy-five cents. Contract parking is $15 a month.

Cost details of the Pigeon Hole portion of the New Haven Parking Authority downtown parking facility are shown in Table X–2.

The costs per car space were high. However, analysis of facility use during its first six months of operation indicate that the estimates which were made for financing purposes will be met.

Table X–2

NEW HAVEN PARKING AUTHORITY PIGEON HOLE GARAGE

Land	$191,405.15
Construction	474,371.04
Equipment	8,359.85
Furnishings and miscellaneous costs	6,963.59
TOTAL	$681,099.63
Cost per car space	$ 2,240.00
Cost per car space, excluding cost of land	$ 1,604.00

CHAPTER ELEVEN

PARKING ON HIGHWAYS

Driving on a highway presents problems different from those of city traffic. In rural travel, cruising-speed hazards infrequent on urban streets should be closely regulated. City travel may have *as many* accidents—less *severe*.

Many highways originally carrying traffic comfortably in high volume at sustained speeds, have lost much of their transportation value through higher accident-severity.

In built-up sections in transition areas where highways enter residential and business areas, and in strip developments where roadside commerce has crowded both roadside and traffic, numerous places present as annoying parking problems as cities.

Rural parking receives less attention than in central business districts. Legal authority, enforcement manpower and technical administrative staffs of state and county highway departments are inadequate for their responsibilities. The force of retail trade loss, city management, and decentralization is absent.

A car stopping on the pavement is not unusual in the city because of urban traffic characteristics. But on the highway, it is unexpected and frequently is accompanied with severe consequences.

The approach to the highway parking problem should provide uninterrupted lanes at normal rural highway speed with reasonable capacity; also provisions for breakdown stops, and parking facilities for roadside business and turn-offs.

Parking and Highway Accidents

Traffic deaths on rural highways increased sixty-nine percent from the five-year average of 1943–47, compared with 1955. Urban traffic deaths for the same period dropped seventeen percent. This spread of eighty-six percent indicates growth in the rural death problem.[1] In 1955, there were 28,900 rural traffic

[1] Accident Facts 1956, page 59.

deaths—3,000 pedestrians; 11,300 from collisions; 12,300 from turning over or running off the roadway; 900 from trains; 200 with bicycles; 1,100 with fixed objects, and 100 others—street cars, animals, and animal-drawn vehicles. The rural mileage death rate was 8.5, more than double the urban death rate of 3.7 a hundred million miles of travel. On country highways, stopping and parking complicate the problem.

Records of 1956 rural fatal accidents show four percent in rear-end collisions involving stopping on the highway; one-point-three percent involved a parked car or one leaving a parked position.[2] These total five-point-three percent or 1531 of the 28,900.[3]

A California report[4] of 1,169 miles of two-lane highways in the interstate system in California, showed the rate of 342 accidents for 100 million miles of roads with no shoulders, dropped to 165 where there were eight-foot minimum shoulders.

Of the fatal vehicle accidents involving speed, eighty percent in rural areas exceed thirty miles an hour; in cities, sixty-four percent were under thirty miles an hour. In rural areas, three percent of the vehicles were reported standing.[5]

These figures are for cars in *fatal accidents*, not from a speed-count of all traffic. The fact that more of the cars in these fatal accidents were in the forty-one-to-fifty mph bracket than in the seventy-one-and-over bracket in rural areas does not suggest that it is safer to drive in the upper bracket. In the forty-one-to-fifty bracket, a highway speed survey would show many more cars—hence more exposure—than in the higher speed brackets.

The common urban bracket is eleven-to-twenty miles an hour containing thirty-one percent of the cases; the largest break is from the one-to-ten bracket with eight percent to the eleven-to-twenty bracket with twenty-one percent. The common rural bracket is forty-one-to-fifty containing twenty-two percent, followed closely by the fifty-one-to-sixty with eighteen percent. Note that only twelve percent was reported in the sixty-one-to-seventy bracket and thirteen percent in the seventy-one-and-over bracket.

2 Accident Facts 1956, page 69.
3 Accident Facts 1956, page 59.
4 Report of study by California Department of Public Works.
5 Accident Facts, 1957, page 50.

DISTRIBUTION OF VEHICLES IN FATAL ACCIDENTS REPORTED BY SPEED[6]

Area	*Total*	*Standing*	*1–10 m.p.h.*	*11–20 m.p.h.*	*21–30 m.p.h.*	*31–40 m.p.h.*	*41–50 m.p.h.*	*51–60 m.p.h.*	*61–70 m.p.h.*	*71 up m.p.h.*
State-wide	100%	3%	5%	9%	13%	17%	20%	15%	9%	9%
Urban	100%	4%	8%	21%	31%	17%	8%	5%	3%	3%
Rural	100%	3%	5%	5%	7%	15%	22%	18%	12%	13%

There is ample evidence that rural highway parking is closely related to the rural accident problem.

As more modern highways are built, the contrast between travel on them and travel on old roads will become more obvious. The driver who leaves the modern highway with wide lanes and excellent shoulders to enter an old road with narrow lanes and no shoulders, may not realize immediately that conditions are less safe. He may neglect to lower his speed as much or as soon as he should. This suggests that old roads adjacent to new super highways should be given priority in shoulder-improvement programs.

Types of Rural Parking

Analysis of rural parking indicates several types of problem. These are outlined with explanation to provide a view of present conditions as an insight into proper corrective measures.

Emergency stops are sometimes unavoidable because of engine or tire failure, empty tank, inability to see the road or an obstacle. In many instances due to the absence of a proper shoulder they suddenly occur on the pavement. Forced stops come when traffic ahead has stopped.

Shopping or Business: Here the motorist stops from choice, or to avoid the slight inconvenience of parking off the highway; both are unwarranted—a menace to fellow travelers. Those involving such items as gasoline, oil, repairs, food, convenience facilities are essential to travel. They are services modern transportation should provide.

Increasingly many types of commercial activities in rural areas along a highway create more and more longer stops. Roadside

6 Accident Facts 1955, page 52.

business should be required to provide parking space. The highway function is to bring the customer to his destination, not to park him on the concrete strip.

Commercial deliveries to roadside businesses often create dangerous road parking situations. Highway shoulders or modest building set-back are inadequate for business operations.

More cars and mileage increase the interest to drive to the country. Some states provide picnic and parking areas at advantageous spots for viewing the scenery. Without special provisions such stops will be made on the shoulder, creating additional hazards to travel on week-end overcrowded highways.

Other Travel Stops: Motorists frequently stop to read maps, destination or route signs, or to decide whether to turn at an intersection. They stop to change drivers, to open the trunk compartment, to check on car noise or take a nap. These as a rule are deliberate and inexcusable.

There is a commendable increase in the number of drowsy drivers who realize the danger promptly and pull off the highway to sleep.

Pavement stops, all forms of bad habits, cannot be ignored in designing a highway facility. Appropriate arrangements should be made to avoid restricting a highway from its full transportation use. This concept precludes highways with no shoulders, narrow shoulders or shoulders usable only in dry weather. There is a *real demand* for off-highway parking space similar to offstreet facilities.

Stopping and Parking Situations

To visualize rural stopping and parking problems, it is necessary to translate driving habits and facility deficiencies into drivers' behavior in terms of consequences. This would give a planned approach toward regulations, design, and facilities. As in other fields, improvements come through experience in specific rather than general situations. Deficiencies can be overcome by definite laws and improved enforcement. Often, special facilities are required.

Assumptions: The driver on an open highway expects understandably to drive at reasonable highway speed. He wrongfully assumes that traffic ahead of him will move at highway speed. He is likely to be surprised but should be prepared if the continuity of normal flow is interrupted. Again he assumes the driver of a car parked on the shoulder will permit him to pass before pulling out. He expects to have a place to pull off the road to change a tire, but is apt to change it on the pavement if no alternative is immediately available.

Thus far, poor driving, insufficient education, law and enforcement have made little progress in correcting driving errors. Only limited progress has been made in the prompt elimination of proved high accident-potential road situations.

With increasing traffic and persistently poor driving, the problem will grow worse.

Avoidance of pavement-parked cars requires a quick decision that even our best drivers do not always make properly. Too often one of these accidents result:

1. The motorist sees too late that the car ahead has stopped. There may be a *rear-end* collision.

2. On a two-lane highway a quick pulling to the left may cause a *head-on* collision.

3. A pull to the right may skid a car on insufficient shoulders.

Substituting One Hazard For Another: The driver who stops on the pavement in fog eliminates the hazard of running into a vehicle ahead, but he creates another for the driver behind him. Most basic speed laws require a driver to stop within a safe distance. Yet opinion generally places the chief blame on the driver hit from the rear while stopped on the pavement.

Often a car stopped on the pavement caused another car to swerve and collide. Usually the stopped car is not mentioned in the accident report, because, though causing the accident, it was not hit. Vehicles stopped on the pavement or parked on the shoulder too close to the pavement, have more influence on accidents than shown in the records.

Unfortunately, under the present enforcement procedure, stopping on the pavement is tolerated. We rarely hear of a motorist arrested for stopping on the pavement when a shoulder was available.

Many drivers seem unaware of the hazards they create. They slow down to window-shop or pass roadside businesses at too-slow speeds.

With a narrow shoulder the car may be too near the pavement. Here the normal driver will instinctively swing left though unable to avoid the parked car or possibly an oncoming one.

When a car is parking near an intersection, creating a blind corner, it may cause an accident due to restricted sight-distance. The presence of a vehicle parked in a threatening position can sometimes distract a highway driver.

Built-up Area Accidents and Delays: Here the highway has become lined with continuous roadside parking and business establishments, creating a higher volume of conflicting movements and confusion usually found on city streets, into which the highway driver frequently moves at highway speeds, reluctant to reduce his speed—a dangerous characteristic of many drivers. Parking facilities and control of access can partly control this situation.

On a two-lane highway, safe speeds may be slowed to twenty miles an hour and capacity halved by dangerous parking and unparking.

On a four-lane highway, one stopped car in the outside lane not only reduces speed and capacity but reduces the capacity of the adjoining lane, through cars cutting over. Stopping and parking on rural highways creates dangerous situations; many result in accidents, and many more in delay. They represent a serious highway problem.

Hazards of Entering and Leaving Roadside Business Establishments: On the main highway where common speeds are over forty miles an hour, any action that requires sudden slowing or stopping creates a potential accident situation. Types of entering and leaving the highway are:

1. Turning off the road, crossing oncoming traffic.

2. Turning right off the road into an abrupt or narrow exit.

3. Entering a lane without unusual care, is a common fault with poor or inexperienced drivers.

Drivers entering the lane are impatient while drivers approaching think they have the right-of-way.

The basic problem is one of variable speeds on different types of roads. This places importance on the number and control of entrances and exits and their designing, so that they can be easily and instantly recognized as points of potential danger. A column of cars parked on the highway shoulders is a greater hazard than the same situation on a city street.

Driver Faults and Highway Facilities: The driver is more at fault than the engineer, though the engineer provided a less than ideal facility within the means available. The driver fails to use existing provisions, either through indifference or lack of appreciation of the hazard he creates. He must accept limitations and drive accordingly. Better enforcement is needed.

Economic Considerations: Providing adequate provisions for stopping can represent substantial expenditures not justified by the budget. Funds for improving old roads are never sufficient in the face of the demand for new ones. A formula would indicate action where the accumulated economic losses from accidents in twenty years or less would equal the cost of the proposed improvement and possibly add a factor of "X" percent reduction in capacity and movement.

On the other hand, stopping and parking that reduces the service-value of busy highways can be regarded as an economic loss through reduction of effectiveness of funds invested in the facility. It will not always be possible to obtain the ultimate, but an effort to raise standards should be made.

Highway Design Improvements

Design improvements as an approach to the problem have several important advantages. They are usually permanent. They remove much of the temptation of the motorist to resort to his own methods of meeting roadway limitations.

Modern highway design has moved from eight-to-ten to twelve or fourteen foot lanes on curves. The wider lane eases the stopping and parking problem in several ways: with a more adequate shoulder a car at high speed centered in the wider lane will have more leeway in going by a car parked on the shoulder. If anything goes wrong, a driver will have more chance to escape. He will feel less need to swing left to avoid potential trouble. If he does wish more room, he can still swing left a few feet without leaving his lane.

Wider Stabilized Shoulders: To meet inevitable highway stopping and parking, shoulders should meet the following requirements:

1. Widths of eight, nine, or ten feet, determined to some extent by the prevalence of trucks. The wider shoulder places a stopped or parked car farther away from the edge of the moving lane.

2. Material and construction which will support a heavy vehicle in bad climatic conditions and thaw.

3. A smooth transition from pavement to shoulder and avoid endangering the traffic to the rear.

4. They should be continuous, including bridges, elevated structures, underpasses, fills and cuts.

It is significant that many newly planned elevated structures now have shoulders.

Adequate shoulders not only improve the parking situation, but have other transportation values:

a. Provide recovery area for drivers when a traffic emergency forces them to leave the pavement.

b. Encourage motorists to center in the moving lane instead of driving farther left.

c. Contribute to adequate drainage and snow plowing. Several highway departments have experimented with paved shoulders of less expensive construction than that used for moving lanes, usually of contrasting color to delineate the moving lanes and discourage regular travel on the paved shoulder.

d. Provide adequate stopping places for school and other buses.

School buses present a major stopping and parking problem, especially on secondary roads where much of their travel occurs. They make innumerable stops on the highway pavement, requiring motorists approaching from both front and rear to stop. Traffic is further delayed because of slow starting, and since there are many stretches where passing is impossible, passenger cars are forced to follow the bus over a long distance.

In 1955, the records in thirty-six states showed 125,000 school buses daily transporting 7,340,000 children with only eighteen killed while in the buses eleven of the eighteen were killed in one bus-train accident. Seventeen were killed crossing the highway. In addition to the eighteen killed in bus accidents, 1,306 were injured. A total of 1,300 children, four years or younger, were killed in traffic accidents in rural areas in towns under 2,500 population. Also 1,350 children, aged five to fourteen were killed. The buses were involved in a total of 5,144 accidents, mostly damage cases.[7]

School bus accidents could be substantially reduced if the turnouts or the special highway shoulders were provided at clearly signed selected locations. The present school bus practice of stopping on the pavement, in effect, violates basic laws that prohibit any car's stopping on the pavement. The problem warrants a realistic study of the school bus situation to overcome some of the present inherent dangers.

Buffers—Islands—Guard-rails: At roadside businesses and built up areas, where there is a high frequency of stopping and parking, it is desirable to insulate the moving lanes, to prevent uncontrolled entering or leaving the highway. It is not realistic to expect drivers to properly meet these many dangerous situations.

The guard-rail is a common device for such insulation. Where space permits, traffic islands may be used, thus providing sight distance and permitting attractive roadside planting. Good examples of insulation are service facilities on toll roads.

Medial Barriers: On highways of four or more lanes, passing through built up areas, where parking and unparking maneuvers are frequent, it is desirable to install medial dividers that physically prohibit left turns. Where there is occasion for frequent stops, off the road parking space should be provided.

Highway Parking Facilities

Highway parking facilities serve a function closely allied to a parking lot.

Scenic Turnouts come under the category of "tourist attractions."

7 Accident Facts 1956, pages 59 and 91.

Here tourists get out of their cars. Parking space should be provided with control for entering and leaving.

Picnic and Rest Areas: Many states provide picnic tables and other accommodations—attractively situated and inviting, an important place in week-end driving, an educational factor for younger city dwellers who hike and enjoy the countryside.

Parking Lots for Roadside Businesses: A common hazard is the roadside business that neglects parking facilities for customers. This situation, though improved, should be required in the building permits.

In other instances, highway departments place "no parking" signs on highway shoulders, and co-operate with roadside business in laying out parking lots, buffer islands, guard-rails and controlled, limited entrances and exits. Standards should be developed, promulgated and later required.

Highway Stopping and Parking Regulations

A confusing variety of regulations bear on rural stopping and parking problems. Besides state statutes and the regulations of county boards of supervision, there are administrative *rulings* of highway departments. Areas covered by law and enforcement include:

1. Stopping forbidden on the pavement.
2. No parking on the shoulder *opposite* a vehicle parked on the shoulder across the highway.
3. Prohibition of parking on the shoulder, except for emergencies.
4. Prohibition of parking on the shoulder for commercial purposes.
5. Requiring specified entrance and exit designs for roadside business.
6. Set-back provisions for buildings of a roadside business.
7. Prohibition of lighting that causes a glare to other motorists.
8. Require illumination of parking lots and entrances and exits.
9. Specifically requiring parking lots for roadside business.
10. Require that commercial vehicles set out flares or other devices, at night when stopped on the pavement in an emergency.

No-stopping Regulation: States have basic statutes that prohibit stopping on the pavement. Most of them follow the general language of the *uniform code:*

Section 11-1001: *Stopping, standing or parking outside of business or residence districts.*—a. Upon any highway outside of a business or residence district no person shall stop, park, or leave standing any vehicle, whether attended or unattended, upon the paved or main-traveled part of the highway when it is practical to stop, park or leave such vehicle off such part of said highway, but in every event an unobstructed width of the highway opposite a standing vehicle shall be left for the free passage of other vehicles and a clear view of such stopped vehicle shall be available from a distance of 200 feet in each direction upon such highway.

b. This section shall not apply to the driver of any vehicle which is disabled while on the paved or main-traveled portion of a highway in such manner and to such extent that it is impossible to avoid stopping and temporarily leaving such disabled vehicle in such position.

Section 11-1002: Officers authorized to remove illegally stopped vehicles.

a. Whenever any police officer finds a vehicle standing upon a highway in violation of any provisions of section 11-1001 such officer is hereby authorized to move such vehicle, or require the driver or other person in charge of the vehicle to move the same to a position off the paved or main-traveled part of such highway.

b. Whenever any police officer finds a vehicle unattended upon any bridge or causeway or in any tunnel where such vehicle constitutes an obstruction to traffic, such officer is hereby authorized to provide for the removal of such vehicle to the nearest garage or other place of safety.

Section 11-1003: Stopping, standing or parking prohibited in specified places.

a. No person shall stop, stand or park a vehicle, except when necessary to avoid conflict with other traffic or in compliance with law or the directions of a police officer or traffic-control device, in any of the following places:

....7. Within 30 feet upon the approach to any flashing beacon, stop sign or traffic-control signal located at the side of a roadway;

....9. Within 50 feet of the nearest rail of a railroad crossing;

....13. Upon any bridge or other elevated structure upon a highway or within a highway tunnel.

Prohibited parking on shoulders: An example is where a highway department has placed "no parking" signs on shoulders adjacent to vending places such as vegetable stands, or small lunch counters and taverns.

Prohibition of shoulder parking became particularly important where the frequency of drivers' parking and unparking would disrupt the traffic flow, and create a big accident potential. The

Kansas Turnpike traffic regulations ban parking on the shoulders except in emergency cases with parking on the shoulders to sleep considered as an emergency.

Most states prohibit the use of shoulders for commercial purposes. It is a desirable law but ineffectively enforced.

Section 11–1004: Additional parking regulations.[8]
. . . .d. The (State highway commission) with respect to highways under its jurisdiction may place signs prohibiting or restricting the stopping, standing or parking of vehicles on any highway where in its opinion, as evidenced by resolution or order entered in its minutes, such stopping, standing or parking is dangerous to those using the highway or where the stopping, standing or parking of vehicles would unduly interfere with the free movement of traffic thereon. Such signs shall be official signs and no person shall stop, stand, or park any vehicle in violation of the restrictions stated on such signs.

Specified entrances and exits: For parking adjacent to a highway, legal authority should be obtained for an authorized entrance and exit design:

1. Limited to points of entrance and exit precisely where the danger points are.
2. They should be clearly delineated, separated, and obvious to the highway driver.
3. They should not be hidden by signs, shrubbery, parking or other obstacles.
4. Entrance and exits should be to aid the driver in sight distance and maneuvering his car in both directions.
5. Exits and entrances should be wide.
6. They should have practically no grade.
7. They should be as far away from intersections, hills, curves as is practical.

Indicative of progress in improving the entrance and exit design and location are recommendations of the "Report of the Subcommittee on Roadside Control of the Committee on Traffic of the American Association of State Highway Officials" presented at the annual meeting in Atlantic City, New Jersey, November 29, 1956, by William J. Miller, Jr., deputy chief engineer, Delaware State Highway Department. The following *design re-*

8 *Uniform Act Regulating Traffic on Highways* (Revised 1956), National Committee on Uniform Traffic Laws and Ordinances, Washington 6, D. C.

quirements for service stations, entrances and exits were recommended:

a. Not more than two driveways from one property to any one highway should be permitted.

b. The maximum width of any one driveway should be forty to fifty feet, with the following exception: that exits to one-way roadways should not exceed thirty to thirty-five feet.

These dimensions to be measured parallel to the highway centerline at curb or shoulder line.

c. The angle of any driveway should not be less than forty-five degrees.

d. Driveway return radii should not exceed forty feet.

e. Pump islands should be no closer than fifteen feet to the right of way line.

f. Any two driveways connecting with a single highway should be separated by an island area. The side of the island next to and parallel to the highway, should be located at the curb or ditch line. The island should extend to the right of way line and should have a minimum length of ten to twenty feet at the right of way line.

g. An island area adjacent to the property line extended measuring five feet parallel to the roadway at the curb or ditch line, should be reserved, in case the adjacent property owners request driveways.

h. All islands within the right of way should be delineated by curbs, posts, guard rails, or planting..

i. The following conditions should apply to corner islands:

1. No driveway should encroach upon curb or pavement radii at intersections.

2. No driveway should cross reserved corner sight distance areas.

3. Minimum distances from side road right of way line to edge of driveways should be thirty feet on the major road, and fifteen feet for urban conditions. This is to apply if no conflict with preceding conditions exist.

j. The permissible grade of driveways should be specified, and the need for approval of drainage provisions should be spelled out.

k. Parking, loading or servicing of vehicles should not be permitted on the right of way.

To illustrate the application of these recommendations to typical service station layouts, sketches showing various conditions are enclosed with this report. See Figures XI–1, 2, 3, 4, 5.

Setback Requirements: Roadside business buildings situated close to the pavement cause innumerable difficulties:

a. Conceal vehicles about to enter the highway.

b. Complicate entrances and exits.

c. Make arrangements for parking space complicated and less attractive and usable.

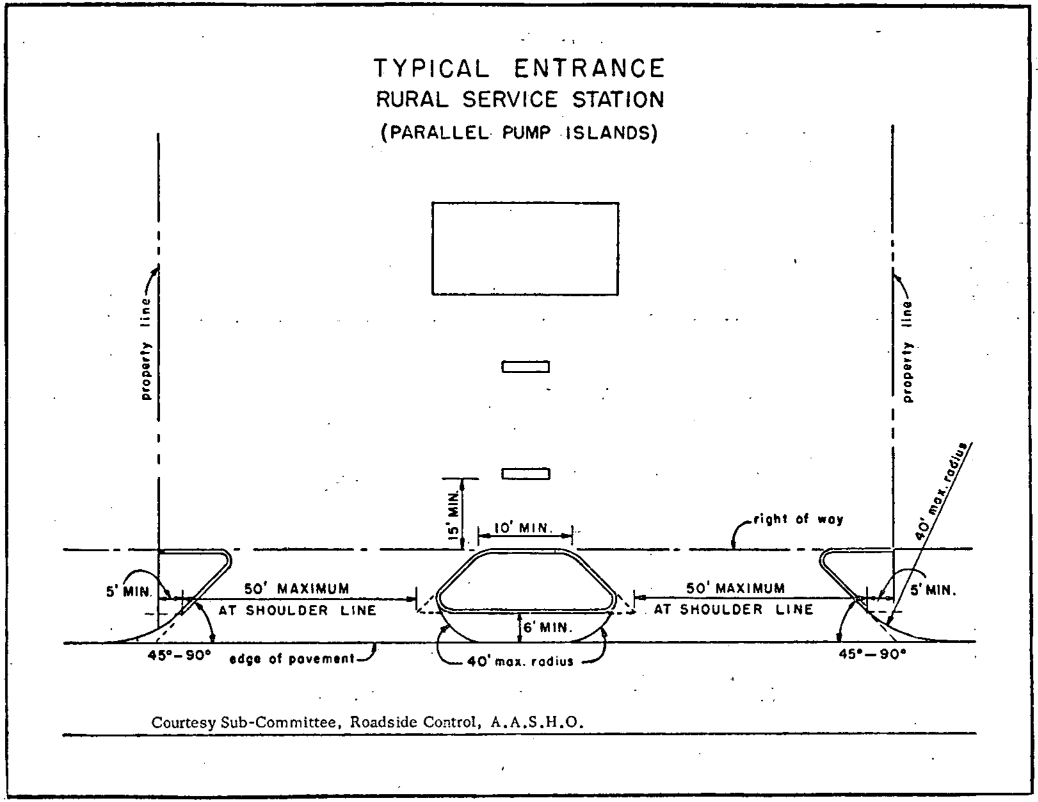
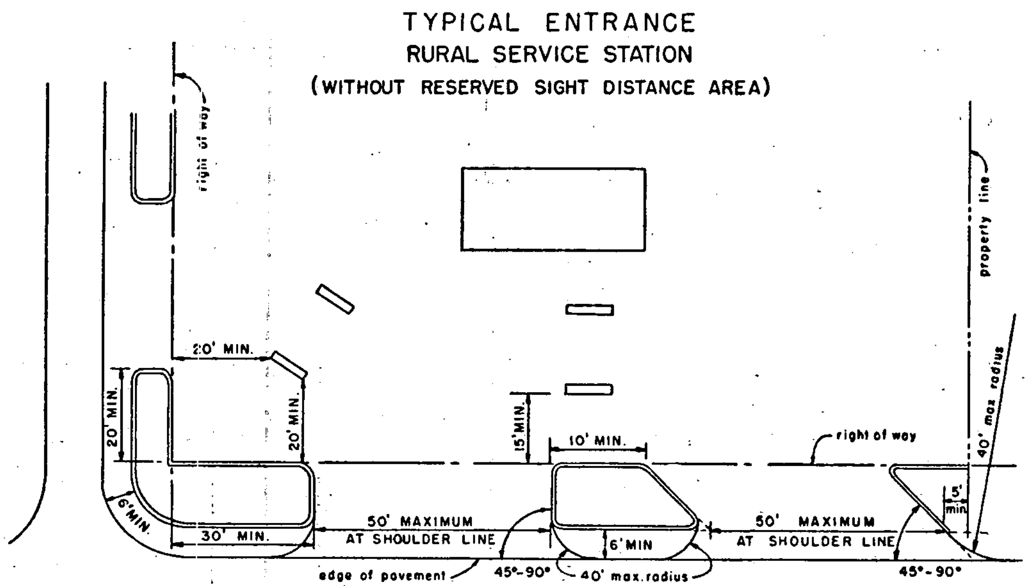
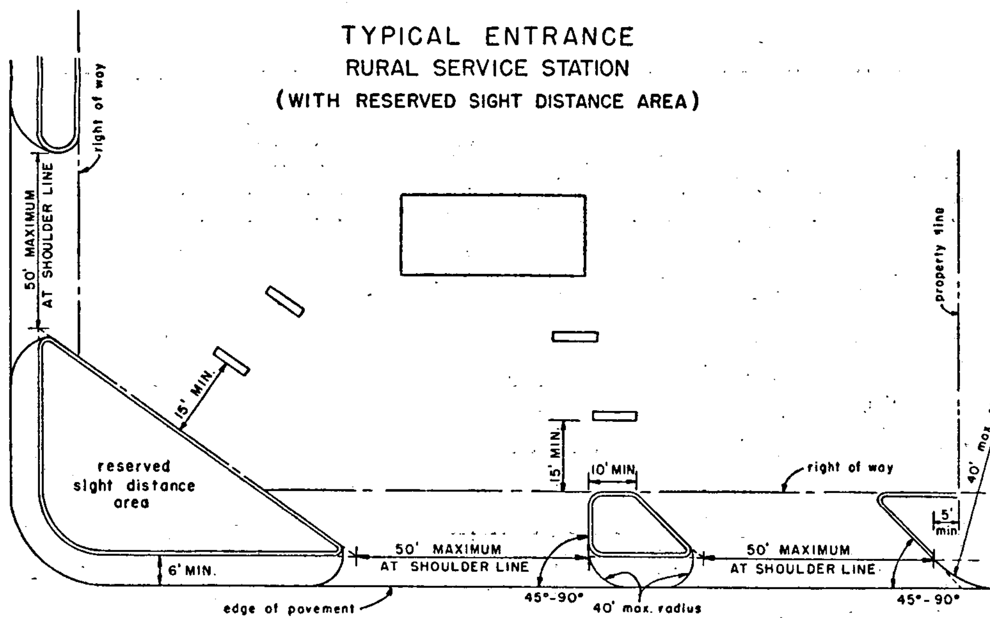

TYPICAL ENTRANCE
RURAL SERVICE STATION
(PARALLEL PUMP ISLANDS)
property line
property line
15' MIN.
10' MIN.
right of way
40' max. radius
5' MIN.
50' MAXIMUM
AT SHOULDER LINE
50' MAXIMUM
AT SHOULDER LINE
5' MIN.
6' MIN.
45°–90°
edge of pavement
40' max. radius
45°–90°
Courtesy Sub-Committee, Roadside Control, A.A.S.H.O.

FIGURE XI–1.



Courtesy Sub-Committee, Roadside Control, A.A.S.H.O.

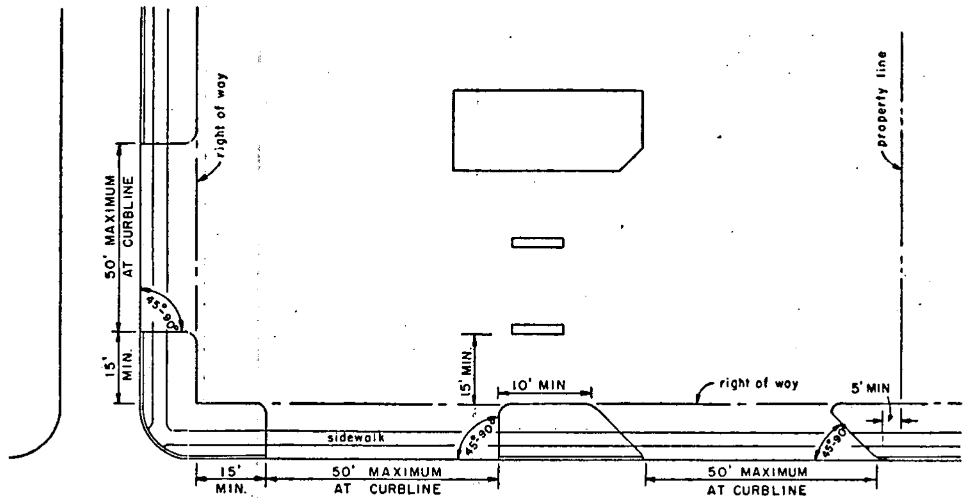
FIGURE XI–2.



Courtesy Sub-Committee, Roadside Control, A.A.S.H.O.

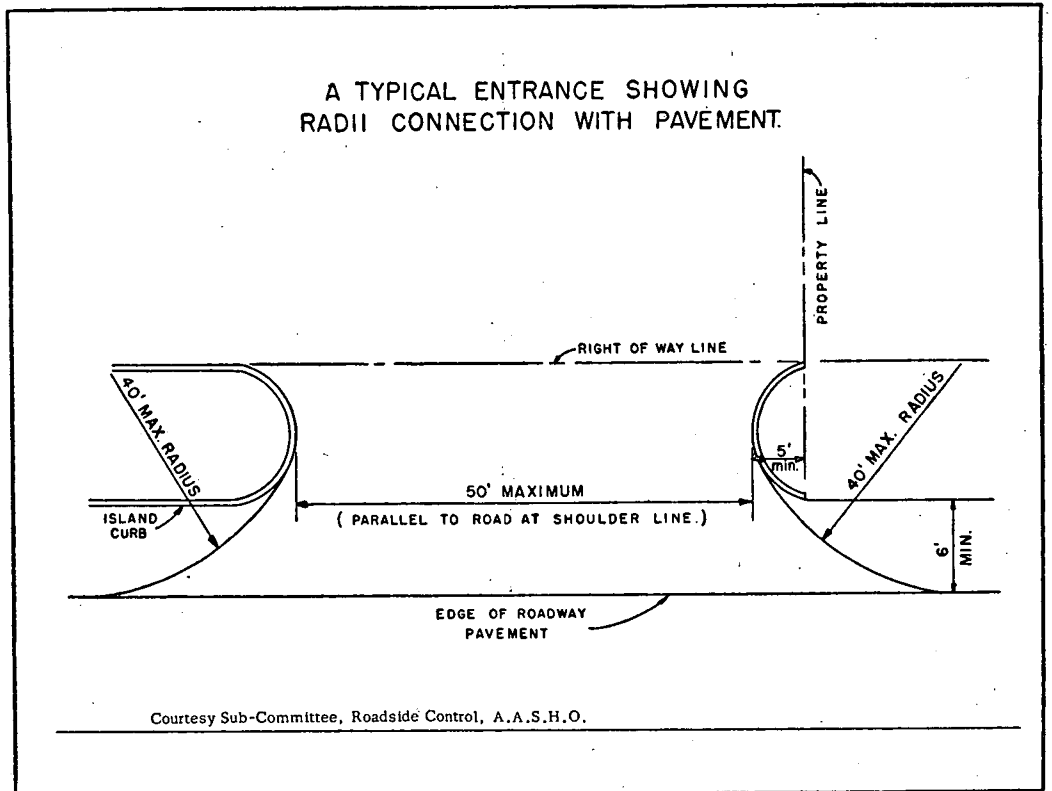
FIGURE XI–3.

TYPICAL ENTRANCE
URBAN SERVICE STATION



Courtesy Sub-Committee, Roadside Control, A.A.S.H.O.

FIGURE XI–4.



Courtesy Sub-Committee, Roadside Control, A.A.S.H.O.

FIGURE XI–5.

d. In some types of business they encourage doing business on the highway shoulder.

Setback plans should be fitted into a general plan for submission to the highway department for approval, before permission is given for access to the highway.

Lighting Specifications: The first requirement should be that no lighting produce a glare on the highways. The requirement should include a light-survey for illumination, advertising, entrances, exits, and parking lots. These requirements should be reduced to standard lighting measurements and set forth in a lighting code.

Roadside businesses that require parking service should be required to provide a parking plan before entrance and exit to and from the highway are approved.

Some states have a statute that requires trucks to set out flares or other warning devices, whenever disabled on the highway. This is also specified by the Interstate Commerce Commission and Public Service Commission for vehicles for hire. Section 12–407 and 408 of the Uniform Act.

Future Trends

Unless parking and stopping on highways are promptly brought under close supervision, they will grow worse. For no substantial reason, they have been tolerated notwithstanding their hazard to highway travel.

The growth of the problem warrants prompt, specific action. The first approach should strengthen laws governing the authority of highway departments. This should be followed by preparing and promulgating an official code for highway parking and access.

APPENDIX I

Extracts from the Model Traffic Ordinance

ARTICLE XIII. METHOD OF PARKING

Sec. 122. *Standing or parking close to curb.* No person shall stand or park a vehicle in a roadway other than parallel with the edge of the roadway headed in the direction of lawful traffic movement and with the right-hand wheels of the vehicle within eighteen (18) inches of the curb or edge of the roadway except as otherwise provided in this article.

Sec. 123. *Signs or markings indicating angle parking.* (a) The city traffic engineer shall determine upon what streets angle parking shall be permitted and shall mark or sign such streets but such angle parking shall not be indicated upon any federal-aid or state highway within this city unless the state highway commission has determined by resolution or order entered in its minutes that the roadway is of sufficient width to permit angle parking without interfering with the free movement of traffic.

(b) Angle parking shall not be indicated or permitted at any place where passing traffic would thereby be caused or required to drive upon the left side of the street or upon any streetcar tracks.

Sec. 124. *Obedience to angle-parking signs or markings.* Upon those streets which have been signed or marked by the city traffic engineer for angle parking, no person shall park or stand a vehicle other than at the angle to the curb or edge of the roadway indicated by such signs or markings.

Sec. 125. *Permit for loading or unloading at an angle to the curb.* (a) The city traffic engineer is authorized to issue special permits to permit the backing of a vehicle to the curb for the purpose of loading or unloading merchandise or materials subject to the terms and conditions of such permit. Such permits may be issued either to the owner or lessee of real property or to the owner of the vehicle and shall grant to such person the privilege as therein stated and authorized herein.

(b) It shall be unlawful for any permittee or other person to violate any of the special terms or conditions of any such permit.

Sec. 126. *Lights on parked vehicles.* Whenever a vehicle is lawfully parked at nighttime upon any street within a business or residence district no lights need be displayed upon such parked vehicle.

(b) Whenever a vehicle is parked upon a street or highway outside of a business or residence district during the hours between one-half hour after sunset and one-half hour before sunrise, such vehicle shall be equipped with one or more lamps which shall exhibit a white light on the roadway side visible from a distance of 500 feet to the front of the vehicle and a red light visible from a distance of 500 feet to rear.

(c) Any lighted headlamps upon a parked vehicle shall be depressed or dimmed.

ARTICLE XIV. STOPPING, STANDING, OR PARKING PROHIBITED IN SPECIFIED PLACES

Sec. 127. *Stopping, standing, or parking prohibited. No signs required.* (a) No person shall stop, stand, or park a vehicle, except when necessary to avoid conflict with other traffic or in compliance with law or the directions of a police officer or traffic-control device, in any of the following places:

1. On a sidewalk;
2. In front of a public or private driveway;
3. Within an intersection;
4. Within 15 feet of a fire hydrant;
5. On a cross walk;
6. Within 20 feet of a cross walk at an intersection;
7. Within 30 feet upon the approach to any flashing beacon, stop sign, or traffic-control signal located at the side of a roadway;
8. Between a safety zone and the adjacent curb or within 30 feet of points on the curb immediately opposite the ends of a safety zone, unless the city traffic engineer has indicated a different length by signs or markings;
9. Within 50 feet of the nearest rail of a railroad crossing;
10. Within 20 feet of the driveway entrance to any fire station and on the side of a street opposite the entrance to any fire station within 75 feet of said entrance (when properly signposted);
11. Alongside or opposite any street excavation or obstruction when stopping, standing, or parking would obstruct traffic;
12. On the roadway side of any vehicle stopped or parked at the edge or curb of a street;
13. Upon any bridge or other elevated structure upon a highway or within a highway tunnel;
14. At any place where official signs prohibit stopping.

(b) No person shall move a vehicle not lawfully under his control into any such prohibited area or away from a curb such distance as is unlawful.

Sec. 128. *Parking not to obstruct traffic.* No person shall park any vehicle upon a street, other than an alley, in such a manner or under such conditions as to leave available less than 10 feet of the width of the roadway for free movement of vehicular traffic.

Sec. 129. *Parking in alleys.* No person shall park a vehicle within an alley in such a manner or under such conditions as to leave available less than 10 feet of the width of the roadway for the free movement of vehicular traffic, and no person shall stop, stand, or park a vehicle within an alley in such position as to block the driveway entrance to any abutting property.

Sec. 130. *All-night parking prohibited.* No person shall park a vehicle on any street for a period of time longer than 30 minutes between the hours of (2) a.m. and (5) a.m. of any day, except physicians on emergency calls.

Sec. 131. *Parking for certain purposes prohibited.* No person shall park a vehicle upon any roadway for the principal purpose of:

(1) Displaying such vehicle for sale.

(2) Washing, greasing, or repairing such vehicle except repairs necessitated by an emergency.

Sec. 132. *Parking adjacent to schools.* (a) The city traffic engineer is hereby authorized to erect signs indicating no parking upon either or both sides of any street adjacent to any school property when such parking would, in his opinion interfere with traffic or create a hazardous situation.

(b) When official signs are erected indicating no parking upon either side of a street adjacent to any school property as authorized herein, no person shall park a vehicle in any such designated place. (SECTION REVISED 1952.)

Sec. 133. *Parking prohibited on narrow streets.* (a) The city traffic engineer is hereby authorized to erect signs indicating no parking upon any street when the width of the roadway does not exceed 20 feet, or upon one side of a street as indicated by such signs when the width of the roadway does not exceed 30 feet.

(b) When official signs prohibiting parking are erected upon narrow streets as authorized herein, no person shall park a vehicle upon any such street in violation of any such sign.

Sec. 134. *Standing or parking on one-way streets.* The city engineer is authorized to erect signs upon the left-hand side of any one-way street to prohibit the standing or parking of vehicles, and when such signs are in place, no person shall stand or park a vehicle upon such left-hand side in violation of any such sign.

Sec. 135. *Standing or parking on one-way roadways.* In the event a highway includes two or more separate roadways and traffic is restricted to one direction upon any such roadway, no person shall stand or park a vehicle upon the left-hand side of such one-way roadway unless signs are erected to permit such standing or parking. The city traffic engineer is authorized to determine when standing or parking may be permitted upon the left-hand side of any such one-way roadway and to erect signs giving notice thereof.

Sec. 136. *No stopping, standing, or parking, near hazardous or congested places.* (a) The city traffic engineer is hereby authorized to determine and designate by proper signs places not exceeding 100 feet in length in which the stopping, standing, or parking of vehicles would create an especially hazardous condition or would cause unusual delay to traffic.

(b) When official signs are erected at hazardous or congested places as authorized herein no person shall stop, stand, or park a vehicle in any such designated place.

ARTICLE XV. STOPPING FOR LOADING OR UNLOADING ONLY

Sec. 137. *City traffic engineer to designate curb loading zones.* The city traffic engineer is hereby authorized to determine the location of passenger and freight curb loading zones and shall place and maintain appropriate signs indicating the same and stating the hours during which the provisions of this section are applicable.

Sec. 138. *Permits for curb loading zones.* The city traffic engineer shall not hereafter designate or sign any curb loading zone upon special request of any person unless such person makes application for a permit for such zone and for two signs to indicate the ends of each such zone. The city traffic engineer upon granting a permit and issuing such signs shall collect from the applicant and deposit in the city treasury a service fee of ($) per year or fraction thereof and may by general regulations impose conditions upon the use of such signs and for reimbursement of the city for the value thereof in the event of their loss or damage and their return in the event of misuse or upon expiration of permit. Every such permit shall expire at the end of one year.

Sec. 139. *Standing in passenger curb loading zone.* No person shall stop, stand, or park a vehicle for any purpose or period of time other than for the expeditious loading or unloading of passengers in any place marked as a passenger curb loading zone during hours when the regulations applicable to such curb loading zone are effective, and then only for a period not to exceed three minutes.

Sec. 140. *Standing in freight curb loading zone.* (a) No person shall stop, stand, or park a vehicle for any purpose or length of time other than for the expeditious unloading and delivery or pickup and loading of materials in any place marked as a freight curb loading zone during hours when the provisions applicable to such zones are in effect. In no case shall the stop for loading and unloading of materials exceed 30 minutes.

Sec. 141. *City traffic engineer to designate public carrier stops and stands.* The city traffic engineer is hereby authorized and required to establish bus stops, bus stands, taxicab stands and stands for other passenger common-carrier motor vehicles on such public streets in such places and in such number as he shall determine to be of the greatest benefit and convenience to the public, and every such bus stop, bus stand, taxicab stand, or other stand shall be designated by appropriate signs.

Sec. 142. *Stopping, standing, and parking of buses and taxicabs regulated.* (a) The operator of a bus shall not stand or park such vehicle upon any street at any place other than a bus stand so designated as provided herein.

(b) The operator of a bus shall not stop such vehicle upon any street at any place for the purpose of loading or unloading passengers or their baggage other than at a bus stop, bus stand, or passenger loading zone so designated as provided herein, except in case of an emergency.

(c) The operator of a bus shall enter a bus stop, bus stand, or passenger loading zone on a public street in such a manner that the bus when stopped to load or unload passengers or baggage shall be in a position with the right front wheel of such vehicle not further than 18 inches from the curb and the bus approximately parallel to the curb so as not to unduly impede the movement of other vehicular traffic.

(d) The operator of a taxicab shall not stand or park such vehicle upon any street at any place other than in a taxicab stand so designated as provided herein. This provision shall not prevent the operator of a taxicab from temporarily stopping in accordance with other stopping or parking regulations at any place for the purpose of and while actually engaged in the expeditious loading or unloading of passengers.

Sec. 143. *Restricted use of bus and taxicab stands.* No person shall stop, stand, or park a vehicle other than a bus in a bus stop (or other than a hackney in a hackney stand), or other than a taxicab in a taxicab stand when any such stop or stand has been officially designated and appropriately signed, except that the driver of a passenger vehicle may temporarily stop therein for the purpose of and while actually engaged in loading or unloading passengers when such stopping does not interfere with any bus (hackney), or taxicab waiting to enter or about to enter such zone.

ARTICLE XVI. STOPPING, STANDING, OR PARKING RESTRICTED OR PROHIBITED ON CERTAIN STREETS

Sec. 144. *Application of article.* The provisions of this article prohibiting the standing or parking of a vehicle shall apply at all times or at those times herein specified or as indicated on official signs except when it is necessary to stop a vehicle to avoid conflict with other traffic or in compliance with the directions of a police officer or official traffic-control device.

Sec. 145. *Regulations not exclusive.* The provisions of this article imposing a time limit on parking shall not relieve any person from the duty to observe other and more restrictive provisions prohibiting or limiting the stopping, standing, or parking of vehicles in specified places or at specified times.

Sec. 146. *Parking prohibited at all times on certain streets.* When signs are erected giving notice thereof, no person shall park a vehicle at any time upon any of the streets described in schedule III attached to and made a part of this ordinance.

Sec. 147. *Parking prohibited during certain hours on certain streets.* When signs are erected in each block giving notice thereof, no person shall park a vehicle between the hours specified in schedule IV of any day except Sundays and public holidays within the district or upon any of the streets described in said schedule IV attached to and made a part of this ordinance.

Sec. 148. *Stopping, standing, or parking prohibited during certain hours on certain streets.* When signs are erected in each block giving notice thereof, no person shall stop, stand, or park a vehicle between the hours specified in Schedule V of any day except Sundays and public holidays within the district or upon any of the streets described in said Schedule V attached to and made a part of this ordinance.

Sec. 149. *Parking time limited on certain streets.* When signs are erected in each block giving notice thereof, no person shall park a vehicle for longer than ( ) at any time between the hours of ( ) a.m. and ( ) p.m. of any day except Sundays and public holidays within the district or upon any of the streets described in Schedule VI attached to and made a part of this ordinance.

Sec. 150. *Parking signs required.* Whenever by this or any other ordinance of this city any parking time limit is imposed or parking is prohibited on designated streets it shall be the duty of the city traffic engineer to erect appropriate signs giving notice thereof and no such regulations shall be effective unless said signs are erected and in place at the time of the alleged offense.

Article XVIII concerns the operation of Traffic Violation Bureau, and Article XIX concerns Penalties and Procedures on arrest.

The appendix of the Model Traffic Ordinance, revised in 1952, adds

PARKING METER ZONES

Sec.____. *Parking meter zones.* (a) Parking meter zones are hereby established within the district or upon those streets or parts of streets described in schedule _____attached to and made a part of this ordinance in which zones the parking of vehicles upon streets shall be regulated by parking meters between the hours specified in said schedule_____of any day except Sundays and public holidays.

(b) The city traffic engineer is hereby authorized, subject to the approval of the city council by amendment of said schedule_____to establish parking meter zones at other locations upon those streets or parts of streets where it is determined upon the basis of an engineering and traffic investigation that the installation of parking meters shall be necessary to aid in the regulation, control, and inspection of the parking of vehicles.

Sec.____. *Installation of parking meters.* (a) The city engineer shall install parking meters in the parking meter zones established as provided in this ordinance upon the curb immediately adjacent to each designated parking space. Said meters shall be capable of being operated, either automatically or mechanically, upon the deposit therein of a five-cent coin of United States currency, for the full period of time for which parking is lawfully permitted in any such parking meter zone, or in lieu thereof, for the following periods of time, upon the deposit therein of a coin or coins of United States currency as specified:

Upon the deposit of one nickel:
For the full lawful parking time.
Upon the deposit of one penny:
For one-fifth of the lawful parking time.
Upon the deposit of two pennies:
For two-fifths of the lawful parking time.
Upon the deposit of three pennies:
For three-fifths of the lawful parking time.
Upon the deposit of four pennies:
For four-fifths of the lawful parking time.
Upon the deposit of five pennies:
For the full lawful parking time.

(b) Each parking meter shall be so designed, constructed and installed, and set that upon the expiration of the time period registered, by the deposit of one or more coins, as provided herein, it will indicate by an appropriate signal that the lawful parking meter period has expired, and during said period of time and prior to the expiration thereof, will indicate the interval of time which remains of such period.

(c) Each parking meter shall bear thereon a legend indicating the days and hours when the requirement to deposit coins therein shall apply, the value of the coins to be deposited, and the limited period of time for which parking is lawfully permitted in the parking meter zone in which such meter is located.

Sec.____. *Parking meter spaces.* (a) The city traffic engineer shall designate the parking space adjacent to each parking meter for which such meter is to be used by appropriate markings upon the curb and/or the pavement of the street. Parking meter spaces so designated shall be of appropriate length and width as to be accessible from the traffic lanes of such street.

(b) No person shall park a vehicle in any such designated parking meter space during the restricted and regulated time applicable to the parking meter zone in which such meter is located so that any part of such vehicle occupies more than one such space or protrudes beyond the markings designating such space, except that a vehicle which is of a size too large to be parked within a single designated parking meter zone shall be permitted to occupy two adjoining parking meter spaces when coins shall have been deposited in the parking meter for each space so occupied as is required in this ordinance for the parking of other vehicles in such space.

Sec._____. *Deposit of coins and time limits.* (a) No person shall park a vehicle in any parking space upon a street alongside of and next to which a parking meter has been installed during the restricted and regulated time applicable to the parking meter zone in which such meter is located unless a coin or coins of United States currency of the appropriate denomination as provided in this ordinance shall have been deposited therein, or shall have been previously deposited therein for an unexpired interval of time, and said meter has been placed in operation.

(b) No person shall permit a vehicle within his control to be parked in any such parking meter space during the restricted and regulated time applicable to the parking meter zone in which such meter is located while the parking meter for such space indicates by signal that the lawful parking time in such space has expired. This provision shall not apply to the act of parking or the necessary time required to deposit immediately thereafter a coin or coins in such meter.

(c) No person shall park a vehicle in any such parking meter space for a consecutive period of time longer than that limited period of time for which parking is lawfully permitted in the parking meter zone in which such meter is located, irrespective of the number or amounts of the coins deposited in such meter.

(d) The provisions of this section shall not relieve any person from the duty to observe other and more restrictive provisions of this ordinance and the state vehicle code prohibiting or limiting the stopping, standing, or parking of vehicles in specified places or at specified times.

Sec._____. *Use of slugs prohibited.* No person shall deposit or attempt to deposit in any parking meter any slug, button, or any other device or substance as substitutes for coins of United States currency.

Sec._____. *Tampering with meter.* No person shall deface, injure, tamper with, open, or willfully break, destroy, or impair the usefulness of any parking meter.

Sec._____. *Application of proceeds.* (a) The coins required to be deposited in parking meters as provided in this ordinance are levied and assessed as fees to cover the regulation and control of parking upon public streets; the costs of parking meters, their installation, inspection, supervision, operation, repair, and maintenance, control and use of parking spaces, and regulating the parking of vehicles in parking meter zones; and the costs of acquiring, establishing, improving, maintaining and operating public offstreet parking facilities.

(b) The coins deposited in parking meters shall be collected by the duly authorized agents of the city (treasurer) and shall be deposited by him in a special fund to be known as the "Parking Meter Special and Trust Fund."

(c) The city (treasurer) shall pay from such special fund the costs of any parking meters purchased by the city and installed as provided in this ordinance, and expenses incurred for their installation, inspection, service, supervision, repair, and maintenance, for making collections from such parking meters, and for the enforcement of the provisions of this ordinance applicable to parking meter zones. The net proceeds of the operation of parking meters in said special fund, after the payment of such costs and expenses, shall be used for parking studies and for the acquisition, establishment, improvement, maintenance, and operation of public offstreet parking facilities as the city council shall from time direct.

Schedule____

Sec.____. *Parking meter zones.* In accordance with Section____parking meter zones are hereby established within the district or upon those streets or parts of streets described herein in which the parking of vehicles upon streets shall be regulated by parking meters between the hours specified of any day except Sundays and public holidays as follows:

(a) One-hour limit:

(1) Between oo a.m. and oo p.m. except (Mondays) and between oo a.m. and oo p.m. on (Mondays).

(2) Between oo a.m. and oo p.m.

(b) Two-hour limit:

(1) Between oo a.m. and oo p.m.

APPENDIX II

Model Specifications for Parking Meters

(As recommended in 1948 by a committee of the Institute of Traffic Engineers[1])

Sealed proposals for furnishing and installing______parking meters addressed to___________________________________will be received at____until__________________________(hour) on____, and will be opened immediately thereafter. All bids shall comply with the following specifications and requirements:

The parking meters furnished shall be the manufacturer's latest models and shall bear a written guarantee against poor workmanship and defective parts for a period of at least______________years from date of installation and initial operation.

The contractor shall furnish the service of a person or persons skilled in the operation and maintenance and repair of the meters for such time as is deemed necessary by the purchasing authority to instruct and assist authorized maintenance personnel to adequately service and repair the meters, but in no event shall this exceed seven days from the beginning of the operation of the parking meters. This service shall be without cost to the City of______________________________.

Each bidder may furnish with his proposal any additional information for sales point or guarantee of his equipment which he may deem to be of value in the city's consideration of his meter for award under this contract and which in his opinion proves the merit or superiority of his parking meter or method of installation. Any additional information shall be separately set forth and must in no manner qualify his bid or be an alternate proposal to preclude compliance with any of the specifications mentioned herein.

The purchasing authority, however, reserves the right to include in any contract any such additional offers or guarantees as may be made in such statements if in its opinion they would inure to the benefit of the City of______________________________. The City of____shall have no obligation to pay any of the purchase price except from money received from the operation of the meters after installation and beginning of operation.

The contractor shall furnish all material and labor for complete installation and shall carry liability and property insurance in an amount of not less than ______________________dollars. The contractor shall present the insurance policy or policies to the purchasing authority for its approval and, in addition, evidence of Workman's Compensation Insurance covering all its employees in connection with the installation of the parking meters in an amount equal to the requirements of the State of____. Said policy or policies shall protect the city against any liability or property damage resulting from the faulty installation or negligence of the contractor for any employee or sub-

[1] For additional standards by 1955 committee of the Institute of Traffic Engineers see Appendix II, p. 365.

contractor of his in the installation of meters or posts and thereafter until title to all meters shall become vested in the City of________________________.

Each bidder must furnish a complete price list of parts which may be required for a parking meter and a price list covering all costs for servicing and installing parts if same is to be done at his factory and necessity requires that the work be done there. Prices as stated are to be firm for a period of at least one year from the date of installation or the beginning of the operation of the parking meters.

A sample of the complete parking meter (except for meter post) to be furnished must be submitted to the purchasing authority with the proposal. The City of________________________is to be held free of any and all liability or expense on account of patent claims, royalty demands, or of defending any suits for alleged infringement of patents in connection with any patented device or designs used in the construction of these meters. The parking meter company's price shall include any royalties or other charges due or payable to any individual, firm, corporation or organization because of work done in the design or development of equipment or methods incorporated in the meters furnished hereunder.

Before the execution of any contract, the Purchaser of Supplies shall require the successful bidder to file a good and sufficient corporate surety bond to be approved by the________________________for the faithful performance of the contract, in a sum of 50 percent of the total contract amount. Wherever the work "City" applies in these specifications it shall refer to and mean the City of________________________.

General Requirements:

The meter shall be of a type which will indicate by suitable signals:

(1) That the meter is in use; that is, it is in the process of measuring the parking time paid for by the depositing of a lawful coin in said meter.

(2) That the meter is not in use; that is, the space at which it is located should be available for parking.

(3) The meter shall be operable by a penny (one-cent piece), or a nickel (five-cent piece), or a combination of sufficient multiples thereof to permit a maximum time interval of one or two hours, measured between the change of signals, as desired and specified in each particular purchase order. It may either be "automatic," that is, the operation is completely automatic after the coin has been inserted; or "manual," that is, the manually operated type in which the operation of the meter is initiated by the user, after the deposit of the coin, by the turning of a handle or similar device after which the operation becomes automatic.

(4) The design and construction shall be such that it assures both that the full parking time will be made available to the user and also that the time-measuring mechanism starts the measurement of the parking time as soon as the "in use" signal is displayed. The meter shall be set so it will not be capable of being operated so that multiples of the parking period can be extended beyond the legal parking time limit.

(5) The meter shall be constructed of corrosion-resisting materials. It shall be of substantial and rugged construction to withstand rough usage and assure

long life with a minimum amount of servicing. The design shall be as simple as practicable to perform the specified functions. All workmanship shall be first class.

(6) Proposals shall indicate a satisfactory method of meter service both during and after the guarantee period. Meters will not be acceptable for purchase unless evidence is presented to show that at least five hundred meters of substantially the same design and construction as that of the particular model offered have been in successful use for a period of at least six months. Sample of meter stipulated in bid must accompany bid for purposes of inspection and a 5 percent certified check or bid bond of the total amount of the contract price must accompany the bid.

DETAIL REQUIREMENTS:

The parking meter shall consist of the following principal parts: A metal enclosing case; a clock or timing mechanism, operating mechanism and coin receptacle.

Parking meter case:

All casting shall be of smooth and clean surface and shall be free from blow holes, cracks, or any other foundry defects. The meter case when assembled shall be accurately fitted so that all parts assemble neatly and uniformly.

The entire parking meter mechanism shall be enclosed in a substantial weather-proof metal case or housing, so arranged as to prevent access to the interior except through the openings provided for servicing the meter, and for the collection of coins. Such openings shall be protected by cylinder locks of at least four tumblers or of approved equal quality. Access to the coin receptable shall not be available through the openings provided for servicing the meter. The lock protecting the servicing opening and the lock protecting the opening for the collection of coins shall not be operable by the same key. The case shall be arranged for mounting at the top of a two-inch or two and one-half-inch standard steel or wrought iron pipe.

Included as part of the parking meter shall be a substantial steel standard shaft or post of such height that when completely installed and ready for operating, the top of the parking meter case will be approximately fifty-four inches above the sidewalk. The design shall be optional and of the type best suited to fit the meter offered. The parking meter case shall be designed for attachment to these shafts in such fashion that when the meters are closed and locked the fastenings are concealed and the meter may not be removed without being opened or damaged.

A direction plate with the proper legend designating the hours during which it is compulsory to use the meter shall be incorporated as a part of each meter.

Clock or Timing Mechanism:

The clock or timing mechanism shall be of acceptable manufacture and will be constructed with a minimum of moving parts and shall be capable of being detached as a unit and replaced with a similar unit with a minimum loss of time and revenue.

The clock or timing mechanism shall indicate correct time at all temperatures between —30°F and 130°F, with an error not exceeding a time lag of two minutes per hour. Errors in which the time recorded exceeds the elapsed time will disqualify the parking meter for consideration.

The clock or timing mechanism throughout shall be of first class workmanship with cut or stamped gears and pinions free from burrs. The clock shall not operate continuously but shall come to a rest after each operating cycle of the meter has been completed.

Operating Mechanism:

The entire operating mechanism (including the clock or timing mechanism) shall be built of stainless steel and brass with the exception of the operating spring or springs which shall be of rust-proof material, and the entire meter operating mechanism shall be constructed as a completely assembled unit capable of readily being removed and replaced as a whole without removing or disassembling the meter case. The meter operating mechanism shall in no case be arranged so that it is exposed directly to the weather when the meter is opened for the removal of coin boxes.

The meter timing mechanism shall indicate on a dial suitable in shape and size the passage of the interval of time. The dials shall be divided into at least two colored sections, one showing legal parking and the other illegal parking with designated graduations, the smallest graduations not to exceed five minutes. The meter mechanism shall be so designed that when the proper coin is inserted in the slot and the lever is properly operated the pointer hand or time indicator will be turned to the designated number of minutes on the dial allowed by the specific parking area. The meter shall then function with the pointer or time indicator moving across the dial until the legal parking time has expired after which time the meter shall register illegal parking. Visible meter dials shall face on-coming traffic in order to facilitate the policing and permit motorists in advance to determine the amount of unused time on the meters.

Coin Receptacle:

Each parking meter shall be provided with two removable receptacles or acceptable alternate device for receiving and safely retaining the coins deposited. The receptacle or alternate device shall be of substantial construction of corrosion-resisting metal and shall have a capacity of not less than three dollars ($3.00) in nickels. Provisions shall be made against the unauthorized removal of coins from the receptacle or alternate device by providing means for sealing and/or locking said receptacle or alternate device. Means shall also be provided against the removal of coins through the opening through which the coins enter the receptacle or alternate device.

There shall be furnished sufficient number of coin box carrying receptacles or cases to house and carry all coin receptacles. The meter shall be so constructed that when a slug is deposited to actuate the meter, said slug shall be clearly visible through a window provided for this purpose on the front of the meter. The coin slot of the receptacle and the coin chute of the meter shall be of such dimensions as to reject coins of greater diameter or greater thickness than those of the genuine coin.

General Installation:

Installation of the parking meter posts must be timed so as to coincide with the installation of the parking meter heads so that the parking meter posts shall not be completely installed more than 15 days prior to the complete installation of the parking meter heads and the date of beginning of operation of the parking meters.

The successful bidder will also be required to furnish all necessary labor for installing the standards, including all labor and equipment necessary for making sidewalk openings and for repairing the same and all labor necessary for attaching the standards and mounting the meters. The contract will include the complete installation of the parking meters and standards in place and ready for use. The successful contractor will be required to pay prevailing local union wage rates for all labor furnished and used in the installation of meters and standards. Local labor shall be used for such installations to the greatest practicable extent.

Meters shall be installed under the supervision and direction of the ______________________________ of said city and in such locations as he shall order. All meters must be installed in a manner satisfactory to __________ and must meet with his approval both as to mechanism and installation.

The City, acting by its City Council, reserves the right to reject any and all bids or to accept any bid which it deems most advantageous for the City.

A 1955 committee of the Institute of Traffic Engineers offers the following additional standards to serve as a guide to traffic engineers and others concerned with the application, installation and operation of parking meters:

Warrants:

Curb parking meters are warranted as an aid in the control of parking in a given block side if all of the following conditions exist:

a. High demand is indicated by usage of at least 80 percent of the available space hours during the time of limited parking.

b. The block side is within walking distance of generators of high short-time parking demand, such as stores and office buildings.

c. Parking time limits exist and are enforced.

d. Observation shows need for greater turnover, indicated for example, by:

1. High average parking duration.
2. High level of enforcement required to prevent overtime parking.
3. Cruising by drivers desiring parking space.

e. Extension of parking time limit to adjacent block sides is not feasible or not effective in relieving parking demand.

Installation:

a. The meter should be installed as follows:

	Parallel Parking	*Angle Parking*
Distance from curb	12″–24″	18″–24″
Distance from front end of stall		
Single stall meter	12″–36″	24″–72″
Two-stall meter	On separation line	On separation line
Height of meter post above sidewalk	36″–48″	36″–48″

b. All parking stalls equipped with meters shall have pavement markings.

Design:

a. Parking meters shall include:

1. A red "violation" or "time expiration" flag with a minimum area of four-and-a-half square inches. The flag should be easily visible to an enforcing officer checking the meters by vehicle.

2. A time scale with a needle indicator showing unexpired time, preferably separated from the violation flag.

3. A plate or sign attached to the meter, stating the hours of meter operation, the meter period, the parking fee, and the coin denominations that the meter will accept. Emphasis on coin limitations is desirable, such as "Nickels Only," or "No Dimes."

b. Standard parking control signs shall be used. In addition, parking meter posts may be painted distinctive colors to indicate the meter period or special restrictions. Meter post colors should conform to the local curb paint colors as much as possible.

Example: green for 12 and 24 minutes
aluminum for one hour or over
red for parking prohibitions during portions of the day.

The type and hours of parking prohibitions may also be emphasized by repeating prohibition message on a decal on the meter or post.

Operation:

a. The maximum permitted parking time indicated by the curb meter and its effective hours and days of operation shall be identical with those posted on the standard parking control signs.

b. The maximum permitted parking time in a metered area shall be determined by the same considerations as in any unmetered area of restricted parking.

c. Rates should be set in simple fractions of an hour and be uniform throughout a city or metropolitan area.

Control:

a. Control by traffic engineering personnel should include:

1. "Before and After" study at time of first installation.

2. Periodic rechecks to ascertain effect of meters on turnover and effectiveness of enforcement.

3. Maximum utilization of meter revenue records for parking study information.

Enforcement:

a. Enforcement is outside the traffic engineer's duties, but within his field of interest. To serve the traffic engineer and the purpose of the parking meter best, enforcement shall be vigorous, consistent, and continuous. It should include:

1. Checking meter flags during *all* hours of meter use.

2. Spot checks of vehicles by tire mark or license plate to discourage paid-for but illegal long-time parking.

3. Vigilance against slugs, jamming, vandalism, and theft.

APPENDIX III

A Simplified Study of Parking In the Central Business District

The purpose of this manual is to provide a simplified study of parking in *small* cities.

I. *Selection of the Central Business District* in the smaller cities (2,500–10,000) will usually include that portion of the main street devoted principally to business establishments, the entire blocks containing those establishments, both sides of the two nearest streets parallel to the main street, and the cross streets as far out as commonly used for downtown parking. Where the main or some other street continues as a "string" development, limits will be arbitrarily set. In larger cities the area may extend a block or two further in each direction.

II. *The Inventory* is the assembly of information about the location, extent, capacity, layout, type and operating characteristics of existing established parking facilities, both at the curb and offstreet. Using whatever local maps are available, prepare several positive prints of a map at a scale of approximately one inch to 100 feet, showing block outlines and (where available) outlines of all buildings for the selected area and approximately one block beyond in all directions. This will serve as a base or working map for the inventory of parking space.

On this map, each block will be given an identifying number, as will each facility (curb face, lot or garage). In numbering blocks, a preferred system considers a block as both sides of a street between two adjacent intersections, including both curbs and lots, garages or buildings entered from those curbs. Alleys, usually one-way, may be assigned to the block from which entrance is allowed. The advantage of this method is that blocks, especially in the smaller cities, are much more homogeneous as to traffic and land usage characteristics.

It is suggested that the inventory be made by a two-man crew, equipped with the base map, a supply of curb and offstreet inventory forms, a clipboard, pencils, and a 50-foot cloth tape. If the base map includes building outlines, the tape need rarely be used. Figure A–1 illustrates the use of the base map.

Curb Space: Every curb face and alley within the selected district will be inspected; and, using the curb inventory record form (Figure A–2), record will be made of every type of space indicated thereon. Where curb spaces are not indicated by meters or otherwise marked, the number of spaces will be determined by a count of vehicles and empty spaces, or by allowing twenty feet per space. The "special" spaces are to be recorded in number of feet, metered spaces are indicated by an M, and "No Parking" by NP.

At the same time a graphic record will be kept on the base map, as indicated in the example. The location of curb cuts, hydrants and "No Parking" areas should also be shown. Alleys will be shown, with direction of traffic indicated and whether passenger-car parking is allowed.

Offstreet Space: Use one offstreet inventory form (Figure A–3) for each lot or garage, make a sketch on the back of each, and show location of each one on

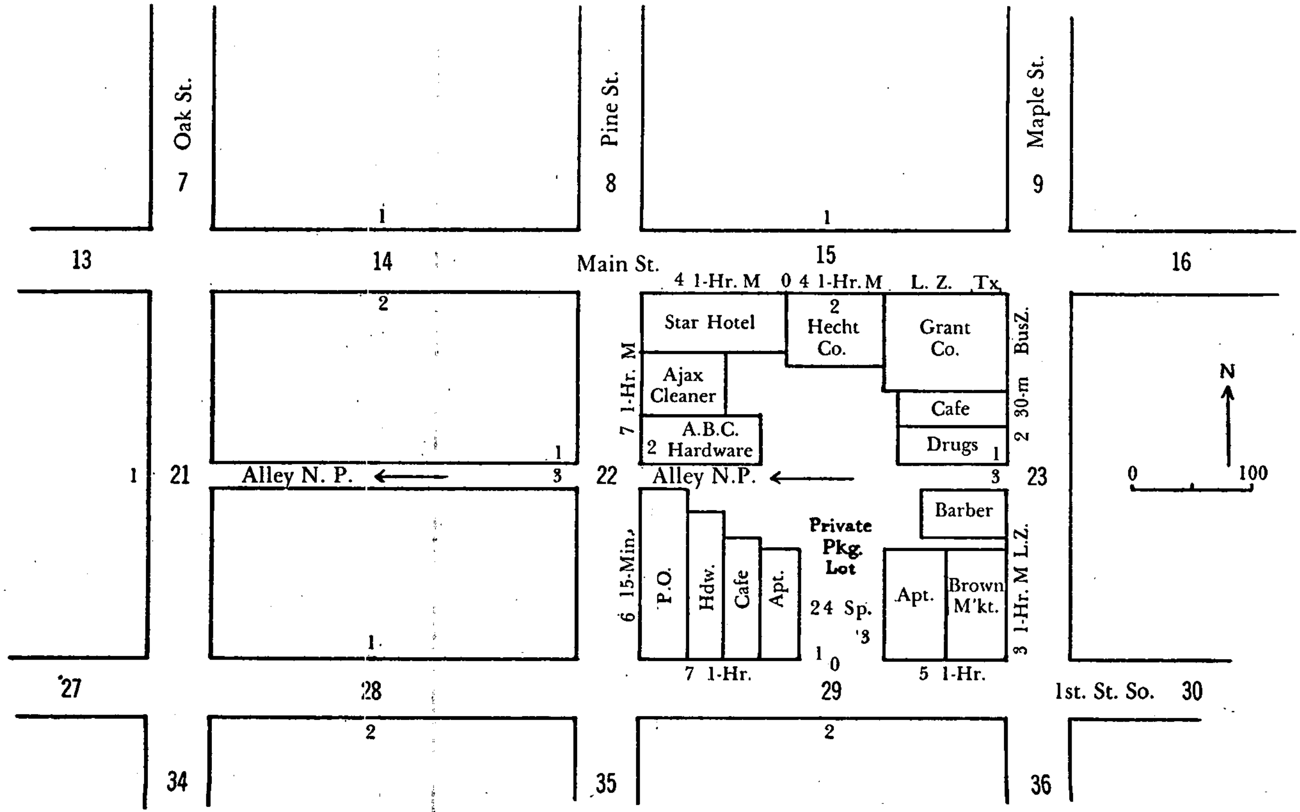


FIGURE A-1. Use of base map.

State of Kentucky

Paris Parking Study

Inventory of curb space in central business district

Page 1 of 9

Location					Public Parking					Special Spaces (feet)					Restricted (feet)	
Block	Side	Subject Street	Bounding Streets		Angle or Par.	No. Spaces	Time Limits	No. meters	Parking Ordinance No.	Hotel, Theater	Truck Load Zone	Bus Zone	Spec. Permits	Taxi Stands	N.P	Alleys, Drives
12	S	Main	Elm	Poplar	Par.	8	M-1 hr.	8	273	25 ft.	45 ft.	—	—	20 ft	12	—
12	E	Elm	Main	1st So.	Par.	4	M-15 min	4	202	—	—	—	—	—	10	10
						6	M-1 hr.	6	202	—	—	—	—	—	10	—

Inventory by J. P. Jones Date March 1955

FIGURE A-2. Curb inventory form.

the base map. Include every offstreet parking area established as such or regularly used. Do *not* include small informal areas or spaces sometimes used by one or more parkers, such as lawns, on vacant lots, between buildings, etc.

Capacity should be recorded both as it would be with clear aisles and as it would be if the lot were packed full. Determine the number of spaces when the lot is nearly full, if possible, by counting the vehicles and empty spaces. In some

____________ Parking Study

Offstreet Parking Facility Inventory

1. Lot____Garage ________ located on ____ side of ____________ Street
between ____________ and __________ Streets. Block No. ______ Facility ______.

2. Public ____ Private ____ Free ____ Pay ____

3. Owner ________________

4. Operator or lessee ____________________

5. Lot dimensions ____________________ Land area ________________

6. Entrance ____ ft. wide from __________ Street. Exit ____ ft. wide to __________ St.

7. (If lot) No. of spaces with aisles clear ____________ if packed ________

(If garage)	Clear aisles	Packed
No. spaces in basement	______	______
ground floor	______	______
2nd level	______	______
3rd level	______	______
4th level	______	______
Total	______	______

8. No. attendants ______ Open from ____ a.m. to ____ p.m.

9. Rates ____

10. Approximate total number vehicles stored daily (est.) ________________

11. Parking area surface type __________ Condition ______________

12. Lighting ________________

13. Sketch layout on back of this sheet, showing aisles, stall arrangement, entrances and exits.

14. Field data obtained ______________ 195__ by ____________________

FIGURE A-3. Offstreet inventory form.

facilities the layout and dimensions are such that in normal usage cars are parked two deep on one or both sides of the aisles. If this arrangement still leaves clear aisles, then these spaces should be included as part of the clear-aisle capacity.

If the central business district has alleys, include any *established* facilities approached from them.

The base map should show the outlines of all existing buildings (from

Sanborn maps or from assessors' maps). The field inventory should add to this the names of the principal occupants or users of commercial buildings. This procedure will greatly simplify sketching the position of curb features. The base map should be checked for any buildings added or removed since the original map was made.

The completed data should include all curb and offstreet inventory forms, and a copy of the base map showing location, type and number of all public parking spaces at the curb and offstreet, and use the of principal buildings and stores. Since the base map shows the outlines of existing buildings it will also indicate the vacant areas and notes should be made of those suitable for development as parking areas.

III. *Study of Usage of Parking Spaces.* Each curb face, lot and garage is to be studied on one weekday from 10 A.M. to 6 P.M. This may be any day from Monday through Friday, inclusive, omitting any holiday, days when stores are open in the evening or days of bad weather. It is not necessary to study all facilities on the same day.

The Parking Usage Study form (Figure A–4) is used for this purpose. Depending upon the number of parking spaces, one (or more) sheets should be used for each curb face, and one (or more) for each lot or garage. One form will cover up to twenty-five spaces, which is ample for the average curb face. *This form should be reprodued cat a larger scale*, to allow room for making entries.

Each curb face and each lot or garage are to be toured every fifteen minutes, from 10 A.M. to 6 P.M. and each observer should be assigned no more spaces than can easily be covered in fifteen minutes, including his return to the starting point. Under average conditions this schedule should permit his covering about fifty vehicles or the four sides of an average small-city block. It is suggested that the assigned faces or the square block be toured in a clockwise direction (or with the buildings at the observer's right hand).

The first tour should start at 9:45 A.M., since it involves more detail and may require up to thirty minutes. The Parking Usage form provided *will have previously had added to it*, in the title space, a description of the location (*one form for each curb face*), and in the left-hand column a graphic diagram showing important buildings and stores, location of driveways, alleys, hydrants, bus and truck zones, and all authorized curb parking spaces, as taken from the inventory forms and maps. The spaces at the foot of the form are for office use only.

On the first tour the observer will make a record of every car or truck parked at the curb, whether in a legal space or elsewhere. It will be noted that the form provides one line for each legal space and one or more lines for each of the various restricted spaces that may be present. Use the line opposite the point where each vehicle is found.

An exception to this is when vehicles are found parked *double*, or in *informal* spaces. These will be recorded in the extra lines near the foot of the page. An informal space is any space *not* at the curb and not in an established lot or garage —an irregular and temporary space, such as on a sidewalk, lawn or front yard, in a vacant lot, between two stores, off an alley, etc.

On the first tour (beginning at 9:45 A.M.), record in the first column (headed 10:00 A.M.) the *last three digits* of the license number of all vehicles present. Also record the type of vehicle; use C for car, T for a truck, and TX for a taxi.

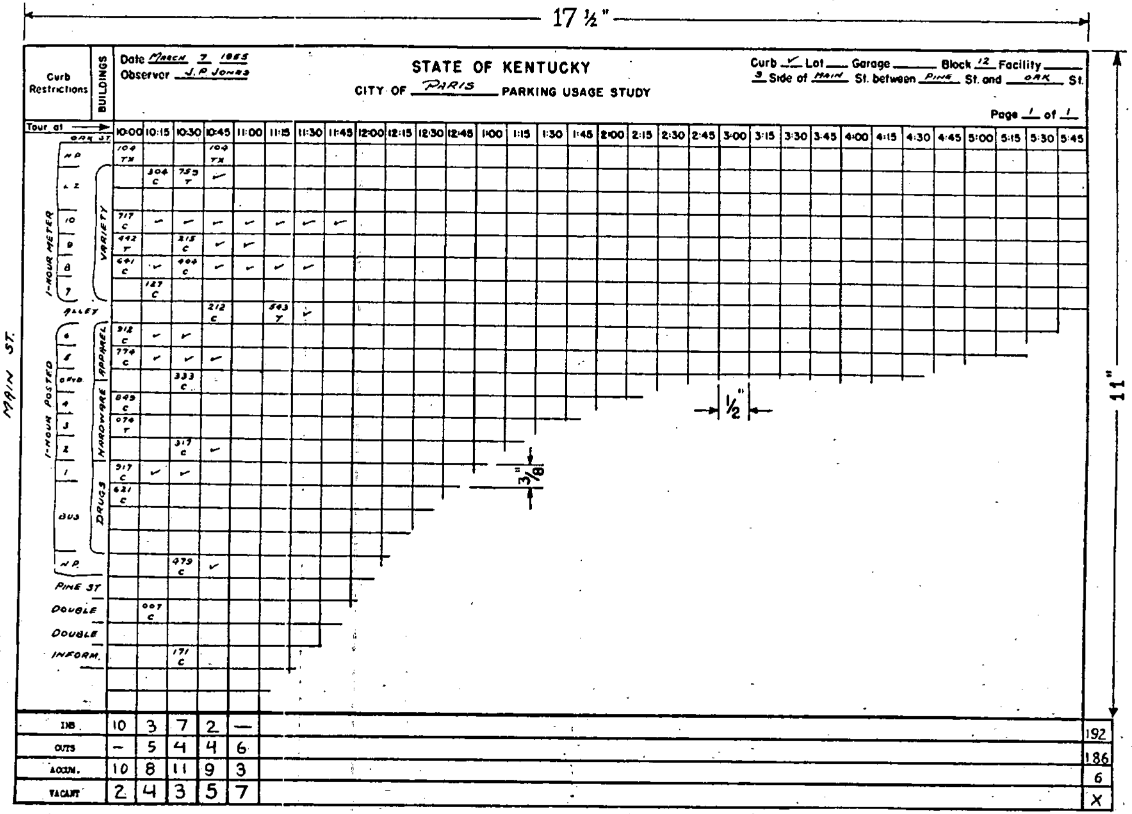


FIGURE A-4. Parking usage study form.

Taxis *in taxi-stands* will not be recorded, but will be recorded if actually parked elsewhere. Buses and emergency vehicles will not be recorded.

The first tour—requiring thirty minutes—must be completed before 10:15 A.M. All following tours, one every fifteen minutes, will start from the same point and follow the same path as the 9:45 A.M. tour.

On each tour (after the first), using the appropriate column, make a check mark for each vehicle found on the preceding tour and still present; for each new vehicle record the last three digits of the license number and a C, T, or TX. See the sample form in this manual for examples. If necessary use extra lines at the foot of the form if several double or informal parkers are found on any one cruise.

Each tour after the first will involve primarily check marks and only a few new license numbers, and can be completed in fifteen minutes or less.

The record concerning any vehicle or vacancy, on each tour, should represent the condition existing at the moment the observer passes that space; he will not make allowance for what he may have seen just before or just after passing it. There should be no interviews and no contacts with drivers, and the recording of license numbers should be as inconspicuous as possible. License numbers are recorded only to permit an estimate of the demand in terms of time, not for enforcement purposes.

Observation of Alleys. Alleys used at all for parking by cars or trucks, legally or not, should be observed in the same way—one form sheet for each alley. In the left-hand column should be sketched the site of any back yards used for informal parking; the record for each vehicle found should be placed on a line representing its approximate location. Each vehicle parked *off* thc alley should be indicated by drawing a circle around the entry, to distinguish the legally parked vehicles (off-alley) from those parked illegally (in the alley).

On an alley tour, do *not* include any vehicles parked on any *established* off-street lots or garages. The base map should show the location of all established lots or garages.

Observation of Lots or Garages. Small cities have few lots or garages. Those found in the inventory and shown on the base map will be toured every fifteen minutes as are the curbs. The same form will be used—one page for every twenty to twenty-five spaces—and the lot should be toured row by row, each time in the same order. The assignment for one observer must be based upon the distance between facilities and the number of spaces. If more than one page is used for one lot, the left-hand margin should be used for identification, such as "West Row" or "Middle Row," and the pages numbered in order.

Observation of 12- or 15-minute curb spaces. The touring or cruising procedure is entirely inadequate for recording the performance at spaces having a twelve- or fifteen-minute time limit. The turnover is usually very high at these spaces—usually near post offices or banks—and many vehicles may both arrive and depart in a fifteen-minute period. If one curb face has more than one or two such spaces, continuous observation for the eight-hour period is desirable.

For this record the same usage form is used and the usual marginal sketch is made, but the column headings (10:00, 10:15, etc.) are crossed out. Each line then is used for a record of performance at the space opposite, and each space thereon is used for a record of one vehicle's performance. The record for each vehicle should show the last three digits of the license number, the type of vehicle, the time it parked (to the nearest minute), and the time it left. Thus the entries on one line might be as follows:

043C	728C	020T	659C	
10:12–10:19	10:21–10:36	10:42–11:12	11:13–11:24	etc...

One line has spaces for thirty-two entries. If more spaces are needed, a second page may be used as a continuation.

Special Sample Study. A touring study of curbs under one-hour (or longer) restrictions, even at intervals of only fifteen minutes, misses an appreciable number of very-short-time parkers. An adjustment for this parking factor may be based on a sample study. Two typical curb faces are selected, one on the main street and one on the parallel street farthest away, and on the same day when those faces are being toured during the normal study; each of these two faces is observed continuously by a separate observer, using the same procedure suggested above for study of fifteen-minute spaces. A comparison of the parallel records will permit determination of an adjustment factor.

Summary and Analysis of Usage. Check each field form and sketch as it is turned in, to insure that each has the necessary data to identify it as applying to one and only one curb face or lot or garage (or alley), and that it agrees with the base map. Also verify that every facility has been covered.

IV. *Local Ordinances.* Make a copy of all city ordinances concerning parking, including those on time restrictions, establishment of metered zones, use of meters, establishment of loading zones, etc.

V. *Meter Revenues.* Obtain data for the most recent fiscal year, by months (and by meters or classes of meters if available), on meter revenue and its disposition.

VI. *Enforcement.* Obtain the most recent fiscal year's summary of parking tickets, offenses and fines.

VII. *Saturday Study.* If parking congestion or conditions are undeniably at their worst on Saturdays—and because it is not practicable to make a full usage study on a Saturday—a simple count of parking volumes will permit a reasonable estimate or comparison.

At that time on a Saturday when the parking accumulation is believed to be at its peak, all available persons should be used to make a single quick count of *all* vehicles parked in the selected area (at the curb, legally, illegally, or informally), in lots or garages, and in or off alleys. The record will be kept separately for each curb face, lot, alley, etc. If the Saturday parking overflows into a larger area, this too will be counted (but kept separate).

Vehicle-counts at the curbs may be done from a touring car. Counts in alleys and offstreet should be on foot.

Comparison of the Saturday peak accumulation with the corresponding average weekday peak accumulation will provide a factor for use in expanding weekday data.

VIII. A two-directional and classified (by type of vehicle) count of traffic may be made at a cordon line surrounding the central business district as selected. Advice and appropriate forms for this count should be obtainable from the highway planning section of the state highway department; it may also be able to lend "clicker" counters for the purpose. This count may be made as a composite sample, whereby each entering street is counted for one weekday, preferably from 6 or 8 A.M. to 6 P.M., by a small crew which counts one or two streets a day.

IX. *Adequacy of Signs and Markings.* This inspection should be made by someone familiar with the national standards for traffic signs and markings. It should include a record of deviations from that code and of poorly located, confusing, conflicting and misleading signs, as well as signs and curb markings placed without authorization of a city ordinance.

Summarizing the Data

The Inventory:

Figure A–5 shows a form for summarizing the data from the inventory field sheets, using one line for each facility (curb face, alley, lot or garage), and one line for each block total. Field sheets show footages for special spaces and restricted curbs, but do not show footage for public parking spaces or for the total curb length. The total curb length may be scaled from the base map, and footage for public parking obtained by deducting the footage of special and restricted curb.

From this inventory summary two listings may be used in the text of a report. First, from the grand total line of the summary, make a list of the total number of spaces of each type of parking available, and of the number of space hours available. For a study made from 10 A.M. to 6 P.M. each space represents eight space hours. Thus for the summary sheet illustrated, the listing would be

Table I

	Spaces	*Space Hours*
Curb Spaces		
Unrestricted	210	1,680
Posted 1-hour	56	448
Metered 1-hour	850	6,800
Metered 15-minutes	4	32
Total curb	1,120	8,960
Public Lots		
Free	64	512
Garages		
Pay	20	160
Total	1,204	9,632

Similarly, a listing may be made of the total curb footage and its breakdown, as

Table II

Curb footage:	*Feet*	*Percent*
Available for public parking	23,520	76.5
Taxi stands, hotel and theater entrances, special permit spaces	6,000	19.5
Restricted (No Parking)	1,200	4.0
	30,720	100.0

City South Bend, Ind.

Date 12 April 55

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INVENTORY OF PARKING SPACES
SUMMARY FORM

Block	Facility	PUBLIC CURB PARKING						CURB FOOTAGE				LOTS					GARAGES			Offst.	Total	Load
		Unr.	P 2-hr.	P 1-hr.	M 1-hr.	M 15-m	Total Spaces	Pub. Pkg.	Spes. Sp.	Restr.	Total	Public Free	Public Pay	Private Free	Private Pay	Total	Public Free	Public Pay	Total	Total	Spaces	Zones
		No.	No.	No	No.	No.	No.	Ft.	Ft.	Ft.	Ft.	No.	No	No.	No.	No	No.	No.	No.	No.	No.	No.
12	0				6	4	10	210	70	20	300											1
	1				10		10	220	80	40	340											2
	2				12		12	240		60	300											
	3			11			11	236	34	70	340											
	4											23				23				23		1
				11	28	4	43	906	184	190	1280	23				23				23	66	4
13	0			10			10	220	60	20	300							20	20			
	1																					
	2																					
							12	260														
							14	300			340											
	3	12					12	264		36	300	30				30				30		
		54					54	1134	50	96	1280	30				30				30	84	
Total		210		56	850	4	1120	23,520	6,000	1,200	30,720	64				64		20	20	84	1204	16

FIGURE A-5. Inventory summary form.

The Usage Study records may be summarized either by manual tallying or by punched cards and machine tabulation. The machine procedure is preferred, but both methods are explained below:

Manual Summarization of Usage Data. Figure A–6 shows a form for manual tallying. One form is used for each block (usually two field usage study forms), for each pair of curb faces, and lots or garages facing on them.

Each act of parking recorded on the field usage form should be tallied *twice* on this summary form, once under type of vehicle (car or truck), and once under the duration column representing the number of periods in which the vehicle was found.

When the form is prepared, it should be adapted to local conditions and should list only the types of parking actually found. Thus if the city has no 30-minute spaces and no alleys, corresponding lines may be omitted. Similarly, as each form is used the types of parking not used at that facility may be crossed out and only the necessary horizontal lines drawn, thus giving ample space for tallying those which are used.

On the sample form in Figure A–6 there has been tallied the parking of fifty-four cars (or taxis) and twenty-one trucks, at unrestricted and metered-one-hour spaces, in loading zones, and in various illegal spaces, at one block (two curb faces) for periods ranging from less than 15 minutes to 8 hours. It will be noted that the entries on the "duration" or right-hand portion of the form balance the entries at the left, and also that the "Total Public Spaces" line has two rows of figures. The upper figure in each case is the total number of vehicles parking for that number of periods, while the lower figure represents the total number of periods used by that number of cars, or the product of the upper number and the number at the head of the column.

Thus in the example shown in Figure A–6, there were four vehicles parked for fourteen periods each, using fifty-six periods. The same procedure is used on the informal line, for vehicles recorded there.

Resulting summary sheets, one for each block, may be combined by using the same form and an adding machine. A grand summary on a single sheet for the entire central business district results. From this a tabulation like the following:

Table III

TYPE OF PARKING

	Type of Vehicle		
	Cars and Taxis	*Trucks*	*All Vehicles*
Legal Curb Parking			
Unrestricted			
Metered 2–hour			
1–hour			

etc., and also a tabulation showing:

Table IV

TYPE OF PARKING

	Length of Time Parked								
	15 min.	30 min.	45–60 min.	1–2 hrs.	2–3 hrs.	3–4 hrs.	4–5 hrs.	Over 6 hrs.	Av.
Legal Curb Parking									
Unrestricted									
Metered 2–hour									
1–hour									
etc.									

A way to calculate the average parking duration is shown in Figure A–7 that illustrates a partly filled-in grand-summary sheet. The upper row of figures on the line for Metered one-hour parking, for example, represents the number of cars parking for each number of (fifteen-minute) periods in the central business district. The *lower* line of figures opposite "Metered one-hour" represents the number of cars multiplied by the number of periods. Thus in the seven-period column you have a total of 106 vehicles, and 7 x 106 = 742 periods. A total of 2,515 vehicles used the metered one-hour spaces for 7,651 periods—an average of 7,651/2,515 = 3 periods. The average duration was 3 x 15 or 45 minutes.

Determination of Arrival and Departure Rates and Accumulations

This requires filling out of the special spaces at the foot of each field usage form, one for each curb face, lot or garage. The number of in-parking vehicles equals the number of license numbers in the column. The number of Outs is the number of blank spaces or new entries which follow an entry in the previous column. The accumulation is the sum of the license numbers plus the checks in the column. As a check, the Accumulation is the previous Accumulation plus the Ins, minus the Outs. The vacancies equal the number of vacant *legal parking spaces* in the column. In the *total* column at the right the figure is the net accumulation or the total "In" minus the total "Out."

Table V: In, Out and Accumulation

A grand summary should be made, for the central business district, for the *in*, *out*, and *accumulation* lines. The accuracy of this addition may be checked for each period by the formula *accumulation* = *previous accumulation* plus *ins* minus *outs*.

From the grand summary a parking accumulation curve may be prepared, similar to that in Figure III–2, showing the fluctuation of the parking volume through the day, and the time of the peak. Similarly, in analysis, accumulation data for any block may be obtained by combining the two or three appropriate usage sheets.

Table VI: Cordon Count Summary

Under experienced guidance, this will be a series of counts, one for each street entering the central business district, each including separate counts of the in-

City Eold, Wis. USAGE SUMMARY SHEET Block 7 Facility 1, 2

Duration (number of periods parked)

Type of Parking	Cars & Taxis	Trucks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	Total Veh.	Total Pds.
Legal Curb Parking: Unrestricted	7	1	1					1			1		1														1						1		8	
Metered 2-hr., 1-hr., 30-min., 15-min.; Posted 2-hr., 1-hr., 30-min., 15-min.	35	13	11	15	6		4					5		2		3				1				1											48	
Total Legal Curb	42	14	12	15	6	2	4	1			1	5	1	2		3				1				1			1						1		56	
Illegal Curb Parking: No Pkg., Bus Zone, Hyd., Sp. Permit, Taxi Stand, Drive, Walk, Entrance	7	3	3	1	2						1					1							1								1				10	
Double Parking	2		1			1																													2	
Truck Loading Zone	3	X (1/)	1	2																															3	
Alley		X (2/)																																		
Total Illegal Curb	12	3	5	3	2	1					1					1							1								1				15	
Lots, Free																																				
Pay																																				
Garage, Free																																				
Pay																																				
Total Offstreet																																				
Total Public Spaces / No. Periods →	54	17	17 / 17	18 / 36	8 / 24	3 / 12	4 / 20	1 / 6			2 / 18	5 / 50	1 / 11	2 / 24		4 / 56				1 / 18			1 / 21	1 / 22			1 / 25				1 / 29		1 / 31		71	420
Informal Parking																																				
3/ Trucks in Load Zones	X	4	2	1		1																													4	
3/ Trucks in Alleys	X																																			
Grand Total	54	21	19	19	8	4	4	1			2	5	1	2		4				1			1	1			1				1		1		75	
No. Legal Spaces (from Inventory) 17																																				
No. Parked at Peak 3/ (from Usage Sheet) 19																																				
3/ Other than Trucks in LZ and Alleys																																				

FIGURE A-6. Usage summary form.

City Eold, Wisc.

USAGE SUMMARY SHEET
Grand Summary
Duration (number of periods parked)

Block Total C.B.D.
Facility ______

Type of Parking	Cars & Taxis	Trucks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Legal Curb Parking																		
Unrestricted	1315	360	601 / 601	204 / 448	140 / 420	118 / 472	90 / 450		85 / 595	60 / 480	45 / 408	35 / 350		25 / 300	30 / 390		25 / 375	25 / 400
Metered - 2-hr.	60	14	30 / 30	14 / 28	9 / 27		6 / 30		11 / 77							2 / 28		
1-hr.	2207	308	1070 / 1070	508 / 1016	301 / 903	203 / 812	182 / 910		106 / 742		30 / 270	28 / 280		13 / 156	12 / 156	11 / 154		8 / 128
30-min.																		

Type of Parking	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	Total Veh.	Total Pds.
Legal Curb Parking																		
Unrestricted	25 / 425	22 / 396		18 / 360	7 / 147		9 / 207	9 / 216	6 / 150		8 / 216	5 / 140	5 / 145	7 / 210	9 / 279	42 / 1344	1675	9921
Metered - 2-hr.							1 / 23							1 / 30			74	273
1-hr.	6 / 102	5 / 90		4 / 80	4 / 84	3 / 66		2 / 48	2 / 50		1 / 27		1 / 29	1 / 30		14 / 448	2515	7651
30-min.																		

FIGURE A-7. Usage grand summary sheet.

bound and outbound volumes of cars and trucks, by half-hour periods. These are combined as in the parking accumulation, to give a record for each half-hour of the number of cars and of trucks entering the area, leaving the area, and accumulated in the area. The adviser should make the necessary adjustments to include an allowance for the vehicles parked in the area when the count was started, and for the vehicles in motion inside the area.

From the cordon count data an accumulation curve may be prepared and presented on the same chart as the parking-accumulation curve. If the work has been done correctly, the cordon curve at all points will be above the parking curve, since it should represent *all* vehicles in the area, including those parked as well as those in motion.

Table VII

SUMMARY OF SUPPLY, USAGE AND OCCUPANCY

Block No.	*Supply*		*Usage*		*Present Occupancy*
	Spaces	Space-Hours	No. Vehicles	Space-Hours	= Space-Hours Usage / Space-Hours Supply

The number of spaces in each block is obtained from the Inventory Summary Form shown in Figure A–5 (Block 12 on that form, showing sixty-six spaces). The space-hours of supply is the number of spaces x 8 (for a 10 A.M. to 6 P.M. study).

Under Usage, the number of vehicles is the sum of the number of cars and of trucks listed on the Total Public Spaces line of the Usage Summary Sheets shown in Figure A–6 (one for each block), plus the number of cars and trucks on the Informal Parking line of these forms. The number of space hours for these vehicles is one-fourth the number of fifteen-minute periods which they used. The periods are taken from the last or total column for the Total Public Spaces and the Informal Parking lines of the same form. Thus for the Block shown in Figure A–6 the *space hours of usage* figure is 420/4 plus 0/4 or 105.

The *percent occupancy* data for Table VII is derived, for each block, by dividing the space hours of usage by the space hours of supply.

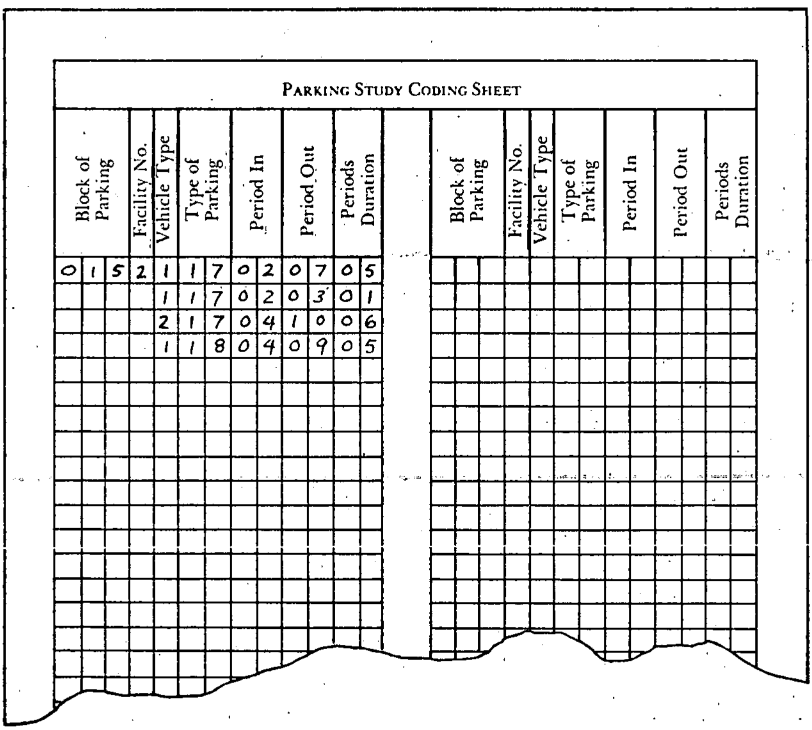
Mechanical Summarization of Usage Data. If the services of a person familiar with the use of punched cards and machine tabulation are available, perhaps through the Highway Planning Survey of the State Highway Department, it will be advantageous to use this procedure. In that case, the study personnel would code the field data—translate the factual data into a series of numbers recorded on coding sheets. These coding sheets would be sent to a field office, perhaps of the International Business Machines Corporation, where the coded data would be punched into cards, mechanically sorted and tabulated to produce the desired set of tables (similar to those previously described for Manual Summarization).

Since this procedure must be supervised by a person familiar with machine accounting, the following instructions include only the information needed by such a person.

Suggested Card Set-Up:

Item	*No. digits*	*Card Columns*
Block of Parking	3	1, 2, 3
Facility No.	1	4
Vehicle Type	1	5
Type of Parking	2	6, 7
Period In	2	8, 9
Period Out	2	10, 11
Periods Duration	2	12, 13

All data are coded from the Usage Study Field Sheets (Figure A–4), coded on a coding sheet (Figure A–8), using a line for each vehicle parking. The result will be one punched card for each act of parking.


PARKING STUDY CODING SHEET

Block of Parking	Facility No.	Vehicle Type	Type of Parking	Period In	Period Out	Periods Duration		Block of Parking	Facility No.	Vehicle Type	Type of Parking	Period In	Period Out	Periods Duration
015	2	1	17	02	07	05								
		1	17	02	03	01								
		2	17	04	10	06								
		1	18	04	09	05								

FIGURE A-8. Coding sheet.

Coding Instructions

Block of Parking. Copy the Block No. shown at the upper right corner. Precede by one or more zeros where necessary, to make three digits.

Facility No. Copy the Facility No. shown.

Vehicle Type. Each entry on the field sheet shows the vehicle as a car (C), a taxi (TX) or a Truck (T). Code C or TX as 1, code T as 2.

Type of Parking. The field form shows the type of space for each vehicle parked. Use the following code or adapt it to fit the types of parking found locally.

Legal Curb:	
Unrestricted	10
Posted 3-hour	11
2-hour	12
1-hour	13
30-min.	14
12 or 15-min.	15
Metered 2-hour	16
1-hour	17
30-min.	18
12 or 15-min.	19
Informal	20
Truck in Loading Zone	21
Truck in Alley	22
Special Permit (legal)	23
Illegal Curb:	
No Parking, Bus Zone, Hydrant, Taxi Stand, Drive, Walk, Entrance, Special Permit	30
Double Parking	31
Truck loading zone (car)	32
Alley (car)	33
Lot, free	40
pay	41
Garage, free	50
pay	51

Period In. The Usage Study field form has thirty-two columns. Number these columns from 01 to thirty-two, doing this on a card which may be positioned above each form during coding. In coding "Period In," code the number of the column in which the vehicle (License No.) is *first* recorded. Prefix a zero where necessary, to make two digits.

Period Out. Code the number of the first subsequent column in which that same vehicle is *not* checked. Prefix a zero where necessary to make two digits.

Periods Duration. The code for this is either (Time Out Code)—(Time In Code), or the number of columns in which the vehicle is entered.

Examples:

Col. No.	01	02	03	04	05	06	07	Codes		
Col. Head	10:00	10:15	10:30	10:45	11:00	11:15	11:30	In	Out	Duration
		745						02	05	03
			606					03	05	02
			722					03	04	01

Tabulations Desired: Tables 1 and 2 concern the supply and are made manually from the Inventory Sheets, as described under Manual Summarization. Similarly, Table 6 is made manually, from the cordon count data, also as described under Manual Summarization.

Table 3: *Type of Parking versus Type of Vehicle.* Sort on Type of Parking (Columns 6–7) and sort each Type-of-Parking group on Type of Vehicle (Column 5), taking card counts.

Table 4: *Type of Parking versus Duration.* Sort on type of parking and sort each type of parking group on periods duration (Columns 12–13), taking card counts and also adding columns 12 and 13. For each type of parking the average duration will be the sum of the addition divided by the card count.

In putting these data into table form, note that certain duration groups are combined to give the groupings shown in Table 4 under Manual Summarization. Also note that since Table 4 is expressed in terms of minutes or hours, the number of periods must be converted accordingly.

Table 5: *Parking Arrivals, Departures and Accumulation.* Sort on type of vehicle (Column 5) and sort each type of vehicle group on *period in* (Columns 8–9), keeping card counts.

Then sort each *type of vehicle* group on *period out* (Columns 10–11), keeping card counts. From these data prepare manually a table showing:

Time of Day

	Cars and Taxis			*Trucks*			*All Vehicles*		
	In	*Out*	*Accum.*	*In*	*Out*	*Accum.*	*In*	*Out*	*Accum.*
On hand 10:00 A.M.									
10:00–10:15									
10:15–10:30									
etc.									

Table 6: *Cordon Count.* Prepare manually, as described under Manual Summarization.

Table 7: *Usage by Blocks.* Sort on Type of Parking (Columns 6, 7) and remove Trucks in Loading Zones, Trucks in Alleys, and Special Permit Legal (Codes 21, 22, 23). These cards are not to be used in Table 7. Sort remaining cards on Block of Parking (Columns 1–3), and on each Block group take a card count and add the Periods Duration (Columns 12–13).

From this may be made the Usage section of Table 7 as described under Manual Summarization, the card count being the number of vehicles, while the sum of the addition for each Block gives the *periods duration*, which when divided by 4 gives space hours.

Other parts of Table 7 are made as explained under Manual Summarization.

Analysis and Interpretation. Tabulation of the data of a parking study simply presents the data in an orderly, uniform and understandable form. These facts are of little value unless and until they have been interpreted in a form readily understandable by a layman.

Analysis and interpretation of the data, unfortunately, are neither routine nor subject to formulation. Perhaps the simplest definition of the process is that it consists of presenting an array of cold facts and extracting therefrom all that is significant, that clearly presents the existing situation and points the way to what should be done.

This can best be accomplished by someone experienced in the field of parking, and services should be sought at this stage. A number of observations may be made without skilled assistance, that should reveal the highlights of the situation.

Data in Tables 1 and 2, summarizing the inventory of space supply, may be compared with similar data to be found in Chapter II (Parking Characteristics) for an average city of the same population group, including information on the area of the central business district, the number of parking spaces per 1,000 population, the proportion of curb space available for parking, etc.

Table 3 will show the use made of Loading Zones and Alleys by trucks, and their misuse by cars. It will show the extent of *double* and other forms of *illegal parking*. Here, comparisons with other cities may be made by reference to Chapter II.

The value of Table 4 is that it clearly indicates the extent of overtime parking, both in metered and posted curb spaces, and points to needed revisions in existing time restrictions. Almost surely it will show a larger-than-expected proportion of very-short-time parkers.

Table 5 will show the rates of arrival of cars and trucks and the build-up of the parking accumulation, thus indicating the time of the peak and the extent to which near-peak conditions hold through the day.

Table 6 presents similar data from the Cordon Count on the arrival, departure and accumulation of vehicles. By the calculation below it is possible to approximate the number and hence the proportion of the vehicles entering the central business district which do not stop to park. The removal of most of these vehicles from the downtown streets, through some form of bypass, obviously would greatly relieve congestion.

Vehicles passing through without parking (example of determination):

Vehicles entering C.B.D. 8 A.M. to 6 P.M. (exclusive of the 8:00 A.M. accumulation)	37,084
Vehicles parking In, 8:00 A.M. to 6:00 P.M. (exclusive of the 8:00 A.M. accumulation)	22,306
Passing through without parking	14,778

Of all the vehicles entering, 14,778/37,084 or thirty-nine percent were "eligible" for bypass use.

Here it must be recalled that under the comprehensive type of parking study, described early in this chapter, data were obtained on the supply of space, the usage of space, and also the demand for space, the demand data being derived from interviewing the parkers concerning their destinations.

By comparing the demand and supply (expressed in space hours) block by block, it was possible to determine the location and extent of space deficiencies; and by balancing deficiencies in one area against space surpluses elsewhere, giving consideration to acceptable walking distances, it was possible to determine net deficiencies.

The simplified type of study, however, involves no interviewing, hence provides no data on destinations. It is not possible, therefore, to compare supply and demand and to resolve deficiencies. The simplified study does give data on supply and on usage, in Table 7, and, by showing *occupancy*, shows in which block the degree of occupancy is highest.

Heavy *usage* in one block does not necessarily mean heavy *demand* for space in that block. The block may get heavy usage because it provides more space and is as near as its users can approach their destinations. Conversely, light usage in a block may not signify light demand. Blocks with heaviest parking demand are usually those in the center of the central business district, where land values are high and, consequently, few lots or garages.

High occupancy or heavy usage is not, for single blocks, an index of heavy demand; but it may safely be assumed that, in a small city, the central several-block area of high occupancy does indicate the general locus of heavy demand. Since this simplified procedure is intended for use only in small cities, this area will not be large and will not involve large walking distances. If additional spaces are to be provided, it is obvious that they must be situated within this area, or more conveniently than surplus spaces further removed from the center of the area.

Special or Spot Studies

Curb check for long-time parkers and "meter-feeders." Many parking studies have revealed that a very common practice, perhaps more so in the smaller cities, is the pre-emption of much of the curb space in the retail area by store owners and employees.

Arriving downtown before the mass of shoppers and those on business and errands, they occupy spaces as close as possible to their place of employment, and keep them all day. If the spaces are metered, as they usually are on Main Street, it is not difficult to feed the meter prior to the patrolman's inspection.

Time-restrictions permit more persons to park by requiring turnover. Meters are intended to simplify the enforcement of time restrictions, but unfortunately many city ordinances are inadequate in that they do not specifically prohibit "meter feeding." The majority of drivers violating time-restrictions understand the need for them and their benefits. Yet each thinks his own violation is inconsequential.

When a city begins seriously to consider its parking situation, it is often the case that the drive is being sponsored by the board of trade, a merchants' association, the chamber of commerce, or some other civic association, with a membership drawn largely from the city's merchants and other leaders. Few points can be so effective to such a group as a statement that, for example:

"We made a study of parking at four blocks along Main Street, that have 100 one-hour metered spaces. Thirty-six of those spaces (more than one third) were used practically all day by merchants, men who have offices downtown, or their employees, many parking for seven or eight hours in spaces supposedly restricted to one-hour parking. Time used *illegally* by these thirty-six would allow some 200 other drivers (many of them shoppers) to park nearer the stores."

Information or evidence of this type is easily obtained. Select a few typical block-faces along Main Street. Inspect them in order, the first tour at 9:30 A.M. On the first, record the license numbers of cars parked at each of the curbs. Repeat at 11:30, 2:30 and 4:30. By comparing license numbers you determine which are long-time or all-day parkers. Check owners' names with the list of registered vehicles (usually available through the police), and determine which are owners or employees of nearby establishments. This procedure should be inconspicuous; names of the offenders should not be revealed.

Check of Employee Parking. A check of the parking of employees in the central business district of a city of 8,000 showed 299 who drove to work. Of these, eighty-one parked all day in metered spaces on Main Street or on the cross streets around the corner from Main Street. By so doing (in two-hour and three-hour spaces) they prevented about 248 shoppers and other short-time parkers from finding convenient space. Every one of these eighty-one employees could have parked in unrestricted and free space within 300 feet of his destination.

Curb check of overtime parking or meter effectiveness. When parking meters are first installed in a city or in an area, it often is well to make a "before-and-after" test of parkers' behavior, or to make a single test in an area to determine the degree of observance of time-restrictions. This may easily be done by using a form similar to the Usage Study form shown in Figure A–4, and following the procedure described under "Observation of twelve- or fifteen-minute curb spaces."

No column headings are used on the form; each line carries a record of the parking at one curb space, and each space on that line is the record of the parking of one vehicle, recording the last three digits of the license number, a symbol for the type of vehicle, and the time-in and time-out to the nearest minute. If the spaces being observed have one-hour or longer time restrictions, one observer should be able to keep track of the parking at two or three adjacent curb faces. If the time restrictions are thirty-minutes or less, there should be one observer per curb face.

This form, when summarized, will give a complete record of the number of cars and of trucks parked, the turnover, the number of illegal parkers, the number of overtime parkers, and the amount of time used beyond the legal limit.

If parallel checks are made, one shortly before meters are installed and again perhaps a month after the installation, it will be a simple matter to determine the effectiveness of the meters in increasing turnover, reducing the number and proportion of overtime parkers, reducing the mount of overtime used, etc.

A check of this type, made at any metered or posted curb, is also an excellent means of determining whether the time restrictions in effect are consonant with the demands of the parkers using the spaces. Possibly it will show a demand for a larger proportion of thirty- and fifteen-minute spaces. A check like this made in 1955 in a city of 8,000 showed that while the central business district has:

	No.	Percent
Unrestricted spaces	329	53.1
3-hour spaces	152	24.5
2-hour	112	18.1
30-minute	7	1.1
15-minute	8	1.3
Total curb	620	98.1

Curb parkers were distributed as follows:

Over 4 hours	242
3–4 hours	79
2–3 hours	174
1–2 hours	366
30–60 minutes	487
15–30 minutes	638
Under 15 minutes	1,611
Total	3,597

which would indicate a need for spaces as follows:

Type Space		*No. Parkers*	*Turn-overs*	*Spaces Needed*	*Per Cent*	*Space Allotment Present*	*Space Allotment Desirable*
Over 4 hours	Unrestricted	242	1	282	47.4	329	294
3–4 hours		79	2				
2–3 hours	3-hour	174	2.5	70	11.7	152	73
1–2 hours	2-hour	366	4	92	15.4	112	96
30–60 min.	1-hour	487	8	61	10.2	12	63
15–30 min.	30-min.	638	16	40	6.7	7	41
Under 15-min.	15-min.	1,611	32	51	8.6	8	53
		3,597	65.5	596	100.0	620	620

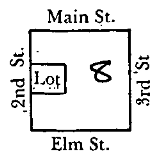
A Study of Industrial Plant Employee Parking

This study, devised by the Association of Casualty and Surety Companies, provides for a quick check at an industrial plant, department store or other place of employment to reveal the parking practices of the employees and their usage of the space available.

It should be attempted only if records are available indicating the license-plate numbers of the employees' vehicles. The study is usually made to determine whether space is inadequate, or to investigate complaints by nearby property owners that employee parking is causing a nuisance or congestion.

The study should include all street and offstreet parking at the establishment, and as far away as the employees park, perhaps as far as half a mile.

At a small plant one person can make the study. At a plant employing thou-



EMPLOYEE PARKING
Field Check

Block 8
Date 17 May 195[illegible]

Curb ✓ Offstreet ✓

DP = Double Parking
IL = Illegal Parking
IN = Informal Parking
C = Car T = Truck

Time Restrictions Unres.

S Side Main St. between 2 St. and 3 St.

W Side 3 St. between Main and Elm

N Side Elm St. between 3 St. and 2 St.

E Side 2 St. between Elm and Main

S Side 8:30 A.M.	S Side 1:00 P.M.	W Side 8:35 A.M.	W Side 1:04 P.M.	N Side 8:38 A.M.	N Side 1:08 P.M.	E Side 8:42 A.M.	E Side 1:12 P.M.
C 27145	✓						
C DP 303147	C DP 12514						
T 86879							
C IL 22924	✓						
C 77876	✓						
T IN 40402	✓						
C 20625	T 55054						
C 118203	✓						
T IL 64167	✓						

Observer O. C. Smith

FIGURE A-9. Employee parking record.

sands it will require as many observers as are needed to record the data for all parked cars in a three-hour period.

Equipment and Time of Study: Each observer will need a supply of the field sheets (Figure A-9), a watch and a 100-foot tape measure.

The study should be made in one day if possible, making one observation of each facility in the morning as soon as the day shift starts, and a second observation in the afternoon, this to be completed before the day shift ends.

Procedure. An inventory or record of spaces available is required, at the curb or offstreet. Forms and procedure may be those described in the earlier pages of this manual.

In the usage study, the observer should use the form shown in Figure A–9 and make a check of the use of every curb and offstreet space where employees customarily park in the vicinity of the plant or store. This is done twice during the day.

It will be noted that one field sheet provides space for recording the usage at four curb faces, and usually one sheet is used for the four faces of a block, with a sketch added for clarification. It will be found advantageous to tour each block in a counter-clockwise direction (with the curb at the observer's left hand).

As the observer comes to each vehicle, the complete license-plate number is listed, with a symbol for the type of vehicle (C for car, T for truck) and a symbol for the type of parking (DP for double parking, IL for illegal parking, and IN for informal parking). Informal parking is the use of an unusual place (not necessarily illegal), such as a front lawn, a vacant lot, a space between buildings, a grass strip, etc.

The same form may be adapted for checking the use of offstreet lots, by making a sketch on the reverse side with reference letters or numbers identifying the rows of cars, tying these rows to the columns on the face of the form.

Recorded license numbers are used later to check with personnel records to determine which vehicles belong to employees. If such records are not available and there is no other way of identifying employee vehicles, employee license numbers will have to be obtained by questioning the employees, which should be done *after* the field check has been made. Employee vehicles should be identified on the field sheets by a colored pencil mark.

Analysis. The following tabulations may be made from the field sheets:

1. A comparison of the number of spaces available at the curb and offstreet, with the number of these spaces occupied (a) by employee vehicles, during (a) the morning check, and (b) the afternoon check. The use of illegal and informal spaces should be included and indicated, and a separate column used to show the situation if these vehicles were forced to use legal spaces. This may indicate a deficiency, if overcrowding exists.

2. A comparison of all-day parkers (same license numbers found in both morning and afternoon checks), as between employer vehicles and other vehicles.

3. An examination of the distances at which employees are found to be parking, and the extent of illegal parking, may indicate deficiencies in space supply and lead to suggestions for the location of added facilities.

The analysis should determine whether the complaints of employees about insufficient parking, or the complaints of property owners as to congestion and abuses, are justified. An examination of existing offstreet facilities may indicate that increased capacity may be obtained through rearrangement of the layout design.

APPENDIX IV

Glossary

Central Business District	The major business district of a city, sometimes called the downtown area.
Commercial Vehicles	Trucks and buses.
Control stations	Locations on principal traffic arteries crossing the cordon line, where, in addition to classification of vehicles, traffic counts are made on a continuous basis for an entire study period to establish relationships and factors to permit expanding single counts to represent daily and weekly characteristics.
Cordon	The boundary of the area being studied.
Cordon stations	Locations on each street crossing the cordon where all vehicles are counted and classified.
Core	That section of the central business district having the greatest demand for parking space and the greatest deficiency in parking spaces.
Demand	The need for parking space as indicated by the actual destinations of the drivers now parking in the central business district. It may be expressed in spaces or space hours.
Destination	The location of the objective of the trip.
Facility, Parking	A curb, lot or garage intended for the parking of vehicles.
Fringe Area	That part of the city adjacent to the central business district.
Generators	Office buildings, stores, theaters, etc., which generate traffic and hence create a demand for parking space.
Municipal Lot or Garage	A lot or garage owned or controlled by the municipal government.
Occupancy	The percentage of the total available space hours which are used for parking.
Offstreet Facilities	Lots and garages intended for parking and entirely off public streets and alleys.
Origin	The location from which the driver started the trip which terminated in the observed act of parking.
Parking	Leaving a motor vehicle temporarily, with the engine stopped.
Customer Parking	Offstreet parking space provided by a business establishment for the use of its patrons.
Illegal Parking	Parking in any place contrary to ordinance or

	police regulations. The term does not usually include overtime parking.
Informal Parking	Parking, whether legal or illegal, on offstreet areas such as front lawns, planting strips, between buildings, behind stores, on vacant lots, or at any other places not formally considered as parking spaces.
Legal Parking	Parking at curbs or in lots and garages intended and designated for that purpose and where permitted by ordinance.
Overtime Parking	Parking for longer than permitted by ordinance.
Peak Hour	The hour during which there is the greatest accumulation of parked vehicles in the central business district.
Private Lot or Garage	Parking lots or garages the use of which is restricted to the owner, tenants, employees or other special persons. A *strictly* private facility is one in which this restriction is actually enforced, through the use of tickets, fences, guards, etc., as opposed to those which actually may be used by anyone.
Prohibited Curb	Curb faces where parking is prohibited during posted hours.
Public Lot or Garage	Parking lots or garages open to the general public, regardless of purpose, or destination. The words "pay" or "free" are sometimes added to distinguish whether or not a fee is charged.
Space Hour	One parking space for one hour is used to measure supply, usage and demand on a comparable basis. For example, 6 vehicles parked for 10 minutes each or 1 vehicle parked for one hour both represent one space hour.
Space, Parking	An area intended for occupancy by a parked vehicle.
Special Permit Space	Curb parking space officially reserved for use by a designated person or group.
Supply	The number of spaces or space hours legally available for parking.
Trip	The one-way travel between origin and destination.
Truck Loading Berth or Dock	Offstreet space reserved for use in loading or unloading of trucks.
Truck Loading Zone	Curb space reserved by ordinance for use in loading or unloading of trucks.
Turn-over	The rate of usage of a facility, or the number of times that a parking stall is used in a stated time. For a facility, a type of facility or an area, the rate equals the number of vehicles parking divided by the number of stalls.
Usage	The number of vehicles parked or the number of space hours used by parked vehicles.
Weekday	Monday through Friday.

APPENDIX V

Selected References

American Automobile Association, 1712 G Street N. W., Washington 6, D. C.
"Parking Manual" (1956 Revision)
"Parking Programs" (1954) ($0.75). Case histories of the initiation and financing of parking improvements in American cities.
American Municipal Association, 1625 H Street, N. W., Washington, D. C.
"Parking Space—What American Cities Are Doing to Provide It." (1956).
Automotive Safety Foundation, 200 Ring Building, Washington, D. C.
"What Parking Means to Business" (1955).
Bureau of Planning, Department of Commerce, Albany, New York.
"Solving Parking Problems—A Guide to Community Action."
Bureau of Public Roads, Washington 25, D. C.
"Parking Study Manual" (1953). Manual of instructions for a comprehensive study.
"Manual on Uniform Traffic Control Devices for Streets and Highways" (obtainable from Superintendent of Documents, Government Printing Office, Washington 25, D. C. $1.00).
Chamber of Commerce of the United States, Washington 6, D. C.
"Curb Parking" (1949)
"Offstreet Parking" (1949) ($0.40). What is being done by private enterprise.
"Parking and its Importance to the Downtown Business District" (1953). Analysis of parking capacity needed in business districts and relation of retail sales and property values to parking.
"The Big Squeeze" ($1.00). Arguments on municipal vs. private ownership, retail sales vs. parking capacities, facts and figures on parking lot costs, design, location, rates, etc.
"Parking Pickle" (1952) ($0.50). Report on parking clinic held in Salem, Massachusetts, December 3, 1952.
"Shopper Bottleneck" (1953) ($1.00). Report on parking clinic held in Stockton, California, March 31, 1953.
Eno Foundation, Saugatuck, Connecticut.
"Traffic Design of Parking Garages" (1957).
"Interior Block Parking Facilities" (1946).
"Parking Lot Operation" (1948).
"The Prohibition of Curb Parking" (1948).
"Municipal Regulation of Parking Lots" (1949).
"Planning Ground Transportation Facilities for New Airport" (1954).
"Parking Authorities" (1953).
"Zoning and Traffic" (1952).
"Parking—Legal, Financial, Administrative" (1956).
"Co-ordinating All Parking Facilities Under the Unified 'System Concept'," Traffic Quarterly, July 1952.
Highway Research Board, 2101 Constitution Avenue, Washington, D. C.

Bibliography 14. "Automobile Parking in the United States" (1953).
Bibliography 16. "Highway Finance" (1954) (Including Parking).
Bulletin 7. "Special and Local Enabling Legislation Dealing with Automobile Parking Facilities" (1947).
Bulletin 15. "Parking" (1948).
Bulletin 19. "Parking" (1948).
Bulletin 24. "Requirements for Offstreet Automobile Parking Facilities in Zoning and Other Local Ordinances" (1950).
Bulletin 33. "Use of Parking Meter Revenues" (1951).
Bulletin 48. "Legislative Trends for Offstreet Parking."
"Effectiveness of Parking Agencies" (1952).
Bulletin 59. "Zoning for Truck Loading Facilities" (1952).
Bulletin 81. "Parking Meters" (1954).
Bulletin 99. "Parking Requirements in Zoning Ordinances" (1955).
Proceedings, 1953. "Influence of Population, Sales and Employment on Parking" (1953).
Special Report 11. "Parking as a Factor in Business" (1955).
Special Report 11-B. "Shopping Habits and Travel Patterns" (1955).
Institute of Traffic Engineers, Strathcona Hall, New Haven, Connecticut.
"Traffic Engineers Handbook" (1950) ($6.00).
"Traffic Engineering" monthly magazine ($3.50 per year).
McGraw-Hill Publishing Co., New York City.
"Traffic Engineering," Smith, Matson, Hurd (1956) ($12.50).
National Committee on Uniform Traffic Laws and Ordinances, 1604 K Street N.W., Washington 6, D. C.
"Uniform Vehicle Code," Revised 1954, Article X ($0.20).
"Model Traffic Ordinance" (1953), Articles XIII–XVI in Appendix D.
National Parking Association, 702 Sheraton Building, 711 14th Street N. W., Washington 5, D. C.
Quarterly magazine of the parking industry.
National Retail Dry Goods Association, 100 W. 31st Street, New York, N. Y.
"Parking—How it is Financed" ($0.75). Case histories of 27 cities.
Public Administration Service, 1313 E 60th Street, Chicago 37, Illinois.
Publication No. 100, "Traffic Engineering Functions and Administration" (1948).
Superintendent of Public Documents, Government Printing Office, Washington, D. C.
"Model Traffic Ordinance" (1952) ($0.20).
Urban Land Institute, 1939 K Street N. W., Washington, D. C.
Technical Bulletin 15, "Special or Benefit Assessments for Parking Facilities" (1951).
John Wiley & Sons, New York, N. Y.
"Planning the Modern City," Harold M. Lewis.

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(*f* following a page number refers to a figure; *n* refers to a footnote; *t* refers to a table)