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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

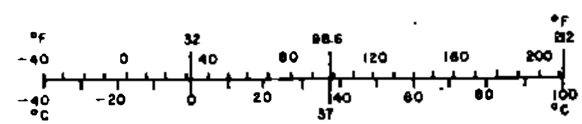
Approximate Conversions to Metric Measures

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.

Park and Ride. 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 increases 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.

CAR POOL PLANNING MANUAL

by

Chris Johnson
Ashish K. Sen

Report Prepared by the School of Urban Sciences for the Program of University Research, U.S. Department of Transportation.

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CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1 Introduction

We define car pooling as a mode of travel in an automobile where:

1. Two or more people travel in the same vehicle;
2. The vehicle is owned by one of the travelers;
3. The owner is not compensated beyond the full cost of operating the vehicle, and the driver is not compensated for his or her efforts.

This rather broad definition includes ride-sharing arrangements ranging from a husband and wife who ride together to work, to a formalized employer-based pooling program where standard fares are charged to the passengers. It excludes arrangements in which either the vehicle is owned by a third party, or the driver is compensated for his services.

Car pooling is the most heavily used of all urban travel modes (see Exhibit 1-1). In spite of this, empty automobile seats still represent a large amount of idle capacity. Lew Pratsch (1975 (1)) has estimated that less than 25% of the available seat miles on all modes are being used, with empty automobile seats representing 90% of that unused capacity. It is not surprising, then, that many energy officials have indicated that increasing the level of auto occupancy has the potential of saving more energy than almost any other transportation alternative. The Federal Energy Administration has estimated that increasing the average vehicle occupancy from the present 1.2 to 2.0 would save 350,000 barrels of oil a day in 1980, whereas doubling mass transit service and ridership would save only 40,000 barrels a day (Stuntz, 1975).

The remainder of this chapter presents background information that will familiarize the planner with types and measures of car pooling, and the current levels of car pooling. Section 1.2 presents a series of statistics on automobile occupancy and the percentage of car pooling compared to other modes. Definitions and examples of measures of car pooling are given in Section 1.3 and a typology of car pools is presented in Sections 1.4 and 1.5.

1.2 Present Levels of Car Pooling

Exhibits 1-1 through 1-5 provide information on the present levels of car pooling from a number of perspectives. A table not shown here but given in Kendall (1975) shows that auto occupancy has declined by about .05 since 1960.

Exhibits 1-2 and 1-3 show that car pooling is extremely low for the journey-to-work. Our calculations, based on National Personal Transportation Study (DOT, 1972 (2)) data, show that 3 billion passenger seat miles a day are unproductive during the peak period. If we note that the work trip is the most regular and consistently routed of all trips and also that they tend to be longer trips (see Exhibit 1-4), it would appear that the journey-to-work is an excellent target for tapping unused transportation capacity through the use of car pools.

1.3 Measures of Car Pooling

There are several measures of car pooling and of the related phenomenon of auto occupancy in the literature. These are described in this section. In the descriptions, it is important to distinguish between auto trips, passenger-trips, and person-trips. For example, if three people travel together in a car we have one auto trip, two auto passenger trips and three car pool person-trips.

Percentage of Car Pooling, is often referred to as capture rate is defined as:

$$\frac{\text{Number of Car Pool Person-Trips Within a Class of Trips}}{\text{Number of Trips in the Class}} \times 100 \qquad (1)$$

By suitably defining the class, we get a number of measures of car pooling. Examples include percent of car poolers in a community or region, in a given company, or among all people eligible or exposed* to a program.

Percentage of New Car Poolers, is the same as above except that the numerator is the number of person-trips which have recently started car pooling usually as a result of some promotional program.

Percentage of Car Pool Passengers, has the advantage that the data to compute it is more easily obtained than (1). It is defined as:

$$\frac{\text{Number of Passenger Trips Within a Class of Trips}}{\text{Total Number of Person Trips in the Class}} \times 100 \qquad (2)$$

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*"Exposed" generally means the number of people receiving information about a car pooling program.

Load Factor, sometimes called auto occupancy, is defined as:

$$\frac{\text{Number of Auto Person Trips}}{\text{Number of Automobile Trips}} \quad (3)$$

Passengers per Vehicle Mile, which is defined as:

$$\frac{\text{Number of Passenger Miles}}{\text{Number of Vehicle Miles}} \quad (4)$$

has been estimated for the nation to be 1.6 by the Federal Highway Administration (FHWA) and 1.3 by Transportation Systems Center (TSC) (Anderson and Clift, 1974 and U.S. DOT, #4).

Notice that (2) and (3) are essentially the same ((2) = (3) + 1) and that (4) is effectively the load factor computed on a per mile basis. As such, (4) is a better measure of energy consumption than any of the others.

An interesting and often confusing difference between two measures of car pooling is illustrated by Exhibit 1-6. The car pool share of the entire commuter market (reflected by the percentage figures) declines as we move towards the Chicago CBD, while the intensity of auto usage near the CBD (reflected by the load factor) is very high. This is not surprising, since the Chicago Central City is well served by public transportation, which results in proportionately fewer car poolers.

1.4 Types of Car Pooling Arrangements

Car pooling may be broken into several different types. In this section we consider financially-based arrangements, while in the next section we consider a typology of car pool groups.

Car pooling can be either "shared cost" or "shared driving". Shared driving refers to a situation where the driving and the vehicles rotate from day-to-day among the participants. In the case of shared cost, the vehicle and usually the driver remains the same. The majority of car pools are of this kind (see Exhibit 1-10). Within shared-cost, we also include the situation of the "free shared-cost" pool where passengers essentially get a free ride (see Exhibit 1-11).

Shared Cost Pools, which constitute a majority of pools, tend to be shorter and have lower occupancies than shared-vehicle pools (Kendall, 1975, see Exhibits 1-12 and 1-13). Free car poolers account for a large part of shared-cost pools; Kendall (1975) reports that about 64% of shared-cost poolers ride free. In Pittsburgh (FHWA Demonstration, Appendix A), the figures are 68% for non-CBD traffic and 55% for CBD bound traffic. While pooling among family members accounts for some of this as Exhibit 1-14 indicates, it does not account for a large part of it.

Davis (1975), notes this same phenomenon and suggests that one of the significant barriers to car pooling is the drivers' unwillingness to charge for the full cost of operating an automobile.

Another disadvantage to this type of car pooling arrangement is the fact that it concentrates the increased liability claim for an accident onto one driver for all trips. While all passengers in the pool have drastically reduced their "exposure" (and, in fact, are eligible for significant insurance reductions), the driver has increased his potential liability by transporting 3-4 breadwinners every day.

In spite of these disadvantages, shared-cost pooling has some important advantages. One person is responsible for driving, scheduling, etc., thus eliminating the confusion of who is driving and constant variations in routing and scheduling. All passengers have the convenience of "chauffeured" journey-to-work without the tension of driving. If the driver is reliable, this convenience and the cost savings are significant incentives to car pooling for the passengers (see Chapter 3). This "convenience" of being a passenger with no driving responsibilities seems to be particularly attractive to women. In the Knoxville, Tennessee (Davis et al., 1975) ride-sharing program, requests for "passenger only status" averaged less than 25% of the applications except in those companies with predominately female workers where such requests ran as high as 50 to 55 percent.

While this kind of car pool remains the most popular, an evaluation of the Milwaukee FHWA car pool program (Appendix A) indicates that car pool promotions and incentive programs may tend to relatively increase the shared-driving type pool. A random sample of the entire SMSA found 57% of the car poolers in shared-cost pools whereas only 45% of those who formed pools due to an incentive program made similar pooling arrangements.

Shared Vehicle Car Pooling arrangements give each pool participant an opportunity of having his own car at work occasionally. However, such pools suffer from problems of reliability. Frequent arrangements have to be made for driving (substituting), and individual arrival and departure times are subject to change depending on who is driving. Such an arrangement also limits car pool participants to those who own a car.

When car pool program applicants are surveyed, most indicate they would prefer the shared-driving arrangement (in spite of the fact that there are more shared-cost type pools actually formed).

1.5 Relationships Among Car Poolers

Virtually all investigations of car pooling have found that successful car pools are formed by individuals who have known each other in some previous context (e.g., Margolin, et al., 1976; Davis, 1975). This observation is reinforced by reports of some FHWA demonstration projects that show that less than 25% of those that requested match-lists ever used them, and only about one-fifth of that group formed car pools. Thus it is possible to classify car pools by the nature of previous relationships among members of a pool:

1) family; 2) work associates; and 3) social acquaintances.

Family Car Pooling. Kendall (1975) estimates that family pools account for over one-third of all car pools in the country, although some estimates for individual cities have been much lower (see Exhibit 1-14).

Family pools have the obvious advantage of no origin-deviation time and perhaps higher levels of tolerance for individual transportation needs. Still, the destinations must be somewhat proximate and consequently, it is not surprising that in Pittsburgh (FHWA demonstration, Appendix A) a much greater proportion of family pooling occurred to the CBD area (21%) than to non-CBD destinations (10%). Family car pools, further, have been shown to be smaller (Kendall (1975) reports that 86% are 2-person pools) and have much shorter trip lengths. This latter observation should be expected if we consider that relatively little deviation is involved, and thus car pooling is economical at all trip lengths. Also, since Johnson (1976) has observed in her study of car pooling in the Chicago area that "family" car pooling is more predominant in areas of low income, it would seem that many family-type pools are motivated out of economic need.

Work Associates. Approximately 60% of the car pools are formed among work associates (Kendall, 1975) which is perhaps why most car pool programs have focused their promotion efforts on employers rather than on the public at large. The underlying reason (besides lack of deviation time at the destination) argues Margolin (1976), who has studied the psychology of car pooling, is that people have a chance to know the individual before being put into a close and frequent social setting. Margolin's thesis is supported by the experience at the Tennessee Valley Authority where only a minority of new poolers used matching lists to contact new poolers (Stokey, 1976).

Social Acquaintances. Although no formal study of this type of pooling has occurred, several attempts at marketing to neighborhood groups and the like (e.g., Vienna, Virginia; Columbia, Maryland; Salem, Orgeon) have met with meager results at best.

Exhibit 1-1

Percent of Urban Person Trips by Mode (Excluding Walking), 1969-70

Mode	Percent
Lone Occupant Auto	23.4
Driver or Passenger in Shared Auto	64.1
Transit Bus	4.0
Rapid Transit	1.1
Commuter Rail	0.1
Taxi	0.3
School Bus	2.6
Truck (Personal Use Only)	3.9
Other (Motorcycles, Bicycles, Airplanes, etc.)	0.5

Source: Womack, 1976 #1. Based on NPTS Data and Independent Calculations.

Exhibit 1-2

Distribution of Auto Occupancy by Trip Purpose

Number of Occupants	Trip Purpose	
	Home-to-Work	All Purposes
1	73.5	50.1*
2	18.2	27.5
3	4.7	10.4
4	1.9	5.9
5	1.1	3.0
6	0.5	1.5
7	---	0.7
8	---	0.2
9	---	0.2
N/A	0.1	0.5
Total	100.0	100.0
Total Number of Trips (000)	53,377	163,964

Source: Womack, 1976.

*The apparent inconsistency between this number and Exhibit 1-1 is resolved to within a round-off error by noting that Exhibit 1-3 describes automobile trips, while Exhibit 1-1 describes person trips.

Exhibit 1-3

Auto Occupancy for Urban Trips by Trip Purpose, 1969-70

Trip Purpose	Average Occupants Per Vehicle Trip	Average Occupants Per Vehicle Mile
Earning a Living:		
To and From Work	1.4 *	1.5
Business Related to Work	1.6	1.6
AVERAGE	1.4	1.5
Family Business:		
Medical	2.0	2.1
Shopping	2.0	2.2
Other	1.9	2.2
AVERAGE	2.0	2.2
Educational, Civic or Religious	2.6	2.4
Social and Recreational	2.5	2.9
All Purposes	1.9	2.2

Source: U. S. DOT, 1972, #20

*The Transportation Systems Center (Anderson, 1974) re-analyzed the same NPTS data and arrived at significantly different results (1.2 instead 1.4, see also Exhibit 1-8). They conclude:

> The problem may lie in the double-counting of passenger occupancy figures. If both driver and passenger work-trip records were used by FHWA to determine auto occupancy, significantly more passenger trips would be counted than actually took place (in that passenger trips are reported on both driver and passenger records). TSC managed to reproduce FHWA estimates of a 1.4 occupancy rate by using both sets of records in calculations.

Exhibit 1-4

Selected Automobile Travel Characteristics by Trip Purpose, 1969-70

Trip Purpose	Percent Of All Trips	Percent Of Vehicle Miles Traveled	Average Trip-Length One-Way (Miles)	Average Occupants Per Car
Earning a Living:				
To and From Work	31.9%	33.7%	9.4	1.4
Business Related to Work	4.3	7.9	16.1	1.6
TOTAL	36.2	41.6	10.2	1.4
Family Business:				
Medical and Dental	1.8	1.6	8.4	2.1
Shopping	15.2	7.5	4.4	2.0
Other	14.0	10.2	6.5	1.9
TOTAL	31.0	19.3	5.6	2.0
Educational, Civic or Religious	9.3	4.9	4.7	2.5
Social and Recreational:				
Vacations	0.1	2.5	160.0	3.4
Visit Friends or Relatives	8.9	12.1	12.0	2.2
Pleasure Rides	1.4	3.1	20.0	2.7
Other	12.0	15.3	11.4	2.6
TOTAL	22.4	33.0	13.1	2.5
All Purposes	100.0%	100.0%	8.9	1.9

Source: Motor Vehicle Manufacturing Association, 1976.

Exhibit 1-5

Average Occupancy in Automobile Trips by Hour of Day Trip Started*

Hour of Day Trip Started	Major Purpose of Trip: To and From Work	Major Purpose of Trip: All Purposes
4:00 a.m.	---	1.7
5:00 a.m.	1.7	1.8
6:00 a.m.	1.6	1.7
7:00 a.m.	1.4	1.6
8:00 a.m.	1.3	1.7
9:00 a.m.	1.3	1.9
10:00 a.m.	1.4	1.9
11:00 a.m.	1.3	2.0
12:00 p.m.	1.3	1.9
1:00 p.m.	1.3	1.9
2:00 p.m.	1.3	2.0
3:00 p.m.	1.6	2.0
4:00 p.m.	1.5	1.9
5:00 p.m.	1.4	1.8
6:00 p.m.	1.3	2.1
7:00 p.m.	1.5	2.2
8:00 p.m.	1.3	2.3
9:00 p.m.	1.3	2.2
10:00 p.m.	1.5	2.1
11:00 p.m.	1.3	2.0
12:00 a.m.	1.3	1.8
1:00 a.m.	1.4	1.9
2:00 a.m.	---	1.9
3:00 a.m.	---	1.8
Average for 24 hours	1.4	1.9
Percent of Total Trips Represented	31.8	100.0

*Although the work trip auto occupancy is low, the peak hour load factor is not correspondingly low (Exhibit 1-5). This is because non-work trips also occur during the peak periods and as Krejci (1975) points out, work trip auto occupancy increases slightly during the peak period.

Source: NPTS, #1.

Exhibit 1-6

Two Measurements of the Degree of Car Pooling for Chicago Work-Trips According to Trip Origin Proximity to the CBD

Trip Origin	Car Pooling Percentage of All Work Trips	Work Trip Load Factor
Chicago City	10%	1.23
Inner Suburban Ring	11%	1.14
Middle Suburban Ring	13%	1.16
Outer Suburban Ring	17%	1.22

Source: Johnson, 1976.

Exhibit 1-7

National Modal-Split of Work Trips

	Percentage
Auto Driver	48.4%
Passenger	19.0%
Transit	7.2%
Walk	5.0%
Other	11.8%
Truck	5.7%

Source: U.S. DOT, #4.

Exhibit 1-8

Percentage Automobile Work Trips by Number of Occupants

Source	Number of Occupants (%)				
	1	2	3	4	5 or Greater
FHWA[1]	74%	18%	5%	2%	1%
TSC[2]	83%	13%	3%	1%	0[3]%
NORC[3]	73%	18%	5%	3%	1%

Sources: [1]U.S. DOT, #4.
[2]Anderson and Clift, 1974.
[3]Kendall, 1975.

Exhibit 1-9

National Estimates of Work Trip Occupancy

1.	1970 Census	1.2
2.	1969 NPTS	
	FHWA	1.4
	TSC	1.2
3.	1973 NORC	1.2

Source: Anderson and Clift, 1974.

Exhibit 1-10

Proportions of Shared-Cost and Shared-Vehicle Car Pools in Selected Studies

Source	% in Shared Cost	% in Shared Vehicle
NORC National Survey	80%	20%
Milwaukee[1]	57%	43%
Pittsburgh[1]	55%	44%
Longwood Medical Center[2]	62%	38%
Hollywood Freeway[3]	43%	51%

Source: NORC
[1]FHWA Demonstration, Appendix A.
[2]Attanucci, 1974.
[3]Voorhees, 1973 (2) (Survey of Car Pool Drivers Only)

Exhibit 1-11

Ways of Distributing Car Pool Costs

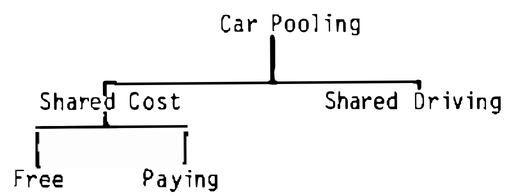

Exhibit 1-12

Cross Tabulation Of Car Pool Type By Car Pool Distance

Distance from Work	Cost Share* Driver %	Vehicle Share Drive C/P %	Cost Share* Passenger %
0 - 5 miles	32	17	50
6 - 15 miles	52	32	37
More than 15 miles	16	51	13

Source: Kendall, 1975

Cost share driver is in a shared cost pool reported by the driver; cost share passenger is a shared cost pool reported by the passenger.

Exhibit 1-13

Cross Tabulation Of Car Pool Type By Occupancy

Type of Car Pool	2	3	4+
Cost Share (Reported by Driver)	41%	31%	29%
Cost Share (Reported by Passenger)	41%	47%	34%
Vehicle Share	18%	22%	37%
N =	(353)	(102)	(86)
	(65%)	(19%)	(16%)

Source: Kendall, 1975

Exhibit 1-14

Comparison Of Proportion Of Non-Cost Sharers To Proportion Of Family Poolers

	% Free Cost-Sharers	% Family Pooling
Pittsburgh, PA	43.7%	21.1%
Chicago, IL	54.8%	9.7%
Sacramento, CA	44.4	28.6%

Source: Peat, Marwick & Mitchell and Market Facts, Inc. 1976, #1.

2. SERVICE CHARACTERISTICS

2.1 Introduction

In this chapter we compare the service characteristics of car pooling with the bus and the SOA (solo occupant auto) from three points of view: travel time, social atmosphere, and flexibility.

2.2 Travel Time

Since car pools typically provide door-to-door service, they generally have travel times longer than the SOA but shorter than the bus. Car pools are faster than buses partly because auto speeds average about 8 m.p.h. higher than bus speeds in urban areas (Urban Densities for Public Transportation, 1976, further details are available in Characteristics of Urban Transportation Systems, 1975), and because bus riding requires excess walking and waiting time.

Car pools are slower than SOA's because deviations are required to pick up or drop off passengers. Two studies (Peat, Marwick and Mitchell and Market Facts, 1976 and Voorhees, 1973 (4)) have placed the median values of the time required for this deviation at 5 minutes. Some distributions of this excess travel time are presented in Exhibit 2-1.

The distance of the deviation varies considerably with trip length, load factor, and network speed--though Kendall (1975) finds that a majority of car pool passengers live within a mile of each other (see Exhibit 2-2). It appears that despite this variation in deviation distance, the excess travel time remains roughly constant.

It should be noted that the difference in time between car pools and SOA consists mainly of riding time (which is generally valued at about .4 times a person's wage rate) while a substantial part of the time spent in taking a bus is spent in walking, waiting and transferring (which are valued at close to the wage rate or higher) (Navin, 1974). The net result is that a car pool, in terms of speed, time and comfort is an extremely close competitor of the automobile.

2.3 Confined Social Atmosphere

The confined social atmosphere of car pools is a deterrent to its popularity. When placed in a car with several other individuals, there is often a perceived pressure to make conversation. It is difficult to ignore others, as could be done on a bus. We believe that the car pool will have a greater chance for success if the members are friends, acquaintances at work, or family members. In developing marketing strategies, it has been suggested by several program directors that this problem be addressed by stressing (verbally and in images) that passenger riding time may be spent reading, sleeping or meditating!

2.4 Flexibility

While car pooling is in many ways more attractive than the bus, car pooling affords less flexibility for several reasons:

- Work schedules of passengers must mesh well.
- If a car pool is missed, there may be no back-up, as in a fixed route system.
- There is limited mobility during the day for grocery shopping, business errands, etc.

Commonality of work schedules is essential in both leaving home and returning. Few people are willing to arrive 30 minutes early or wait 30 minutes just to car pool. Car pooling also limits mobility during the day. The need for an auto for mid-day trips probably does not exist for a majority of the work force (see Exhibit 2-3) but those who do need a car find it difficult to pool. Efforts to promote car pooling in light of this fact should encourage provision and use of public transit during the mid-day.

One of the most frequently cited problems of car pooling is the lack of back-up transportation should the driver be unable to make pick-ups, or should the pooler miss his pool. This is especially a problem at the destination end of the trip where there may be no available bus or other transit service. The reliability of car pool members is essential in order to avoid such situations. In the case of driver illness (or other legitimate reasons), it is important for the car pooling groups to pre-arrange a course of action in order to provide a back-up system. The planner, as he considers car pooling as a part of an integrated system may consider teaming car pooling with a taxi or a skeletal fixed-route system.

Exhibit 2-1

Excess Travel Time Due to Car Pooling

Los Angeles[1]

50% spend > 5 minutes in pick-up

Boston[2]

3 minutes average extra time for Passenger
4 minutes average extra time for Drivers

Aerospace[3]

61% less than 5 minutes extra*
25% between 5-10 minutes extra
11% between 10-15 minutes extra

Monroe[4]

57% less than 5 minutes extra
23% between 5-10 minutes extra
10% between 10-15 minutes extra
10% between 15+ minutes extra

*In excess of solo journey-to-work

Source: [1]U.S. FEA, 1976, #1.
[2]Heaton, 1976.
[3]Bush, 1975.
[4]FHWA Demonstration, Appendix A

Exhibit 2-2

Distance Between Residences of Passengers by Car Pooler's Distance From Work and Commuting Time

	Distance from Work (miles)			Commuting Time (minutes)		
	0-10	11-15	15+	0-15	15-30	30+
Furthest Passenger Lives:	%	%	%	%	%	%
0 - 1/2 mile	54	36	30	65	33	13
1/2 - 1 mile	15	9	16	6	26	31
1 mile or more	32	55	54	29	41	56
N =	(157)	(67)	(97)	(77)	(132)	(112)

Source: Kendall, 1975.

3. USER CHARACTERISTICS AND ATTITUDES

3.1 Socioeconomic Characteristics

There has been more research done on the influence of socio-economic factors on the level of car pooling than many other aspects of ride-sharing. Such studies are of some importance from two perspectives. They could help predict areas where car pooling may be particularly high, and also aid in tailoring an effective marketing program. In approaching these studies, it is important to distinguish two types of pools; 1) the "baseline" pools which have been formed without promotion or other incentives; and 2) "program induced" pools which have been formed primarily as a result of car pool promotion efforts. As we shall show in this chapter, there is evidence to suggest that the "baseline" or old car poolers have lower income levels, shorter trip lengths, and are more likely to work at "blue collar" or clerical-type jobs. However, the car pooler responding to current promotion efforts and/or energy crisis is often middle-income, suburban, and professional with a fairly long journey-to-work.

In this first section, we shall examine the effects of five variables: income, automobile ownership, family size, sex, and occupation on levels of car pooling.

When a phenomenon is affected by several variables simultaneously, there is an inherent danger in trying to consider the effects of only one (or a few) variables at a time. This problem is illustrated by the following example. Consider the data set:

X	Y	Z
8	1	9
6	2	8
4	3	7
2	4	6

It will be seen in the above data set that the equation $z = x + y$ fits this data set perfectly and if we keep either x or y fixed, z is an increasing function of the other. However, if we ignore x, the values of y and z fit the equation $z = 10 - y$, indicating that z is a decreasing function of y. The reader should be warned of this type of problem in almost all of the studies reported below. One exception is noted in the section on interactive effects.

Income. Studies of baseline car pooling indicate that load factors decrease with income (see Exhibit 3-1, and Johnson, 1976).

Increased levels of car pooling by lower income groups is also indicated by Exhibit 3-2, and also by the work of Dobson and Tischer (1977), Berry (1975) and Womack (1976).*

The situation is quite different for program-induced pools where it would appear that persons in middle and upper middle income groups have been more responsive (see Exhibit 3-3). Heaton's (1976) work in Boston and results of other FHWA-sponsored demonstrations (e.g., Milwaukee, FHWA Demonstration) support this claim. Thus we conjecture that in the lower income groups for whom pooling may be an economic necessity, most of those who can conveniently pool are already doing so. Hence, if a choice has to be made, it is the middle and upper middle income groups that should be targeted for advertising programs. These groups with longer trip lengths will result in greater energy savings.

Sex. For both baseline and program induced car pooling we find that at present, men and women car pool to about the same extent (Exhibit 3-4). However, this may be due to the fact that no program has been specially directed at women and women may need to be treated differently (e.g., women have greater difficulty than men in calling strangers identified in computer matching lists.

We suggest that women are a particularly attractive target for car pool promotion programs for two reasons: 1) women have a greater dislike for driving than men. This is indicated by the fact that a larger proportion of women ride public transportation than men (see e.g., Peat, Marwick and Mitchell, #1) and the fact that in car pooling programs, women have shown a greater preference than men for being strictly car pool passengers (Kendall, 1975; Davis, 1975); and 2) women are entering the labor force (many for the first time) in increasing numbers and are not as yet entrenched in the solo-driving habit.

Family Size. Baseline car pooling goes up with the number of employees per household (Johnson, 1976; Dobson and Tischer, 1977; see also Exhibit 3-5).

Auto Ownership. Most baseline car poolers come from families with one or more cars (Exhibits 3-6, 3-7; see also Heaton, 1976). Even for program-induced pooling, the Portland demonstration (Appendix A) found its lowest rate of application coming from zones with low auto ownership and

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*We note that some very detailed economic analyses of the effect of income and of the interactions between income and trip length on car pooling have been conducted by Berry (1975) and Womack (1976).

Davis, (*et al*. (1975) found that in Knoxville, Tennessee, 75 to 98 percent of the employees who participated in car pool programs in individual companies had automobiles available for their journey-to-work. These findings would suggest that the need for back-up transportation for poolers (at the origin end) may not be as acute a problem as is sometimes suggested.

Occupation. The reported effects of occupation type on car pooling parallel those of income. Higher proportions of blue collar and clerical employees have been found in baseline car pools (see Exhibits 3-8 and 3-9; Johnson, 1976; Heaton, 1976; and Krejci, 1973) whereas professional (as well as clerical) employees have been more likely to respond to car pool promotion programs (e.g., Boston (Heaton, 1976); Milwaukee FHWA Demonstration).

Several reports of promotion programs indicate that the transportation and work conditions at the job site (i.e., lack of parking, public transportation, irregular hours, job turnover, etc., see Chapter 4) are more likely to affect levels of car pooling than the type of employees at the company.

Interactive Effects. The only empirical study of the interactive effects of various socioeconomic factors is for baseline car pooling done by the authors. The study resulted in calibrating the following model:

$$Y = .107 + .82 X_1 + 1.2 X_2 + .34 X_3$$

where:

Y is the average load factor for a given zone

X_1 is the product of % of households with incomes less than \$6000 and % of households with 2 or more employed

X_2 is the product of the % of households with blue collar employment and % of households with 3 or more employed

X_3 is the product of the % of households with incomes less than \$6000 and % of the households with no automobile.

This model indicates that there are probably at least two types of poolers: those coming from areas of low income with more than 1 member employed; and those coming from areas with high blue collar employment, again with high instances of multiple employment in the family.

3.2 Attitudes Toward Car Pooling

Understanding attitudes and perceived barriers to car pooling can be helpful in designing an effective advertising campaign. Below, we present the results of several studies that have addressed these issues.

Attitudes. Several of the attitudinal studies have found that car poolers value reliability and the convenience of car pooling, whereas solo drivers perceive car pooling as inconvenient and unreliable (see e.g., Horowitz and Seth, 1976; and Voorhees, 1973 (b)). Surprisingly, neither group has been shown to be highly motivated one way or the other by out-of-pocket costs. Because perceptions of time loss, inflexibility and unreliability of ride-sharing strongly affect commuters' attitudes toward car pooling, Horwitz and Seth (1976) suggest that promotional campaigns should focus on the following positive aspects of ride-sharing:

a) Travel Time. The time spent as a passenger could be used in a number of relaxing activities (e.g., reading).

b) Convenience. Often commuters perceive that it would be difficult to initiate contacts and find poolmates. A face-to-face organized program at the place of work might overcome this reluctance. Barkow (1974) believes pooler contacts should be initiated by humans, not computers.

c) Reliability. Promotional campaigns should concentrate on such aspects as car pool longevity and satisfaction with poolmates and reliability of transportation.

Several studies have stressed the importance of the potential poolers being prior acquaintances. Margolin, et al., (1976) found that women in particular are resistant to telephoning a stranger to discuss a potential car pool, and Levin (1977) makes the interesting observation that if the potential pooler is not an acquaintance, males prefer a rider of the opposite sex and females prefer other female riders.

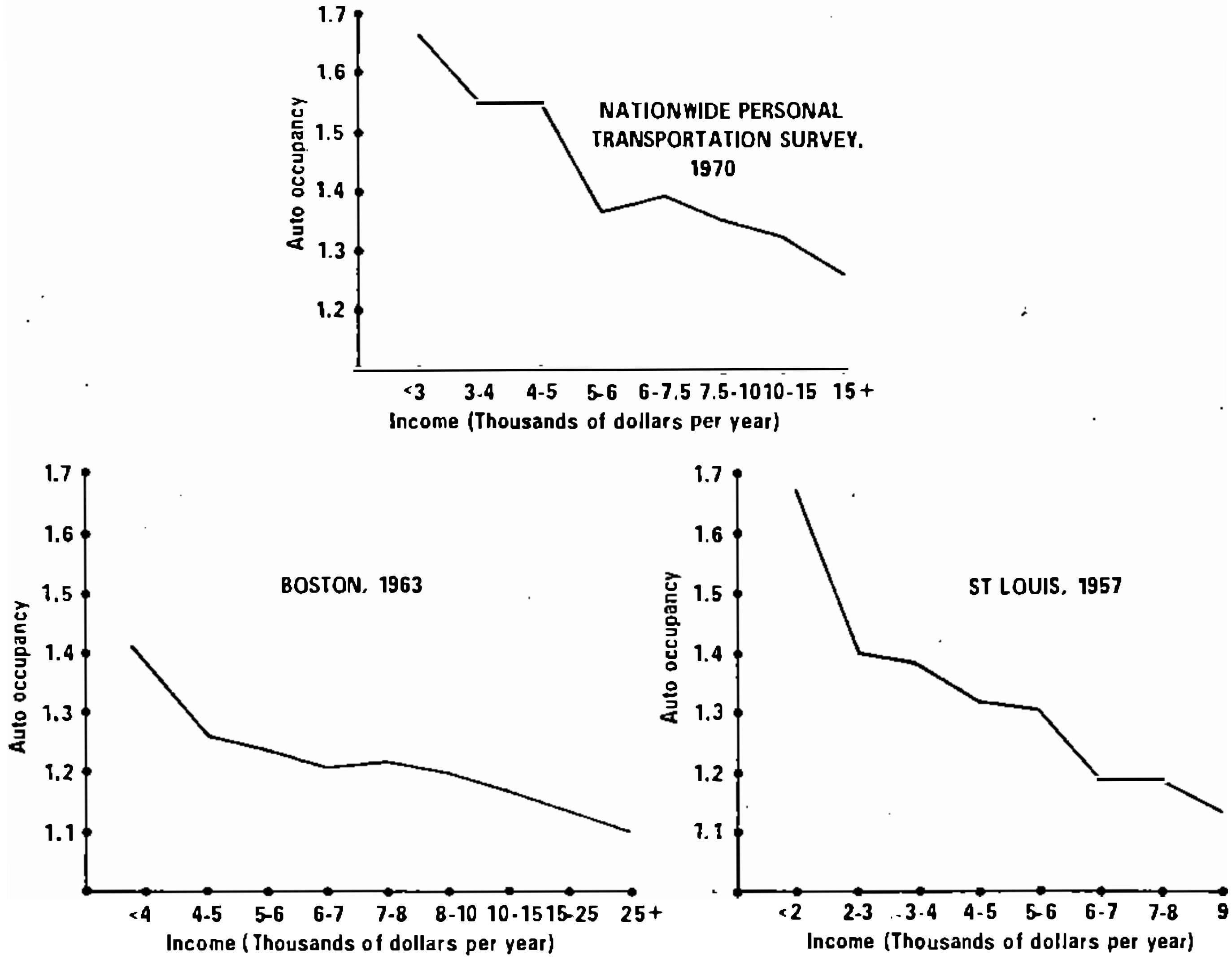
Stated Barriers to Pooling. Three of the most commonly stated reasons for not car pooling are: 1) lack of a car pool match; 2) need of a car during mid-day; and 3) schedule incompatibility (see Exhibit 3-10). Reasons (2) and (3) are discussed in Chapters 2 and 4 where we state some of the need for a car during the day; and flexible work hours may help increase car pooling in some companies. Although it has been widely believed that provision of matching services may overcome the "lack of a poolmate" problem, several investigators (e.g., Voorhees, 1974 (b); Berry (1975) have suggested that lack of matching may be more of an excuse than a real barrier.

Preliminary evaluation of some FHWA demonstration projects indicates that "matchlists" designed to overcome this problem were not extensively used. (see Exhibit 3-11). One demonstration report of a car pool project in Salem, OR concluded that although people indicate they need help in finding matches, once they have actually tried computer matching this 'reason' for not pooling is less frequently stated. Again, suggesting that matching may have just been an excuse.

Factors in Switching to Car Pooling. Reasons often cited by former solo-drivers who have switched to car pooling are: environmental concern, desire for socializing, cost savings, or convenience related (reliability, efficiency, safety), making the auto available to others in the family etc., (see Exhibit 3-12). Exhibit 3-13 indicates that pools formed during the gasoline crisis of 1973 were strongly motivated by cost savings. Davis (1975), however, makes the interesting observation that while cost savings may initially motivate some car pooling, it is primarily convenience and social circumstances which will perpetuate them.

Exhibit 3-1

Relationship Between Work-Trip Auto Occupancy and Income



Source: Krejci, 1973, based on 1963 Boston data.

Source: Krejci, 1973, based on 1957 St. Louis data

Exhibit 3-2

Distribution of Solo Drivers and Car Poolers by Income

Income	% Solo	% Car Poolers
< 6,000	11%	18%
6,000 - 9,999	18	20
10,000 - 14,999	25	23
15,000 - 19,999	23	16
20,000 - 24,999	10	12
> 25,000	13	11
	100%	100%

Distribution of Auto Drivers and Auto Passengers by Income

Annual Household Income	Driver	Automobile Passenger
Less than $3,000	3.0	6.0
$3,000 - $3,999	3.2	5.2
$4,000 - $4,999	3.6	5.6
$5,000 - $5,999	7.4	7.7
$6,000 - $7,999	12.2	13.8
$7,500 - $9,999	19.4	20.1
$10,000 - $14,999	27.4	24.3
$15,000 and over	14.3	10.0
Not applicable	9.5	7.3
	100.0	100.0

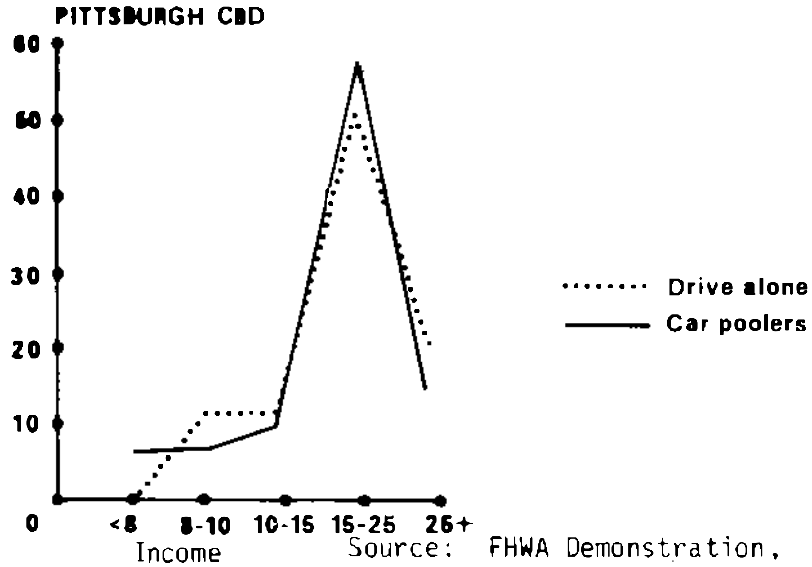
Sources: Kendall, 1975.

Data from unpublished Table H-5 of the Nationwide Personal Transportation Survey conducted by the Bureau of the Census for the Federal Highway Administration, 1969-70.

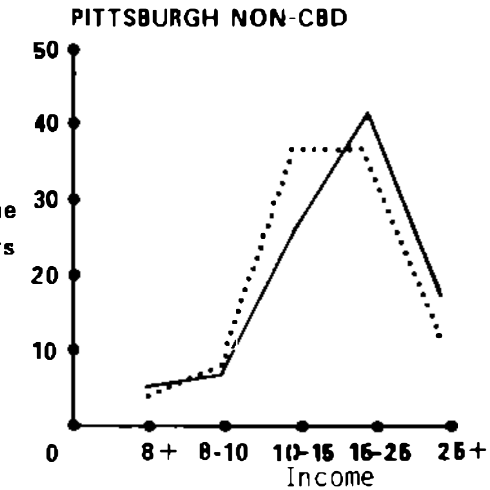
Exhibit 3-3

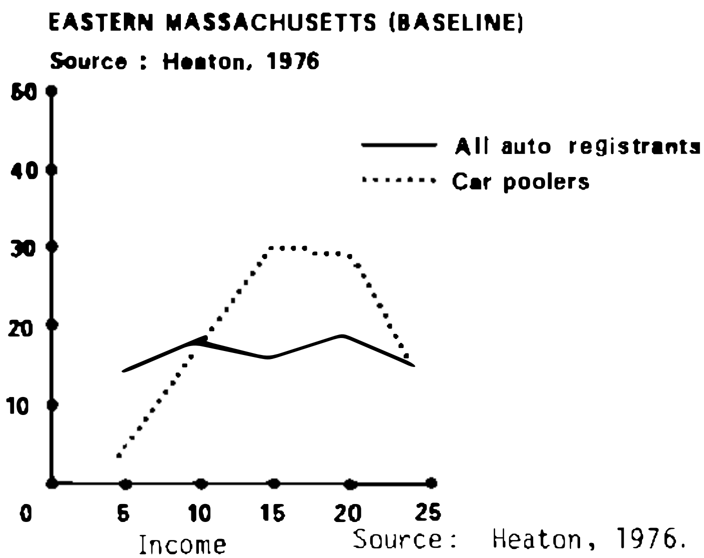
Comparison of Car Poolers
and Non-Car Poolers According to Income

% of Car Poolers



Source: FHWA Demonstration, Appendix A.





Source: Heaton, 1976.

y = persons using a mode in each category expressed as a percent of all those using the mode.

Exhibit 3-4

Proportion of Male and Female Car Poolers Relative to Labor Force Distribution

Portland (FHWA Program)

	% of Dial in Car Pool Applicants[1]	Distribution in Labor Force
Male	47	59
Female	53	41

Milwaukee (FHWA Program)

	% of Car Poolers[1]	Distribution in Labor Force
Male	57	56
Female	43	44

Pittsburgh (FHWA Program)

	% of CBD Car Poolers[1]	Non CBD Car Poolers	Distribution in Labor Force
Male	63	81	66
Female	37	19	34

Percent of Auto Commuters in Each Sex Who Car Pool

NORC Data[2] (Baseline)

	% of Male & Female Auto Commuters who Car Pool
Male	26
Female	30

Boston[3] (Baseline)

	% of Male & Female Commuters who Car Pool	% of Male & Female of Non-Poolers Interested in (WBZ/ALA Car Pool Program Respondents).
Male	18	24
Female	19	28

Percent of Commuters in Each Sex Who Car Pool

Pittsburgh[4] (Baseline)

	% of Male & Female Commuters who Car Pool
Male	20%
Female	19%

Chicago[2]

Male	17%
Female	16%

Sacramento[2]

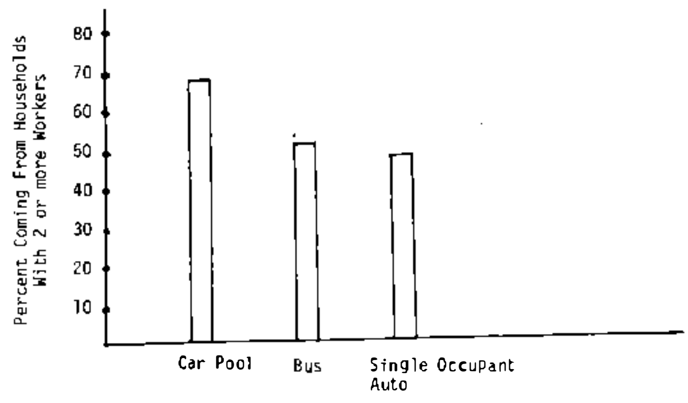
Male	17
Female	19

Source: [1]FHWA Demonstration, Appendix A.
[2]Kendall, June 1975.
[3]Heaton, May, 1976.
[4]Peat, Marwick & Mitchell and Market Facts, Inc., 1976 (I).

Exhibit 3-5

Percentage of Car Poolers, Bus Users and Single Occupant Drivers from Households with 2 or More Workers

Journey-to-Work



Source: Dobson and Tischer, 1977.

Exhibit 3-6

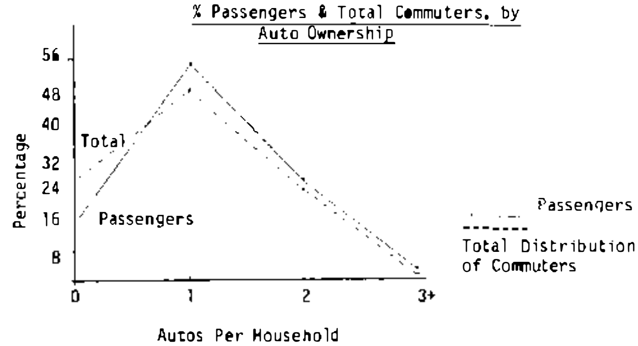
Number of Cars per Household by Solo Driver and Various Members of Car Pools

Number of Cars per Household	Solo Drivers	Total Car Pools	Drivers	Car Pool Alt. Dr.	Passengers
	%	%	%	%	%
0	0	6	0	0	13
1	26	31	27	20	39
2	53	44	45	66	33
3	15	11	12	6	13
4	6	8	16	8	2
N =	(1582)	(541)	(203)	(117)	(221)

Source: Kendall, 1975.

Exhibit 3-7

% Passengers & Total Commuters, by Auto Ownership



Source: Johnson, 1976.

Exhibit 3-8

Work Trips, Auto Occupancy and Percent of Car Pools by Occupation

Occupation	Work Trips: Auto Occupancy	Work Trips: All	Work Trips: Car Pool	Morning Peak Work Trips: Auto Occupancy	Morning Peak Work Trips: All	Morning Peak Work Trips: Car Pool
Professional	1.13	17.18	22.04	1.18	20.13	25.52
Managerial	1.08	15.70	7.76	1.11	13.12	6.77
Clerical	1.31	17.38	15.92	1.49	17.75	17.19
Traveling Salesmen	1.02	10.48	2.04	1.04	3.68	0.52
Craftsman	1.20	16.49	27.35	1.25	21.00	28.13
Semiskilled	1.42	13.52	21.22	1.55	16.37	18.75
Unskilled	1.32	1.39	1.63	1.41	1.83	2.08
Protective	1.10	2.93	0	1.15	2.33	0
Personal Services	1.46	2.22	0.41	1.64	1.85	0.52
Miscellaneous	1.32	1.48	0.41	1.37	1.25	0
Students	2.06	0.91	0.41	2.12	0.51	0.52
Unknown	1.50	0.32	0.82	1.73	0.18	0
TOTAL	1.21	100%	100%	1.31	100%	100%

Source: Krejci, 1973.

Exhibit 3-9

Percent Car Pooling by Occupation

Characteristic	Boston SMSA Workers	WBZ/ALA Respondents	Eastern Mass Respondents
Occupation	%	%	%
Professional	20	51	37
Managerial	9	17	23
Sales & Clerical	31	14	19
Blue Collar	39	7	21
Other	1	11	---

Source: Heaton, 1976.

Exhibit 3-10

Reasons for Not Car Pooling

	Schedule	Need Car During Day	Match Problems
Aerospace[3]	26	12	23
Lehigh Valley[2]	11	04	05
Milwaukee[2] Baseline Data	35	12	21
Boise[2]	51	25	--
Tallahassee[2]	37	--	14
Boston Eastern Mass.[1]	54	31	--
Los Angeles[4]	26	12	23

Sources: [1]Heaton, 1976
[2]FHWA Demonstration, Appendix A.
[3]Bush, 1974.
[4]Voorhees, 1973 (6)

Exhibit 3-11

Match Contact Rate

Place	% of Matched Who were Contacted or Contacted others on the list	% of Those Who used Match List Who Formed a Pool
Lehigh Valley, PA	20	---
Omaha, NB (CBD)	23	19.9
Pittsburgh, PA (Non-CBO)	40	24
Lackawana County, PA	23 *	8
Luzerne, PA	19.5 *	6

*Used Car Pool or Bus Information

Source: FHWA Demonstrations, Appendix A.

Exhibit 3-12

Reasons for Car Pooling*

Place	Cost (%)	Convenience (%)	Social (%)	Conservation/Environment (%)
Aerospace[1]	36	21	4	39
Milwaukee (Promotion)[2]	46	11	--	11
Milwaukee (Baseline)[2]	--	11	3.6	2
Boise[2]	39.3	--	17	23
Salem[2]	25	--	--	43
Omaha[2]	24	17	--	11
Monroe[2]	36	--	--	38
Tallahassee[2]	28	14	25	1
Kendall (NORC)[3]	28	--	4	25
Boston[4]	74	66.9	21.5	64.9
Greensborough[5]	50	27.8	--	15
Pima Arizona[2]	Least Important Reason			

*In some surveys respondents were allowed to list more than one reason thus rows may exceed 100%.

Sources: [1]Bush, 1974.
[2]FHWA Demonstrations.
[3]Kendall, 1975.
[4]Heaton, 1976.
[5]Pun and Kidder, 1976.

Exhibit 3-13

Motivation to Car Pool

What Matters Most in Work Trips

	Time %	Cost %	Dependability %
Joined 0-3 Months ago (Energy Crisis)	31	52	56
Joined 4-12 Months ago	23	22	22
Joined 12 Months ago	46	26	22
	100%	100%	100%

Source: Kendall, June 1975.

Chapter 4: TYPES OF CAR POOL DESTINATIONS

Many car pool programs have focused promotion and matching efforts on the destination. Therefore, the characteristics of companies or destinations where car pooling programs are more likely to be successful have become a matter of interest to local implementors. Below, we consider four aspects of the place of employment: size, location, type of firm, and working conditions.

Company Size. As would be expected, baseline car pooling has been reported to increase with the size of a company (Exhibit 4-1, see also Zevin, 1972). On the other hand, Ingram (1977) finds little relationship due to car pool programs and company size (see Exhibit 4-2). Exhibit 4-3, drawn by the authors, further supports this finding. Since percentage changes in program-induced car pooling do not appear to be related to firm size, it is reasonable to conclude that the number of new poolers would be linearly related to firm size when a ride-sharing program is implemented.

In an effort to concentrate limited resources, many programs have focused their efforts on firms above a certain size, and there has been some effort to identify some good cut-off sizes. Davis (1975), for example, recommends 600 (Exhibit 4-4 presents a few cut-off sizes actually used). A little thought, however, will indicate that formulating a fixed cut-off size even within a region is not prudent. The probability of a destination-based match in any given origin area will vary depending on whether that origin also serves several other large destinations (since each destination gets only a portion of trips from an area) or whether it serves only that one destination. This has important consequences. In rural areas (e.g., especially in the less populated Western States), very small trip-origin densities may support car pooling to a single large site, whereas these densities would be quite inadequate in a metropolitan area. Even within a metropolitan area, there will be considerable variation. The 'full gravity' model accounts for this situation, but its application is sufficiently site-specific and complicated that an application of SAIM (Report 5 see also Chapter 6) is considerably simpler for targeting specific destinations.

Destination Density. Baseline car pooling sharply increases with destination density. Voorhees (1974,#2) found that 66% of the car poolers on the Hollywood Freeway were bound for high density destinations. Similarly, a Twin Cities study (1962) found that if income is held constant, auto occupancy increased from 1.2 at moderate density destinations to 1.8 at high density destinations. A similar tendency probably holds true for promotion-induced car pools as well, since parking becomes more scarce and expensive with higher densities. Voorhees (1974, #5) has found parking availability to be the single, most powerful variable effecting levels of car pooling (see also Exhibit 6-7 and Chapter 8).

Destination Type. As reported in Chapter 5, studies of car poolers (irrespective of destination) have shown high proportion of blue collar baseline car poolers but larger proportions of professionals in promotion-induced pools. Only one study (Levin, 1977) has considered the effect of a firm's classification on the overall success of a car pool program. Although Zevin found lower occupancies among manufacturing firms, he attributed the finding to the fact that nearly all of these firms provided ample and free parking. From these findings and from the wide variety of types of firms that have sponsored successful car pool programs, it appears that other factors such as parking and work schedules (discussed below) play a greater role in a successful car pool program.

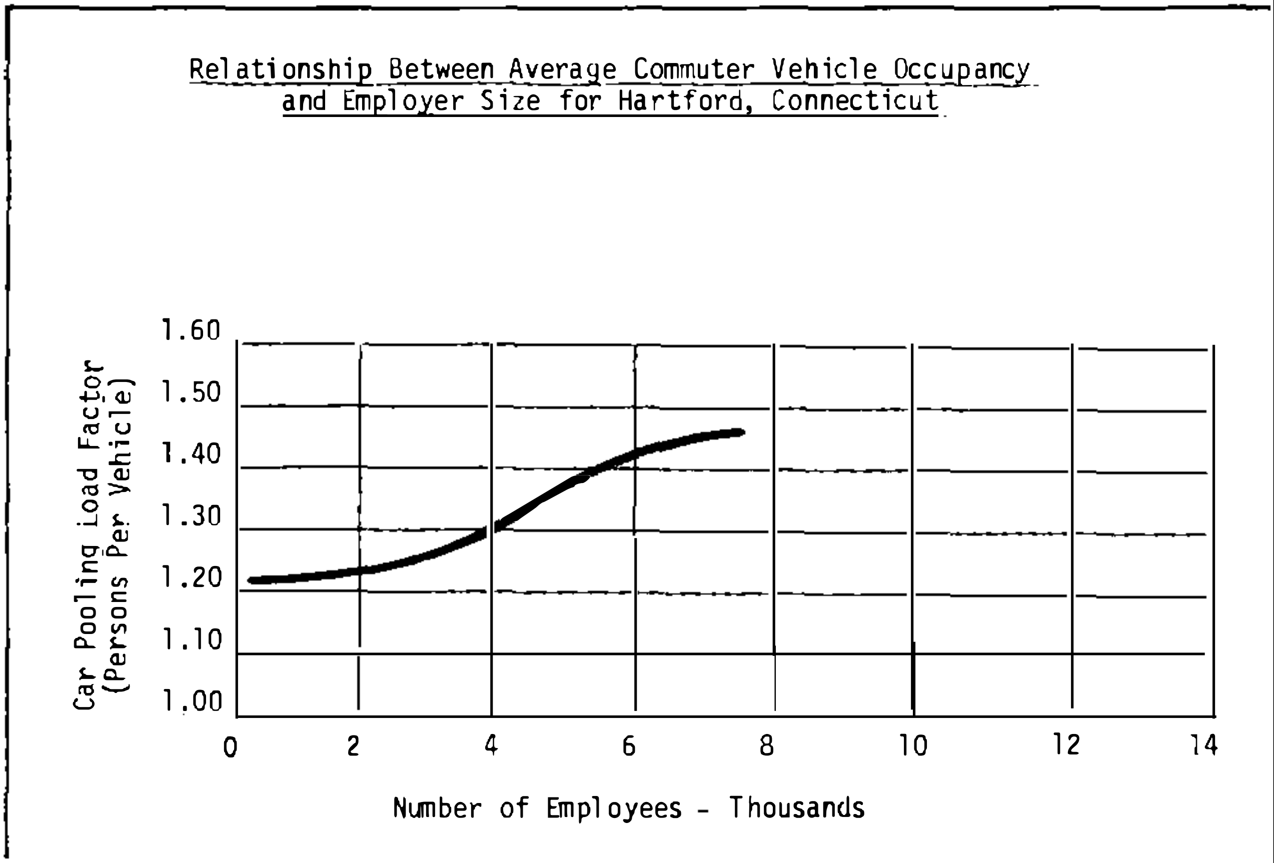
Working Conditions. Surveys of non-car poolers and reports of various demonstration projects indicate that some of the key working conditions affecting levels of car pooling are: the rate of job turnover, the flexibility of starting times, the presence of staggered hours, the amount of overtime regularly worked, and fluxtuating employment levels.

If a company has high levels of employee turnover or frequent periods of layoff, there is not the stability to maintain car pools, and probably not sufficient initiative to repeatedly start new car pools. In Boise, for example, 47% of the car pool drop-outs were due to either a move or a change in jobs. Horowitz and Sheth (1976) found that car poolers had been with their company a significantly longer time than had the solo driver.

Flexible hours and staggered hours have virtually opposite effects in the potential success of a ride-sharing program. Staggered hours involve staggering the start-up and ending hours of employees over a range of times. Each employees' individual schedule, however, is fixed. While such a strategy may reduce traffic congestion, it effectively reduces (in geometric proportion to the number of start-up times) the number of potential matches for that particular company. Flexible hours, on the other hand, give the employee discretion in determining start-up and ending times (within a certain range) thus allowing an individual the option of adjusting his arrival time for the convenience of the car pooling groups.

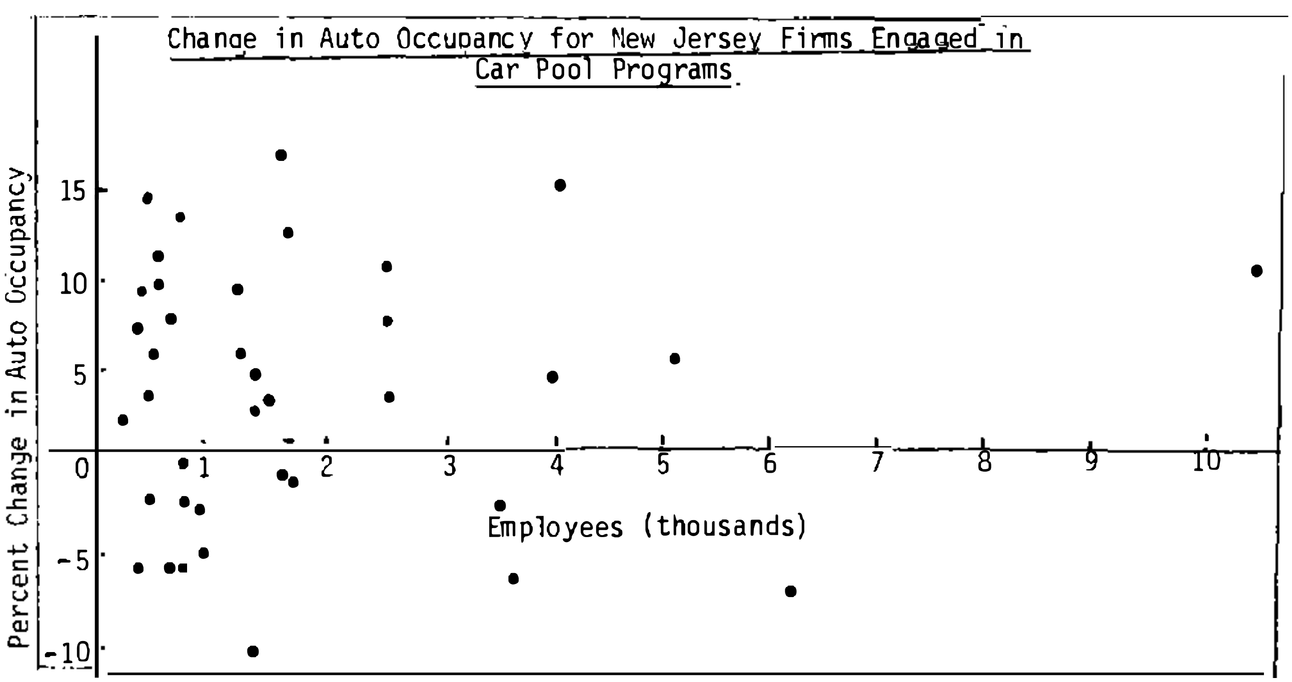
Large amounts of unscheduled overtime or "shift schedules" where the people in the shift change, are also barriers to car pooling. While it is doubtful that the overtime policy of a company will be changed to accommodate car pooling efforts, it is reasonable to encourage companies with shifts to move the same personnel from shift to shift in order to maintain the continuities of a car pool program.

Exhibit 4-1



Source: Zevin, 1972.

Exhibit 4-2



Source: Ingram, 1977.

Exhibit 4-3

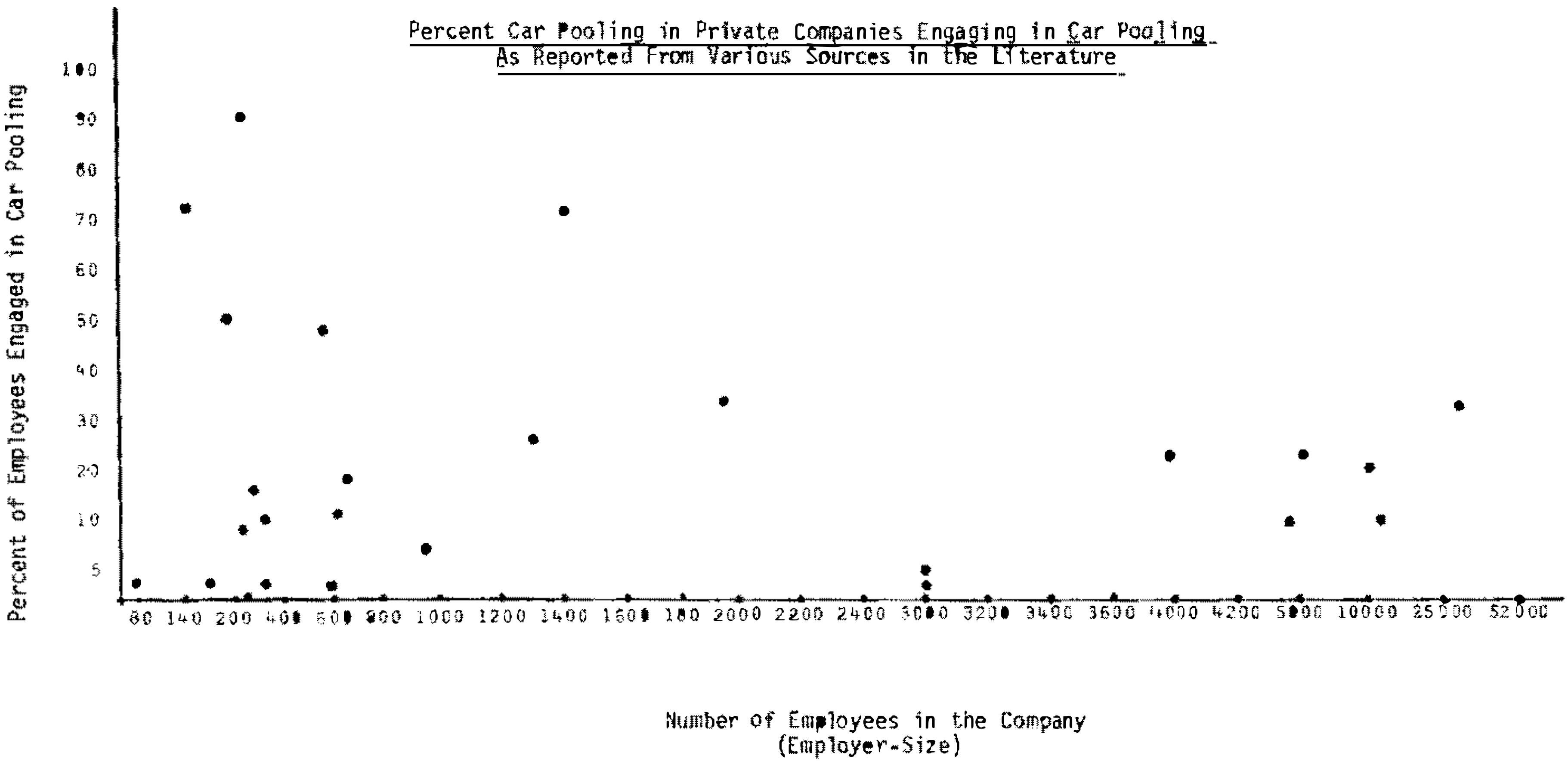

Percent Car Pooling in Private Companies Engaging in Car Pooling
As Reported From Various Sources in the Literature
Percent of Employees Engaged in Car Pooling
100
90
80
70
60
50
40
30
20
10
5
80 140 200 400 600 800 1000 1200 1400 1600 180 2000 2200 2400 3000 3200 3400 3600 4000 4200 5000 10000 25000 52000
Number of Employees in the Company
(Employer-Size)

Exhibit 4-4

Employer Size Cut-offs and Measures of Car Pooling Results

Place	Employer Size Cut-off	Size of Area*	Ratio of Cut Off To Area Size	Applicants as a Percent of those Exposed	Car Poolers As % of Area Working Population
Monroe, LA	300	40 sq.mi.	7.50	18.44%	.063%
New Orleans, LA	100	84 sq.mi.	1.19	41.31%	.108%
Louisville, KY	100	210 sq.mi.	.47	36.08%	0
Houston, TX	250	538 sq.mi.	.45	70.67%	.34%
Lehigh Valley, PA	300	60 sq.mi.	5.00	22.83%	0
Boise, ID	100	80 sq.mi.	1.25	47.51%	1.61%
Indianapolis, IN	250	381 sq.mi.	.65	12.4%	N. A.

Source: FHWA Demonstration, Appendix A.

*Area defined as urbanized area.

PART II - PLANNING

CHAPTER 5: CAR POOL PROMOTION STRATEGIES

5.1 Introduction

In this chapter, we present different car pool promotion strategies that have been suggested. These strategies may be divided into two broad categories:

1. Those based essentially on persuasion (e.g., media promotion, and matching programs). We call these strategies car pool promotions or sometimes, loosely, programs.

2. Those that give special incentives to poolers (e.g., special expressway lanes or ramps, parking privileges) or special disincentives to SOA's (parking restrictions, gasoline tax, etc.). We call such strategies policy incentives.

We consider the two categories in Sections 5.2 and 5.3, respectively.

Most policy incentives involve creating substantial disincentives for SOA's and they raise some very complex legal and political issues. In addition, in several strategies major and often complex questions of highway design and traffic management arise. Because of these problems few of these incentives have actually been applied, nor is their widespread application anticipated within the next few years. It is much more likely (for a variety of reasons) that car pool strategies in the near future will simply involve marketing and promotion. We have thus focused our attention in the remaining chapters on planning for, and implementing these types of programs.

5.2 Car Pool Promotion

Car pool promotion, which has been sponsored by private employers, civic organizations (e.g., Chambers of Commerce, JayCrees, etc.) radio stations, governmental agencies, and local community groups are basically of two types: 1) the privately-sponsored company program; and 2) the area-wide program which may target particular employers in a community, appeal to the area as a whole, or use a combination of the two techniques.

The Privately Sponsored Car Pool Programs. A number of large corporations across the country have successfully sponsored their own car pool programs. In these programs, the company has conducted its own surveying, engaged in its own promotional effort and conducted its own matching. Exhibit 5-1 summarizes the results of some of these efforts, as well as noting the motivations underlying the efforts. The results, in terms of car pool levels, are surprisingly good. Conversations with those involved reveal that the key to their success is the enthusiastic support (and often participation) of top management. The money and time that go into a program of this quality are not inconsequential. We estimate it to be nearly $4500 annually (see Chapter 7). Hence, unless a company can see a tangible benefit from this kind of investment, whether it be reduced parking demand, improved public relations, or better company morale, it is doubtful that such a car pool program will be initiated voluntarily. This observation is partially borne out by Exhibit 5-1 which indicates that in a large number of cases, there has been a motivation other than a purely altruistic one underlying the car pool effort.

Hallmark Cards in Kansas City, Missouri is a typical case study of a company car pool program. They found themselves in a parking squeeze but it was not financially feasible to expand the existing highrise and underground lots. As the situation became critical, Hallmark instituted a car pool program among its employees. The employees responded favorably to the preferred parking incentive offered by the company, and today 1,135 employees participate in more than 300 car pools.

Many private programs, however, have failed. During the energy crisis, companies across the country were forced into some form of car pool program simply to cope with absenteeism. Unfortunately, the "benefit" of car pooling was seen as temporary and many of these programs were make-shift. Of significant importance is the fact that these programs soured employees on the feasibility of pooling in their company, creating a barrier to future efforts at intiating a program.

<u>Area-Wide Car Pooling Programs.</u> A number of organizations have sponsored programs aimed at promoting car pooling in the community at large. Three general approaches have been used:

A) A generalized targeting of the entire population through media promotion and dial-in matching service (which we refer to as a regional program);

B) Working directly with a number of employers to encourage their employees to car pool (with the survey and matching services provided by the sponsoring agency rather than the employer);

C) A combination of the regional and employer approaches.

Of the three approaches, the employer-based promotional effort has been more successful in terms of the number of car pools formed. Unfortunately, there has been no evaluation of the effect that area-wide programs (mainly media campaigns) may have had in changing the attitudes of the solo-driver toward ride-sharing (see Chapter 6). Below we examine each of these approaches individually.

(a) Regional Approaches to Area-Wide Car Pooling. In this approach, the car pool promotion is directed to all commuters in the area. Matching is based on proximity of origin and destination and on similarity of work schedules. In theory, this approach has great potential since the data base is all interested car pool participants in an entire area and the probability of a match increases with increased data base size. In practice, however, these advantages have not materialized. No strictly regional approach has accumulated a data base of more than 10,000-15,000 and existing evidence (summarized in Exhibit 5-2) suggests that the approach has achieved much less success (especially per dollar expended) than destination-based approaches.

One problem with the regional approach is physical. In moving from one destination to several, the number of combinations of origins, destinations and work scheudules increase rapidly. As a result, the EPA (1974) found that in general, "regional systems" have matched 25% or less of their applicants whereas destination-based systems have exhibited matching rates of 50% or more.

A more important problem, however, is psychological. Numerous studies have shown that prior acquaintance with a potential car pooler is crucial to car pool formation (Margolin, 1976; Davis, 1975). A regional approach more often than not, is providing the name of a total stranger to an interested participant and the likelihood of a contact between the two (let alone a pool) is small.

A good case study of a strictly regional program is the Boston WBZ-ALA car pool campaign, whose promotion strategies have been repeated by several other group "W" (Westinghouse radio) stations across the country (see Kendall, 1975). In 1973, radio station WBZ joined forces with a Boston-based automobile club, the ALA Auto and Travel Club, to promote car pooling in the Boston area as one of WBZ public service programs. The system details were described and an audience response requested in a special 90-minute television program that initiated the program in August, 1973. The matching system was intensely advertised on the air, in other media, and through industrial groups and the Chamber of Commerce. Despite the comprehensiveness of the promotion, the results were disappointing. Carla Heaton (1976) in the only evaluation of this type of program, reports that by September 1974, the total number of applicants had reached 13,500, a disappointing level on several counts since this was less than .25% of the approximate 1.5 million Eastern Massachusetts workers. WBZ reports only being able to match one-fourth of the applicants, and of those matches it is not known how many actually pooled. In a private conversation, Heaton further pointed out that the costs of the program were essentially buried in other program items because the' were so large, and the true costs of the program will never be known.

(b) Employer-Targeted Area-Wide Programs. A number of area-wide car pooling programs have targeted specific employers and enlisted their aid in increasing car pooling levels among employees. The area-wide sponsor provides survey and matching assistance, and in-company promotion. Some of these programs have been quite successful. Again, the key has been top management support of the car pool effort.

An employer-targeted program has several advantages. Destinations are reduced to a few large employment sites which makes matching easier and often more effective since participants are matched with fellow employees. More important, program resources concentrate marketing car pooling in a few places rather than having the effort diffused area-wide. The results of these types of programs are presented in detail in Chapter 6. For comparative purposes, Exhibit 5-3 effectively shows the success of the employer-targeted approach over the regional approach in those cities which have used both.

(c) Combination Area-Wide Programs. Many area-wide programs have combined the region-wide promotion effort with the employer-targeting approach. Generally, these programs have been set up to accept dial-in individual applications which are then matched to applications generated from employers. Though the absolute number of dial-in applicants compared to employer-generated applicants is very small (Exhibits 5-3, 5-4), it has been noticed that the dial-in applicants may be more serious about pooling.

Two of the more successful combination systems are in Knoxville and Portland. Knoxville as a community has invested heavily in ride-sharing (see Chapter 10). The city has several large, relatively separated employers who account for much of the work force. This undoubtedly accounts for much of the programs success. Destination-based matching is used, but this is supplemented with a dial-in facility. To date, the program has had approximately 95% of its applicants dial-in service. The proportion of dial-in applicants is expected to increase somewhat in the future, but never exceed or match the employer-based applicants (conversation with John Beeson, University of Tennessee).

The Portland area has sponsored one of the most successful car pool programs in the nation. Although much of their success stemmed from the employer-targeted component, the program sponsors stress that the regional component of the program has been valuable (if unmeasureable) in "raising consciousness" about car pooling. Though citizens may not answer a newspaper ad or call in, they may be more receptive to the employer-based promotion when it comes to their particular company (see further discussion in Chapter 11).

While the local constraints for any given car pool program may vary, in general we recommend this kind of combined approach--region-wide advertising (within a reasonable budget) and concentrated marketing to targeted employers. Defense of this recommendation will be made in Part III. If this kind of promotion/marketing approach is chosen, the planner should recognize that although dial-in response for the regional components of programs have been small, their marginal cost can also be small--involving only advertising an area-wide phone car pool phone number and establishing a procedure to receive applicants' requests (a telephone answering service, for example, might be considered).

5.3 Policy Incentives

A number of policy incentives are discussed below. Some have never been tried; even for those that have been tried, little information exists on their effect on ride-sharing, except for a few rare exceptions noted below. This is because while we can estimate levels of ride-sharing after the incentives went into effect, we do not know what the base levels were. Some forecasts of the effects of these incentives have been made by Peat, Marwick and Mitchell and Market Facts (1976, #2) using a psychological trade-off model and by Cambridge Systematics (FEA, 1972 #2) using a behavioral demand model. These are presented in Exhibits 5-6 and 5-7.

(a) Reduced In-vehicle Travel Time. The methods for reducing travel time for car pooled vehicles include exclusive or preferential lanes on freeways, freeway ramps, and at toll plazas. Exclusive refers to separate facilities, while preferential refers to special lanes within existing structures. These types of incentives are most applicable to large urban areas with congested freeways.

On the Shirley Highway in Washington, D.C., "approximately 15 minutes travel time is saved by buses and car pools during the height of the peak periods (Voorhees, 1975, #5)." In northern New Jersey, a contra-flow experiment reports that "bus riders saved 8 to 15 minutes for a 2.5 mile length trip compared with the previous situation when buses were mixed in a heavily congested stream of autos." (Voorhees, 1974, #5) On the Long Island Expressway in New York, a contra-flow lane for buses saves 14 minutes during normal peak hour traffic (Voorhees, 1974, #5) Presumably, similar time savings would extend to car poolers if they were to use the facility. They have not, as yet, been allowed to use these contra-flow lanes due to potential safety problems.

Another policy to encourage car pooling is the initiation of special toll lanes and freeway ramps for shared riders. On the San Francisco-Oakland Bay Bridge, it is reported that approximately 5 minutes are saved by car poolers (Voorhees, 1974, #5) and in Los Angeles, the preferential freeway ramps allowing car poolers to bypass the metering signals has resulted in a better than 5 minutes reduction in time for car poolers (Voorhees, 1974, #6). In Minneapolis, bypasses on metered ramps save only about a minute for the buses that use it since congestion levels are lower (FEA, 1976, #1).

On the special ramps in Los Angeles, it was found that 60% of the car pools using the ramps were newly formed, while the remainder shifted to the priority ramp from other facilities (Voorhees, 1974, #5).

Peat, Marwick and Mitchell and Market Facts estimate that there would be a 7.3% increase in the number of car poolers if travel time for car poolers was reduced by 20%. However, since they estimate that this incentive can probably be made available to no more than 10% of the commuters in a given area, the maximum impact would be .73% increase in the number of car poolers (Exhibit 1-21).

Implementation of this incentive lies entirely in the control of state and local governments which have experienced some difficulty. The preferential lanes on the Santa Monica Freeway, for example, were closed on the grounds of having no environmental clearance, but in reality were closed because solo drivers were outraged at the increase in congestion in their lanes. Some states are now passing legislation which would more clearly delineate the power of the state to institute such preferential traffic control.

(b) Reducing Parking "Costs". This incentive is effective only when free parking is not available, thus most programs are limited to areas in or near the CBD. The reduced cost can be given to poolers directly at the parking lots or through employer reimbursement. Case studies do not give any indication as to the number of new car poolers started due to this technique (see Exhibits 5-6, 5-7).

Cities where reduced parking costs for car poolers were tried include Boston, Seattle, San Diego, and Portland. The Prudential Insurance Company in Boston (1967) established a program of free parking for employees in car pools of three or more occupants (others must pay $2.00). Roughly, 30 percent of all employees and 60 percent of auto commuters participate in the car pool program which now has a waiting list. While this program is apparantly successful, we remark that the nearby John Hancock office shows even higher automobile occupancy without having parking incentives for car poolers (although they encourage car pooling through matching programs). The city of San Diego operated an employee parking facility downtown where rebate coupons worth $ .20 per passenger per day are given to car poolers.

(c) Preferential Parking Areas. Employers have made car pooling more attractive by offering parking that is: 1) reserved for car poolers (attractive when lots are crowded); or 2) closer to the building (attractive when lots are very large).

Some employers that have used these techniques with success are GEICO, U.S. DOT, the Pentagon in Washington, D. C., General Electric in Lynn Massachusetts, and Southern New England Telephone. It was reported that workers at GEICO came to work 30 to 45 minutes early, and employees at Southern New England Telephone as much as an hour early in order to be able to find a parking place. Clearly, in situations like these, the incentives offered by special parking areas are strong. However, Peat, Marwick, and Mitchell and Market Facts, Inc., (1976, #2) estimate that less than 20% of employers had a shortage of parking. For this group of employees, preferential parking offers a relatively inexpensive method of reducing crowded parking facilities and encourages car pooling (see further discussion in Chapters 8 and 12).

(d) Car Pool Subsidies. Tax credits and proposals to subsidize car pools focus on state or federal changes in tax reductions. One proposal is that a tax credit of $ .50 per day for car poolers be established. While no prototypes exist, evidence indicates that this would have a moderate effect on demand. The Federal Energy Administration estimated that the number of car poolers would increase by about 5%, based on their estimate of car pool elasticity (FEA, 1976, #1). Other estimates are given in Exhibits 5-6 and 5-7.

(e) Tolls. One of the more immediate means of reducing travel costs for car poolers is reducing or eliminating costs for car pool vehicles at places which regularly charge tolls (bridges, tunnels, and turnpikes). Places experimenting with this policy include: the Port Authority of New York and New Jersey, Connecticut Turnpike, San Francisco-Oakland Bay Bridge, and the Evergreen Point Floating Bridge in Seattle. The effectiveness in encouraging car pooling is uncertain since none of these facilities knew the number of car poolers before the policy change, which would enable them to compute the new number of poolers. Market Facts suggests that toll rates have little impact on car pooling behavior (Peat, Marwick and Mitchell and Market Facts, Inc., 1976, #2).

(f) Parking Surcharge. Parking surcharges are costs added to parking, usually by local government authorities, in order to make automobile driving less attractive. The Environmental Protection Agency tried to add surcharges for parking on the order of $2.00 in Los Angeles, San Francisco, San Diego, and Washington, D.C. in 1973. Strong local opposition backed up by Congressional disapproval stopped implementation of these plans. In 1970, a 25% surcharge was imposed city-wide in San Francisco and Market Facts reports that the parking tax had little effect on total traffic, with at most, a 2% reduction of traffic in the city. Exhibits 1-21 and 1-20 provide other estimates. The weakness of this incentive is that it affects only a small proportion of commuters--those that must pay to park.

Gasoline Surcharge. Gas taxes have been proposed at all levels of government for the dual purpose of financing energy-efficient transportation programs, and to create an auto disincentive. Proposed increases are from $ .10 to $ .40 per gallon. However, the demand for gasoline is rather inelastic (FEA, 1976 #1); Kunze, 1977) (see also Exhibits 5-6 and 5-7. The near doubling of gasoline costs between 1973 and 1974 did little to reduce VMT or increase car pooling. A Northwestern University study based on Chicago data reported that the availability of gasoline had a larger effect in influencing travel behavior than did price. The Market Facts study, however, finds that a gasoline surcharge would have a strong effect on car pooling. They found that car pooling would increase 4.3% with a $0.20 surcharge and 8% with a $0.40 surcharge.

Gasoline Rationing. Gasoline rationing would limit the amount of gasoline that a person or household could use over a set unit of time. This could probably only be attempted at the national level. The World War II experience showed that while there were abuses gasoline use was reduced by one-third. The Highway Traffic Advisory Committee found, based on spot checks, that auto occupancy increased from 2.0 in July 1942, to 2.44 in December 1942, and 2.66 in March, 1943. While being the most effective method in promoting car pooling, this policy would undoubtedly be the most unpopular. While short term rationing may be palatable during a crisis, chronic rationing would be politically difficult.

Exhibit 5-1

Motivation and Results of Selected Privately Sponsored Car Pool Programs

Program	Motivation	Results
Aerospace[1]	Parking, Energy Crisis	58.7% of Those Contacted Joined Pools
Prudential Insurance, Boston	Parking Shortage	NA
Hallmark Cards[1]	Parking Shortage	1,135 Employees in 300 Car Pools
Pentagon, Washington, D.C.[1]	Parking Shortage	52% of Employees Participated in Car Pools
GEICO[4]	Parking Shortage	NA
Boeing, Seattle[1]	Parking Shortage	Of 15,240 Employees, 37% Car Pool
TVA, Knoxville[2]	Parking Shortage	Of 3,000 Employees, 47% Car Pool
Bell Helicopter, Ft. Worth[2]	Parking Shortage	Of 4,400 Employees, 40% Car Pool
Gulf Research Development Corp.[2]	Parking Shortage	60% of Employees Ride-Sharing
Sperry Flight Systems[1]	Parking, Save Energy	26% Participation Rate
Western Sugar, Denver[1]	Parking, Save Energy	25-38% of Employees Car Pool
NASA[1]	Parking, Energy Saving	62% of Employees Car Pool
Bell Labs, Greensboro[3]	Energy Crisis, Parking	Of 740 Employees, 28.1% Car Pool
Burlington Industries, Greensboro[3]	Energy Crisis, Parking	Of 1,000 Employees, 10.4% Car Pool
Western Electric, Greensboro[3]	Energy Crisis, Parking	Of 1,200 Employees, 14.1% Car Pool

Sources: [1]EPA, April, 1974.
[2]Davis, August, 1975.
[3]Kidder and Pun, May, 1976.
[4]Bush, 1975.

Exhibit 5-2

Results of Selected Regional Car Pool Programs

Program	# Applicants	# Matches	Cost*	Type of Sponsor
WBZ-ALA[1]	15,000	2,800		Radio Station-Auto Club
WIND, Chicago[1]	3,500	750		Radio Station
KDKA, Pittsburgh[1]	5,000	500		Radio Station
KPIX, San Francisco[1]	25,000	12,600		TV Station

Program	# Applicants	# Matches	Cost	Type of Sponsor
Delaware State[2]	5,376	293	$273,032	Regional Planning Commission
Washington Council of Governments[3]	64,000	6,500		

*The cost figures were not available. Carla Heaton (who evaluated the Boston System) says the true costs tended to be buried and the organizations did not make them known because they were so high, even to the boards of directors.

Sources: [1]EPA, April, 1975.
[2]FHWA demonstration, Appendix A.
[3]Metropolitan Washington Council of Governments, 1975.

Exhibit 5-3

Comparison of Results of Employer Component vs. Regional Component of Area-Wide Car Pool Programs

Place	Regional Component: Applicants as a % of Working Pop.	Regional Component: Poolers as a % of Working Pop.	Employer Component: Applicants as a % of Working Pop.	Employer Component: Poolers as a % of Working Pop.
Boise, ID	.47%	.12%	7.05%	1.62%
Sacramento, CA	.39%	.15%	2.46%	.47%
Houston, TX	.23%	.09%	.55%	-----
Cambria County, PA	.21%	.005%	-----	.34%

Source: FHWA demonstration, Appendix A.

Exhibit 5-4

Comparison of Employer Targeted Car Pool Response With Regional Dial-In Response

Program	Employer-Targeted Pooling As a % of Total Working Population	Dial-In Pooling As a % of Total Working Population
Portland, OR	2.90%	.02%
Sacramento, CA	.47%	.15%
Houston, TX	.37%	.09%
Cambria County, PA	.34%	.005%

Exhibit 5-5

Comparison of Pooling As A Percentage of Application and Employer Programs

	"Dial-In"	Employer Targeted
Sacramento, CA	37.30%	19.30%
Portland, OR	15.90%	29.90%
Boise, IA	25.16%	23.00%

Source: FHWA demonstration, Appendix A.

Exhibit 5-6

The Effectiveness of Various Policies on Car Pool Formation

Policy	% Increase # Car Poolers
Preferential Highway Lanes, Ramps Car Pool Ride Time Decreased 20%	.7
Reduced Parking Cost for Car Pools ½ Cost of 2-person Pools, Free for 3+	1.5
Subsidy for Travel Cost (Car Poolers) $260 per Year for Car Pool Members	4.0
Parking Srucharge CBD Parking Surcharge $2 per Vehicle/Day	1.7
Gas Surcharge 20¢/Gallon Surchage 40¢/Gallon	4.3 8.0
Rationing 25% Reduction in Gasoline Supplies	44.0

Source: Peat, Marwick and Mitchell and Market Facts, Inc. 1976 (2).

Exhibit 5-7

The Effectiveness of Various Policies on Car Pool Formation

Policy	% Increase # Shared-Ride Work Trips for Washington, D.C.
Preferential Highway Lanes, Ramps	
Shared Ride Time Decreased by 8 Minutes for CBD Destination Work Trips	1.2
Subsidy for Travel Cost (Car Poolers)	
$250/Year	1.3
$500/Year	2.6
CBD Parking Surcharge of	
$1/Day	1.0
$2/Day	2.0
$3/Day	3.0
Increase in Gasoline Price	
x2	1.6
x4	4.9
Rationing	
12.75 Gallons per Vehicle/Week	9.1

Source: Federal Energy Administration, 1976 (2).

CHAPTER 6: DEMAND

6.1 Introduction

We define the generic term, "demand for car pooling" analogously to demand for other modes. At an individual (disaggregate) level, the demand for car pooling is the probability that an individual under a given set of conditions will participate in a car pool of a given size. At an aggregate level, the demand could be the number of people who car pool or it could be the number participating in pools of different sizes.

In Section 6.2, we present a very simple disaggregate demand model and derive from it estimates of how far people are willing to deviate from their normal routes in order to car pool. The same model was also used for van pooling and the estimates of derivations in both cases seem to match empirical observations of those who do pool. The deviation estimates are useful for matching programs and also are inputs into the Service Area Identification Methodology (SAIM -- see Report 5) which identifies areas where car pooling is likely to work and also provides estimates of the maximum potential of car pooling in a given area. This maximum potential is a realistic maximum in that SAIM considers potential pooling trips to be only a fraction of those trips with common destinations which are adequately and spatially clustered. It is a maximum potential and not the actual level because the demand model only considers quality of service and not some other important issues such as problems of finding someone to pool with the psychological problems of pooling with a stranger, or breaking the SOA habit.

In Section 6.3, some models for estimating actual baseline demand are presented. Baseline demand estimates are valuable for setting program targets and for conducting "before and after" studies of program efficacy. Clearly, baseline demand can be obtained from direct counts of vehicle occupancies, or surveys; therefore, the methods of Section 6.3 are only valuable when the results of such direct procedures are not available.

The purpose of promotional programs is to remove the two barriers to car pooling mentioned above--finding someone to pool with, and the attendant psychological problems. As such, these programs attempt to increase the level of pooling from the base level to the full potential. How well they do depends on a number of factors including the managerial abilities of those running the program and the level of effort. Unfortunately, there does not appear to be any clear relationship between cost and level of success. Thus the best available method of forecasting change in demand may be to simply use averages of the changes in demand due to previous programs (although some work being done by Wagner under an FHWA contract may improve the situation). Such numbers are presented in Section 6.4 and could be used to set targets. Also presented in Section 6.4 are reasonable targets for some of the interim steps (e.g., success rates for media promotion, application rates for matching). Once targets have been set, reasonable cost estimates can be obtained from Chapter 7.

6.2 Estimating the Maximum Potential of Car Pooling in a Given Area

In this section, we present a simple demand model for estimating the potential of car pooling in a given area. We begin with the derivation of the model, and then compare the model results to other published results. We then discuss how the model is applied in the SAIM methodology.

Model. To estimate any sort of car pooling potential, we must determine the maximum distance a driver will deviate from his normal journey-to-work to pick up passengers.

We can express that distance as the point where the total cost (time and money) of car pooling exceeds that of driving alone or

$$(\ell + d)(T/S^{cp} + C_v^{cp}) \leq \ell(T/S^a + C_v^a)$$

where

ℓ = Line haul distance of driver
d = Total deviation necessary for car pool collection
T = Value of time, defined as \$3.00 p.h. and \$4.00 p.h. in Exhibit 6-2
S^{cp}, S^a = Average speed of the car pool and the SOA, respectively
C_v^{cp}, C_v^a = The variable cost per passenger of the car pool and SOA. The variable costs were used since these are generally the only perceived costs of driving, and in any shared vehicle-type arrangement the option of selling the vehicle is not open.

which may be expressed with the deviation distance as a constant function of the trip length:

$$d/\ell = \frac{\frac{T}{S^a} + C_v^a}{\frac{T}{S^{cp}} + C_v^{cp}} - 1$$

Substituting the various speeds at various load factors presented in Exhibit 6-1 (see Appendix B for their derivation) and variable costs based on the SOA operating cost of \$0.078 per vehicle mile (see Chapter 7), we calculate the set of maximum deviation to route length ratios presented in Exhibit 6-2. We stress that the resulting deviation to route length ratios are maximums, not averages since they are solutions to an inequality. The results of Exhibit 6-2 indicate that the d/ℓ ratios vary considerably with speed, load factor, and value of time. The majority, however, fall in the range of $.1\ell$ to $.2\ell$. We suggest $.15\ell$ as a good midpoint estimate of the d/ℓ ratio for an average car pool with a load factor of 2.5.

<u>Other Reported Results.</u> There have been few empirical studies of circuity distance.* Instead, most studies have reported excesses of travel time. Our estimates, however, are consistent with similar ratios of travel time which are reported by Voorhees (1974, #5) based on a study of car pooling on the Hollywood Freeway, and Attanucci (1974) based on car pooling at MIT and Longwood Medical Center. Other investigators have also derived similar estimates of a distance based d/ℓ ratio. The National Petroleum Council (1974), for example, estimated an <u>average</u> deviation of about $.04\ell$ per passenger. For an average car pool load factor of 2.5 (or 1.5 passengers) that would be about $.06\ell$ total distance, roughly half our estimated <u>maximum</u> at lower speeds. (see also Kendall, 1975; and Anderson, 1974). The results also agree reasonably well with the several studies ~~that~~ have reported an average 5 minute increase in a car pooler's travel time (see Chapter 2). Consider, for example, a 15-mile direct work trip of a person who forms a 3-person car pool. If we consider $.15\ell$ (a reasonable midpoint) as the deviation distance, the excess distance is 2.25 miles and at 20 m.p.h. the excess time is about 7 minutes. The excess time per person if we consider a one minute dwell time (as suggested by the Market Facts Study, 1976) may be calculated as:

	Drive Time	Dwell Time		
Driver	7.0 min.	2.0 min.	=	9.0 min.
1st Passenger	3.5 min.	1.0 min.	=	4.5 min.
2nd Passenger	0	0	=	0 min.
				13.5 min.
		AVERAGE EXCESS TIME		4.5 min.

which is consistent with reported increases.

The sharp variation in route derivation with respect to speed is also very indicative of a reasonably constant tolerable excess travel time, as has been reported and discussed in Chapter 2. Finally, we note that at higher speeds car pool d/ℓ ratios are similar to those of van pools (see Report 2) and yet have less than half the occupancy. This is reasonable since in van pooling, capital costs are included in the "fare", and the implication is that in areas where densities are too low for van pooling, car pooling is still a viable alternative.

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*Circuity distance is defined as the car pool route distance minus the distance of the driver's direct route to work.

Applications. Since the maximum deviation of a car pool is a constant proportion of trip length, the service area of a single car pool is a "wedge" defined by the two parameters illustrated in Exhibit 6-3. As discussed in greater detail in Report 5, α can be derived from the d/ ratio through the formula:

$$= \quad 3\,\frac{d/\ell}{n-1}$$

where n is the load factor of the car pool. Substituting a value of .15 d/ and 2, 3 and 4 for n we estimate values of 25°, 12°, and 8° for each of the respectively sized car pools. Thus, for example, there must be at least two trips within the area defined by the 25° wedge in a 2-person car pool.

In practice, however, we know there must be more, since experience has shown that only a small portion of those matched in car pool programs actually form pools. We estimate about 50% of the trips in a SAIM wedge are, or could become car pool trips based on the following reasoning. Average car pool occupancy of 1.2 would result in about 30% of the vehicle trips being car pool trips. This number of probably low considering we are looking only at trips with common destinations. We report in Chapter 6 that about 10% of those who apply for pooling become new poolers. If we add those new poolers to the old poolers, we will find a maximum pooling potential of 40-50%. We choose the high number to be inclusive rather than exclusive.

6.3 Estimating Baseline Car Pooling

The Federal Highway Administration in 1972 published a review of methods used to estimate baseline occupancy (DOT, 1972, #3). Three distinct methods were discussed and are summarized briefly below. In addition, we have presented estimates based solely on city size.

Average Factor Method. Average occupancy values are determined either for different trip purposes or for different destination land use classes. These average occupancy values are then applied in forecasting future vehicular travel.

Exhibit 6-4 presents average occupancy values for different trip purposes in 19 urban areas. Although most of the data were collected in the mid-1960's there is no reason to believe that the basic relationships have changed. It is noted, in fact, that the average journey-to-work occupancies nicely coincide with TSC's analysis of NPTS data.

Exhibit 6-5 presents average occupancy values for eight selected study areas classified by land use at the trip destination.

Curve Fitting. Relationships are determined between auto occupancy and a variety of other factors (e.g., auto ownership, household income, parking costs, trip length, etc.). Regression-type predictive models are created, or curves are derived which are stratified by purpose or destination.

The Twin Cities Area Transportation Study employed regression analyses to relate income, and employment density to work trip auto occupancy for the 1958 survey data. The resulting regression equation is shown in Exhibit 6-6 along with a matrix of occupancy values for different levels of income and employment density.

Using a series of socioeconomic variables, Johnson (1976) derived the following auto occupancy model based on Chicago-area Census data (see also Chapter 3).

	Regression Coefficient	t	Standard Error
Intercept	.031	1.33	.023
% Households with No Auto (NOAUTO)	.138	2.50	.055
% Households with 2 employed (EMP 2)	.169	2.69	.058
% Households with 3+ employed (EMP 3)	.320	2.81	.011
% Households with incomes to 6,000 (INCL)	.200	2.36	.065
% Blue Collar (BC)	.100	2.43	.041

$$R^2 = .697$$

Two other studies (Cleveland and OKI Studies) have developed a set of stratified curves predicting percent of auto drivers based on travel time and distance. The results are somewhat disturbing (see Exhibit 6-7) since they suggest that work-trips have much high occupancies at shorter trip lengths, contrary to many other findings. Although there is not sufficient information at this time to resolve the problem, if the dependent variable is a mode split of all commuters the findings are entirely reasonable and consistent with other reports which show findings with shorter CBD-oriented trips among lower income groups where few automobiles are available. Also, of particular interest in this Exhibit is the illustration of the impace of parking costs on car pooling which has been discussed in greater detail in Chapter 4.

Cross Classification Methods. Analysis zones are grouped into homogeneous classes or cells and average occupancy valuse are computed for each cell. This process is normally carried out separately for different trip purposes. When forecasting future travel, the characteristics of many analysis zones may change and the zone will be reclassified into a new cell which may have a different occupancy value. The Puget Sound Regional Transportation Study (PSRTS) utilized a cross-classification technique in order to obtain reliable estimates of vehicle occupancy. Analysis zones with similar characteristics were grouped together by PSRTS for the purpose of developing person-trip production and attraction parameters. These same groupings were also used to determine average occupancy values by trip purpose. The average occupancies varied sufficiently from cell to cell to make the cross classification worthwhile. For example, work trip average occupancies range from a low of 1.12 to a high of 1.36.

Occupancy Based on City Size. The Federal Highway Administration has provided estimates of occupancy-based solely on city size which were calculated from the National Personal Transportation Data. Exhibit 6-9 presents these estimates.

6.4 Estimating the Results of a Car Pool Program

Nearly all ride sharing programs to date have been of the matching/ promotion type. In this section, we provide some estimates which may be used to forecast the results of these types of programs and to set targets. We begin by presenting a very rough estimate of the number of new car poolers that can be expected as an over all result of the program. Then we provide a breakdown of estimates for individual components of the program. These include estimates of exposure (proportion of people receiving car pool information), employer response rate (proportion of employers likely to respond to the promotion effort), application rate (proportion of people within a company or in the community at large requesting matching) and percentage of pools likely to be formed from those who apply. Each of these estimates along with their definition are presented in Exhibit 6-10. The bases for the estimates are presented in greater detail below.

Estimating Total Response as a Percent of Working Population. Exhibit 6-11 summarizes the responses of several area-wide car pooling programs which have been funded by FHWA in the past few years. The programs range form very limited operations where there was virtually no promotion and only major employers were contacted to very comprehensive combination programs with extensive television, radio and newspaper coverage. All have been in operation from one to two years. Since the median value of the response rate is .33%, unless unusual conditions exist, it is reasonable to suggest this as a forecast for future similar programs.

While the responses in Exhibit 6-11 vary considerably, there appears to be no indication of any relationship between program response and money spent. Among cities for which both cost and response rates were available, there was little change between the median response rates of 9 cities with the highest expenditures, and 9 cities with the lowest. Far more important it would appear, from reading the various evaluation reports, is the way the money was spent, quality of organization, the various groups that were targeted, and the way the community accepted and felt that they were a part of the car pooling campaign (see Part III).

Estimating the Exposure Rate of a Car Pool Program. Exposure rate is defined as the proportion of people who have received some information on the car pooling program. In programs which have incorporated media and public relations campaigns the exposure rate has been high, between 66% and 75% (see Exhibit 6-12). Where only employers have been contacted the exposure has been lower, less than 20% of the labor force (see Exhibit 6-13). We caution, however, that this latter figure is highly dependent on the type of marketing (see Chapter 11) and type of employment concentration in a community.

Employer Response Rate. The success of employer-targeted promotion campaigns depends on how well employers respond. We define an employer response rate as the portion of employers who are contacted who respond by distributing brochures and surveys and giving employees an opportunity to participate. We estimate from the responses reported in Exhibit 6-14 that about half the employers will respond positively. We further note from Exhibit 6-15, the possible tendency for the rate to increase with employer size.

Estimating Data Base or Application Rate. In estimating staff and computer requirements of a program it is often helpful to know about how many applications will be made to the program. For an area-wide dial-in only program, the rate of application is exceedingly low. The Boston WBZ-ALA program, for example, estimated that less than one percent of the total labor force applied for matching services (Heaton, 1976). Similarly, in Omaha (FHWA demonstration) it was estimated that 53% of the population were exposed to the car pooling program and of that number less than two-tenths of a percent applied through the dial-in service. In Houston, where 41% of the population were exposed, less than four-tenths of one percent of that number chose to use the service. In Sacramento, where there has been a major effort to handle dial-in calls, the request for service has never been more than 200 to 300 per month.

In estimating the data base, or the application rate of a "combined" program (one with both area-wide and employer promotion) a rule-of-thumb which is used by many program specialists is 1% of the entire population.

Within a given company, the application rate varies widely (see Exhibit 6-16) and depends heavily on how the program is marketed and how it is supported by top management (see Chapter 11). It seems reasonable to assume that if an employer accepts the program in principle, roughly 20% of the employees will request matching services (20% is slightly lower than the median of Exhibit 6-17 since we suspect only the more successful programs are reported in the literature). That figure can be significantly increased with very well planned marketing strategies. Frank Davis, for example, reports application rates of well over 41% with his marketing team. David Roper with Commuter-Computer in Los Angeles, who has opted for a more "turnkey" approach (doing within company promotion as well as matching, see Chapter 11) in marketing, is reporting application rates of over 30%.

Estimating Car Pooling, as a Percentage of Those Who Have Applied. It is reasonable to assume that about 10% of those who apply for matching services will actually form car pools as a result of the program. Exhibit 6-17 presents new car poolers as the percentage of applicants in selected FHWA-sponsored programs; the range is between 0-30%, the median is about 10%. Those areas that experience high car pooling rates were those programs that had extensive public relations and media campaigns--most notably San Antonio, Sacramento, Houston, Omaha and Milwaukee. The Commuter-Computer operation in Los Angeles which has been in operation for over three years also reports a 10% rate.

Exhibit 6-1

Speed Matrix (MPH)

Used in Calculating D/ℓ Ratios of Exhibit 6-2

Load Factor			
1	2	3	4
15	14.5	14	13.5
20	19.5	19	18.5
25	24.0	23	22.0
30	28.5	27	25.5

Exhibit 6-2

D/ℓ Ratios for Car Pooling Derived for Various Speeds

	T = $4.00 per hr.			T = $3.00 per hr.		
	Load			Load		
Speed (mph)	2	3	4	2	3	4
15	.08	.09	.08	.13	.16	.16
20	.14	.17	.18	.18	.24	.25
25	.16	.19	.18	.21	.27	.27
30	.18	.21	.20	.23	.30	.30

Exhibit 6-3

Service Area of a Car Pool

Exhibit 6-4

Auto Occupancy for Selected Areas by Trip Purpose

Study Area	Year	Work	Social-Recreation	School	Shop	Other	Non-Home Based	Weighed Averages
Dallas	1964	1.10	2.00	1.40	1.70	--	--	1.70
OKI	1965	1.23	2.15	3.55	1.62	1.46	1.46	1.54
Cleveland	1963	1.51	1.37	--	2.00	1.30	1.18	1.45
Puget Sound	1961	1.25	2.26	9.33	1.41	1.27	1.35	1.54
Twin Cities	1958	1.12	2.01	1.36	1.79	1.59	1.51	1.57
Lehigh Valley	1966	1.28	1.72	2.04	1.40	1.42	--	1.47
Oahu	1960	1.22	2.26	1.33	2.05	--	--	1.81
Pittsburgh	1958	1.19	1.71	1.33	1.67	--	1.45	1.46
Indianapolis	1964	1.16	1.85	1.67	1.63	--	1.48	1.56
Chicago	1956	1.20	2.10	3.50	1.50	--	1.60	1.56
Lincoln	1963	1.10	1.90	1.20	1.70	--	--	1.60
San Francisco	1965	1.18	--	2.76	1.46	1.81	1.44	1.44
Joliet	1964	1.30	--	--	1.47	1.99	1.52	1.65
Orlando	1965	1.20	2.05	1.45	1.84	--	--	1.67
Memphis	1964	1.12	--	1.31	1.77	2.05	--	1.60
Harrisburg	1965	1.45	2.47	1.83	2.29	--	--	1.86
Lake Charles		1.00	1.80	1.20	1.60	--	--	1.60
High Point	1960	1.10	1.70	1.40	1.40	--	--	1.50
S.E. Wisconsin	1963	1.22	--	5.38	1.53	1.59	1.36	1.42
Average		1.18	1.93	2.39	1.65	1.60	1.43	1.57

Source: DOT, 1972 #3.
Voorhees, 1973 #6.

Exhibit 6-5

Automobile Occupancy by Land Use at Destination for Eight Selected Study Areas

Study Area	Year	Land Use* 01	02	03	04	05	06	Weighted Average
Galveston, TX	1964	1.61	1.54	1.36	1.37	1.72	2.17	1.60
Chicago, IL	1956	1.62	1.48	1.28	1.26	1.70	1.93	1.56
Dallas, TX	1964	1.54	1.43	1.24	1.26	1.71	1.73	1.51
Pittsburgh, PA	1958	1.50	1.43	1.27	1.20	1.78	1.99	1.48
S.E. Wisconsin	1963	1.64	1.52	1.35	1.33	--	2.10	1.56
Jefferson, MO	1964	1.53	1.38	1.42	1.30	1.73	1.92	1.51
Upstate NY	1966	1.60	1.40	1.30	1.40	1.60	2.00	1.50
Average		1.57	1.44	1.30	1.30	1.70	1.94	1.52

*Land Use Codes

01 - Residential
02 - Commercial
03 - Manufacturing
04 - Transportation Facilities
05 - Public Buildings
06 - Public Open Space

Sources: DOT, 1973 #3.
Voorhees, 1973#6.

Exhibit 6-6

Results of Twin Cities Auto Occupancy Model

Work Trip Auto Occupancy = $1.411 - 0.202 \times 10^{-4}$ (Income)
= $0.972 + 5.878 \times 10^{-4}$ (Employment Density)

"Other" Trip Auto Occupancy = $1.75 - 0.16 \times 10^{-4}$ (Income)

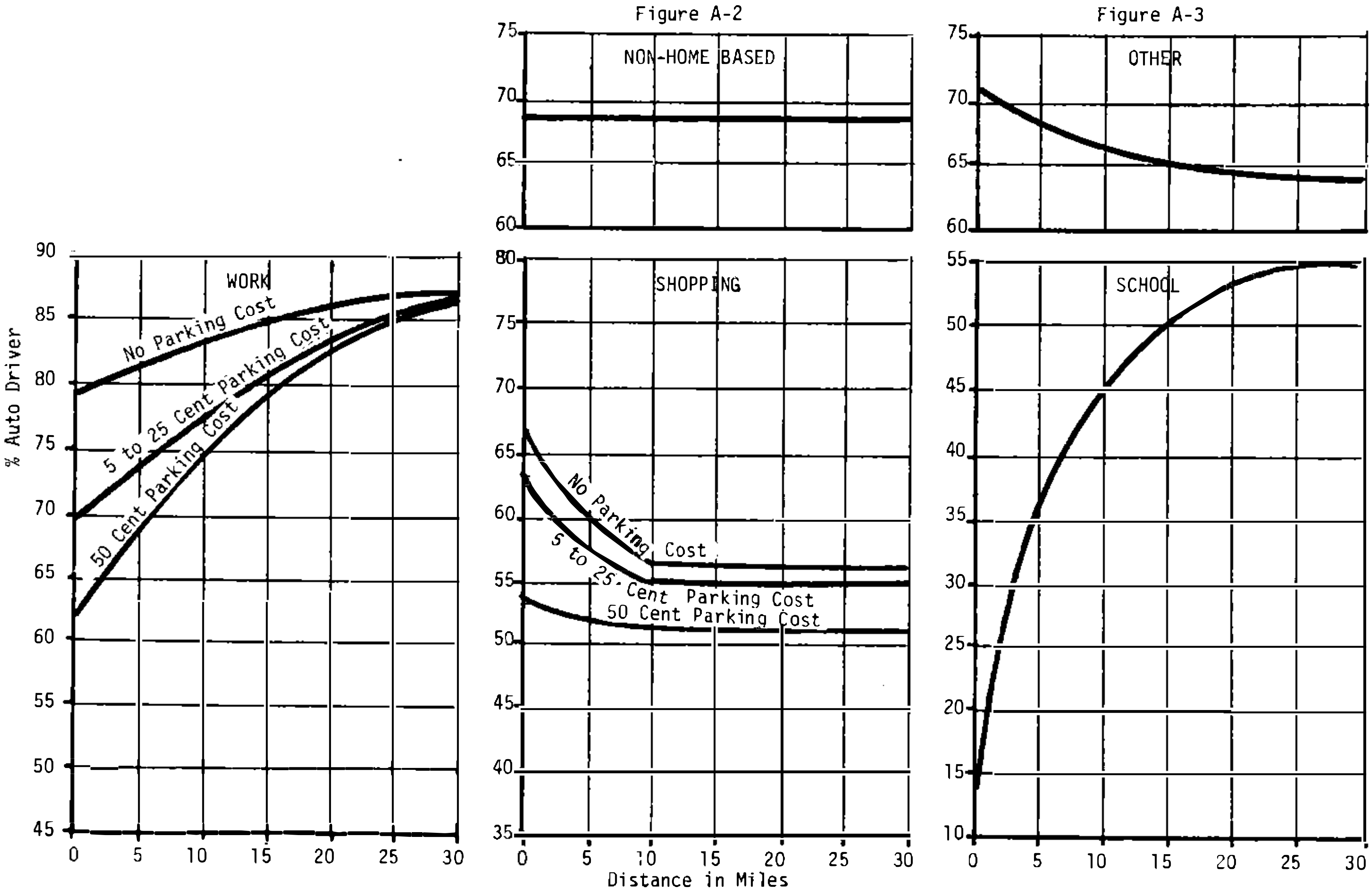
Predicted Work Trip Auto Occupancy

Income at Production End	Employment Density at Attraction End (per gross acre) 1	10	50	100	500	1,000
$20,000	1.00	1.00	1.01	1.04	1.27	1.57
15,000	1.08	1.08	1.11	1.14	1.40	1.73
10,000	1.18	1.18	1.21	1.21	1.53	1.89
8,000	1.22	1.22	1.25	1.29	1.58	1.95
5,000	1.27	1.28	1.31	1.35	1.66	2.04
2,000	1.33	1.34	1.37	1.41	1.74	2.14

Sources: DOT, 1973 #3.
Voorhees, 1973 #6.

Exhibit 6-7

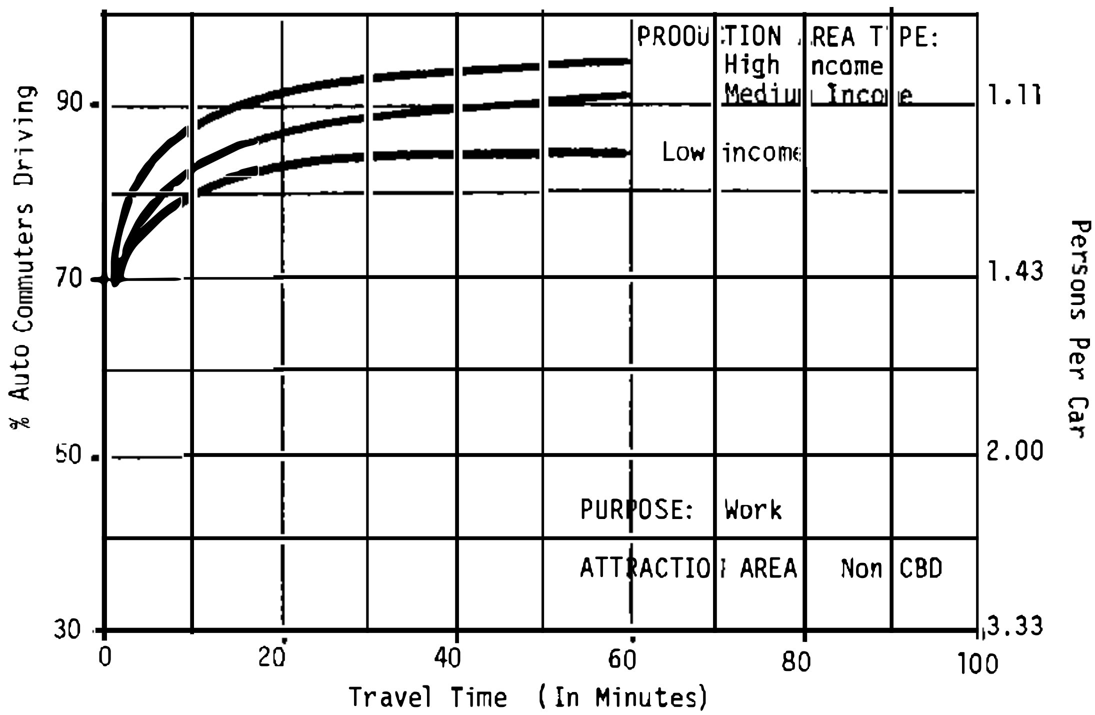
OKI Occupancy Curves by Trip Purpose



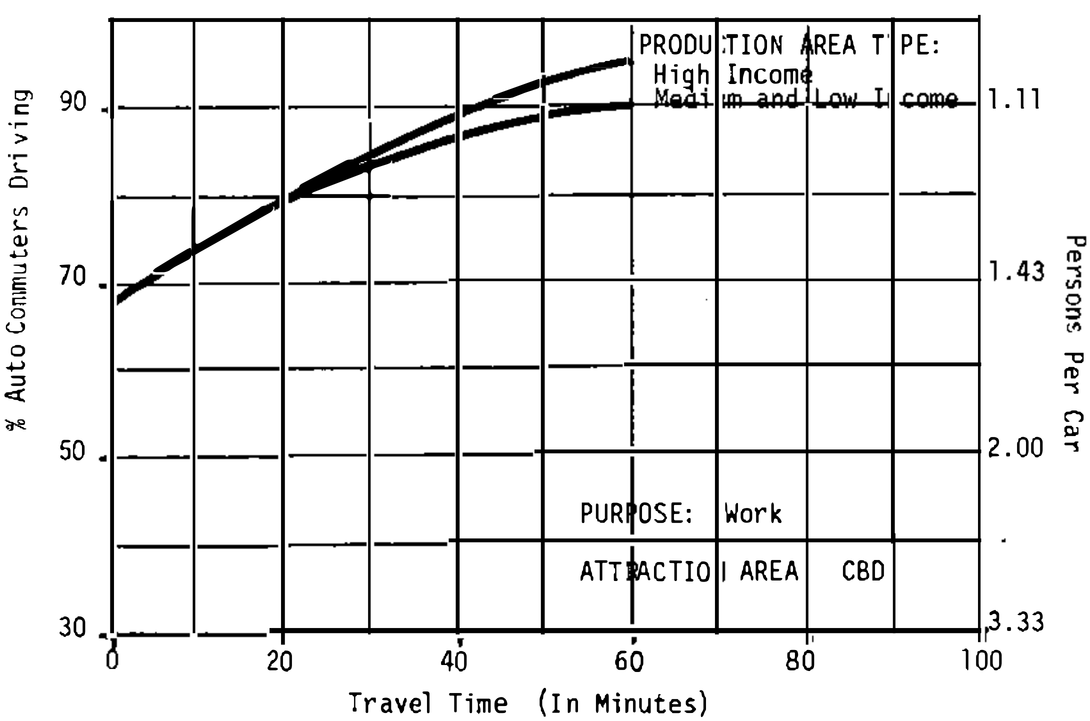
Sources: Ohio-Kentucky Regional Transportation and Development Plan
Voorhees, 1973 #6.

Exhibit 6-8

Cleveland, Ohio Occupancy Curves: Work, Non-CBD



Cleveland, Ohio Occupancy Curves: Work, CBD



Sources: DOT, 1972 #3.
Voorhees, 1973 #6.

Exhibit 6-9

Average Occupancy in Automobile Trips Classified by
Major Purpose of the Trip and Place of Residence in Standard Metropolitan Statistical Areas

SMSA Size	Major Purpose of Trip													
	Earning a Living			Family Business				Educational, Civic and Religious	Social and Recreational					All Purposes
	To and from Work	Related Business	Total	Medical and Dental	Shopping	Other	Total		Vacation	Visits to Friends or Relatives	Pleasure Rides	Other	Total	
Under 250,000	1.4	1.6	1.4	1.9	2.0	1.9	2.0	2.5	*	2.2	3.0	2.6	2.5	2.0
250,000-499,999	1.4	1.6	1.4	2.0	2.0	2.0	2.0	2.5	*	2.3	2.5	2.5	2.4	1.9
500,000-999,999	1.4	1.8	1.4	2.1	2.1	2.0	2.0	2.3	*	2.4	1.8	2.5	2.5	1.9
1,000,000-1,999,999	1.4	1.5	1.4	2.1	1.8	1.9	1.9	2.3	*	2.4	3.1	2.9	2.7	2.0
2,000,000-2,999,999	1.4	1.6	1.4	2.0	1.9	2.0	1.9	2.6	*	2.4	2.6	2.5	2.5	1.9
3,000,000 and Over	1.3	1.4	1.4	2.1	2.0	1.9	2.0	2.5	*	2.4	2.6	2.5	2.5	1.9
Total SMSA's	1.4	1.6	1.4	2.1	2.0	1.9	2.0	2.5	3.4	2.2	2.7	2.6	2.5	1.9

Source: Based upon unpublished Table P-8 from the Nationwide Personal Transportation Survey conducted by the Bureau of the Census for Federal Highway Administration, 1969-70.

*Available data not sufficient for analysis.

Exhibit 6-10

Summary of Forecasting Estimates for Matching Promotion Programs

Measure	Definition	Estimate
New Poolers as a % of Working population		.33%
Exposure		
(a) Area-wide, Media Promotion	Proportion of Labor Force Receiving Some Information about Car Pooling Program	66% - 75%
(b) Employer Contact only		less than 20%
Employer Response Rate	Proportion of Employers Contacted who respond positively to a car pool promotion contact	50%
Application Rate		
(a) Area-wide Dial-in or Mail-in	Proportion of a given group applying for car pool matching service	less than 1% of Exposed
(b) Combined Area Promotion and Employer Target		1% of Entire Population
(c) Within a Company		20% of Those Employed
New Poolers as a % of Applicants		
(a) Combined Area Promotion/Employer Target		10%

Exhibit 6-11

Capture Rates by Program Type

Location	Response Rate (Program Induced Car Poolers as a percent of all commuters)
Omaha, NB	2.700
Boston, MA	.025
San Antonio, TX	1.100
Conn. DOT	.790
New Orleans, LA	.104
Baton Rouge, LA	.050
Lafayette, LA	.010
Monroe, LA	.145
Shreveport, LA	Negligible
Lake Charles, LA	Negligible
Tucson, AZ	5.500
Portland, OR	5.450
Boise, ID.	1.010
Sacramento, CA	1.290
San Diego, CA	.340
Houston, TX	.340
Cambria County, PA	.200
Pittsburgh, PA	.090
Luzerne City, PA	.037
Lehigh Valley, PA	.004
Overall Median	.34%

Car Pool Costs Per Capita (Working Population)

Monroe, LA	$.15
Shreveport, LA	.36
New Orleans, LA	.53
Omaha, NB	.20
Waterloo, IA	.44
Boise, ID	.91
San Diego, CA	.44
Houston, TX	.15
Louisville, KY	.29
Baton Rouge, LA	.60
Conn DOT	.08
Lehigh North Hampton, PA	.54
Lafayette, LA	.41
Lake Charles, LA	.64
Portland, OR	.53
Sacramento, CA	.17
San Antonio, TX	1.06
Milwaukee, WI	.35
Pittsburgh, PA	.27
Cambria County, PA	.66
Blair County, PA	.31
Tucson, AZ	.80

Source: FHWA Demonstration, Appendix A.

Exhibit 6-12

Exposure in Programs using Area-Wide Promotion

Location	% of Population Having Received Information on a Car Pool Campaign
Boston (WBZ/ALA)[1]	75%
Houston, TX[2]	41%
Omaha, NB[2]	53%
Salem, OR[2]	70%
Boise, ID[2]	84%
Milwaukee, WI[2]	68%

Source: [1]Heaton, 1976.
[2]FHWA Demonstration, Appendix A.

Exhibit 6-13

Exposure as a % of Labor Force in Programs Contacting only Employers

22	
20	
18	X
16	
14	
12	X
10	X
8	XXX
6	XX
4	
2	XXX
0	X

Source: FHWA Demonstration, Appendix A.

Exhibit 6-14

Response Rates* Within Selected Employer-Targeted Programs

	Employer Response Rate
Monroe, LA [1]	.57
New Orleans, LA [1]	.47
San Diego, CA [1]	.51
Louisville, KY [1]	.46
Raleigh, NC[1]	.35
Lehigh Valley, PA [1]	.51
Chattanooga, TN [2]	.45
Pittsburgh, PA [1]	
CBD	.57
Non-CBD	.38

Sources: [1]FHWA Demonstration, Appendix A.
[2]Davis et al., 1975.

Exhibit 6-15

Exposure Rate and Employer Response Rate for Employer Targeted Program in Chattanooga

Employer Size	% of Labor Force Exposed Among Employees In That Category	Employer Response Rate
< 100	.006	.56
100 - 299	.037	.625
300 - 499	.023	.66
500 - 1000	.046	.80
1000+	.110	.70

Sources: Davis, et al., 1975.
FHWA Demonstration, Appendix A.

*Response rates are defined as the number of employers who initiated a car pool program out of all those who were contacted and asked to do so.

Exhibit 6-16

Selected Application Rates From Single Employers

Employer	Application Rate
Nalor Mfg.	100%
L.F. Markel & Sons	93
DVRPC	100
Pentagon	72
Briggs	70
HIT	49
Levi Strauss	75.3
Blue Bell	39
Franklin Institute	42
Penn Dot	36
Campbell Soup	34
General Electric	33
John Deere (#2)	33
Viking Pump	27
Scott Paper	24
Hamilton Bank	25
KUB	23.9
Millers	19.8
John Deere	21
Aerospace Corp	20
Leeds & Northrup	15
King of Prussia	13
Chamberlain	13
Union Fidelity	14
Park Bank	12.1
John Deere (#3)	3.4
Mt Holly	5
UNI	7.6
Rath Packing	3.1
John Deere (#4)	1.2

Exhibit 6-17

New Car Poolers as a % of Data Base (Applicants) in Selected FHWA Programs

Lehigh Valley, PA	2.0%
Lafayette, LA	4.0%
Luzerne County, PA	2.5%
Sacramento, CA	21.0%
San Antonio, TX	30.0%
Talahassee, FL	0
Milwaukee, WI	42.0%
Pittsburgh, PA	10.0%
Lackawanna County, PA	1.0%
Monroe, LA	11.9%
New Orleans, LA	9.6%
Omaha, NB	18.2%
Waterloo, IA	3.0%
Boise, ID	11.0%
Raleigh, NC	15.0%
San Diego, CA	11.0%
Houston, TX	29.0%
Alexandria, PA	5.4%
Baton Rouge, LA	10.0%

Source: FHWA Demonstration, Appendix A.

CHAPTER 7: THE COSTS OF CAR POOLING

7.1 Introduction

There are two types of costs to consider in estimating the total costs of car pooling: user cost and the supplier or program cost. Societal "costs" are primarily benefits and will be treated in Chapter 8. There are two components of user costs: 1) out-of-pocket-costs, or the car pool "fare"; and 2) the cost of travel time. Supplier costs are the costs associated with a program designed to persuade people to car pool. We discuss two basic types of programs: the company-sponsored car pool program and the community-sponsored (FHWA-type) program. Since costs must ultimately be expressed in units of output, we conclude this chapter with a discussion of car pool longevity so that we may accurately apportion annual costs per car pooler.

7.2 User Costs

Since all out-of-pocket car pool user costs represent some portion of the cost of solo driving (the benefit would be the difference between the two costs), we present nere the costs of operating an automobile alongside estimates of car pool fares. We then present methods for estimating and valuing excess travel time.

The Costs of Owning and Operating an Automobile. Exhibit 7-1 summarizes the costs of operating an "average" automobile. A full discussion of the assumptions and calculations is presented in Appendix C. We note nere a few important assumptions. The costs are based on a standard-sized car averaging 12 m.p.g. during rush hour traffic. Maintenance costs are averaged over the first four years of ownership, and the annualized capital expense (estimated car life of 4 years) includes the increased cost (due to inflation) of replacing the car. Insurance costs are based on a suburban male driving a standard-sized car and carrying $50,000 in combined liability and comprehensive protection and $2,500 of personal injury insurance. Parking costs are thought to be $200 per year or slightly under $1 per day. We assume a total of 10,000 miles will be traveled annually.

In Exhibit 7-2, we present operating costs on a per vehicle mile basis for various trip lengths; various car pool fares can be calculated from these. If a car is used for both journey-to-work and other family travel, it is inappropriate to base car pool fares on the total annual cost of operating that automobile. Rather, they should be based on the variable costs of the journey-to-work plus both the increase in maintenance costs due to the additional mileage and the increased insurance costs due to classification in a higher mileage category. Exhibit 7-3 presents some marginal cost estimates of various journey-to-work trip lengths. In Exhibit 7-4, we present various car pool fares for different trip lengths and load factors.

Excess Travel Time. The largest user cost of car pooling is the added time for pick-up and delivery. In Chapter 2, we have discussed a number of estimates of this additional travel time. If no other information is available, it is reasonable to assume that the average excess collection time is 5 minutes per car pooler and about 2 to 3 (2.5) minutes excess distribution time for the trip home--7.5 minutes total. This excess time can then be valued at 40% of the median hourly wage (Beesley, 1965) within the target area.

An alternative and perhaps more accurate method is to use the car pool load distributions, if they are known, and assign 5 minutes excess time to each passenger. For all 3-person car pools the cost of excess time would be calculated:

Driver	10 minutes	X	0.40% hourly wage
1st Passenger	5 minutes	X	0.40% hourly wage
2nd Passenger	0 minutes		

Cost for each car pool size could be determined and multiplied by the expected number of pools in that category, and the products summed for total user time cost.

7.2 Program Costs

Too often car pooling has been considered "free" of supplier or public cost. The only car pooling method without these costs is baseline car pooling. Any car pooling above this level requires some expenditure to persuade people to pool. Since these costs are rarely if ever reflected in a car pool fare, these costs represent a car pool subsidy. In this section, we consider the costs of two types of programs: the company-sponsored program and the area-wide, FHWA-type program. For both, we consider two types of program costs: the start-up costs and the on going costs of maintaining the program.

The Company-Sponsored Program. Company-sponsored programs, as discussed in greater detail in Chapter 5, involve the company staff in promoting, matching and organizing ride-sharing pools. In informal interviews with car pool coordinators all over the country, we have found both the initial organizing costs and maintenance costs to vary widely, not so much with company size, but with the quality of the program and/or the kind of incentives used. Well planned and promoted programs often take months of top management preparation time and often continue to require a full time secretary to maintain the program. Other programs simply involve putting up a map, printing response cards, and sending out a ride-sharing memo.

In our interviews, we have found that the primary expenditure of staff time was not on car pool promotion directly, but rather on administering an incentive program such as preferential parking or a car pool subsidy. Further, we found that most of the costs were "program" expenses. That is, there are certain costs associated with setting up and operating a car pool program which are the same regardless of whether the program is designed for a very large company or a small one.

(a) Start-up Costs. In Exhibit 7-6, we present a few estimates of the staff time spent in organizing various company pools along with reasonable, but arbitrarily chosen, dollar values of this time. On the basis of these estimates, we suggest that a moderately well organized car-pool promotion/matching program can be put together for about $12,000 in staff time and materials.

We can convert this $12,000 start-up cost to an annual cost by assuming that these initial costs are borrowed and that the principal will never be repayed. The annual cost of this investment, then, is the interest on it. We assume this interest to be 3% which is the difference between what one would have to pay in cash for interest less the inflation rate. Thus we estimate the annual start-up cost for company car pooling to be .03 x 12,000 = $360. This estimate is probably most applicable to moderately large firms (1,000 or more employees), where only simple (if any) car pooling incentives are planned.

(b) Ongoing Costs. Exhibit 7-6 presents estimates of the time and cost associated with maintaining various private car pool programs. Our informal interviews indicated that this cost could range from nothing (if after the program was promoted there was no further corporate involvement) to the cost of one or more full time staff members. If there is no further company involvement, it is likely that car pooling over a period of time returns to baseline levels due to attrition (see discussion on longevity which follows). In our estimate, we assume a conscientious continuing company effort to keep car pools filled but no complex incentive program. From our conversations with various clerks, secretaries, and management people currently involved in car pool programs, it would appear that the work could be readily accomplished by a quarter time secretary. We thus estimate an annual maintenance cost (including overhead) of a car pooling program to be roughly $4000 and the total cost (including the annualized cost of the initial investment) to be about $4360.

Area-wide Car Pool Programs. By area-wide car pooling programs we are referring to those government or private organizations (often funded with FHWA demonstration funds) which promote car pooling to companies and/or the community, at large. The cost of these programs can range from as little as $6,000 for a one year program in Monroe, La. to several hundred thousand dollars. Hidden in these overt costs are donated services that are often never accounted for. For example, Portland has reported receiving well over $100,000 in donated advertising time. Commuter-Computer in Los Angeles estimated the value of strictly donated services to be on the order of $1 to $1.2 million per year.

The cost estimates presented below are largely based on expenditures for FHWA demonstration programs. The figures are, in some cases, quite crude but nevertheless give some estimate of program costs. As of September 30, 1976, 77 of these type car pool matching projects had been approved. Two projects listed as pending have since been approved, resulting in at least 79 matching projects. For these 70 projects, $10,113,908 were authorized. The mean authorization value was $128,000 and the median value $60,000. In almost all projects the cost per commuter was less than $1.00. However, the costs per car pool applicant and per new car pooler are much higher. The sample of 20 cities in Exhibit 7-7 indicates that the mean cost per car pool applicant is $30, while the median cost is $18.46. The mean cost per pooler is $196, while the median is $83.29.

Because the life of promotion induced car pools has so far been fairly short (we estimate one year; see discussion following), it would appear that these area-wide car pool programs, unlike third party van pool programs (see report 3), must keep a full marketing staff to maintain given levels of pooling. Thus the cost of an area-wide operation is almost entirely an ongoing or maintenance expense. We thus assign the per pooler cost of Exhibit 7-7 as an annual program cost. We notice that the cost per car pooler varies dramatically. We further notice from Exhibit 7-8 that the cost per car pooler decreases sharply with an increase in total number of new car poolers. This probably indicates the existence of a certain (probably high) level of fixed costs.

Much could be (and undoubtedly will be) written on how to achieve higher response rates. (We have made some recommendations in Section III.) But, since the "how" is not our concern here, we simply use these costs per pooler based on varying response rates as a simple cost function without regard to how the responses would be achieved. (Realistic ones can probably be estimated based on findings in Chapter 6.) We further note that it would be inappropriate to use the estimates for expected response rates much below 100 new poolers per program.

Based on the budget break downs provided by many of the FHWA car pool evaluation reports, we roughly estimate that about 55% of the funds will be spent on program staff and evaluation, roughly 24% on promotion, 11% on overhead and 10% for matching.

Longevity. Estimates of the life span of promotion-induced car pools are important in allocating costs and determining cost-effectiveness. No good data exists from which such estimates could be made partially because car pool programs have been implemented fairly recently. Some of the better available data is in Exhibit 7-9 which records duration times for existing car pools. If we could assume that the total level of car pooling was fixed, then we could use such data to estimate measures of average longevity (e.g., half life). That assumption cannot be made since the rate of formation has been altered in all cases by the gasoline crisis, and/or the car pool program. It does, however, provide a lower limit which we estimate to be about 10 months (based primarily on the Milwaukee study). Since on a highly skewed distribution of this type, the median is less than the mean, the long-term mean would be higher. An estimate of a life span of a year has been used in the California car pool promotion cost benefit analysis (Jones and Derby, 1975) and in line with that we will also use one year in our cost estimates, cautioning that this estimate is probably low.

Exhibit 7-1

Auto Cost

(Assumed 10,000 Miles Yearly)

	$/YEAR	$/VM	
Fuel[1]	$500	.050	
Maintenance[1]	280	.028	
Total Variable Cost			.078
Insurance[2]	$230	.023	
Fees & Licenses	70	.007	
Park & Garage	200	.020	
Capital[3]	956	.096	
Total Fixed Cost			.146
Total Without Parking	$2036/YR		$.204
Total With Parking	$2236/YR		$.224

Sources: [1]Average of 1st 4 years of life of car
[2]Average for suburban car, driven to work by male head of family over 30
[3]Standard American Car owned for 4 years - See Appendix C

Exhibit 7-2

Automobile Cost Per Mile as a Function of Trip Length

JTW Length Rd Trip	Total Yearly Mileage	Fuel	Maintenance	Insurance	Fees Etc.	Park & Garage	Capital	Cost/VM Without Park	Cost/VM With Park	Total Yearly Cost Without Park	Total Yearly Cost With Park
0 Pleasure	6600	.05	.028	.028	.011	.030	.146	.242	.292	1725	1925
10	8120	.05	.028	.026	.008	.022	.105	.216	.238	1967	2167
13.5	10,000	.05	.028	.023	.001	.020	.096	.204	.224	2036	2236
20	11,640	.05	.028	.020	.006	.017	.082	.185	.203	2164	2364
30	14,160	.05	.028	.019	.005	.014	.068	.169	.183	2397	2597
40	16,680	.05	.028	.016	.004	.012	.057	.156	.168	2594	2794
50	19,200	.05	.028	.014	.004	.010	.050	.145	.155	2791	2991
60	21,720	.05	.028	.012	.003	.009	.044	.138	.147	2987	3187
70	24,240	.05	.028	.011	.003	.008	.039	.131	.139	3184	3384
80	26,760	.05	.028	.010	.003	.007	.036	.126	.133	3380	3580
100	31,800	.05	.028	.008	.002	.006	.030	.118	.124	3773	3973

Exhibit 7-3

Marginal Cost of Driving

Round Trip Mileage	Fuel	Maintenance	Depreciation	Insurance	Total
0	.050	.028	.010	0	.088
10.0	.050	.028	.010	.018	.106
13.5	.050	.028	.010	.014	.102
20.0	.050	.028	.010	.009	.097
30.0	.050	.028	.010	.011	.099
40.0	.050	.028	.010	.008	.096
50.0	.050	.028	.010	.006	.094
60.0	.050	.028	.010	.005	.093
70.0	.050	.028	.010	.005	.093
80.0	.050	.028	.010	.004	.092
100.0	.050	.028	.010	.003	.091

Exhibit 7-4

Car Pool Cost Per Passenger Per Day by Trip Length

Round Trip Length in Miles	Variable Cost Only — Passengers Per Car: 2	3	4	Full Cost (Without Parking) — Passengers Per Car: 2	3	4
10	$ .39	$ .26	$ .19	$1.08	$ .72	$ .52
20	$ .78	$ .52	$ .39	$1.86	$1.24	$ .93
30	$1.17	$ .78	$ .58	$2.53	$1.69	$1.26
40	$1.56	$1.04	$ .78	$3.12	$2.08	$1.56
50	$1.95	$1.30	$ .97	$3.62	$2.41	$1.81
60	$2.34	$1.56	$1.17	$4.14	$2.76	$2.07
70	$2.73	$1.82	$1.36	$4.58	$3.05	$2.29
80	$3.12	$2.08	$1.56	$5.04	$3.36	$2.52
100	$3.90	$2.60	$1.95	$5.90	$3.90	$2.95

Exhibit 7-5

Estimates of Company Investment Needed to Initially Organize a Car Pool Program

Company	Management Time (Person Hours)	Secretarial Time (Person Hours)	Materials	Management Cost (25,000 Annual Salary)	Secretarial Cost (12,000 Annual Salary)	Overhead (33%)	Total	Company Size
Burroughs Corp. Pasadena, CA	756	252	N/A	$9,500	$1,500	$3,630	$14,630	1,000
Martin Marrietta Torrence, CA	--	42	N/A	--	$2,000	$ 660	$ 2,660	1,500
Airesearch Manufacturing Phoenix, AZ	180	--	$7,200	$2,232	--	$ 736	$10,168	5,000
Hallmark Cards Kansas City, MO	Estimated Cost of $12,000-15,000 for Staff and Materials							

Exhibit 7-6

Estimated Annual Staff Time and Cost Required to Maintain Various Company Car Pool Programs

Company	Management (Fraction of Full Time Effort)	Secretarial (Fraction of Full Time Effort	Company Size	Comment
Prudential New Jersey		1.5	4,000	Staff Time Primarily spent in administering preferential parking
John Hancock Boston, MA	1	1.0		
AT&T Long Lines New Jersey		.38	about 1,000	Staff time spent in matching only
Mountain Bell Denver, CO		.05	11,000	Matching only
Hallmark Cards Kansas City, MO		Estimated at $25,000 per year.	5,000	Includes Administration of parking
Motorola Chicago, IL		No Cost	7,000	Self Service Match
Kraft Inc. Chicago, IL	.02		700	
Sandia Laboratories New Mexico		.25	7,000	Simple Matching
Airesearch Manuf. Phoenix, AZ	.25	.25	5,000	

Company	Management ($25,000)	Secretarial ($12,000)	Overhead (33%)	Total Cost	Company Size
Prudential Ins.		$18,000	$5,940	$23,940	4,000
John Hancock	$25,000	$12,000			
AT&T Long Lines		$ 4,560	$1,504	$ 6,064	1,000
Mountain Bell		$ 600	$ 198	$ 798	11,000
Hallmark Cards				$25,000*	5,000
Motorola				No Cost	
Kraft Inc.	$ 500		$ 165	$ 665	700
Sandia Laboratories		$ 3,000	$ 990	$ 3,990	7,000
Airesearch Manuf.	$ 6,250	$ 3,000	$3,052	$12,302	5,000

Source: Private telephone conversations with company personnel involved in ride sharing program.

Exhibit 7-7

Cost Per Car Pooler of Various Programs
Grouped by Program Response

	Cost Per Pooler	Median
5,000 + New Car Poolers		
Conn DOT	11.59	10.66
Portland, OR	9.74	
1,000-5,000 New Car Poolers		
Sacramento, CA	13.44	
Pittsburgh, PA	28.00	
Omaha, NE	41.79	42.00
San Diego, CA	128.70	
Houston, TX	42.93	
San Antonio, TX	94.10	
500-1,000 New Car Poolers		
Milwaukee, WI	114.95	94.60
Boise, ID	74.26	
Less than 500 New Car Poolers		
Baton Rouge, LA	12.24	
Lafayette, LA	824.05	
Cambria County, PA	224.18	262.17
Monroe, LA	83.29	
New Orleans, LA	513.13	
Waterloo, IA	300.17	

Exhibit 7-8

Cost Per Car Pooler vs. Number of New Car Poolers

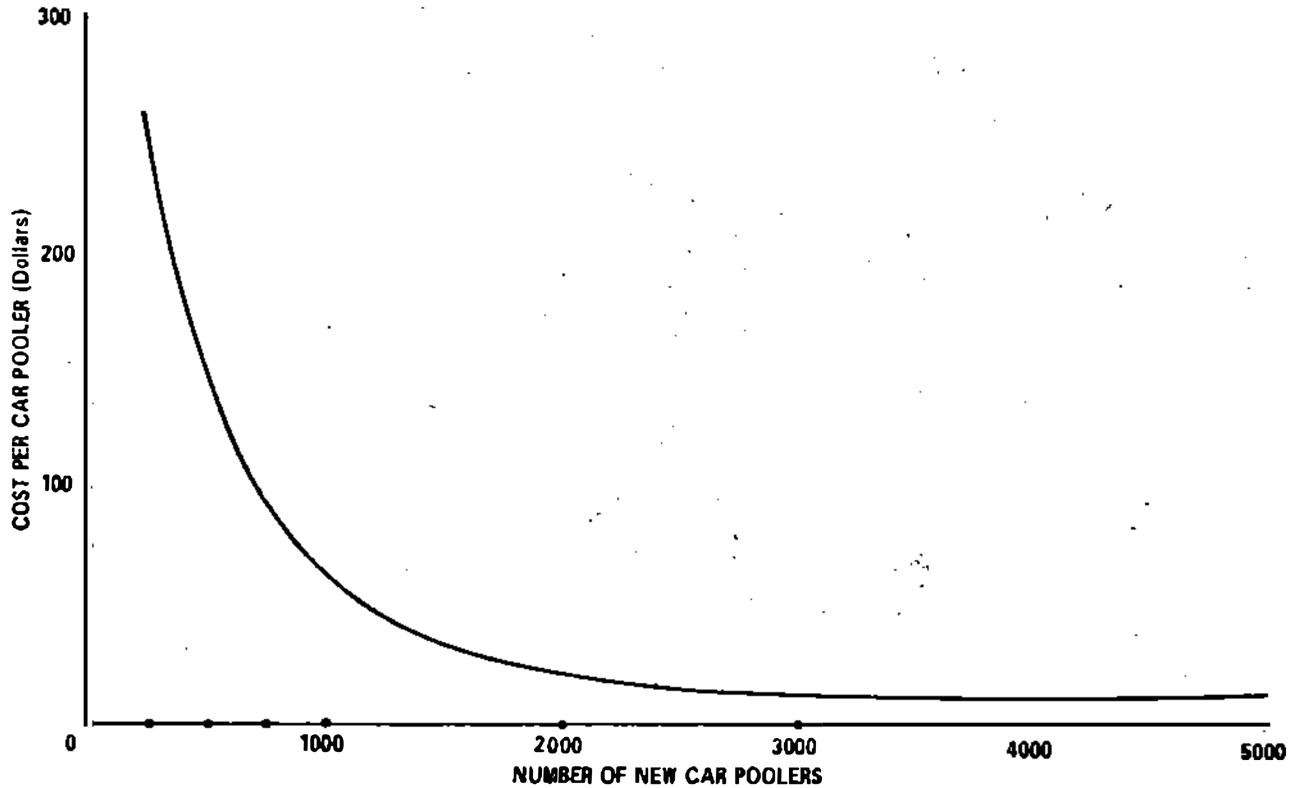


Exhibit 7-9

Duration of Car Pools

Chronological Distribution of Formation of Car Pools

Time of Formation	% of Medical Area Respondents	% of Medical Area: Car Pool Daily	% of Medical Area: Car Pool 2 or More Days
w/in last 6 mos.	36.2	28.7	44.0
6 mo. - 1 yr.	20.6	27.5	24.7
1 - 2 yrs.	17.3	19.6	15.2
> 2 yrs.	19.9	24.5	16.1

Source: Attanucci, 1974.

Duration of Portland Area Car Pool Membership

	Percent	
5 yrs. to 9.9 yrs.	3.6	
1.5 yrs. to 4.9 yrs.	8.1	
1 yr. to 1.4 yrs.	19.6	
2 yrs. or more	17.6	
		(48.9)
11 mos.	.8	
10 mos.	4.3	
9 mos.	4.2	
8 mos.	3.3	
		(12.6)
<8 mos.	34.8	
Duration not Specified	3.6	
	99.9	

Source: FHWA Demonstration (Portland), 1975.

Duration of Milwaukee Area Car Pool Membership

100%	≤	1 mo.	
60%	≤	3 mos.	¼ yr.
30%	≤	15 mos.	1¼ yr.
9%	≤	30 mos.	2½ yrs.
5%	≤		3¼ yrs.
3%	≤		4¼ yrs.
1%	≤		5 yrs.

Source: FHWA Demonstration, Appendix A.

Duration of Boston Area Car Pool Membership

0 - 6 mos.	26%
6 mos. - 1 yr.	31%
1 - 2 yrs.	13%
3 - 10 yrs.	17%
10 +	6%

Source: Boston, 1976.

CHAPTER 8: ESTIMATING BENEFITS OF CAR POOLING

8.1 Introduction

Like any other mode the benefits of car pooling can accrue to the user as well as the non user. Since sometimes employers sponsor or at least strongly support car pool programs we shall distinguish between employer benefits and social benefits.

In Section 8.2, we discuss user benefits and in Section 8.3 employer benefits. Since one of the most important social benefits is energy savings, in Section 8.4 we discuss methods of estimating reductions in auto use, VMT, and energy consumption. In Section 8.5, other social benefits (e.g., reduction in air pollution and congestion) are discussed.

8.2 User Benefits

For those who shift to car pooling from SOA's there are at least four potential sources of benefits which are discussed below.

Reduced Share of Auto Operating Expenses. Exhibit 8-1 shows the annual savings per car pooler (if the full variable costs of driving are shared) by trip length. Total user savings for an area can easily be computed from these by simple arithmetic operations.

Parking. Parking costs affect only a small percentage of the commuting population. The Nationwide Personal Transportation Survey states that 7.3% pay for parking (U.S. DOT, 1973 #4) while the National Opinion Research Center data indicates that about 6% pay for parking (Kendall, 1975). Parking costs are much more likely to occur in central city work destinations than in suburban or rural areas. The NORC data shows that 19% of auto commuters to the CBD pay for parking, while only 5% of those commuting to other city work locations, and virtually none of the commuters to suburban and rural locations pay for parking (Kendall, 1975). About 50% of CBD-destination automobile commuters and 100% of other commuters pay parking fees of less than $0.50 per day (Kendall, 1975). Only 27% of CBD destination automobile commuters pay more than $1.00 per day (Kendall, 1975). Since CBD work-trip destinations account for only 18% of all automobile commuter trips nationally, the percentage of automobile commuters who pay over $1.00/day would be (.18) (.27) = 4.86%. Thus a small number of automobile commuters could save significant amounts of money, while the vast majority of workers would save little or nothing in parking expenses due to car pooling. To accurately reflect this cost locally, an estimate will have to be made of the number of new poolers expected to be destined for a CBD or some other limited parking area.

Insurance. Many insurance companies offer reduced rates on liability premiums for car poolers. Aetna Insurance Company, the Kemper Group, and Fireman's Fund American reduce these premiums by 13% to 18% to car poolers who use their own car to drive to work no more than two days out of five. Allstate reduces the premiums up to 22% for its policyholders who join car pools. The degree of reduction depends on the distance the driver previously drove to work before joining a car pool, and the annual mileage driven (Donahue, 1974). Pennsylvania State Farm Mutual, State Farm Fire and Casualty, Nationwide, and Erie Insurance Exchange also have special rates for car poolers. State Farm reclassifies car poolers into a short-trip commuter category which reduces premiums by about 15% (Voorhees, 1974, #5). Womack estimates that reduced premiums due to car pooling are usually from "10 to 15 percent".

Reduced Auto Ownership. At present, all available evidence indicates that there is no appreciable reduction in auto ownership due to car pooling.

8.3 Estimating Employer Benefits

There are a number of benefits which accrue to the employer-sponsored car pool programs. Those most often reported include:

(a) Improved Public Relations
(b) Improved Access to Distant Labor Markets
(c) Improved Company Morale
(d) Reduced Tardiness and Absenteeism
(e) Reduced Demand for Parking
(f) Reduced Congestion
(g) Increased Personal Security at Large Parking Lots.

While each one of these have been important reasons for various companies to sponsor very successful programs (see Chapter 5), only d, e and f are readily quantifiable for comparative cost benefit analysis, and even these present problems. While several companies have reported reduced absenteeism and tardiness to date, the only formal evaluation of it done by Kocher and Bell (1977) indicates there is no significant reduction.

Reduced local congestion can provide significant savings to the employer through improved public relations, reduced employee travel time, and elimination of the need to construct special traffic facilities. These savings are extremely local, accruing to perhaps only a few specific employers experiencing particularly acute problems. We shall discuss congestion costs further in Section 8.5.

Savings due to parking can be substantial. Shallbetter (1975) estimates that for about 80 percent of all work trips the employer is either directly or indirectly paying the parking costs for employees. His estimates of average savings due to car pooling are presented in Exhibit 8-2. The figures are highly dependent on the location of the company (i.e., the cost and availability of land) and the expansion plans of the given firm (see Report 4 on Park and Ride facilities for detailed cost). In very congested areas, parking is often not provided by the employer. Thus benefits due to savings in parking construction will have to be estimated on an individual basis.

8.4 Estimating Reductions in Auto Use, VMT and Energy Use

Below, we present some estimates of trip lengths, load factors, and diversions from SOA's that are necessary for estimating reductions in auto use, VMT and energy consumption. We then present a simple method of estimating "S" which is the percent reduction in the number of auto trips. We conclude by showing that "S" is also a reasonably accurate estimate of the percent reduction in VMT and energy use.

An important point raised in this section is that although the median value of the commuters who shifted to car pooling due to a program is only .33 (Chapter 6), "S" can be a much larger amount if car pool programs have the effect of increasing the load factors of vehicles previously used for pooling.

Some Preliminary Estimates

(a) Trip Length. To make even rough estimates of the regional benefits of a car pooling program, some knowledge of trip length is critical. Such information can be obtained from journey-to-work home interview surveys which are very expensive and generally only readily available in larger metropolitan areas, or from UTPP Census data. Barring the availability of these or similiar data sources, the Federal Energy Administration has recommended the use of the figures in Exhibit 8-3 for rough averages.

In Exhibit 8-4, distributions of trip lengths (both for car poolers and non-car poolers where available) are presented for cities of various sizes, densities, and with various transportation characteristics which have implemented car pool programs. It can be noticed from each of the reported distributions of poolers to non-poolers that car poolers account for a disproportionate number of longer trips, and as Exhibit 8-5 shows, the average occupancy of a car pool also increases with trip length.

Few attempts have been made to create a generalizable estimate of the increased probability of car pooling solely as a function of trip length, since there are many variables to be considered (such as city size, population, density, and road networks, which vary form city to city. Two exceptions are Zevin (1972) and NPTS (1972, #1) (see Exhibits 8-6 and 8-7). It is interesting to note that if the points are plotted and a straight line fitted to both, the slopes are identical (0.008).

(b) Load Factors. Reasonable estimates of the distribution of car poolers in car pool vehicles is critical to assigning benefits (in reduced VMT) to a car pooling program. Whether new car poolers distribute themselves two-to-a-car or four-to-a-car makes a substantial difference in calculated energy and congestion reductions. Exhibit 8-8 summarizes reported base-line distributions in selected cities. Exhibit 8-9 presents a few reported distributions following car pooling programs, and Exhibit 8-10 presents average occupancies for car pool vehicles following a car pool program.

It will be noticed from examining the three exhibits that new car pools tend to have a higher occupancy. The average baseline car pool occupancy is 2.5 while the median of the numbers in Exhibit 8-10 is 2.93.

To compute energy savings, we should also note that on the average high occupancy autos get lower mileage than SOA. Some estimates are presented in Exhibit 8-11. On examining it, one is struck by the rather rapid decrease in MPG as occupancy goes over 3. (This may be due to the fact that large numbers of occupants usually ride in bigger cars).

(c) Car Left at Home. When a car pooler leaves a car at home it often gets used for shopping. FEA (1976, #3) estimates this use to account for about .122 gallons a day or about 1 to 2 miles per day.

(d) Frequency. In estimating the number of vehicle miles to be saved by a car pool or governmental program, there needs to be some estimation of how often a car pooler actually rides in the car pool. It appears from the relatively limited data available to us, that it is reasonable to assume that between 75-80% of those regularly participating in car pool programs ride five days a week. This estimate is based on three reports of ridership frequency which are summarized in Exhibit 8-12.

The frequency of car pool riding in any given company is extremely variable. It is highly dependent on the nature of the occupations of the car poolers (e.g., if they frequently go out of town and require a car to go to the airport, or if travel is part of their work, then the car pool may be used only two or three days a week). A good example of this is the Aerospace Corporation, where a large number of employees are engineers or technical people who do a great deal of traveling. There, only 47% of those who car pool do so on a five-day a week basis, another 46% report car pooling on a four-day a week basis. However, private conversation with Leon Bush indicated that even these estimates may be a bit high. Bush pointed out that once one accounts for the number of days of absenteeism a full car pool probably only exists between three and four days a week.

Wide variations in work schedules also reduce the frequency of ridership. For example, at MIT only 50% of the car poolers reported car pooling five days a week. At Longwood Medical Center, where there were a number of shifts, only 44% of the car poolers reported car pooling five days a week (Attanucci, 1974).

Diversion From Solo Driver Automobiles. Knowledge of the previous modes of new car poolers is important to accurately estimate VMT reduction, since if a majority of car poolers came from other higher occupancy vehicles VMT might actually increase! From Exhibit 8-13, it would appear that diversion rates from SOA's of about two-thirds are reasonable. The rate, however, is highly dependent on the local availability of public transportation, and where and how car pooling is marketed.

Estimating Reductions in Automobile Trips. Reduction in the number or percentage of automobile trips in a community can be estimated in a number of different ways. We present one method below which uses data that are reasonably easy to gather (a large number of FHWA-sponsored demonstrations have done so) and reasonably easy to forecast using the results of

Chapter 6 and the last section. To illustrate the general procedure we start with a numerical example based on work trips.

Consider a community which before the program started had an auto load factor of 1.2 and a car pool load factor of 2.5 among those who were already pooling. Suppose that as a result of the program .22 percent of all commuters switched from SOA's to car pooling and pooled every day. And, suppose that the auto occupancy of the pooling vehicles rose to 2.8. For this situation let us estimate the reduction of auto trips.

Before the program 100 cars carried 120 people, 20 of whom were passengers. Since there are 1.5 passengers per car pool, 20/1.5 = 13.33 cars are involved in pooling. Of the 86.67 people who are in SOA's, .0022 X 120 = .26 shift to pooling. The 20 + 13.33 + .26 = 33.6 poolers, now have a load factor of 2.8 and thus use 33.6/2.8 = 12 cars. Thus at the end of the program, the same 120 people are using 86.4 + 12 = 98.4 cars--a reduction of 1.6% in auto trips. Incidentally, the new overall load factor is 1.22.

Now let us go over the arguments algebraically. Let the initial overall load factor be x and among pooling vehicles assume that the load factor has changed from y_1 to y_2. Also assume that α percent of all commuters have shifted from SOA's to pooling.

Before the program 100 cars carried 100(x-1) passengers and there were

$$100(x-1)/(y_1-1)$$

cars involved in pooling. Of those in SOA's, $100\alpha x$ shift to pooling. The

$$100(x-1)[y_1/(y_1-1)] + 100\alpha x$$

poolers now have a load factor of y_2 and thus use

$$(1/y_2)[100(x-1)(y_1/(y_1-1)) + 100\alpha x]$$

cars. Thus at the end of the project the percent reduction in the number of auto trips is

$$S = 100\alpha x + 100(x-1)/(y_1-1) - (1/y_2)[100(x-1)(y_1/(y_1-1)) + 100\alpha x]$$

$$= 100/y_2[\alpha x(y_2-1) + [(x-1)(y_2-y_1)/(y_1-1)]]$$

Notice that α should be written as $AB\alpha$,

where A is the percent of all commuters who start pooling,
B is the fraction of new poolers who come from SOA's and
α is the frequency with which an individual pools.

Unless better estimates are available, B + .66 and α= .9 seem reasonable default values.

Estimating VMT Reduction A simple method of estimating the percent reduction (due to a program) in vehicle miles traveled is to use S (percent reduction in the number of auto trips). Thus the total VMT reduced would be

$$SLN \qquad (1)$$

where L is average trip length and N is the number of auto trips made before the program.

In fact we recommend this approach. We consider below three causes of inaccuracy (due to VMT generated by pick-ups and drop offs, use of car left at home, car pool trips tending to be longer than SOA trips) in the estimate and find that in most cases, the total effect of these is very slight compared to the many other uncertainties in the estimates. Moreover, the data required to correct for the causes of inaccuracy are difficult to obtain and the corrections can get so complicated that errors could occur. In fact, a formula given by FEA (Program to Promote,..., 1976) which accounts for these problems is itself wrong.

(a) VMT Generated by Pick-up and Drop-off. This has been estimated (see Chapter 6) to be .04L per new pooler. Hence, in the numerical example of the previous section it is

$$.04L \times .4 = .016L \qquad (2)$$

Notice that since car pool trips tend to be longer than SDA trips we should have increased the estimate; on the other hand, pick-up of passengers after the first requires smaller marginal deviations suggesting a decrease in the estimate. Since we do not have information to make these corrections we shall leave the estimate as it is.

(b) VMT Generated by Cars Left at Home. Using the estimate that cars left at home are used for about 1.5 miles a day the total effect of this in the numerical example of the last section would be 1.6 miles or .24L assuming L = 10 miles.

(c) Effect of the Longer Length of Car Pool Trips. Let a_{ij} be the number of people shifting from vehicles of occupancy i to those of occupancy j. Let l_{ij} be the average length of the trips taken by these people. Then the total reduction in VMT is

$$\sum_{i<j} a_{ij}\, l_{ij}\, \delta_{ij} \qquad (3)$$

assuming occupancy only increases and letting $\delta_{ij} = i^{-1} - j^{-1}$. But data this detailed are seldom available. For the numerical example of the last section, if we assume that a reasonable distribution of occupancies (based on the Milwaukee situation and that 4 and 5 person pools have 1.5 times the lengths of 1, 2 or 3 occupied autos) we find that (1) is an under-estimate by about .2L.

Since a and b would tend to deflate (1) and c would tend to inflate it, the net effect of the three for our example (for 100 cars) is a deflation of .056L.

Estimating Reduction in Gasoline Use. Here too, we suggest use of S for percent reduction of gasoline use and

$$SLN/G$$

where G is the average miles per gallon of automobiles in the community. There are at least two causes of inaccuracy in this estimate which we consider below:

(a) Gas Consumption of High Occupancy Vehicles is higher than low occupancy vehicles. Using the estimates of Exhibit 8-5 and assuming in our numerical example that due to the program, ex solo drivers would only form 2 person pools and i-person poolers would only form i+1 person pools we estimate that the effect of this is too deflate our estimate by .014 L/G which is perhaps too slight to consider.

b) Gas Consumption. On highly congested roads is higher than on less congested ones. This could be a serious problem but we do not, at present, have enough information to correct for it. Also in highly congested areas, car pooling by reducing congestion can enhance m.p.g.'s of other cars (see section on congestion for formula).

8.5 Other Social Benefits

Reductions in Pollution. S can be used as a rough estimate of the percent reduction in auto-related air pollution in the community. This estimate will have the same inaccuracies as those mentioned in Section 8.4 (i.e., higher occupany vehicles emit more pollutants than low occupancy vehicles, and emissions are higher on highly congested roads than on less congested ones). Again, the effect of the first is probably negligible and the second is offset to some extent by the fact that car pooling may reduce the emissions of other vehicles on the road by reducing congestion.

Reductions in Congestion. Each time a car is removed from traffic, all other users benefit by a small reduction in travel time due to the reduction in volume of traffic and consequent increase in operating speed, while individual savings may be negligible, the summation of time savings for all drivers can be considerable for the elimination of only one car from traffic. Sen, et. al., (1977) have suggested a method for estimating the summation of time savings. They use estimates from the C.U.T.S. Manual (1973) of variations in speed with changes in the volume-capacity ratio and the formula

$$-\frac{V\,dT}{dV} = rs^{-2}\frac{ds}{dr} \qquad (2)$$

where

V is volume in vehicles per hour
T is travel time in hours
r is the volume-capacity ratio
S is speed in m.p.h.

$-V\frac{dT}{dV}$ is an estimate of the time saved per mile by all the users of a road when one car is removed. It will vary with the type and location of the road and the level of congestion.

In addition to reducing travel time, removal of one car from the road will also reduce the fuel consumption of the remaining road users by increasing their speed. The total amount of fuel saved can be estimated with the formula

$$- \frac{VdF}{d} = \kappa r s^{-2} \frac{ds}{dr} \qquad (3)$$

where

F is fuel consumption in gallons per mile,
κ is a constant

$- V \frac{dF}{dV}$ represents the summation of the fuel saved by the remaining users of the road when one car is removed.

A reasonable estimate of k is .7607. The derivation of formulae (2) and (3) is presented in Appendix E. A table developed by the authors is also presented in the appendix for quick reference.

Exhibit 8-1

Savings for Individual Car Poolers in Various Sized Car Pools over Single Occupant Autos for Work-Trips of Varying Lengths

Trip Length (Miles)	Savings (Without Parking) Passenger Per Car 2	3	4
10	$1.08	$1.44	$1.64
20	1.86	2.48	2.76
30	2.53	3.30	3.81
40	3.12	4.16	4.68
50	3.62	4.84	5.44
60	4.14	5.52	6.21
70	4.58	6.12	6.88
80	5.04	6.72	7.56
100	5.90	7.90	8.85

Exhibit 8-2

Annual Parking Savings to Employers

	Total Investment	Construction & Operation	Operation Only
Surface Parking			
Per Employee Who Car Pools	$ 96	$ 53	$10
Per Car Pool Formed	$282	$155	$30
Structure Parking			
Per Employee Who Car Pools	$272	$230	$15
Per Car Pool Formed	$801	$675	$45

Source: Shallbatter and Herz'org (1975)

Exhibit 8-3

Trip Length and Number of Automobile Work Trips Related to City Population

City Population	Trip Length (miles)	Automobile Work Trips Per Capita Per day
Under 250,000	7.4	0.40
250,000 - 500,000	10.1	0.35
500,000 - 1,000,000	8.1	0.35
1,000,000 - 2,000,000	8.4	0.28
2,000,000 - 3,000,000	9.7	0.28
Over 3,000,000	11.3	0.30
Weighted Average	9.3	0.39

Source: Program To Promote the Availability and Use of Car Pools, Van Pools, and Public Transportation (1976), Instructions provided to States by FEA for preparation of State Energy Conservation Plans.

Exhibit 8-4

Distribution of Car Poolers by Trip Length in Selected Cities

Hollywood Freeway, CA[1]

Trip Length (miles)	Car Poolers	Non Car Poolers
>5	3%	5%
5-9	9	16
10-14	19	26
15-19	22	22
20-24	21	15
25-29	17	10
30+	9	2

Boston, MA[2]

Trip Length	WBZ/ALA PROGRAM Pooler	Base Line Pooler	Total Commuter Trip-Length Distribution
0-4	6%	8%	22%
5-9	20	16	21
10-14	18	20	18
15-19	17	24	12
20-29	24	26	15
30-39	10	30	6
40+	5	19	3

San Diego, CA[3]

Trip Length	Car Poolers	Non Car Poolers
1-5	4%	9%
5-10	12	19
10-15	34	28
15-20	27	21
20-25	14	11
25+	9	12

Houston, TX[3]

Trip Length	Car Poolers
1-5	14%
5-10	30
10-15	24
15+	31

Milwaukee, WI[3]

Trip Length	Car Poolers
1-3	21.0%
4-6	20.0
7-9	16.0
10-12	16.0
13-15	9.2
16-18	5.4
19-21	2.9
22-26	5.1
27-31	1.0

Monroe, LA[3]

Trip Length	Car Poolers
1-4	51%
5-10	16
10-25	25

Sacramento, CA[3]

Trip Length	Car Poolers
1-5	5%
5-10	22
10-15	25
15-20	16
20+	32

Sources: [1]Voorhees, 1973, #4.
[2]Heaton, 1976.
[3]FHWA Demonstration, Appendix A.

Exhibit 8-5

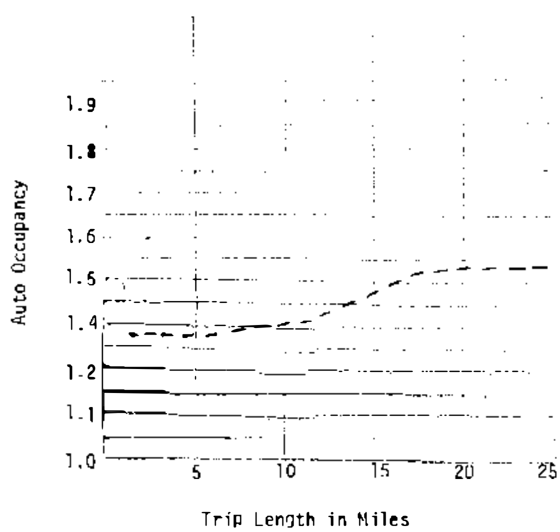
Auto Occupancy vs. Trip Length

Trip Length in Miles	Persons per Car 2 %	3 %	4+ %
0-5	43	29	14
5-10	19	43	14
10-15	21	06	35
15+	18	22	37

Source: Kendall, 1975 ([illegible]).

Exhibit 8-6

Auto Occupancy as a Function of Trip Length for Car Poolers in Hartford, Connecticut



Raw Data

Trip Distance (in miles)	Auto Occupancy
5	1.28
10	1.32
15	1.38
20	1.44
25	1.42

Source: Zevin, based on 17,363 vehicles.

Exhibit 8-7

National Auto Occupancy vs. Trip Length	
Trip Length (Miles)	Occupancy
.5	1.3
.5- 2.9	1.4
3.0- 5.9	1.3
6.0-10.9	1.4
11.0-15.9	1.4
16.0-20.9	1.7
21.0-30.9	1.7
31.0-40.9	1.5
41.0	1.6

Source: NPTS, 81.

Exhibit 8-8

Baseline Distribution of Car Poolers to Vehicles

	Occupancy			
	2	3	4	5
Milwaukee[1] (561,000)	.60%	.27%	.083%	.036%
FHWA[3]	.69	.19	.07	.03
TSC[4]	.76	.17	.05	--
NORC[5]	.65	.19	.11	.05
Chicago[2]	.60	.27	.076	.044
Pittsburgh[2]	.52	.21	.173	.087
Sacramento[2]	.651	.247	.06	.04

Sources: [1]FHWA Demonstration, Appendix A.
[2]Peat, Marwick and Mitchell and Market Facts, Inc., 1976.
[3]U.S. DOT, 1973 (4).
[4]Anderson, 1974.
[5]Kendall, 1975.

Exhibit 8-9

Distribution of Car Poolers Following a Car Pool Program

	Occupancy			
	2	3	4	5
Portland[1] (403,600)	.518 %	.269 %	.13 %	.06%
Monroe[1] (46,155)	45	.33	.167	.042
Milwaukee[1] (561,000)	52	.27	.134	.074
Aerospace[2]	.24	29	.23	14
GM[3]	.56	.26	.12	.02

Sources: [1]FHWA Demonstration, Appendix A.
[2]Bush, 1975.
[3]Horowitz, 1976.

Exhibit 8-10

Average Occupancies After Car Pool Programs

Omaha, NB	3.0
Salem, OR	3.0
Boise, ID	2.57
San Diego, CA	2.93
Houston, TX	2.7
Louisville, KY	2.62
San Antonio, TX	3.0
Milwaukee, WI	2.76
Sacramento, CA	3.2

Source: FHWA Demonstration, Appendix A.

Exhibit 8-11

Mileage Related to Vehicle Occupancy

Occupants	Miles/Gallon
1	12.3
2	12.0
3	11.6
4	11.0
5	10.0

Source: U.S. FEA, 1976

Exhibit 8-12

Frequency of Ridership

Milwaukee, WI[1]	85% of applicants to car pool programs rode 5 days per week.
Houston, TX[2]	93% of program participants rode 5 days per week.
Hollywood Freeway, CA[2]	68% of survey respondents rode 5 days per week.

Sources: [1]FHWA Demonstration, Appendix A.
[2]Voorhees, 1973, #4.

Exhibit 8-13

Reported Diversion Rates From Single Occupant Automobiles to Car Pools

Place	Diversion of New Car Poolers From Single Occupant Automobiles
Omaha, NE [1]	80.0%
San Diego, CA [1] (County)	74.0
Houston, TX [1]	52.0
Boise, ID [1]	67.0
Milwaukee, WI [1]	62.0
Salem, OR [1]	92.5
Pittsburgh, PA [1]	
CBD[1]	14.3
Non-CBD	59.1
Sacramento, CA [1]	57.0
Boston, MA [2] (Eastern, MA)	75.0
WBZ/ALA[2]	66.0

Sources: [1]FHWA Demonstation, Appendix A.
[2]Heaton, 1976.

CHAPTER 9: FUNDING

At this writing, there are two major sources of funds specifically available for car pool programs: the Federal Highway Administration and the Federal Energy Administration. The requirements for each are discussed briefly below.

The Federal Highway Administration. The Federal-Aid Highway Act of 1976 allows states to use monies apportioned under Section F 104 (b) and (6) of Title 23, U.S.C., for demonstration projects that will increase the use of car pooling in urban areas. The majority of programs discussed in this manual have been funded from these monies. Activities eligible for funding through this Act have been broadly defined with few specific requirements. The complete regulations have been published in the June 25, 1976, Federal Register. Highlights are presented below:

> Federal-aid primary system and urban system funds may pay 90 percent of the cost of car pool demonstration projects including van pool projects. The normal federal share for primary and urban projects is 70 percent, and the 90 percent federal share provides a bonus to encourage states to participate in the program.
>
> It is FHWA policy that federal-aid highway funds do not participate in car pool or van pool projects that attract a substantial number of persons who use public transportation. The metropolitan forum for coordinating the development of ride-sharing projects with public transportation operators is the M.P.O.
>
> The maximum federal share for a single demonstration project is $1 million; however, there is no limit on the number of projects within a state.
>
> Projects shall have the concurrence of the metropolitan planning organization, clearance by the A-95 agency in accordance with local procedures, and provisions for project evaluation.

Eligible costs for a car pooling program include:

1) Systems, whether manual or computerized, for locating potential participants in car pools or bus pools and informing them of the opportunities for participation.

2) Work necessary to designate existing highway lanes as preferential car pool lanes or bus and car pool lanes.

3) Traffic control devices necessary to advise motorists and control the movement of car pools.

4) Signing of, and minor modifications to, publicly-owned facilities to provide preferential parking for car pools.

It is important to understand that these funds are not "new" or additional funds to the state. Rather, they are existing funds which are regularly allocated to states to be used for a wide variety of transportation (mainly highway) projects. A car pooling program may face severe competition from other state and local projects in actually getting funded. It can become a priority question of which is more important: road construction for a highway link carrying thousands of passengers daily or a car pooling program? The process for incorporating a car pooling program into the planning/programming, and ultimately grant application process has been discussed in Chapter 10.

Futher, it should be clearly understood that the programs are funded on a demonstration basis for one or two years only. If the program is expected to continue beyond this time, other sources of revenue will have to be used. Further information on FHWA funding for car pooling can be obtained from:

Federal Highway Administration
Urban Planning Division (HHP-26)
Washington, D.C. 20590

<u>The Federal Energy Administration</u> (FEA). The FEA through the Energy Policy and Conservation Act has made a car pool/van pool program a required element in State Energy Conservation Plans. The minimum criterion for meeting this element is fairly broadly defined and can include promotion of public transportation as an alternative. During FY 78 these plans were in part funded with FEA funds.

CHAPTER 10: THE ORGANIZATIONAL STRUCTURE OF A LOCAL AREA-WIDE RIDE-SHARING PROGRAM

10.1 Introduction

It has been our observation that one of the factors contributing to the success of an area-wide car-pooling program is how well the program is organized to effectively attract and use the various resources of the community. In this chapter, we present some guidelines for organizing a "community" car pool program. Exhibit 10-1 presents one possible time phasing of these activities.

We begin by suggesting some criteria for selecting a "lead" or local sponsoring agency and discussing the pros and cons of four potential sponsors: private company, government agency, local transit operator, and civic organization. The selection of the sponsor will depend on local conditions. We then discuss coordination of the various community resources in both the planning and implementation of the ride-sharing program. We conclude with some suggestions on the internal organization of the full-time ride-sharing staff and some rules-of-thumb for staff sizing.

10.2 Selection of the Sponsoring Agency

There are precedents for numerous kinds of ride-sharing sponsoring agencies. Usually the more successful programs involve cooperative efforts of several groups with one group acting as "lead" agency. Below, we suggest a number of criteria which may be considered in the selection process:

1. The organization must facilitate and encourage private employer commitment to ride-sharing. That commitment should include public support, manpower, and funding.

2. The structure of the organization should allow easy coordination with ongoing transportation planning and implementation activities.

3. The organizational structure should easily accommodate, seek, and make efficient use of, donated financial support and manpower from local civic and service organizations, and business leaders.

4. The organization should be highly visible especially to the media and the general public. It should give the impression of solidarity and continuity--not a "fly-by-night" fad.

5. The organization should be client/service oriented--easily accessible and responsive to the public at large, as well as local employers.

6. The organization should have the ability to interact successfully with legislative bodies to improve, through legal measures where appropriate, the ride-sharing environment.

Below we consider the advantages and drawbacks of four possible lead agencies in light of these criteria.

The Private Sponsor. Private ride-sharing sponsors might include the local radio broadcaster, a public service project by a very large local industry, or a private profit-making or non-profit group specifically in the business of organizing car pools.

A private group often has the advantage of drawing on an existing and often client-oriented business structure. The start-up costs for comparable support would be prohibitive. For example, when a radio station sponsors the program, an entire promotional organization (including airtime) is in place. Business contacts are immediate since many are already advertising clients. The Northern Natural Gas Company in Omaha began a car pool campaign which later was adopted by service organizations. But in its infancy, it had the planning and organizational expertise of executives, the overhead support of a large organization and the business contacts necessary to promote the program.

A privately sponsored ride-sharing program structure has the important advantage of being able to attract, and efficiently use, donated funding and manpower. Historically, private business has been reluctant to "donate" to government; nor has government been able to receive such donations. It was this fact principally which caused CALTRANS to set up the non-profit Commuter-Computer in Los Angeles.

A non-profit group was created with loaned government and private industry personnel, and joint government and private industry funding. However, without some kind of joint sponsorship, such as has been done in California, a private organization may suffer from a lack of official status. It may not become a truly community-based project, and will probably have difficulty becoming a part of the transportation planning process. There may also be a lack of continuity since the program exists at the pleasure of a private company.

It should be noted in passing that there have been a large number of for-profit matching services, most of which have failed or have been able to provide only limited service because of very limited funding.

Government Agencies. Since federal funding for ride-sharing has become available, government sponsorship of such programs has become increasingly common. Sponsors range from local councils of governments, metropolitan planning organizations, street departments, and state DOTs. Government agencies generally have the significant advantage of funding; they are generally recognized as "official" and tend to mount a community-wide campaign. A government agency also has contacts within other governmental units and sometimes the power to coordinate community ride-sharing efforts and ensure that ride-sharing is included in the planning process.

Although a government agency has the needed organizational back-up for a ride-sharing effort, it may suffer from being "ad-hoc" (EPA, 1974) consisting of personnel loaned from various departments for the project with only one or two specifically hired for the ride-sharing project. This, in itself, is not a tremendous barrier except that government is notoriously not client-oriented. It tends to conform to policy guidelines rather than retain a flexibility to respond to the needs of a particular situation, and its employees usually do not have a sales orientation. These problems do present a serious threat to program success. Further, as noted earlier it is more difficult for government to elicit and use privately donated support whether it be manpower or dollars.

Despite these drawbacks, there have been several successful government or quasi-government sponsored programs. The brokerage concept in Knoxville, Tennessee represents a particularly innovative approach. A ride-sharing department has been created within the city government's infra-structure (see Exhibit 10-2) to match trips on demand to the "best" (based on convenience, cost, service, etc.) means of transportation available whether it be bus, taxi or ride sharing. One factor in the program's success is that operations are handled out of the local university where there is a strong marketing orientation and where there is little public perception that it is a "government agency". A similar route was chosen by the Mass Pool Program in Massachusetts, where the entire operation was contracted out to a consulting firm which actually ran the operation. The State Department of Transportation in California has had reasonable success in running their own state-wide operation by decentralizing the operation and making a major effort to incorporate local community leaders.

Service Organizations. Service organizations such as Jaycees, Rotary Clubs, etc. have successfully sponsored a few ride-sharing operatings and have been an important force in many others. Service organizations have the clear advantage of donated (often very high level) management and marketing expertise. Further, many of their members are the very business leaders, who must be contacted to encourage ride-sharing among their employees. Unlike any other sponsor, the membership of these organizations cuts across the community spectrum, and thus with whole-hearted support they have the best potential of creating a "ride-sharing bandwagon". There is significant risk, nevertheless, in relying on these organizations as a lead sponsor. The work is volunteer and thus may not be as dependable. The loose organization structure makes the chance of a long-term commitment to a ride-sharing operation rather small.

Local Transit Operator. Although there have been no well publicized attempts to use a local transit operator, these agencies have some significant advantages. First, the benefits of additional funding, staffing, etc. associated with the car pool program will come to an organization that might otherwise suffer (however slightly) from the ride-sharing promotional effort. Second, the operator can effectively coordinate all ride-sharing and public transit marketing efforts. A transit agency may not otherwise have the opportunity to hire a marketing staff solely to make presentations to employees on ride-sharing options (including the bus). Third, the transit operating agency is to an extent, client-oriented. Its whole business is moving people, thus it should be able to provide good administrative and organizational back-up. It seems reasonable, for example, that if a telephone information service exists for public transportation it could be expanded to include dial-in matching.

10.3 Coordination of Actors in Planning and Implementation

No matter which group is eventually chosen as a "lead" or sponsoring group there are many actors who must be actively coordinated in both the planning and implementing phases.

Planning. Many of the federal funds available for ride-sharing require the ride-sharing program to be included in the 3-C transportation planning process. Not only is this planning a necessity for obtaining FHWA, it has the advantage of coordinating long term ride-sharing programs with other planned transportation investments. The steps involved in incorporating ride-sharing into the planning process were outlined at a National Car Pool Convention (U.S. DOT, 1975, #24) in Dallas. A summary is presented below:

Most transportation planning functions center around the Metropolitan Planning Organization (MPO). The Unified Work Program is a key part of the process, and it is essential to get car pool programs included in it if the programs are to be funded with FHWA funds. The Unified Work Program describes the annual planning activites which must incorporate among other things: 1) consideration of social, economic, and environmental effects; 2) coordination with air quality planning; 3) consideration of energy conservation; and 4) technical elements including an evaluation of alternative transportation systems management improvements, and implementation programming.

Usually the Unified Work Program for a jurisdiction is prepared so that all the prospective funding is committed for several years in advance. All projects on that program are there because they have been proposed by strong advocates. The car pool project's rationale of seeking to increase car occupancy and reduce vehicle miles traveled will probably not be immediately understood and/or accepted. Rather, it will require a major change in philosophy by decisions-makers at the local and regional level. That change will be aided by the new UMTA/FHWA TSM requirement, now a required part of the planning process, which specifically includes ride-sharing activities as an option. The projects recommended for implementation from the TSM element should be included in a Transportation Improvement Program (TIP).

Being included in each of these planning phases will not necessarily guarantee coordination and cooperation, but it will make the car pool program "legitimate', facilitate the transportation decision-making process, and increase the likelihood of funding on a continuing basis.

Implementation. Coordination for the actual implementation of the project involves a wide range of actors, including the business community, civic organizations, the media, public officials, and public agencies. The general attempt is to capitalize on each group's strengths and resources to mount a broad-based, united effort to persuade solo drivers to change their habits for the good of the community.

One coordination technique that has been used effectively is the Ride-Sharing Advisory Board--which serves as a resource and policy coordinator for the actual ride-sharing operation. If possible, the board members should be appointed by the governor or mayor in a highly publicized manner and should be top level representatives of the industrial community, various public agencies and elected officials, service groups, public transportation executives, and the media. Care should be taken in selecting the board to choose dynamic leaders who personally endorse the program and who will be willing to help obtain enthusiastic support from the sector they represent. Though this group is supported by the actual organization staff, the community's efforts represented by the board might be coordinated in a manner similar to that diagrammed in Exhibit 10-3.

10.4 Internal Organization of Full-Time Ride-Sharing Staff

Exhibit 10-4 diagrams some of the functions necessary in a ride sharing organization. The chart does not necessarily represent the optimal internal relationship since organizational lines are probably best worked out with the personalities and particular emphasis of the individual programs. These functions are detailed below:

Program Director/Coordinator. The primary function of this individual is in coordinating the efforts of his own staff and other community groups. The individual should be a dynamic, effective spokesman for the program--preferably with good community and business contacts. He/she should be of a stature that can gain easy access to top management.

Administrative Services. This function is primarily administrative, the principal effort aimed at the smooth functioning of the internal organization. In a large organization, these functions may require a full-time middle or lower level management person. In smaller groups, the functions could probably be handled by a good executive secretary/administrative assistant.

Public Information. The primary function of this individual is in dealing with the media, community groups and various aspects of the public. This individual will handle the advertising campaign, arrange for talk show appearances, periodically write press releases, coordinate various publicity stunts (e.g., the "commuter race" done by WBZ/ALA), etc. He/she should be supported by, and coordinate donated, creative help from, the various media and advertising agencies.

Computer Matching Services. Installing, de-bugging, adapting, and testing the matching program can be a full-time effort for a month or so and requires the expertise of a good programmer. Unless this level of expertise is available on a volunteer basis it is probably worthwhile to bring in a consultant. Once the program is installed and tested, a less technically skilled programmer can make the periodic match runs as required. It is not unreasonable to expect that this part-time programming help could be donated by an agency or business with an established computer staff.

To some extent, the entire operation hinges on efficient matching. A faulty program or one that "breaks down" or is not sufficiently adapted to the unique needs of the locality can severely undermine the marketing effort. We recommend that the consultant and the person who will eventually operate the program on a continuing basis participate in the selection of the matching program.

Client Services. The size of this group will vary directly with the expected number of applications and with the level of service the program expects to provide the client (see Chapter 11). The basic function of this group is to prepare applications for matching, including geo-coding (unless there is a compelling reason to do otherwise, we suggest geo-coding applications in house), checking for missing information, and arranging for or doing the keypunching. Where very small companies request destination-based matching, this group might also provide hand matching. Once matching lists are mailed out, the group may be responsible for doing a random follow-up survey to see if pools were formed, if the matchlist was adequate, and/or if the program could be of any further service. These functions can generally be performed by secretarial/clerical type personnel. We estimate, based on Commuter-Computer statistics, that one of these persons can handle about 3,000 applications per year. In some organizations where budgets are very tight and/or there is good service club support, these functions might be handled by a group of service club volunteers.

Marketing Services. The primary function of this group is "selling" ride-sharing generally to companies and their employees. The rate at which the staff can make their presentations and "enroll" companies in ride-sharing depends on the level of services the program intends to provide each client (see Chapter 11). Commuter-Computer, which provides a mix of the so-called "turnkey" and coordinator-type strategies (see Chapter 11), estimates that one marketing representative can make about 16 contacts a week (some of these contacts may be repeat visits) and can "enroll" about 3 companies per week. Omaha has reported that one of their marketing teams can make about 60 contacts per month.

If it is planned that a ride-sharing operation will be a permanent effort within the community, the size of the marketing staff should be planned with a realization that there will be an initial "sales" effort, then a good maintenance operation in which marketing representatives follow up on companies for re-surveys and re-matching where necessary with occasional promotional presentations.

The staff chosen for this function should exhibit the qualities of good salespersons and should be able to gain access to higher levels of management. This staff does not necessarily have to be a full-time staff. The work can be done by well-trained, conscientious volunteers. The Knoxville organization has had considerable success with hiring retired upper management individuals on a part-time basis. Davis reports they are an enthusiastic, excellent sales force and are comfortable with presidents of firms.

Exhibit 10-1

Time Phasing

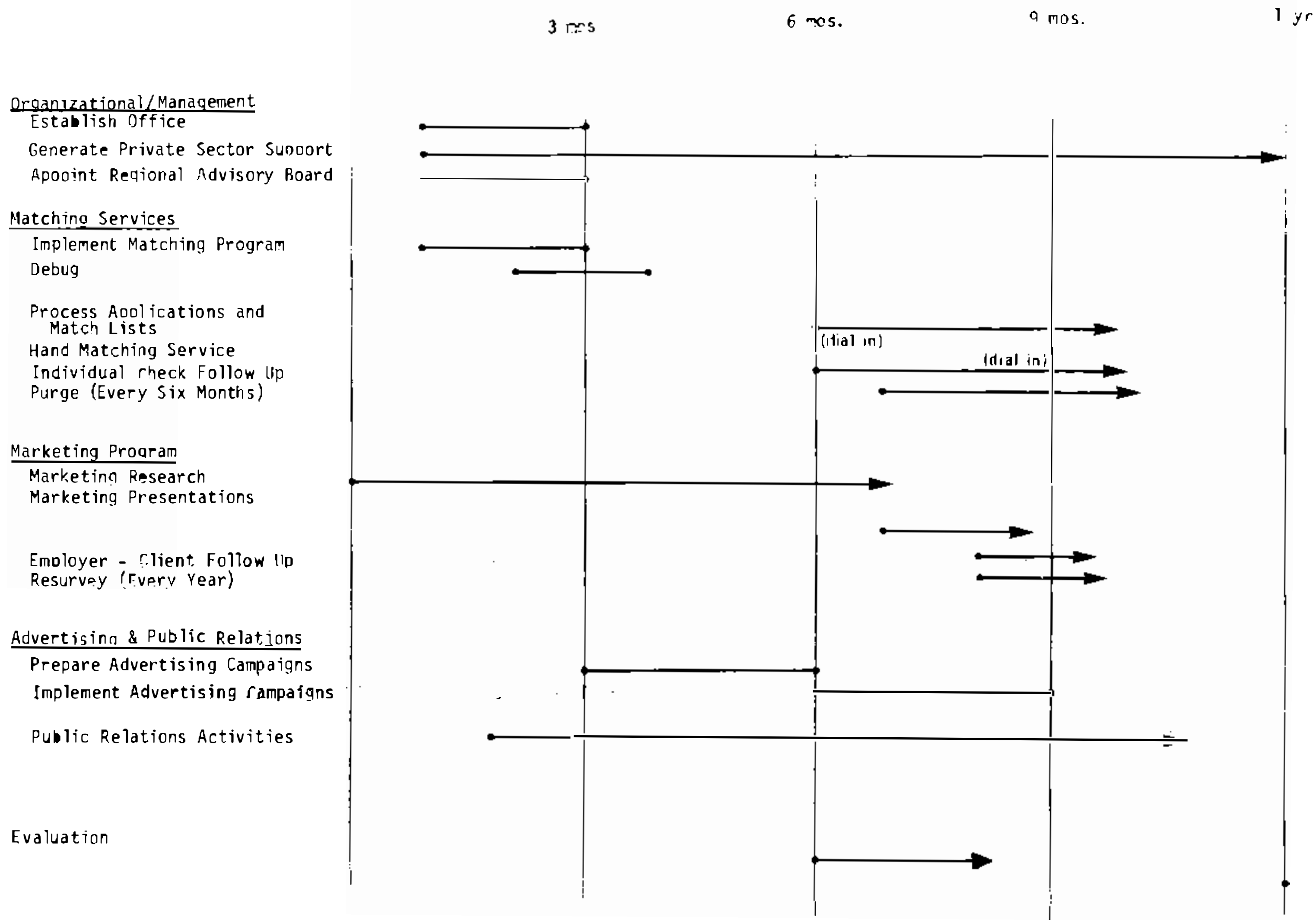
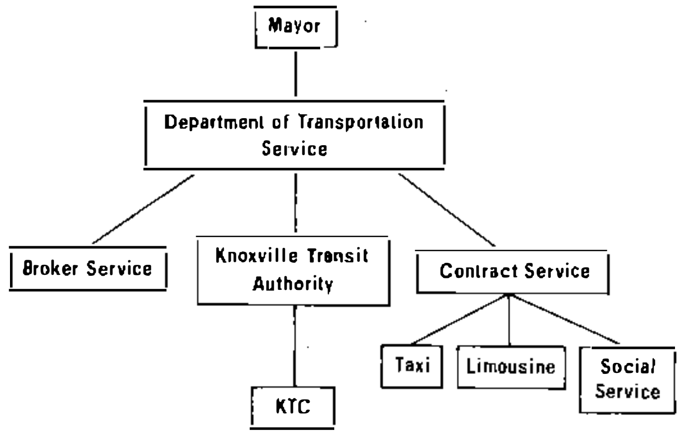


Exhibit 10-2

Organizational Chart of Knoxville Operation



Source: Private conversation with Frank Davis, University of Tennessee.

Exhibit 10-3

Suggested Coordinating Scheme for Ride-Sharing

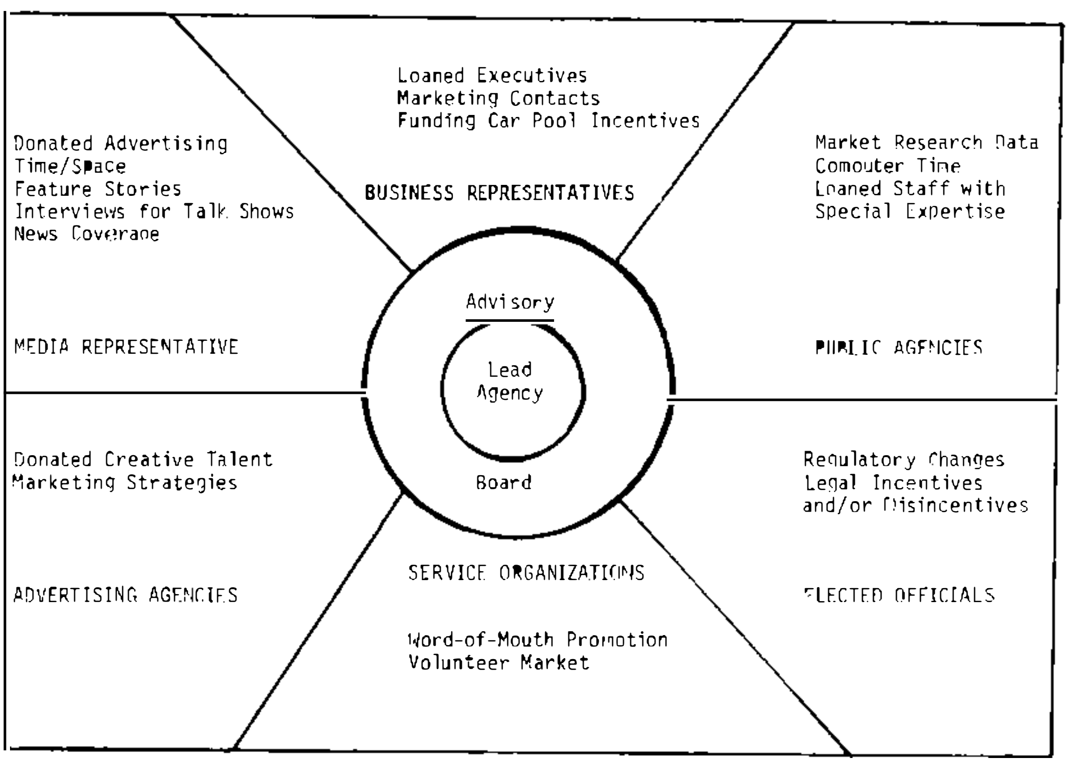
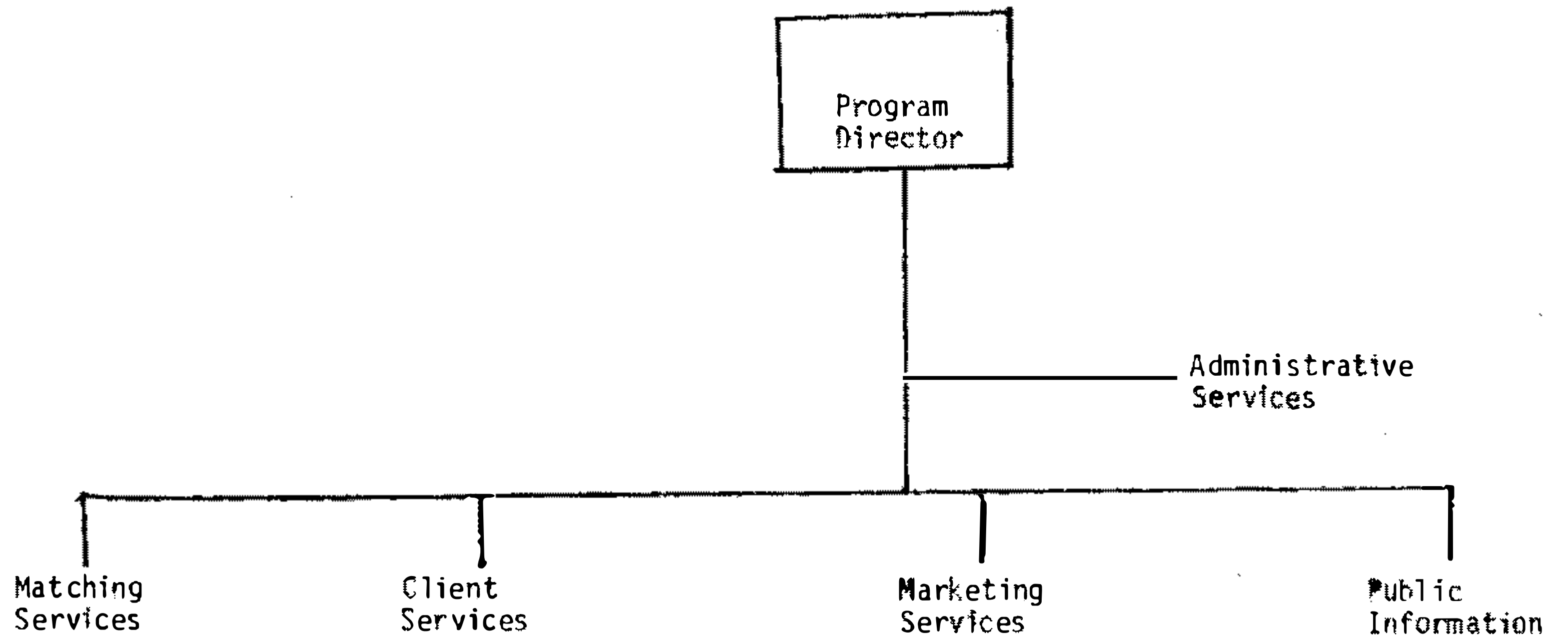


Exhibit 10-4

Model Organization



CHAPTER 11: ADVERTISING AND MARKETING CAR POOLING

11.1 Introduction

Evaluations of several car pool programs indicate that good marketing and advertising are crucial to program success. However, if it is done effectively, marketing and advertising are expensive and that expense is often difficult to justify, particularly on government budgets. Moreover, if the marketing strategies are not carefully planned and timed, the most generous budget can be essentially wasted. It is our observation that of any element of the car pool program, marketing and advertising need the most detailed planning and highest level of expertise to keep costs down and ensure the maximum effectiveness of the money that is spent.

The switch from solo-driving to car pooling appears to be a two step rather than a one step process. That is, a commuter moves from being a solo driver and liking it to being aware that there is a reasonable and perhaps pleasant alternative, to actually finding a car pooling partner and car pooling. Accordingly, we distinguish between two types of car pool promotion: 1) "advertising" which is designed to "soften-up" the solo driver and make him perceive car pooling as a positive alternative; and 2) "marketing" which is a one-on-one sales effort designed to motivate the solo-driver, who may have been "softened up" by advertising, to car pool. Advertising is generally carried out through the media and directed to the public at large where marketing involves staff and promotion at the work site. Both provide a vital function and programs which have opted for only one approach have had poorer results than those which have used both. However, if a choice has to be made, the "marketing" approach has the potential of producing more immediate and measurable results.

In Section 11.2, we present a number of guidelines on structuring and advertising campaigns including discussions of ad content, media accessment, advertising timing, and cost. In Section 11.3, we discuss various marketing strategies and the kinds of appeals that may be made to both the employer and employee.

11.2 Advertising Car Pooling

The principal objectives of an area-wide promotional/advertising campaign are to:

1) <u>Provide Information about the Car Pool Program</u>
   Inform the public of the program, its purpose, how to participate, and the techniques that are being used (this should include information on security, privacy, and confidentiality of stored data).

2) <u>Present Car Pooling as a Positive Transportation Alternative</u>
   Present benefits of car pooling for both the individual and the community, as well as "images" of car pooling as the "thing to do".

While most of the advertising should provide some information about the local program, the main thrust is to change attitudes--to, in a sense, "soften up the potential pooler" for a direct marketing contact at his place of employment. The art of using the media to change attitudes is a highly developed one, and based on our evaluation of several programs, we stress acquiring the professional help of not only an ad agency but of a public relations firm which can get the kind of media "news coverage" the program needs. It is not unusual for either type of firm to take on one or two public service clients essentially free of charge.

Below we present some guidelines on creating the advertising message and using the various media to communicate that message. We conclude with some brief comments on timing and cost.

The Message. What is actually communicated in the promotional effort can be broken into two parts: 1) information about the program; and 2) the "persuasive" presentation of car pooling. Many advertisers suggest that the program should be linked with a logo which can associate any persuasive presentation immediately with the local program. The information aspect (which may be most appropriate for news stories, talk shows, and publicity stunts) should clearly explain the program objectives and strategies, how the matching works, what security is being used, and perhaps more importantly, how the individual citizen can get involved either in a car pool or in helping with the program.

The persuasive element of the promotion is aimed specifically at the solo driver. This message should (in rank order):

a) Diffuse the Negative Attitudes of the Solo Driver Toward Car Pooling.
b) Explain Individual Cost Savings of Car Pooling.
c) Make an Appeal for the Social Benefits of Car Pooling.

Diffusing Negative Attitudes. The findings of most psychological studies of car pool attitudes suggest that the advertising campaign must recognize and address the negative deterrents to car pooling--the perceived extra time, inconvenience and inflexibility. Horowitz and Jagdish (1976), for example, found that the negative perception of more time and inconvenience exceeded the positive perception of cost savings. The promotional information may point out that car pooling is not a life-long commitment (one does not have to car pool every day); that the passenger time can be used productively for reading, sleeping, etc.; and that car pooling generally takes only 5-7 extra minutes per day for over $600-700 in annual savings! Testimonials from former solo drivers at the executive or management level who are now car pooling may be helpful.

Cost Savings and Social Appeal. Counters to the negative perceptions of carpooling should be coupled with the positive individual and social benefits. ~~Many demonstration~~ projects have surveyed new car poolers to determine the reason behind their switch (see Chapter 5). One (but not necessarily the principal) motivating factor behind these switches was "cost." It is a fact that most people do not know how much they spend to drive and must continually be reminded of these costs. (One rather novel suggestion is the slogan, "You could split the bill if you car pooled," which could be printed on garage, insurance, and new car sales bills, and affixed to gasoline pumps). Besides these individual cost savings, it would appear from Chapter 3 that individuals are somewhat sensitive to the social benefits of car pooling, particularly the young middle/upper income male (Horowitz and Sheth, 1976). This sensitivity may become more acute as the country embarks on a nationwide energy conservation campaign.

The Medium. Where the car pool message is communicated will determine how much information is communicated to how many people. It will also determine the kind of person the car pooling information reaches.

While marketing specialists, either with an advertising company or with one of the media organizations, can provide more expert media penetration information pertinent to the locality, the summaries in Exhibit 11-1 present some relative measure of effectiveness of the various media. These results should be viewed cautiously, however, since what may have been very effective in one town may not have been well done in another area. For example, Baton Rouge, La. and Blair County, Pa. found well-placed billboards a particularly effective and inexpensive means of promotion, though this method scored poorly in other areas.

It is reasonable to expect some "free" public service radio and TV time. The quality of that time varies. A radio may take on the car pooling project as its "own" and really do an "extra mile" campaign, completely donating creative advertising talent and material. Some media people advocate allowing all media (e.g., all radio stations) to simultaneously promote one car pool system. Others contend that this is counterproductive arguing that when only one broadcaster has the rights to the publicity for the campaign, he will carry it out more vigorously, whereas, simultaneous support by all stations may quickly degenerate to a few perfunctory public service announcements each week. This decision, as well as other media decisions will have to be made locally.

Putting together an effective media mix--no matter how finely costed and planned, is ultimately an art which is dependent on a personal relationship with the media. A set of promotional workshiops at the 1975 National Conference on Area-Wide Car Pooling provided some helpful tips in putting together a media campaign which are excerpted below.

(a) Television Public Service. Public Service Announcements (PSA's) are one of the best public relations tools available to area-wide car pool programs. The Federal Communications Commission requires that each television and radio station commit a certain amount of unpaid time to "public service". However, the number of spots varies with each station and the choice is entirely up to the stations's Public Service Director. Thus it is practical in smaller areas to make the personal acquaintance of the Public

Service Director as the first step in obtaining public service production and time.

Most television stations are extremely cooperative both in scheduling air time and in donating production time for PSA's. If time and/or production budget is limited, then probably it is quite easy to utilize the national "Double-Up America" film advertisements available from the Department of Transportation dubbing in the local program name and phone number at the end of each. It is necessary to buy only one set and have one of the local stations transfer the filmed "spots" to video tape for use by other stations.

If there is a decision to produce local ads, these should be done under the direction of a professional for two reasons. First, Americans are used to seeing very "slick" professional ad production and copy. They can easily detect amateur work no matter how well done, and tend to subconsciously associate it with "charity" or a second-class product. Secondly, both television and radio stations are more likely to accept public service "spots" from a well-known ad firm and run them more frequently.

(b) Radio Public Service and Special Promotions. It is very helpful to have at least one radio station as an integral part of the car pool program. Many stations have an obligation to carry out major public service promotions and are the only medium that can reach the commuter who is trapped in congested traffic on his way to work.

Radio public service announcements have the same requirements as television. Production mediums differ with each station. Some stations will accept only brief :10 announcer copy and others use :20, :30, and :60 audio tapes. Again, if there is not time or money to produce local tapes, national ones can be used. Radio copy changes frequently because there is less production involved than for television, so new material should be sent in about once a month.

Besides these advertisements, special promotions may include: announcements of companies who have joined the car pool program, interviews with car poolers, and news and feature stories on the program's progress.

(c) Public Affairs and Broadcast Media News Coverage. Many times the public affairs interview shows are under the jurisdiction of the News Director, and in many cases there will be a producer for each different format. It is best to check with the station Community Relations Director or Public Service Director for a list of show formats and producers and prepare a copy to their requirements.

(d) Newspaper Features. Weekly or suburban newspapers are the most likely place for getting car pool stories in print. Most weekly newspapers do not use a wire service and print very little national or international news. They depend on local news to fill their pages. Various deadlines should be noted and stories personalized for the area the paper covers.

These stories are the best medium for the information element of the campaign. They can explain the way the program works, discuss how car pools are organized, present detailed analyses of the cost of driving and the savings of car pooling, etc. If well-known public figures (governor, major, senator) can be spokesmen for this information, their speeches are more likely to receive news coverage and the information may have added credibility.

Besides news and feature stories, editorials and letters to the editor are another way to keep car pooling before the public eye. Further, newspaper ad space may on occasion be donated. If the paper runs a feature story on car pooling, it might be a good idea to run the car pool match application in an ad.

(e) Fliers. Fliers of an informational nature or as actual applications for matching are relatively inexpensive to produce. However, distribution can be expensive if the U.S. Postal Service is used. Many programs have been successful in having fliers included in utility bills, paycheck envelopes or as hand-outs at shopping centers.

(f) Publicity Stunts. There have been a number of "attention" gimmicks used successfully for car pool campaigns. For example, some of the group"W" broadcasters have sponsored auto races down high density freeways at the peak of rush hour. Others have sponsored lotteries, "Car Pool of the Week" contests, and various mileage contests.

(g) Endorsements. One of the most effective and least expensive promotional tools is enthusiastic support from Public officials and other community leaders. The more these individuals can be involved in addressing service clubs on car pooling, participating in publicity stunts or talk shows, and the like, the greater will be the media coverage.

(h) Billboards. Billboards, especially when they have been placed on high volume freeways, have been at times very effective. The Pima Association of Governments in Tucson used billboards extensively in their car pool program and found them to be fairly effective in drawing dial-in applicants. Baton Rouge found that their twelve billboards coupled with commuting time radio announcements were the most effective elements of the advertising campaign.

Timing. A common suggestion from marketing specialists is that advertising and promotion are most effective if they are done in concentrated "doses". They should obviously be carefully coordinated with the marketing plans--always slightly preceding a new marketing effort.

Cost. Though penetration and audience should be important factors in choosing advertising strategies, the promotion budget will probably be a deciding factor. Promotion costs vary widely, and, depending on the level of community support, whole categories could be no cost at all. Thus the advertising/promotion budget and blend will be unique to each community.

11.3 Marketing Strategies

We are defining marketing strategies here to mean the various techniques or approaches a car pool marketing staff might use in initially contacting private companies to promote car pooling. Below we distinguish between two of the most popular approaches--the coordinator method and the "turnkey method"--and recommend, where resources permit, turnkey marketing. We conclude with some recommendations on marketing appeals to both employers and employees.

Two Basic Approaches. Two basic car pool marketing strategies have become popular. In the first, which we will refer to as the "coordinator approach", the marketing staff spends sufficient time with the company to get a commitment from top management initiating ride-sharing in their company. The company is then asked to appoint an employee car pool coordinator. The market representative may or may not train the coordinator. From that point on, however, ride-sharing in that company is the responsibility of the company coordinator. The market representative provides him with survey forms and matching assistance, but the follow-through is left to the coordinator.

In the other approach, which we will call the "turnkey method", the marketing representative makes an initial presentation to top level management to gain their commitment and also arrange for a ride-sharing coordinator. But the market representative stays with the company, making promotional presentations to employees and assisting with the surveying and distribution of matchlists. The latter method is obviously more effective since it takes much of the time commitment and promotional responsibility away from the companies. However, it requires a greater resource commitment from the ride-share staff.

The effectiveness of the turnkey approach has been demonstrated vividly by a pilot project carried out in New Orleans (FHWA demonstration). Two rather large employers were selected. In both, top management highly endorsed the car pooling program. However, for the first employer, the marketing team went into the organization and actively marketed car pooling, setting up organizational meetings and running the surveys. Over 40% of all the employees in this firm completed and returned their questionnaires. In the second firm, the team appointed an employee car pooling coordinator who had the responsibility of promoting the program, conducting the survey and organizing the pools. Although this firm had equally high support from its top management, only 3 questionnaires out of 2,000 distributed were returned.

Commuter-Computer in Los Angeles, which has used a mix of the strategies, has kept statistics on the effectiveness of each strategy. A selection is presented in Exhibit 11-2, again confirming the effectiveness of the turnkey method. If resources are not adequate to provide a full turnkey approach, a policy of providing turnkey services to those companies with a particularly large number of employees or a particularly lackluster coordinator might be used.

If the program is to be a continuing service of the city, we suggest that the marketing staff follow-up on company contacts every few weeks after the initial enrollment. This will allow for trouble shooting and then every six months for purging and re-surveying.

Marketing Appeals to Employers. So much of the success of the program is dependent upon upper level management that the strategies to gain this group's commitment must be well planned. First, the initial contact if at all possible, should not be made cold. Rather, the individual should be approach through a familiar, trusted source, such as the Chamber of Commerce, Rotary or the like. This is the value of initially enlisting the support of service organizations and civic groups. The targeted individual is probably a member of one of these organizations. In many cities, these civic organizations have undertaken substantial public relations campaigns in support of car pool systems among the firms represented by their membership.

In making the presentation, the unique problems of the firm should be studied in advance. Is the firm well served by public transportation? Is parking a problem? From where does the firm draw most of its labor force? The presentation should be as carefully tailored to the particular company as possible, pointing out such benefits as less congestion, parking savings, better company morale, and improved community relations. There is also the value of having a functional plan in the event of a gas crisis. Many firms are very conscious of community relations, particularly if their employees are largely from the inner city or from lower income groups. The public relations aspects of company car pool operations has been a basic incentive for the employers participating in the WBBM "Ride Together/Driver Together" system in Chicago. Firms receive mention on the air and in press releases, and consequently obtain free and favorable publicity.

The importance of top management support probably cannot be stressed enough. Management should be further encouraged to appoint an enthusiastic high-level ride-sharing coordinator who will carry out the program with the full support of the chief executive. Finally, the chief executive should be encouraged to institute car pool incentives such as priority parking, subsidized ride-sharing, etc. The Federal Highway Administration has a number of publications detailing various approaches for employers. They also have a number of brochures which may be useful in a presentation.

Appeal to Employees. Car pool appeals to employees are delivered by a program representative and/or company coordinator through a number of devices. Employers may be encouraged to ask employees to attend informal presentations or informational slide shows. Promotional brochures may be distributed and survey forms distributed and collected. Some employers (particularly smaller ones) may be unwilling to commit company time to public information presentations, but will encourage the distribution of informative materials (Omaha, FHWA demonstration, Appendix A). One rather effective technique has been to make employee presentations at lunch (or just after) with the employees seated at tables according to their Zip Code. This allows face-to-face contact with potential poolers.

Exhibit 11-1

Recognition Survey Results

List of Media	Boston[1] (N=4293)	Milwaukee[2]	Omaha[2] (N=137)	Boise[2] (N=129)
Radio Ads	67.00%	35.00%	8.00%	10.00%
TV Ads, Editorials	56.00	43.00	16.00	8.00
Newspaper Ads	34.00	24.00	--	19.00
Billboards	11.00	41.00	1.00	16.00
Magazines	6.00	--	--	--
Program Literature	--	--	--	3.00
Posters and Fliers	--	--	3.00	--
Relative, Neighbor or Friend	--	7.00	--	3.00
Employer Contact	--	53.00	8.00	35.00
Co-Worker	--	--	--	4.00
Public Speakers	--	0.12	--	--
Respondents Who Had Heard of the Program	--	--	53.00	84.90
Unaware of Any of the Above	--	0.37	--	--
Other	--	3.00	--	4.00

Sources: [1]Heaton, 1976.
[2]FHWA Demonstration, Appendix A.

Exhibit 11-2

Comparison of Marketing Strategy Effectiveness

Name	Type of Marketing Approach	Total Employees	Total Employees at Location	% of Regular Car Pools (Total Employees)	Employees Surveyed	Emergency Car Pools	Regular Car Pools	% of Regular Car Pools (Of Surveyed)	Van Pool Interest		Absolutely No
L.A. Flood Co.	Turn Key	850	450	18.0	231	220	157	67	128	55%	11
County Engineer	Turn Key	850	650	24.7	340	233	164	47	126	37%	NA
American Airlines	Turn Key	---	4,500	.7	71	45	35	49	29	41%	23
Union Oil	Company Coordinator	---	1,200	1.2	NA	15	15	1±	7		NA
St. Joe's Hospital	Company Coordinator	---	1,400	7.0	NA	109	108	7+	1		NA
Bendix	Company Coordinator	---	1,100	5.0	NA	60	123	NA	10		NA

Source: Commuter-Computer, 1977 (private conversation).

CHAPTER 12. INSTITUTIONAL BARRIERS TO CAR POOLING

In practice, there have been relatively few regulatory, insurance or other institutional problems associated with car pooling. This is true because of the informality of car pools and because car pool programs have to date not been viewed by any other mode as particularly threatening.

There have been, however, a number of jurisdictional and legal questions associated with various policies designed to induce car pooling. These we have discussed briefly in Chapter 5. Here, we focus on four areas which may present some problems in setting up a car pool program.

Incentives From Private Companies. Employer incentives for car pooling range from priority and subsidized parking to direct transportation reimbursement (see Womack, 1976; FEA, 1976, or EPA, 1974 for several examples). Most have been extremely successful. However, Berry (1975) relates a situation that could occur as car pool programs become more extensive and incentives more attractive. Greyhound in Phoenix offered fairly substantial parking incentives to employee car poolers. Some employees argued, however, that the subsidy discriminated against those who lived in areas where it was difficult to find other matches. The program director agreed and the subsidy was modified. Other employers have been very concerned that some incentives could be construed as coercion, leaving them liable in case of car pool accidents. Finally, some employers have been reluctant to use very extensive incentives for fear that provision of transportation could become a demand in labor negotiations. The logic of this position is not particularly clear since most employers have already accepted their responsibility to provide some transportation facilities by bearing all or part of the cost of parking.

Regulation. One of the criteria often used to determine the regulatory status (vis-a-vis the Public Utilities Commission or similar body) of a particular mode is whether or not the driver is compensated or receives some other "consideration" for his efforts. Drivers of private automobiles clearly do not. However, car pooling often involves either compensation or "consideration" (as in rotating drivers). At times the compensation represents the passengers' portion of the full cost (including capital) of the automobile and thus is no different than a small van pool which is often regulated (see Report 3). Nevertheless, there have been few if any attempts to impose such regulations on a car pool. Womack (1976) reports that no state in his rather extensive survey has interpreted Public Utilities Commission legislation as affecting car pooling.

Confidentiality. Confidentiality or security of employee records constitutes another issue in car pooling. Many employers have been reluctant to release personnel records or survey information to a central matching service for fear of disclosing "private information". This argument too is difficult to understand since the information involved is little more than that published in a telephone directory. The employer or matching agency is responsible, however, for the confidentiality of these data, and some measures must be instituted to limit kinds of data collected, access to them, and kinds of data released for matching purposes. This should help to allay fears related to personal privacy and information misuse.

Insurance and Increased Liability. A concern of many drivers and insurance companies is the increased potential for claims against the liability policy of a car pool driver. Claims could be made against that policy by the car pool passengers in the event of an accident. Two different issues are considered below: (1) the two ways a car pool driver increases his liability; and (2) the way insurance companies handle these increased risks.

(a) The Concentrated Liability of a Driver. The driver of a car pool vehicle increases his potential liability in two ways. The first is obvious. If he is involved in an accident where he is at fault, he can not only be sued by the occupants of the other car but by his car pool passengers (all often heads of households). Second, since he is involved in a car pool where compensation or consideration exists, he cannot use a "guest status" defense against passenger claims, and the degree of negligence that a car pool passenger must prove is less in many cases than for other passengers. In some 27 states which have guest statutes, a passenger in a private non-car pool automobile ordinarily has very little recourse against the driver unless he can prove "willful and wanton negligence" (sometimes called gross negligence). The passenger is considered a non-paying "guest" who has knowingly "accepted a ride from the driver". In states without guest statutes and in all situations where there is "consideration" or payment on the part of the passenger for the ride (as in the case of either shared-cost or shared-driving car pooling), the driver is required to show the ordinary caution of a prudent person. The passenger, in order to claim liability, must simply prove negligence. Since car pooling generally involves some sort of exchange, it seems clear that it is this ordinary degree of care which would be required of drivers. See Houghtaling vs. Davis (1959, 140 Colo. p. 327. 344 p. 2d 176 where the plaintiff had paid her driver $1.50 each week "to apply toward the gas" in exchange for regular transportation to and from work. In affirming judgment for the plaintiff against the driver, the court noted: "The duration of the relationship between (the parties), the regularity of the transportation provided, and the regular receipt...of the agreed payment (were) inconsistent with the claim that (plaintiff) was a 'guest'...").

(b) Insurance Premiums. Since car pooling (shared-cost) concentrates the liability/exposure on one driver and reduces exposure for others, there has been some question as to how this affects individual insurance policies. If the car pool is of the shared-vehicle type, there is little, if any, problem. In fact, Womack (1976) found that there customarily is a car pool discount of about 10-15% (see Exhibit 12-1). For shared-cost car pools the premiums, in theory, should increase for the driver. In practice, most insurers have tended to classify all car pools as shared-vehicle regardless of whether or not they are. Recently, the Insurance Services Organization has "agreed to continue to ignore the additional passenger exposure which exists when a priavately-owned automobile is used as a pool vehicle," (Davis, 1975) and has essentially set the same rates as on an ordinary private policy. Womack (1976) notes that in no state did he find evidence "of insurers attempting to charge commercial vehicle rates for compensation car pools." In three of the states, insurance commissions have specifically addressed this issue and required that compensation car pools be charged no more than other private passenger vehicles. As a practical matter, however, it is generally recommeded that drivers of shared-cost car pools increase their bodily injury coverage in order to compensate for the greater potential claims in case of accident.

Competition With Existing Modes of Transportation. Probably one of the most significant barriers a local planner may encounter (besides public indifference) is the fear that a strong car pool program may compete with an existing public transportation system. FHWA regulations in fact explicitly state that federal funds cannot be used to promote car pooling where significant numbers would be drawn from an existing public transportation system. A local operator may argue that a car pool program would represent unfair competition, particularly if it is marketed heavily at CBD destinations.

Of all areas in ride-sharing policy, this and similiar questions of competition need research. We have virtually no hard facts on which to make a recommendation but we offer the following observations.

Johnson (1976) in her study of baseline pooling in Chicago found that the effect on public transit did not appear to be significant. FEA (1976) in a simulation of ride sharing strategies in the Washington, D.C. area found that ride-sharing would increase by 13.25%, but at the expense of 2.3 percent in transit ridership.

From present evidence it would appear that whatever the effect is, it is not large. This is because a promotion program is likely to affect only about .33% of all commuters (Chapter 6), and most of those, affected 66% will be former solo-drivers (Chapter 8). The energy savings in car pool programs come more from old car pools consolidating than from new pools (see Chapter 8). We further observe that car pooling may complement bus or rail service as train peak hour service is often strained beyond capacity. Car pooling may reduce the load somewhat making the rush hour ride more pleasant for everyone concerned.

Exhibit 12-1

Car Pool Insurance Status

State	Car Pool Discounts and Amounts
Arizona	No discounts required by law. Most companies offer lower premiums for autos not driven every day, but saving is offset by need for increased level of liability. Possibly no net saving for car poolers.
California	Discounts offered for vehicles not driven to work. Saving partially offset by additional liability coverage needed for car pool vehicles.
Colorado	10-15% liability discount for vehicles driven to work fewer days per week due to car pooling. Although increased liability coverage is recommended for car pool vehicles, the additional cost should not absorb much of the potential saving.
Florida	None.
Georgia	None.
Massachusetts	A discount is required by the state insurance commission. At least one company offers a discount of 10% on liability premiums for vehicles used in a car pool on a rotating basis. Purchase of higher liability coverage levels would absorb some of this saving.
Minnesota	Yes, for vehicles left at home altogether. No, for vehicles driven fewer days in a rotating car pool.
Ohio	Some insurers offer 10-16% liability discounts to car poolers who drive no more than two days per week. Discounts not required by state.
Oregon	Discounts of 12-33% on liability premiums are offered by insurers for reduced driving due to car pooling. No insurer, however, is required to offer discounts. State insurance commission has ruled that insurers cannot classify compensation car pools as commercial arrangements and therefore charge higher rates.
Pennsylvania	Some insurers offer discounts of 5-10% on liability premiums for vehicles left home because of car pools. No state requirements that discounts be offered.
Tennessee	Insurers offer a 25% discount on liability premiums for vehicles left home because of car pooling. However, if a vehicle is driven even one day a week, it is considered a work-trip vehicle and is ineligible for the discount.
Virginia	Some insurers offer discounts of 10-15% for car pool vehicles, provided the vehicles in question are not driven to work more than twice a week.

Source: Womack, 1976.

CHAPTER 13: MATCHING

13.1 Introduction

We have presented some evidence that suggests that matchlists may not be used extensively in the pool formation process. It is our conjecture, however, that bad matchlists (i.e., filled with inappropriate names) can damage the efforts of a car pool program. Thus, if a decision is made to offer matching services, the kind of program that is selected, and the way the data base is maintained is important.

The purpose of matching is to enable people who are interested in car pooling to contact others who are similarly interested. The concept is to send all interested persons a list containint names and a means of contacting interested individuals who live relatively close by, travel at similar times, and work in the same or similar location. The available matching programs meet these goals in varying degrees. The programs also differ in their ease of use and flexibility in meeting specific area needs. Each of these considerations should be considered in selecting a matching program for a particular organization/area.

In this chapter, we discuss the two basic approaches to matching: manual (Section 13.2) and computer (Section 13.3 and 13.4).

In discussing the computer-matching methods, our purpose is to introduce a perhaps unfamiliar area to the planner. We present an overview of the basic logic of matching programs and purging methods so that he/she can guide technical staff in selecting a program to meet the particular organization and/or geographic needs of the area. In Section 13.5, we have listed several sources for more detailed documentation of particular programs. We also recommend Douglas Peterson's "An Evaluation of Car Pool Matching Systems" (1974), for a comparative analysis of various programs. We have drawn heavily on this work in the sections below.

13.2 Manual Matching

An old manual technique is the use of a locator board. This usually consists of a map of the area on which grid co-ordinates may be superimposed. Either through coded pins stuck on the map at the place of residence or through cards corresponding to the home grid numbers, the necessary information is passed on to others. Such methods require little, if any, company staff time.

Another method is to hand match, using procedures similar to those used in computer programs. Information from survey forms is located on a map by staff and grouped according to home residence and work hours. Matching lists are then sent to those most likely to be able to car pool. Voorhees suggests that such manual methods are appropriate for fewer than 1,000 employees while larger firms should consider computer programs for larger numbers of employees (Voorhees, 1975, #5).

13.3 Factors Common to Matching Procedures

Spatial Compatibility. The heart of a matching system is the pairing of persons according to similar home and work locations. The pairing on both ends of the trip can be through fixed-area boundaries (conformant area) (see Exhibit 13-1). The conformant areas can be Zip Codes, Census tracts, or other geo-coded boundaries. Origins (or in some cases destinations) falling within either a common conformant (i.e., Zip Code) or non-conformant area (i.e., radius of one-half mile) are considered close enough to match for a car pool.

In addition to those persons falling into either the conformant or non-conformant area, some programs also include as potential matches, persons living between the origin and destination--particularly if those persons indicate that they are interested in always riding. This very valuable feature is contained in the most recent updates of the FHWA matching program.

Each method of matching has its strengths and weaknesses. The non-conformant area method is more precisely able to match those who live closest to each other since straight-line distances between locations are used. However, it requires far more precise geo-coding and thus greater data handling resources. The conformant area system has easier geographic location methods for input (i.e., Zip Code or Census tract number). It sufferes, however, from the build-in assumption that everyone living within a cell lives at the center of the cell. Two persons living across a boundary are treated exactly as those who live at the remotest points of two adjoining cells (see Exhibit 11-4 of Report 3). This lack of accuracy is compensated for by the fact that it is much easier to program for conformant area matching than for non-conformant matching. Conformant area matching also has the advantage in that the most likely route to work can be programmed while non-conformant area assumes a straight-line trip to work. This becomes important when accurate matching of those living along the work-trip route is desired. A final important consideration is that systems using the conformant area format are capable of handling a larger number of applicants than are systems using non-conformant areas.

Whether conformant or non-conformant area matching is used a very important ultimate consideration is the size of the matchlist and/or the size of the match area. That is, if the program is unable to find matches in the initial match area, does the program stop indicating no match? Or, does the program expand the area over which it searches for a match eventually finding a "match" although not particularly close? The trade-off is a lower match rate or poorer quality matches.

Temporal Compatibility. The purpose of temporal compatibility is to match only those people who have similar working schedules. A consideration would be days of the week that a car pool would be used, (unusual working days could affect the chances of a successful car pool). Another factor would be the actual work hours of the matches. Incompatible working hours reduce the chances for car pool formation. Car pooling programs which take this into account usually use 15 and 30 minute time windows. This matching factor can be active or passive. The passive method merely lists the work schedule next to the names on the spatial matching lists. The matchee may then decide what time "window" is tolerable. The active method would be to send only compatible matches to prospective car poolers. The hope is that while the number of potential matches is reduced by this process, those who are matched will be more likely to attempt and achieve successful car pools.

Personal Compatibility. Some programs have the option of including personal characteristics in the matching process in order to reduce the chances of incompatible car pools. A person's sex, age, martial status, or whether they smoked, for example, could affect the chance of a successful car pool. The assumption underlying this feature is that people are more comfortable with certain types of other people. They will therefore be more likely to carry through with car pooling efforts if they know that they will be matched with (only) certain character-types. These factors can be transmitted through the matching program either passively or actively. If it is done passively, there is a serious problem of information disclosure.

13.4 Updating and Purging Data Bases

Ongoing matching programs should periodically have their lists checked to see if those listed are still at the same address and still are interested in car pooling. Giving out lists of unavailable or uninterested people seriously compromises the credibility of the matching process. One method of purging and updating is the positive response approach where all data is purged on a periodic basis unless a person requests that his name be retained. The negative response approach is to keep all data unless the applicant requests that his name be removed. A third method is for all lists to be removed on a periodic basis and for a new survey to be taken. Each method represents a trade-off between having as many names as possible and the quality of the names listed.

13.5 For Further Information

The following is a list of contacts and their addresses from whom the reader may obtain literature describing the particular matching system.

FHWA

Federal Highway Administration
Urban Planning Division, HHP-26
Washington, D.C. 20590

The reader will receive a package containing several reports generally related to means of increasing vehicle occupancy. Reports particularly valuable for selection of a matching program are:

- Commuter Information System Overview
- Commuter Information System, City of Dallas Pilot Test

The following documentation for the FHWA Carpool Matching Program is available from the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22151:

- User Documentation for the FHWA Carpool Matching Program, NTIS # PB-258771
- Program Documentation for the FHWA Carpool Matching Program, NTIS # PB-258840/AS

Bureau of the Census (CARPOOL)

Bureau of the Census
Washington, D.C.

Washington COG

Washington Council of Governments
1255 Connecticut Avenue, N.W.
Washington, D.C. 20036

UCLA

Campus Computing Network
User Relations Office
Room 4903 Math Sciences Addition
University of California
Los Angeles, CA 90024

Connecticut Department of Transportation (ConnDOT)

Bureau of Planning and Research
Connecticut Department of Transportation
24 Wolcott Hill Road
Wethersfield, Connecticut 06109

Burroughs Corporation (Operation Energy)

Applications Software
Head Office
80 York Mills Road
Don Mills, Ontario, M3B 1X7

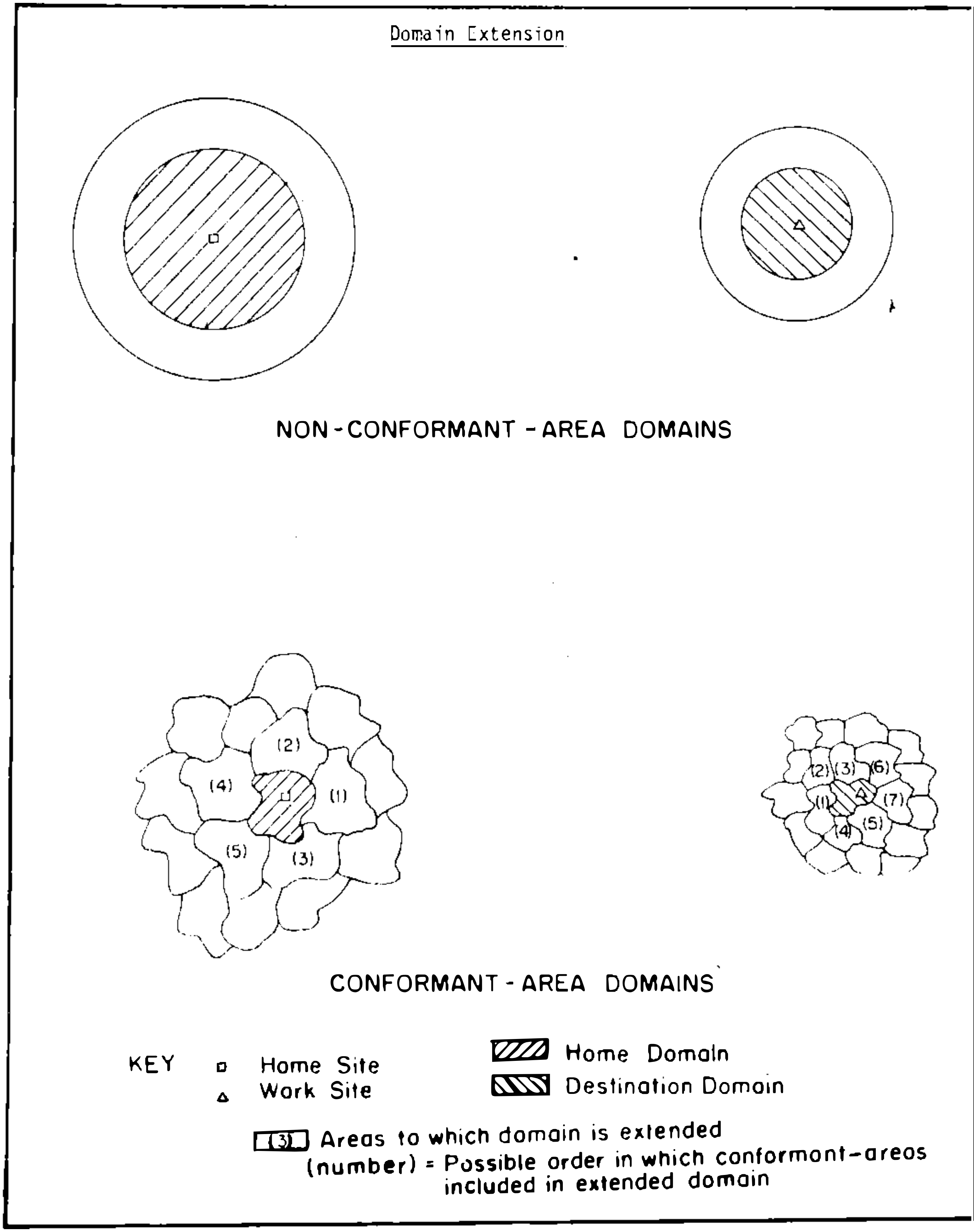
Group Five/CKOY

Group Five Consulting Limited
P.O. Box 4364
Station E, Ottawa. KIS 5B4

ETSIA

ETSIA Engineering
85 Range Road
Ottawa. Ontario, KIN 8J6

Exhibit 13-1



Source: Peterson, 1974.

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APPENDIX B

Car Pool Speeds

In order to determine D/L ratios for car pools, we assume average speeds for car pools given average traffic speeds; in other words, if a single-driver car will travel at a given speed along a route, at what speed will a car pool travel the same route?

At low average speeds (say, 15 to 2D m.p.h.), the actual stopping-starting time involved in picking up a passenger is no different than stopping for a stop sign and will show an imperceptible difference in speed. However, the one minute dwell time will significantly affect time.

For any given distance and average traffic speed, the average speed of a car pool can be calculated using the formula:

$$S_{cp} = \frac{D}{\frac{D}{S_a} + (L.F. - 1)t}$$

where S_{cp} = Average car pool speed

D = Total distance

S_a = Average traffic speed

$L.F$ = Load factor

and t = Dwell time per passenger = 1 minute

The effect of picking up a passenger is greater for a short trip than for a long trip. However, to simplify the subsequent calculations, we chose a mid-point of ranges of distances so that we could produce a matrix of speeds for two variables, average traffic speed (L.F. = 1) and load factor. The matrix is presented in Exhibit 6-2.

APPENDIX C

The Costs of Operating an Automobile

C1 Costs and Assumptions

Our primary sources for operating costs for automobiles were the U.S. Department of Transportation Energy Statistics (U.S. DOT, 1975 Bibliography) and The Cost of Operating an Automobile (U.S. DOT, 1976) The costs are based on a standard-sized car, driven an average of 10,000 miles per year (U.S. DOT, 1975). For a privately-owned car, there are no labor or administration costs as normally perceived.

Fuel. Fuel costs depend on the price of gasoline, the fuel efficiency of the car involved, and driving conditions (speed, terrain, temperature). For price, we have used the average 1975 price of $0.60 per gallon. For fuel efficiency, we have used 12 miles per gallon, which represents an average of cars on the road in 1975 and congested traffic as we are primarily concerned with the journey-to-work. According to Chase Econometrics, the average for all driving in 1975 is about 14 m.p.g. (see Exhibit C-1). A price of $0.60 per gallon at 12 m.p.g. yields a cost of $0.05 per mile.

Maintenance. The cost of maintaining an automobile increases with the age of the auto. However, if we assume that there is a mixture of cars in the area of analysis, the average cost of maintenance would be

$$\frac{1}{A} \sum_{i=1}^{A} \frac{n_i x_i}{N}$$

where

A = number of age categories

n_i = the number of cars in the ith age catagory

x_i = the cost of maintenance in the ith age category

N = the total number of cars

We assumed for our computation that cars are sold after four years. This is based on DOT studies that indicate that a car passes through 2-3 owners in a ten year period--the mileage drops after the first few years, indicating that it is a second car rather than a journey-to-work car, and the cost of maintenance sharply increases in the fourth year. We further assumed that there is an even distribution of ages. Although in the suburbs, the average age is probably skewed toward one and two years, this is compensated for by cars older than four years. The average cost of maintenance then becomes

$$\frac{1}{4} \sum_{i=1}^{4} x_i$$

The x_i values are based on Cost of Operating an Automobile, DOT, April 1974. See Exhibits C-2 and C-3. To this, we will add the cost of tires at $0.24/VM from Cost of Operating an Automobile and the cost of oil at $0.15/VM, both from Energy Statistics (U.S. DOT, 1975). All of these prices are for 1974. To change them to 1975 prices, we have calculated an actual growth rate from the Consumer Price Index for each item. To understand how we calculated the growth rate, see the section on Real Growth of New Car Price. Both tires and oil show a negative growth rate; however, both are made from oil which has been increasing rapidly in cost since 1974 and will continue to do so in the near future according to most predictions. Balancing the past decreasing trend against the increase in cost of crude oil, we have assigned a zero real growth rate for 1975. The new 1975 prices are shown in Exhibit C-5. The total cost of maintenance in 1975 dollars is $ .028/VM.

Insurance. Insurance rates vary with as many as 20 factors, including such things as type of coverage, location, age, sex, and marital status of the driver, whether the car is driven to work, and the type of car. Based on averages for low density journey-to-work automobile trips, we have arbitrarily assumed a 30 year old male head of family driving a Chevy Impala with $50,000 combined public liability, full comprehensive fire and theft, uninsured motorist, personal injury protection ($2,500) and $100 deductible collision. Seventy-five percent of all vehicles in the U.S. have $50,000/ $100 coverage or less.

As for location, within the greater Chicago area there are differences of over 100% by location and up to 24% within the City of Chicago. These differences are based in insurance companies' actual experience with claims. The average difference between city and suburb is about 10 percent. We are using suburban rates because they are more representative of low density areas.

Under type of driving, there are three categories that interest us: pleasure only, journey-to-work one-way between 0 and 15 miles, and journey-to-work one-way greater than 15 miles. An annual mileage of 10,000 is consistent with a journey-to-work between 0 and 15 miles. DOT estimates that about 3,400 of the 10,000 miles is for journey-to-work (U.S. DOT, 1975); this would accommodate a 13.5 mile round trip or approximately 7 miles one way. Our average cost for 10,000 miles annually of $230 per year is based on conversations with local agents (Chicago and suburbs) and the DOT figure which is relative to Baltimore suburbs. This amounts to $ .023/VM.

According to Insurance Service Office (ISO, 1976), pleasure-only insurance rates would be 20% lower (or $184 per year) and journey-to-work greater than 15 miles would be 16% greater (or $267). Exhibit C-7 which shows all automobile costs at different annual mileages reflects these jumps in insurance costs for different mileages. (It is assumed that 6,600 non work trip miles per year is constant at all annual mileages).

Fees and Licenses

The cost of license plates vary from \$2 in Hawaii to \$43.50 in Washington, D.C. (Chicago Motor Club). The cost of a local sticker is determined by city and county. We know it varies substantially (from \$0 to \$50 in the Chicago area) but we could not obtain nation wide data. Registration and titling also varies from \$5-200 but is only charged in the first year. Altogether, these costs are only 2-3% of the total yearly costs so we arbitrarily used \$70 per year. This is .7¢/VM at 10,000 miles.

Parking and Garaging

Parking and garaging also varies greatly with location. It could be virtually zero in a small city or town to \$1000 or more per year in a high density area of a large city. We used a cost of \$200 per year or 2¢/VM based on DOT. However, the total cost is figured with and without parking as there is much controversy about whether it should be included.

Capital Costs. If we were to divide the cost of the car evenly over the four years as is usually done, the cost of a new car bought in the fifth year must be considered. We have used a method that spreads this increase evenly across the four years. If the car owner were to buy a new car of equal quality every four years, his cost in each year would be equal to the quantity

$$y\ (1 + \alpha)^{k - 1}$$

where

α = real growth in price of new car

k = number of years from base year

and

$$y = \left[\frac{x(1 + \beta)^n - x^1}{\left[(1 + \alpha)^n - (1 + \beta)^n\right]} \right] (\alpha - \beta)$$

where

β = cost of capital

x = cost of new car in base year

x^1 = salvage value = $x(1 + \alpha^1)^n$ where α^1 = depreciation

n = number of years in life time in vehicle

This method also has the advantage of making the capital cost of a private automobile compatible with capital costs of vehicles in fleets used for public transportation.

The Consumer Price Index for new automobiles for 1975 is 127.6 (based on 67 = 100). The CPI for all items = 161.2 (67 = 100). Using the formula

$$t_0 + n = t_0 (1 + \alpha_a)^n$$

where

t_0 = index in base year

$t_0 + n$ = index in new year

n = number of years

α_a = appreciation (average annual actual increase in price)

and solving for α_a the actual average annual increase in the price of new cars from 1967 to 1975 is 3.1% and the average annual inflation (increase in prices of all items) for the same period is 6.2%. The real average annual increase (α) in the cost of a new automobile is the actual increase minus the inflation rate, or -3.1%. This means that in the last 8 years, the costs of automobiles in terms of real value of money has been decreasing at a rate of about 3% a year (for the period 1959-1970, the average decrease was 2.4%/year). As a decrease in the real cost of a car of 3% per year would lead to absurdly low prices when projected for more than a few years, we have chosen to use no change in real price instead.

The cost of capital is usually considered to be the difference between the interest rate on a loan and the inflation rate over the period of the loan. It is difficult to guess what the inflation rate will be, however, the Federal Reserve Board (Mr. Martin Millison) has given us an estimate for the real cost of capital of 3%. The lifetime of the automobile is four years as stated in the Maintenance Cost section.

The average price of a new standard sized fully equipped car in 1974 was $4,251, according to DOT's Energy Statistics. The increase in cost in 1975 cars was 8.6%, according to CPI making the average price about $4,620 in 1975 dollars. The resale value of a four year old standard sized car is about $1,200 according to local dealers. Our equation now yields

$$y = \frac{\$4620\ (1.03)^4 - 1200}{(1)^4 - (1.03)^4}\ (-.03)$$

$$y = \$956$$

Because appreciation is zero, the cost in any year = $y(1.0)^n$ = $956.

Exhibit C-6 shows all the costs tabulated for an average of 10,000 miles based on DOT statistics of average yearly mileage. Variable costs are those that vary with distance driven, and fixed costs (constant per year) are shown separately.

C2 Effect of Length of Journey-to-Work on Cost of Driving

The variable costs of driving per mile remain the same no matter how far the car is driven. However, the fixed costs per mile decrease as more miles are driven. Thus a cost per mile depends on the total mileage. Exhibit C-7 shows the effect of increased mileage. It is assumed that non journey-to-work driving is a constant 6,600 miles per year (based on DOT estimates) and that the increase in annual mileage is due to increased distance to work. Insurance, despite the increases that occur between zero and 10 miles per round trip and 20 and 30 miles per round trip, decreases as a per mile cost.

C3 Marginal Cost of Driving to Work

Many people own cars for pleasure trips or other purposes than driving to work. If they drive to work as well, the cost of driving to work does not include the fixed overhead. Instead, it includes only those costs that increase with additional mileage (i.e., fuel, maintenance, increased cost of insurance, and increased depreciation). For work round trip of 0 to 15 miles, the increase in insurance over pleasure only trips is $46 or $ .014 per mile for an average 13.5 mile trip. Over 15 miles one way, the insurance surcharge is $82 per year. Depreciation is based on both age and mileage. Exhibit C-8 shows the amount that is added or subtracted from the resale price of a medium-sized four year old car due to mileage. The average slope of the step function is $ .01 per mile. Fuel and maintenance are $ .05 and $ .028 per mile as before. Exhibit C-9 shows these costs per mile for various length trips to work. Exhibit C-10 shows this graphically. The increase in the insurance cost at a 30 mile round trip causes a break in the curve which in the total cost curve shows up as a flattening of the curve due to the magnitude of the other expenses.

C4 Future Costs

Fuel

The cost of fuel has shot up in the last several years (see Exhibit C-11). The future costs will depend on OPEC, tax legislation, and energy innovation. In order to take into account some of these various factors, we have used 3 different scenarios to project fuel costs: a 2% growth rate, 4% growth rate, and 10% growth rate in the price of gas. Exhibit C-12 shows the cost of a gallon of gas (the 1975 base price of $ .60 includes tax). Because gasoline taxes are not percentage but a fixed rate per gallon it is not logical to assume that they will increase at the same rate, but having no further insight into the tax situation we projected them along with gas. Car manufacturers are under a lot of pressure to increase the efficiency of their motors.

Exhibit C-1 shows the miles per gallon projections that Chase Econometric Associates made for the Council on Environmental Quality. These estimates are for average consumption, including open highway driving. We are interested in mileage during rush hour traffic. Assuming that the general improvement will follow a similar curve, we have projected our rush hour mileage along a similar curve.

Exhibit C-12 shows the miles per gallon and the cost of fuel per vehicle mile along with the price of fuel per gallon.

Maintenance. Exhibit C-13 shows the increase in the cost of maintenance in the last 6 years. Exhibit C-14 shows the three components of our maintenance figure with the growth rates determined earlier projected to 1980, 1985 and 1990.

Insurance. The increase in insurance rates has been very erratic over the past 8 years (Exhibit C-15). There are two trends that are running counter to each other: 1) the increase safety features in cars and the reduction in speed limits; and 2) the major increase in automobile repair and the size of liability awards.

A real growth figure of 1.7% was calculated from the Consumer Price Index for insurance in 1973 (average actual growth of insurance is 5.5% less average inflation rate or 4.8%). We used 1973 instead of 1975 because 1973 was the year that the speed limit was lowered to 55 m.p.h. That one event lowered the cost of insurance in the years after the event, however, it is unlikely that such an event will occur again in the next 15 years (see Exhibit C-16 for the projected insurance costs).

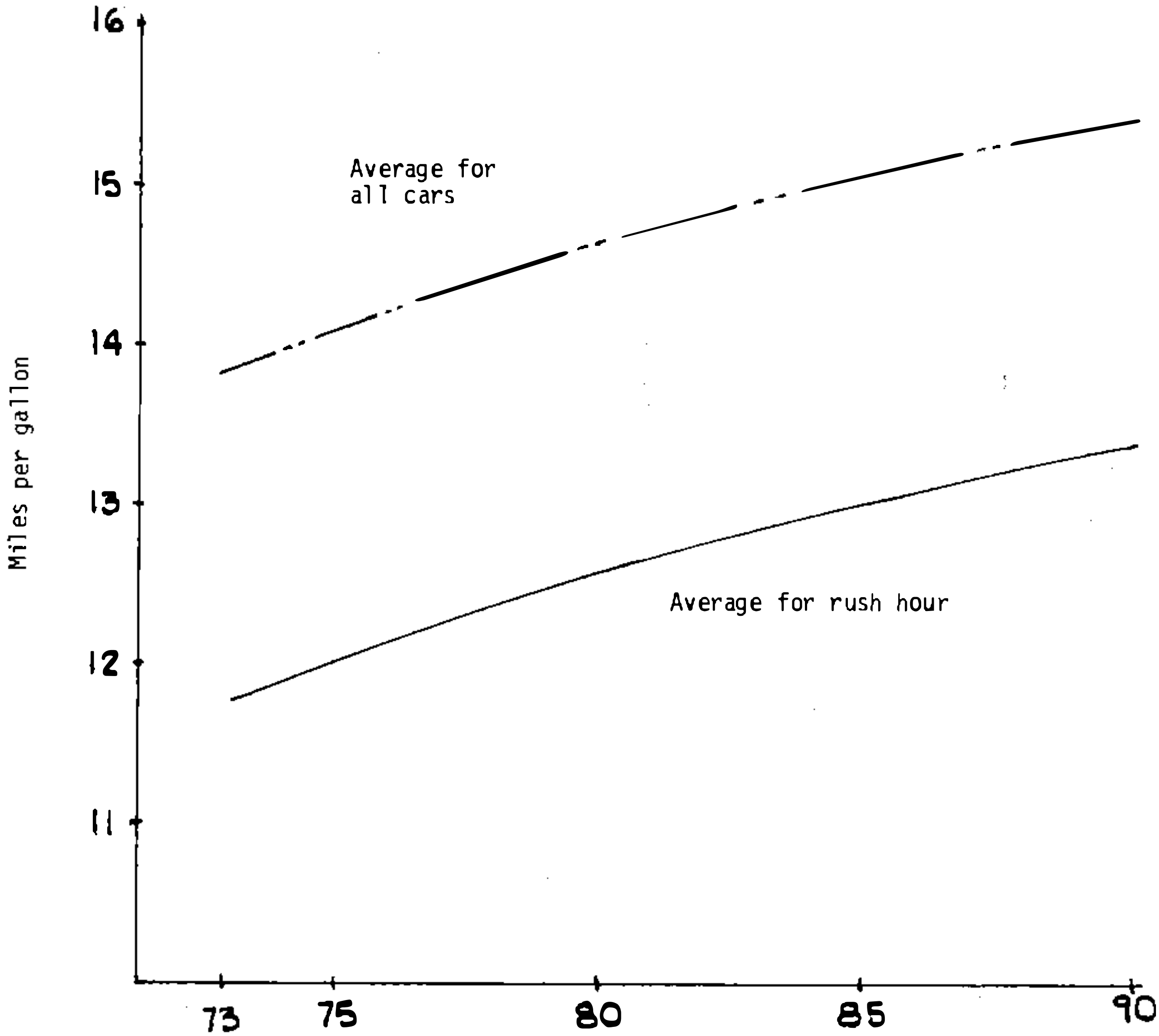
Fees, Parking, Capital

The average annual real growth of fees and licensing for automobiles has been about -3% since 1967. This cannot be assumed to continue; there is no doubt a lag in the increase in fees and licensing due to politicians' avoidance of moves unpopular with the voters. This lag is accentuated in times of high inflation. We will assume a zero growth over the long run.

The cost of parking has increased at the average annual rate of 7.2% since 1967. If we subtract the average annual inflation of 6.2% for the same period, we have a 1% growth rate. In the earlier section on the real growth of the price of a new car, we had assumed a zero real average growth for capital costs.

Exhibit C-1

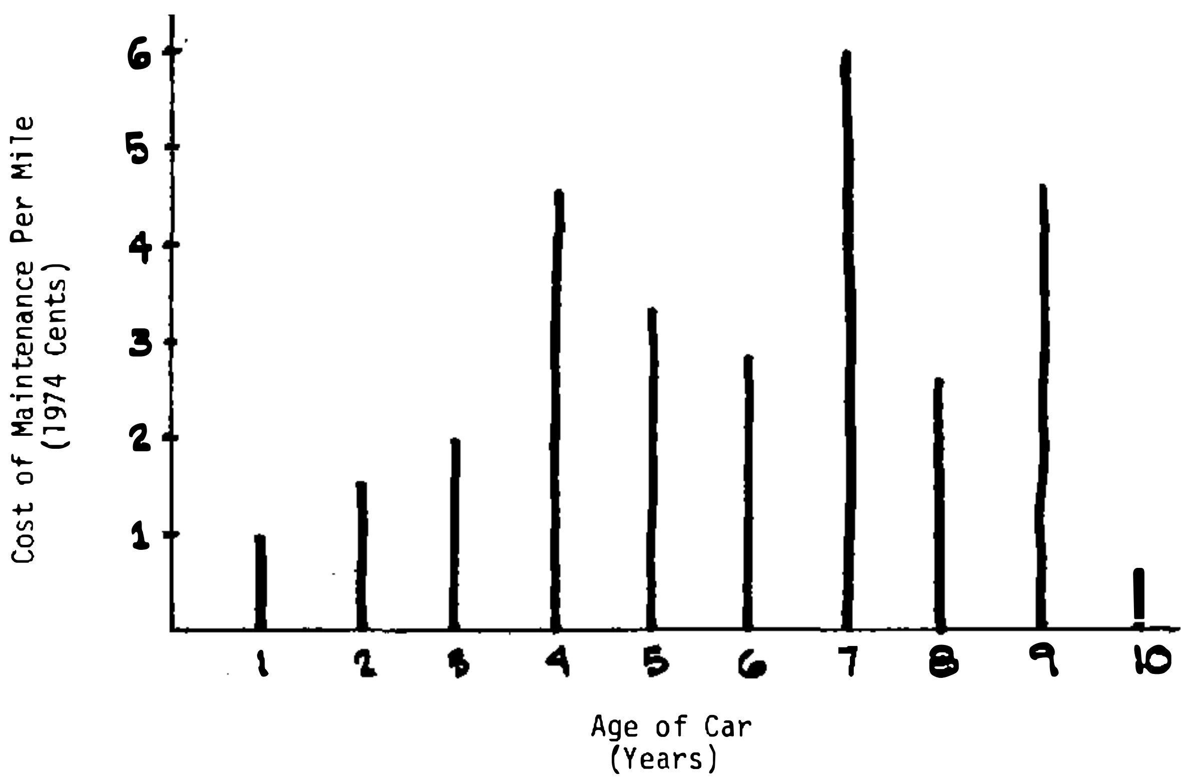
Future Automobile Gasoline Consumption



Source: Chase Econometrics Associates
for Council of Environmental Quality

Exhibit C-2

Cost of Maintenance Per Year



Source: Cost of Operating an Automobile
DOT, 1974

Exhibit C-3

Cost of Maintenance-1974¢/VM

1st Yr.	2nd	3rd	4th	AVE
.9	1.2	2.0	4.5	2.15

Cost of Maintenance-Growth Rates
(%)

	CPI (67=100)	Average Annual Growth Since 1967	Average Annual Inflation Since 1967	Real Average Annual Growth Rate	1975 Inflation Rate	Growth Rate To Inflate To 1975
Maintenance	176.6	7.40	6.2	1.2	9.1	11.3
Tires	126.3	2.96	6.2	-3.2	9.1	9.1
Oil	155.3	5.70	6.2	-0.5	9.1	9.1

Exhibit C-5

Cost of Maintenance in 1975
(¢/VM)

	1974 Price	Growth Rate	1975 Price
Maintenance	$2.15	11.3	$2.39
Tires	0.24	9.1	0.26
Oil	0.15	9.1	0.16
TOTAL			2.18¢/VM

Exhibit C-6

Automobile Cost

	Auto Cost (Assumed 10,000 miles yearly) $/YR	$/VM
Fuel	$500	.050
Maintenance	280	.028
Variable with Distance	--	.078
Insurance	230	.023
Fees and License	70	.007
Park and Garage	200	.020
Fixed	500	.050
Capital	956	.099
Total Without Parking	$2036/YR	$.204/VM
Total With Parking	$2236/YR	$.224/VM

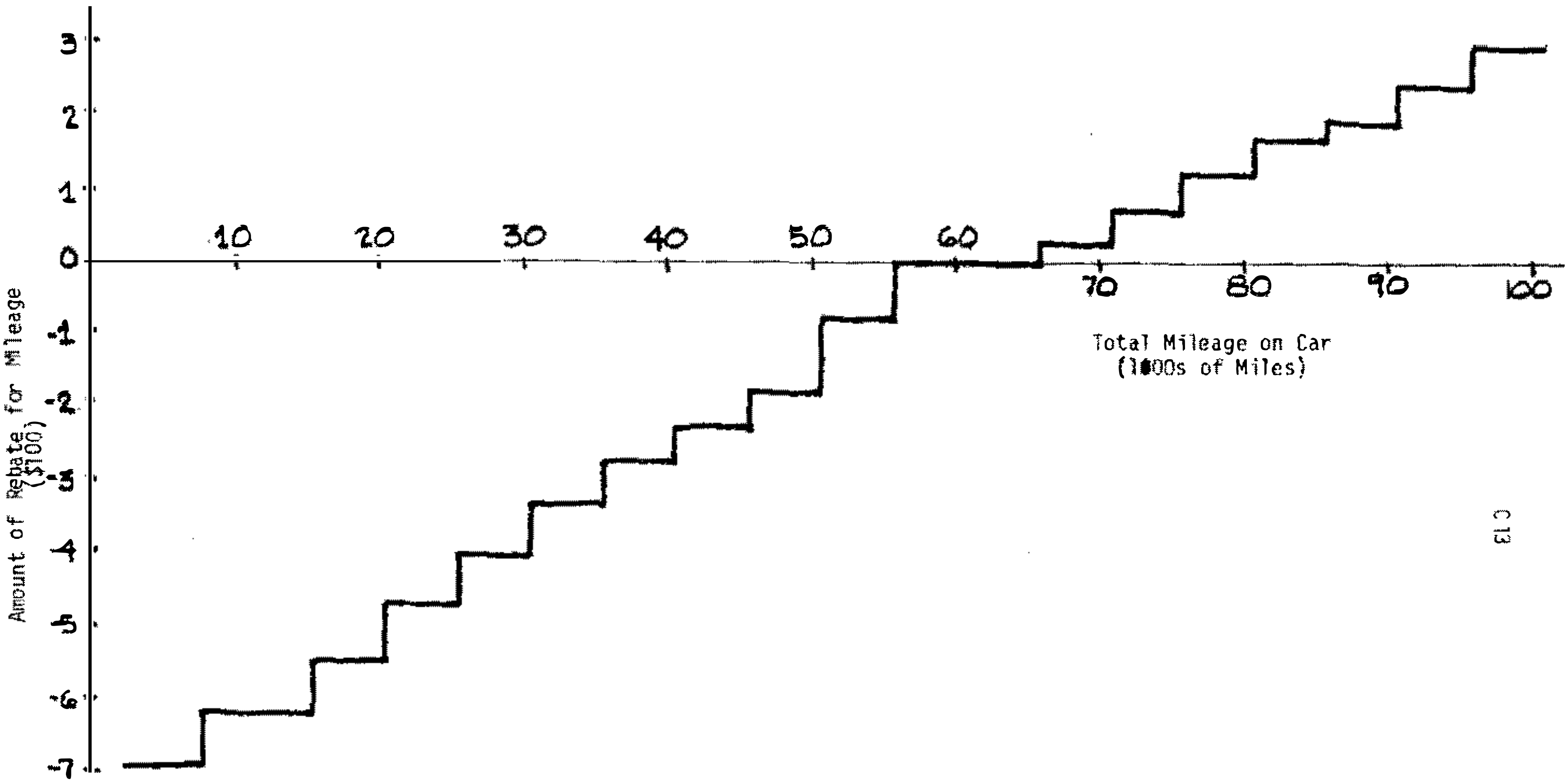
Exhibit C-7

Automobile Costs With Mileage
(1975 $/VM)

Journey-to-Work Length (Round Trip)	Total Yearly Mileage	Fuel Fuel .05/VM	Maintenance .028/VM	Insurance 1840 23010-20 266.84	Fees, etc. 70	Park and Garage 200	Capital 956	Cost/VM Without Park	Cost/VM With Park	Total Yearly Cost Without Park ($/Year)	Total Yearly Cost With Park ($/Year)
0 Pleasure	6,600	.05 (330)	.028 (185)	.028	.011	.030	.145	.262	.292	1725	1925
10	9,120	.05 (456)	.028 (235)	.025	.008	.022	.105	.216	.238	1967	2167
13.5	10,000	.05	.028	.023	.007	.020	.096	.204	.224	2036	2236
20	11,640	.05	.028	.020	.006	.017	.032	.186	.203	2164	2364
30	14,160	.05	.028	.019	.005	.014	.068	.169	.183	2397	2597
40	16,680	.05	.028	.016	.004	.012	.057	.156	.168	2594	2794
50	19,200	.05	.028	.014	.004	.010	.050	.145	.155	2791	2991
60	21,720	.05	.028	.012	.003	.009	.044	.138	.147	2987	3187
70	24,240	.05	.028	.011	.003	.008	.039	.131	.139	3184	3384
80	26,760	.05	.028	.010	.003	.007	.036	.126	.133	3380	3580
100	31,800	.05	.028	.008	.002	.006	.030	.118	.124	3773	3973

Exhibit C-8

Amount Added to Resale Price of Used Car for Mileage
(Based on 4 year old Medium sized car)



Source: NADA Official Used Car Guide, National Automobile Dealer Association, April, 1977

Exhibit C-9

Marginal Cost Of Driving

Journey-to-work Round Trip Mileage (miles)	Fuel (.050) Maintenance (.028) And Depreciation (.00) ($/Mi)	Insurance* ($/Mi)	Total ($/Mi)
0.0	0.088	0.000	0.088
4.0	0.088	0.044	0.134
10.0	0.088	0.018	0.106
13.5	0.088	0.014	0.102
20.0	0.088	0.009	0.097
30.0	0.088	0.011	0.099
40.0	0.088	0.008	0.096
50.0	0.088	0.006	0.094
60.0	0.088	0.005	0.093
70.0	0.088	0.005	0.093
80.0	0.088	0.004	0.092
100.0	0.088	0.003	0.091

*Based on no additional insurance cost from 0 to 3 miles, $46 additional from 3 to 29 round trip miles and $82 additional for 30 and more.

Exhibit C-10

<u>Marginal Cost of Driving to Work</u>

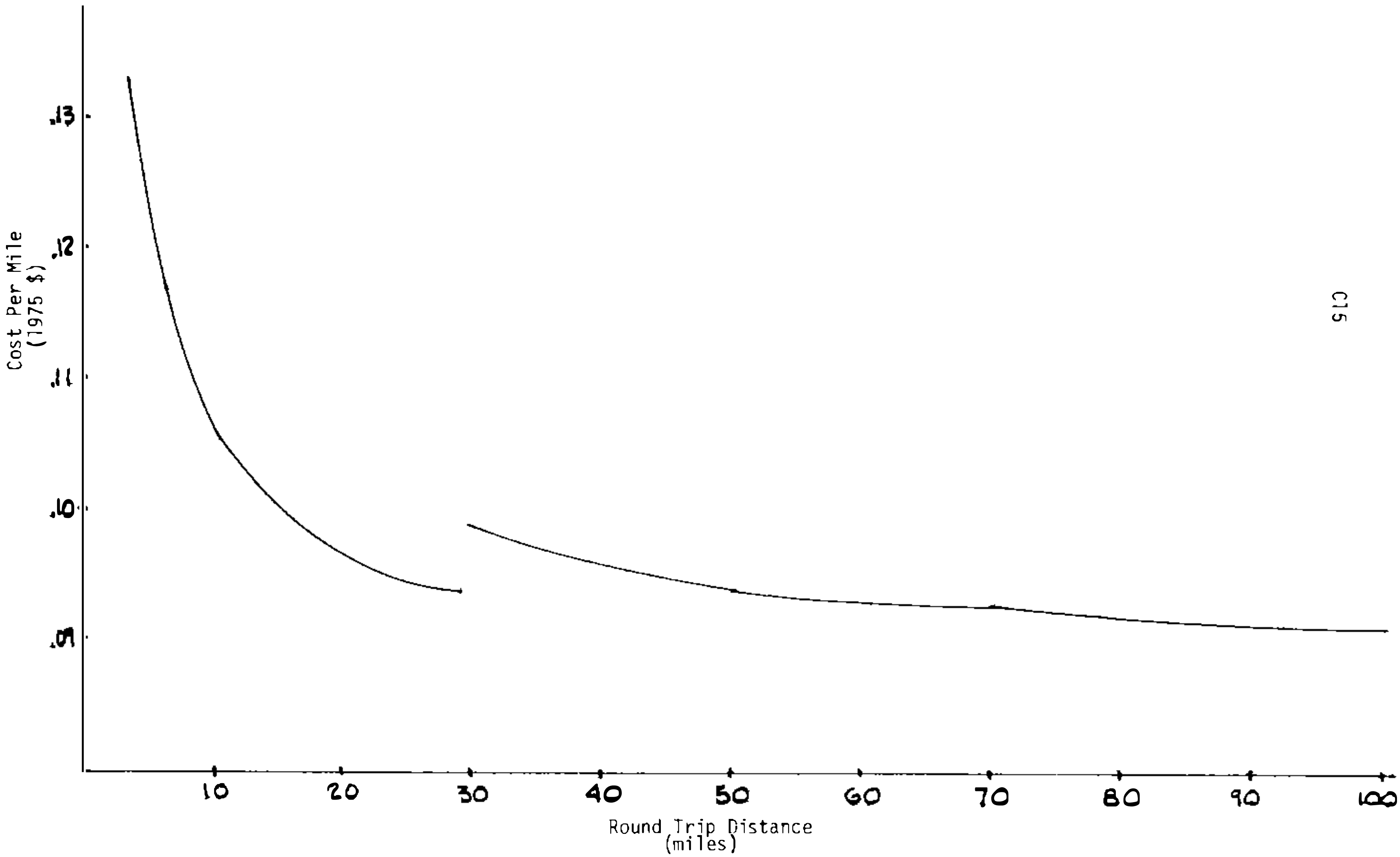
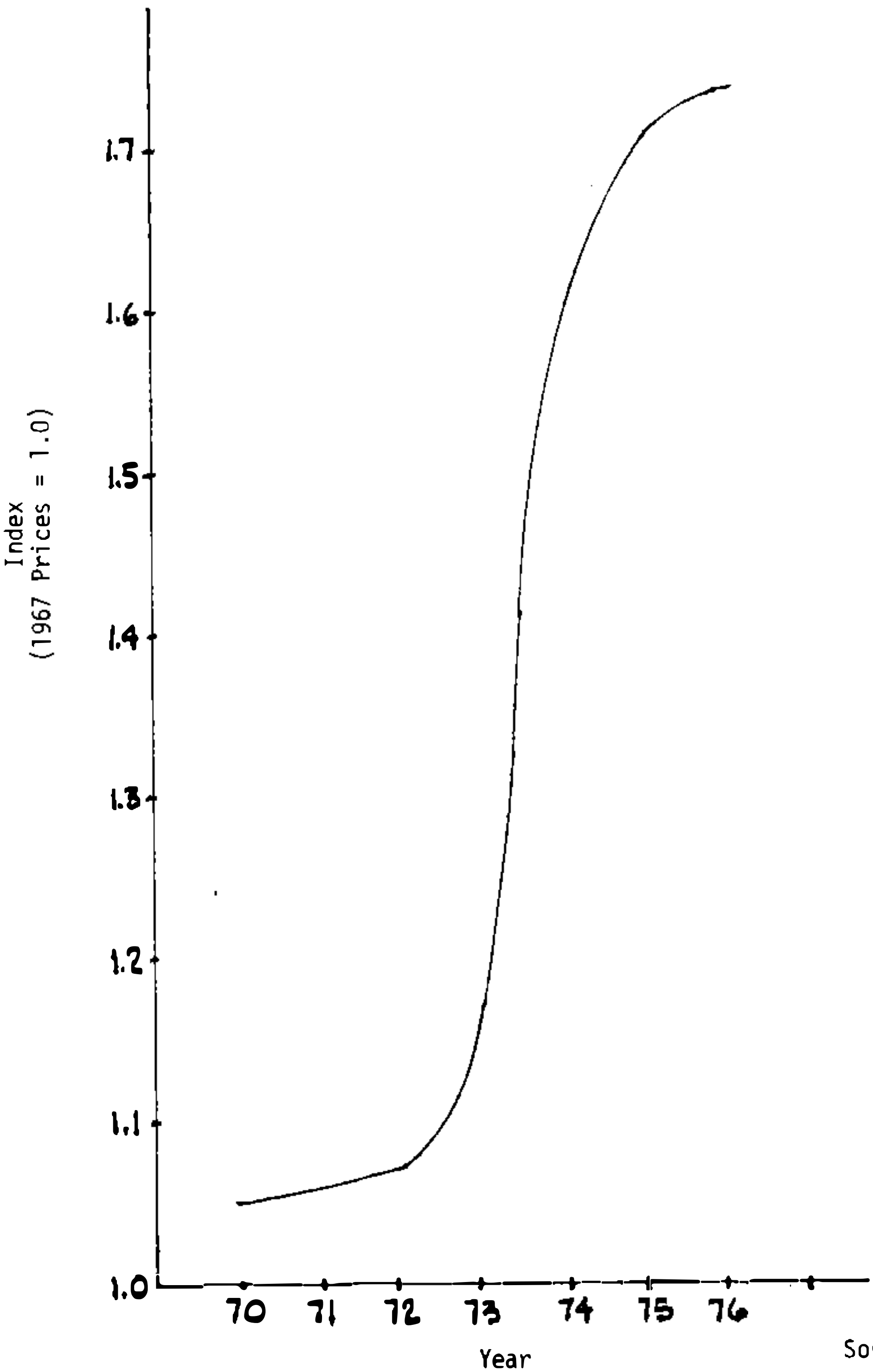


Exhibit C-11

Price of Gasoline Index



Source: Consumer Price Index

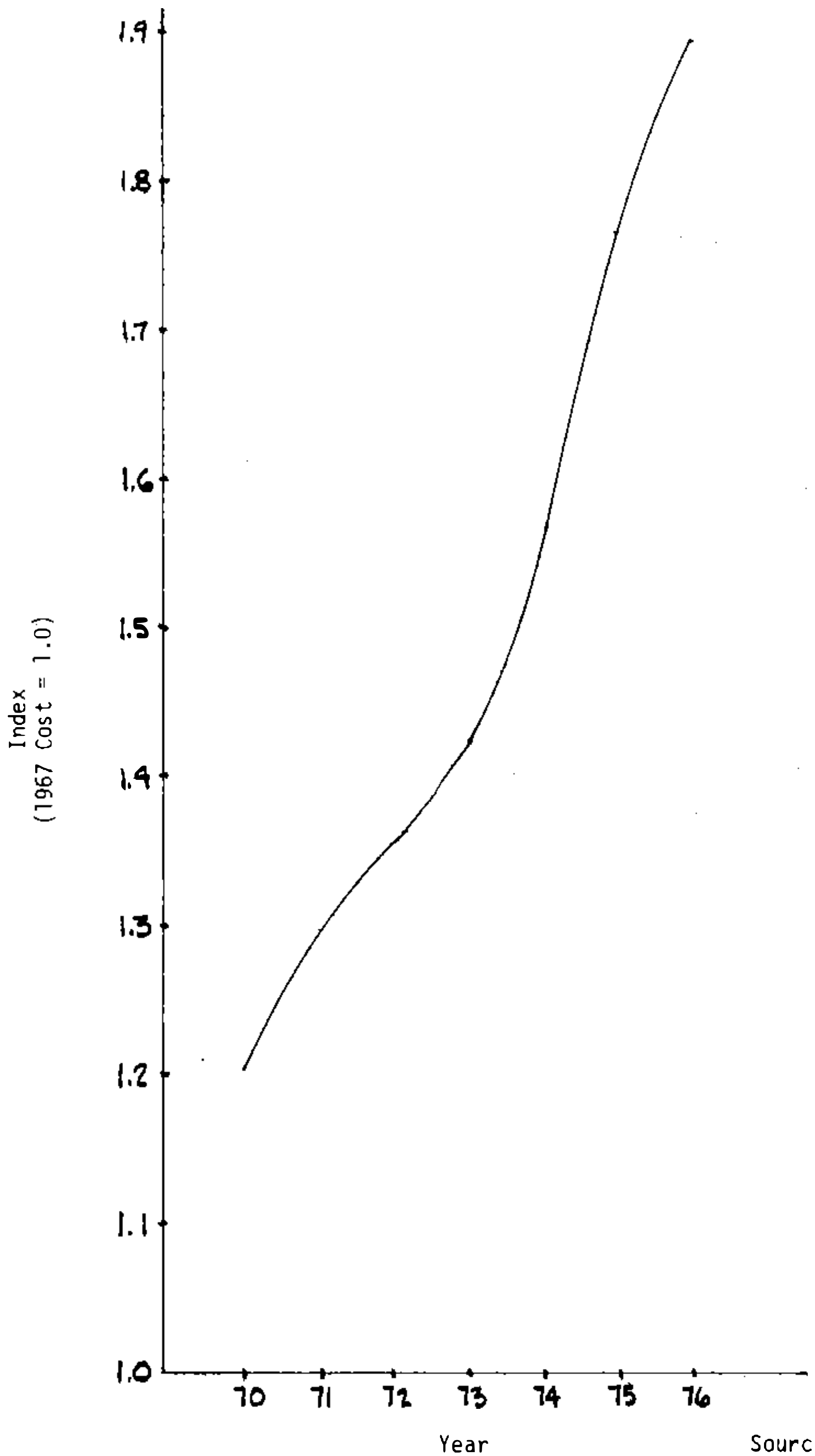
Exhibit C-12

<u>Future Cost of Gasoline</u>
<u>(In 1975 Dollars)</u>

	Base 1975	Inflation Rate	1980	1985	1990
MPG	12.00	--	12.60	13.00	13.40
$/GAL ╱ $/VM	00.60	2%	0.660 / 0.052	0.730 / 0.056	0.810 / 0.060
	00.60	4%	0.730 / 0.058	0.890 / 0.068	1.080 / 0.080
	00.60	10%	0.970 / 0.077	1.560 / 0.120	2.510 / 0.187

Exhibit C-13

Cost of Maintenance Index



Source: Consumer Price Index

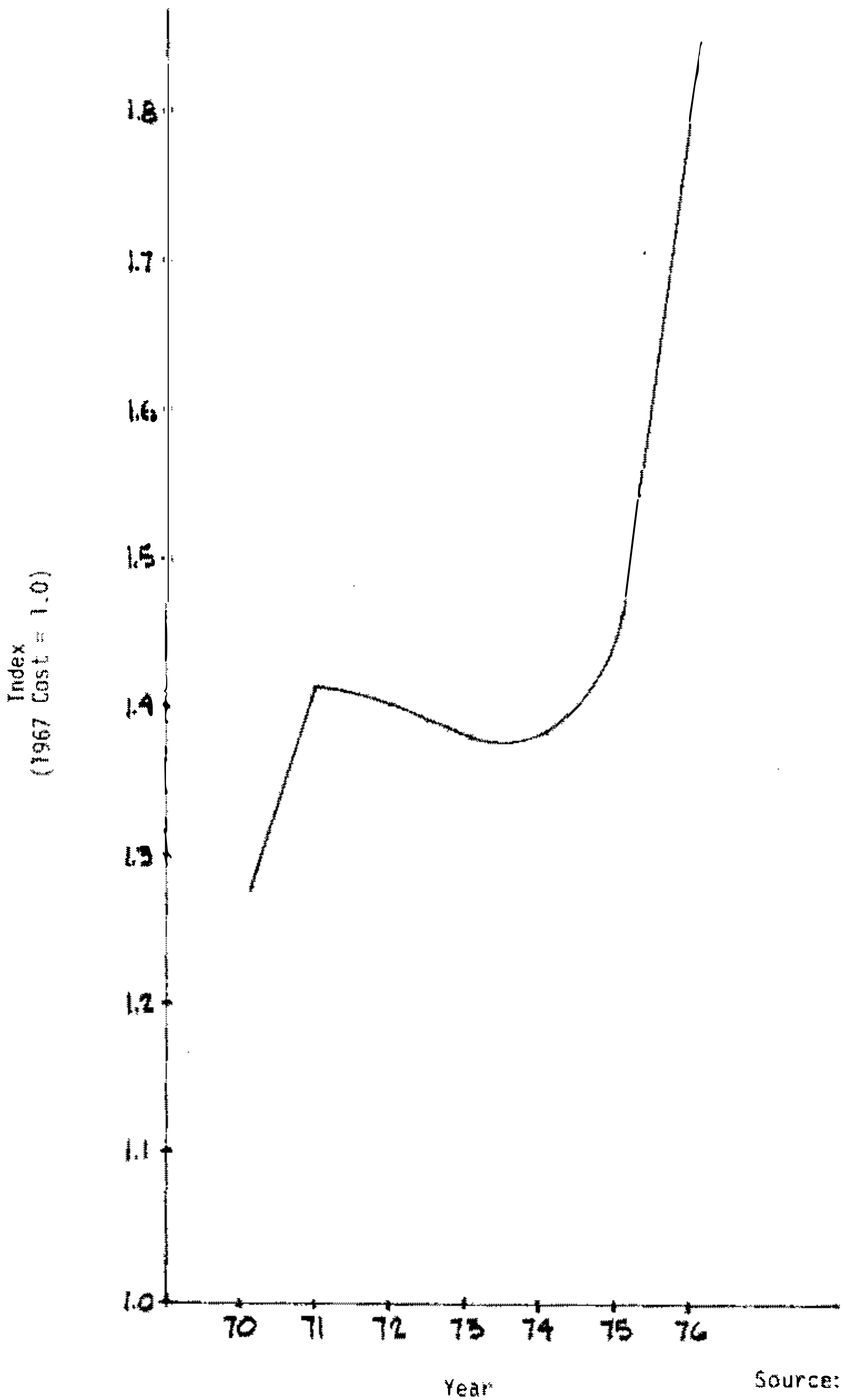
Exhibit C-14

Future Maintenance Costs
(In 1975 Dollars)

	Average Annual Growth Rate	Base 1975	1980	1985	1990
Maintenance	1.2	.0239	.0254	.0269	.0286
Tires	0	.0026	.0026	.0026	.0026
Oil	0	.0016	.0016	.0016	.0016
TOTAL		.0280	.0300	.0310	.0330

Exhibit C-15

<u>Cost of Insurance Index</u>



Source: Consumer Price Index

Exhibit C-16

Future Costs of Automobile
(For Annual Mileage = 10,000)

	Base 1975	1980	1985	1990
Assumed MPG	12.000	12.600	13.000	13.400
Fuel				
a) @ 2%	.050	.052	.056	.060
b) @ 4%	--	.058	.068	.080
c) @ 10%	--	.077	.120	.187
Maintenance @ 1.2%	.028	.030	.031	.033
Insurance @ 1.7%	.023	.025	.027	.030
Fees and Licenses @ 0%	.007	.007	.007	.007
Parking and Garaging @ 1%	.020	.021	.022	.023
Capital @ 0%	.096	.096	.096	.096
Total Without Park	.204	a) .210	.217	.226
		b) .216	.229	.246
		c) .235	.281	.353
Total With Park	.224	a) .231	.239	.249
		b) .237	.251	.269
		c) .256	.303	.376

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