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Volume III

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FINAL REPORT

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16. Abstract

The product of this PUR project is a planning package (guidelines, estimating procedures, examples and computer software) for the highway oriented para-transit modes of car pooling, van pooling, and park and ride. The package is designed to be a reference to the planner who, for example, must assess the regional or sub-regional potential of one of these modes for TSM planning, or who, at a later stage, must estimate the costs and benefits of implementing that mode, or, still later, must target specific companies, stations or areas for actual implementation. It is further designed to be used by the implementor to estimate staff requirements, write specifications, design a marketing program, and so on.

Contained in this package are four individual reports, a Service Area Identification Methodology computer program, and an Executive Summary. The reports include:

The Car Pool Planning Manual............... VOLUME I
The Van Pool Planning Manual............... VOLUME II
The Park and Ride Planning Manual.......... VOLUME III
The Service Area Identification Methodology Report (SAIM)......................... VOLUME IV

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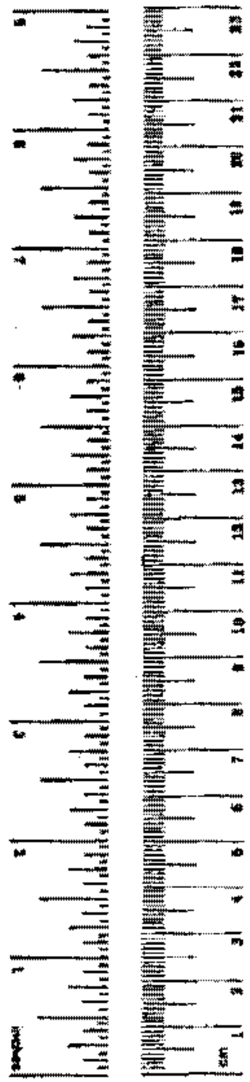
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

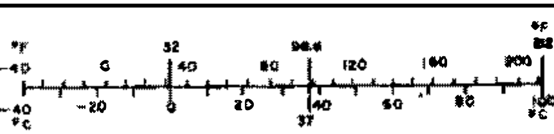
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in ≡ 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



EXECUTIVE SUMMARY

1. Overview

The product of this PUR project is a planning package (guidelines, estimating procedures, examples and computer soft ware) for the highway oriented para-transit modes of car pooling, van pooling, and park and ride. The package is designed to be a reference to the planner who, for example, must assess the regional or sub-regional potential of one of these modes for TSM planning, or who, at a later stage, must estimate the costs and benefits of implementing that mode, or, still later, must target specific companies, stations or areas for actual implementation. It is further designed to be used by the implementor who, for example, must estimate staff requirements, write specifications design a marketing program, and so on.

Contained in this package are four individual reports, a Service Area Identification Methodology computer program, and this summary. The reports include, and are subsequently referenced as:

- The Car Pool Planning Manual
- The Van Pool Planning Manual
- The Park and Ride Planning Manual
- The Service Area Identification Methodology Report (SAIM)

Together, these reports and the computerized software constitute a comprehensive planning package for investigating, evaluating, planning, and implementing these three automobile-oriented transportation improvements. Each of these reports, however, can stand alone providing a self-contained explanation of its particular subject matter, or they can be used in various combinations to provide a complete package for any particular mode or pair of modes.

2. Report Descriptions

Mode Manuals. Each manual contains three parts: description, planning, and implementation. The first describes the mode, and places it in the context of the entire transportation system in terms of: the kinds of services the mode can reasonably provide, the groups of people served, the types of trips made, and the kinds of destinations served.

The objectives of this summary are: 1) to give the planner a good understanding of the strengths and weaknesses of a mode in a particular socio-geographic setting or transportation system and 2) to provide the estimates needed for grant applications and the implementation plans.

The second part of each manual (planning presents estimates, of and estimating procedures for the demand, costs and benefits of each mode. Demand estimation as most planners know is still very much an art. This is particularly true in the case of paratransit. Thus, although rather sophisticated demand models have been built in some cases (i.e., car pooling) we have chosen to only reference these models and present some general "rules-of-thumb" which can be used for essentially "sketch" planning. More detailed estimates of potential can be obtained with the SAIM computer package.

Costs have been estimated in 1975 dollar values, except where noted. To make the mode costs comparable to other modes with longer or shorter life spans, capital costs have been estimated so as to account for the increased expenditures (due to inflation) of replacing shorter lived vehicles and facilities. While the costs presented represent the best available information, we note that there is a great deal of variation, and by the time this report is published many prices will have changed. Thus, our intent is simply to provide initial estimates and relative costs. It is assumed the planner can scale these costs to current dollars and adjust for regional variation. The quantifiable benefits of congestion relief, energy savings, and reduced parking demand and pollution have been discussed for each mode. In many cases, tables or formulae are presented for estimating each benefit.

The final part of each manual deals with implementation planning. Here we present funding sources, staffing requirements, specifications, marketing guidelines, and so on. The objective in these sections is to provide sufficient information to create a reasonably detailed implementation plan or strategy.

These three sections (Car Pool, Van Pool, Park and Ride) combined should provide the tools and estimates necessary for effectively assessing the cost/effectiveness of each of these modes in any regional, sub-regional or local alternative analysis.

Service Area Identification Report. The SAIM Program Report describes a computer-based methodology for geographic identification of trip patterns that can be cost-effectively served by a particular mode. The SAIM programs were designed to be used with the manuals to help a planner identify those areas in a region where one of these modes could cost-effectively meet transportation needs. The searching techniques and parameters are derived from the cost, benefit and demand estimates explained in the planning parts of each of the manuals. The output of SAIM are both maps and various printed estimates. The maps geographically identify areas where a particular mode has high potential.

The printed output provides an estimate of the total regional potential of the mode in question. Various summary statistics (in the case of ride-sharing) provide a zone by zone analysis of the mode's potential.

SAIM was designed to be used with Census UTPP data, since these data are readily available at low cost to all metropolitan areas, although other data bases could be used. Because Census data often have to be adjusted in a variety of ways to yield results acceptable for planning, we have also included a documentation and computer program of methods we have found useful in making these adjustments.

3. Research Observations

Because the purpose of this project was to draw together current research and demonstration findings into a useable planning and implementation package and to present a computer-based methodology which could identify geographic areas in a region that could be well-served by car pooling, van pooling or park and ride, there are no research findings in the classic sense of finding an answer to a specific question. We have nevertheless made several observations from our surveillance of demonstration projects and other research efforts. We have also been able to identify those areas clearly in need of research and perhaps more important those areas in which further research would add only marginally to the body of knowledge needed to accurately plan for, implement and evaluate these modes. These are summarized below by mode.

Car Pooling. We have observed that car pooling, loosely defined is a major mode of transportation. There are, for example, twice as many car pool trips as solo-driver trips. We have distinguished two kinds of car pooling in our work: 1) "baseline" pooling or that kind of pooling that occurs naturally for reasons of economy or convenience; and 2) "promotion-induced" pooling. The vast majority of pooling is the former. We estimate that a car pool promotion program results in less than 1% of the commuters (about .33%) becoming new poolers. The cost of adding these new car poolers is not inconsequential; on the average it costs about $83 per year per new pooler or about $0.32 per day per pooler (assuming the average life span of these pools is about one year).* That nevertheless, compares very well to the most recent public transit operating subsidies of $0.23 per trip or $0.46 per day for a journey-to-work (APTA, Fact Book, 1977). While these figures as well as energy consumption and convenience measures argue strongly for public investment in car pooling, we nevertheless note that much car pooling has already been produced by the private market

* In "Evaluation of Carpool Demonstration Projects, Interim Report," Frederick Wagner reported $35 per new carpooler.

place. If there is a desire over the long run to establish a more permanent system of high occupancy transportation it may be wiser to allow increased prices (i.e., gas and parking) to induce car pooling and invest public money in a van pool system (which, in fact, induces car pooling) or other low density transportation systems.

If a choice is made to develop a car pool promotion program, we have observed that combined company-targeted, area-wide promotion is more effective than either approach alone. We have further found that the most effective marketing technique (and well worth the extra money) is what we call "turnkey service" where the ride-sharing representative after receiving permission/endorsement from top management handles all promotion, matching, organizing, etc. within the company--almost completely relieving company staff of time commitments to the program. We also note that matchlists per se may not directly overcome a "lack-of-match" barrier to car pooling. Their use is surprisingly low; once received, however, they may act as a catalyst to initiate a personal search for a poolmate. We thus suggest in a tight budget situation, that marketing should take priority over sophisticated matching systems.

Finally, in compiling this planning document we are satisfied that with two or three exceptions, further research would add little to the ability to make car pool matching/marketing policy decisions or to operate an effective matching/marketing program. (We are assuming that the formal evaluation of FHWA car pool demonstrations will update the cost, demand and benefit estimates presented here.) The exceptions are: 1) a carefully designed study is needed to assess the competition between promotion-induced car pooling and public transportation; 2) a study is needed to assess the changes in baseline car pooling due to car pool promotion. (We have had reason to believe that the load factors of existing car pools may increase as a result of promotion, yielding greater VMT savings than are usually reported.); and 3) we would encourage some general marketing research, not on the attitudes, and socio-economic status of the solo driver (these if anything have been overly researched), but rather on the marketing techniques that are effective in changing the solo-driver's behavior.

Van Pooling. We have been impressed with both the cost and energy efficiencies of van pooling as well as its market place success. Of the many low density (para-transit) modes we have observed, van pooling appears to have the ingredients for long term success, both as a component of an energy conservation program and as a comprehensive transportation system. We have noted four key elements for its marketplace success:

Door to Door Service. The mode provides nearly the access/ egress convenience of the auto and speed of the auto, with excess travel times averaging about 10 minutes per passenger.

Private Entrepreneur. Car pooling, too, provides the speed and comfort of a private automobile. The difference with van pooling is the incentive given to the driver, resulting in a personal commitment to provide adequate service to maintain a full van. Loss in ridership is a loss in incentive money to him/her. The result is a "mini-marketing" service with each van.

Vehicle Investment. An investment is made in a special journey-to-work vehicle. Sponsors must thus maintain some long term interest in program success.

Quality Transportation. Because a special vehicle is purchased, it can be customized to the consumers' taste and pocket-book. Many vans offer commuters a very attractive, comfortable ride that is genuinely comparable to that of the standard-sized automobile.

However, like car pooling, this mode does not totally pay for itself. The installation costs of a van pool program in a company are sufficiently high to limit its spontaneous implementation to those companies with acute transportation problems or to those firms which would substantially benefit from the good public relations.

These installation and ongoing administrative costs are quite low relative to other transportation subsidies, however. For a typical company implementing a ten van program, we estimate the annual cost at about $29 per van pooler over and above the full cost of van operation or about $60 per car removed since only about half of the van poolers can be expected to be former SOA's. The cost of providing "public" van pool service is considerably higher. Based on Commuter-Computer statistics (which may be unusually high over the long run) the annual cost of third party service (with a fleet of 200 vans) would be roughly $83 per van pooler, or $166 per car removed.

These simple cost estimates, along with the energy efficiencies which have been extensively reported elsewhere, argue strongly for public investment in van pooling. Adding weight to the argument is the fact that van pooling is more like provision of public high occupancy transportation than (say) car pooling. There may be some merit over the long run of re-orienting commuters from "private" provision of journey-to-work transportation (in the automobile or car pool) to the "public" provision of the same service, since ultimately we will have to make increasingly collective decisions on the consumption of our resources.

The cost figures further suggest that every effort should be made to have private companies sponsor van pooling through both tax incentives and public provision of turnkey installation service as discussed in the Car Pool Report. Where third-party service is warranted (i.e., small office complexes), we feel there are substantial economies to be realized (similar to those realized in private companies) from adding on to an existing transportation agency as opposed to setting up a separate entity. There are also the additional benefits of creating a coordinated transportation system, and such an approach could eliminate some of the regulatory and insurance problems van pooling has traditionally faced.

While we are enthusiastic about van pooling as an excellent mode for serving some low density transportation needs, we note that ultimately the role of van pooling in a total transportation system is limited. Nationally, only about 25% of the trips are in excess of ten miles. Many of these trips are CBD bound and could perhaps be better served by public transportation. Of the remaining trips, only a fraction are sufficiently clustered at both the origin and destination points to be effectively served by a van pool. In our final tests of Chicago area commuters, we found that only about 2200 van pools could realistically be expected to form in the six county area.

<u>Park and Ride.</u> Our study of the park and ride mode has indicated that the major advantage of providing a park and ride service is the diversion of parking from one destination to another. We have also found that generally it is necessary to provide about four park and ride spaces in order to divert just one auto from parking at the ultimate destination. Thus the park and ride mode <u>increases</u> the total number of parking spaces which must be provided in a metropolitan area. To justify this, the benefits of diverting parking from a particular destination must be significant. We have suggested that such a situation typically exists only in the CBD's of fairly large metropolitan areas. This recommendation is further supported by the results of surveys which indicate that commuters who switched to the park and ride mode from auto most often did so to avoid high trip costs, especially CBD parking charges. Thus in small CBDs where parking is easily available and inexpensive (say, less than $1.50 per day), the conditions necessary to stimulate demand for park and ride are absent.

We have distinguished two types of park and ride service by the location of the park and ride lot. Peripheral park and ride lots are located close to the destination and the transit service provided is typically a shuttle bus. Remote park and ride service provides a line-haul transit service originating from a lot considerably farther from the destination. Since peripheral park and ride lots are not located in low density areas (the primary focus of this report), we have limited our consideration to remote park and ride services.

In fact, remote park and ride is uniquely suited to low density areas, since it significantly increases the size of the area served by a single transit stop. The use of private automobiles for the first (collection) part of the journey makes it possible for persons who live in areas with densities too low to support feeder bus service to use transit for the line-haul part of their journey.

Experience with various transit modes indicates that commuters on relatively long work trips are sensitive to the travel time of the park and ride transit mode as compared to travel time by automobile. Thus local bus service is not used for remote park and ride. One rule-of-thumb states that park and ride with an express bus operating in normal highway traffic will not generate much demand if the bus trip is longer than five miles or twenty-five minutes. However, when park and ride is provided with transit service by modes which have a separate right-of-way, there are typically no problems in attracting park and riders to use the service. This information leads us to the major recommendation of the park and ride report: We recommend that in fairly large metropolitan areas (population over 250,000) with scarce and expensive CBD parking (at least $1.50 per day), park and ride service should be supplied in conjunction with any existing or planned commuter rail, rail rapid transit, or bus-on-busway systems.

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Part I - DESCRIPTION

CHAPTER 1: INTRODUCTION

1.1 Definition

A person who drives an automobile to a transfer point, parks it, and then transfers to a transit or para-transit mode is said to be using park and ride. A park and ride facility consists of a park and ride lot where commuters' automobiles are parked, and a station or some transfer point where commuters board the transit mode. A park and ride service is defined to include both the park and ride facility and the transit mode.

Park and ride is an effective way of combining the automobile and mass transportation, using each mode in the geographic area to which it is best suited. Because the automobile is used for the initial collection part of the journey, park and ride draws trips from a relatively large market area to a point where there is enough concentrated demand to support mass transit. For this reason, the mode is especially suited to low density areas which may not otherwise be able to support fixed-route service.

Park and ride is not a new concept. For example, private parking for a fee has been provided along trolley lines in the Pittsburgh area since at least World War II (Comsis Corporation, 1975). By 1966, at least thirty-six cities in the United States had tried park and ride, and park and ride facilities were in operation in at least twenty-eight of them (Deen, 1966).

1.2 Types of Park and Ride Service

Park and ride services can be classified by the location and type of the park and ride lot and by the mode the user takes after parking.

Location of the Lot. Park and ride services may be designed to serve different segments of the journey. In this sense, there are primarily two types of park and ride: peripheral and remote. In peripheral park and ride, the commuter completes most of the journey in his or her car and switches to transit for the final segment of the trip. Peripheral park and ride services generally include a shuttle bus covering the downtown area.

Remote park and ride intercepts the auto trip much closer to the origin. In this case the transit mode serves the line haul and sometimes the distribution part of the journey, with the automobile serving only as the collector.

Park and ride services are best suited to Central Business District (CBD) destinations, but there are examples of park and ride services oriented towards other destinations. In Rochester, NY, for example, park and ride bus service has been organized to serve major employment areas outside the CBD. Also in Rochester, a group of auto-repair shops sponsors a "repair and ride" service. Both of these services, however, attract relatively small numbers of commuters. In a number of metropolitan areas, many persons use park and ride to sport events, concerts, and festivals where the service helps to reduce congestion and parking demand at the destination.

Type of Lot. Park and ride lots may be either single-use or joint-use. A single-use lot is one constructed solely for the parking of commuters' automobiles. A joint-use lot serves more than one purpose. For example, a number of spaces in a shopping center parking lot might be used for commuter parking during the day. Parking lots which are primarily used during non-working hours, such as those at bowling alleys, drive-ins, or churches, are good candidates for joint-use park and ride lots.

The Transit or Para-Transit Modes. In park and ride, the automobile may serve as a feeder to a number of different modes. Most commonly, transit service is by bus, commuter rail, or rail rapid transit. Bus transit service may be local shuttle bus service, express bus operating in highway traffic, or bus on busway. (In this report we will use "bus" to denote an express bus operating in highway traffic, while local, shuttle, or bus on busway will be indicated as such.) Although some park and ride lots are designed to facilitate car pools and van pools, there is little information available on them and that is presented in the Car Pool and Van Pool reports. Therefore, we shall not consider them further in this report.

1.3 Objectives Of Providing Park and Ride

The most obvious reason for providing park and ride service is the diversion of automobile parking from areas of high land cost, such as the CBD, to areas of lower land cost at the fringes of the CBD or in more remote sections of the metropolitan area. For example, Pittsburgh's remote park and ride services, with about 1150 users on an average day have succeeded in diverting about 400 commuters from downtown parking to remote parking. Since most of those diverted are long-term parkers, parking spaces for short-term parking are freed. Since these spaces are used primarily by persons on shopping and personal business trips, the provision of park and ride can be an important component of a city's efforts to promote the economic well-being of the CBD.

Park and ride can also satisfy the objectives of diverting auto drivers, and decreasing vehicle-miles, pollution, congestion, and energy consumption (see also Chapter 8). Pittsburgh's park and ride services (mentioned above) result in a decrease of about 6600 vehicle-miles of automobile travel daily, which does not take into account extra bus mileage (Comsis Corporation, 1975). In low density areas, park and ride makes transit more accessible for persons who live beyond walking distances of transit stations.

While park and ride does address the objective of reducing CBD parking demands and other objectives common to most mass transit systems, it is important to note that (since the service is designed for and primarily used by auto owners) it does not significantly increase the mobility of transit captives.

CHAPTER 2: SERVICE CHARACTERISTICS

Two unique characteristics of park and ride are discussed in Sections 2.1 and 2.2 below. Parking cost and transit mode fares are briefly described in Sections 2.3 and 2.4.

2.1 Need for Automobile

Since park and ride requires that the commuter use an automobile for the first part of the journey, it caters to a "choice" rather than a "captive" transit market. The existence of the alternative of the automobile for all park and ride users means that park and ride services must provide a high quality of service competitive with the automobile. As Brown (1975) suggests, "incentives such as free or very inexpensive parking, high frequency of service, express bus routes, and seating for all riders are crucial in maintaining this transit market."

2.2 Transfer

Since all trips by park and ride involve two separate modes, a transfer is a necessary component of all trips. Transfer time is generally agreed to be the most burdensome of all travel time segments, some studies claiming it to be nine times as onerous as in-vehicle times (Pagitsas, 1977). Thus park and ride planning must attempt to reduce the difficulty of the transfer in order to attract riders from the auto. In addition, it is unlikely that auto owners would tolerate a second transfer in the same journey. In Stamford, Connecticut, the idea of a park and ride service with an express bus to a railroad station was discarded, on the basis of a survey of railroad commuters (Connecticut State Highway Dept., 1969). The proposed park and ride service would have required two transfers in a single trip. In fact, most park and ride trips only involve one transfer, since most commuters using park and ride walk from the transit vehicle to their ultimate destination (Exhibit 2-1).

2.3 Parking Charges

Over half of park and ride lots charge no parking fee, and only a few lots charge $1.00 or more (Exhibit 2-2). Parking costs are therefore much lower at park and ride lots than at CBD lots, and these savings have been proven to be an important incentive for the use of park and ride (see Section 3.5).

2.4 Transit Fares

The majority of park and ride services cost less than $1.00 for a one-way transit trip. Exhibit 2-3 indicates that the highest fares are charged at rail-serviced lots, because rail trips often cover longer distances than bus trips.

Exhibit 2-1

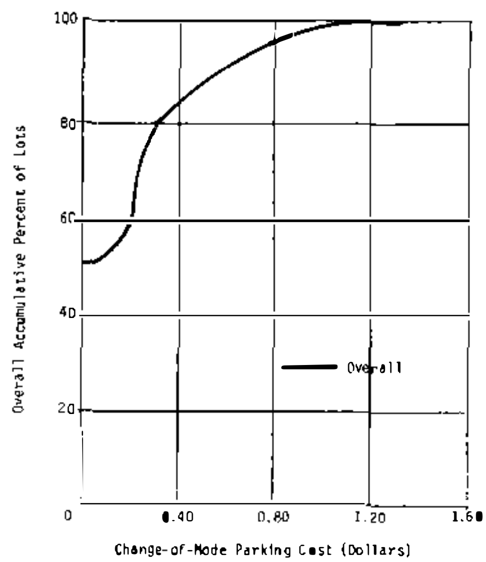
Egress Modes

	Pittsburgh[1]	Vancouver[2]
Walk	92.0%	93%
Transit	6.5%	
Auto	1.0%	7%
Other	0.5%	
Total	100.0%	100%

Sources: [1]Comsis Corp., 1975
[2]Brown, 1973

Exhibit 2-2

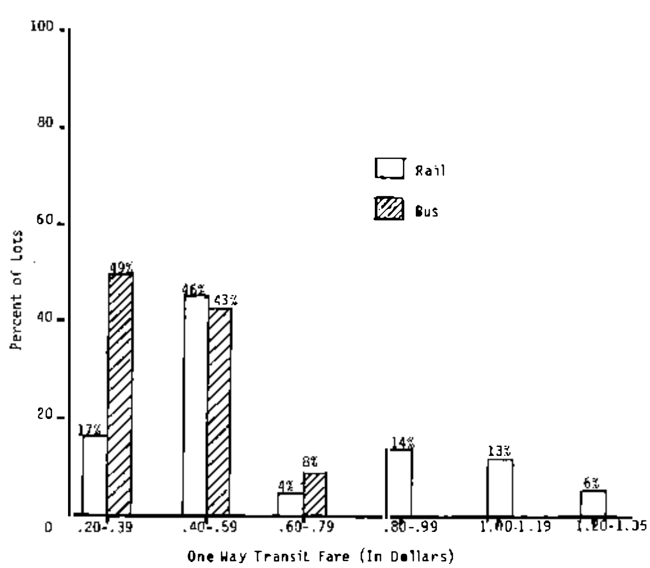
Accumulative Percent of Lots By Change-of-Mode Parking Cost



Source: Institute of Traffic Engineers, 1973.

Exhibit 2-3

One Way Transit Fare By Percent of Lots By Type of Transit Service



Source: Institute of Traffic Engineers, 1973.

CHAPTER 3: USER CHARACTERISTICS

In this chapter we discuss a number of characteristics of park and ride users--namely auto ownership, income, sex and age.

3.1 Auto Ownership

As mentioned earlier, an auto is necessary for the first part of a journey by park and ride. Therefore, it is no surprise to find that almost all users of park and ride services have at least one automobile per household (Exhibits 3-1 and 3-2). These exhibits point out the extent to which park and ride appeals to a clientele which is much different from that of mass transit in general. The fact that virtually all park and ride users are "choice" riders demonstrates the necessity of creating and maintaining incentives for the use of this mode.

3.2 Income

Most studies indicate that park and riders tend to come from households in the middle or high income range. For example, the median income of park and ride users in Vancouver, B.C. was $10,000 per year (Brown, 1975) while more than half of the park and ride users in Dallas had family incomes of more than $10,000 (DeShazo, 1975). Peat, Marwick, Mitchell and Company (1971) report that the majority of users in Atlanta, Cleveland, Milwaukee and Seattle had incomes greater than $10,000.

The relatively high incomes of park and ride users are not surprising, since these are primarily auto owners who are employed in the CBD. In terms of planning a park and ride service, this characteristic of park and ride users suggests that a high level of service is necessary, since these users will value their time at a higher rate than would lower-income persons or transit captives.

3.3 Sex

Although women generally make less than half of all work trips, they make up more than half of the users of three out of four park and ride services (see Exhibit 3-3)--which, as will be shown in Chapter 4, primarily serve work trips.

3.4 Age

As Exhibit 3-4 indicates, park and ride is especially appealing to the younger commuter. This is further supported by the fact that Vancouver's express bus drew 67.9% of its passengers from those under 25 (Brown, 1975). The Atlanta "Town Flyer's" passengers are roughly comprised of 60% young women, the rest young to middle-aged businessmen and students (City of Atlanta, 1967).

3.5 Reasons for Choosing Park and Ride

Surveys of park and ride users in several metropolitan areas reveal that, apart from the quality of service, a reduction in travel cost and avoidance of congestion seem to be the most important factors motivating commuters to park and ride (Barton-Aschman Associates, 1970, Peat, Marwick and Mitchell, 1971). These two factors are discussed below.

Travel Cost. A study of auto drivers who shifted to park and ride revealed that the reduced travel cost was the main reason for the shift to park and ride (Brown, 1972). Also, several authors have suggested that there is evidence that the cost of downtown parking is the most significant factor stimulating demand for park and ride (Gatens, 1974, Institute of Traffic Engineers, 1973). Deen (1966) reports that park and ride lots were established in Harrisburg, Pennsylvania, Fort Wayne, Indiana, Richmond, Virginia, San Diego, California, and Louisville, Kentucky previous to 1955, but failed to generate significant demand, probably due to the low parking costs in those CBD's. Park and ride lots, which typically charge very little or nothing for parking, offer a distinct cost advantage over downtown parking rates in many metropolitan areas. Commuters seem to be more sensitive to changes in park and ride lot charges than to changes in destination parking fees. For example, Kulash (1974) reports that the elasticity of demand for downtown parking for work trips is about -0.3. Experience with the Atlanta "Town Flyer" park and ride service suggests (our computation) that the elasticity of demand for park and ride parking is higher--about -0.54. Thus a small fare increase for park and ride service may decrease its usage more than a similar increase in downtown parking charges would affect the usage of downtown lots.

Exhibit 3-5 indicates that high downtown parking costs and a high level of service interact to create demand for park and ride. On this graph, the circled numbers represent the in-vehicle time plus the average waiting time, which is weighted at 2.5 times the in-vehicle time. It is clear that where travel times and waiting times are low, and parking costs are high, the percent of park and ride spaces used will generally be high.

Congested Driving Conditions. Most successful park and ride facilities are located in heavily traveled corridors which become congested during peak hours. Traffic congestion induces park and ride usage in two ways:

1) As speeds of auto travel decrease, the time savings offered by modes that operate on a separate right-of-way become more significant--this applies to commuter rail, rail rapid transit, and express bus on busway;

2) In the case of an express bus park and ride service that must operate in the same traffic as automobiles, the stress of driving an auto in congestion can be an incentive for the commuter to change modes.

Gatens (1974) suggests that a bus park and ride lot should be placed in a corridor just a little further from the CBD than the point at which serious congestion begins to occur. Until traffic begins to slow down, the commuter is able to minimize his or her total travel time by continuing the trip

Exhibit 3-1

Auto Ownership of Park and Ride Users

	Automobiles per Household				
	0	1	2	3+	Total
Milwaukee "Freeway Flyer"	0%	31.7%	63.4%	4.9%	100%
Atlanta "Town Flyer"	0%	34.0%	50.0%	16.0%	100%
Philadelphia "Lindenwold Hi-Speed Line"	2.6%	45.5%	41.7%	10.2%	100%

Source: Peat, Marwick, Mitchell and Co., 1971.

Exhibit 3-2

Auto Ownership, for Park and Ride Users and for all CBD Mass Transit Users, Milwaukee

	Automobiles per Household				
	0	1	2	3+	Total
3 "Freeway Flyer" Routes-1971 Survey	0%	31.7%	63.4%	4.9%	100%
All CBD Mass Transit-Trips (1963 Survey)	43.3%	48.0%	8.0%	.7%	100%

Source: Peat, Marwick, Mitchell and Co., 1971.

Exhibit 3-3

Sex of Park and Ride Users in Various Cities

	Female	Male
Philadelphia (Lindenwold Hi-Speed Line)[1]	40.0%	60.0%
Atlanta (Town Flyer Shuttle)[2]	60.0%	40.0%
Vancouver (Express Bus)[3]	58.6%	41.4%
Milwaukee, Mayfair Freeway Flyer, 1966[1]	56.2	43.8

Sources: [1]Peat, Marwick, Mitchell & Co., 1971.
[2]City of Atlanta, 1971.
[3]Brown, 1975.

Exhibit 3-4

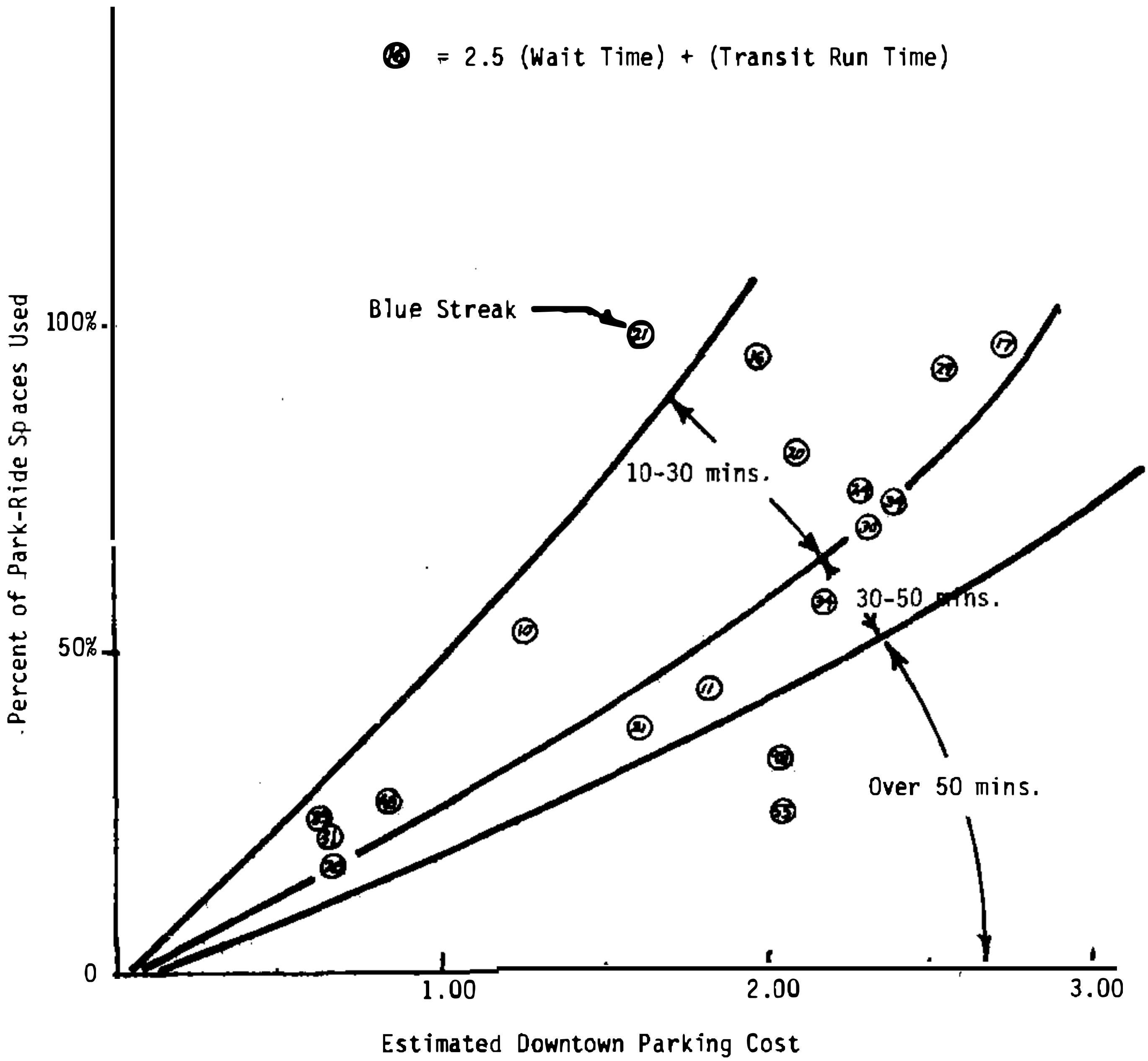
Milwaukee "Freeway Flyer" Riders, Age Distribution on 3 Routes

	Age Group				
	5-24	25-44	45-64	Over 64	Not Given
Mayfair (1966)	34.8%	31.9%	26.8%	1.7%	4.8%
Bayshore (1966)	30.8%	33.4%	28.2%	2.9%	4.7%
West Allis (1969)	39.9%	35.5%	25.9%	1.1%	2.3

Source: Peat, Marwick, Mitchell & Co., 1971.

Exhibit 3-5

PARK-RIDE LOT USAGE AS A FUNCTION OF DOWNTOWN PARKING COST



Source: Voorhees and Associates, 1973.

by auto. As the speed of travel by auto becomes lower, the commuter stands to lose less in travel time and gain more in relief from congestion by changing modes at a park and ride lot.

CHAPTER 4: TRIP CHARACTERISTICS

Section 4.1 shows that most park and ride trips are work trips. Section 4.2 discusses lengths of park and ride trips and Section 4.3 discusses the destinations of such trips. Since a traveler can arrive at a park and ride facility by modes other than an auto (e.g., walk), it is interesting to examine the distribution of users of different access modes. This is done in Section 4.4.

4.1 Trip Purpose

Remote park and ride services are used almost exclusively for work trips (Exhibit 4-1). This is in contrast to the trip purposes served by mass transit in general. For example, in Milwaukee, only about half of all mass transit trips are work trips, while almost all park and ride trips are work trips. Remote and peripheral park and ride facilities differ in the proportion of work trips served. The Institute of Traffic Engineers (1973) observed that parking lots located closer to the CBD have a somewhat higher turn over rate than those located further away. This suggests that peripheral lots serve more non-work trips (e.g., shopping and personal business trips, which are of shorter duration than work trips) than do remote park and ride lots.

Generally, the structure of park and ride services and the incentives for their use are such that work trips are served best. Park and ride is typically oriented toward a CBD where there are numerous work destinations. For a work trip with a single destination, unlike a shopping or personal business trip which often combines several destinations, it is less of an inconvenience to leave the car parked at a distance. Where destination parking charges are high, the cost of parking daily is much more of a burden than the cost of parking for an occasional shopping trip. Also, during the peak hours when most work trips are made, traffic congestion provides an additional incentive to park and ride.

4.2 Trip Length

We divide park and ride trip lengths into three components: access distance to the facility, length of the transit trip, and egress distance.

Access Distances. A general rule-of-thumb in planning bus routes assumes that almost all of the riders will walk from within 3/8 mile of the transit stop. The addition of a park and ride facility makes the service area of the transit stop several times larger. Exhibit 4-2 indicates that in the case of remote lots, 50% of the users of the park and ride facility came from within 4 miles of the station. In most cases, 75% of the users came from within 8 miles of the station. Thus although the maximum distance traveled may be quite high, (Brown, 1975, reports that in Vancouver some commuters live 20 miles away from a remote bus lot), the majority of users (75%) will come from within 8 miles of the park and ride facility.

Access distances for commuters using CBD peripheral lots may be considerably longer, since such distances combine both access and line-haul portions of the trip. In Atlanta's CBD-peripheral lot, for example, 75% of the users came from more than 7 miles away from the lot (City of Atlanta, 1972).

Length of Transit Trip. Barton-Aschman Associates' (1970) study of parkers at highway interchanges found that 89% of parkers in New Jersey traveled more than 30 miles from the parking place to their ultimate destinations in New York City. However, line-haul distances in other metropolitan areas appear to be considerably shorter. The same study found that 80% of park and ride users destined for Boston traveled a line-haul distance of 20 miles or less. For Cleveland's rail park and ride system, the average line-haul distance is only 7.6 miles (Ihnat, 1969) while Deen's (1966) survey of a number of cities revealed that the average line-haul distance for rail transit trips was 6.5 miles, and for bus transit trips was 3.7 miles.

The distance which a commuter will travel to reach a remote park and ride lot appears to depend on the total trip length. Barton-Aschman Associates (1970) suggest that mean access distance is roughly equal to 20% of total trip length.

Egress Distance. As shown in Section 2.2, the dominant egress mode is walking. Consequently, egress distances are small and therefore for park and ride trips using remote facilities, fairly high employment densities are required at the destination.

4.3 Destination Characteristics

Most successful park and ride programs have been aimed at providing transportation to CBD's. Some of the major incentives to the use of park and ride--congested driving conditions, high parking costs, and scarcity of parking at the destination are typically found only in relatively large CBD's. The CBD is generally the area's largest center of employment, and as shown in Section 4.1, park and ride service is particularly suited to serving work trips. Tanner and Barba (1973) suggest that the activity center selected as the focus of the park and ride service should have at least 10,000 employees, since areas with fewer employees do not typically generate large numbers of travelers on interchanges greater than a few miles in length. They also suggest that peaking of travel to the destination is desirable, since a concentrated demand at one location over a short period of time allows the transit operator to provide a high level of service at that time.

Since the difficulty and expense of parking close to destinations are major incentives toward the use of park and ride, a destination where parking is easily obtained and not significantly more expensive than transit fares is not a promising candidate for a park and ride service. Deen (1966) mentions five cities in which park and ride services were discontinued due to lack of patronage: Harrisburg, PA, Fort Wayne, ID, Richmond, VA, San Diego, CA, and Louisville, KY. In each of these cases, it is believed that the inexpensiveness of parking downtown contributed to the failure of the park and ride services.

4.4 Access Modes

While the distinguishing characteristic of a park and ride service is the provision of parking for commuter's automobiles, there are a number of modes which may accomplish the collection function. These other access modes are important for consideration because they contribute to the total ridership of the transit mode, even though they do not require the provision of parking space. Riders boarding transit at a change-of-mode facility may arrive by any of the following modes: drive own automobile and park, passenger in an automobile which is parked at the lot (car pool), other para-transit modes (e.g., dial-a-bus, taxi), passenger in automobile which is driven away (kiss-and-ride), feeder bus, bicycle, and walking.

Exhibits 4.3 and 4.4 present the distributions of access modes for several park and ride lots. The distributions differ according to the type of area in which the transit station is located. Exhibit 4.4 illustrates this phenomenon. In Stamford, Connecticut, where 95% of the commuters arrive by auto and only 2% walk, the commuter rail station is located in the CBD at some distance from residential areas. The other two stations are located in residential areas, which is reflected in the percentage of users who walk to the station (34% and 19%). The distribution of the various access modes does not seem to be related to the type of transit service provided, but it is clear that the commuters' choice of an access mode is a function of the distance from the origin to the transit station (Exhibit 4-5).

4.5 Egress Modes

As was discussed in Section 2.2, most park and ride users reach their ultimate destination by walking.

Exhibit 4-1

Work Trips as a Percentage of All Park and Ride Trips in Selected Metropolitan Areas

Area	Percent of Park and Ride Trips That are Work Trips
Connecticut - Five Stations on Penn Central[1]	97%
Seattle - Blue Streak Bus[2]	85%
New Brunswick Commuter Rail[3]	90%
Milwaukee Freeway Flyer Buses[2]	90-100%

Sources: [1]Connecticut State Highway Department, 1969.
[2]Peat, Marwick, Mitchell & Co., 1971.
[3]Tri-State Transportation Commission, 1967.

Exhibit 4-2

Access Distances to Remote Park and Ride Lots

	50% of Access Trips	75% of Access Trips	Travel Mode
Mayfair (Milwaukee)[1]	≤ 2 miles	≤ 3 miles	Bus
Bayshore (Milwaukee)[1]	≤ 2 miles	≤ 4 miles	Bus
Blue Streak (Seattle)[2]	≤ 2-2.5 miles	≤ 5-5.5 miles	Bus
NE Corridor Study (quoted in[3] Gatens, 1974)	≤ 5 miles	≤ 10 miles	Rail and Bus

Sources: [1]Peat, Mar[illegible], Mitchell, 1971.
[2]Voorhees, [illegible].
[3]Gatens, 1974.

Exhibit 4-3

Access Modes to Remote Park and Ride Lots

Mode	Vancouver[1] (Bus)	Milwaukee[2] (Bus)	Hartford[3] (Bus)	Pittsburgh[4] (Bus)	Cleveland[5] (Rail)
Drive/Park	77%	46%	66%	53%	46%
Car Pool Kiss/Ride	11%	33%	30%	20%	9%
Bus	1%	9%	---	6%	
Walk	10%	12%	4%	8%	45%
Other	1%	---	---	2%	
	100%	100%	100%	100%	100%

Sources: [1]Brown, 1972.
[2]Peat, Marwick, Mitchell, 1971.
[3]Zevin, 1972.
[4]Comsis Corporation, 1975.
[5]Ihnat, 1969.

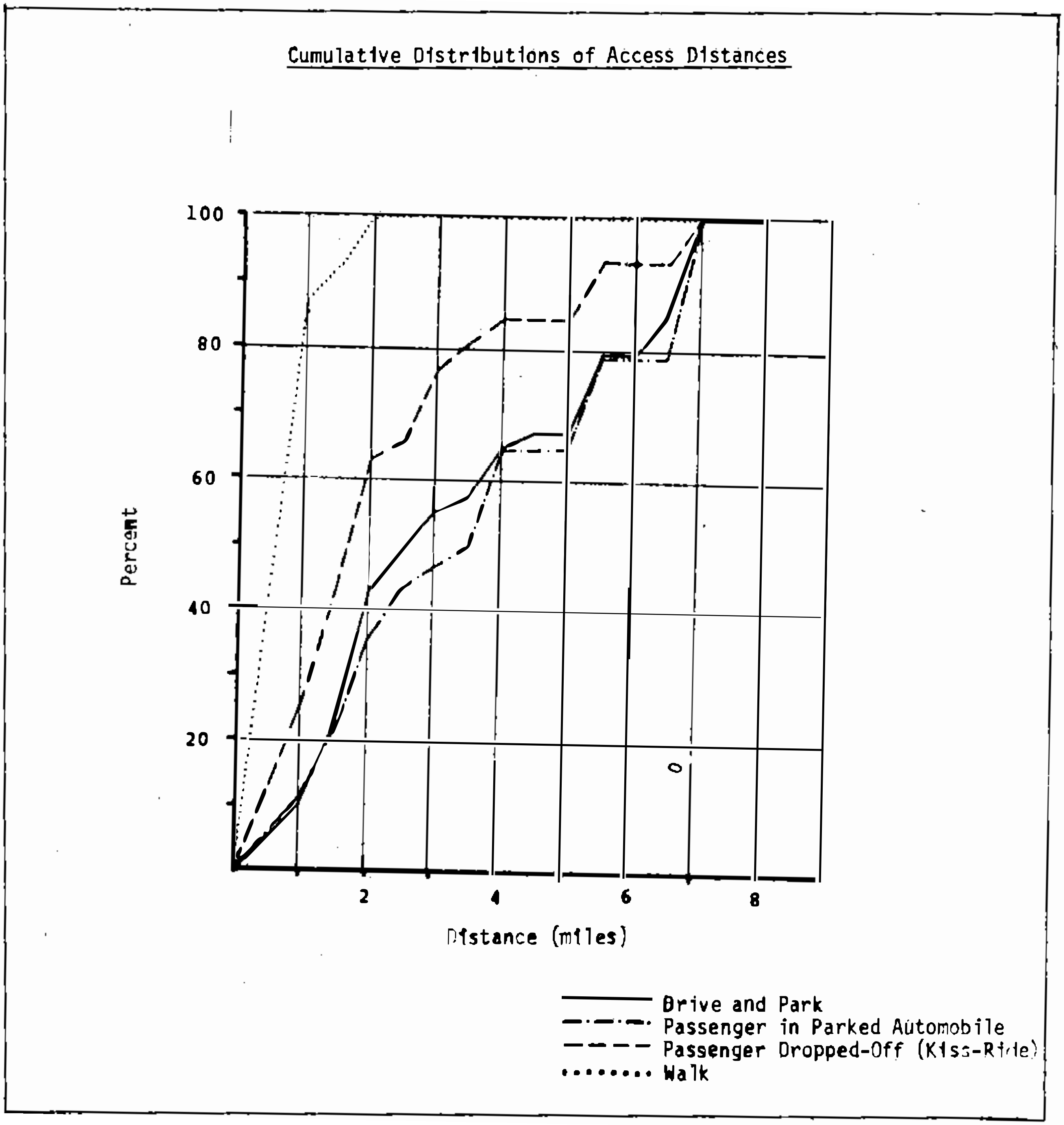
Exhibit 4-4

Access Modes to Remote Park and Ride Lots
With Commuter Rail Service to New York City

Mode	Stamford	Riverside	Glenbrook
Drive/Park	72%	34%	53%
Car Pool	7%	6%	4%
Kiss/Ride	16%	25%	23%
Bus	3%	---	---
Walk	2%	34%	19%
Other	---	1%	1%
	100%	100%	100%

Source: Connecticut State Highway Dept., 1969

Exhibit 4-5



Source: Prepared by Peat, Marwick, Mitchell & Co. from data provided by the Seattle Transit System, 1970.

PART II - PLANNING FOR PARK AND RIDE

CHAPTER 5: OVERVIEW OF PARK AND RIDE PLANNING

In Section 5.1 we provide an overview of the situations where regional planning for park and ride is appropriate and some rules-of-thumb for identifying these situations. Section 5.2 discusses some exceptions to the rules and suggests how planning for these exceptions might be handled. Some further general guidelines for park and ride planning are presented in Section 5.3.

5.1 Park and Ride Service for Low-Density Areas

The information presented in Part I of this report gives us the ability to identify the conditions under which park and ride is most appropriate, and thus narrow down the number of alternatives which must be considered in planning for low density park and ride service. Planning a park and ride service includes choosing a destination for the service and locating a park and ride facility. We have seen that the primary objective of providing park and ride service is the diversion of parking from one area to another (Section 1.3). This objective will help us determine the destinations which should be served by park and ride. We can then begin to consider the areas to which parking demand can be diverted, which will indicate the locations of park and ride facilities.

Destinations. We know that most park and ride users will walk from the transit mode to their ultimate destination (Section 4.5), and that almost all park and riders are on work trips (Section 4.1). This leads us to describe the park and ride destination as an employment center in a relatively high density area, where many trip ends are located within a short walk of a transit stop, and where it might be difficult to provide sufficient parking to meet demand.

Since in an urban area the CBD has the highest employment density, if the CBD is not a suitable destination for park and ride trips, no other suitable destination is likely to be found in the area. In fact, most existing park and ride serves CBD destinations (Section 4.3). Surveys of commuters who park and ride indicate that they consider a reduction in travel cost to be the most important consideration in the decision to use park and ride (Section 3.5). Additionally, park and ride demand studies have revealed that, when the costs of park and ride are roughly equal to the costs of a trip by auto, the percentage of commuters choosing park and ride is very low (Section 6.1).

Since overall trip costs vary according to trip lengths, it is convenient to consider one important component of total trip cost, the CBD parking cost. We have seen that when downtown parking costs are less than $1.50 per day, park and ride lots tend to be poorly utilized (Exhibit 3-5, Section 3.5). We can support this further through a comparison of some auto and park and ride costs. For the commuter, the major benefit of park and ride is the avoidance of downtown parking charges, while the most significant cost incurred is the extra time involved in transferring from auto to another mode. Let us assume that the commuter makes his or her modal choice by comparing this cost and this benefit. If the extra time cost of transferring amounts to about 10 minutes each day, and the commuter values this time at $10.00 per hour, the transfer time is worth roughly $1.70 per day.

This information suggests that in the case of a downtown parking cost level below $1.50 to $1.70, few commuters are likely to use a park and ride lot. Since the level of parking cost also indicates the demand for parking and the demand for the land used in parking, it is reasonable to conclude that in CBD's where parking costs are below this level, there is little need to divert parking away from the CBD. Realizing that other variables such as the level of transit service are important in determining park and ride demand, we shall adopt the more conservative figure ($1.50 per day parking cost), as the point below which CBD's should not be considered as destinations for park and ride services.

Location of the Park and Ride Facility. Although suitable park and ride destinations are unlikely to be found in low-density areas, such areas are suitable locations for park and ride facilities. In fact, park and ride is especially suited to such areas, since the use of automobiles for the first leg of the trip greatly extends the coverage of the transit service.

The previous discussion of park and ride destinations has limited our planning recommendations to park and ride serving the CBD's of fairly large metropolitan areas. Since this report is concerned with planning for low-density areas, we can next consider where those low density areas might be in metropolitan areas where park and ride is a suitable mode. Using our cutoff point of $1.50 CBD parking cost, and referring to the graph in Exhibit 5-1, it appears that a metropolitan area of 250,000 or more is likely to have a CBD parking fee of $1.50 per day ($0.75 per one-way trip.) Next, using Exhibit 5-2, we can see that such a metropolitan area has its highest residential densities at about 4 to 5 miles from the CBD and declines at greater distances from the CBD.

Our knowledge of existing park and ride services indicates that demand for bus park and ride drops significantly when the distance from the CBD is greater than about 5 miles, or travel time on the bus is greater than 25 minutes (See Section 5.3). In contrast, it appears that demand for park and ride is not significantly affected by trip distances when the transit mode operates on a separate right-of-way. Thus park and ride with bus service is best used for services requiring a shuttle or a short line-haul. For the low density areas which are the subject of this report, we recommend that park and ride be provided in connection with rail rapid transit, commuter rail service or express bus on busways.

5.2 Some Exceptions

Several exceptions to the general cases of park and ride outlined in the previous section may occur. For example, parking scarcity may occur even in low density areas when there is a popular sports event, concert, or convention. However, for temporary park and ride services such as these, regional planning in great detail is unlikely to be necessary.

Other exceptional cases are situations where van pools, subscription buses or ECBS (Employment Center Bus Service) may originate from an existing parking lot. In such cases, planning consists of primarily dealing with the para-transit mode and the parking aspects of such efforts are likely to be minimal. However, some of the information presented in this report will still be useful.

A final exception is one which frequently occurs at airports where lots get so large or dispersed that a bus service is needed. We do not consider this case in the report.

5.3 General Pointers and Guidelines

In this section we discuss some guidelines that are suggested by previous experience with park and ride, with regard to transportation corridors, distance from park and ride lot to the destination, and accessibility of the park and ride lot.

Transportation Corridor. The selection of a transportation corridor in which to locate a parking lot is a more important consideration in planning a remote park and ride lot than a peripheral one, since peripheral park and ride facilities tend to draw parkers from a fairly wide market area. Here we will deal with remote park and ride, exclusively.

In most cases, the park and ride corridor should be a heavily traveled one already defined by an existing highway, rail line, or bus routes, leading to a major activity center. For bus park and ride, the existence of a highway is crucial, since the express bus must be able to travel on a highway to compete with the travel time of the auto. Additionally, most successful bus park and ride lots are located within one-half mile of an expressway in order to provide easy access for the commuter to the park and ride lot and for the bus to the highway.

Distance from Lot to Destination. The distance from the destination at which a park and ride lot is located is important in determining the success of the facility. It is desirable to induce the commuter to change modes as soon as possible in order to minimize vehicle miles traveled. This implies a location as far as possible from the CBD. However, especially with bus park and ride lots, the greatest demand for parking seems to be generated relatively close to the CBD. Deen (1966) observed that most successful bus park and ride lots seem to be located within 5 miles or 25 minutes travel time of the CBD. This phenomenon, he suggests, may be due to the fact that even express buses do not generally offer travel time savings over the automobile, and thus commuters will not usually tolerate long trips on the bus when they have an auto as an alternative.

Comsis Corporation (1975) observes that in general, the more successful of Pittsburgh's bus park and ride lots are located closer to the CBD, but that lots at distances less than 15 miles are equally successful. Those lots located greater than 15 miles from the CBD, however, seem to be less successful. In locating a bus park and ride lot, the distance from the CBD should be selected through a consideration of distances and, more importantly, travel times. In most instances, keeping bus travel times under 30 minutes seems to be a reasonable guideline.

Because of the travel time savings provided by a mode with a separate right-of-way, rail and busway park and ride lots may be located at greater distances and greater travel times from the CBD than bus lots. Even when total travel times by rail and busway are long, the trip tends to be faster than a comparable trip by auto. Thus commuter rail, rail rapid transit, and bus on busway, park and ride lots, seem to be successful as far away from the CBD as those commuter stations are found. In New Brunswick, NJ, a successful park and ride lot for the commuter rail service is located 33 miles away from its Manhattan destination (Tri-State Transportation Commission, 1967).

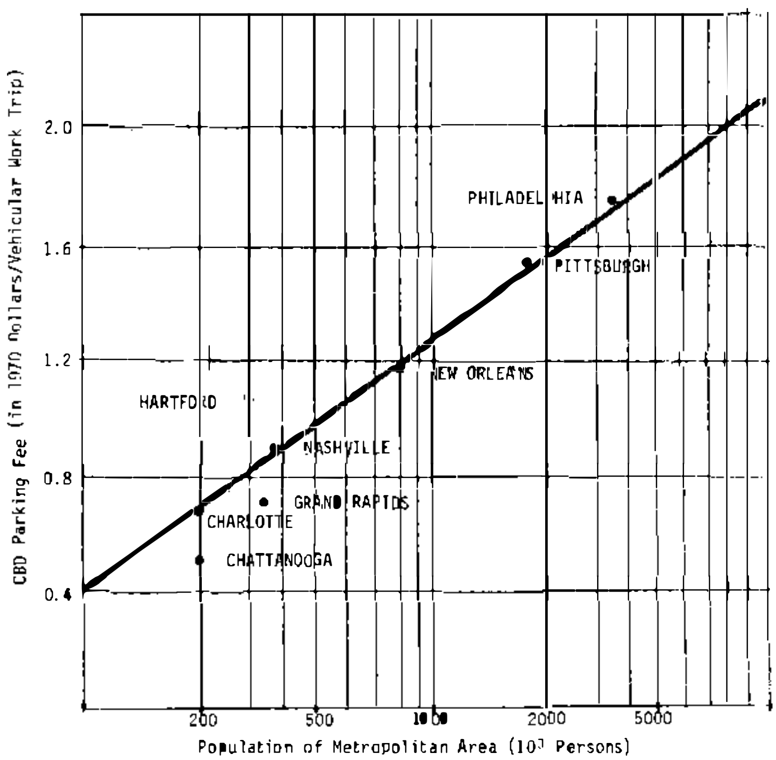
Accessibility of the Park and Ride Lot. The market area of a bus park and ride lot may be considered to be the traffic on the highway near the location of the lot. Thus the time from which the commuter leaves the highway to park the car until he or she resumes traveling on the highway in the transit vehicle may be considered an excess time cost. This additional time cost is a disincentive to the use of park and ride. Thus, locating the lot as closely as possible to the highway is desirable since it minimizes the time spent by the commuter driving to the lot as well as the time spent by the bus driving to the freeway. Tanner and Barba (1973) suggest that where it is not possible to allow the commuter to make right turns to enter the lot, turning lanes and signals should be provided to encourage easy access.

The accessibility of land near highway interchanges makes it attractive for uses other than park and ride, therefore, acquiring sites near an interchange may be both difficult and expensive. As an alternative, Barton-Aschman Associates (1970) recommended that state highway departments and local governments exercise their authority to use rights-of-way for parking. The joint use of parking facilities is another low-cost alternative to acquiring land. Milwaukee, for example, operates six bus park and ride routes from various shopping centers. All of these are within one-third mile of a freeway ramp which provides excellent accessibility and minimizes the time lost in changing modes (Peat, Marwick, Mitchell & Co., 1971).

Commuter rail park and ride lots tend to be located in the CBD's of suburban municipalities and draw their users from that suburb. The location of a parking lot near the CBD may cause an increase in congestion in that area, as well as inhibiting accessibility to the rail station itself. An alternative is moving the rail station to a location outside the CBD, although the cost is often prohibitive. In New Brunswick, NJ, a second station with a parking lot was opening in addition to the downtown station, which did not make provision for parking. This facility was located at a railroad siding in a non-residential area. Despite the fact that service was less frequent than at the downtown station, it was found that the new station was well used (Tri-State Transportation Commission, 1967).

Exhibit 5-1

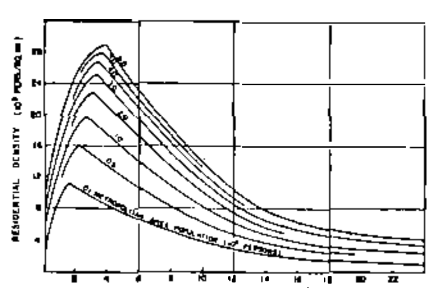
Variation of CBD Parking Fee With Metropolitan Area Size



Source: Abdus-Samad and Grecco, 1972.

Exhibit 5-2

Residential Density as Function of Location Within City and Metropolitan Area Size



Source: Abdus-Samad and Grecco, 1972

CHAPTER 6: DEMAND FOR PARK AND RIDE SERVICE

In Section 6.1 we discuss some of the models which have been used for predicting park and ride demand. For estimating the benefits of park and ride, it is necessary to know the former modes of park and ride users. This is discussed in Section 6.2. In Section 6.3 some empirical information on park and ride demand is presented which was developed by the Institute of Traffic Engineers.

6.1 Demand Models

Several general types of park and ride demand models are discussed below. These models have been applied to a number of different park and ride situations, as is noted in the discussions.

Questionnaire-Based Models. The New York State Department of Transportation has done a considerable amount of research on travel demand forecasting based on questionnaire surveys. Any forecasting procedure of this type encounters the problem of non-commitment response, which is the tendency of respondents to overestimate their usage of the proposed transit service since their response does not commit them to using it. Based on past experience with predicted and observed transit ridership, a method of adjusting non-commitment responses to reflect "true" responses has been developed. This method is described in detail in Hartgen (1973), where it was used to predict demand for remote park and ride with express bus service from several suburban communities to the Rochester, New York CBD. The collection of the questionnaire survey data is described in Schaefer *et al*., (1973).

A questionnaire survey was also used to estimate demand for fringe parking in Stamford, Connecticut. In this case, there was a shortage of parking at the commuter rail station (with service to Manhattan) which was located in downtown Stamford. Present parkers were asked whether they would be willing to use park and ride service from some point outside the CBD to the railroad station (Connecticut State Highway Department, 1969).

Parking-Generation Models. Some models for park and ride demand are based on forecasting parking demand and then allocating that demand to various parking facilities, including park and ride facilities. Such a technique was used by Austin and Lee (1973) to forecast demand for peripheral park and ride in Los Angeles. The parking allocation procedure used information about present parking behavior of downtown workers, which was assumed to be based on a trade-off between the cost of parking and proximity to the destination. By varying the assumed costs of parking and travel times on the transit system, estimates of peripheral park and ride demand under different conditions were developed.

Walker and Cummings (1972) estimated future parking demand in the Baltimore CBD by using parking-generation rates for different land uses.
The allocation of parking demand to remote park and ride facilities was done through a questionnaire survey designed to estimate the percentage of downtown all-day parkers who would use park and ride. The forecasted downtown parking demand was reduced by this percentage. The authors did not make any adjustments

for the bias caused by non-commitment response.

Level-of-Service Models. Abdus-Samad and Grecco (1972) have developed a linear regression model which takes into account the effects of a large number of factors on park and ride demand. The model is based on data gathered through a mail survey covering 73 rail and 20 bus facilities. The following aggregate variables were derived from the information in the survey:

Transit Service Rating
Metropolitan Area Rating
Parking Facility Location Rating
Facility Safety Rating
Physical Quality of Facility Rating
Facility Reliability Rating
Facility Flexibility Rating
Facility Parking Fee Rating

For example, the transit service rating is comprised of: 1) quality of station terminal building; 2) transit fare; 3) overall transit travel speed; 4) proportion of downtown jobs easily accessible by transit; 5) cost of transfer; 6) number of fare zones; and 7) ticket marketing and collection methods. These seven variables are added or multiplied together, based on the authors' judgment of how they are perceived by commuters.

The final regression model estimated demand (measured as the number of vehicles using a park and ride facility in a 24-hour period) as a function of the total number of parking stalls provided, the type of transit (rail or bus), the facility's ratings for reliability, transit service, metropolitan area, the interaction of flexibility and parking fee ratings, and of the transit service and reliability ratings.

Modal Split/Submodal Split Models. Some park and ride demand models forecast demand in two stages. In the first, the number of persons who will use a particular transit service are estimated (modal split). In the second stage, the users of the transit service are assigned to access modes (sub-modal split).

This type of model has been used by Mufti, et al., (1977) to estimate future demand for park and ride at commuter rail stations in the Philadelphia area. Market areas were assigned to each station, and in the modal split stage the proportion of commuters in the market area choosing rail was estimated from diversion curves based on disutility variables. At the sub-modal split stage, the percentage of station users who would park and ride at the station was estimated as a function of the access distance from each zone to the station.

Travel Time and Cost Models. Liou (1974) and Keck and Liou (1974) have developed several models for predicting park and ride demand at two peripheral lots in Albany, New York. The data for these models come from license plate surveys of the two lots, and the variables used are: 1) airline distance between a zone and the downtown; 2) travel time difference (park and ride minus auto); 3) travel cost difference (park and ride minus auto); and 4) combined cost difference, where the travel times were given a value of $4.20/hour and combined with travel cost. Several models which were developed from these data are discussed and compared in Liou (1974). It is interesting to note that these models predict low park and ride usage (around 2% of the market) when the levels of service of park and ride and auto are about equal. A modal split of 50% occurs for about a half hour difference in favor of park and ride (this lends support to the same recent findings that the value of time spent transferring may be as high as nine times on board time e.g., see Pagitsas, 1977).

Attitudinal Models. Brown (1973) has developed a discriminant model to explore the reasons why former automobile drivers shifted to park and ride. His work indicated that a reduction in travel cost was the most significant reason for the modal shift. The importance of the travel cost difference was also indicated by a questionnaire survey of park and riders who formerly drove all the way.

6.2 Diversion of Auto Drivers to Park and Ride

Although park and ride services are designed to divert auto drivers to transit for part of their trip, park and ride also attracts users from other modes such as buses or car pools. Thus a one-to-one correspondence does not exist between the number of park and ride spaces provided and the number of auto drivers diverted from downtown parking spaces. Deen (1966) estimates that in Washington, D.C., one car is removed from the traffic stream for every four spaces provided in a park and ride lot. His estimate is based on the results of an on-board survey of users of three Washington, D.C., area park and ride services. The results from this and three other surveys are presented in Exhibit 6-1.

6.3 Parking Demand at Existing Park and Ride Lots

Most park and ride services are designed to serve a CBD, and the facilities are located throughout a metropolitan area at various distances from the CBD. Exhibit 6-2 gives an idea of the distances from the CBD at which park and ride lots are located. It is clear that rail park and ride lots extend much further from the CBD than do bus lots, probably because rail is better able to compete with the automobile for long trips.

Exhibit 6-4 indicates that parking demand for peripheral bus lots (say, within 3 miles of the CBD) is extremely high, but that demand drops sharply after this point. Deen (1966) reached a similar conclusion in his study of park and ride services. He suggested that because bus travel typically does not offer travel time savings over auto travel, commuters will not usually tolerate bus trips longer than 5 miles or 25 minutes. The ratio of autos parked/parking spaces at peripheral bus lots is greater than one, which suggests that peripheral bus lots are used by many short-term parkers as well as all-day parkers on work trips.

Demand for parking at rail-serviced park and ride lots is low at locations close to the CBD but rises between 5 and 10 miles from the CBD, where, as we noted, demand for bus park and ride declines. The number of spaces at rail lots declines slowly at distances greater than 10 miles. Generally, the turnover rate is slightly less than one at these lots, suggesting that supply and demand are fairly closely matched and that the spaces are being used by all-day parkers.

Exhibit 6-1

Former Travel Modes of Users of Park and Ride Services in Vancouver, BC, Milwaukee, WI Washington, D.C. and New Brunswick, N J

Vancouver, B C[1]
(new express bus service)

Drove	38%
Bus	21%
Car Pool Passenger	8%
Other	33%
	100%

Milwaukee, WI[2]
(new express bus service)

Drove	25%
Transit	38%
Car Pool Passenger	18%
Other	19%
	100%

Washington, D.C.[3]
(new express bus service)

Drove	25%
Parked on street, rode bus	14%
Walk	15%
Kiss and ride	9%
Car Pool Passenger	18%
Other	19%
	100%

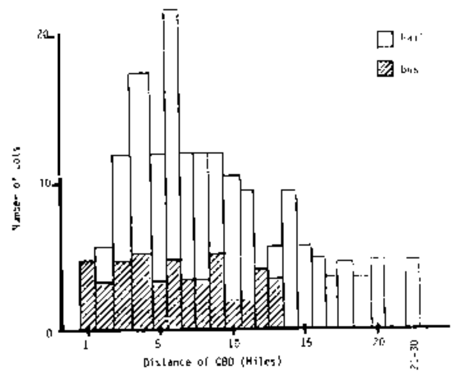
New Brunswick, N J[4]
(new commuter rail station)

Drove	11%
Bus	13%
Other (includes rail users from another station)	76%
	100%

Source: [1]Brown, 1973.
[2]Peat, Marwick and Mitchell and Market Facts, 1971.
[3]Deen, 1966.
[4]Tri-State Transportation Commission, 1967.

Exhibit E-2

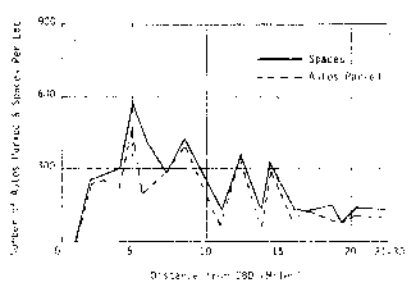
Number of Lots by Distance to CBD and by Type of Transit Service



Source: Institute of Traffic Engineers, 1973 based on survey of [illegible] bus and 139 rail lots in 8 metropolitan areas.

Exhibit [illegible]

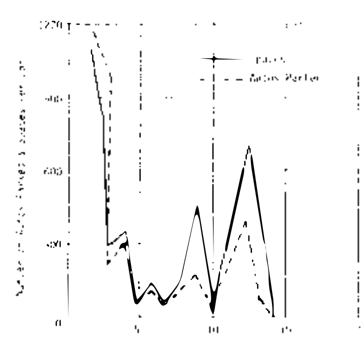
Number of Autos Parked and Number of Spaces at Rail Serviced Lots By Distance From the CBD



Source: Institute of Traffic Engineers, 1973

Exhibit E-4

Number of Autos Parked and Number of Spaces at Bus Serviced Lots By Distance From the CBD



Source: Institute of Traffic Engineers, 1973.

CHAPTER 7: COSTS

The costs of a park and ride service include the costs of providing parking as well as the costs of providing transit service from the park and ride lot to the destination. In this report we present only the parking lot costs and leave transit costs to other reports (e.g., Sen, et al., 1977). If a parking lot is to be constructed solely for use as a park and ride lot, three major areas of cost must be considered. These are: acquisition of land, construction of the lot, and maintenance of the lot (Sections 7.1, 7.2, 7.3 below). The costs of leasing an existing parking lot for joint use are discussed in Section 7.4.

7.1 Land Costs

The costs of land acquisition vary widely within a metropolitan area. Most park and ride services are designed to divert parking from the CBD, where the highest costs per square foot are generally found, to areas where the demand for and price of land are lower. Of course, even outside the CBD, land costs vary widely. Exhibit 7-1 indicates the initial cost and the annual cost of land per stall for surface lots at various price levels. As land costs increase, it may become less expensive to construct multi-story or underground lots than surface lots. This is discussed more fully in the following section.

7.2 Construction Costs

The most important variable determining the construction cost of a parking facility is whether the facility is surface, multi-story, or underground. The costs of construction include all fixed costs (pavement, barriers, lighting, and so on) except for the cost of the land.

Construction costs for a surface lot, according to Means (1975), are about $2.40 per square foot, although they vary depending on soil conditions and local construction costs. About 330 sq. ft. are required for each stall, which accounts for both the parking space and access areas, so that the construction cost per stall for a surface lot is about $792.

Construction costs for multi-story lots vary with the number of stories. Exhibit 7-2 shows that the costs per square foot increase rapidly up to about six stories and then reach a plateau. Construction costs per stall behave similarly (Exhibit 7-3).

Construction costs for underground lots are considerablely higher than surface or multi-story because of the additional costs of excavation and ventilation. These costs may range from $4,000-8,000 per stall (Means, 1975). The decision whether to build a surface, multi-story, or underground lot is influenced by both the cost of land and the cost of constructing the various types of parking facilities. The costs per stall of constructing the various facilities at different land costs are shown in Exhibit 7-4. At land costs of less than $7.50 per sq. ft., a surface parking lot will generally be least expensive. Where land costs are higher than this figure, a multi-story lot will probably be most practical. Underground lots are very expensive in all cases.

7.3 Maintenance Costs

Operating expenses vary considerably from one situation to the next, as do land and construction costs. Exhibit 7-5 gives operating costs from two different sources. Labor costs vary greatly, and in Smith's (1965) data they comprise a very large proportion of operating costs. The information from the University of Illinois suggests that the operation of surface lots is generally somewhat less expensive than that of multi-story structures.

Total annual costs of several types of parking facilities are shown in Exhibit 7-6. The annual costs of land and construction were computed based on the formula described in Sen, et al. (1977). Annual operating costs were based on University of Illinois estimates, as discussed previously. In terms of total annual costs, it appears that surface lots are the most economical parking facility at land costs of under $6.00 per sq. ft. At higher land costs, multi-story lots become more economical.

7.4 Leasing Parking Costs for Joint-Use Lots

Many park and ride facilities, especially those with bus service, are parking lots originally constructed for some other purpose and then leased for use by commuters during certain hours of the day. Sometimes such a joint-use lot may be the only feasible way of locating a park and ride facility in a certain desirable area (e.g., close to a freeway interchange). The costs of leasing spaces for park and ride will vary with the location and ownership of the lot, but it may be the most economical alternative in some cases. For example, the City of Atlanta leased 1,248 spaces for the "Town Flyer" operation at an annual cost of $117,250, or about $94 per space.

The flexibility of a joint-use lot with bus service can be beneficial to the park and ride operator. In the event that the service is unsuccessful, or if travel patterns change, the park and ride service can be moved to another location without the loss of an initial capital investment.

Exhibit 7-1

Land Cost Per Stall for a Surface Parking Lot at Various Price Levels

Price of Land Per Square Foot

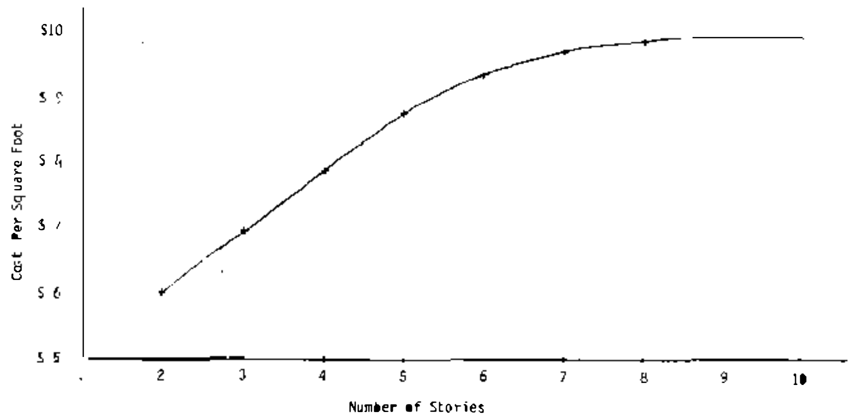
	$ 2.50	$ 5.00	$ 7.50	$ 10.00	$ 12.50	$ 15.00
Total Cost Per Stall	$825	$1650	$2475	$3300	$4125	$4950
Annual Cost Per Stall	$ 24.75	$ 51.00	$ 74.25	$ 99.00	$ 123.75	$ 148.50

Based on 330 sq. ft. of Space Per Stall.

Source: Annual Cost Computations based on Sen, et al., 1977.

Exhibit 7-2

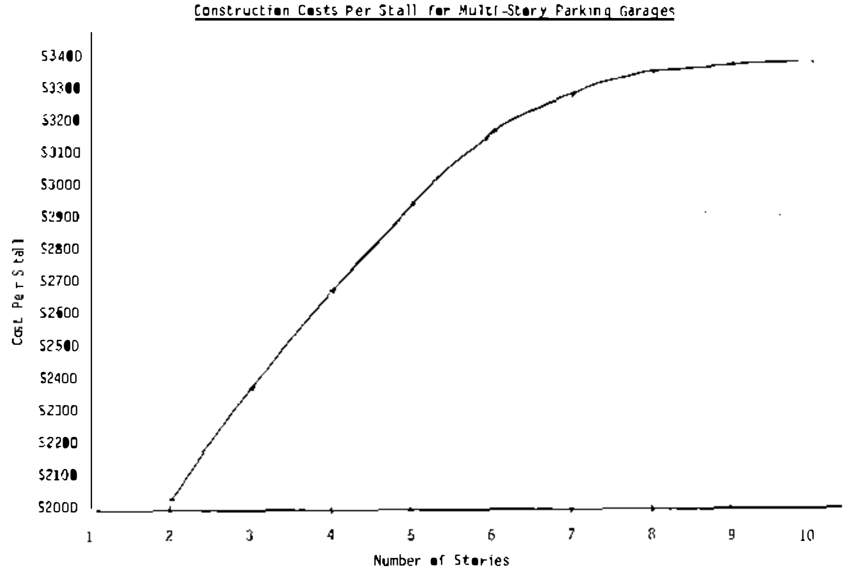
Construction Costs Per Square Foot for Multi-Story Parking Garages



Source: Means, 1975.

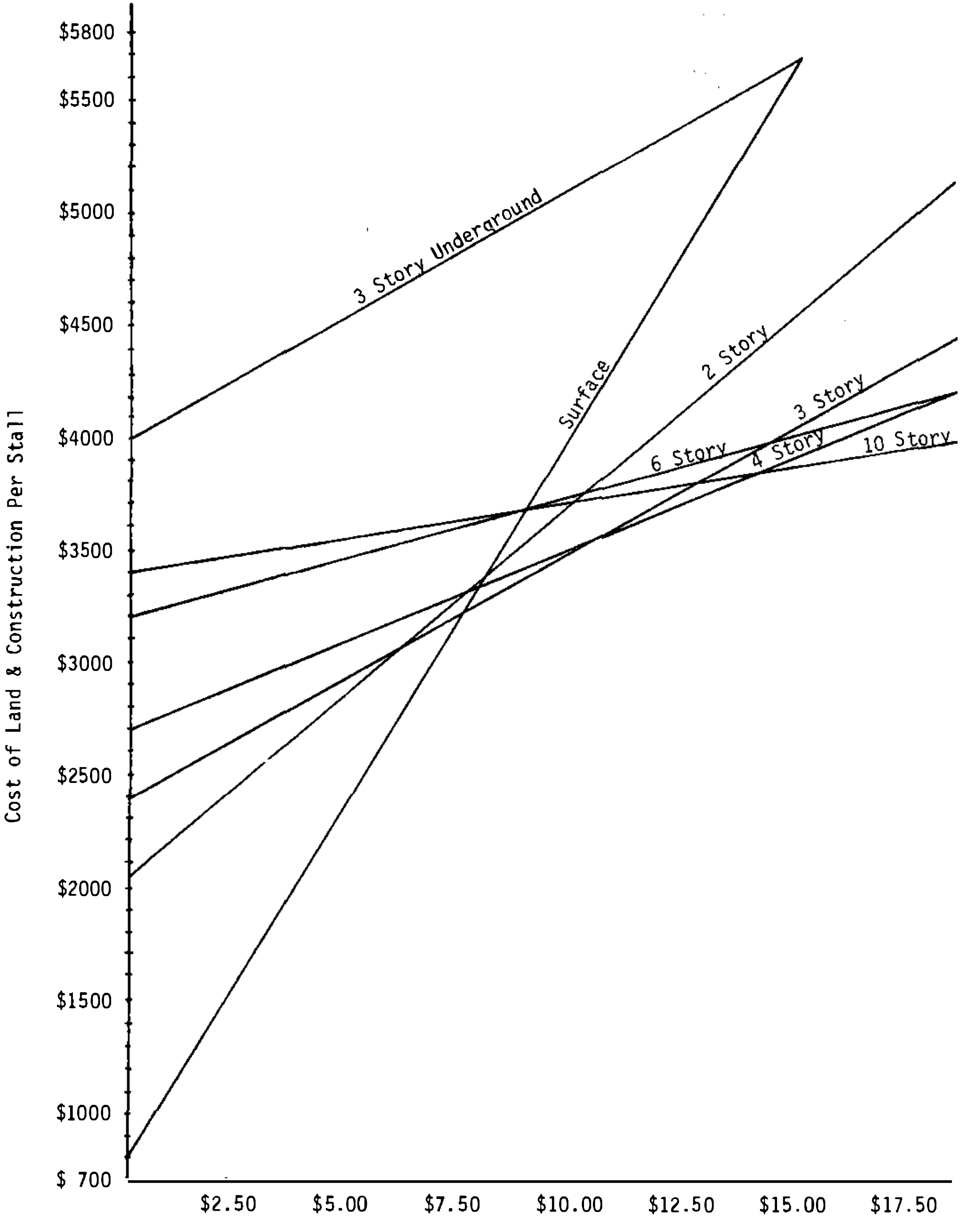
Exhibit 7-3

Construction Costs Per Stall for Multi-Story Parking Garages



Source: Means, 1975.
Based on 340 Square Feet Per Stall.

Exhibit 7-4



Source: Authors Computations based on Means, 1975.

Exhibit 7-5

Operating Expenses Per Stall for Parking Facilities[1]

	1961	1975 (Adjusted)
Labor	$ 76.68	$137.96
Insurance	8.36	15.04
Utilities	11.90	21.41
Maintenance	23.69	42.53
TOTAL	$120.63	$216.94

Fiscal Year 1975-76[2]

	Surface Lots	Parking Structure
Labor	$ 6.75	$22.69
Insurance	.03	.48
Utilities	2.06	11.77
Maintenance	8.27	5.39
Administration	10.96	10.06
Other (Security, Supplies, Snow Removal, etc.)	14.59	8.27
TOTAL	$42.66	$58.66

Sources: [1]Smith, 1975.
[2]Osowski, O., Auxiliary Services, University of Illinois Chicago Circle

Chapter 8: BENEFITS AND IMPACTS OF PARK AND RIDE

Section 8.1 is a general discussion of the benefits and impacts of park and ride. The impacts of park and ride on diversion of parking, energy consumption, congestion, and pollution are discussed in Sections 2.1 through 8.5. Section 8.6 presents an example of how the impacts of a park and ride service may be computed.

8.1 Overview of Park and Ride Impacts

The major benefits of park and ride service are the diversion of parking from a destination where parking is scarce or expensive and a reduction in vehicle-miles traveled, which also reduces energy consumption, traffic congestion, and pollution. These benefits are the primary reasons for supplying park and ride service (see Section 1.3). There are a number of other impacts of park and ride, such as reductions in travel cost and increases in mobility, which will not be dealt with in this chapter. A fairly thorough listing of these impacts is provided in Exhibit 8.1.

8.2 Diversion of Parking

Park and ride services are designed to divert parking from a destination where parking is scarce or expensive to an area where parking is more readily available or less expensive to provide. However, the provision of a given number of park and ride spaces will not reduce parking demand at the destination by the same amount. This occurs because park and ride attracts transit users as well as auto drivers. While some commuters who formerly drove all the way shorten their auto trips, other commuters who formerly made their entire trip by public transit will begin to drive to the park and ride lot. Thus the number of parking spaces that are diverted is equal to the number of park and ride users who formerly made their entire trip driving an auto.

The percentage of park and ride users who are diverted from auto is discussed in Section 6.2. Based on park and ride experience in the Washington, D.C. area, Deen (1966) suggests that the need for parking at the destination is reduced by one space for each four park and ride spaces that are provided. Thus, using the cost of providing land as a criterion, it appears that no cost savings will be realized unless the price of land in the CBD is more than four times higher than the price of land where park and ride is to be provided. While this is only a rough computation, it reinforces the recommendation that park and ride be considered only to serve the CBDs of fairly large metropolitan areas.

8.3 Energy Consumption

Park and ride reduces energy consumption by diverting drivers from automobiles for the portion of their trip that is covered by the transit mode. At the same time, it increases energy consumption in several ways: (1) Through the construction of the parking lot and the transit vehicles, (2) by inducing commuters who fomerly took transit to drive or be driven to the park and ride lot, and (3) through the energy consumed in the operation of the transit vehicle. For short trips with a cold-start engine (such as most trips from home to the park and ride lot), the energy consumption per mile is higher than for a relatively long trip during which the engine has a chance to warm up (See Exhibits 8-2 and 8-3). Thus, if a park and ride service induces a great deal of short trips without diverting a significant number of long trips, its net effect on energy consumption may be little or nothing.

8.4 Congestion

Park and ride can reduce traffic congestion at or near the destination it serves, but will increase congestion levels near the park and ride facility. The method for computing congestion costs which was described in the carpool chapter, and the table of costs can also be applied here. As Exhibit 8.4 indicates, the costs in time to all road users of adding one car to a roadway vary depending on the type of road in question and its volume/capacity ratio. Thus the overall impact of park and ride on congestion is very much dependent on existing traffic congestion in the areas where automobiles will be removed and added.

8.5 Pollution

Since a vehicle with a cold engine emits more pollution than a warmed-up vehicle, the emission of pollutants by an automobile is relatively higher on a short trip than on a longer one (Exhibit 8.5). Thus a park and ride service which attracts a large number of short trips without diverting many long trips could fail to reduce overall pollution levels.
It should also be noted that the effects of pollution vary from one location to another depending on the level of pollutants already in the air. Although it is not easily quantified, this aspect of pollution should be taken into consideration when the impacts of pollution on various areas are considered. For example, a park and ride lot in a suburb serving a transit facility leading to a CBD will probably improve the air quality of the CBD. But at the same time pollution output will have increased in the suburb because of the attraction of auto drivers and other transit users to the lot. Furthermore, most of these trips will be short, resulting in a high emission rate from the autos.

8.6 Computation of Impacts of Park and Ride

In this section we present a generalized method for estimating the impacts of park and ride. We discuss, first, how the former modes of park and ride users affect the impacts of the service, and then how the net effects of park and ride on vehicle miles travelled, energy consumption, congestion, pollution, and parking needs can be computed.

Former Modes of Park and Ride Users. Assume that a park and ride lot provides X parking spaces, all of which are used. If α represents the load factor of the automobiles parked at the lot, then αX is the number of persons who park and ride. The total number of persons who use the transit service provided at the facility is $\alpha X + A$, where A may include new on-street (near the station) park and riders represented by αa, where a is the number of vehicles parked on the street.

We will be interested in the modes that our park and riders, X, formerly used. We can represent the former modes by

M_a - the percentage of park and riders who formerly drove.
M_p - the percentage of park and riders who formerly were passengers.
M_{pr} - the percentage of park and riders who formerly parked on the street.
M_{kr} - the percentage of park and riders who formerly were kiss and riders.
M_w - the percentage of park and riders who formerly walked to the station.
M_o - the percentage of park and riders who formerly arrived by other modes.

the number of new transit riders is $X (M_a + M_p) +$ a.

Diversion of Parking. αXM_a is the number of people who were diverted from parking in the CBD. If there was previously parking on the street in the area of the transit station, then the number of street spaces freed (near the park and ride facilities) is XM_{pr} - a.

Vehicle-Miles Travelled (VMT). The VMT added by a park and ride service is $XL_{pr} + L_{pr}$ where L_{pr} is the average park and ride trip length. The VMT reduced by the park and ride service is $X (M_a L_a + M_{pr} + M_{kr} L_{kr}) + a (M_a L_a + M_{kr} L_{kr})$ where L_a = average length of auto trips of former auto users L_{kr} = average length of a kiss and ride trip from home to station to home again. The net change in VMT due to the park and ride service, then, is the VMT generated miles the VMT reduced.

Energy Consumption. The net change in energy consumption is easily computed, based on the net change in VMT. It is

$(XL_{pr}F_{pr} + a\,L_{pr}\,F_{pr}) - (XM_aL_aF_a + XM_{pr}L_{pr}F_{pr} + XM_{kr}\,L_{kr}\,F_{kr}) + a\,(M_aL_aF_a + M_{kr}\,L_{kr}\,F_{kr})$, where F_{pr}, F_a and F_{kr} are the energy consumption factors per vehicle mile that apply to the respective trip lengths. (See Section 8.3).

<u>Congestion Costs.</u> The net change in congestion cost will be $(XL_{pr}\,C_{pr} + aL_{pr}\,C_{pr}) - (XM_aL_aC_a + XM_{pr}L_{pr}C_{pr} + 2XM_{kr}\,L_{kr}\,C_{kr} + a\,(M_aL_aC_a + 2M_{kr}\,L_{kr}C_{kr}))$, where C_{pr}, C_a and C_{kr} are the congestion costs per vehicle-mile for the area where the trip takes place.

<u>Reduction in Pollution.</u> We know of no accurate estimates of pollution output per mile based on various trip lengths. However, a cold vehicle does emit more pollution than a ~~warm ve~~hicle. The Environmental Protection Agency has published a document listing pollution emission factors on a grams per mile basis and describing the methodology needed to adjust the factors for different percentages of cold operation. The reader may refer to this document, entitled <u>Compilation of Air Pollutant Emission Factors</u> (1976) to obtain the factors necessary for computing reductions in pollution. A formula which can be used to compute the reduction of ~~each of the three major~~ pollutants emitted from mobile sources is:

Reduction of Emission of Pollutant P =

$x(M_aL_a + M_{pr}L_{pr} + M_{kr}L_{kr})$ (Emission Factors For Pollutant P)

$- (X\,L_{pr} + a\,L_{pr})$ (Emission Factor For Pollutant P)

Exhibit 8-1

A Matrix of Park and Ride Effects

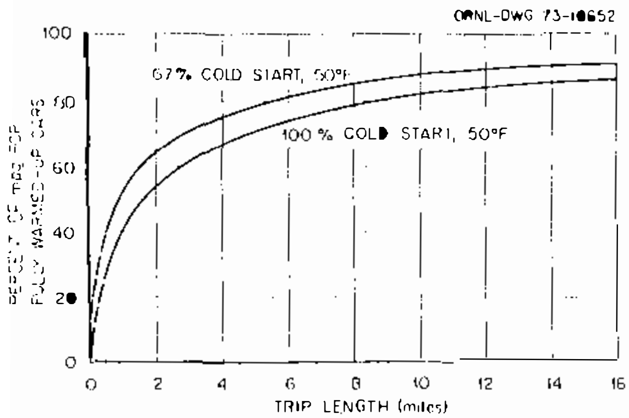
Effect \ Party	System User	System Operator	City (CBD)	Site Owner	Employment Center	Physical Environment	Community (Market Area)
Negative	1. fares 2. loss of freedom of movement 3. must park some distance from destination and transfer to bus. 4. loss of privacy	1. operating costs 2. capital costs 3. promotion costs	1. promotion costs	1. snow removal 2. conflict with other users 3. promotion costs	1. snow removal 2. promotion costs 3. conflicts with non bus riders	1. pollution* due to bus 2. increase in auto pollution* from freed auto	1. extra traffic or localized congestion due to Park and Ride facility
Positive	1. service-speed, comfort, convenience 2. parking benefits 3. freed auto (possibly) 4. psychological freedom from driving worries 5. arrive much closer to destination 6. opportunity for socializing.	1. fare (revenue) (plus revenues from promotion effort)	1. benefits of reduction in parking problems (savings) 2. promotion of trade 3. increase in tax revenues from greater business 4. opportunity to reuse land that would otherwise be tied up in parking	1. increase in business or increase in sites other benefits 2. promotion of trade	1. reduced parking requirements 2. fewer cars to contend with 3. opportunities to better use former parking space	1. net pollution* reduction due to bus in place of auto's work trip	1. enhanced mobility within the market area from the freed auto

*In terms of noise, gaseous and particulate emissions.

Source: Tanner and Parla, [illegible].

Exhibit 8-2

Urban Automobile Fuel Economy as a Function of Trip Length Due to Cold Start



*

Source: Hirst, 1974. Direct and Indirect Energy Requirements for Automobiles, Oak Ridge Nat'l Lab. (Feb., 1974) p.6.

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*Note that the curves show integrated m.p.g. for given trip lengths, not instantaneous m.p.g. for given distances from cold start.

Exhibit 8-3

Energy Consumption in Gallons/Mile of Automobiles for Various Trip Lengths

Trip Length (miles)	Gallons/mile
1	.17
2	.14
3	.12
4	.11
5-9	.10
10-13	.09
14-16	.08

Source: Authors Computations based on Hirst, 1974. See Table 8-2.

Exhibit 8-4

CONGESTION COSTS

	Central Business District			Fringe			Residential			Outlying Business District		
	V/C	S	T	V/C	S	T	V/C	S	T	V/C	S	T
Freeway	.250	43.0	.0032	.250	43.0	.0032	.250	62.0	.0016	.250	53.0	.0021
	.625	35.5	.0119	.625	35.5	.0119	.625	53.5	.0073	.625	44.5	.0106
	.875	30.5	.0226	.875	30.5	.0226	.875	42.0	.0381	.875	35.5	.0367
	1.000	28.0	.0306	1.000	28.0	.0306	1.000	34.0	.0554	1.000	30.0	.0551
	V/C	S	T	V/C	S	T	V/C	S	T	V/C	S	T
Expressway	.250	35.5	.0014	.250	41.0	.0021	.250	45.5	.0009	.250	35.5	.0014
	.625	33.5	.0027	.625	36.5	.0068	.625	42.5	.0050	.625	33.5	.0027
	.875	32.0	.0082	.875	33.5	.0112	.875	39.5	.0081	.875	32.0	.0082
	1.000	31.0	.0100	1.000	32.0	.0141	1.000	38.0	.0100	1.000	31.0	.0100
	V/C	S	T	V/C	S	T	V/C	S	T	V/C	S	T
Arterial	.250	21.0	.0027	.250	28.0	.0015	.250	31.0	.0012	.250	23.0	.0023
	.625	17.5	.0490	.625	26.0	.0044	.625	29.0	.0071	.625	20.0	.0300
	.875	13.5	.0691	.875	20.0	.1050	.875	21.5	.1181	.875	15.5	.0874
	1.000	12.0	.1000	1.000	15.0	.1991	1.000	15.0	.2204	1.000	13.0	.1420

Notes:

V/C = Volume-capacity ratio.
S = Speed.
T = Time cost in hours, assuming an average auto occupancy of 1.2.
Figures for arterial assume coordinated signal progression.

Exhibit 8-5

Auto Emission Factors (Grams/Mile)(50°F)

Average Route Speed		% Cold Operation* 10	20	40	60	80	100
10	CO	79.60	108.3	159.63	212.98	266.33	320.47
	HC	8.23	9.5	11.54	13.77	15.94	18.12
	NO	3.82	3.8	3.76	3.70	3.65	3.61
15	CO	49.11	66.4	97.43	129.65	161.87	194.58
	HC	6.71	7.7	9.20	10.88	12.52	14.16
	NO	3.60	3.6	3.53	3.48	3.43	3.40
20	CO	38.78	52.4	76.90	102.31	127.72	153.53
	HC	5.90	6.7	7.95	9.33	10.68	12.03
	NO	3.70	3.7	3.63	3.57	3.53	3.49
25	CO	30.26	40.8	59.84	79.56	99.28	119.31
	HC	5.23	5.9	6.92	8.07	9.18	10.30
	NO	3.85	3.9	3.79	3.73	3.68	3.65
30	CO	25.01	33.7	49.39	65.64	81.90	98.41
	HC	4.81	5.4	6.29	7.29	8.27	9.25
	NO	4.01	4.0	3.94	3.88	3.83	3.79
35	CO	20.94	28.2	41.29	54.86	68.43	82.21
	HC	4.53	5.1	5.87	6.78	7.66	8.54
	NO	4.14	4.2	4.07	4.01	3.96	3.91
40	CO	18.39	24.7	36.20	48.08	59.95	72.02
	HC	4.32	4.8	5.54	6.37	7.17	7.98
	NO	4.31	4.3	4.24	4.17	4.12	4.08
45	CO	16.36	22.0	32.18	48.72	53.27	63.98
	HC	4.22	4.7	5.37	6.15	6.91	7.67
	NO	4.40	4.4	4.33	4.26	4.20	4.16

Source: EPA, 1976.

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*'Cold Operation' is defined as the first 500 seconds of operation after an engine-off period of at least four hours.

PART III - ESTABLISHING AND OPERATING A PARK AND RIDE FACILITY

CHAPTER 9: ESTABLISHING JOINT-USE PARK AND RIDE FACILITIES

Establishing a joint-use park and ride facility may be difficult because the cooperation of the parking lot owner and the transit agency is required. In New Jersey, a number of possible sites for joint-use park and ride facilities were investigated, but forming agreements with the lot owners proved a problem (New Jersey Department of Transportation, 1975). However, in many areas, joint-use lots have been successfully established. Examples of these are lots at several shopping centers in Milwaukee and at gas stations, shopping centers and churches in Pittsburgh.

Parking lot owners are often reluctant to have their parking spaces occupied by persons who are not their customers. Peters and Vaetch (1970) have found that storeowners may realize an increase in business due to park and riders shopping at their establishments. Among the park and riders in the Pittsburgh area who use lots located at shopping centers, about 65% shop at the center at least once a week (Comsis Corp., 1975). This advantage to business owners might be stressed during negotiations. An offer of free publicity may also be appealing to parking lot owners. In Milwaukee, the "Freeway Flyer" park and ride bus routes are named for the shopping centers at which they originate. For example, the "Mayfair" route originates at the Mayfair shopping center.

Tanner and Barba (1973) recommend that a contract be negotiated between the operator of the park and ride service and the owner of the parking lot, rather than relying on an informal agreement. In addition to delineating the number and location of spaces to be made available for park and ride, and permitting the use of signs, markings and a bus shelter, the agreement should specify which party will be responsible for maintenance, snow removal, lighting, and liability.

CHAPTER 10: DESIGNING THE PARK AND RIDE FACILITY

Park and ride lots are unique among parking lots because they must accomodate transfers between automobiles and buses or trains. Generally, some short-term parking is provided so that drivers can drop off passengers or wait for them to return. In addition, park and ride lots must be designed to handle most of their traffic in two short peak periods daily. In this chapter we discuss those aspects of the design of parking lots which are especially important for park and ride lots. For the more general aspects of parking lot design, works such as Parking Principles (Highway Research Board, 1971) and Parking Design Manual (Parking and Highway Improvement Contractors Association, Inc., 1968) are good references.

Accessibility. Accessibility of the park and ride lot is important since it helps to minimize the time a commuter spends changing modes. A direct approach to the lot with easy entrance and exit should be provided. If it is impossible to locate the parking lot on the right side of inbound traffic, then special left-turn signals should be provided (Tanner and Barba, 1973).

Layout of the Park and Ride Lot. An example of a park and ride facility at a rapid transit terminal is shown in Exhibit 10-1. Several aspects of this design will be important in most park and ride facilities. Both long-term and short-term parking (for drivers who drop off or pick up passengers) are provided. These areas are separated in order to improve the flow of traffic. A special area for feeder buses should also be provided if feeder buses are to be used. Also, the lot is arranged so that commuters will have only a short walk from their car or bus to the platform.

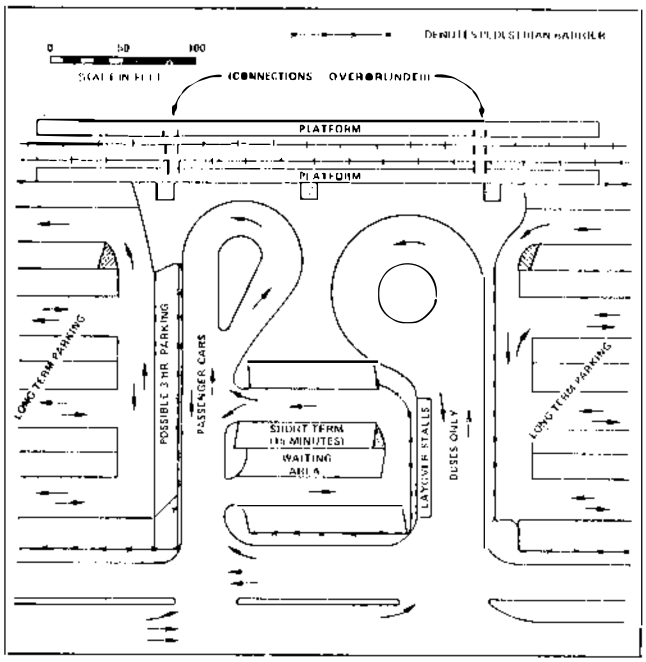
Amenities at Park and Ride Lots. Exhibit 10-2 indicates that paving, lighting, and shelter are present at most facilities, since these are probably important for attracting auto users to park and ride. A survey of park and ride users in Pittsburgh revealed that the most frequent suggestion for improving the service was that presently unpaved lots be surfaced (Comsis Corporation, 1975). Lighting is particularly important for winter afternoons when commuters may be returning to their cars in the dark. A bus shelter helps to make the transfer from the car to the transit mode more comfortable.

Exhibit 10-2 also suggests that attendant parking is an unnecessary expense. Employing an attendant may be necessary to collect fares and/or parking purposes alone.

Finally, signs seem to be very important in attracting ridership. Sixty-one percent of Pittsburgh's park and ride users learned of park and ride by seeing the lots (Comsis Corporation, 1975).

Exhibit 10-1

Example of a Park and Ride Facility with Rapid Transit Service



Source: Parking Principles, 1971.

Exhibit 10-2

Amenities at Park and Ride Lots in Selected Cities

	Attendant Parking	Attendant On Duty	Paving	Lighting	Shelter
Milwaukee	No	No	Yes	Yes	Yes
Seattle	No	No	Yes	Yes	Yes
Philadelphia	No	No	Yes	Yes	Yes
Atlanta	No	Yes	Yes	Yes	No
Cleveland	No	Yes	Yes	Yes	Yes

Source: Peat, Marwick, Mitchell & Co., 1971.

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