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16. Abstract

This report assesses the feasibility of the shared-ride auto transit (SRAT) concept from operational, legal, institutional, and behavioral considerations. SRAT is an innovative approach for increasing auto occupancy in rural and urban areas. The SRAT concept in a typical application envisions registered commuters using their own vehicles to carry riders to points along the driver's route. A fee may or may not be changed by drivers, depending on system policy.

The concept has several possible applications in urban and rural areas. SRAT can provide sufficiently high service levels that moderate driver and rider participation is possible. However, concerns over personal security, reliability, and social acceptability will have to be met. Legal and regulatory problems can be overcome or avoided in most areas, including Federal, state, and local regulation, insurance, taxes, traffic regulations, registration of participants, and liability of the SRAT agency. A number of potentially serious institutional barriers to SRAT exist, but by designing the system to reflect a site's particular institutional setting, it appears that in many cases these barriers can be overcome.

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FINAL REPORT:

FEASIBILITY STUDY OF SHARED RIDE AUTO TRANSIT

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I. SUMMARY OF RESULTS

A. Description of SRAT

Shared ride auto transit (referred to as SRAT in this report) is an innovative approach for increasing auto occupancy in rural and urban areas. In a typical application, registered commuters would use their own vehicles to carry riders to points along their route to work. A fee may or may not be charged. No fixed schedules, predetermined ride matches, or full-time drivers are necessary to the concept, although some of these options may be included in particular SRAT designs. In short, the concept builds on the current informal practice of hitchhiking but uses institutional measures to facilitate ride matching and to ensure the safety of participants.

Formulation of the SRAT concept was motivated by several concerns:

- energy conservation, by increasing auto occupancy,
- transit service extension to areas unable to economically justify conventional transit services, particularly in suburban and rural areas, and to particular groups such as the travel disadvantaged,
- transit service replacement to achieve greater efficiency and to reduce transit deficits primarily in suburban areas,
- provision of inexpensive transit service to users,
- increasing the safety and reliability of hitchhiking especially in areas with high concentrations of youth.

Several SRAT system designs could be developed to meet certain of the above goals. For example, a free, legalized hitchhiking system would perhaps address the last objective. A managed, structured system with fares, operating rules, and identification would, on the other hand, not really serve the existing hitchhiking market, but would focus on attracting a new group of users to the service for energy conservation or cost savings goals.

Many elements enter into the design of a SRAT system. For systems having a fare, the fare structure must be determined. This involves choosing a method for calculating fare: no fare, flat fare, expense-sharing, or zone formulas. Payment methods must be developed: cash (possibly exact change), or coupons are the leading options. Also, the amount of the fare may be set to achieve specific goals, such as avoiding regulation as a public conveyance, attracting an acceptable ratio of riders to drivers, and possibly discouraging jitney operation disguised as SRAT.

The procedure for matching drivers and riders is another important element of SRAT system design. Visual contact is the simplest method, possibly with the driver or rider displaying identification markings. Pre-dawn and after-dark operations, which may be necessary for work trips during winter, create special problems that may require lighted stops. Citizen's band (CB) radio and the telephone may also be used to aid matching in some SRAT designs. Electronic contact through the use of receivers and transponders is another option.

As part of the matching procedure it is important to identify the driver's route and destination. If signs are used, there are tradeoffs between the complexity of the signs and the amount of information they convey. Two possible approaches are: origin-destination zone and route identification. With an origin-destination zone approach, the geographic area served by SRAT is divided into a set of zones. Drivers would display a sign indicating their destination; however, riders destined to points short of the driver's ultimate destination would not know if the driver's route took them through their destination zone. In the route classification approach, the information displayed on the vehicle would denote the route

as well as the destination; riders wishing to travel only to some intermediate point on the driver's trip would then know whether they could accept a ride with a given vehicle.

SRAT pick-up and drop-off points may range from fairly expensive shelters with lighting, fixed signs, telephones, bicycle racks, and benches, to a system that allows pick-up and drop-off anywhere. The locations for stops must also be chosen: expressways, arterials, local streets, or off-street points such as parking lots.

In addition to the operational issues that determine SRAT service concepts, potential travel markets for SRAT service must be considered. One application that prompted the SRAT concept was the urban work trip market. This market can be served by SRAT in several different ways:

- a system providing service to SRAT users from origin to destination, either with or without transfers;

- a service that complements existing transit systems by feeding into or possibly replacing transit operations; or

- an employer-based (or other restricted group) system involving a fixed pool of participants and some regularity of matches, although still maintaining flexibility.

Urban non-work trips are also possible SRAT markets in several settings:

- community systems oriented toward shopping and other local trips, possibly serving the elderly or transportation disadvantaged, and probably involving some type of advance arrangements; or

- major activity centers (universities, hospitals, etc.) with elements of both the employer-based and community SRAT concepts.

Finally, rural areas may find SRAT systems useful in several applications:

- work trip ride sharing, as in urban areas;
- general service for the carless; and
- youth-oriented recreational trips within activity areas.

Depending on the SRAT system design, different agencies or groups may serve the management function. A government agency (regional transit district, state department of transportation, city or county government) will be a candidate operating agency in many cases. However, employers or community organizations may be logical alternatives for some of the more restricted concepts. Also, a club arrangement which requires membership for SRAT participants, both riders and drivers, may be feasible.

There are several options for financing a SRAT system, including government funding at the Federal, state, or local level. Limited private financing may be possible for selected aspects of a SRAT system, such as advertising or promotion. Some SRAT designs, such as the club concept, may even be self-financing.

The SRAT management agency must perform several key functions in most of the service concepts discussed above. Its most basic role may be in registering drivers and riders, both to allay fears for personal security and to protect passengers against drivers with poor driving records. It will also have to address regulatory issues at the federal, state, district and local level, set insurance standards for drivers in the system, issue operating rules including pick-up and drop-off procedures, fare level, and hours and area of operation. A related institutional issue that must be considered is the liability of the SRAT management agency in case of incidents involving the system. This potential liability presents further insurance issues.

The remainder of this report discusses factors which are expected to influence the feasibility of SRAT implementation, focusing on: operational concepts, potential usage, legal and regulatory issues, and institutional issues.

B. Study Methodology

The study methodology can be briefly summarized as follows:

Task I - Preliminary Analysis of SRAT Operational Concepts

This task is reported in chapter II of the report. A set of alternative SRAT system concepts was developed through a review of the literature, consideration of stated objectives for SRAT systems, and summary data collected on urban travel patterns. Feasible ranges of fares, stop locations, hours of operation, and other considerations were developed using "sketch" analyses. Also, a set of relationships to predict the SRAT service levels (walk times, wait times, travel times, and costs) as a function of rider and driver flows was developed for use in the more detailed analysis in Task II. Finally, a brief comparison of SRAT operating and service characteristics with other paratransit modes is presented.

Task II - Demand Analysis

This task is reported in Chapter III. A disaggregate demand model is used first in a prototypical household analysis to explore SRAT system designs from the user's point of view and to lead to preliminary estimates of SRAT driver and rider participation. A series of case studies using the disaggregate demand model (and models of SRAT operations developed in Task 1) are then presented to assess the feasibility of a series of SRAT system alternatives. A section of Chapter III then presents the small amount of empirical data that exists on SRAT-like systems to supplement the demand model results. Finally, the results of a set of focus group interviews with the general public that investigated attitudes toward SRAT are presented - this is another piece of evidence that can be used to assess likely participation in SRAT.

Task III - Legal and Regulatory Analysis

This material is summarized in Chapter IV. Analysis of legal, regulatory, insurance, and other such issues is presented, to begin to bound the complex issues facing SRAT implementation. Reference to rulings, decisions and opinions of various courts and regulatory agencies is used extensively to assess possible legal and regulatory issues with SRAT. A summary of these possible issues, and possible ways to minimize or avoid problems is presented at the end of this chapter. Four case study states are used.

Task IV - Institutional Analysis

This is presented in Chapter V. The chapter deals with institutional issues that, while deeply related to legal and regulatory issues, fall more into the realm of exploring agency objectives and relationships rather than legal issues themselves. Four case study urban areas are used. Alternative SRAT concepts, management agencies, and implementation strategies are discussed.

To summarize the study methodology, it consisted of roughly equal effort in four key areas:

- analysis of SRAT operations ("supply") through a set of simple models, varying demand levels parametrically, to explore alternative operating rules and service levels,
- analysis of SRAT demand from three persepctives: a disaggregate demand model, empirical evidence, and a set of focus group results on attitudes,
- analysis of laws, regulations and other conditions with which SRAT systems will have to deal in a formal way, and
- analysis of the institutional structures with which SRAT will have to deal.

Answers in all these areas are required for a full assessment of SRAT feasibility.

C. Conclusions

The feasibility of SRAT depends on the answers to three critical questions:

- What travel patterns, demand densitites and operating rules are required to effect a level of service that will attract enough participants to sustain a SRAT system?
- If a SRAT system were available, would potential travelers (drivers or passengers) use it?
- What legal and institutional barriers must be overcome to permit a SRAT system to operate?

Travel patterns at a regional level were analyzed for eight sample U.S. cities to determine average driver flows in peak and off-peak periods. These average flows turned out to be quite low (often only one trip per hour between one square mile suburban areas). Thus SRAT service is unlikely to be ubiquitious*, in most applications, but must be concentrated in areas where the driver density is significantly greater than average. Intermediate origins and destinations must be served by driver trips (instead of only carrying passengers whose entire trip coincides with that of the driver) in many settings if an acceptable service level for riders is to be achieved. Unfortunately, the need to concentrate in higher density markets will bring SRAT into conflict with existing modes in some cases.

A more detailed analysis of four case study cities shows that it is possible to find some settings for SRAT in urban areas that do not directly compete with transit, and yet possess sufficient driver flows for the SRAT system.**

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*This claim has never been made for SRAT, but it was considered an open question by the study.

**However, in at least one city, this was taken to be evidence that transit could be supported in the setting.

The study determined that peaking of work trips is fairly sharp. Driver flows fall sharply at 9 a.m. and 6 p.m., creating a situation that may require provisions for back-up service. Finally, due to the high transit mode shares to the central business district (CBD) in most cities, the highest driver flows were actually observed to other parts of the central city than the CBD.

Turning to the second issue--potential system usage--several conclusions emerge. Urban SRAT systems carrying passengers from their origin to their destination appear to offer a moderate service level and may generate a moderate number of riders, based on extrapolation from observed carpool behavior.* SRAT typically attracted 10% mode shares of both drivers and passengers in the case studies examined, although these varied markedly by auto ownership level. In carless households, 30 or 40 percent of work trips would be made by SRAT in many cases, and of course no drivers are generated. One car-households generate perhaps 15% drivers and 5% riders, while two-car households generate very few riders or drivers. Thus, based strictly on measured service level attributes, there appears to be potential for attracting participants to SRAT in well-designed urban applications. Attitudinal concerns, especially those related to personal security and perhaps reliability, could change this conclusion, however.

Preliminary assessments of attitudes of the general public toward SRAT indicate that there is some concern over entering a car with strangers and some apprehension over the system neither having a fixed schedule like

*The models used in this study rely basically on measured variables such as time, cost and income; they assume that the non-measured attributes of SRAT like security, reliability, and flexibility are, taken together, equivalent to carpooling. This may or may not be a valid assumption, but without actual operational experience with SRAT, it is perhaps the best prediction that can be made.

transit nor a prior agreement like carpooling. These concerns would have to be addressed directly in setting up a SRAT system.

Another area of concern in the model results in the high proportion of riders from carless households while drivers come from one- and two-car households. Previous carpooling surveys have shown the composition of most carpools to be very homogeneous; the effect of social differences is not included in model projections.

Low fare levels (25 or 50 cents) appear to produce the highest SRAT driver and rider participation. Riders appear to be quite elastic with respect to fare, and thus expected driver revenues rise as fare decreases. Relatively low occupancies result for SRAT with drivers picking up one or no passengers on a typical trip. Regional changes in vehicle miles travelled (VMT) and auto occupancy even with an extensive SRAT system were negligible because some SRAT drivers and riders were diverted from higher-occupancy carpool and transit modes; in fact, VMT actually increased slightly in a few cases.

Rural systems showed about the same performance as urban systems in terms of market shares, occupancy, and recommended fare. However, rural systems may have much greater impacts on trip frequency and mobility than mode choice. Due to the lack of transportation alternatives and the simpler institutional structure in these areas, SRAT may be even more attractive in rural than urban settings. Urban community systems serving shopping and other non-work trips and employer based systems restricted to employees of a single company were analyzed only briefly: they appear to have some potential, but because of the restricted number of participants they appear to require some aids to matching riders and drivers (probably

through the use of the telephone) to operate satisfactorily. Urban SRAT systems based on strong integration with transit (such as a feeder system) appeared to be the least feasible concept.

The third basic determinant of feasibility is the legal and institional framework for SRAT. One of the findings of the study is that SRAT has three opportunities to escape regulatory problems in most areas: 1) agencies will lack jurisdiction to regulate SRAT (e.g. no fare systems), 2) SRAT may qualify for a statutory exemption from regulation (e.g. carpooling), 3) regulation would be by a local agency favorable to SRAT (e.g. the implementing agency). To a large extent, whether and how SRAT is regulated, especially on the local level, will depend on how persuasive the SRAT advocates are, and how receptive the regulating agencies are. No firm guidance can be given, as each situation will have a unique set of characteristics. If SRAT must qualify as a certified common or contract carrier, the burden of compliance is likely to be so onerous that SRAT cannot be implemented.

If a SRAT agency uses any funds under the Urban Mass Transportation Act of 1964, it must agree under section 13(c) of the act to protect the interests of mass transit employees who will be affected by the assistance. There are several strategies that can be used to minimize the impacts of this provision, including avoiding competition with existing transit routes, allowing existing unions some role in SRAT management or operations, and identifying factors in the service area other than SRAT that might contribute to a worsening of employment conditions for transit workers and including this in the 13(c) agreements. However, since section 13(c) is really one element of a larger, on-going bargaining relationship between transit management and labor, some concessions beyond

the minimum required by a strict reading of section 13(c) may be necessary if SRAT is managed by a transit agency. The final measure, of course, for avoiding section 13(c) issues is to use funding from a source other than UMTA, such as the Federal Highway Administration Carpool Demonstration Project funding, state funds, private funds, or to make SRAT self-supporting. Even some of these sources may have associated labor issues.

A registration procedure for riders and drivers must balance the added personal security and confidence of strict requirements with the cost, possible exclusion of certain groups, and deterrence of potential users that these requirements might also imply. The limited data available concerning hitchhiking and taxi crime indicates that the problems faced by SRAT may not be as serious as first imagined. Nevertheless, a registration requirement may improve security significantly.

Applicants could be required to fill out an application form and present verification of valid driver's license, insurance, residence, vehicle inspection and age. Verification of driving record can generally be obtained from the state registry of motor vehicles; however, state and Federal records on past criminal convictions typically would not be available to a SRAT agency because of state and local privacy laws.

In incidents involving the SRAT system, it is possible that the SRAT agency would be one of the parties named in any lawsuit. Liability insurance may be appropriate; at this point its cost can be estimated only very generally, but it is not expected to be expensive.

It is assumed that SRAT activities will be covered by ordinary private passenger automobile insurance policies; insurance company and state insurance officials have informally agreed that SRAT would not fall within the clause in many policies that excludes coverage if the car is used as a

"public conveyance". To offset the concentration of liability of SRAT drivers who at times may carry several passengers, higher-than-minimum bodily injury limits are suggested, with limits of $100,000 per person, $300,000 per accident being perhaps the most appropriate level. The cost of this additional insurance is expected to be relatively low for drivers with safe driving records, however, some high-risk drivers may have difficulty obtaining it, or may have to pay very high rates.

Federal income tax rulings indicate that SRAT would be treated as a shared-expense carpool arrangement and that fares collected by a driver would not be treated as income unless they exceed the vehicle operating expenses. Neither can drivers (or riders) deduct SRAT expenses from their taxable income. Generally, the income tax consequences at the state level will be the same, since most states rely upon the Federal income tax definitions for gross and taxable income. In some states, however, SRAT revenue would be treated as income and could create extra paperwork for drivers.

Traffic law considerations make it advisable in most areas to designate pick-up and drop-off points that are separate from the flow of traffic. This will add some expense for SRAT and may require riders to walk greater distances to stops.

The factors that facilitate or impede SRAT implementation vary markedly from site to site. While a number of potentially serious barriers to SRAT exist, it appears that by designing the system to reflect a site's particular institutional setting, most of these barriers can be overcome.

There are, however, a number of concerns that will probably have to be addressed in any urban and some rural applications of SRAT: 1) Police agencies are likely to express a strong concern for personal security. 2) Government agencies were concerned over liability in the event of crime, especially in areas where insurance costs have increased greatly. 3) There was a fear that if a public agency promoted SRAT, public expectations regarding security precautions would be increased. 4) Concern over competition with existing transit services was emphasized by transit and taxi operators (with only one exception), as well as other agencies, in all case study cities. 5) The potential for increasing traffic accidents was cited frequently although it was not perceived to be as difficult to overcome as the personal security issue. In short, careful design and promotion of the system will be required to overcome these and other institutional barriers. Identification of a lead agency to implement SRAT must be very sensitive to local conditions, with local, regional and private agencies all being possible candidates in different localities.

II. OPERATIONAL CONCEPTS

A. Possible SRAT System Designs

Although the basic SRAT concept is very simple, there are several important operational and design issues which must be addressed for the system to operate efficiently. This section outlines several different system designs that may be considered for application in urban or rural areas.

Chapter II explores a range of operational concepts for SRAT. Section A details seven possible concepts identified in the study for further analysis, ranging from work to nonwork trip applications, urban to rural settings, visual or telephone matching and other variations; many of these concepts have been proposed for implementation in specific areas. (See Appendix A for a summary of proposed and existing SRAT systems.) Section B discusses SRAT operational issues such as fares lighting, matching, and costs. Section C outlines some of the analyses of SRAT operations used to derive a set of feasible system concepts and settings, and to optimize (to the extent possible) the system design. Section D presents a brief comparison of SRAT and other paratransit modes, to highlight the key innovations in the SRAT concept.

1. Urban Service to the General Public

This system configuration has been suggested by Mann (1974) and Stetten (1975) under the names Auto Rapid Transit System (ARTS) and Community Auto Rapid Transit System (CARTS). The SRAT system carries riders from their origin to their destination with no integration with

the transit system. In the ARTS system, two transfers are generally involved for riders, since service is first provided to a central point in each community, then vehicles leave for other community centers, and finally different vehicles perform distribution for the passenger trip. Presumably, one could also park and ride to the first ARTS collection point. CARTS, on the other hand, is designed to provide service without transfers from neighborhoods to major activity and employment centers. Both of these designs were considered within the broader framework of this SRAT system design.

The urban SRAT design likely would operate only during peak periods, as the work trip is the major market. Registration of riders and drivers is probably required to allay fears for personal security in urban areas. Many pick-up and drop-off points must be established both in neighborhoods and activity centers; this will generally preclude sophisticated shelters at stops. Matching of riders and drivers is done visually, with either or both displaying signs or relying on fixed signs at stops. Darkness occurs during the morning or afternoon peak periods during approximately half the the year in U.S. cities, so some measures must be taken to facilitate ride matches during darkness or semi-darkness.

A fare is generally envisioned for this system, ranging from 25¢ to $1.00 per trip, depending on distance and pricing policy; a variety of fare payment methods are possible.

Such a system would almost certainly operate in several local jurisdictions and would have to be designed to account for varying local conditions. Competition with the transit system would be minimized through judicious selection of a service area, but some competition is inevitable. Some competition with taxis might also result. In this design it may be

desirable to have back-up service along principal SRAT pickup points by a taxi or perhaps a bus vehicle. Back-up service at the end of the morning and evening rush hours would assure service to riders after driver flows fall off sharply. A back-up service could also be used to mitigate some institutional problems, by giving potentially affected mass transit employees a role in the SRAT system and perhaps a stake in its success.

The management agency for this system likely would be either a government agency (transit authority, city or county government) or a private, nonprofit* organization. Each of these options is analyzed in the report.

2. Urban System Integrated with Transit

To minimize potential competition with transit and to restrict the service area to a manageable size during early stages of implementation, SRAT could operate as an extension of an area's regional transit system. There are two forms this could take: a feeder system where there is none presently, or replacement of transit routes that have low service levels and low ridership.

The SRAT feeder to transit could be established to feed commuter rail and express bus operations in outlying areas with no existing feeder. Ideally, the transit stop should be located near a major highway facility so that drivers other than those who park and ride can offer SRAT service. Pick-up and drop-off could be anywhere along designated routes or at designated stops only. Operation would likely be only during peak periods. A low fixed fare of perhaps 25¢ would be reasonable in most cases.

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*It is not a strict requirement that the agency be nonprofit, but profits do appear to be unlikely.

Registration of drivers and riders is possible, although it may not be necessary. Since this system is a many-to-one operation, route or zone designations are simple. Operation of the system could be entirely within a local jurisdiction in many cases, which will lessen implementation problems. The city, transit agency, or a private agency could be the implementing agency. Taxi service often exists in these circumstances and serves trips of the sort that SRAT is serving; to minimize competition, the taxi operator might possibly be given a role in the operation, including providing back-up service.

The second manner in which SRAT would integrate with existing transit is by using SRAT to replace marginal bus routes or create new routes in marginal areas. These routes could be left on the transit service map designated as SRAT routes, and perhaps even have approximate headways indicated. Stops would probably be at existing bus stops. The hours of operation would have to span those of the previous bus operation and would likely involve mid-day and peak service. A fixed fare comparable to that of the transit system would be charged.

Registration is possible although it might be cumbersome. Drivers and riders would have to be made aware of routes and transfer points, possibly through signs at bus stops and large highway signs. Bus service could remain as a back-up service on long (1-2 hour) headways if desired. The system would operate in a small number of local jurisdictions and would have to be well-coordinated with, if not operated by, the transit operator.

3. Service to Major Activity Center

Flexible ride-sharing arrangements can be organized for several urban activity centers such as universities, hospitals, and possibly airports. University "commuter" trips are difficult to accomodate in

carpool programs due to variation in class schedules from day to day for each individual. However, if a small group of students pool rides, a variety of arrival and departure times will result each day, and some individuals may be able to accept a ride with a different driver each way instead of having to drive themselves. Such a system could be instituted by having a university compile and send out lists of students living in the same area. Fares presumably would be worked out within each group, with guidelines perhaps being suggested. As an incentive for pooling, priority parking could be made available by the university.

Registration would probably not be required, as registration at the university should be sufficient. This form of SRAT would be so close to existing carpool arrangements that few legal or regulatory issues should arise. An informal arrangement like this at Boston College was described to the study team in one of the focus group interviews (see Section III.E.)

The second example of a major activity SRAT application is hospital trips for visitors, outpatients, and possibly employees. This model is discussed below as part of the community system which is very similar.

The third model is a SRAT service for airport trips. Trips outbound from the airport could use visual matching in a designated area: inbound trips would have to be matched by telephone, probably a day in advance. A zone fare system could be used, with fairly large steps ($1, $2, . . .). Pick-up and drop-off would be at the rider's door. Hours of operation would be set by the period during which flows are high enough to arrange matches; this might be all day or just during peak hours.

Registration of riders and drivers is possible, though it may be unnecessary. The airport is the obvious operating agency for this SRAT

system; there would almost certainly be competition with other airport ground transportation services, however. This model has not yet been proposed anywhere, although Massport (1977) has instituted a "Share-a-cab" service from Boston's Logan Airport in a similar manner. It is currently making successful matches of riders in peak periods only.

4. Community-based Services

This form of SRAT is intended to provide the same range of services as community minibus systems: elderly and handicapped trips, shopping trips, school-age trips, and others. It is possible to organize such a system either with designated stops and routes and visual matching of drivers and riders, or by using telephone matching. (It was the strong preference of the focus group interviews to use telephone matching, although part of this can be attributed to unfamiliarity with the other option.) A central call-in number to offer or request rides would have to be maintained for the phone matching, with call-backs to confirm matches. Such a system would operate during daytime hours. Either a low fixed fare or possibly no fare could be charged. People's Transhare in Portland, Oregon uses telephone matching for intercity trips. (See Appendix A.) The system would rely heavily on volunteers, and it is possible that some would make special trips for riders, thus operating outside the true SRAT mode on occasion.

Registration may be desirable in many cases. The town or private organization are the most likely lead agencies for this SRAT system. There may be some competition with transit and taxi services; the transit competition could be mitigated by the dispatcher (if the phone system is used) directing riders to use transit if it is available for their trip.

5. Employer-based Systems

This SRAT concept is that of a flexible carpool, not dissimilar from the concept mentioned for university trips. Employees of the same or nearby companies who live near each other and wish to carpool would form the basis for this concept. They would have a fixed match for days on which they travel to or from work at their regular time. However, on days when their schedule varies or they miss their ride, they will be able to ride with another member of the group. This flexibility is provided by all members of the group passing or meeting at a designated parking lot or other point near their residences (riders could either be picked up at their door or park-and-ride). An alternative arrangement is for each member of the group to have a list of the other drivers in the group and their usual travel times, and to simply telephone to arrange a ride at a different time.

Fares could be set within the group, based on cost-sharing. Registration would not be necessary. This concept is so close to conventional carpooling that few problems are envisioned; in fact, it might be considered an element of a good carpooling program.

6. Rural Systems

SRAT can be applied to rural areas to serve many of the same trips discussed in the urban cases above. One model of SRAT, proposed by Clear Creek County, Colo. (1975), involves the construction of shelter locations in the five concentrations of population in the county, with telephone, bicycle, and wheelchair facilities. Pick-up is restricted to these locations, although drop-off presumably could be at the rider's door if the driver is willing. Rural systems in general would operate all day. Either a low fixed fare or no fare may be charged.

Registration is possible, but may be unnecessary. Generally there is no transit in rural areas, and possibly no taxi service. This eliminates the problems with competition and at the same time increases the probable benefits of SRAT. The county or a private agency are possible implementing agencies.

The target markets for a rural SRAT system include: elderly, handicapped, student (all travel disadvantaged groups in areas without transit or taxi), and work trips. Telephone-aided matching is possible, and in rural areas the option of using CB radios is attractive as well.*

A final rural market for which SRAT service may be possible is local recreational trips within a designated area or a community. The service could be useful to those arriving by public transportation, or for children and others not having an automobile available for certain trips.

7. Legalization and Promotion of Hitchhiking Only

This is a possible minimum option for instituting SRAT, with no further steps being taken to organize a system. While this is the minimum effort approach, it is also likely to yield the least transportation impact. Many states have already legalized hitchhiking, and it should be possible for others to alter their laws.

*Use of CB radios appears to be legal as long as no fares are charged in the system.

B. General Operational Issues

This section presents operational approaches to the SRAT concepts described above. The operational approaches were suggested from the results of using a set of simple models described in Section C.

1. Fare Structure. Analysis indicates that fine gradations in fare structure are not necessary. A very simple structure should suffice: either a flat fare or zone fares with large steps for areas too large for a single fare.* Demand analysis indicates that fares should be quite low for most trips, and that expected SRAT vehicle occupancy is not high. Because drivers would not be carrying large amounts of money, cash fares are acceptable from the security point of view. This is certainly the simplest system to administer. Exact fare payment should be encouraged to simplify the transaction, but it need not be a fixed rule. Coupon systems appear to have few advantages over cash. Perhaps the only significant one is that, if the coupons are lottery tickets, drivers will see this as a larger economic incentive to participate than a straight 25 or 50 cent fare; one of the issues highlighted in the focus groups was that drivers found the economic incentive to participate in SRAT weak.**

With the typically low SRAT fares that appeared appropriate in the analysis, entry of jitneys into urban travel markets under the disguise of SRAT does not seem to be likely. If fare levels were high enough to support jitney operation in some area, and this was not desired, restriction of SRAT operation to rush hours only would eliminate the profit-making potential of the system.

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*Some SRAT systems, such as the employer-based and university systems, can have informal fare arrangements.

**Womack (1977) found that having money change hands was a significant deterrant to regular carpool arrangements.

Fares must also reflect the demands made upon drivers who must deviate from their shortest path to pick up and drop off passengers. In general, since attracting riders to the system appears to be more difficult than attracting drivers, drivers should be required to make some of these deviations for riders. If the demands on drivers become excessive, however, they will not participate even at a higher fare.

2. Matching System. In the options requiring visual matching of drivers and riders, several pieces of information must be exchanged between the driver and rider. This information may include:

- membership in the system
- driver's destination
- rider's destination
- willingness of driver to pick up rider
- willingness of rider to accept ride

The simplest option is for the driver, upon sighting a potential passenger, to pull over and ask the destination. This is probably feasible in low density or rural areas, where the number of participants is not large. Also, for many-to-one systems such as transit feeder or a restricted system such as a transit route replacement, there is no need to check destination.

In these cases, there may still be a desire for either the driver or rider to ascertain the registration of the other. The driver's vehicle could carry the following identification:

- bumper sticker,
- flag, or
- identification on the outside of the sun visor in the car.

The rider could carry or wear an identification card.

The willingness to give or accept a ride is an easier matter for the driver than the rider; the driver can simply not stop. On the other hand, the

rider has difficulty seeing the driver even after the driver stops. Then, if the rider does not want to accept the ride, he must communicate this to the driver in a more personal way. This could create an uncomfortable situation.

The next level of sophistication in visual matching is to introduce the use of signs. It is possible to have only the vehicles carry signs indicating their destination and possibly their route. Riders would then flag vehicles that could take them to their destination. A drawback to this system is that it would be almost impossible for riders to read signs or symbols on or inside vehicles during darkness, even at lighted stops, unless the vehicles were stopped. A prototype lighted vehicle sign was built for this study but proved impractical. Also, due to laws restricting or prohibiting windshield signs, such signs would not be easily visible even in daytime to many riders.

Systems serving a very limited number of destinations could have a small number of letter or color codes. However, for larger systems, it will be difficult to transmit all route and destination information, as discussed in the next section.

Rider signs indicating only destination are also possible. These may either be carried by riders, which the focus group interview indicated may be laughed at, or they could be fixed signs at stops. Either type could be reflectorized for use during darkness; prototype signs were built and were quite visible at distances of several hundred feet in auto headlights. It is suggested that the uniform traffic sign standards for "stop" signs (8-10 inch letters, depending on speed) be used.

Signs could also indicate "M only" or "F only" for riders willing to accept rides with male or female only; this was also viewed as silly by the focus group, however. Some matching system beyond drivers simply stopping and asking a rider's destination is probably needed in larger urban SRAT systems, since making multiple stops just to exchange information would be burdensome for drivers.

If telephone matching is used, it generally would operate through a centralized dispatcher. CB radio matching could be decentralized (agreement between rider and driver made directly), or there could be a centralized dispatcher as well to relay requests and offers of rides made at different times or by telephone.

3. Destination and Route Identification. There are two basic options in the structure of SRAT operations: zone and route classifications of riders and drivers. With a zone structure, the SRAT service area is divided into a set of zones; high-density or specialized locations could, of course, be designated specifically. Drivers for SRAT would have a destination sign for one of these zones and would pick up riders with the same destination. In this case, the driver is free to choose any path between the origin and destination; the exact dropoff arrangements in the destination area are discussed in section 4. A disadvantage of this system is that a rider going to some destination short of the driver's posted destination does not know if the driver's path takes him through his destination.

The other basic option to match drivers and riders is the route classification. In this system, the information carried on the auto denotes its path instead of its destination. Riders with destinations along the path

would be picked up, since they would also be displaying signs or otherwise indicating the path along which their destination lies. While this system has the advantage of letting any potential rider along the route use it, there are several disadvantages. First, a limited set of routes must be defined for drivers to follow; this may inconvenience or dissuade drivers. Indeed, driver paths simply may not be amenable to being classified in a route structure at all. Variations and operations on multiple routes must all be handled. Finally, if routes traverse areas with differing socio-economic characteristics, route matching may deter some potential participants.

Analyses were conducted to find the configurations of SRAT that would provide the best service level to potential drivers and riders. Service level is defined here as the wait time, walk time, and travel time to the passenger; and pick-up/drop-off and deviation times for the driver.

The first matching system analyzed is the zone system. Riders within the zone must walk to a single stop located at the center of the zone; all participating drivers must pass this stop and pick up riders going to their destinations. (The issue of whether drivers must pick up passengers destined for other points in the direction of their trip is deferred until the next section.) The critical variable that must be determined is, of course, zone size. As zone size increases, for example, the following tradeoffs occur:

- average rider walk time increases
- average rider wait time decreases, since more drivers will now pass the SRAT stop in the center of the zone
- average driver deviation time to pass the SRAT stop increases

By trading off these elements using weights based on people's observed reaction to walk, wait, and travel time, a "best" zone size can be estimated for various conditions. This zone size is very strongly dependent on the number

of drivers per square mile. If the number is large, zones can be small to keep walk and deviation times low, while still providing acceptable wait times. As driver density decreases, zone size must increase to keep the expected wait time low. This will increase walk and deviation times.

The results of the analysis of the zone system indicate that for most applications this concept cannot provide a good level of service to users even with high driver flows, because the need to walk to only a single point in a zone produced unacceptable walk times for riders. This result has obvious implications for lighting and other capital expenditures on stops, since a limited number of stops will not provide good service levels.

The second alternative matching system is a route system, in which certain streets are designated as the paths which SRAT vehicles will follow. Riders need only to walk to the nearest designated street running in the desired direction of their trip, and can hail a SRAT vehicle at any point along it. This system results in much lower walk times than the previous option, and can provide adequate service levels at high driver flows. With SRAT driver flows of five per hour from a one square mile origin area to a one square mile destination area, the following service levels for a one-way trip result:

average rider walk time = 9 minutes*
average rider wait time = 5 minutes**
average driver delay = 3 minutes

Routes are spaced approximately 0.9 miles apart at these driver flows. For comparison purposes, the corresponding values in the zone system were:

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*This is time to walk to pickup; dropoff at door for rider's destination assumed. In general, this arrangement appears to provide the best balance between providing good service to riders while not seriously inconveniencing drivers.

**This wait time can, in general, be expected to have an exponential distribution, and thus reliability may be a serious problem.

average rider walk time = 24 minutes
average rider wait time = 7 minutes
average driver delay = 2 minutes

A third alternative is to have multiple pickup points within a zone. In this option, SRAT stops are located throughout a zone such that the maximum rider walk distance is 0.25 mile, which is the typical "walk refusal distance" for transit service. SRAT drivers would be required to pass all stops in their origin zone and make all required stops to drop off passengers at the destination zone. This option places a much greater degree of inconvenience on the driver than the previous two options in order to improve rider service levels. Since it is likely to be more difficult to entice people to leave their cars at home and become SRAT riders than to merely switch to being SRAT drivers, placing a greater burden on drivers than riders may be appropriate.

Having multiple pickup points produces the best service levels for riders of any system. At the same driver flows as before, the service level is:

average rider walk time = 3 minutes
average rider wait time = 4 minutes
average driver delay = 8 minutes

The major drawback to the multiple stops per zone concept is that it can be used only at the driver's origin and destination zones; it is probably unreasonable to expect drivers to make extensive tours of intermediate zones to pick up and discharge riders. The route and zone options, however, work equally well with intermediate stops as with pure origin-destination matching.

Appendix B discusses the choice of zone size or route spacing in more detail. While only rough guidelines were given here, it is important to pay some attention to this element of structuring an SRAT system. All the above concepts will require signing to aid system operation and possibly even system

maps to aid drivers and riders. Simple color codes will not be adequate in most cases.

Turning to the issue of origin-destination matching versus use of intermediate stops, analysis of driver flows in sample U.S. cities indicates that there are many areas in which flows are not adequate to provide good service levels to passengers. Consequently, ways of increasing the effective density of SRAT rides available to riders must be explored.

One way to increase the ride density is to have drivers handle rider trips to and from intermediate points along their trip. A single driver trip can handle many rider origin-destination pairs, thus multiplying the effective amount of service. If intermediate stops are served by SRAT drivers, the effective amount of service available to riders is increased by an order of magnitude, and adequate service to riders exists in most areas, as long as driver participation is reasonable. Rider trips that are still not well served even with drivers serving intermediate stops are:

- trips not destined to areas that have greater than average concentrations of employment;
- longer "reverse commute" trips;
- many suburb-to-suburb trips; and
- trips near the fringes of the peak period.

Unless analysis in the actual site shows different results, the SRAT route or zone system should be structured so that service to these areas is de-emphasized.

A final route/zone option is the use of transfer points in the service areas, so that a rider trip might consist of three different vehicles: feeder, linehaul and distribution. While this option does concentrate driver and rider flows through a limited set of stops, it worsens the service level by introducing transfers, creating deviations in trips to pass by a transfer point,

and by requiring (presumably) three fares to be paid. In general, demand analysis showed the one-ride, route-designated system serving intermediate stops provides wait times averaging only a few minutes with moderate driver participation rates. Thus, unless one wishes to extend service to the cases mentioned above that are not well served in the route concept, the transfer point concept does not appear to be necessary.

4. SRAT Pickup and Dropoff Areas. With any kind of matching system, there are two basic choices in handling the point at which the driver and passenger make contact: line stops, in which a rider hails a driver (or the driver looks for passengers) anywhere along a specified street or route, and fixed stops, which are a specified point at which drivers and riders meet.

Several characteristics of line stops involve some tradeoffs. Being able to hail a SRAT vehicle at any point minimizes rider walk distance. However, it makes it more difficult to match people; drivers must be constantly on the lookout for riders, and riders may have to make strenuous efforts to attract drivers' attention, especially in bad weather or after dark. It will be difficult in most cases to provide pull-over lanes everywhere; thus, there may be objections on safety or traffic reasons from police or traffic departments. Passengers may also be tempted to stand out in the roadway to increase their visibility, also causing a safety problem and possibly violating hitchhiking laws. No shelters or lighting can be provided without fixed stops. Finally, dropoff of riders at any point is more feasible than pickup, since there is no matching problem, and the driver has more latitude in choosing the dropoff point than the pickup point, and would be able to pull over more safely.

Thus, it appears that fixed stops may have to be used in most circumstances. Where feasible, however, line stops can be used to provide a better service level to riders by decreasing their walk time. The facilities provided at stops will be dictated by the climate and the capital resources of the system.

5. Registration: Registration of SRAT riders and drivers is an important factor in implementing a SRAT system. While it is theoretically possible to register only drivers, or only riders, registering both is the preferred procedure.

The goals of a registration procedure are to protect SRAT members from traffic accidents and criminal incidents. Registration is discussed in detail along with other legal issues in Chapter IV.

6. Management Options. There are two major issues in SRAT management: how much management should be provided, and what institution(s) should manage the system.

The major management functions that a SRAT agency may perform include:

- registration of riders and drivers, including issuing and verifying applications, and issuing identification cards,
- promotion of SRAT,
- enforcement of operational rules, investigation and arbitration of complaints, and
- liaison with other regional, state, and local agencies.

Not all of these functions need to be undertaken by the management agency. For example, enforcement may be left to current police efforts and peer pressure; disputes may be left to the courts; and so on.

Chapter V provides a preliminary discussion of the possible institutions that could manage SRAT; these include private agencies or nonprofit corporations, transit operators or districts, cities, counties, state departments of transportation, special government agencies, employers, and others. Cooperation will be required from a set of other agencies, including state and local regulatory agencies, police, local traffic and highway departments, and state motor vehicle departments. The exact structure of the arrangements will vary markedly from site to site.

7. Anticipated SRAT Costs. The cost of a SRAT system will depend not only on the size of the system, but also on the sophistication of the system design and registration procedures, the extensiveness of the promotional campaign, the number of managerial personnel required, and the extent, if any, of insurance coverage for the managing agency or the participants. Estimated cost figures, indicating a range of effort, are listed below for each aspect of SRAT operation. The cost of implementing various SRAT systems ranges from about $5,000 to $150,000.

At the lower end of this continuum, SRAT potentially could be self-supporting by charging each person a fee to cover registration costs, utilizing existing agency personnel or volunteers, using cash instead of tickets, not using shelters, providing minimal liability insurance for the managing agency (to cover negligence) and securing the assistance of local merchants, citizens' groups, media and corporations (especially oil companies) in promoting SRAT. This type of system could cost very little and also help gain support, enthusiasm and participation from local community members.

At the upper end of the continuum, outside financial assistance would

be necessary to provide salaries for administrative personnel, construction and promotion expenses, printing of tickets and insurance coverage.

Registration Costs: $5-$25 per person, possibly covered by registration fees. These costs depend on whether criminal and driving records are checked, whether fingerprinting is required, and how sophisticated such items as identification cards, car stickers, and signs are.

Administration: $0-$25,000 annually. These costs vary widely, depending upon whether existing personnel or volunteers can be used.

Promotion Costs:

Mailing:

Low: 4,000 households	=	$ 500
Medium: 30,000 households	=	$ 4,000
High: 100,000 households	=	$13,000

(Costs can be lower if first-class mail is not used.)

Posters:

Low: provided by corporations	=	$ 0
Medium: $2 @ poster (black and white) x 500	=	$ 1,000
High: $5 @ poster (color) x 500	=	$ 2,500

Radio:

Low: public service announcements	=	$ 0
Medium: 10 times per week @ $20/minute for 3 wks.	=	$ 600
High: 20 times per week @ $50/minute for 3 wks.	=	$ 3,000

Newspaper Ads:

Low: have local papers write news or feature articles	=	$ 0
Medium: 1/16 page ad @ $300 each x 10	=	$ 3,000
High: 1/16 page ad @ $600 each x 10	=	$ 6,000

(Promotion Costs, cont'd.)

Shelters: $3,000 each ($2,000 structure, $1,000 installation)

Low: no shelters, warm climates	=	$ 0
Medium: 5 shelters	=	$15,000
High: 20 shelters	=	$60,000

(These costs will be higher in major urban areas.)

Signs:	5 signs	20 signs	100 signs
Low: $35 @ sign	$175	$ 700	$ 3,500
Medium: $35 @ sign + $20 installation	$275	$1,100	$ 5,500
High: $80 @ sign + $20 installation	$500	$2,000	$10,000

(These costs will be higher in major urban areas.)

Insurance:

Liability insurance for SRAT managing agency; only liability covered would be for negligence in screening. Limits: $100,000 bodily injury coverage per incident; $300,000 property damage coverage per incident.

	100 Participants	500 Participants	1000 Participants
Low: $.50/person	$ 50	$ 250	$ 500
Medium: $1.00/person	100	500	1,000
High: $2.00/person	200	1,000	2,000

Tickets:

Low: use cash	= $ 0
Medium: @ $.006 each- 500,000 tickets	= $3,000
High: @ $.006 each - 500,000 tickets + distribution machines at $500/each - 6 machines	= $6,000

It should be noted that many of these costs are one-time expenses only. The continuing costs consist of administration, insurance, maintenance of signs and shelters (not estimated), promotion (perhaps at a lower scale), and tickets (if used).

If a system has 500 members, 20 stops, a part-time administrator ($10,000 per year), free promotion except for mailing and a medium level of newspaper advertising, and liability insurance for the system, the annual cost per member would be about $31, spreading fixed costs over 5 years. $20 of this amount would go for administration, $7 for promotion, $3 ($15 pro-rated over 5 years) for registration, $1 for liability insurance, and less than $1 for signs at stops. In addition, high liability limits ($100,000 per person, $300,000 per accident) on a personal auto insurance policy would cost SRAT participants a considerable amount; the cost of $100,000/ $300,000 insurance is estimated by the Insurance Services Office to be 89% higher than the more typical $10,000/$20,000 limits carried by drivers of private autos.

C. Empirical Analysis of SRAT Operations

(Note: This section contains data in support of several issues discussed in the previous section. Readers not interested in technical details may proceed to section D.)

1. Basic Data

The study compiled data about travel patterns in several U.S. cities to form a background for analyzing the role and impacts of SRAT systems. The cities were chosen based on data availability, geographical distribution, and size distribution. Nine cities were selected, as follows:

Boston, Massachusetts
St. Louis, Missouri
Louisville, Kentucky
Seattle, Washington
Stockton, California
Fall River, Massachusetts
Manchester, New Hampshire
Oklahoma City, Oklahoma
Colorado Springs, Colorado

Table 1 shows basic home-to-work trip data as obtained from the 1970 U.S. Census for each area. Three modes of travel are shown: auto driver (AD), auto passenger (AP), and transit rider (T). The zone definitions are:

Zone 1 - CBD
Zone 2 - Central city, outside of CBD
Zone 3 - Rest of SMSA, outside central city
Zone 4 - Outside SMSA

Table 1

Source: 1970 Census

Daily Work Trips

SMSA	Mode	From Zone 2 to:				From Zone 3 to:			
		Zone 1	Zone 2	Zone 3	Zone 4	Zone 1	Zone 2	Zone 3	Zone 4
Boston	AD	5178	51729	30906	3054	17598	92138	389680	37488
	AP	1638	12218	6265	1053	4677	16639	71670	4852
	T	24083	61197	14831	1447	28623	45293	45350	2178
St. Louis	AD	4971	83662	29923	821	11668	135804	337986	8231
	AP	1855	24360	7910	199	3439	24667	56451	1185
	T	6076	34120	7270	178	3945	9129	10187	317
Louisville	AD	13587	49489	22040	1753	14625	53869	65776	4255
	AP	4130	11439	5002	352	2781	7424	12550	765
	T	6304	9135	2250	70	1411	750	1180	80
Seattle	AD	10562	116593	24133	2365	8723	103065	124039	7409
	AP	3476	19876	2990	442	2097	12099	13431	921
	T	10421	21037	1570	258	1737	2185	814	216
Stockton	AD	-	19293	7631	979	-	17397	25085	3817
	AP	-	2617	1303	126	-	1684	2964	426
	T	-	949	231	36	-	286	132	59
Fall River	AD	1766	13667	1084	6237	927	7262	3056	6056
	AP	517	5952	239	2008	153	1110	441	816
	T	327	1458	35	131	-	149	46	32
Manchester	AD	-	18498	1027	3585	-	3425	1035	1171
	AP	-	5403	326	542	-	665	253	198
	T	-	2212	78	54	-	140	39	27

Table 1 (cont.)

Source: 1970 Census

Daily Work Trips

SMSA	Mode	From Zone 2 to:				From Zone 3 to:			
		Zone 1	Zone 2	Zone 3	Zone 4	Zone 1	Zone 2	Zone 3	Zone 4
Oklahoma City	AD	9059	95607	10396	2131	4296	47330	33937	2219
	AP	2776	14242	1742	220	963	6267	3910	257
	T	960	2256	165	70	120	151	266	45
Colorado Springs	AD	-	31301	9335	661	-	14278	13276	726
	AP	-	3574	1142	71	-	1541	1601	96

Table 2 shows auto trip data for all trip purposes for these cities. Home-based work trips (HBW) are the number of one-way trips: there is a roughly equal number of work-to-home trips. Home-based other (HBO) trips (shopping, social/recreational, etc.) are given, as are non-home-based (NHB) trips and external trips (EXT) passing through the area. This data is derived from transportation studies for the various areas (PMM, 1972), which were done at various times and cover areas different from those in the Census data; thus, some minor differences in data will exist. Table 2 also gives average trip lengths, average auto occupancies, and the breakdown of total travel in each city by facility type: expressway, arterial, and collector.

Table 3 shows the land areas covered in the Census and the various transportation studies. The so-called 24 hour volume capacity (V/C) ratio of each area's highway system is shown as a measure of congestion and volume. The two-way average annual daily traffic (AADT) on arterial streets in each city can be derived from these estimates and is shown in the table.

Table 4 shows the percentage of work trips and all trips over the day for each city; note that peaking is very pronounced. Finally, Table 5 was produced as the end product of Tables 1-4. Table 5 shows the number of auto driver work trips from any one square mile area (of each zone) to any other one square mile area (of each zone) by time of day.*

Thus, in the hour beginning at 6:00 AM in Boston, there are eleven drivers per hour making work trips from each square mile of the central city (zone 2)

*The CBD is assumed to be one square mile in all cities in the absence of more reliable data for most of the cities shown.

to the CBD (zone 1). This computation assumes complete uniformity of trip origins and destinations over each zone.

This data forms the basis of the supply analysis. A general conclusion that emerges is that the average auto driver densities in U.S. cities are really quite low. A SRAT system could not operate in origin-destination trip-matching fashion with one square mile zones in most regions, even with 100% driver participation.

Two important conclusions are suggested by Table 5:

a) SRAT service is unlikely to be ubiquitous, but must be concentrated in areas where the driver density is significantly greater than the average, and/or

b) intermediate origins and destinations served by driver trips must be able to hail rides if an acceptable service level is ever to be achieved. This need to concentrate in higher-density markets will bring SRAT more into conflict with existing modes.

Table 2

Summary Travel Characteristics

Daily Auto Driver Trips:	Boston	St. Louis	Louisville	Seattle	Stockton	Fall River	Oklahoma City	Colorado Springs
HBW	1,147,000	800,000	271,000	456,000	56,000	32,000	217,000	66,000
HBO	1,861,000	1,171,000	343,000	856,000	126,000	90,000	596,000	173,000
NHB	1,006,000	371,000	165,000	435,000	72,000	58,000	357,000	71,000
Ext.	350.000	111,000	56,000	95,000	63,000	50,000	380,000	36,000
Census HBW	628,000	614,000	226,000	398,000	75,000	40,000	204,000	69,000
Trip Length*:								
HBW	28 8.0	31 8.2	25 6.3	25 7.6	16 4.2	13 2.5	29 5.3	16 4.3
HBO	19 3.9	19 4.6	20 3.7	16 4.2	12 2.6	11 2.0	23 3.1	13 2.9
NHB	19 4.1	21 4.9	19 3.8	16 4.2	13 2.5	11 1.7	24 3.2	12 2.5
Ext.	- 19.0	- 21.7	- 18.1	- 15.0	- 10.1	- 5.9	- 25.2	- 12.5
Occupancy:								
HBW	1.29	1.25	1.25	1.27	1.16	1.60	1.23	1.22
HBO	1.61	1.74	1.89	1.66	1.50	1.65	1.58	1.59
NHB	1.34	1.61	1.51	1.32	1.23	1.41	1.42	1.24
% of Trip:								
on expressway	32.2	-	-	21.8	19.9	11.7	-	-
on arterial	60.8	-	-	64.6	70.2	81.4	-	-
collector	7.0	-	-	13.6	9.9	6.9	-	-

Manchester: 31.0% expressway, 55.3% arterial, 13.7% collector.
Boston SMSA considerably smaller than Boston transportation study area; other comparisons acceptable.
* auto driver trips (min.) (miles)

Table 3

Summary Land Area Data

	Boston	St. Louis	Louisville	Seattle	Stockton	Fall River	Manchester	Oklahoma City	Colorado Springs
Land Areas: ($mi.^2$)									
Central City	60	50	50	80	25	20	30	300	64
Urbanized Area	1200	500	180	400	35	40	35	500	90
SMSA	1400	5000	1000	6000	900	150	120	1250	2000
Transportation Study Area	2500	1640	910	1000	190	110	220	1250	290
24-hour V/C ratio	0.64	0.48	0.44	0.49	0.26	0.59	0.30	0.30	0.23
AADT: (two-way)									
Average 2-lane Arterial	10000	7500	7000	8000	4000	9000	5000	5000	4000
Average 4-lane Arterial	20000	15000	14000	15000	8000	18000	9000	9000	7000

Table 4

Time-of-day Factors for Urban Travel

Hour	Boston		St. Louis		Louisville		Seattle		Stockton		Fall River		Oklahoma City		Colorado Springs	
	HBW	All	HBW	All	HBW	All	HBW	All	HBW	All	HBW	All	HBW	All	HBW	All
0	1.0	1.1	1.5	1.5	2.0	1.3	2.2	1.5	0.9	0.9	0.4	0.8	0.8	0.6	0.8	1.1
1	0.4	0.5	0.8	0.7	0.5	0.5	0.9	0.7	0.5	0.6	0.2	0.3	0.6	0.4	0.4	0.5
2	0.3	0.2	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.0	0.1	0.4	0.2	0.2	0.3
3	0.2	0.1	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.2	0.1	0.2	0.1	0.2	0.2
4	0.3	0.2	0.5	0.3	0.5	0.4	0.4	0.2	0.6	0.4	0.4	0.2	0.6	0.2	1.1	0.5
5	1.2	0.6	1.9	1.1	2.3	1.3	1.4	0.8	1.6	0.8	2.7	1.1	1.1	0.5	3.3	1.3
6	8.3	4.0	9.8	5.1	12.2	5.8	10.2	4.4	9.8	3.3	7.9	4.1	7.1	3.1	13.3	4.2
7	20.6	9.0	20.0	10.0	18.0	8.6	20.6	8.9	19.6	7.3	19.2	9.3	24.4	9.5	19.4	6.4
8	12.3	6.7	9.0	5.6	8.9	5.5	10.2	5.7	7.9	5.8	9.2	5.3	9.6	6.5	6.1	4.2
9	3.0	4.2	2.1	3.6	2.2	4.0	2.6	3.7	2.7	4.7	3.0	3.8	2.4	4.4	2.4	4.4
10	1.2	4.4	1.0	3.9	1.2	4.3	1.2	4.3	0.9	5.0	0.7	4.4	1.0	4.7	1.1	5.1
11	0.9	4.4	0.8	3.9	1.0	4.2	1.1	4.7	1.4	5.5	0.6	4.4	1.0	5.0	1.2	5.4
12	1.2	4.5	1.4	4.0	1.2	4.5	1.2	4.6	3.7	6.0	2.1	5.1	1.7	5.1	2.1	6.4
13	1.1	4.6	1.1	4.1	1.0	4.4	1.3	4.8	2.0	5.7	2.0	5.4	1.3	5.3	1.6	5.8
14	2.3	5.3	2.4	4.6	3.3	5.4	2.5	5.4	3.3	6.2	3.8	4.9	1.9	5.5	2.4	6.0
15	4.8	6.4	6.0	6.5	8.6	7.5	5.8	7.1	7.9	7.8	6.3	6.3	4.5	7.1	4.9	6.8
16	11.7	9.3	14.7	10.4	12.5	9.8	13.2	10.1	10.8	8.7	13.7	9.0	11.9	9.0	16.5	10.0
17	15.5	10.3	14.3	10.0	12.3	9.2	12.8	9.6	14.9	9.9	12.4	8.1	16.9	10.8	11.0	8.5
18	5.7	6.4	4.4	6.0	4.0	5.8	4.9	6.0	3.4	6.3	3.7	6.2	5.9	6.8	4.2	5.9
19	2.0	5.4	1.6	5.4	1.4	5.1	1.6	5.1	2.0	5.0	2.3	6.7	1.9	5.2	2.0	5.6
20	1.2	4.1	1.1	4.1	1.2	4.1	1.2	3.9	0.8	3.0	1.6	5.0	1.2	3.5	1.6	4.3
21	1.4	3.4	1.5	3.5	1.6	3.6	1.3	3.2	1.4	2.6	3.0	4.2	1.4	3.2	1.4	3.0
22	1.6	2.6	1.5	2.7	1.5	2.2	1.1	2.6	1.4	2.1	2.8	3.0	1.0	2.1	1.5	2.4
23	1.7	2.2	1.7	2.3	2.0	1.8	1.6	2.0	2.0	1.7	1.9	2.0	1.2	1.3	1.4	1.9
	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 5: Auto Drivers per hr. per Square Mile (O-D)

	BOSTON						ST. LOUIS						LOUISVILLE						SEATTLE					
	From 2 to:			From 3 to:			From 2 to:			From 3 to:			From 2 to:			From 3 to:			From 2 to:			From 3 to:		
Hr.	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
6 a.	11	1.5	0.06	2.7	0.2	0.05	16	4.3	0.2	5.1	1.0	0.3	52	2.9	0.6	27	1.6	0.9	27	3.7	0.2	6	0.8	0.2
7	28	3.8	0.15	6.6	0.5	0.13	32	8.7	0.4	10.4	1.9	0.7	76	4.3	1.0	41	2.3	1.4	54	7.5	0.4	11	1.7	0.5
8	17	2.3	0.09	3.9	0.3	0.08	14	3.9	0.2	4.7	0.9	0.3	38	2.2	0.5	20	1.2	0.7	27	3.7	0.2	6	0.8	0.2
9 a.	4	0.6	0.02	1.0	0.7	0.02	3	0.9	0.05	1.1	0.2	0.1	9	0.5	0.1	5	0.3	0.2	7	0.9	0.05	1	0.2	0.06
3 p.	7	0.9	0.04	1.5	0.1	0.03	10	2.6	0.1	3.1	0.6	0.2	37	2.1	0.5	19	1.1	0.7	15	2.1	0.1	3	0.5	0.1
4	16	2.2	0.09	3.7	0.3	0.08	24	6.4	0.3	7.6	1.4	0.5	53	3.0	0.7	28	1.6	1.0	35	4.8	0.2	7	1.1	0.3
5	21	2.9	0.12	5.0	0.3	0.10	23	6.2	0.3	7.4	1.4	0.5	52	3.0	0.7	28	1.6	1.0	34	4.7	0.2	7	1.0	0.3
6 p.	8	1.0	0.04	1.8	0.1	0.04	7	1.9	0.1	2.3	0.4	0.1	17	1.0	0.2	9	0.5	0.3	13	1.8	0.1	3	0.4	0.1

	STOCKTON						FALL RIVER						OKLAHOMA CITY						COLORADO SPRINGS					
	From 2 to:			From 3 to:			From 2 to:			From 3 to:			From 2 to:			From 3 to:			From 2 to:			From 3 to:		
Hr.	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
6 a.	-	6	1.2	-	2.7	2.0	7	1.4	0.1	3.7	0.7	0.3	4	0.2	0.02	3.1	0.1	0.1	-	3.9	0.6	-	1.0	0.5
7	-	12	2.4	-	5.5	3.9	17	3.5	0.3	8.9	1.8	0.7	15	0.5	0.08	10.4	0.4	0.4	-	5.7	0.9	-	1.4	0.7
8	-	5	1.0	-	2.2	1.6	8	1.7	0.1	4.3	0.9	0.4	6	0.2	0.03	4.1	0.2	0.2	-	1.8	0.3	-	0.4	0.1
9 a.	-	2	0.3	-	0.8	0.5	3	0.5	0.04	1.4	0.3	0.1	1	0.05	0.01	1.0	0.03	0.04	-	0.7	0.1	-	0.2	0.1
3 p.	-	5	1.0	-	2.2	1.6	6	1.1	0.09	2.9	0.6	0.2	3	0.1	0.02	1.9	0.1	0.1	-	1.4	0.2	-	0.4	0.2
4	-	7	1.3	-	3.0	2.2	12	2.5	0.2	6.3	1.3	0.5	7	0.3	0.04	5.1	0.2	0.2	-	4.9	0.8	-	1.2	0.6
5	-	9	1.8	-	4.1	3.0	11	2.2	0.2	5.7	1.2	0.5	10	0.4	0.06	7.3	0.3	0.3	-	3.3	0.5	-	0.8	0.4
6 p.	-	2	0.4	-	0.9	0.7	3	0.7	0.05	1.7	0.3	0.1	4	0.1	0.02	2.5	0.1	0.1	-	1.2	0.2	-	0.3	0.2

Zone 1 - CBD

Zone 2 - Central city, excluding CBD

Zone 3 - Urbanized area, excluding central city

2. SRAT Route and Stop Analysis

This section summarizes key findings for SRAT route and stop locations. The analysis depends on simple formulations of rider wait and walk times, and driver pickup and drop-off times as a function of driver and rider flows. These relationships are summarized below, with derivations given in appendix B.

Let K = rider walk time from home to SRAT stop (min.) expected
W = rider wait time for ride to destination at SRAT stop (min.)
T = extra driver time required to pass SRAT stops to search
A = area around each SRAT stop from which riders are drawn ($mi.^2$)*
ρ = driver flow rate (drivers/hour/$mi.^4$) as defined in section II.B.1.
M = maximum walk distance for SRAT riders to SRAT stop (min.).

Relationships for K, W, and T as a function of A, ρ, or M are shown for three SRAT route/stop options:

- one stop per zone, in which a single designated pickup and drop-off point serves riders from a surrounding area (zone),
- one route per zone, in which pickup and dropoff are allowed at any point along a single route (street) through a zone,
- multiple stops per zone, in which several pickup and dropoff points are established in each zone (not necessarily along a single street) and all SRAT drivers are required to pass all of these points; this is the only option in which drivers are required to deviate from their normal path.

Table 6 shows K, W, and T, and Figure 1 graphs these relationships. As can be seen, there is a tradeoff between rider wait time, and rider walk time and extra driver time as zone size (A) varies. Furthermore, by weighting K, W, and T appropriately, a "best" zone size A as a function of driver flow ρ can be determined for each of the three stop options outlined above. These three options can then be compared and recommendations made as to a "best" option. Appendix B again gives details of

*Passengers are always assumed to walk to the nearest SRAT stop from their origin.

Figure 1

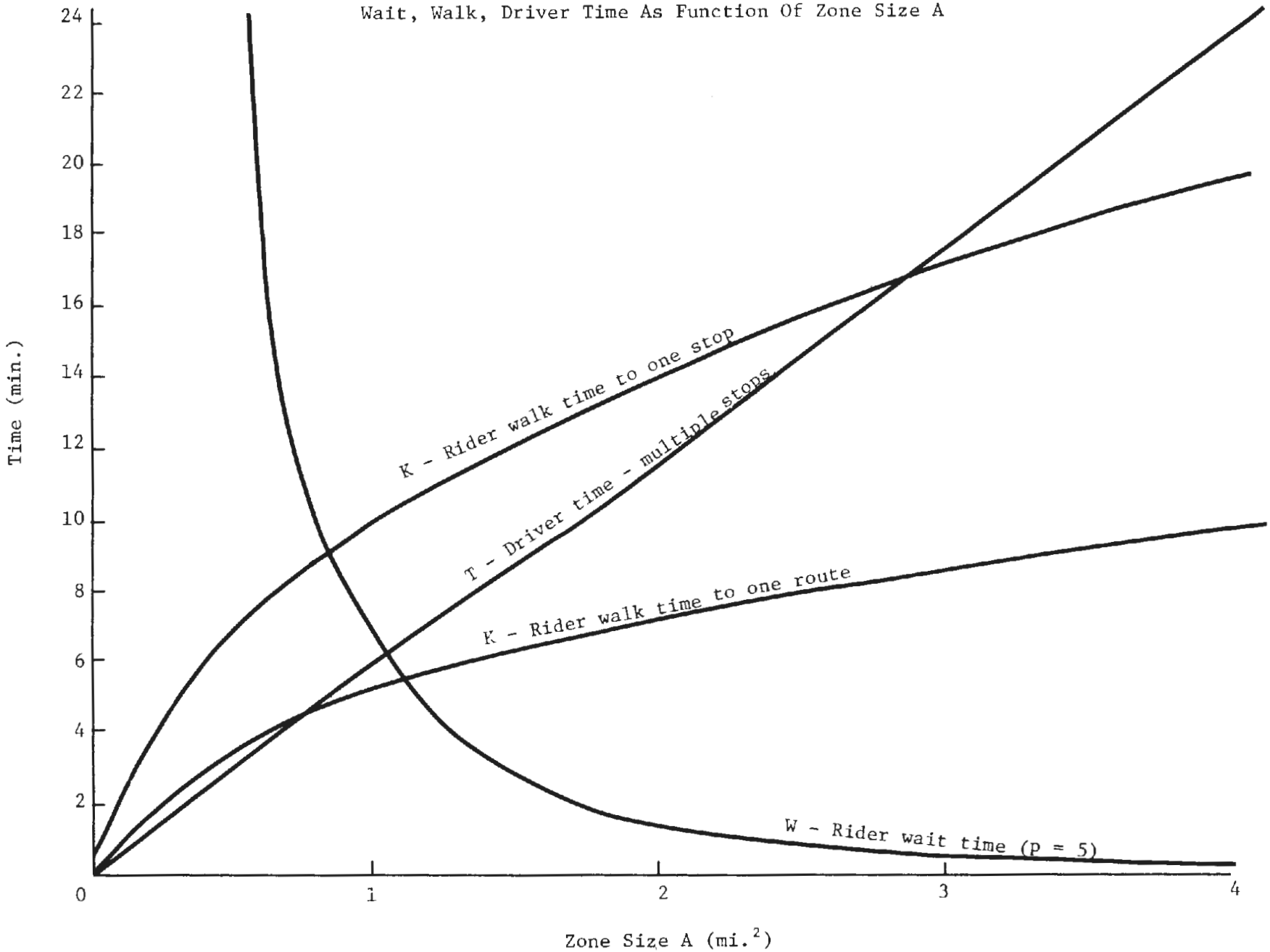
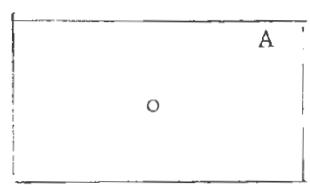

Wait, Walk, Driver Time As Function Of Zone Size A
Time (min.)
24
22
20
18
16
14
12
10
8
6
4
2
0
1
2
3
4
Zone Size A (mi.²)
K - Rider walk time to one stop
T - Driver time - multiple stops
K - Rider walk time to one route
W - Rider wait time (p = 5)

Table 6

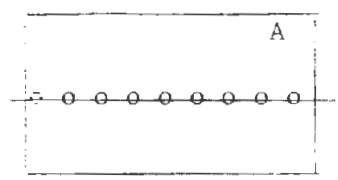
Summary of Wait, Walk and Driver Times
for SRAT Stop Configurations

Stop Option	Walk Time K	Wait Time W	Driver Time T
One Stop	$10\sqrt{A}$	$30/\rho A^2$	0
One Route	$5\sqrt{A}$	$30/\rho A^2$	0
Multiple Stops	10M	$30/\rho A^2$	6A

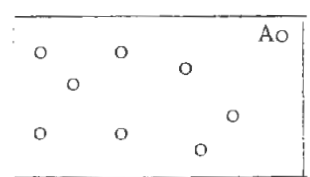
One Stop:



One Route:



Multiple Stops:



of these computations.

Table 7 summarizes the wait, walk, and driver times at various levels of driver flow ρ, using the following weights c for K, W, and T:

$c\ (W) = 1$

$c\ (K) = K$

$c\ (T) = 1$

Wait time and driver time are weighted equally. Walk times are given a proportionally higher weight as the time increases. A one-minute walk is weighted the same as wait or driver time, but a two-minute walk is weighted four times as much as a one minute walk:

$c(K)\ .\ K = K^2$

These weights were chosen based on travel demand coefficients and on the observed fact that transit ridership falls sharply with walk distance. They reflect our best judgment at this time. However, these weights are very uncertain for SRAT service, and appendix B outlines how to use alternative weights.

Referring to Table 7, in the one stop per zone options, even at driver densities of 20-50 drivers/hour/mile[4], the average walk distance is about 1/4 mile (5 minutes), with the maximum walk being about 1/2 mile. Also, even at $\rho = 50$, the average rider wait time, assuming uniform headways, is 15 minutes. With some variability in the arrival rate of drivers which must be expected, actual wait times may sometimes be more than a half hour. Thus, the single stop per zone SRAT does not appear very attractive.

Table 7

Service Levels Produced by SRAT Stop Configurations

Driver Flow ρ	One Stop: Area A* ($mi.^2$)	Wait W (min.)	Walk K (min.)	Driver T (min.)	One Route: Area A* ($mi.^2$)	Wait W (min.)	Walk K (min.)	Driver T (min.)	Multiple Stops: Area A* ($mi.^2$)	Wait W (min.)	Walk K (min.)	Driver T (min.)
0.1	1.8	92.6	13.4	0	2.9	35.7	8.5	0	4.6	14.2	2.5	27.6
0.5	1.1	50.0	10.5	0	1.7	20.8	6.5	0	2.7	8.2	2.5	16.2
1.0	0.8	46.9	8.9	0	1.3	17.8	5.7	0	2.2	6.2	2.5	13.2
5.0	0.5	24.0	7.1	0	0.8	9.4	4.5	0	1.3	3.6	2.5	7.8
10.0	0.4	19.4	6.3	0	0.6	8.3	3.9	0	1.0	3.0	2.5	5.0
20.0	0.3	16.7	5.5	0	0.5	6.0	3.6	0	0.8	2.3	2.6	4.8
50.0	0.2	15.0	4.5	0	0.4	3.8	3.2	0	0.6	1.7	2.5	3.6

A* - " optimal" zone size for given driver flow ρ and stop configuration.

The "one route per zone" option provides better wait and walk times at every driver flow and is thus preferred on service level grounds, although legal, institutional, or safety considerations may require the use of single designated stops.

In the "multiple stops per zone" option, SRAT stops are located throughout an SRAT zone such that the maximum walk distance M is 1/4 mile. All drivers must pass all stops at the origin, and make all required stops to drop off passengers at the destination. Note that, unlike the previous options, this scheme can be used only at the origin zone and destination zone of each driver's trip as only a single stop is reasonable in intermediate zones. Thus, the system will operate with "pure" O-D matching of riders and drivers with no intermediate stops. This option provides the best service levels of the three alternatives, but requires, in some cases, considerable extra driver time, which may dissuade their participation.

3. Alternative Means for Matching Riders and Drivers

The analysis presented in the previous section indicated that means to raise the driver flow rate ρ seen by SRAT riders should be explored, as SRAT does not appear to provide good service levels at low driver flow rates. Furthermore, Table 5 had indicated that driver flow rates are often quite low in typical U.S. cities.

The effective amount of SRAT service can be multiplied dramatically by drivers handling intermediate stops on their trips. A single driver trip can serve many rider origin-destination pairs. The details of the analysis of the effect of intermediate stops on service levels are presented in appendix B. The results of the analysis are shown in Table 8. The effect of intermediate stops varies with trip length, as a driver trip can serve many short trips along its path, but only a few longer trips.

The first column of Table 8 shows trip length relative to the regional average trip length L. L is typically 5 to 8 miles for work trips.

The second and third columns show a typical trip length distribution for an urban area; this is another element in the computation. The fourth column labeled "ride density" shows the combined effect of trip length distribution and the handling of intermediate stops on the driver flow ρ seen by SRAT riders wishing to travel various distances. If the regional average driver flow is, say, 2.5 drivers/hr./mi.^{4}, a SRAT rider wishing to go 0-0.2L miles, would have an effective driver flow of 123.2 . 2.5, or 308. A rider wishing to travel 1.0-1.2L miles would see a driver flow of 11.3 . 2.5, or 28. By referring to Table 7, wait and walk times corresponding to these values of ρ can be found.

The effect of intermediate stops is therefore quite large, increasing effective driver flow by an order of magnitude over that provided by strict origin-destination matching.

4. Example Case Study: St. Louis

Table 9 shows average SRAT rider wait times by hour in St. Louis. The table assumes:

- 100% driver participation, as a limiting case,
- a "single route per zone" service configuration
- drivers will pick up and drop off passengers at intermediate points along the driver's trip,
- a zone size (A) of approximately 0.6 mi.^{2} (0.8 mi. by 0.8 mi.) is used for the computations; an average rider walk time of 4 minutes both at the origin and destination results,
- 30% of the average driver trip is on an expressway, on which no intermediate stops are made.

Inspection of the table shows that high driver participationis critical for most suburban SRAT service and the longer central city trips. Low driver participation may cause very low service levels in these cases.

Table 8

Effect of Intermediate Stops on SRAT Service

Trip Length	Proportion of Total Trips	Cumulative Proportion of Trips	Ride Density
0-0.2L	.062	.062	123.2
0.2-0.4L	.129	.191	79.9
0.4-0.6L	.146	.337	51.0
0.6-0.8L	.138	.457	31.9
0.8-1.0L	.119	.594	19.4
1.0-0.2L	.098	.692	11.3
1.2-1.4L	.077	.769	6.2
1.4-1.6L	.060	.829	3.1
1.6-1.8L	.045	.874	1.3
1.8-2.0L	.034	.908	0.4
>2.0L	.092	1.000	-

Table 9

SRAT Wait Times for St. Louis

	From 2 to:									From 3 to:								
	1			2			3			1			2			3		
Distance:	2[a]	5[a]	10	2	5	10	2	5	10	2	5	10	2	5	10	2	5	10
Hour:																		
6 a.m.	0.5	4.8	-	0.3	0.7	3.4	5.6	14.0	72.2	-	-	2.8	1.1	2.8	14.4	3.7	9.4	48.2
7	0.3	2.9	-	0.1	0.3	1.7	2.8	7.0	36.1	-	-	1.4	0.6	1.5	7.6	1.6	4.0	20.6
8	0.6	5.7	-	0.3	0.7	3.7	5.6	14.0	72.2	-	-	3.1	1.3	3.1	16.1	3.7	9.4	48.2
9 a.m.	2.8	26.7	-	1.3	3.1	16.1	22.4	56.2	289.0	-	-	13.1	5.6	14.0	72.2	11.2	28.1	144.0
3 p.m.	0.9	8.6	-	0.4	1.1	5.6	11.2	28.1	144.4	-	-	4.7	1.9	4.7	24.1	5.6	14.0	72.2
4	0.4	3.8	-	0.2	0.4	2/3	3.7	9.4	48.2	-	-	1.9	0.8	2.0	10.3	2.2	5.6	28.9
5	0.4	3.8	-	0.2	0.4	2.3	3.7	9.4	48.2	-	-	2.0	0.8	2.0	10.3	2.2	5.6	28.9
6 p.m.	1.2	11.5	-	0.6	1.5	7.6	11.2	28.1	144.4	-	-	6.3	2.8	7.0	36.1	11.2	28.1	144.0

Times in minutes.

a) assumes no suburban drivers pick up or drop off

Zone 1: CBD
Zone 2: Rest of central city
Zone 3: Urbanized area outside central city

D. Comparison of SRAT with Other Paratransit Modes

The study explored the tradeoffs between SRAT and other paratransit modes in terms of cost, time, vehicle occupancy, vehicle-miles travelled, and other indicators. For work travel, SRAT was compared to carpooling and vanpooling, and for nonwork travel SRAT was compared to dial-a-ride. Rigorous comparisons were not possible in either case because travel demand, supply, and cost models for these modes are either experimental or nonexistent, and empirical evidence is also highly variable and site-dependent.

Table 10 gives a summary of the key service characteristics of the modes. All the entries in Table 10 are intended to be representative of the typical situations in which each mode is used. Specific cases will exist in which the general characteristics shown in Table 10 will not apply.

While SRAT provides the best travel time of the three work-trip modes shown, it has wait and walk time components that the others don't. SRAT's better flexibility is also traded off against the other modes' better reliability and security. Finally, SRAT costs per user and vehicle occupancy are not likely to be as favorable as the other modes', but are still better than those of single occupant auto. Thus, this table points out SRAT is a desirable mode if travel time savings and flexibility are the key considerations, but that carpool or vanpool programs will be preferred if wait time, walk time, reliability, and security are more important.

While no comparison with conventional transit is shown, SRAT is preferred with respect to travel time, while transit is preferred as regards reliability and security. All other attributes may favor either SRAT or transit, depending

Table 10

Comparison of SRAT and Other Paratransit Modes

Work Travel

	MODE		
Attribute:	SRAT	Carpool	Vanpool
Travel time (in-vehicle)	near auto, little pickup time	near auto, slightly more pickup time	substantially greater than auto
Wait time	dependent on driver flow, variable	none	none
Walk time	usually several minutes	almost none	almost none
Reliability	driver arrivals variable	good	good
Flexibility	multiple departures	single departure	single departure
Security	possible problems	excellent	excellent
Cost per user	low, if sufficient occupancy	expected to be lower than SRAT	lowest, due to highest occupancy, even with higher vehicle costs
Vehicle occupancy	variable, 1-4, average may be less than 2	stable, 2-4 average near 3	stable, 8-15

Table 10 (cont.)

Nonwork Travel

Attribute	MODE	
	SRAT	Dial-a-Ride
Travel time (in-vehicle)	near auto	substantially greater than auto
Wait time	dependent on driver flow, variable	dependent on system, predictable
Reliability	driver arrivals variable	good, some variability in pickup and travel time
Flexibility	multiple departures	ride availability usually certain, advance request often required
Security	possible problems	excellent
Cost per user	low	higher due to labor costs
Vehicle occupancy	variable, 1-4, average may be less than 2	variable, 1-20, typically average 3-8 passengers/hr.

on site-specific factors.

Turning to the nonwork mode comparison, almost the same tradeoffs exist as in the work case. SRAT provides better travel times, possibly better wait times, flexibility (although this is system-specific), and probably lower costs. Dial-a-ride is preferred on its walk time, reliability, and security.

It is difficult to assess the importance of the attributes shown in Table 10 in any general way, and thus the choice of system will be influenced by local conditions and assessment of the attributes. Previous research in demand modelling has indicated that wait times and walk times are more important to users than in-vehicle travel times. Costs in many cases are found to be less important than travel times. Security is often rated very highly in attitude surveys in transportation research, but its relationship to other attributes is not clearly established. The relative importance of reliability and flexibility has not been well established.

III: POTENTIAL USAGE OF SRAT

Chapter 3 presents multiple approaches to assessing potential driver and rider demand for SRAT. Section A describes the disaggregate demand model used for the analysesin Sections B and C. Section B undertakes a prototypical household analysis of the SRAT supply/demand equilibrium process. This quantitative analysis is first conducted in a simplified setting. Later, a variety of policies, each designed to enhance the attractiveness of SRAT, are introduced and their effect on SRAT supply and demand potential is analyzed. Section C extends the use of the disaggregate model to case studies using data from four U.S. cities. Section D presents empirical evidence of SRAT demand from SRAT-like systems in Pittsburgh, Pennsylvania & Ft. Collins, Colorado, Last, Section E outlines the results of focus group interviews of suburban Boston residents conducted to assess consumer reaction to the SRAT concept.

A. Demand Modelling Strategy

An analysis of SRAT demand must explicitly address both the demand for passengers and the supply of drivers. The supply and demand for SRAT service are strongly interrelated. Consider, for example, the "experimentation" process after the introduction of SRAT service when some commuters shift modes in an attempt to find the best service. If, after an initial entry of a certain size SRAT driver fleet, the short run equilibrium results in a high system ridership and a commensurately high revenue for drivers, additional drivers may be induced to enter the market. Conversely, if after an initial entry of a certain number of SRAT passengers, passenger wait times are relatively low (i.e., because of a large SRAT driver fleet), more commuters may be induced to use SRAT as passengers. Because of their strong interrelationship, the study modelled both the SRAT driver demand and the SRAT rider demand simultaneously.

Three variables represent the linkage between SRAT riders and SRAT drivers:

- SRAT rider wait time is inversely proportional to the number of SRAT drivers;
- SRAT driver revenue is proportional to the number of SRAT riders;
- SRAT driver (and rider) travel time increases with the number of riders picked up and dropped off.

A simple "equilibrium" model was constructed to examine likely driver and rider participation. Commuters were assumed to have six choices of mode to travel to work:

- auto driver, alone

- auto driver in carpool
- auto driver for SRAT
- auto passenger in carpool
- auto passenger in SRAT
- transit passenger (when transit is available)

Each of these six modes was described by three level of service variables:

- in-vehicle travel time
- out-of-vehicle travel time (walk, wait, transfer)
- out-of-pocket travel cost.

Three market segments based on auto ownership level (0,1, and 2+ autos) were used to represent the variation in socio-economic characteristics (income, household size, auto ownership, number of workers, etc.) that also affects mode choice to work. Analysis was then done in several case studies to predict the probabilities of using any of the six travel modes under varying conditions.

A disaggregate behavioral demand model was used in this "equilibrium" model to predict these probabilities. The model was calibrated in Boston, Massachusetts, on existing ridesharing behavior, which is assumed to hold for SRAT as well. Needless to say, the original observations in the data set of shared ride drivers and passengers did not represent SRAT patrons; they consisted of carpoolers and/or intra-household ride sharers. The two SRAT modes (driver and rider) were added to the model after calibration. This mode split model was employed in the analysis because it appears to be the only disaggregate logit work mode split model which explicitly incorporates both shared-ride driver and shared-ride passenger modes. The model specification and estimation results are shown in Tables 11 and 12 respectively. The values of time implied by the estimated model coefficients are displayed in Table 13.

Table 11

Work Mode Choice Model

Definition of Variables

Variable Code		Definition
D_{da}	=	1 for drive alone 0 otherwise
D_{srd}	=	1 for shared ride driver 0 otherwise
D_{srp}	=	1 for shared ride 0 otherwise
IVTT	=	Round trip in-vehicle travel time (in minutes)
OVTT	=	Round trip out-of-vehicle travel time (in minutes)
$OPTC_{da}$	=	Round trip out-of-pocket costs for drive alone & shared ride driver (in cents)
$OPTC_{srp}$	=	Round trip out-of-pocket costs for shared ride passenger (in cents)
$OPTC_{t}$	=	Round trip out-of-pocket costs for transit (in cents)
$AUTOS_{da}$	=	Number of household autos (in drive-alone utility function)
$APERW_{srd}$	=	Autos per worker (in shared ride driver utility function)
$APERW_{srp}$	=	Autos per worker (in shared ride passenger utility function)
$HHSIZE_{sr}$	=	Household size (on srd and srp utility functions)

Table 12

Work Mode Choice Model

Estimated Coefficients

Variable Code	Coefficient	t-Statistic
D_{da}	-1.362	-5.54
D_{srd}	-1.998	-6.38
D_{srp}	- .8095	-2.83
IVTT	- .3887E-01	-3.69
OVTT	- .1122	-9.12
$OPTC_{da}$	- .1259E-01	-7.01
$OPTC_{srp}$	- .8626E-02	-4.20
$OPTC_{t}$	- .4680E-02	-0.89
$AUTOS_{da}$	0.7950	6.36
$APERW_{srd}$	0.1656	0.78
$APERW_{srp}$	- .9764	-4.49
$HHSIZE_{sr}$	0.5950E-01	1.51

Table 13

Values of Time in Dollars Per Hour

Derived from the Work Mode Split Model

Mode	Value of In-Vehicle Time	Value of Out-of-Vehicle Time
Auto Driver	$1.85	$5.35
Shared Ride Driver	1.85	5.35
Shared Ride Passenger	2.70	7.78
Transit	4.98	14.38

While one cannot be confident of the accuracy of the results of demand prediction for a transportation mode that does not currently exist, some assumptions can be made to provide a basis for examining and comparing various SRAT alternatives. In the demand model, the auto-driver-carpool and auto-driver-SRAT modes have the same utility equation; that is, if they had the same time and cost attributes, they would attract equal shares of the travel market. This assumes that people percieve these two choices in the same way with respect to non-measured attributes such as safety, reliability, comfort, and flexibility. Likewise, the auto passenger-carpool and auto passenger-SRAT utility equations are the same; again this assumes that people perceive the non-measured attributes of the two choices as equal. This is a tenuous assumption, as perceptions of safety, reliability, and flexibility are probably not the same for SRAT and carpooling; to the extent that these factors are more or less negative for SRAT as compared to carpooling, SRAT demand will be over- and under-predicted, respectively.* Sensitivity analysis was performed with the SRAT passenger mode being given the same utility equation as transit passenger; this assumes that SRAT and transit are perceived as equal in their non-measured attributes. The sensitivity analysis indicated that use of the transit passenger utility produced higher SRAT passenger volumes, but the overall difference in predictions was not large.

A long run aspect of the demand/supply equilibrium of SRAT service that is not modelled but bears mentioning is the effect of the SRAT system on automobile ownership. Prior research (Cambridge Systematics, 1976)

*The focus group interviews (Section II.E) indicate that SRAT is perceived less favorably than carpooling,

has indicated that policies designed to increase vehicle occupancy can have the ancillary long run effect of decreasing automobile ownership. In particular, in multi-vehicle households where the primary worker joins a carpool (or in our case, becomes an SRAT passenger), the household may decide to sell "the second car." In a SRAT system, however, the analysis of long run effects on automobile ownership is somewhat complicated by the fact that in households where the primary worker enters the SRAT market as a driver, household automobile ownership could conceivably increase.*

One last point should be raised with regard to the effects of SRAT service on work mode choice and automobile ownership. Research on the impacts of various carpool incentive programs (Cambridge Systematics, 1976) indicated that most of these policies had the desired effect of increasing work trip vehicle occupancy, decreasing work trip VMT, and to some extent reducing automobile ownership. But it was also found that non-work travel tended to increase in response to the carpool incentive programs because of the increased auto availability to non-workers in households where the primary worker joined a carpool. This effect was not modelled in this study, and is not included in the VMT summaries at the end of this section.

*If SRAT utilization and revenue are high, some households may purchase a new car, using anticipated SRAT revenues to recover part of the capital and operating costs of the new vehicle.

B. Preliminary Analysis

For this preliminary analysis, a simplified approach was adopted for predicting mode shares using the work mode split model presented in the last section. The main features of this approach are as follows:

1. A prototypical household analysis was conducted. Thus, for the household descriptor variables included in the model (e.g., number of autos, household size, autos per worker), values representative of different types of households were assumed. The results from this type of analysis may be interpreted as showing how different homogeneous classes of households would respond to SRAT service. In reality, there exists a distribution of household types (with respect to auto ownership, number of workers, household size, etc.) within any geographical area. And, it may be expected that households with differing characteristics will respond differently to SRAT. The analysis results presented here are thus suggestive if not conclusive of expected SRAT demands.

2. Representative values of level of service (LOS) were assumed for the prototypical households. For example, auto driver in vehicle times were computed by assuming a (peak-hour) average speed of 30 mph and auto costs were based on a six cents per mile figure. Note that each mode is represented by three components of LOS: in-vehicle time (IVTT), out-of-vehicle time (OVTT), and out-of-pocket travel cost (OPTC). For the auto driver and transit modes, each of these values were set a priori. For the SRAT passenger (srp) mode, fare was set*, as was IVTT.** However, the out-of-vehicle travel time component for

---

*And parametrically varied in the analysis which follows.

**Assumed equal to auto driver INVTT.

SRAT passengers ($OVTT_{srp}$) was computed as a function of the number of SRAT drivers. Specifically,

$$(1) \quad OVTT_{srp} = K_{srp} + \frac{60}{\rho_{srd}}$$

where

K_{srp} = round trip SRAT passenger walk time in minutes

ρ_{srd} = number of SRAT driver vehicles per hour connecting SRAT passengers' desired origin and destination

For SRAT drivers, both OVTT and OPTC were computed as a function of the number of SRAT passengers.* For OVTT, although it is not strictly out-of-vehicle time, it was assumed that the possible circuity to collect and distribute passengers, stop time, fare collection and record keeping (if necessary) would require one minute of SRAT driver time per passenger. Thus,

$$(2) \quad OVTT_{srd} = K_{srd} + 2 * \frac{N_{srp}}{\rho_{srd}}$$

where

$OVTT_{srd}$ = round trip SRAT driver out-of-vehicle time in minutes

K_{srd} = round trip SRAT driver walk time in minutes

N_{srp} = number of SRAT passengers per hour between the driver's desired origin and destination

$\frac{N_{srp}}{\rho_{srd}}$ = average number of passengers per driver between the driver's desired origin and destination**

*IVTT for SRAT drivers was assumed to be equal to auto driver time.

**The factor of two represents one minute of OVTT per passenger on both the inbound and outbound leg of the round trip work commute.

SRAT driver cost was derived by computing the difference between out-of-pocket driving costs and expected fare revenues:

$$(3) \qquad OPTC_{srd} = cpm*D - 2*f*\frac{N_{srp}}{\rho_{srd}}$$

where

$OPTC_{srd}$ = round trip SRAT driver out-of-pocket travel costs in cents

cpm = cents per mile operating cost

D = round trip work commute distance in miles

f = SRAT fare

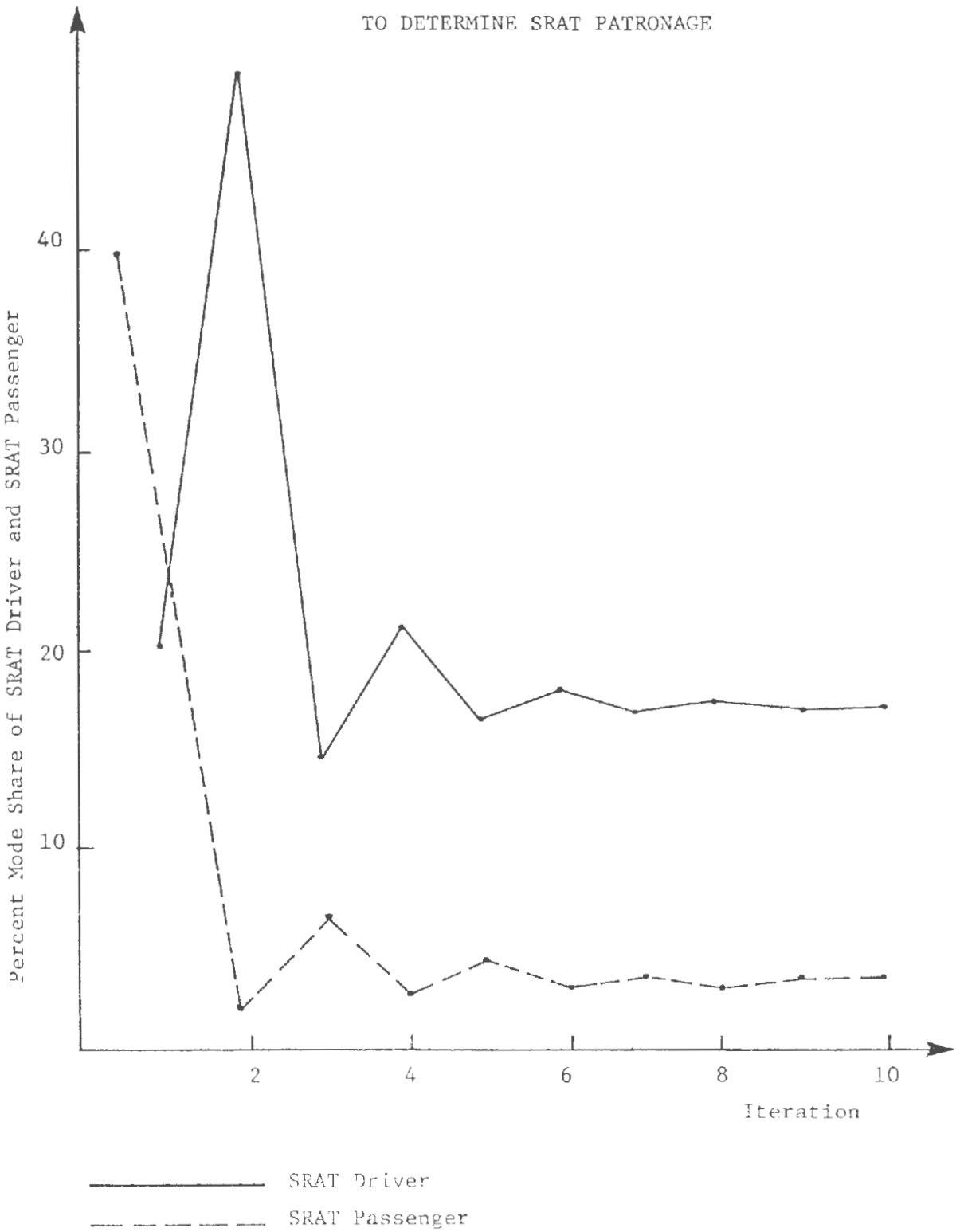
Note that if system utilization is sufficiently high, SRAT driver "cost" can be negative indicating a profit for supplying SRAT service.

3. Because LOS components for either SRAT mode (i.e., driver or passenger) depended on the demand for the other SRAT mode, an iterative equilibrium procedure had to be adopted. Basically, initial SRAT driver and passenger demands were used to compute LOS for both modes. Then the demand model was applied to predict revised SRAT patronage which in turn was used to recompute LOS as input to another demand prediction iteration. Figure 2 displays an example of one iterative solution for SRAT demand equilibrium.
4. Only 4 modes were used in the demand model: auto driver alone, auto driver-SRAT, auto passenger-SRAT, and transit. Thus, the conventional ride-sharing modes are not included and all ride-sharing is assumed to occur as SRAT. This is intended only to simplify the preliminary analysis; the full 6-mode model is used later.

Figure 2

ITERATIVE EQUILIBRIUM PROCEDURE

TO DETERMINE SRAT PATRONAGE



In order to quantitatively examine the SRAT supply demand equilibrium process and identify the key determinants of SRAT passenger demand and SRAT driver supply, analyses were performed on two types of prototypical households: an outer suburban household and an inner suburban household. As explained earlier, the results from a prototypical household analysis may be interpreted as indicating the aggregate demand response from a homogeneous group of households with a particular (prototypical) set of characteristics. Table 14 displays the socioeconomic and level of service characteristics assumed for the two prototypical household types. The outer suburban household has relatively high automobile ownership (average = 1.7). Average line haul speeds for auto and transit are higher for the outer suburban household but so too are the average walk times for SRAT passenger and transit modes.*

Results from the prototypical household analysis for the outer suburban household are displayed in Table 15 and Figure 3 for a range of SRAT fares and origin-destination trip densities. The results indicate that:

- SRAT passenger demand increases with O-D person trip densities but at a decreasing rate. Note that in this analysis we have parameterized total origin to destination (work trip) flow rather than SRAT driver flow because we are (simultaneously) predicting SRAT driver and passenger demand.
- SRAT driver demand also increases with O-D flow at a decreasing rate. The analysis indicates that SRAT driver demand is relatively insensitive to fare level but in fact lower fares attract more SRAT drivers. This is because SRAT passenger demands were elastic with respect to

*It was assumed that housing and arterial densities were higher in the inner suburban area.

Table 14

DESCRIPTION OF THE PROTOTYPICAL HOUSEHOLDS

	OUTER SUBURBAN	INNER SUBURBAN
SOCIO-ECONOMIC CHARACTERISTICS		
Auto Ownership	1.7	1.2
No. of Workers	1.25	1.1
Household Size	3.9	3.9
LEVEL OF SERVICE CHARACTERISTICS		
Distance to CBD Work Place (One-Way)	10 miles	5 miles
Line Haul Highway Speed (Applicable to Auto Driver & SRAT Modes)	30 mph	25 miles
Auto Operating Costs (Applicable to Auto and SRAT Driver Modes)	6 cents/mile	6 cents/mile
Transit Average Speed	17.5 mph	15 mph
SRAT Fare	$1.00	$1.00
Round Trip Out-of Vehicle Time		
Auto Driver	4 minutes	4 minutes
Transit	18 minutes	13 minutes
SRAT Driver (Walk Time only)*	4 minutes	4 minutes
SRAT Passenger (Walk Time only)*	12 minutes	10 minutes
Transit Fare	75 cents	75 cents

*Total OVTT for SRAT driver and passenger computed according to equations 2 and 1 respectively

Table 15

WORK TRIP MODAL SHARES

FOR OUTER SUBURBAN HOUSEHOLDS

O-D Person Trip Densities (trips/hour)	SRAT Fare 50¢	$1.00	$1.50	MODE
50	67.99	68.65	69.28	AD
	14.77	14.92	15.05	T
	15.72	15.77	15.40	SD
	1.52	.66	.27	SP
100	65.18	66.69	68.13	AD
	14.16	14.49	14.80	T
	17.03	17.24	16.41	SD
	3.63	1.58	.66	SP
200	63.03	65.21	67.18	AD
	13.70	14.17	14.60	T
	18.02	18.31	17.24	SD
	5.25	2.31	.98	SP
500	61.58	64.16	66.49	AD
	13.37	13.93	14.45	T
	18.61	19.07	17.83	SD
	6.44	2.84	1.23	SP

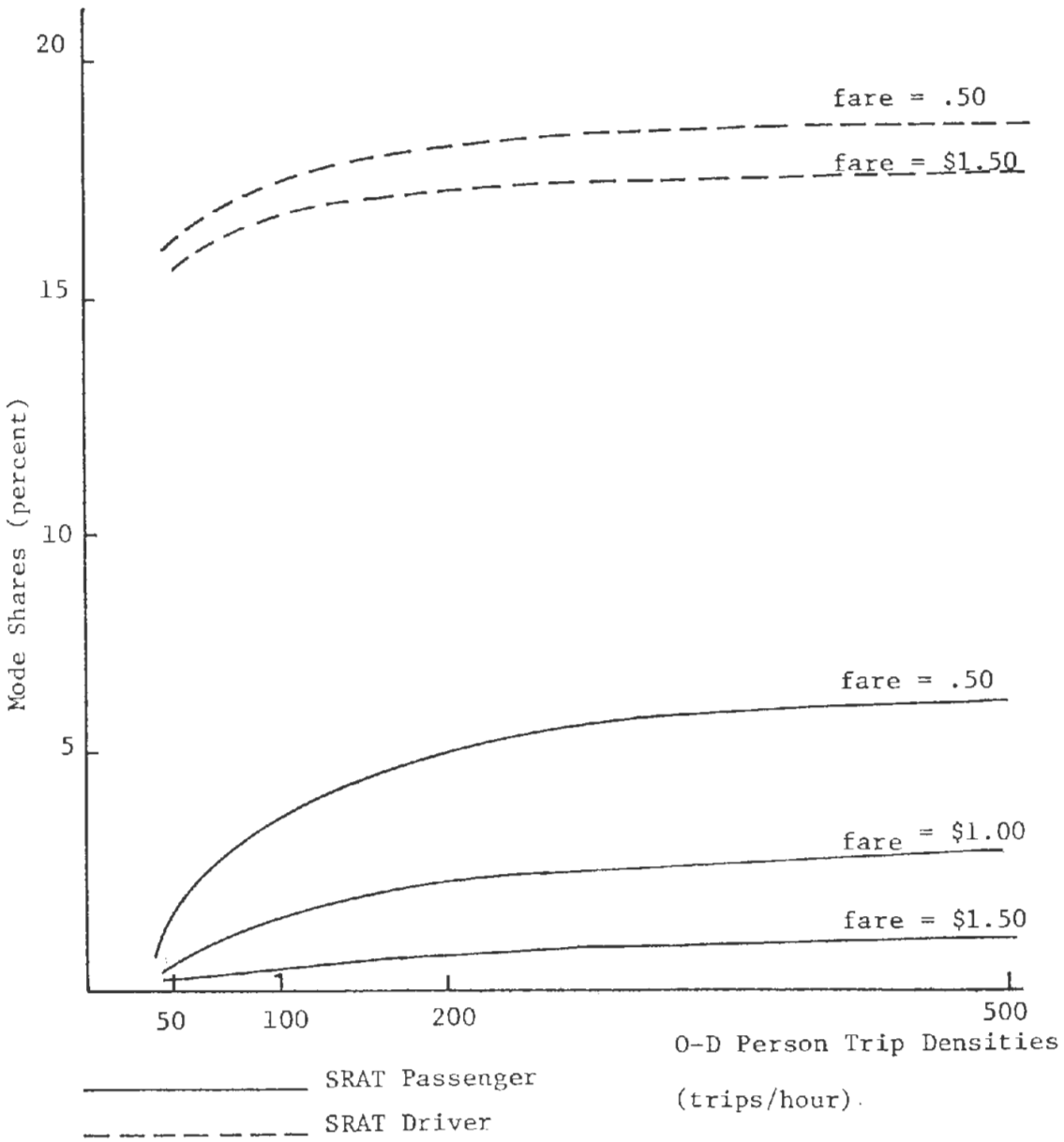
Cell entries represent percent mode shares for

AD - auto driver
T - transit
SD - SRAT driver
SP - SRAT passenger

Figure 3

WORK TRIP MODAL SHARES

FOR OUTER SUBURBAN HOUSEHOLDS



fare; thus fare increases lower SRAT drivers' revenue per trip. To see this we have displayed below the expected SRAT driver revenue for an O-D flow of 200 per hour and fares of 50¢, $1.00 and $1.50.*

	Fare Level (One-Way)		
	50¢	$1.00	$1.50
Expected Revenue Per Round Trip	29.13¢	25.23¢	17.05¢

- SRAT passenger demand is relatively insensitive to O-D work trip volumes because of the large fixed component of SRAT passenger OVTT -- namely, walk time (to and from SRAT pickup points on arterials, and to and from the passengers' ultimate destinations).

- As noted above, SRAT passenger demand was found to be relatively sensitive to SRAT fare level. At each level of O-D trip volume, halving fare (e.g. from $1.00 to 50¢) more than doubled SRAT passenger demand, indicative of a fare elasticity greater than one.
- The complementarity of SRAT driver and passenger modes (synergy) was indicated by increases in both SRAT patronages as O-D volume increased.
- The results indicate a heavy auto dominance. Roughly 80-84% of all person trips (for all fare levels and O-D volumes displayed in Table 3) involved an automobile (i.e., either an auto driver or SRAT driver). This is partly due to the high auto ownership level assumed for the outer suburban prototypical households. However, it also suggests

*For each fare level f, the expected round trip SRAT driver revenue was computed as 2*f*number of SRAT passengers ÷ number of SRAT drivers.

that it may be easier to attract SRAT drivers than SRAT passengers. While there are undoubtedly safety considerations which affect the decision to enter the SRAT "market" either as a passenger or a driver, switching from auto driving to SRAT passenger commuting involves a significant decrease in accessibility. In all of the analyses summarized in Table 15, the ratio of SRAT passengers to SRAT drivers was less then .35. Thus, for the conditions assumed in this prototypical household analysis, at best, every third SRAT driver vehicle would attract one SRAT passenger.

- Consequentially, expected driver revenues were extremely low. Even under the best circumstances (high O-D volumes, low SRAT fare), expected SRAT driver revenue was less than 60% of SRAT driver costs.
- Admittedly, the socioeconomic and LOS characteristics assumed in this prototypical household analysis were not particularly favorable for SRAT service. In particular:
    - It was assumed that transit <u>was</u> available to outer suburban household commuters
    - No auto driver parking costs were assumed
    - SRAT passenger out-of-vehicle times were significantly higher than auto or SRAT driver OVTT's
    - Auto ownership was relatively high

On the other hand, with the exception of transit availability and zero auto parking costs,* the characteristics of SRAT service assumed in the <u>outer suburban</u> prototypical household analysis were felt to be realistic. And, in fact, the range of O-D work trip volumes assumed in this analysis are probably

*The effect of changing these assumptions is discussed below.

higher than what realistically could be achieved (section II.C). What emerges from this analysis is that:

- SRAT service will not attract a significant number of previous auto drivers to SRAT passenger use
- Relatedly, because expected SRAT driver revenues are only a fraction of auto driver costs, there will not be a significant shift from auto driver to SRAT driver modes.

The demand analysis of inner suburban prototypical households yielded results largely similar to the previous analyses. Table 16 and Figure 4 summarize the SRAT driver and SRAT passenger mode shares for a range of SRAT fares and origin-destination trip densities. For all cases analyzed, SRAT patronage (driver and passenger) is lower for the inner suburban households than for the outer suburban. This is mostly due to:

- a relatively better transit service as depicted by decreased transit wait time
- a relatively lower auto ownership level which tended to reduce the number of households which could provide SRAT driver service (which in turn had a deflating effect on SRAT passenger demand).

The largest difference between the two prototypical analyses is in transit patronage which was roughly 27% for the inner suburban households and 15% for the outer suburban households.

Table 16

WORK TRIP MODAL SHARES

FOR INNER SUBURBAN HOUSEHOLDS

SRAT Fare

O-D Person Trip Densities (trips/hour)	50¢	$1.00	$1.50	MODE
50	62.66	62.86	63.05	AD
	27.62	27.79	27.79	T
	9.23	9.22	9.08	SD
	.49	.21	.08	SP
100	60.34	61.28	62.16	AD
	26.59	27.01	27.39	T
	10.67	10.68	10.04	SD
	2.40	1.03	.41	SP
200	57.84	59.56	61.11	AD
	25.49	26.26	26.93	T
	12.09	12.18	11.14	SD
	4.58	2.00	.82	SP
500	56.03	58.28	60.28	AD
	24.67	25.69	26.57	T
	13.05	13.28	11.97	SD
	6.25	2.75	1.18	SP

Cell entries represent percent mode shares for

AD -- auto driver
T -- transit
SD -- SRAT driver
SP -- SRAT passenger

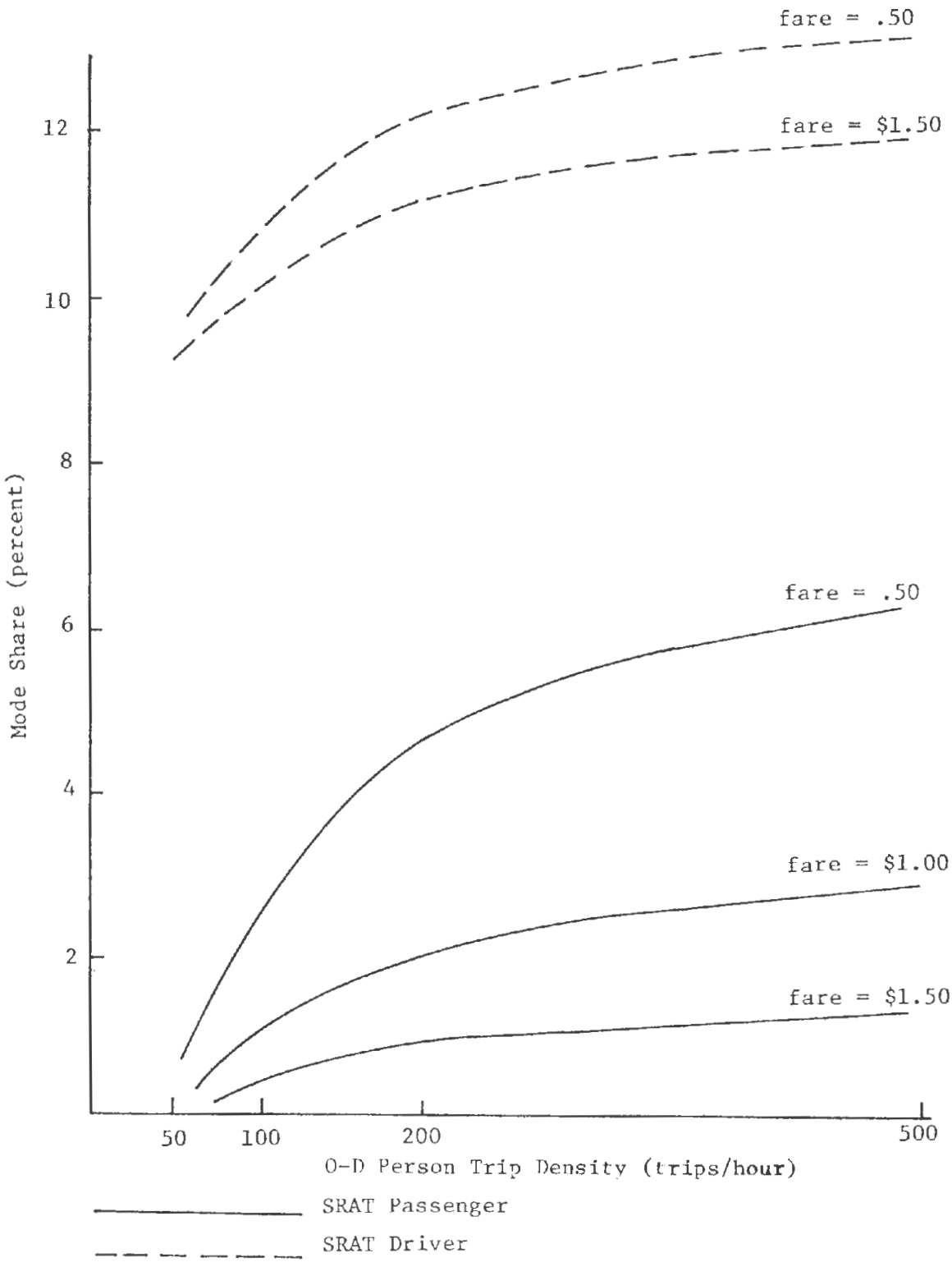


Figure 4

WORK TRIP MODAL SHARES FOR

INNER SUBURBAN HOUSEHOLDS

In the preceding prototypical household analyses, SRAT patronage was found to be relatively low for a range of SRAT fares and work trip O-D densities. To conclude this section, a variety of policies, each designed to enhance the attractiveness of SRAT* are analyzed. Five policies were evaluated, as shown below.

Primary Impact

(+ indicates positive influence, - indicates negative influence)

Policy	Auto Driver	Transit	SRAT Driver	SRAT Passenger
1. Reserved Lane for Sharers: Increase SRAT Line Haul Speeds			+	+
2. Parking Surcharge for Auto Drivers (not SRAT Drivers)	–			
3. Additional SRAT Designated Pickup Areas: Reduction in SRAT Passenger OVTT				+
4. Elimination of Transit Availability		–		
5. Combination of Above Policies	–	–	+	+

* Or decrease the attractiveness of competing modes.

In each analysis reported in this section, the outer suburban prototypical households were examined, assuming an SRAT fare of $1.00 and a trip density of 100 work trips (between a given origin and destination) per hour.

Policy 1: SRAT Reserved Lane

For this policy, it was assumed that SRAT vehicles could use a reserved lane on a radial arterial or expressway. The effect would be to increase SRAT line haul speeds. There are two ways to implement this policy. First, only vehicles with two (or three) or more occupants would be allowed to use the reserved lane. This policy variant would have the possible effect of inducing SRAT drivers to "cruise" around their neighborhoods looking for riders.* A second operating variant would be to allow any licensed SRAT driver to use the lane regardless of vehicle occupancy. The problem here is that many SRAT drivers may use the reserved lane without making any attempt to pick up SRAT passengers. This problem could be mitigated if

- SRAT pickup areas would be designated at the entrances to (and/or along) reserved lane arterials and expressways
- SRAT drivers are obligated to pick up licensed SRAT passengers

The policy analysis reported here assumes that all SRAT drivers can use reserved lane facilities regardless of vehicle occupancy. The analysis results are displayed in Table 17 for line haul speeds ranging from 30 mph (the base case) to 60 mph. As shown, this policy significantly increases SRAT driver participation (mode split) from a base level of 17.24% at 30 mph line haul speed to

*And thus, this policy may have deleterious energy consumption impacts.

Table 17

WORK TRIP MODAL SHARES AS A

FUNCTION OF SRAT LINE HAUL SPEEDS

Line Haul Speeds for
SRAT Driver and SRAT Passenger

(MPH)

	30	40	50	60
Auto Driver	66.69	60.30	55.89	52.76
Transit	14.49	13.11	12.13	11.45
SRAT Driver	17.24	23.98	28.64	31.92
SRAT Passenger	1.58	2.61	3.34	3.87
SRAT Passengers per Driver	.092	109	.117	.121
No. of Vehicles ÷ No./Pers.Trips	.839	.843	.845	.847

almost 32% at line haul speeds of 60 mph. SRAT passenger mode share more than doubled over the assumed speed range but achieves only a 3.87% mode share for a 60 mph line haul speed. Increases in SRAT driver participation come largely from previous auto drivers so that the total number of autos used in response to this policy remains practically the same. SRAT passengers per driver, a measure of average vehicle occupancy, increases slowly with respect to line haul speed, achieving a value of only .12 at the 60 mph speed level.

Policy 2: Auto Driver Parking Surcharges

The original prototypical household analyses assumed no auto driver parking charges. It was found in these analyses that the auto driver mode was the predominant work trip mode choice. In this analysis, parking surcharges of 50¢, $1.00 and $2.00 were assumed for auto drivers (but not SRAT drivers). The results of this policy analysis is shown in Table 18. As expected, predicted auto driver mode shares are significantly reduced as auto parking costs increase. But again, mode shifts are primarily from auto driver to SRAT driver. For the highest parking surcharge, SRAT passenger mode split is 6.14% compared to a transit share of 34.93% and an SRAT driver share of 45.99%. While the total number of vehicles used per 100 work trips decreases from 84 to 59 as parking charge increases from 0 to $2.00, SRAT passengers per SRAT driver increase from .09 to only .134.

Policy 3: Decreasing SRAT Passenger Walk Times

This is the only policy examined which is directed primarily at enhancing the attractiveness of the SRAT passenger mode. Essentially, we may assume that this

Table 18

WORK TRIP MODAL SHARES AS A

FUNCTION OF AUTO DRIVER PARKING SURCHARGES

	Parking Surcharge for Auto Drivers		
	50¢	$1.00	$2.00
Auto Driver	50.62	34.83	12.94
Transit	20.63	25.65	34.93
SRAT Driver	25.85	34.27	45.99
SRAT Passenger	2.90	4.25	6.14
SRAT Passengers per Driver	.112	.124	.134
No. of Vehicles ÷ No. of Pers. Trips	.765	.691	.589

policy is affected by increasing the number of designated SRAT pickup points. In any event, we examined the effect on SRAT demands of decreasing round trip SRAT passenger walk times from 12 minutes to 6 minutes. SRAT passenger demand appeared to be unit elastic with respect to SRAT passenger walk time: halving the walk time (from 12 to 6 minutes) doubled the SRAT passenger mode split from 1.58 to 3.18%.

The policy analysis results shown in Table 19 illustrate the complementarity of SRAT passenger and SRAT driver demands. Note that this policy -- directed at improving SRAT passenger accessibility -- also had the effect of increasing SRAT driver demand. The total number of vehicles used was virtually constant for the assumed range of SRAT passenger OVTT's,* but SRAT passengers per driver increased significantly from .092 to .163 as SRAT passenger walk times decreased from 12 to 6 minutes.

Policy 4: No Transit Availability

In this policy analysis, it was assumed that no transit service was available to the outer suburban-to-CBD work commuters. The mode split results shown in Table 20 suggest that the majority of previously predicted transit users would switch to auto driver and SRAT driver use. In fact, Table 20 indicates that nearly 98% of person trips would use a vehicle for their trip while only 2% would choose the SRAT passenger mode. These results further display the auto driver dominance of the outer suburban commute patterns.

*This is because decreases in auto driver use were compensated by increases in SRAT driver patronage.

Table 19

WORK TRIP MODAL SHARES AS A

FUNCTION OF SRAT PASSENGER WALK TIMES

	Round Trip SRAT Passenger Walk Times in Minutes			
	12	10	8	6
Auto Driver	66.69	65.84	64.81	63.55
Transit	14.49	14.31	14.39	13.81
SRAT Driver	17.24	17.85	18.58	19.46
SRAT Passenger	1.58	2.00	2.52	3.18
SRAT Passengers per Driver	.092	.112	.136	.163
No. of Vehicles ÷ No. of Pers. Trips	.839	.837	.834	.830

Table 20

WORK TRIP MODAL SHARES:

NO TRANSIT AVAILABLE

MODE	MODE SHARE
Auto Driver	77.44
SRAT Driver	20.49
SRAT Passenger	2.07
SRAT Passengers per Driver	.101
No. of Vehicles ÷ No. of Person Trips	.979

Policy 5: Combination of the Above Policies

In this analysis the four policies discussed above (and analyzed individually) were combined into a single policy package. In particular, the following LOS values were assumed for the analysis:

Policy	LOS Effect Analyzed
Reserved lane for SRAT	SRAT line haul speed = 50 mph
Auto Driver Parking Surcharge	Parking Cost (AD) = $2.00
Increase in SRAT Pickup Point Density	Round Trip SRAT Passenger Walk Time = 8 minutes
No Transit Available	

As in all the above policy analyses, work trip density was taken to 100 persons per hour. Two SRAT fare levels were analyzed -- 50¢ and $1.00. Table 9 displays the demand model results.

The first column of this table represents the "best possible" operating environment for SRAT within the outer suburban prototypical household analysis framework. At the 50¢ fare level, SRAT passenger mode split is 23.06% while SRAT drivers comprise over 50% of the work trips. The resulting SRAT passenger to driver ratio is less than .5 and expected SRAT driver revenue per round trip is 44¢, 37% of SRAT driver operating costs. The number of vehicles used per 100 work trips remains high even in this combination policy analysis.

Table 21 indicates that increasing SRAT from 50¢ to $1.00 would be counterproductive:

- total vehicles used increases (per 100 person trips) from 76.9 to 88.4
- SRAT passenger demand drops from 23.06% to 11.64%
- expected SRAT driver revenue per round trip drops from 44¢ to 39¢

Table 21

WORK TRIP MODAL SHARES

FOR A COMBINATION OF POLICIES

- Line Haul Speeds for SRAT = 50 mph
- Auto Driver Parking Surcharge = $2.00
- Round Trip Walk Time for SRAT Passengers = 8 minutes
- No Transit Service Available

MODE	MODE SHARE	
	SRAT Fare = 50¢	SRAT Fare = $1.00
Auto Driver	24.10	27.94
SRAT Driver	52.84	60.42
SRAT Passenger	23.06	11.64
SRAT Passengers per Driver	.44	.19
No. of Vehicles ÷ No. of Person Trips	.769	.884

In general, our policy analyses indicate that while it may be possible to attract a significant SRAT driver participation, it is difficult to attract SRAT passengers to use the service.

C. Case Study Modelling Results

Turning to the detailed demand analysis, seven case studies of SRAT designs were performed using data from four areas:

- Clear Creek County, Colorado (rural),
- Lenawee County, Michigan (rural)
- Rochester, New York (urban) and
- Greece, New York (suburban, in Rochester SMSA).

The seven system designs were:

- 2 rural counties
- 1 metropolitan areawide system
- 2 urban activity centers (CBD and other)
- 1 suburban feeder to transit
- 1 suburban bus replacement

Table 22 gives summary characteristics for each of the areas. A base system was designed in each case study, and variations in fare and operating policy were then also tested.

The SRAT operating policies were based on earlier analyses as discussed in Chapter 2: optimal zone sizes were found based on trip densities, intermediate stops were incorporated, and drivers are required to deviate to drop a rider at his final destination but not to pick him up. A fifty cent base fare was used for all systems, but considerable variation was performed. Hours of operation were either peak periods or all-day, depending on the type of SRAT service and the trip density in the area in peak and offpeak periods.

1. Clear Creek County, Colorado

Clear Creek County is a unique setting for SRAT because all towns in the county are located along a single Interstate highway, which concentrates trips to a much larger extent than in a typical rural area. There is a single SRAT stop in each town. While the actual SRAT system proposed

Table 22 - Summary Characteristics of Seven Case Study Areas

Site	Type	Trip Density**** (trips/mi.^{4})	Average Trip Length (mi.)	Population Density (persons/mi.^{2})	Area (mi.^{2})	Transit Avail-ability	Hours of Analysis	Person-Trips Per Hour ***
Clear Creek Co. Colorado	small, rural	.08	4.5	48.2	100	no	12	825
Lenawee Co. Michigan	large, rural	.04	13.1	122.7	600	no	12	15,500
Rochester,N.Y.	CBD	43.0	2.4	18,725**	16	yes	3	11,000
Greece, N.Y.	transit feeder	.47	7.5*	376	150	yes	3	10,700
Greece, N.Y.	transit replace-ment	.47	7.5*	376	150	no	3	10,700
Rochester,N.Y.	urban linehaul	.70	5.9	2,519	250	yes	3	43,700
Rochester,N.Y.	activity center	55.0	2.0	18,275*	16	no	12	900

*Length of total trip; SRAT would serve only a portion.

**Density shown is that of area producing the majority of trips to the CBD or activity center.

***With SRAT as an available alternative.

****Driver trips per hour from a one square mile area to another one square mile area.

for Clear Creek County is primarily to serve the elderly and students, this analysis focuses on its use by the general public. All county residents are assumed in this analysis to be eligible to participate in the services. No through trips are included.

Table 23 shows the model results for this case. In run A, drivers pass the SRAT stop at their origin to see if there are any passengers in their direction; if there are, drivers will drop them off at the stop in the town to which the rider is destined. This appears to be a workable arrangement, as the demands placed on the driver are not excessive, but the service to the rider is quite good. In run B, passengers are only dropped off at interchanges, and their number drops sharply. In run C, even with drivers stopping at all interchanges on their trip to look for passengers, there are few riders. Option D is similar to option A except that there is no fare, and option E parallels option C. In both cases, the driver participation drops but is still adequate, while rider participation increases. In option F, drivers are required to drive through every town along their trip for no fare; this is demanding too much, and no drivers participate.

Nine percent of Clear Creek households have no car; 1 to 18% of these households would make SRAT passenger trips in the runs made. Forty-two percent of Clear Creek households have one car; their use of the SRAT passenger mode is between 0 and 5%. The remainder of Clear Creek households have two or more cars, and their use of SRAT as passengers is less than 1%. Between 8 and 12% of 1-car households and 5 to 6% of 2+ car households will be SRAT drivers, according to the model.

Table 23 - Clear Creek County Demand Model Results

Alternative:	A	B	C	D	E	F
Fare (cents)	50	50	50	0	0	50
Pickup/dropoff:*	town	hwy	hwy	town	hwy	town
Intermediate stops?:	no	no	yes	no	yes	yes
Results:						
% SRAT drivers:	8.4	12.4	12.6	6.8	12.1	0
% SRAT riders:	1.3	0.2	0.3	2.1	0.8	0
Avg. SRAT wait (min.):	4.6	4.1	2.5	6.0	2.6	-
SRAT riders per vehicle:	0.2	0.0	0.0	0.3	0.1	-

*"Town" indicates drivers leave the highway and serve a stop within the town; "Hwy" means drivers stop only at interchanges to serve passengers (typically 1-2 miles from town) except at the driver's origin or destination.

2. Lenawee County, Michigan

This rural county has a more typical distribution of activities in a broader area than Clear Creek County. The SRAT driver mode share ranges (with one exception) from 6 to 9% over the alternative systems tested (0 to 50 cent fare, intermediate stops or not, pickup/dropoff of riders at their door or not). The SRAT rider mode share varies from 0.2% to 13%. The SRAT driver mode split is only 3% for a system with no fare and to-your-door service required, and SRAT ridership, responding to long wait times, is only 1.5%. The most successful design is a system with 50 cent fares, intermediate stops, and dropoff at the rider's door, which has a 13% SRAT rider mode share and an occupancy of 2.1 SRAT riders per vehicle. This 13% mode share reflects a 20-80% mode share of 0-car households and a 0-40% share for 1-car households depending on their location. SRAT rider mode share increases sharply as trip length increases, due to the lower relative weight of walking and waiting time for longer trips than short trips in the demand model. However, the model is being used for trip lengths beyond its range of validity. Average waits for rides are 10-15 minutes and average walks are also close to 10 minutes.

3. Rochester, New York CBD

This alternative concentrated on trips from high density areas to the Rochester CBD. Transit is available and has a 22% mode share. When SRAT is introduced with no fare, driver and rider mode splits are each 1%, and transit ridership drops to 21.5%. With a 50 cent fare, SRAT drivers become 10% of the market, SRAT riders 4.1%, and transit drops to 18.6%. SRAT wait and walk times are very low (about 2 minutes) due to the high person trip flows.

4. Greece, New York Transit Feeder

Transit carries 8.5% of the peak period trips from Greece to the rest of the Rochester area. There is currently a dial-a-ride feeder that serves about 1% of all trips as a feeder to the fixed route transit line. If SRAT were used as the feeder instead, with no fare it would carry about 0.55% of all trips; with a 50 cent fare it would carry 0.25% of all trips. Total transit ridership would thus decrease by 0.4 and 0.7% respectively. About 12% of the drivers passing the transfer point to the linehaul service would be willing to carry riders at either no fare or a 50 cent fare. There is practically no extra time required for drivers. SRAT passengers experience an average 5 minute walk, a 1 minute wait for the SRAT feeder, and a 10 minute wait for the linehaul transit service. The level of service is quite poor in this concept because of the difficulty in coordinating the SRAT feeder with a 20 minute headway transit service; this may be a general problem in using SRAT for this application.

5. Greece, New York Transit Replacement

The Greece-Rochester fixed route is replaced by SRAT service along the same streets and using the same stop locations. Transit mode share drops from 8.5% in the peak period in the existing case to 7.0% with SRAT at the same 40 cent fare as the existing service. Average wait times for SRAT are 3.3 minutes as opposed to 5 to 8 minutes for the 20 minute headway route. The drop in patronage is due to the more negative effect of non-measured attributes in ride-sharing than in transit that is reflected in the model. About 8% of the person trips in this corridor will be SRAT drivers. With no fare, only a 2% driver and 1.6% rider mode split occur. In both runs, all intermediate stops are served, and there is approximately one SRAT passenger per SRAT driver.

6. Rochester, New York Urban Service to the General Public

The current peak period transit mode share is 10.3%. With the introduction of SRAT with 50 cent fares, SRAT mode shares for both drivers and riders are 9.6% with transit mode share falling to 8%. SRAT rider mode share for 0-car households (which are about 6% of the total households in the area) is near 40%; for 1-car households (about 55% of the total) it is 12%, and for 2+ car households it is 2%.

Average SRAT rider and driver trip lengths are very close to the total person average trip length of 6 miles.

7. Rochester, New York Activity Center

A high-density zone within Rochester with shopping opportunities was chosen for this analysis. SRAT drivers are 11% of the person trips, while SRAT passengers are 8%. No transit is available in this particular zone. The activity center system is assumed to work with telephone matching to minimize walk and wait times. There is little sensitivity to fare.

Table 3 shows a summary of the overall changes in auto occupancy and VMT in a representative alternative in each of the seven case studies. Overall changes are moderate. Decreases in auto occupancy occur when carpool riders or drivers or transit users are induced to become SRAT drivers with lower occupancies in their vehicle. Increases in VMT also occur when some carpool riders and transit users are diverted to being SRAT drivers.

To sum up the results of the case studies, it appears that well-designed SRAT systems have the potential to attract moderate levels of rider and driver participation, based on an economic model of behavior that assumes the evaluation of alternative modes by travellers primarily

Table 24 -
VMT and Auto Occupancy Changes

Site	Average Auto Occupancy			Total VMT (mi.x1000)		
	Before SRAT	With SRAT	Change	Before SRAT	With SRAT	% Change
Clear Creek	1.17	1.16	-.01	37.30	37.56	+1
Lenawee	1.18	1.33	+.15	1973.0	1761	-11
CBD	1.29	1.31	+.02	50.27	51.85	+3
Feeder	1.25	1.22	-.03	163.0	170.0	+4
Bus Replacement	1.19	1.25	+.06	176.4	183.1	-4
Urban	1.24	1.33	+.09	548.8	518.1	-6
Activity Center	1.34	1.37	+.03	15.96	15.6	-2

based on time and cost. SRAT in-vehicle travel times and costs are always quite competitive with other modes and, if suffficient driver flows exist, wait times and walk times for riders can be satisfactory, though not as convenient as driving alone or carpooling. In fact, it appears that driver flows are adequate for SRAT in many cases if the service is carefully designed and concentrates on higher-density markets.

The demand estimates in this section should not be taken as estimates of the participation that would actually occur upon implementation of a SRAT system. Rather, they should be viewed as estimates of potential participation if SRAT becomes an accepted travel alternative for the general public. It is the study team's opinion, based on the focus group interview and other literature, that, at this point, people would have reservations about using the system until it was proven to be safe and reliable, and was socially acceptable. One of the major issues facing a SRAT system would be to overcome these negative attitudes.

D. Empirical Evidence on SRAT Demand

A few elements of operational experience with SRAT do exist, and they can provide some limited insights into SRAT demand from a different perspective than modelling. Data from Pittsburgh, Pa., and Fort Collins, Colo., is reported in this section; both systems are described in Appendix A.

1. Pittsburgh, Pa., Transit Strike, December, 1976

The Courtesy Ride program was set up in response to an anticipated transit strike. Since the strike lasted only three working days (December 1-3; Wednesday, Thursday, and Friday), there was no time to conduct a survey of the persons using the Courtesy Ride program. However, two weeks after the strike, a telephone survey was conducted. Seven hundred commuters (348 to CBD work destinations and 352 to non-CBD work destinations) were polled, and 300 regular transit riders who were not commuters also were included in the survey. Questions were asked about alternative modes used during the strike, especially whether the Courtesy Ride program (C-program) had been used.

The questions that are of interest have been summarized in the following tables. Figure 5 compares persons traveling to work destinations in the CBD with those traveling to work outside the CBD. The population represented is 379 persons who drove to work on Friday. Figure 6 gives a similar breakdown for 320 auto passengers on Friday.

In the survey administered to those who were non-commuters but regular transit riders, questions were compared to analyze the differences between drivers and riders. Figure 7 shows the results.

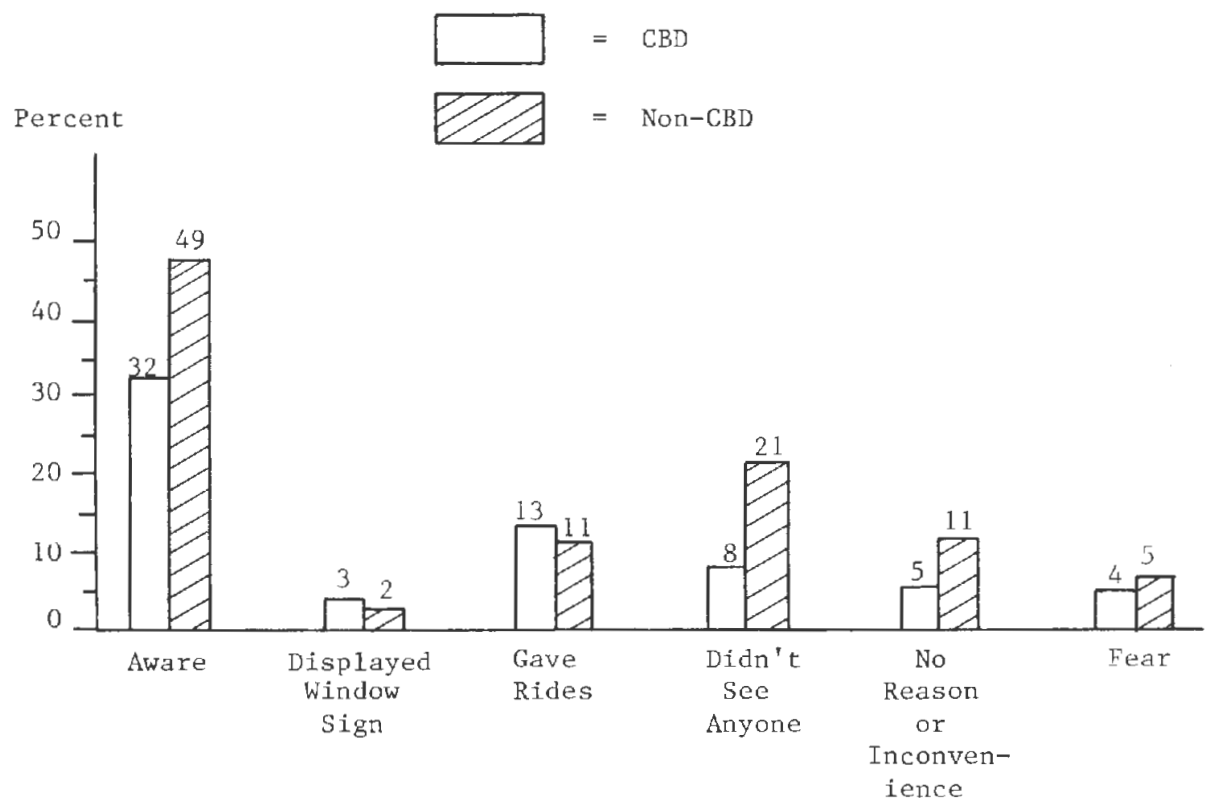
Analysis of the three tables shows that passengers were more likely than drivers to be aware of the courtesy ride program and that passengers looking for a ride to the CBD were the most aware of the C-program. More commuters gave rides than displayed window signs, but more non-commuters indicated their willingness to participate than did actually give or take a ride. The non-commuter sample was heavily skewed toward those 55 years of age and over. The heavy representation of the elderly in this population might explain the very small numbers who reported using the

Figure 5

Responses to Courtesy Ride Program
Persons Who Drove to Work Friday

Total = 379

(240 to non-CBD)
(139 to CBD)



Source: Joan Adibi, Carnegie-Mellon University.

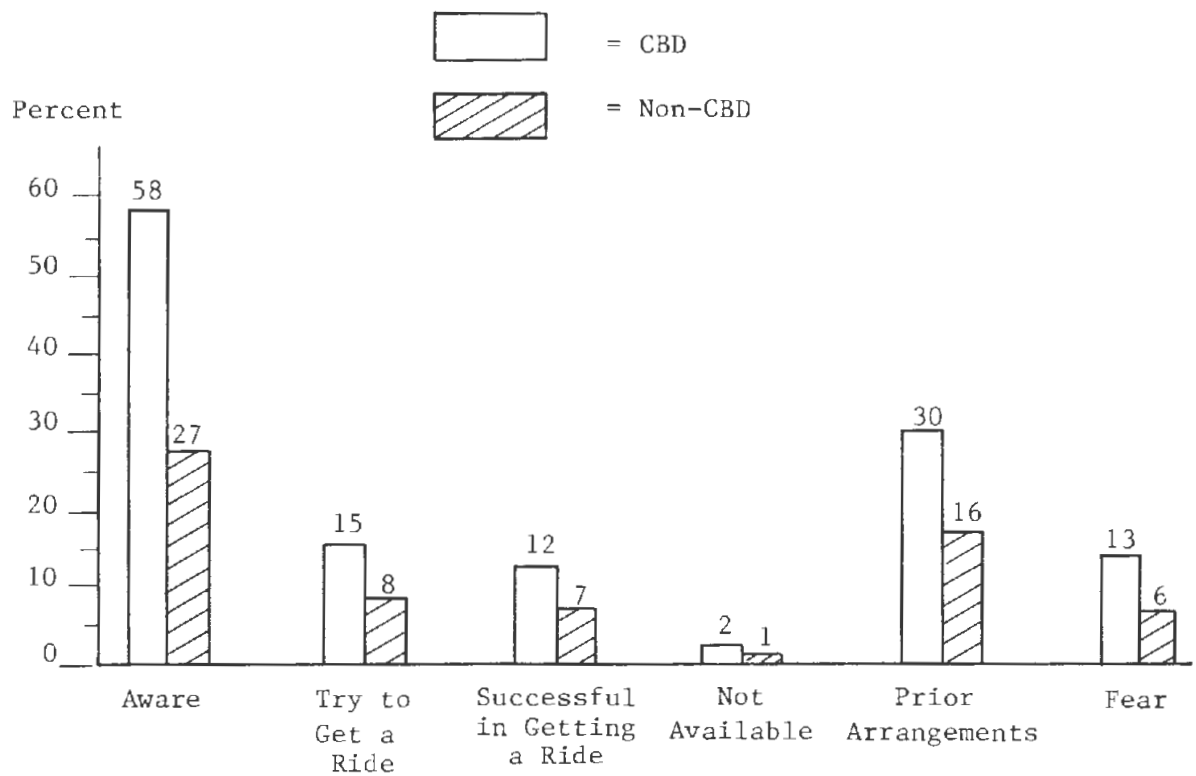
Figure 6

Commuters Who Were Passengers on Friday (by %)

Total = 320

(111 to Non-CBD)

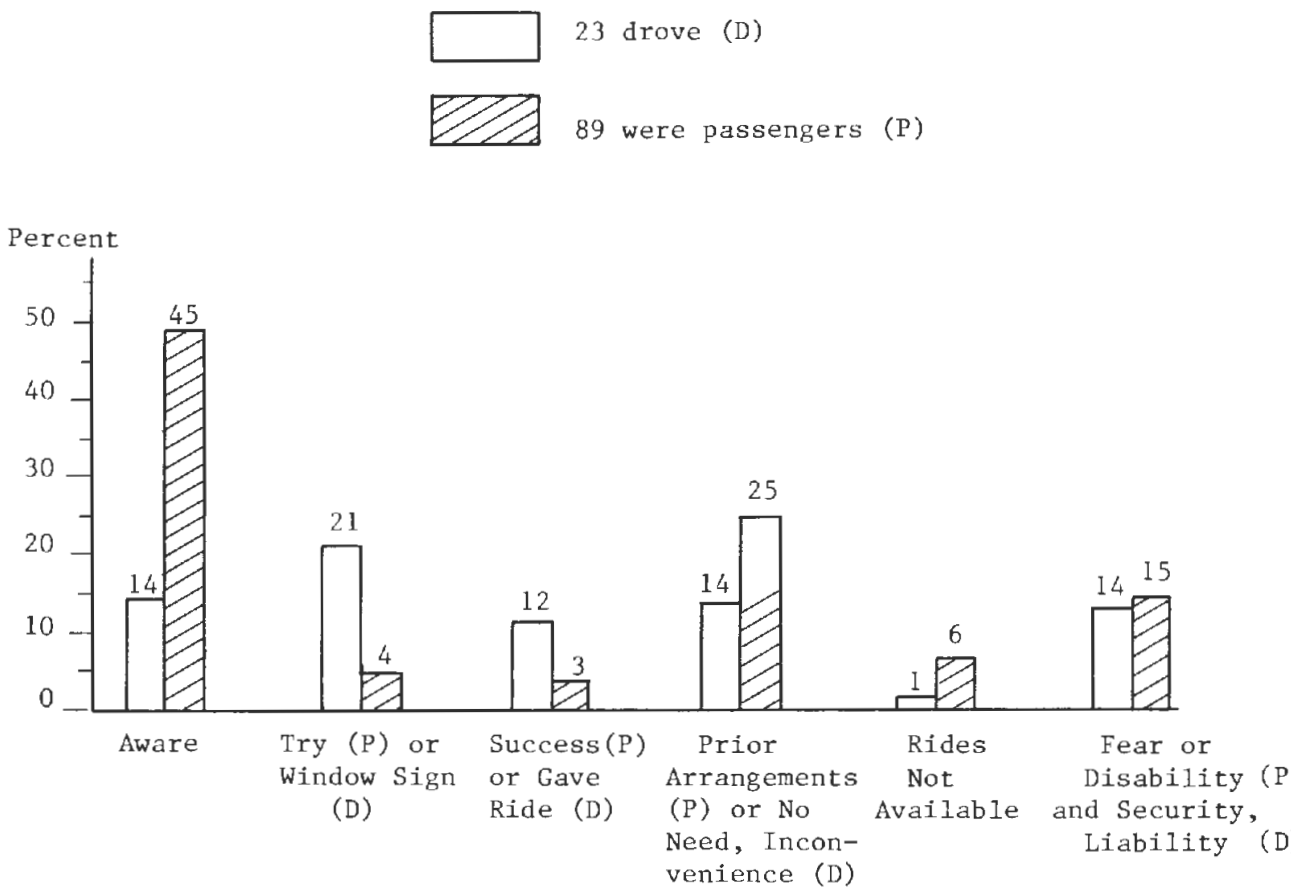
(209 to CBD)



Source: Joan Adibi, Carnegie-Mellon University.

Figure 7

Non-Commuters Who Either Drove or
Who Tried to Get a Ride
During the Strike



Source: Joan Adibi, Carnegie-Mellon University.

C-program (only 13 drivers gave rides and only 5 passengers tried to get a ride). Two explanations are that these respondents perceived the C-program as "hitchhiking" and were fearful, and that the non-commuters were not doubt travelling during non-peak hours when the C-riders and drivers were not as visible or as prevalent. Among the commuting drivers the most frequently mentioned reason why they had not participated in the C-program was that they had not seen any potential riders (29%).

Relatively few gave fear for their security or their liability as a reason why they had not used the C-program: a total of 76 passengers and 52 drivers, if commuters and non-commuters are included.

Percentages Indicating Fear
As a Deterrent to C-Program Use

	Passengers		Drivers	
	Number	Percent	Number	Percent
CBD	42	13	17	4
Non-CBD	20	6	19	5
Non-Commuter	14	13	16	14
	76	10	52	6

Pennsylvania's recent "no-fault" insurance legislation minimizes the liability risk of ride sharing and only 5% were worried about liability.

The anecdotes or human interest stories reported in the newspapers indicated that people were offering rides to strangers whether or not they used the C-sign. More often, it seemed that persons had arranged carpools with work colleagues, friends, or relatives. Another common pattern documented in the telephone survey was that persons who usually take the bus were dropped off at their destination by drivers who then either returned home or went on to another destination.

2. Fort Collins, Colorado, Community Carpool (FCCCP)

In September, 1973, Fort Collins began a legalized and controlled hitch-

hiking system. In June, 1974, the hitchhiking cooperative had 2,600 members registered as riders or drivers, out of a total population of 55,000. This is approximately a 5% participation rate. It was also interesting to note that riders gave drivers discount coupons for use at a food cooperative as a fare payment, but the practice was discontinued because few drivers used the coupons. Adequate driver participation did, however, exist. This issue is addressed further in the focus group interview.

A small survey of 21 participants was performed by the University of Colorado (1975). Although these characteristics cannot be universalized, there are some interesting points to note in this survey of FCCCP participants:

- There were no respondents over the age of 27. This suggests that school age persons and those in their early and middle twenties were major users of the system, although, according to the system manager, a number of older people were enrolled as hitchhikers.

- The most frequent occupation category was student, but there were a number of other jobs in which the participants were employed. This indicates that while students played a major role in the system, they were not the sole users.

- Males in the system outnumbered the females almost two to one. It is difficult to form any conclusions from these limited data, but it would appear that this system followed the general hitchhiking pattern of having more male participants than females.

- Nearly all respondents were Caucasian, but this is probably due to the racial composition of Fort Collins, which has relatively few minorities. There were more than twice as many single as married people, which is not surprising in view of the age of respondents.

- Information on the last year of education was too incomplete to make any assumptions about the level of education of the system's participants.

- Most members of this FCCP sample (14) participated as both hitchhikers and drivers. Five of the remaining seven were hitchhikers, and only two listed picking up hitchhikers as their only role.

- It appears that almost all of this sample of members (19 out of 21) had hitchhiked or picked up hitchhikers before becoming members, and that their activity had, for a majority (13 out of 21), increased. Only one respondent had never hitchhiked or picked up hitchhikers and had begun to do so since joining FCCCP.

- A definite majority (17 out of 21) felt a hitchhiking system would be acceptable without registration.

- An overwhelming majority (19 out of 21) hitchhiked or picked up hitchhikers who were not at the designated stops.*

- Almost all participants (18 out of 21) did not object to being fingerprinted and assigned a number for identification purposes.

- Although the majority of drivers picked up hitchhikers who were not carrying FCCCP identification (15 out of 21), it was not as definite as the majority of hitchhikers who would accept rides from drivers who did not display FCCCP identification stickers (18 out of 21).

- Almost twice as many hitchhikers said they hitchhiked at night (13 out of 21) than did not, but the majority was not as discernible as in the previous questions.

*Since this proportion is so high, this indicates that most respondents were simply youth hitchhikers; thus generalizations from this sample to other categories of travellers may be inappropriate.

3. Other Data

A survey was performed by the University of Colorado (1975) of 195 randomly selected individuals from the Denver area to explore attitudes toward hitchhiking. Data was obtained on the percent of current hitchhikers and drivers who pick up hitchhikers (19% and 31%), percent who had ever hitchhiked or picked up hitchhikers (43% and 52%), social characteristics, crime statistics, ways of hitchhiking, opinions on the legal status of hitchhiking and possible participation if certain reforms were made.

Fear of crime and traffic accidents were the two major problems that inhibited a large portion of the public from hitchhiking or picking up hitchhikers. Other less important reasons were inconvenience, inbred feeling that it should not be done, and fear of arrest.

Major positive factors influencing people to hitchhike were environmental concern, social interaction, personal convenience, economics, and inadequacy of public transportation. Major positive factors influencing drivers to pick up hitchhikers were hitchhiking location, personal appearance, adventure, and identification with the hitchhiker.

A Polish system, referred to as Autostop, provides rides for 35,000 riders using 4,000 drivers each summer. This information, however, sheds little light on similar systems in this country. Finally, People's Transhare in Portland, Oregon,(see Appendix A for a description) reports about 7,000 registered participants nationwide for its intercity service.

E. Focus Group Results

Focus groups are small groups of representative potential consumers brought together in a comfortable room and encouraged by a trained moderator

to discuss how they choose among their travel options. These interviews provide an indication of attitudes and often surface important issues which otherwise might have been missed. While they are only the first step in a comprehensive application of attitudinal research techniques, they are used in this study to provide yet a third perspective on potential SRAT demand.

Three focus group interviews were conducted in Dedham, Massachusetts, a suburb of Boston, in March 1977, to qualitatively assess consumer reaction to several of the SRAT concepts developed in this study. Each interview consisted of 8 to 12 people, representing a mix of auto drivers, passengers, and transit users; two of the interviews were held in the evening and consisted mostly of workers, both male and female, while the third was held in the afternoon and consisted mostly of female non-workers.

Overall reaction to the concept in all three groups was relatively negative, but a few did express willingness to try the system as riders. The people that were willing to try were generally those with no auto available who generally relied on friends and public transit. More of the group (perhaps a third) expressed a willingness to consider picking up riders. Perhaps two-thirds had picked up hitchhikers at some times.

The key concern among riders and drivers was personal safety. Registration systems did not allay these fears, due to concerns about stolen identification, difficulty in checking identification without exposing one's self to danger, and the criteria used for registration. The one circumstance that did seem to alleviate concern over personal safety was knowledge of the other individual or at least residence in the same community. Central phone dispatch of riders and drivers with a chance for them to speak to each other before making the trip was also viewed favorably. Drivers and riders both felt they would sometimes refuse matches.

Interpersonal relations come into play strongly when consumers try to imagine what it is like to participate in a highly personalized system such as SRAT. Drivers become concerned about their own obligation to the system. They feel that it would restrict their flexibility of movement and infringe upon their personal freedom. While not at first apparent, this sociological effect occurs because "the system has memory." People's schedules are not totally random but have some regularity to them. Thus, when a driver passes the same point day after day, he is likely to see the same potential riders. Under these circumstances, once a person is given a ride, a driver may feel he must give that person a ride every time they meet. This obligation restricts the driver's personal freedom. Similarly, the rider is embarrassed to feel in someone's debt, even if he pays for the ride. There is also some concern by a rider about the embarrassment associated with rejecting a ride.

While payment for transportation service is the custom, it is not necessarily viewed as part of a system as personal as SRAT. First, there is consumer misunderstanding about the possible entrepreneurial nature of the service. The preconception seems to be that SRAT is more like a volunteer service where each driver acts as a "good samaritan", giving a needed service to the community. Consumers are used to this type of service and analogize to SRAT. This problem can, of course, be addressed with consumer education, but it cannot be ignored if preconceptions are to be overcome. Once the payment system is explained, it still does not seem socially comfortable. Consumers feel the rider's or driver's company is worth any inconvenience or they want to feel as if they are doing a service for society. These statements were particularly strong for housewives as opposed to workers. It seems that workers are more accustomed to monetary transactions and feel less embarrassed about them. On the

other hand, small marginal payments such as a quarter or fifty cents did not seem to be sufficient. Drivers find it easier to visualize the $2-3 associated with "gas money" for a long trip. Also there is a feeling that the risk of crime associated with indiscriminate ride sharing will catch up with you if you do it enough to profit.

There was a nearly universal feeling that one's insurance rates would rise if one participated in the system. There was also fear of lawsuits if riders were injured entering or leaving a driver's car.

The non-worker group was asked to rank SRAT, minibus, and shared taxi services for providing within-town services. The surprising and strongly supported ranking by the group was: minibus (strongly preferred, even with fixed routes and hour headways), then SRAT, and last, shared taxi. Very strong concerns about unreliability, high cost, and unsafe driving and vehicles were indicated for the shared taxi concept. However, one worker group was also asked to do this ranking, and ranked SRAT lowest, after minibus and shared taxi.

There was little reaction to the impact on the transit financial deficit of SRAT versus, say, the minibus, and in fact, consumers suggested use of school buses and drivers (and other such alternatives) as ways to provide "minibus" service efficiently.*

To sum up the initial focus group interviews, the "good samaritan" principle seems to be the strongest force in favor of participating in a SRAT system; and economic reasons seem not to be important. Several people expressed concern that SRAT would parallel the experience of many volunteer efforts, which have large participation for a short while, and then people

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*The transit deficit in the Boston area is quite high and has a large impact on property tax rates.

lose interest. The most favorable system seems to be a community-oriented one because of lower security concerns and then only under strong energy constraints.

It should be noted, of course, that Boston is not necessarily representative of many areas that might consider SRAT. Concerns about safety and security and other matters may vary widely in other places. However, these interviews do provide some insights into consumer reaction to the concept.

IV. LEGAL AND REGULATORY ISSUES

Introduction

This chapter explores the legal and regulatory issues relevant to the operation of a SRAT system. Because the most feasible SRAT systems will be those with the fewest legal and regulatory constraints, this discussion focuses on opportunities to modify SRAT design to minimize the potential for legal and regulatory problems. Specific topics covered in this discussion include:

- potential for regulation of SRAT by a public utilities commission (PUC), transit district or local agency
- competition with existing transit and labor protection under Section 13(c)
- registration of SRAT participants
- potential liability of a SRAT management agency
- automobile insurance for participating drivers
- income tax issues related to fares collected by SRAT drivers
- traffic regulations governing pickup and dropoff of SRAT passengers.

In order to provide varied examples of the legal and regulatory issues to be faced by a SRAT system, four states were selected as case studies for examination of specific statutes and regulations:

- Colorado
- Virginia
- Connecticut
- Oregon

When examining the legal and regulatory issues in these four states, four SRAT system designs were considered:

- urban feeder
- general urban service
- bus replacement
- major activity centers

A. Regulatory Issues

Because SRAT is a new and innovative service, it is necessary to identify the various federal, state, regional, and local regulations that may affect its operation and determine their probable impacts. Next, exemptions must be examined to determine whether the proposed new service will be exempt from regulation.

While there are various regulations that may apply to SRAT, major emphasis was placed on state public utility regulations. There are several reasons for this. First, federal regulation of SRAT would exist only if a SRAT system operates across state lines. Second, a knowledge of state public utility regulation is necessary before district or local regulations can be understood, since state regulations generally serve as the model for district and local regulations. Finally, local jurisdictions generally agree, at least informally, to specific exemptions granted at the state level.

State Jurisdiction

State statutes use two criteria in delineating the scope of PUC jurisdiction (or authority) over transportation services such as SRAT: if the transportation service both serves the general public and is for hire, it falls within the jurisdiction of the PUC (see Table 25). A system without a fare is not for hire and therefore is unregulated. Even when SRAT operates with a fare, there are two possible arguments that it is still not for hire. The first argument is that the expected revenues are so low that no profit will be realized. Therefore, the driver receives no real compensation. However, states interpret compensation differently,

Table 25 - State Regulatory Issues

Sample Site	Criteria for State Jurisdiction	Possible Exemptions from State Regulation	SRAT Systems to which Exemptions Apply
Virginia	Common Carrier -for general public -compensation -by any arrangement Restricted Common Carrier -restricted class -compensation -by any arrangement	Shared Ride Exemption -may share not more than expenses of operation (unofficially interpreted to include insurance, maintenance, and depreciation) -unofficial opinion that SRAT would qualify Employee Haul Exemption -directly to and from employment -need permit; $50 fee -must list employees served Transit District Exemption -if wholly within transit district	All systems Employer Based General Urban Bus Replacement Bus Feeder* All systems
Connecticut	Main Criterion is compensation	Work Related Exemption -shared ride in private vehicle -between work and residence -reasonable compensation -to reduce fuel consumption Transit District Exemption -if district assumes jurisdiction from state (none has yet) -if wholly within district	Bus Replacement General Urban Bus Feeder* Employer-based All systems
Colorado	Common Carrier -compensation -fixed termini/regular routes -indiscriminately accept riders Contract Carrier -compensation -by contract or otherwise	No specific statutory exemptions for SRAT Carpools -unofficial exemption -requires recognition of SRAT within unofficial exemption Transit District -not regulated in light of district's sovereign immunity from suit - if operated by the district - if SRAT drivers shielded by district's sovereign immunity	All systems All systems
Oregon	Common Carrier -for hire -to those "who choose to employ him..." Contract Carrier -compensation -special individual contract; lease arrangement	Intra-city Exemption -if wholly within 3 air miles of city but including the entirety of any contiguous city Transit District Exemption -if operated by the district	All systems All systems

*While the bus feeder model would not operate directly to and from the place of employment as the exemption literally calls for, the general purpose of conserving energy through ride sharing is accomplished.

with the strictest standard being whether there is any exchange of value regardless of profit. Others allow recapture of direct trip-related expenses before the threshhold of PUC jurisdiction is crossed. The second argument that SRAT is not for hire is that the policy behind regulation is to control bona fide businesses only; since SRAT is an incidental use of a private vehicle for limited periods, it does not have the status of a business. This incidental use argument has some support in the case law,[1] but does not enjoy sufficiently wide acceptance in most states to be relied upon.

The test of whether SRAT serves the general public is more than a question of whether or not ridership is restricted. Since a major goal of regulation is to ensure adequate transportation service for the general public, a new system affecting the adequacy of existing service by competing with certified carriers is also subject to PUC jurisdiction - even if the new service limits ridership through licensing or registration. A SRAT system operating over similar routes and during similar times as a certified carrier is probably competing for a common market of travelers, and could therefore be regulated.

State Exemptions

Even where there is PUC jurisdiction over SRAT, specific exemptions may be available, including work-related, shared-ride ventures, and shared-expense ventures (see Table 25). SRAT's fare structure is important in determining whether the system qualifies under these exemptions. Exemptions such as the Connecticut and California work-related shared-ride exemption[2] allow drivers to receive reasonable compensation from riders. A fare approximating that of

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[1] See Chauncey v. Kinnaird, 279 S.W. 2d 27 (Ky., 1955).

[2] Conn. Gen. Stat. Ann. §16-328 (West Supp. 1977); Cal. Pub. Util. Code §226 (West Supp. 1977).

public transit would meet this standard. Other exemptions allow the sharing of expenses among drivers and riders as long as not profit is realized. Interpretations vary from the extreme view that all vehicle expenses including insurance and depreciation may be recovered, to an indication that only directly-related trip expenses, such as oil, fuel, tolls and parking may be included.[1] Arizona's PUC statute defines nonprofit as 20 cents per mile.[2]

Even if a SRAT system is specifically designed to qualify for one of these exemptions, it may be attacked as not falling within the intended coverage of the exemption. For example, an argument may be made that a particular exemption was written in view of traditional carpools and vanpools only, or that the policy behind the exemption is that regulation would be impractical because of the difficulty of detecting certain shared-ride ventures. Since SRAT would pick up and drop off passengers much like conventional transit, it is much more visible than traditional carpooling ventures. On the other hand, a policy to conserve gasoline, or to promote employment, might provide a compelling argument that SRAT should be included within the exemption. It should also be noted that while these exemptions are generally self-executing,[3] if a challenge to SRAT arises the burden would be on the proponents of SRAT to show why it had not complied with regulations. A prior determination from the regulatory agency that SRAT is exempt is therefore advisable.

A final group of exemptions reflects a deference by state authorities to local needs and control. These exemptions include intra-city service, intra-transit district service, and transit district operated service. In these cases, regulation is by municipalities and transit districts.

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[1]Southern California Commuter Bus Service, Inc. v Zapitelli, No. 84316 (Cal. PUC Apr. 15, 1975); rescinded due to subsequent statutory amendment (Cal. PUC Code §226), No. 85052 (Cal. PUC, October 28, 1975).

[2]Ariz. Rev. Stat. §40-601(A)(1)(1974)(for amount greater than 20¢ per mile the burden shifts to the driver to prove that he is not making a profit.)

[3]But see, e.g., N.C. Gen. Stat. §62-260(g)(1975)(prior certificate of exemption required).

Transit District and Local Regulation

A transit district or local government may have authority over a transportation system either in lieu of state level control or in addition to it. Besides being for hire and serving the general public as outlined above, a transportation system must also be within the agency's authority as promulgated in the appropriate legislation. Under the enabling legislation of some states, the district may have authority over all publicly and privately operated transportation within the district; jurisdiction may be automatic, or may require a voluntary assumption of power by the district. In other states, district authority is limited to systems that are actually operated by that district. Whatever the scope of district jurisdiction, it is generally exercised in conformity with state regulatory standards, either by statute or by convenience (see Table 26).

Where no transit district exists, or where a transportation system is exclusively a local concern, the local government may exercise independent jurisdiction, generally outlined in broadly worded ordinances. For SRAT to escape local regulation, these ordinances must be interpreted and enforced with a sympathetic attitude. Because most local regulators probably will not be sympathetic to SRAT, persuasive advocacy will be an essential for SRAT success.

Compliance

In the event that SRAT is regulated by a PUC, the major burden of compliance would be the need to justify routes, schedules, and abandonment of service. This generally would be done through a formal hearing process, which is time consuming and costly, especially if extensive legal services are needed. Other PUC regulations, such as requirements that minimum fares be charged and that certain minimum hours of daily service be provided, could significantly reduce the flexibility of SRAT. It is uncertain whether each driver would have to comply separately or whether SRAT management could fulfill the requirements for all participating drivers.

Table 26 - Transit District and Local Regulatory Issues

Sample Site	Transit District Regulatory Issues	Local Regulatory Issues
Virginia	State jurisdiction delegated to district -if wholly within district (whether or not operated by district) -district follows state guidelines on issue of competition -requires sympathetic district regulation	If within transit district jurisdiction, then municipal jurisdiction exercised through local government membership on transit district board Municipal regulation -broad scope of regulation -probably includes SRAT -requires sympathetic municipal regulation
Connecticut	State jurisdiction delegated to district -if district assumes jurisdiction (none has yet assumed it) -if wholly within district -by statute, district must use same standards as state	No municipal level regulation
Colorado	State does not regulate district-operated transportation in light of district's sovereign immunity from suit	If operated by transit district, then municipal jurisdiction exercised through local government membership on transit district board Municipal regulation -broad scope of regulation -probably includes SRAT -requires sympathetic municipal regulation
Oregon	State does not regulate district-operated transportation	If operated by transit district, then municipal jurisdiction exercised through local government membership on transit district board Municipal regulation -broad scope of regulation -probably includes SRAT -requires sympathetic municipal regulation

Since any competitive effects of SRAT would come from the system as a whole, an analogy can be made to taxi services where the organization itself complies for all its member taxis. On the other hand, because there is no employment relationship between SRAT management and SRAT drivers, each SRAT driver is an individual carrier and may have to comply separately.

If SRAT is proposed as a replacement service for existing bus routes, the requirement of justifying abandonment of service may be a problem even if SRAT itself is unregulated. Before existing bus service could be discontinued, public hearings may be necessary to establish whether public convenience and necessity was being jeopardized.

Another aspect of compliance is whether commercial vehicle plates, chauffeurs' licenses, and commercial insurance are necessary. Commercial plates and chauffers' licenses would generally not be required for an unregulated SRAT system. However, since the obligation of obtaining these special licenses generally mirrors PUC regulations and exemptions, if SRAT were regulated these licenses would probably be required. Likewise, while the test of for hire transportation for insurance purposes may be somewhat more lax than the test for regulatory purposes, if SRAT were regulated, it is almost certain that commercial insurance would be required. The time and inconvenience involved in obtaining the special licenses and insurance would probably discourage many potential participants. While the annual costs for the licenses may be only $10 to $30, the annual cost of commercial insurance, $1,000 to $2,000 per vehicle, is prohibitive.

Conclusions and Recommendations

An examination of SRAT regulatory issues indicates that, although SRAT is probably within the scope of regulatory agencies' jurisdiction, a system may be designed to minimize that probability of regulation or to qualify SRAT for a specific statutory exemption. The probability that SRAT would be classified as transportation for hire can be lessened by setting fares as low as practicable or by pegging fares to direct expenses. A no-fare system would eliminate classification as for hire transportation. The appearance of competition with certified carriers can likewise be lessened by limiting SRAT services to areas not presently served by public transportation and by using SRAT to complement bus service (e.g., bus feeder). Even then, the success of a SRAT system may simply mean that SRAT is encroaching on potential new markets for certified carriers.

The most practical implementation approach would be to design SRAT to qualify for a specific statutory exemption and to obtain prior determination from the regulatory agency that SRAT qualifies. While exemptions based on energy conservation goals such as shared-expense or work-related ventures limit the possible applications of SRAT, they may be the easiest to qualify for. Exemptions that defer to regional or local needs and control offer flexibility regarding design, but require cooperation by respective regional or local regulatory agencies. Favorable regulation by a Transit District would be assured if that agency were persuaded to implement SRAT on the local level. Strong advocacy on the part of SRAT proponents would be essential to ensure favorable interpretation of broadly worded ordinances.

If SRAT comes under state PUC jurisdiction and no exemption exists, it will have to qualify as a certified carrier. In that case, the burden of compliance may be so onerous that SRAT cannot be implemented.

B. Labor Protections Under Section 13(c)

Applicants for federal financial assistance under Sections 3,5, and 6 of the Urban Mass Transportation Act of 1964, 49 U.S.C. §1601 et seq. (1976), must agree under §13(c) of the Act to protect the interests of transit employees who will be affected by the assistance.[1] If SRAT uses UMTA §6(a) demonstration funds that directly or indirectly affect operational aspects of a SRAT project, then it will be necessary to negotiate with appropriate local or international transit unions and have the U.S. Department of Labor (DOL) certify the labor protection provisions. Whether UMTA funding directly or indirectly affects the operational aspects of SRAT is a determination that would be made by UMTA legal counsel, after consulting with the DOL.

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[1] Section 13(c) of the Urban Mass Transportation Act of 1964 reads as follows:

"It shall be a condition of any assistance under Section 3 of this Act that fair and equitable arrangements are made, as determined by the Secretary of Labor, to protect the interests of employees affected by such assistance. Such protective arrangements shall include, without being limited to, such provisions as may be necessary for (1) the preservation of rights, privileges and benefits (including continuation of pension rights and benefits) under existing collective bargaining agreements or otherwise; (2) the continuation of collective bargaining rights; (3) the protection of individual employees against a worsening of their positions with respect to their employment; (4) assurances of employment to employees of acquired mass transportation systems and priority of reemployment of employees terminated or laid off; and (5) paid training or retraining programs. Such arrangements shall include provisions protecting individual employees against a worsening of their positions with respect to their employment which shall in no event provide benefits less than those established pursuant to Section 5(a)(f) of the Act of February 4, 1887(24 Stat. 379), as amended. The contract for the granting of any such assistance shall specify the terms and conditions of the protective arrangements."

While §13(c) does not define or limit the class of employees to be protected, DOL and UMTA interpretations of the law indicate that the certified 13(c) arrangements must protect any affected "mass transit" employee. This qualification generally excludes top level mass transit officials from the protection of this provision. Administrative policy also favors the exclusion of employees who are associated with transit companies that do not provide "mass transit" services. Consequently, taxi employees would not be covered by the 13(c) agreement unless the company has a policy of providing shared-ride service on a regular basis. In most cities, shared-ride taxi service does not appear to be provided on a regular basis. In fact, in many cities, providing shared-ride service is prohibited by local regulation.[1]

The certification process required by 13(c) involves several steps. First, the applicant must submit an application for assistance to UMTA. The application should discuss the potential impact of SRAT on existing transportation workers and identify applicable union representatives. Second, the application is forwarded by UMTA to DOL, where it is distributed to appropriate union officials. Third, the applicant must negotiate labor protection provisions with appropriate union officials. This would probably involve using common 13(c) provisions, and adding or substituting different provisions reflecting the unique aspects of SRAT. Finally, the Secretary of Labor must certify that the agreement negotiated is "fair and equitable." If mass transit workers in the service area are

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[1] But note that taxi companies in Portland, Oregon, and Hartford, Connecticut, are negotiating for a change in applicable laws and policy so that they may provide shared-ride service. In addition, Yellow Cab in Hartford was recently made signatory to a 13(c) agreement, indicating that labor protection will be extended to those taxi employees.

not represented by unions, then no negotiation is necessary and the Secretary's letter of certification will set the terms and conditions which shall apply for protecting employees.[1] This is the same procedure followed if the parties cannot reach agreement. Generally, if negotiations fail and the Secretary must impose conditions, the conditions will be less tailored to the particular needs of SRAT.

The 13(c) agreements negotiated for several paratransit demonstration projects, including the Tidewater, Virginia, Knoxville, Tennessee, and Golden Gate District, California, vanpool projects, provide useful models to utilize in negotiating the SRAT 13(c) agreement.

Even before the 13(c) negotiation process begins, it is possible to minimize the potential for future claims under the 13(c) agreement by designing SRAT to avoid competition with existing transit, thereby reducing the possibilility of adverse effects on mass transit employees. Once negotiations are underway, the potential for claims can be further minimized by including provisions that give the existing unions some role in SRAT management or operations, such as providing backup service for SRAT, performing maintenance work on SRAT vehicles or managing operational or administrative aspects of SRAT. The purpose of this type of provision is to encourage the unions to accept some competition in exchange for a role in the SRAT project.

Another method that can be used during the negotiation process to minimize potential claims is to identify factors or conditions in the

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[1] Urban Mass Transportation Act of 1964 Proposed Guidelines, 29 CFR §215.1 et seq., 42 Fed. Reg. 3319-3321 (January 18, 1977).

service area that might contribute to a worsening of the employment condition of mass transit employees even if SRAT was not implemented. This can be done either in the 13(c) agreement or in a supplemental agreement. The 13(c) agreement for the Tidewater, Virginia, vanpool project included a supplemental agreement of this type. Under the Tidewater agreement, the liability of the vanpool project is limited to adverse effects caused by the operation of the vans, and only to the extent the effects are caused by the vans.*

After the 13(c) agreement is certified and SRAT begins operating, if any protected employee claims to be adversely affected by SRAT, the SRAT operator will have the burden of showing that the effect was caused by other factors. If SRAT is found to bear any part of the blame, the claiming employee will prevail. As mentioned above, if the 13(c) agreement or a supplemental agreement has identified other factors that could cause adverse effects, this burden will be lessened and liability for claims will be lessened.

At first glance, the terms of the 13(c) arrangements may seem onerous with respect to the liabilities of the SRAT agency receiving UMTA funds. However, a carefully negotiated agreement can substantially reduce the risk of adverse judgments, especially expensive ones. If claims do arise, they likely can be settled through arbitration.

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*This is extremely significant because the standard DOL interpretation of 13(c) is that the competitive service is fully liable even if only partially responsible, so long as there is any responsibility for worsening the affected employee's position at all.

The final measure for avoid 13(c) issues is to use funding from a source other than UMTA. Several alternative sources of funding are available, including: (1) Federal Highway Administration Carpool Demonstratin Project funding; (2) state government funds (e.g., state DOT's and environmental agencies) (3) private funding from corporations, community agencies, banks and other investment or financial institutions; and (4) making SRAT self-supporting through membership fees.

While there are several measures that can be taken to minimize adverse effects of 13(c) requirements, it must be realized that if SRAT is managed by a transit district, the 13(c) agreement for SRAT will be only one issue in the larger, on-going bargaining relationship between transit management and labor. For this reason, SRAT management may need to make some concessions beyond the minimum required by a strict reading of 13(c).

C. Registration

Safety from traffic accidents and crime is likely to be a major concern of potential SRAT users. One reason for the concern is the possible perception of SRAT as hitchhiking, which is often considered unsafe. While there are ample anecdotes about the danger of hitchhiking, a 1974 study by the California Highway Patrol indicates that hitchhiking safety is probably not as serious a problem as most people think. The study notes, for example, that of the relatively few traffic accidents involving hitchhiking, most occur after the rider is in the car and could not be related to hitchhiking. Similarly, the report indicates that criminal incidents are surprisingly infrequent. Of course, just as the popularity of hitchhiking differs from region to region, attitudes about safety also differ.

While hitchhiking may be safer than the picture painted by the popular press, the problem of overcoming people's perceptions about hitchhiking safety must still be faced. For this reason a SRAT system must take precautions to ensure the greatest safety of participants. Safety can be ensured in two basic ways. First, the SRAT system can be designed to minimize the potential for accidents and crimes. Second, participants can be screened through a registration procedure.

When considering how to design a safe SRAT system, some patterns observed by the California Highway Patrol report are helpful. The report indicates that hitchhikers are more likely to be victims of crime than are drivers, women are more likely to be victims than are men, and hitchhiking crimes are more likely to occur at night than during the day.

Building safety into the design of a SRAT system can be done in many ways. For example, the system can be limited to daytime and (in winter) early evening operation, and it can have clearly visible and easily identifiable pick-up and drop-off spots that do not interfere with traffic flow. Similarly, the system can be limited to commuter corridors and major employment centers. These, and other aspects of design that affect safety, need to be carefully considered by those who design and operate SRAT systems.

In addition to system design, safety can be ensured by registering drivers and riders. Registration can vary from simply issuing some form of SRAT identification to all drivers and riders who apply, to a more sophisticated procedure that requires such information as proof of insurance for drivers.

In determining what registration criteria to use for a particular SRAT system in a particular city, several factors must be kept in mind. First, the more comprehensive a SRAT registration procedure is, the more inconvenience and cost is introduces for both managers and users. Accordingly, SRAT registration must strive for a balance between security and simplicity in the registration procedures. Second, security requirements, and hence registration requirements, will differ from one site to another, and from one SRAT design to another. For example, a rural area where all members of the community know one another may need only a minimal registration procedure, while an urban system that serves commuter routes only, or that operates only during daytime, could use a simpler registration procedure than a ubiquitous system that operates 24 hours a day. Finally, registration criteria must be rationally related to the goal of safety.

When considering what specific safeguards to incorporate into a registration scheme, it is useful to look at the analogous licensing requirements for chauffeurs, school bus operators, driving instructors, and taxi drivers. It is also useful to examine the registration requirements for existing or proposed transportation systems similar to SRAT. See Tables 27 and 28. After the security needs of a particular SRAT system have been determined, a registration procedure can be fashioned by selecting appropriate criteria from the Tables 27 and 28.

To provide the greatest security for a SRAT system, it will be necessary to check an applicant's criminal records. However, this presents invasion of privacy problems, as well as extra time and expense. In the smaller, more settled communities, a check of local criminal records may suffice. Such a check may also be unnecessary; people in small towns know with whom they want to ride. But in larger urban areas, a check of both state and federal records would be desirable. These records, however, are protected by privacy laws which generally prohibit dissemination of centralized records to anyone other than a criminal justice agency engaged in law enforcement activity. Some states, such as Oregon, permit an individual to request a copy of his own state record if he consents to fingerprint identification and pays the processing fee. In most states, however, information in these records is available only to police departments, or through an exemption authorized by statute, ordinance, or executive order. In any event, a requirement for criminal records should be limited to convictions committed within the last five years that are related to SRAT participation, such as assualt or robbery.

Table 27: Possible Registration Criteria

I. DRIVER REGISTRATION CRITERIA	II. RIDER REGISTRATION CRITERIA
A. Application made in person	A. Application made in person
B. Completion of general application form (GAF)	B. Completion of general application form (GAF)
C. Valid personal identification 1. social security card 2. driver's license 3. passport 4. credit cards 5. school identification (all or some may be used)	C. Valid personal identification 1. social security card 2. passport 3. credit cards 4. school identification 5. library card 6. drivers licenses
D. Valid driver's license and chauffeur's license where required by state law	D. Not applicable
E. Safe driving record: defined as having no accidents or moving violations with the preceding three years	E. Not applicable
F. Required automobile insurance coverage	F. Not applicable
G. Vehicle standards: 1. vehicle identification number and license number 2. annual vehicle inspection 3. seat belts: lap or shoulder	G. Not applicable
H. Minimum age: 18 years old unless signed parental consent obtained	H. Minimum age: 18 years old unless signed parental consent obtained
I. Maximum age: none as long as valid drivers license is held	I. Elderly and handicapped must be reasonably independent and mobile
J. Employee, student, or resident in SRAT county or locality	J. Employee, student, or resident in SRAT county or locality
K. Absence of criminal record within the preceding five years--fingerprints required	K. Absence of criminal record within the preceding five years--fingerprints required
L. Character reference(s) for 1. stable mental and physical condition 2. no addiction to drugs or alcohol	L. Character reference(s) for 1. stable mental and physical condition 2. no addiction to drugs or alcohol

Table 28: Registration Procedures

I. APPLICATION PROCEDURE	II. VERIFICATION PROCEDURE
A. Applicant must appear in person at designated SRAT agency	A. Identification presented at time of application
B. Applicant must present completed general application form (GAF) to SRAT agent	B. Verified by SRAT agent
C. Applicant must present the required identification to SRAT agent with completed GAF Applicant must also submit recent photograph for SRAT office files	C. Verified by SRAT agent
D. Driver's license is presented under procedure C above Chauffeur's license must also be presented with GAF where applicable	D. Verified by SRAT agent
E. Information requested on GAF	E. Verified by department of motor vehicles
F. Applicant must present copy of insurance policy for verification	F. Verified by SRAT agent
G. 1. Information requested on GAF 2. Applicant must present a certi- 3. Information requested on GAF	G. 1. Visual check of vehicle 2. Visual check of inspection 3. Visual check of vehicle
H. Information requested on GAF	H. Driver verification on driver's license Rider must present proof of age at time of application (i.e., birth certificate)
I. Information requested on GAF	I. Elderly and handicapped requirement verified by personal appearance
J. Information requested on GAF	J. Verification by telephone check with employer/school Those unemployed and not a student must provide proof of residence (i.e., telephone directory if phone number is published; ID with address
K. Information requested on GAF -fingerprints taken at time of application	K. Verified through procedures approved by relevant privacy laws
L. Information requested on GAF	L. Verified by telephone check of character references requested on GAF

D. Potential Liability of SRAT Management

The potential liability of an agency managing a SRAT system arising from traffic accidents involving SRAT members or crimes against members using SRAT may be a major concern of potential SRAT management agencies. Although the potential liability and approaches to minimize it will vary depending on the SRAT design in a particular locale, it is useful to consider the potential bases for liability by comparing SRAT with carpools and taxicabs.

One possible theory of liability may be based on an employment relationship between SRAT management and SRAT drivers. For example, taxicab companies that own their vehicles and employ drivers are vicariously liable for acts their employees commit in the course of their employment. This basis of liability, however, will not apply to SRAT; there is no employment relationship because SRAT management will not be employing the SRAT drivers (or riders). In this sense, SRAT is similar to a carpool matching service which clearly has no liability for pairing riders with drivers.

A more probable basis for liability of SRAT management would be based on negligence in performing its management tasks, especially screening participants. In this respect, SRAT differs from carpool matching services which usually do not purport to screen participants.

The standard used to determine liability for negligence will be whether SRAT management has performed its various tasks in a reasonably careful manner. Thus, the most important thing SRAT management can do to minimize liability is to perform registration, or any other tasks, carefully. For example, if it is decided that character references and driving records are to be checked,

the procedures must be followed carefully. SRAT should not represent that its registration does more than it does. SRAT management should be careful that its advertising is not misleading in this regard.

Of course, if registration is performed by the police department, as is generally the case for taxi companies, there may be no liability. This is because police departments (and other government agencies) often are protected from suit by their sovereign immunity.

Insurance provides another way an agency managing a SRAT system may minimize its potential liability. An insurance policy could be obtained to protect against negligence in carrying out registration procedures and to provide for legal defense in a suit for negligence. Local organizations purchase similar policies where volunteer drivers provide community services, such as transportation of the handicapped and elderly. These policies cost from $150 to $200 per year for a group with 200-300 members; the usual liability coverage is $100,000 per person, $300,000 per accident. In areas where insurance is more expensive, a policy covering a large SRAT program may cost up to $1 to $2 per member for the same protection. If SRAT is sponsored by a public agency that is already insured, such as a metropolitan transit system, the existing policy likely can be extended to cover SRAT.

Private insurance does not offer compensation to victims of crime through present types of insurance coverage. However, several states, such as California, reimburse crime victims; where this protection is available, SRAT members would benefit in the same way as other residents would.

To sum up, this is a potentially very serious problem for a SRAT system. Careful consideration must be given to how the system represents its control over user safety to the public and the degree to which it implements registration procedures to achieve this goal.

E. Automobile Insurance

The primary insurance problem raised by the SRAT concept is how best to protect SRAT drivers and riders from liability they might incur or losses they might suffer as a result of being involved in a traffic accident while participating in the SRAT program.

For drivers, the potential problem is the "concentration of liability" they face. Typical automobile liability coverages assume a vehicle occupancy of less than two persons. SRAT vehicles, though, may carry as many as three or four passengers, and if these passengers are injured in an accident which is the fault of the SRAT driver, the driver may face a damage judgment that exceeds his insurance coverage.

For riders, the potential problem is that the amount of insurance carried by many drivers is inadequate to reimburse the riders for a large percentage of losses they might suffer in a serious accident. Riders face not only the danger that the SRAT driver's insurance will not provide adequate coverage, but also the prospect that a non-SRAT driver causing an accident will not have adequate coverage.

Before turning to a discussion of the potential insurance issues of four specific states, several general points applicable to all states should be mentioned.

First, it appears that SRAT vehicles would be covered by the ordinary private automobile insurance policy and that special or public liability insurance would not be required. However, if SRAT service is regulated by a state Public Utility Commission (PUC) as a "public conveyance" for insurance purposes, this would mean obtaining very costly public liability insurance. Even though a vehicle may not be a "public conveyance" within the meaning of PUC regulations, an insurance company could still require that commercial

insurance be carried. Insurance company officials and state insurance officials informally agree that the SRAT system would not fall within the clause in many policies that excludes recovery under the policy if the car is used as a "public or livery conveyance." However, a prior determination by the state insurance commission is advisable.

Second, there are many advantages to requiring SRAT drivers to carry extra insurance beyond current minimum amounts. To be extra cautious, bodily liability coverage should be $100,000 per individual, and $300,000 per accident (100/300); medical payments coverage should be $10,000 per person; and underinsured motorist coverage (where available) should equal the bodily injury liability amounts of 100/300. While increasing liability coverage has some potential for encouraging higher damage estimates in claims or litigation, the additional coverage gives reassuring protection to both riders and drivers.*

Third, riders without their own automobile insurance may want to consider obtaining a personal accident policy or joining a health plan if one is available. In almost all cases, however, riders without their own automobile insurance will be covered by the driver's policy.

The cost of obtaining additional insurance will vary. Figures from Virginia indicate that the suggested coverage for SRAT would mean an increase of about $26 per year for a typical policy now costong $200 per year. This is a 13% increase for a two-person, safe-driving household. For a high risk driver, such as a young single male with a moving violation on his record, the premium increase would be closer to 25% of the total; the liability portion may nearly double. It may be possible for the extra coverage to be provided by SRAT management under a group travel policy.

*By requiring extra auto insurance, one might deter a proportion of drivers who would pick up SRAT passengers without compensation. In Miami, when the county required the taxis participating in its special paratransit service for the handicapped to carry extra insurance, they drove out the vast majority of cabs. Of course, taxi insurance rates are very high, but taxi operators are accustomed to red tape and record keeping also.

Because insurance requirements vary from state to state, any suggestions for SRAT insurance must be carefully tailored to the requirements for each state. The following discussion presents a description of automobile insurance in four states.

Colorado requires every automobile owner to carry liability insurance with minimum bodily injury coverages of $15,000 per person and $30,000 per accident (15/30). No-fault insurance provides benefits of:

1. Medical payments up to $25,000 per person for the driver and passenger under the policy carried by the driver;
2. Payment of rehabilitation expenses up to $25,000 per person;
3. Payments for lost wages up to $125 per person per week for 52 weeks.

In Colorado, no-fault insurance does not entirely preclude the injured parties from filing tort suits to recover additional damages (i.e., for pain and suffering). However, one of the following conditions must be satisfied before a suit can be filed: (1) medical and rehabilitation services exceed $500; or (2) the injury causes permanent disfigurement, permanent disability, dismemberment, or loss of earnings for more than 52 weeks, or death.

Because current no-fault provisions offer adequate medical payments, SRAT drivers in Colorado would only have to increase bodily injury coverage up to the suggested maximum of 100/300. See Table 29.

Connecticut requires every automobile owner to carry insurance with minimum liability and uninsured motorist coverages of 20/40 for bodily injury and $5,000 for property damages. No-fault provisions include "basic reparations benefits" of $5,000 per person. Under this coverage, persons in a car collect medical and hospital expenses under the policy purchased by the owner of the car.

The Connecticut law also provides "added reparations coverages" that motorists may purchase to supplement the benefits provided under the basic reparations coverage. Added reparations benefits are also paid without regard to fault. Under conditions similar to those required in Colorado, Connecticut also allows accident victims to file tort suits for additional damages.

A feature of Connecticut insurance law (which also exists in Virginia) allows the driver to purchase protection against underinsured motorists. Underinsured motorist coverage, which provides coverage in excess of the mandatory uninsured motorist coverage, would pay that part of a judgment greater than the amount collected from the other driver, but not exceeding the underinsured motorist coverage. Thus, if the other driver had 20/40 coverage, judgment was for $80,000, and the SRAT driver had underinsured motorist coverage of 100/300, the SRAT driver's coverage would pay the extra $40,000. A driver can buy only as much underinsured motorist coverage as he has bodily injury coverage. Thus, if he carries 50/100 bodily injury coverage, he cannot buy more than 50/100 motorist coverage.

In Connecticut, the $5,000 per person basic reparations benefits would have to be augmented by $5,000 added reparations benefits to meet the suggested $10,000 per person medical payments protection. Additionally, underinsured motorist protection in 100/300 amounts may be advisable.

Oregon does not require automobile owners to purchase automobile liability insurance. For motorists who do purchase insurance, however, Oregon has enacted no-fault personal injury protection. This no-fault coverage is automatically included in every automobile policy. The personal injury protection offers no-fault benefits to every person in the vehicle of $5,000 per

Table 29

Suggested Insurance for SRAT Drivers

Sample Site	Suggested Bodily Injury Coverage	Suggested Additional Coverage
COLORADO	100/300	Because $25,000 medical payments per person is part of required insurance, no additions needed.
CONNECTICUT	100/300	$5,000 basic reparations benefits per person under present no-fault plan; suggest $5,000 added reparations coverage, plus 100/300 underinsured motorist coverage.
OREGON	100/300	$5,000 per person medical payments currently provided by no-fault; suggest additional $5,000 per person medical payments.
VIRGINIA	100/300	Suggest $10,000 per person medical payments, plus 100/300 underinsured motorist coverage.

person for medical and hospital expenses and 70% of the wages lost up to $750 per month for up to one year. An additional $5,000 per person medical payments coverage may be advisable to supplement the present no-fault level of $5,000.

Virginia does not require automobile owners to purchase automobile liability insurance. The state has enacted limited no-fault legislation that requires insurers to offer no-fault medical and wage loss benefits, but the law does not require persons with auto insurance to purchase these benefits. The optional coverages provide benefits of up to $2,000 per person for medical and hospital expenses and up to $100 per week for 52 weeks for wage loss. The benefits would be paid to any person in a vehicle covered by a policy with these optional coverages. Underinsured motorist coverage is also available. An increase sufficient to meet the $10,000 per person medical payments plan and 100/300 underinsured motorists protection may be advisable.

F. Tax Issues

The primary federal income tax question for SRAT drivers is whether the fares they are paid by SRAT riders must be included in the driver's gross income under §61 of the Internal Revenue Code. In general, provision of SRAT service will be incidental to trips that the driver would make in any event. Furthermore, SRAT drivers generally will will not realize a profit over and above recovering their operating expenses. Under these circumstances, the IRS Revenue Ruling 55-555 on the income tax consequences of share-the-expense carpool arrangements should determine whether SRAT fares must be included in a driver's gross income.

Revenue Ruling 55-555 indicates that whether or not money from a carpool must be included as income depends upon a case-by-case analysis to determine whether the money received exceeds the operating expenses of the work trip. At least theoretically, the excess would be taxable income.

Although the IRS has not provided a definitive answer concerning whether SRAT falls within this ruling, as a practical matter it is unlikely that SRAT drivers will collect enough fares in the course of a year to o-fset the operating expenses of traveling to and from work. On the federal level, therefore, the income tax consequences for drivers participating in SRAT should not present any barrier.

For carpool ride-sharing arrangements, federal tax policy prohibits deducting fares or other commuting-related expenses from their gross federal income tax. The Internal Revenue Code does not allow deductions from gross income for personal expenses. I.R.C. § 262. The cost of commuting to and from a place of business or employment is considered a non-deductible personal expense. IRS Regulation 26 C.F.R. §§262(a)(5) and 1.2.2-1(f).

*Some SRAT concepts might include special trips by drivers to serve passengers. Many of the systems could be volunteer systems, but if fares were charged, there would be an income tax liability in most cases.

Generally, the tax consequences at the state level will be the same as at the federal level. This is because most states rely upon the federal income tax definitions for determining what is gross, adjusted gross, and taxable income. These states follow Revenue Ruling 55-555 on carpooling and would be expected to follow any IRS determination of how to treat money received by SRAT drivers.

Although Oregon has also adopted the 1954 Internal Revenue Code, it has not adopted the federal administrative rulings on the code. Thus Revenue Ruling 55-555 is not applicable in Oregon. Carpool income must be included in gross income, but may be offset by carpool expenses; the amount greater than expenses is included in the driver's taxable income. Oregon tax officials indicate the SRAT fares and expenses would be treated in the same manner. Accordingly, in Oregon, requiring a driver to keep records and report SRAT fares as income may create extra paperwork for potential SRAT drivers.

For carpool riders, state tax policy follows the federal practice of treating commuting expenses as personal, non-deductible expenses. Of course, in states like Connecticut, which do not have a personal income tax, tax problems do not arise.

To the extent that SRAT can be treated like carpools for federal and state income tax purposes, the tax consequences of participating in SRAT will not be a significant consideration in deciding whether to implement (or join) a SRAT system. However, if SRAT for any reason does not qualify for the treatment accorded carpools, the burden of keeping records of SRAT expenses (which would be used to offset SRAT income), of filing additional tax forms, and of paying additional taxes, may discourage some potential SRAT participants.

G. Traffic Regulations

SRAT design and operation must be compatible with existing traffic laws and regulations. The design and operation must also be sensitive to the attitudes of local police departments, who will be enforcing traffic rules that affect SRAT.

The most obvious traffic regulations affecting SRAT are those dealing with hitchhiking. While the majority of states place some restrictions on hitchhiking, most allow solicitation of rides from anywhere other than roadways. City codes are consistent with the state laws in most localities, although cities generally have the power to ban the soliciting of rides within city limits. Police departments evidence various degrees of tolerance towards hitchhiking, and often do not concentrate their enforcement efforts in this area unless a person solicites a ride in an unsafe manner.

In addition to the legality of hitchhiking, there are numerous other traffic laws and regulations that might affect either SRAT vehicle operation or the designation of pick-up and drop-off locations. Specific local ordinances regarding parking and stopping of vehicles may affect SRAT's operations by prohibiting stopping in certain areas (e.g., near driveways, fire hydrants, intersections or bridges) or by prohibiting use of bus stops and delivery zones. It may be possible under some circumstances to obtain special exemptions or licenses to allow SRAT's joint use of these zones. Limitations on opening doors, starting parked vehicles, and driving in reverse must also be obeyed by SRAT drivers. Moreover, many states prohibit or restrict the size of any SRAT identification placed on windshields. Finally, it will be necessary to comply with general traffic laws related to speed limits, yielding, U-turn prohibitions, and traffic signs and signals.

For SRAT passengers, compliance with pedestrian laws is important. Predestrian accidents resulting in fatalities constitute almost twenty percent of the total national highway death toll. Again, the most obvious law concerns where pedestrians may stand to solicit rides. For example, most cities require pedestrians to stand on sidewalks or shoulders when soliciting a ride; and on highways, pedestrians must walk on the left side, facing approaching traffic. Other important pedestrian laws require pedestrians to yield to vehicles when crossing roadways at any point other than within a crosswalk and prohibit jaywalking between adjacent intersections controlled by traffic signals. These laws are designed to eliminate accidents caused by people darting unexpectedly into roadways and are especially important for SRAT passengers who may need to cross a road to obtain a ride.

To promote safer and more efficient SRAT operation, traffic laws and regulations may be supplemented by establishing SRAT operating rules. These rules could govern queuing procedures for vehicles and passengers at SRAT stops (e.g., first in, first out), how and where passengers may be picked up and dropped off, and methods for displaying designation signs.

In order to be effective, traffic laws, regulations and operating rules must be enforced. Local police departments have their own enforcement priorities for traffic law violations, and as mentioned, police often concentrate on more serious violation and tolerate certain types of minor violations in specific locations or under certain circumstances, especially with respect to hitchhiking laws. SRAT management could also have a role in enforcing traffic laws and operating rules by providing SRAT participants with manuals reciting applicable traffic laws and listing operating rules.

If possible, SRAT managers might even occasionally observe SRAT stops to determine whether rules are being violated. Finally, SRAT management may want to establish incentive awards for participants who are courteous or carry the most passengers over a certain period of time.

SRAT participants can also help enforce laws and rules by reporting violations of SRAT management. SRAT users could be provided with postcards for that purpose.

Traffic laws and regulations have numerous implications with respect to the location of SRAT stops, and whether or not specific stops should be designated. While not having designated pick-up and drop-off points may increase the flexibility of the system, it may also encourage participants to violate the law. By designating specific locations, SRAT would not only ensure greater compliance with laws, but also enhance its own visibility. City traffic departments or public works department would need to be consulted to determine the best location for stops. This way, high accident locations can be identified and avoided. Making effective use of traffic patterns (e.g., one-way streets, intersections where turns are prohibited) and existing facilities (building entrances, roadside stops, and delivery and bus zones, if possible) will increase the operational safety and efficiency of SRAT. Finally, SRAT stop locations should be clearly visible so that drivers can easily recognize potential riders, and other motorists will know to be particularly cautious of stopping and merging vehicles at these locations. An added benefit may be that non-SRAT drivers will realize how convenient the SRAT stops are to their own commuting routes and be encouraged to participate.

H. Summary

The legal and regulatory framework that any SRAT system must operate in is oriented toward conventional mass transit and their employees. Because of this orientation, it is not surprising that an innovative transportation concept such as SRAT does not fit neatly into the existing framework. In many cases, the introduction of SRAT will require breaking new ground in order to overcome regulatory and other legal barriers.

Perhaps the most significant barrier facing SRAT is the complex set of federal, state, district and local regulations. If SRAT is held to be a common carrier or otherwise regulated as a public utility, licensing and certification burdens may prohibit timely and economic operations. Thus, it may be impossible to introduce SRAT in a state where no regulatory exemptions exist, unless the laws and regulations can be changed, a process which, in itself, will present timing problems. In the many states where regulatory exemptions for SRAT do exist, SRAT would be carefully tailored to comply with the exemptions. The easiest method for avoiding regulation is by designing SRAT as a no-fare system.

The next most significant barrier for SRAT involves the need to protect existing mass transit workers who may be affected by SRAT operation. If UMTA funding is used, §13(c) of the Urban Mass Transportation Act requires negotiation of labor protection provisions. On its face, §13(c) will not prohibit SRAT operation, but in some instances it can mean lengthy, pre-operational negotiations with transit unions, and potentially costly subsequent claims by mass transit employees adversely affected by SRAT. Methods for limiting or eliminating labor problems include avoiding competition with transit, or getting unions to accept some competition in

exchange for some role in SRAT management or operation. Finally, since 13(c) labor problems only arise when UMTA money is used, the need for 13(c) agreements can be eliminated entirely if alternative funding is secured.

Insurance requirements and recommendations also affect the feasibility of SRAT. Current minimum automobile insurance requirements in most states may not provide enough protection against potential "concentration of liability" problems faced by SRAT drivers. It is suggested that SRAT drivers carry bodily injury insurance coverage in the amount of $100,000 per person, and $300,000 per accident. The cost of this additional coverage should not be prohibitive. A further insurance consideration concerns the availability of no-fault insurance coverage; states offering no-fault will present fewer insurance problems for SRAT than states without no-fault.

For SRAT to be a feasible transportation alternative there must be a sufficient number of people who are willing to use it. A screening and registration procedure for SRAT membership can help to ensure that people are not kept away by fear of crime. Where a registration procedure is used, the criteria should be carefully and objectively chosen, and the procedures should be carefully followed. Otherwise, SRAT management may be liable for negligently performing its responsibilities. It may be prudent to protect against this type of negligence by purchasing liability insurance for the management agency.

Other legal issues concern tax and traffic laws. Neither of these areas, however, should create insurmountable problems. The most significant traffic law concerns the legality of hitchhiking; restrictions and prohibitions affect SRAT by limiting methods and locations of passenger pick-up and drop-off stops. In most localities, though, hitchhiking laws should not

present a major barrier to SRAT. Likewise, SRAT fares are not subject to taxation under current tax law, as long as fares do not exceed operating costs for the driver.

In conclusion, before a SRAT system can be implemented, legal and regulatory issues must be studied and resolved. SRAT must comply with applicable laws and regulations, even though these laws were not designed with innovative transportation in mind. In some jurisdictions, compliance with various laws may be so burdensome that SRAT will not be able to operate efficiently. In other jurisdictions, compliance may entail limiting SRAT operations. In still other jurisdictions, however, compliance will be possible.

V. INSTITUTIONAL ISSUES

A. Case Study Objectives and Methodology

The purpose of this chapter is to identify the institutional factors which may affect the feasibility of SRAT and to assess the importance of these factors in four case study cities.

SRAT is a non-capital intensive system making use of an existing transportation mode, the private automobile, but involves managing and operating the system in a new way. Because of the emphasis on modifications to the operation of the existing transportation system, implementation of SRAT may be similar to implementation of management and efficiency-oriented measures included in the joint UMTA/FHWA regulations on Transportation Systems Management.* Experience with TSM measures has shown that:

- existing institutional arrangements vary widely from area to area, so that while general observations on the success of measures can be made, detailed arrangements must be worked out by individual areas on a case by case basis
- management options require the coordination of several agencies, which have different interests in and authority over the existing system
- interagency and intergovernmental coordination is necessary for successful implementation as well as initial planning and design of management measures
- like construction of major facilities, attempts to implement management and efficiency oriented measures can become controversial, particularly if plans have been formulated without input from all affected agencies and the general public**

In light of this experience with other TSM and paratransit options the institutional analysis focused on:

*40 Federal Register 42976, September 17, 1975.

**Elizabeth Deakin et al, "Transportation Systems Management and Transportation Control Planning: A Review of Current Activities", MIT Center for Transportation Studies, December 1976.

- Existing Transit and Taxi Services: the existence and adequacy of transit and taxi services must be assessed since active opposition from existing operators may be anticipated if SRAT is perceived to be in competition with services either currently provided by or within the capabilities of these groups. A potentially large number of legal and regulatory issues can be employed to impede SRAT implementation if the fear of competition is apparent.

- Level of Interagency Coordination and Cooperation: the level of interagency coordination that is required to implement SRAT varies significantly depending on the detail and sophistication of the SRAT design concepts and the number of jurisdictions involved. The requirements for interagency coordination are likely to increase when the system requires formal government endorsement and promotion, the use of fixed routes and designated stops, the establishment of a fare policy, and the licensing of drivers. Additionally, as the number of partipating political jurisdictions increases, interagency coordination is likely to become more complex.

- System Management and Promotion: if a public agency is required to organize and manage a SRAT system, the selection of the appropriate agency will depend on an agency's existing authority for and involvement in transportation (particularly paratransit); interest in promoting and assuming responsibility for a SRAT system; and acceptability to the public and other agencies.

- Public Acceptability: the factors influencing SRAT's public acceptability include safety provisions, registration requirements, image of agency assuming lead responsibility and promotional efforts accompanying system implementation, and past experience with hitchhiking. Anticipated public reaction to the SRAT concept is likely to be a major factor influencing a management agency's willingness to become involved in SRAT.*

Naturally, there is a strong relationship between the legal and regulatory issues discussed in the previous chapter and the institutional factors identified above. In many cases, potential legal and regulatory barriers can be exploited by agencies or groups opposed to SRAT. In other cases the results of the legal and regulatory analysis have identified ways that SRAT systems can be designed to minimize institutional barriers and enhance public acceptability.

*Citizen attitudes expressed during the focus group sessions (ChapterIII) provide additional insights into public concerns.

Because the importance of specific institutional factors was expected to vary considerably in different institutional settings, an analysis of institutional issues in specific sites was felt to be necessary as part of the feasibility study.

The four urban areas selected for conducting a detailed assessment of SRAT institutional feasibility are:

- Boulder, Colorado
- Boston, Massachusetts
- Portland, Oregon
- Tidewater, Virginia

These four sites were chosen to represent areas with varying institutional structures in which to implement SRAT:

- Boulder Colorado, has considered SRAT-like systems in the past, has a large college population, and is a relatively small city;

- Boston, Massachusetts, is a large, older Eastern city with a diversity of residents and a large array of institutions involved in transportation issues;

- Portland, Oregon, is a medium-sized Western city in a progressive state and in an area where transportation innovations and flexibility have been demonstrated;

- the Tidewater region in Virginia is a medium-sized Eastern area with multiple jurisdictions, some experience in transportation innovation, and a typical set of transportation institutions.

Together, these four areas give considerable depth to the institutional considerations SRAT might face.

The objectives of the case study analysis are to identify the specific insitutional issues likely to impact SRAT implementation for that site, and to identify the opportunities for designing, implementing and operating SRAT in a variety of institutional settings. Four design concepts for urban area SRAT systems were considered:

- urban feeder to transit
- general urban service
- bus replacement
- service to major activity centers

A series of interviews, both on site and by telephone, were conducted to develop an understanding of the potential prospects and barriers for SRAT implementation. Those agencies which might be involved in, or impacted by, some aspect of an SRAT program were contacted. Information was sought on the existing institutional arrangements, agency interrelationships and agency's views on their potential role in SRAT planning or management, including those insurance, regulatory, licensing and labor issues that could affect their involvement.

A brief discussion of each agency's responsibilities, concerns and current or previous involvement in the operation or enforcement of transportation services is provided as background for the specific SRAT observations which follow. While there can be no assurance that these factors will definitely affect SRAT implementation, they do provide a basis for assessing the system's overall prospects in each of the case study areas, identifying the problems which can be anticipated, and indicating those SRAT system designs likely to face the fewest barriers in a particular area.

Many of the implications for SRAT listed in the individual case study analyses reflect the specific characteristics of that site. However, there are some observations which appear to be applicable for all of the areas. The final section of this chapter draws some summary conclusions.

B. Case Study Findings

Boulder, Colorado

1. Background

The Boulder area had a 1975 County population of 169,900 and a City population of 92,200. This reflects a 29% growth in the County population and an 18% increase in the City population since 1970. The University of Colorado and a large IBM Center are the area's two major employment sites. In addition, there are three major activity centers within 1 1/2 miles of each other in the City, one of the centers being the University campus.

While the automobile is the primary means of travel in the Boulder area, both bicycling and hitchhiking constitute a visible, though minor, proportion of trips. Public transit accounts for 1½% of all trips made in the Boulder Valley and the use of taxi services declined over the past five years.

Two characteristics of the Boulder area which have important implications for the potential of an SRAT system are:

- The University of Colorado's location in Boulder and the large student and transient population (more than 50% of whom did not own an automobile in 1973), make this area very conducive to hitchhiking as a means of transportation. While the Colorado statutes state that hitchhiking from traffic lanes is illegal, the interpretation of hitchhiking from shoulders of roads without curbs or sidewalks is unclear. The accident and crime rate associated with hitchhiking may be higher than other areas in the country.

- The residents of Boulder are very aware of environmental issues and a favorable attitude for improving and preserving the environment exists.

2. Existing Public Transportation System

The only public transit operator currently serving the Boulder area is the Regional Transportation District, which was created by state statute in 1969 to serve the entire Denver metropolitan area. Prior to RTD's take-over of municipal service in 1974, the City of Boulder and the Public Service Company provided these services. The Denver-Boulder Bus Company providing intercity service was purchased by RTD in May 1975.

In 1975, seven routes consisting of approximately 62 miles and a fleet of 22 buses, served an average of 5,000 riders daily. Approximately 94% of the population is within 1/4 mile of a bus route. An additional 34 buses operate between Boulder and Denver. All regular buses are operated by unionized drivers. RTD also operates a free eight-mile circulation shuttle bus service connecting the City's major activity centers. The fares for regular intracity routes are $.25 for adults and $.10 for children, elderly and handicapped persons.

In addition to regular bus service, RTD purchased a 15-passenger van and contracted out to a single non-unionized individual (who could in turn hire other drivers) to provide both scheduled commuter and community responsive paratransit service (CRT) to the communities of Louisville and Lafayette. The service was specifically designed not to duplicate any existing services.

The Amalgamated Transit Union protested the CRT service prior to actual implementation on the basis that this was a "new line" being offered by RTD and, as such, service should be provided by unionized employees. The union claim was upheld during arbitration and the paratransit service concept in Louisville/Lafayette had to be abandoned. Commuter service was later implemented, however, using conventional fixed route service.

RTD anticipates that it will attempt a similar paratransit service in the community of Nederlands which also cannot be economically served by conventional transit. Although the concept will be the same, the service will have to be provided solely by the individual with whom RTD contracts.

Currently, the general level of RTD service provided is considered by City and County representatives to be good and improving. The financial picture was portrayed as excellent for the entire RTD operation since sales tax and property tax revenues more than offset farebox deficits.

The other transportation service in Boulder is provided by Yellow Cab Taxi Company. Their fleet of 14 vehicles is serviced by full-time non-unionized drivers, most of whom are under 30 years of age and are students or hold other jobs. The drivers do not own the cabs and the average length of employment is less than two years. Approximately 99% of the taxi trips are prearranged by phone dispatch and almost all are exclusive ride, although shared ride is permitted. The number of cabs, drivers and calls have been declining over the past five years and the financial situation of Yellow Cab Company in Boulder is not a healthy one.

3. Institutional Characteristics

City of Boulder

The City has not provided public transit services since their municipal bus service was acquired by RTD in 1974.

Taxicabs are municipally regulated and the definition of the types of vehicles subject to City regulation is very broad and it is very possible that SRAT would not be exempt.

In 1974, the City Department of Transportation did preliminary research on a "Ride/Stop" program which had some similarities with an SRAT

system. Lack of City Council enthusiasm for "legalized hitchhiking" at that time precluded any further research efforts. There has been no subsequent revival of this concept. Since this time, however, the composition of the City Council has changed.

The Boulder City Police Department has traffic enforcement responsibilities on streets within the City boundaries. They are responsible for enforcing hitchhiking regulations and issuing traffic citations, although it is not obvious that hitchhiking is strictly enforced. The City Police Department coordinates many functions with the County Sheriff's office. Both are housed in the same building and keep combined records. All communications are initially directed to the Sheriff's office and that office in turn makes assignments to the Police Department on the basis of jurisdictional responsibility.

In 1973, when the City was considering the Ride/Stop Program, the Chief of the Police Department felt that hitchhiking should not be legalized because it would increase the potential for crimes.

Another police official felt that even if hitchhiking were not banned, he would be opposed to Ride/Stops since this would create "hubs" for crime.

Recently, the City of Boulder was not able to renew their insurance policy and are presently self-insured. The Police Department in particular had severe insurance problems.

County of Boulder

Generally, the City and County coordinate closely on programs. The County of Boulder is less involved with transit than the City, although they have been recently coordinating more closely with RTD on service decisions. The County is represented on the RTD Board of Directors.

Since RTD acquired the Boulder bus service, there is a feeling that desirable improvements have been made.

Recently the County staff considered the idea of placing peripheral parking lots outside of the downtown to relieve congestion. The idea was that employees who parked in peripheral lots would be picked up by other employees on their way into downtown. While such a program would have certain similarities to an SRAT system, the proposal is not being actively considered.

The County Sheriff's Department, unlike the City Police Department, is not involved in traffic enforcement. This function is handled by the Colorado State Patrol in all of the unincorporated areas of the County. The Sheriff's office is concerned with criminal matters and rarely issues hitchhiking citations since this is not their concern. A captain of the Sheriff's Department observed that a large proportion of hitchhikers within the County are transients, although within the City of Boulder they are primarily students.

As mentioned previously, the Sheriff's Department shares many functions with the City Police Department. They are currently involved in record keeping for several programs provided by other social service agencies within the County and have access to the criminal and traffic records of individuals.

With regard to actual traffic operations, the traffic code specifies that any picking up or dropping off of passengers off the main road is acceptable but that on main arteries, an extra pull off lane would be required for safety reasons. Pull off lanes have been constructed for bus loading and unloading on the main arteries.

The Regional Transportation District

RTD, as described previously, is the transit operator for the region. Like representatives of the City and County, the manager of the RTD operations in Boulder feels that a good working relationship exists between RTD, the City and the County.

RTD, as the designated public transit operator for the region, would be concerned with and closely monitor other agencies' initiatives in providing transportation services that were perceived to be in competition with RTD services. This is particularly true because of RTD's broad interpretation of the types of services which are within their capabilities and statutory authority to provide, notably their recent attempts with paratransit services. However, under existing legislation, RTD cannot operate strict demand responsive services. They can, however, operate on the basis of call in, subscription or pick up/drop off along a regularly scheduled route.

Whether or not RTD was to actually provide a new service like SRAT, both the City and County expressed the opinion that as the regional operator, RTD should be involved in initial discussions so that any problems could be discussed.

RTD, like the City, is self insured and it must be able to adequately cover the many liabilities associated with its bus operations.

Denver Regional Council of Governments

The Denver Regional Council of Governments (DRCOG) is the Metropolitan Planning Organization for the Denver Metropolitan area, in which Boulder is included. DRCOG is predominantly a planning, coordinating and administrative

agency and does not have implementation responsibilities. (The exception is DRCOG's carpooling program).

DRCOG is the federally designated A-95 review agency for the region. Alltransportation planning funds must be requested in the region's Unified Work Program which is coordinated by DRCOG, and DRCOG consequently receives the grant funds which it then allocates to its member agencies in accordance with the authorized program.

DRCOG's independent authority is actually limited since its membership is voluntary and there is consequently a strong tendency for DRCOG to reflect and accommodate the opinions of its member jurisdictions which are represented on the DRCOG policy board. In general, a strong consensus among agencies for a particular transportation program or the strong desire on the part of one agency as long as it was not in conflict with other agencies' feelings would most likely cause DRCOG to approve a proposal.

4. Implications for SRAT

On the basis of the institutional characteristics, existing public transit services and the agency attitudes discussed in the preceding section, the following observations relating to SRAT can be made. While there can be no guarantee that these factors will either positively or negatively affect SRAT feasibility, they do provide some basis for assessing the system's overall prospects in Boulder and the problems which will have to be overcome in the process.

General Observations

- All interviewees cited the need for a SRAT system to include the registration of drivers and riders. The intent would be to minimize

crime potential, provide a means for reporting accidents and, in general, to provide as much assurance to the public as possible regarding the safety of an SRAT system. Many interviewees felt that potential SRAT participants might have difficulty adjusting to the idea of "legally riding with a stranger" and registration would be an attempt to allay some of those concerns.

- Between 1973 and 1975, the City of Boulder staff researched the hitchhiking situation and developed the concept of a "Ride/Stop" program which has many similarities with SRAT. In 1975, however, the Boulder City Council shelved all work on this program upon a recommendation from the City Manager that there were no available resources to fund further study and that "we (the City) have a great many pressing transportation issues and hitchhiking does not compare in seriousness with the numerous other transportation activities we must lend our efforts to." However, Council membership has changed and the Council might be more receptive towards a SRAT system today.

- In accordance with Boulder Traffic Code regulations, any SRAT operation would require the construction of an extra lane turnoff area for picking up and dropping off passengers. Recently, several extra turn off lanes have been constructed for RTD bus use. But, it is unlikely that SRAT vehicles could make use of these same lanes due to possible competition with the buses.

- Representatives of the City and County felt that RTD would have to develop SRAT service. RTD has the experience and resources to conduct the extensive marketing effort that would probably be necessary and is probably best equipped to handle any potential liability claims against the system management agency. However, while RTD is interested in monitoring any efforts to develop a shared-ride program, it is not clear the agency would be willing to become actively involved in SRAT.

Factors Which Could Facilitate SRAT Implementation

- A high degree of institutional coordination exists among the City, County and RTD.

- Because of the Sheriff's Department's involvement in the recordkeeping for many social service programs sponsored by other departments, a representative felt that they could provide similar assistance for SRAT registration.

- The degree of coordination and sharing of many functions between the Sheriff and Police Departments would facilitate and greatly simplify any administrative involvement they had in SRAT.

- Although it has been difficult to regulate hitchhiking within the County, since many of the hitchhikers are transients, an SRAT system with registration could be used as a screening agent to reduce transient hitchhiking.

- Several areas of the County are not served by public transit services and because of their lower densities, cannot be economically served by conventional transit. These areas could be potential SRAT sites but coordination with RTD regarding their paratransit operations would have to be established.

Potential Barriers to SRAT Implementation

- RTD has good and improving transit service with good peak hour coverage and connection of major activity centers by free shuttle buses although their overall services are not heavily utilized. Since RTD is making a conscious effort to increase their ridership, any SRAT competition with RTD services would be a serious problem. The SRAT design concepts of urban bus replacement, activity center service and general urban service (except in certain areas) are probably not feasible for Boulder. Feeder bus, and in some cases a general SRAT service might be considered in rural areas of the county which are currently not served by RTD.

- Although an RTD representative felt that, although SRAT could potentially accommodate excess peak period RTD riders, the problem of designing SRAT to only capture excess ridership was intractable and therefore RTD would be in opposition.

- As mentioned previously, RTD's involvement with paratransit services and their current problems with the transit unions would discourage their involvement at this time. RTD would also oppose any other agency which provided a competing service. This opposition, however, is characteristic of only this point in time and their future attitude will depend on their resolution of the current labor problems and the success of their paratransit operations.

- Because the taxi company in Boulder (Yellow Cab) is experiencing financial difficulties, they would be likely to oppose the introduction of a new service like SRAT which could further hurt their business. Although one interviewee felt that taxi users are a very different population than SRAT users (taxi users are mainly elderly and high income; SRAT users might be middle income, commuters) he still felt that the cab company would protest. A Yellow Cab official claimed that SRAT would, in fact, be direct competition since they serve a cross section of the population, and in particular, many commuters during the morning and evening peak periods.

- Although the Sheriff's Department has access to individual criminal and traffic records, they would be unwilling and unable to provide definite character assurances on the basis of these records.

- The City Police Department is concerned that personal safety and traffic safety will be jeopardized by "legalized hitchhiking" even if some form of registration is attempted.

- A potential problem is that by providing legal and public "sanctions" to a SRAT program, the public might expect greater security precautions than can actually be achieved. A higher crime rate is tolerated with non-legalized hitchhiking since there is no public agency supporting or promoting the action and the risk is thus assumed by the individual.

Boston, Massachusetts

1. Background

The Boston SMSA covers an area of 987 square miles and in 1972 had a population of 2,753,800, 20% of whom rode public transportation to work. Jobs in the downtown area have remained constant over the last ten years, and the mode split to the downtown has shifted slightly toward the automobile over the last twenty years.

While the downtown remains an important source of employment, suburban employment has been growing. The development of the electronics industry along circumferential Route 128 is an excellent illustration of this phenomenon, and it has led to an increased amount of suburb to suburb commuting.

Boston has a large college student population and although hitchhiking is illegal, it has either been condoned or enforced sporadically in areas frequented by college students. Several well-publicized hitchhiking incidents have occurred in the Boston area, one of them resulting in the death of a student in 1975, and as a consequence there is considerable concern for the personal safety issues inherent in any ride solicitation scheme.

2. Existing Public Transportation System

The Massachusetts Bay Transit Authority (MBTA) is the regional transit agency and operates a system which includes subway, bus, trackless trolley, and commuter rail services. There are 199 MBTA bus routes covering a total of 722 route miles; 5 streetcar routes covering 35 route miles; 3 rapid transit routes covering 38 route miles; and 4 trackless trolley routes covering 16 route miles. The above components of the system

carry approximately 480,000 passengers per day. The commuter rail lines carry a total of 30,500 passengers per day and operate over a total of 240 route miles. In all, the MBTA operates about 1,300 vehicles which travel approximately 135,000 miles each weekday.

In addition to its regular service, the MBTA is operating suburban paratransit demonstration programs in the towns of Natick, Needham and Bedford under contract to private carriers. MBTA unions have accepted this service because it never competes directly with existing MBTA service and it is being offered on an experimental basis. The future of the program is uncertain from both a financial and a labor perspective.

MASSPOOL, the statewide carpool matching program, was funded by a $600,000 two year FHWA grant and is currently administered by the Executive Office of Transportation and Construction. EOTC hopes to turn responsibility for MASSPOOL over to the Massachusetts Department of Public Works. Vanpooling efforts were initiated as part of the MASSPOOL program, and at present 12 employer vanpools are in operation in the Boston area.

Massport, the airport operator, has two transportation services; the shuttle bus service from the airline terminals to the nearby MBTA rapid transit station, and a Share-A-Cab program for transportation to and from the airport for communities outside of Boston. The shuttle bus was previously an MBTA service which MBTA unions unsuccessfully attempted to retain. The Share-A-Cab program has been operational for approximately two months and was initiated as a result of taxi driver protests of increased limousine services at the airport. Massport dispatchers are responsible for grouping passengers and have tried to get three people in all shared cabs, a situation which has resulted in long wait times for some passengers.

Surveys to determine repeat use have not yet been performed, but total ridership on the system is approximately 200 passengers per day, compared to an original estimate of between 300 and 500 passengers per day.*

In 1930 a special act of the Massachusetts legislature limited the number of taxi licenses and gave exclusive regulatory authority over the taxi industry to the Boston Police Commissioner. At present there are 1525 taxis licensed to operate in the city of Boston, approximately one-third of which are owned and operated by taxi companies having fleets. Most of the independent taxi operators belong to the Independent Taxi Operators Association (ITOA).

A taxi medallion (or license) has a capital cost of approximately $25,000 in the city of Boston, and about 200 medallions change hands every year, half of which are foreclosures. Because of the high medallion cost, it is difficult to make a good living being a cabbie in Boston. Taxis do carry some work trips. Generally, the passenger and the driver arrange in advance, and often negotiate a weekly or flat rate fare. Because these arrangements are strictly between the driver and the passenger, ITOA could not estimate the number of work trips served in this way.

3. Institutional Characteristics

City of Boston

Boston has been focusing on non-automobile transportation within and to the city. The Mayor's transportation staff feel that most areas of the city are well-served by transit during commuting hours and they would be most interested in providing door to door service to meet the needs of residents during evening hours. While it was acknowledged that some of the evening service might be provided by a SRAT system

*The annual operating cost of Share-a-Cab, mostly dispatcher wages, is near $400,000, which results in a high cost per ride.

(activity center or general urban configuration), a higher priority is to widen the scope of taxi cab services to include shared ride schemes, taxi stands at shopping centers, and service to medical areas. Taxis are viewed as an important component of the existing public transportation system, and one that can be improved.

As a general rule, the city does not wish to encourage any programs which provide for expanded use of private automobiles because there is concern that shared ride schemes will divert some riders from transit to automobile.

The Police Department is responsible for licensing and regulating the taxi industry in the city of Boston, and it is also responsible for granting rate increases. Due to restrictions imposed by recent privacy rulings, the Police Department is no longer able to screen potential taxi cab drivers for previous convictions.

The City of Boston has been careful not to antagonize taxi interests because taxi industry threats of a strike constitute a potent force. One of the barriers to expanding taxi services, according to city staff, is a fear that offering increased service will result in increased regulation of the taxi industry, either by the city or by the Department of Public Utilities. The taxi industry may be unwilling to expand service if it is accompanied by increased reporting requirements or by closer scrutiny of a regulatory body.

Because some percentage of work trips in the city are made by taxi, and because the taxi industry is in relatively poor shape in Boston, a taxi operators' representative stated that the taxicab association would vehemently oppose a system like SRAT. Even if it could be shown that the

number of people who would switch from taxi to SRAT would be miniscule, taxi interests would fight SRAT on principle because they particularly do not want to see the private automobile involved in the transportation business, since it means competition in the long run.

The Department of Traffic and Parking has jurisdiction over stopping and street signs, and would have to be consulted if SRAT stops were to be located on any streets in the city.

It is important to note that Boston contained only 23% of regional population in 1970 and in many ways is the least likely part of the region for SRAT operation.

Massachusetts Bay Transit Authority

The MBTA is a regional transit agency, offering service to 79 cities and towns. Half of the MBTA deficit is covered by the state and the other half is covered by the cities and towns in the service area in proportion to the number of MBTA users whose trips originate in the town. In 1975, Boston paid approximately 45% of the portion of the deficit picked up by the cities and towns. Although the MBTA is sensitive to the service needs of suburban communities, the magnitude of the deficit and the higher cost per passenger of offering service in low density areas means that transit level of service is excellent downtown and decreases as distance from the CBD increases. The city and the MBTA work together quite closely, with the city proposing modifications which will improve service to residents and commuters.

MBTA staff feel that their agency is not likely to sponsor something like SRAT, if only because they are currently overloaded enough administratively that it would be difficult to accept responsibility for any

new service. As a regional transportation agency, the MBTA would want to be in a position to determine where and how any transportation service within their area would operate, regardless of what agency or group was responsible for its management.

The MBTA has 28 collective bargaining units and the "union situation" is considered to be a significant force in shaping Boston's transportation services. MBTA staff almost guarantee that unions would oppose an SRAT service, but observed that whether or not the unions are successful would probably depend on where SRAT was to operate and on how "competition" is defined.

Metropolitan Planning Organization (MPO)

Boston's MPO is a committee of signatories, which consists of the chief executive officers of the six signatory agencies. The six signatory agencies are: the MBTA, the MBTA Advisory Board, the Executive Office of Transportation and Construction (EOTC), the Department of Public Works, the Metropolitan Area Planning Council (regional planning agency), and the Massachusetts Port Authority (Massport). Because the MPO is a confederation of several agencies, it often cannot provide a strong regional perspective on transportation matters. Although MPO approval would be necessary for a federally funded SRAT program, the actual policy decision on whether or not to sponsor such a program is likely to be made within the Executive Office of Transportation and Construction (EOTC) rather than within the MPO.

The Executive Office of Transportation and Construction

The EOTC is responsible for state transportation policy, acts as advisor to the Governor on transportation matters, and its secretary is an appointee of the governor. The organization has no implementing authority. EOTC often plays the role of innovator or motivator in Boston

transportation, at least in part because it is free of modal bias. EOTC is extremely influential in shaping the transportation decisions made in the Boston area.

Several key staff in EOTC personally support in ride sharing. According to EOTC, one of its most recent and visible successes is a "voluntary" high occupancy vehicle lane on the Southeast Expressway, an extremely congested artery serving the downtown. Commuters have been encouraged to seek alternative modes, and failing that, to renew their carpooling efforts while reconstruction of the Expressway's bridge decks is undertaken. EOTC staff estimate that approximately 350 new carpools have been formed in the first months of the program's operation.

EOTC has been active in expanding the range of transportation services offered in the Boston region, not only with measures like promoting carpooling, but also in terms of minimizing the barriers to programs like employer vanpools.

EOTC staff recieved a proposal for an SRAT-like system for use along Route 128 from an interested citizen. Although EOTC staff are favorably inclined toward the concept, management agency liability issues are of great concern to EOTC, and would have to be clarified before the agency could consider an SRAT proposal. EOTC staff suggested that if SRAT is seriously considered, a possible management agency candidate is the Massachusetts Department of Public Works since that agency will be assuming responsibility for the state's carpool program.

Massachusetts Department of Public Works

The Massachusetts Department of Public Works (DPW) is the highway implementing agency. The DPW has a large staff and its interests are

well represented in the state legislature. The agency is generally considered to be conservative and has been reluctant to endorse schemes involving changes in highway operations. However, the assumption of responsibility for the statewide carpool matching program may make DPW a desirable candidate to manage an SRAT system.

4. Implications for SRAT

Based on the general characteristics of the Boston area, the coverage of the existing transportation system, and the institutional characteristics described in the previous section, several observations can be made about the feasibility of SRAT implementation in Boston.

Factors Which Could Facilitate SRAT

- The timing is good for a program of this type because EOTC has been successful with the preferential lane on the Southeast Expressway, and is receptive to ideas which will increase opportunities for ride sharing.

- EOTC and DPU commissioners feel that the potential DPU regulatory barriers can be overcome for a well-designed, well-presented program which encourages ride sharing. DPU staff were encouraged to recognize that certain kinds of vanpool arangements should not be subject to regulation, and a commissioner stated that every effort would be made to interpret relevant statutes to permit expanded opportunities for ride sharing.

- There is a recognized need for improved transportation service along Route 128, a circumferential road around Boston along which a number of employment centers are located. It is difficult to serve transportation needs with conventional solutions in this high volume corridor because there is considerable suburb to suburb commuting, and because many employers are too small to permit a high level of within-firm carpool matching.

Barriers to SRAT Implementation

- Potential problems of competition are raised by proposing SRAT service in any area currently served by the MBTA, thereby excluding most of Boston proper and many high volume commuting corridors from consideration.

- There would be vehement opposition from Boston taxicab interest for any SRAT system in the city because of perceived

competition for work trips and also on general principles.

- The liability of the management agency is considered to be a significant problem and has been a barrier to pursuit of SRAT proposals by EOTC.

- Tne City is reluctant to endorse any system which encourages automobile use within its jurisdiction because existing transit service is considered adequate for work trips.

- The aspect of SRAT which is similar to hitchhiking evokes strong concerns for safety because of well publicized incidents of crime in the Boston area that were associated with hitchhiking.

- The only potential management agency identified was the Massachusetts Department of Public Works, and this was because of its proposed takeover of responsibility for the statewide carpool matching program. Since the DPW has not played this type of management agency role previously, it might be premature to consider SRAT until the MASSPOOL program is well in hand. The Registry of Motor ehicles might be a better agency than the DPW to perform the function of issuing identity cards, however.

Portland, Oregon

1. Background

The Portland metropolitan area is made up of three Oregon counties - Washington, Multnomah, and Clackamas - in which there are about 34 cities and towns. The Columbia River forms Oregon's northern boundary and runs 8-10 miles north of downtown Portland; the city of Vancouver, Washington is on the other side of the river. The metropolitan area has a population of approximately 1.1 million people, 380,000 of whom live in the city of Portland. The 1970 census data shows that in the metropolitan area as a whole, 6% of the labor force used public transit to work. In the city of Portland 167,650 people were employed in 1970, 11.1% of whom used public transportation to get to work.

Hitchhiking is legal in Oregon, although the hitchhiker is prohibited from standing in the travelled roadway. What constitutes the travelled roadway is subject to various interpretations, as some police departments are content if people are off the paved part of the road but on the shoulder, while others prefer that people stand behind the guard rail.

2. Existing Public Transportation System

Tri-Met, the regional transit agency, offers regular public transit service to the three Oregon counties in the Portland area. In addition, Tri-Met is operating a bus line from Vancouver, Washington to Portland on a "temporary emergency" basis.

Tri-Met currently operates buses on 52 routes within its regular service area. 404 buses are in service during the peak periods; weekday peak hour capacity utilization is 113% and average utilization is 55.2%. In addition to needing more peak hour capacity, the Tri-Met bus routes do not

yet operate as an integrated system, so it is difficult to make cross town trips by public transit. Proposals for a West Portland station to facilitate transfers from bus to bus and automobile to bus are currently under consideration. Tri-Met charges a flat 40¢ adult fare for its regular bus service.

In addition to regular bus service, Tri-Met operates Portland's carpool matching program and is attempting to institute a vanpooling program. They also provide a service called Early Bird Express in which regular buses are used off-peak to operate special runs between employment centers and park and ride lots. The Early Bird is available to employers who can get 40 or more people to make a commitment to use the service; there are currently 10 successful Early Bird routes.

Tri-Met operates a demand-responsive van service for the mobility impaired called the LIFT, and has contracted for taxi back-up for the program. Tri-Met drivers for both the regular bus service and the LIFT are members of the Amalgamated Transit Union. A supplemental 13(c) agreement was negotiated with the union so that the taxi back-up could be provided.

Tri-Met also participates in FHWA's Rural Highway Public Transportation Demonstration Program by contributing $20,000 per year per county to the programs in each of their three counties and by providing route and planning assistance.

DART, Inc., has an airport to downtown hotel service which appears to be very successful. The DART fare is a flat $2.50 per person. There are three taxi companies in Portland, two associations of about 290 independent cab owners (Broadway Cab Co. and Radio Cab Co.), and an independent, the New Rose City Cab Co. As of November 1974, authorized

licenses were distributed as follows:

Broadway	113
Radio	105
New Rose City	11
	209

Broadway and Radio had been one company but the City, which is responsible for taxicab regulation, felt that it was operating as a monopoly and split it in two. They still coordinate very closely, and responded to Tri-Met's request for taxi back-up to the LIFT as a joint venture.

A new taxi ordinance passed in May 1977, provides for expanded taxi operations by permitting:

- Cruising and sidewalk pickups with a blinking light: previously pickups had been by radio or at designated taxi stands only,
- Shared riding: in the downtown area any trip within a specified zone will have a flat fare of $1 if the driver is allowed to pick up other passengers. If a passenger wants to ride alone, the fare is by the meter. From downtown to the airport a flat rate of $3.00 per passenger is charged, with a 3 passenger minimum.

Taxi companies agreed to expand their services to include the above provisions in return for approval of a rate increase of approximately 30%.

3. Institutional Characteristics

Several institutions in the Portland area may have an influence on the feasibility of implementing an SRAT system. The following discussion explores the relationships among the agencies and highlights those portions of agency responsibility which are most relevant to SRAT.

City of Portland

The City of Portland is influential in transportation decision making because the mayor has taken a personal interest in transportation and has attracted a staff in the city's Bureau of Planning with considerable

transportation expertise. The mayor plays a visible role in the region's transportation deliberations, and the city has been involved in all aspects of transportation planning from undertaking an arterial streets study to encouraging the formation of a long range system planning team in an effort to improve the quality of the technical analysis being performed in the region. The proposed team would be staffed jointly by the city, the three counties in the region, the metropolitan planning agency (CRAG) and the Oregon Department of Transportation.

Although the Police Department avoids taking stands on issues unless it is asked to undertake a study by the Commissioner, Police Department personnel stated that they would probably be reluctant to endorse anything that encouraged additional hitchhiking. Although the Department does not have good statistics to back them up, they feel strongly that increases in the number of rape and assault incidents in recent years are related to an increasing tendency for young females to hitchhike.

The city is responsible for licensing and regulating the taxi cab industry, and the Traffic Engineering Department is responsible for establishing taxi stands. The Traffic Engineering Department works with Tri-Met in establishing bus stop locations, and participated in the study team for the transit mall doing work on signal timing to improve traffic flows in and around the mall. This department would have to approve stops or pull outs for an SRAT system.

Columbia Region Association of Governments (CRAG)

CRAG has been the object of considerable debate over the last few years and proposals have been made to either abolish the organization or combine it with other agencies. CRAG membership consists of the three Oregon counties in the Portland area and the municipalities within these

counties; three towns in Washington are associate members. Part of the motivation for attacking the organization may be a perception held by the member counties that decisions are being dominated by the city, and that county interests are not being well represented. CRAG was a voluntary organization until 1975, when state law made membership mandatory for land use and planning functions. Despite its mandatory status, there was a referendum on the ballot last fall to abolish CRAG. Although 60% of the voters indicated that they wished to keep the organization in existence, individuals interviewed feel that changes in the structure and authority of regional agencies in the Portland area may still be forthcoming. Both CRAG staff and city staff favor any measures which will increase transportation services in the Portland area, but neither felt that SRAT could offer a sufficient level of service or adequate safety features to be a regular part of the transportation system.

Tri-Met

Tri-Met, the other regional agency, was created in 1970 and has been slowly building a regional transportation system. Tri-Met is undertaking a sector by sector route rationalization effort to improve bus service and they are sponsoring several paratransit and non-transit programs in an attempt to meet the area's total transportation needs. Staff from other agencies in the Portland area have characterized Tri-Met as conservative, too slow to break away from the concept of a freeway-dominated transportation system, and reluctant to make a commitment to major transit investments. Tri-Met is still considered a "new" agency, in the process of finding a role for itself in the regional bureaucracy. For example, there is some disagreement between Tri-Met and CRAG over who should be

doing long range planning.

Oregon Department of Transportation (ODOT)

The state's role in transportation in Portland is changing in response to the local institutional situation. Apparently ODOT was prepared to establish a mini-DOT to do planning for Portland when CRAG's future was uncertain last fall. Now that an equilibrium has been established, CRAG staff feel that ODOT wants to get out of the planning business and an increasing number of tasks previously performed by the state, such as air quality analysis, will become the responsibility of CRAG.

ODOT has not made any effort to influence Tri-Met's short range activities such as the sector studies that will lead to improved routing; however, Tri-Met staff feel that ODOT will have a great deal of influence over the long range decisions. ODOT's interest in the short range may increase with changes in national priorities and availability of money for large scale projects.

Tri-Met feels that if it is to sponsor a vanpooling demonstration, the regulatory status of vanpools must be clarified. Tri-Met is working with the Department of Energy and ODOT to get a bill passed in the legislature which will exempt vanpools from PUC regulation, both to insure the smooth working of Portland's program and to clear the way for other cities. ODOT has been on a campaign to cancel PUC exemptions because the weight and mile tax on regulated carriers is a source of income, so its support of the exemption for vanpools may be viewed as a contradiction.

4. Implications for SRAT

The fact that an SRAT program had not received consideration in the Portland area for regular commute trips made it difficult for individuals interviewed to come to any strong conclusions about SRAT feasibility. However, based on the interagency relationships and the priorities of agencies at the present time, several observations can be made about the potential for SRAT implementation.

General Observations

- Individuals in all agencies contacted indicated a willingness to consider SRAT because of a shared perception that expanding transportation services is desirable, particularly when the program encourages ride sharing. However, a more concrete proposal would have to be developed in order to get official agency reactions to SRAT.

- Several individuals interviewed had heard of other shared ride programs, particularly the program from Lane Community College to Eugene, and saw greater potential for SRAT in a smaller area than for Portland itself. People felt that a less urbanized area would have a greater need for SRAT (less overlap with existing transportation service), and that the potential safety problems would be minimized in a smaller community.

Factors which could facilitate SRAT implementation:

- A taxi company representative stated that work trips do not constitute a significant portion of their trips, and they are unlikely to object to an SRAT proposal as a competing service.

- Tri-Met acknowledges that all areas within its jurisdiction are not well served by transit at the present time. The sector by sector route studies currently being undertaken by the agency will help improve bus service, but in the interim, Tri-Met has been building up its range of services by offering regional car-pool matching and vanpooling through its Customer Development section. These two factors, a need for additional service and a predisposition toward shared ride, imply that Tri-Met might be willing to endorse an SRAT program.

- Tri-Met staff indicated that if a SRAT system is to be implemented in Portland, the most efficient way to do it from an administrative viewpoint is to manage it from Tri-Met, thereby minimizing coordination problems with existing services. Management by Tri-Met would have the advantage of integrating SRAT into an existing transportation service package, giving it what some perceive as needed "legitimacy", and Tri-Met would also be in a good position to provide promotion for the system.

- The fact that hitchhiking is legal in Oregon improves the feasibility of SRAT because no legislative changes would be necessary to permit ride solicitation.

Potential Barriers to SRAT Implementation

- Because Tri-Met's service is comprehensive, Tri-Met staff were not convinced that an SRAT system could be identified that would not compete with one of the services offered by Tri-Met, particularly the carpool matching program.

- The inclusion of shared ride programs in Tri-Met's Customer Development Division has given non-bus alternatives a significant boost by treating the shared ride program as part of the whole transit picture. The usefulness of the vanpool program must be demonstrated before additional services are added. At present, Tri-Met staff feels it is premature to consider SRAT.

- Although it was universally agreed that screening of riders and drivers was necessary, some of the interviewees felt strongly that there was no way to design a system that effectively prevented participation of undesirable riders and drivers.

- The feeling at the Police Department that there is a correlation between increased hitchhiking and increased incidence of crime may act as a negative factor, particularly if a study shows that these feelings can be substantiated.

Implications for SRAT design

In view of the considerations raised in the previous discussion, a SRAT system with the following design features has the most likely chances of success in Portland:

- A carefully defined target group for SRAT service that will compliment rather than compete with carpool programs and bus patronage, for example: an orientation toward the needs and travel patterns of the 18-24 year old age group, since this is the group which already hitchhikes most frequently in the Portland area.

- Management by Tri-Met, so that opportunities for supplementing existing service can be most fully exploited.

- A system of registering drivers and riders.

Tidewater, Virginia

1. Background

While there are no commonly accepted boundaries of the Tidewater region, for the purposes of this discussion the area will be defined as the two counties and six cities comprising the Southeastern Virginia Planning District. The six cities in the region are Norfolk, Virginia Beach, Chesapeake, Suffolk, Portsmouth and Franklin. The two counties, which only include unincorporated areas outside of the six municipalities, are Ile of Wight and South Hampton.

The current population of the Tidewater region is approximately 807,000. The largest city is Norfolk (1970 population of 307,000), followed by Virginia Beach (172,000) and Portsmouth (110,000). Largely residential Virginia Beach is the fastest growing community in Tidewater. Employment in the region is dominated by several large military installations (principally Norfolk Navy Base and the Navy Air Station at Sewells Point) and the Portsmouth shipyard. The largest employment center is the Norfolk Navy Base employing approximately 50,000. In contrast, the CBD in Norfolk provides employment for about 18,000.

2. Existing Public Transit

The region's major public transportation system is Tidewater Regional Transit (TRT) which is owned by the Tidewater Transportation District (TTD). The TRT provides fixed route service within the cities of Norfolk, Chesapeake, Virginia Beach, Portsmouth and Suffolk, and between Norfolk and Portsmouth. The other communities with the Southeastern Virginia Planning District (SVPD) are not part of the TTD at this time.

The TRT owns 206 transit coaches and uses 175 vehicles during peak hours and 145 during the offpeak. Service is provided on 48 fixed routes, most

within the city of Norfolk. A free circulator service is provided within the Norfolk CBD and there is free service from intercept parking lots into downtown Norfolk. The TRT has a staff of 450 which is unionized and affiliated with the Amalgamated Transit Union.

Average daily ridership (no service on Sundays) is about 35,000 which represents a 3.4% decrease since 1973. TRT has recently cut back service and further ridership and fixed route service reductions are anticipated.

The TTD, in addition to owning and managing TRT, leases vans to the Southeastern Virginia Area Model Program (SEVAMP). SEVAMP is a private non-profit agency providing social services to the elderly. The program uses 22 vans with non-union (and mainly volunteer) drivers. The TTD is also starting a vanpool program in which 50 12-passenger vans will be leased to Navy employees in the Fifth Naval District. The majority of these vanpools are expected to originate in suburban Virginia Beach and serve Norfolk Navy Base. The vanpools will not be directly competing with either TRT fixed routes or private haulers. It is estimated that vanpool riders will be charged $40 per month.

There are approximately 100 transit vehicles which are operated by independent haulers on a non-franchised basis. These haulers operate between one and ten vehicles and provide primarily commuter subscription service to Sewell's Point and Portsmouth shipyard. Under state laws passed during World War II, the Navy regulates these independent haulers by requiring vehicle permits and insurance. Most of the drivers are Navy employees who park their vehicles at the Naval installations. The average fare for the subscription service is about $25 per month. The TTD leases used transit coaches to a number of these haulers and others have requested that used school buses also

be made available for leasing. Like TRT, the independent haulers have been losing ridership and have cut back service in recent years.

Taxi operators can only pick up passengers in the city in which they are licensed and the availability of taxi service varies from city to city. Norfolk has the most extensive taxi services available with 223 vehicle permits currently issued to 5 taxi companies and one independent operator. However, Yellow Cab of Norfolk, the largest operator, is currently using only 100 of its 140 permits. Taxi ridership in Norfolk has declined substantially in the past few years (six years ago, Yellow Cab operated 200 vehicles) and further decline is expected. Few cab trips serve work trips and the busiest period is between 7 and 12 PM. In Norfolk, taxis are not allowed to cruise or to provide shared ride service although both of these regulations are difficult to enforce.

The Norfolk cab companies opposed the SEVAMP vanpooling program on the grounds that they could provide the service at lower cost. However, taxi operator testimony to the Norfolk City Council in opposition to the vanpooling program did not generate any support for their position.

3. Institutional Characteristics

While the local laws and regulations relating to traffic operations, taxis and hitchhiking in all Tidewater communities were reviewed, on-site interviews were conducted only with regional agencies and local officials in Norfolk and Chesapeake.

Southeastern Virginia Planning District Commission (SVPDC)

The SVPDC, together with one member of the Virginia Highway Commission,

serve as the designated MPO for the Tidewater region. The SVPDC provides the staff for the MPO and in general encourages efforts aimed at increasing paratransit services in the region. The SVPDC supported the TTD's vanpool programs and has worked with taxi companies in Chesapeake in an effort to utilize taxis for both elderly and handicapped and general shared-ride service.

The SVPDC staff has reviewed a number of proposals for SRAT service, including a system proposed for Northern Virginia and a proposal developed by MITRE Corporation staff. Proponents of both of these systems have met with SVPDC staff. While exposure to these proposals for SRAT systems has stimulated SVPDC's interest in developing a shared-ride program for Tidewater, staff members currently favor a "club concept." The club would provide a mechanism to restrict membership and offer a series of incentives to club members. SVPDC staff feel a club arrangement is desirable whether fixed carpools or a more flexible matching system is used. While the SVPD Commission has encouraged staff to examine the possibilities for a general ride-sharing program, it is likely that SVPDC would be involved only in organizing and promoting such a program but not in managing the club. SVPDC feels that a ride sharing program would have to be managed by an existing operating agency (e.g. TTD) or a newly created organization.

While local traffic ordinances and regulations governing taxis and hitch-hiking vary among the Tidewater communities, the creation of a regional "umbrella" agency may facilitate a multijurisdictional ride sharing program. The executive director of SVPDC has advocated such an agency with the mayors and city managers of each municipality to serve on the policy board and technical

committee respectively. In addition, the mayors are being urged by the SVPDC to appoint themselves to the policy committees of all existing regional agencies (e.g. SVPDC, TTDC, etc.) to ensure cooperation between the umbrella agency and existing special purpose regional commissions.

Tidewater Transportation District Commission (TTDC)

In addition to owning the region's largest public transit system, Tidewater Regional Transit, the TTDC has developed two vanpooling programs and has sought to establish good working relationships with both private contract haulers and the area's taxi operators. After an attempt to convince a social service agency to use taxis to provide service to the elderly failed, TTDC agreed to include a request for new cabs in its capital improvement program. If the request is accepted the new cabs would be leased to taxi operators under an arrangement similar to that between TTDC and the social service agency which is leasing vans.

While the top management of TTDC supports paratransit, there are reservations about how effective an SRAT program could be. In particular, reservations were expressed about the reliability and personal security aspects of an SRAT system. If convinced that such a program would provide a valuable public service, TTDC might be willing to both promote and manage the program.

TTDC management feels that an auto shared ride program, similar to the vanpooling program with the Navy, is likely to be most successful in fast growing suburban areas of Virginia Beach where there is currently no fixed route service. Thus such a program could be implemented without competing directly with TRT's fixed routes. A program which threatened direct competition would probably be opposed by TRT's union and, in any case, a 13(c)

agreement similar to the one negotiated for the vanpool program with the Navy might be required. The 13(c) agreement for the vanpool program took a year to negotiate and requires that only trips to Navy installations be served and that there be no direct competition with any of TRT's existing fixed routes.

City of Norfolk

Both traffic and police officials in Norfolk expressed concern about the potential traffic disruptions caused by a ride sharing program. Currently, hitchhiking is prohibited and taxi pickups and dropoffs must occur off the main roadway. In addition, concern was expressed for driver and rider security even if some form of licensing occurs. Safes are now being installed in the city's cabs and drivers will carry only five dollars worth of change. Police reported that requiring exact change for buses did decrease crime but the major taxi operator reported that even without the safes, the incidence of crimes in taxis is quite low.

Of all the communities in Tidewater, Norfolk has the most extensive fixed route bus system and city support for the current level of service is expected to continue. Thus, the potential for direct competition between TRT and SRAT is greatest within Norfolk. In addition, the police expressed concern that allowing SRAT vehicles to cruise would conflict with the city's regulation prohibiting cruising by taxis and would represent unfair competition.

City of Chesapeake

Similar to Norfolk, the city manager's office in Chesapeake expressed concern about traffic safety and personal security as well as the city's lia-

bility for any accidents, crime or insurance costs. Any stopping along arterial streets was viewed as undesirable and specific passenger collection points at designated parking lots was felt to be more practical.

The city views public transit as principally serving the work trip and there is no fixed route service at night. Recently several bus routes were eliminated and, unlike Norfolk, further cuts in fixed route service are anticipated. Nonetheless concern was expressed about the possibility that an SRAT program might compete with those bus routes requiring the lowest subsidy and it was suggested that it might be desirable to restrict the areas in which the program operated. A recent proposal before the city council to subsidize taxis rather than buses for some trips was defeated.

4. Implications for SRAT

On the basis of the discussions held with agencies in the Tidewater area a number of general conclusions can be drawn. Again, it should be noted that direct contact was made primarily with selected regional agencies and local officials in Norfolk and Chesapeake.

General Observations

- Both regional and local agencies support the need for increasing paratransit services in the Tidewater region. However, there were a number of major concerns with an SRAT system including:
    1) driver and rider security
    2) traffic safety and disruption
    3) competition with existing fixed route bus service
    4) reliability of the service provided by a system using flexible driver/rider matching.
- In response to these concerns, most of the individuals contacted felt that:
    1) licensing of participants or creation of a ride sharing "club" was required to ensure public safety;
    2) designated collection points (e.g. parking lots, etc.) would be preferable to having vehicles stop along arterial street.

3) any SRAT service ought to primarily targeted for, or restricted to, those areas not currently served by fixed route service.
4) some form of backup service, possibly provided by taxi operators, was desirable.

- During the past few years the staff of the SVPDC has reviewed a number of proposals for an SRAT system. While SVPDC staff is enthusiastic about a ride sharing program, a "club carpool" arrangement is currently felt to be the most promising approach. The club arrangement would provide a mechanism to offer promotional incentives for participants and to overcome reservations about personal security. While some flexibility in driver/rider matching would be possible within a club arrangement, it was originally conceived to include only prearranged carpools.

- All individuals contacted felt that a regional agency, and specifically, either SVPDC or TTDC, ought to organize, promote and manage any ride sharing program. While SVPDC is willing to promote and organize such a system, it is not an operating agency and would probably not be willing to manage an ongoing program. While TTDC is the major transit operator in the region and very supportive of increasing paratransit services, they would have to be convinced that an SRAT system would provide a needed public service before their participation could be ensured.

Factors which may facilitate SRAT

- The executive director of the Southeastern Virginia Planning District Commission (SVPDC) is familiar with the SRAT concept and is an enthusiastic supporter of a club concept for ridesharing.

- SVPDC is pushing the creation of a regional umbrella agency which should increase coordination among the jurisdictions in the district and might provide a good mechanism for promotion and management of SRAT in a new agency under the umbrella agency, in SVPDC or in the Tidewater Transportation District Commission (TTDC).

- The executive director of TTDC is a supporter of paratransit who has initiated implementation of a vanpool program (including negotiation of a favorable 13(c) agreement) and who seems quite willing to confront his own union over paratransit services that provide a "reasonable" service.

- The TTDC executive director feels that any SRAT potential for decreasing peak period bus ridership and equipment requirements would offer TTDC potential budget savings.

- Both public and private transit services in the area have been cut back recently due to ridership losses and the trend is not believed to have bottomed out. A similar trend has been experienced by taxi companies.

- Existing public transit provides adequate service into and within the Norfolk CBD and older parts of the city. However, Virginia Beach, the fastest growing area in the region, is not served by fixed routes or franchises. This is the target area for a vanpool program and could be the focus for SRAT. Major work trip attractors are military installations, the Norfolk CBD, and a few industrial parks.

- Taxi operators under a contract arrangement might be willing to provide backup service for an SRAT program.

- TTDC has broad powers including regulatory powers for common carriers and some powers over local street operations.

Potential barriers to SRAT

- There is some degree of competition between SVPDC and TTDC. SVPDC would like to promote SRAT (or club carpooling) but not manage an ongoing program. TTDC cooperation and support would be a big boost to SRAT prospects and might be more readily obtained if they controlled the program or at least if it wasn't identified as a SVPDC program.

- The taxi companies in Norfolk would probably oppose SRAT even though it would probably not harm them if SRAT is oriented toward work trips. Taxi operators would appeal to the City Council (Norfolk) or to state legislators.

- The TTDC transit union is also very likely to oppose SRAT, and would obviously not agree with the TTDC director's view of the peak shaving concept. If federal funds are involved, the union may be able to delay a 13(c) agreement for a long time. The vanpool program 13(c) agreement took one year to negotiate.

- Private contract bus operators serving military installations also would probably oppose SRAT. However, some of these operators are already leasing equipment from TTDC and their opposition could be minimized if new SRAT services did not directly compete with their operations.

- Given the pattern of employment locations and residential areas and the distribution of current fixed route service, the most promising SRAT program in Tidewater will probably involve multiple jurisdictions. Currently, local laws and regulations governing hitchhiking, traffic operations and taxis vary from city to city and may create coordination problems.

C. Conclusions

As expected, the factors which might facilitate or impede SRAT implementation varied from site to site. On balance it is difficult to generalize about how significant any institutional factors will be in impeding the implementation of a specific SRAT concept for all institutional settings. While it is clear that a number of potentially serious institutional barriers to SRAT exist, it appears that by designing the system to reflect a site's particular institutional setting, in many cases all, or the most severe, of these barriers can be overcome. In settings where transit is strong, however, the costs of implementing SRAT may be very high, and must be weighed in the context of large uncertainties over how well SRAT might work.

While specific institutional issues did vary widely among the case study sites, there were a number of concerns that arose in each of the sites that will probably have to be addressed in any urban area application of SRAT. Each of these concerns is discussed below.

1. Personal Security

Two aspects of personal security were of major importance:

- The impact that user security concerns would have on the program's public acceptability;
- The liability of the management agency in the event of crime incidents resulting from SRAT. This concern was greatest in those cities currently experiencing difficulties with their insurance policies (e.g., Boulder was recently forced to become self insured) since SRAT may place additional financial burdens on these agencies.

The concern for security was greatest among the law enforcement agencies. The police departments in both Boulder and Portland felt that any increases in hitchhiking would result in more crime and this fact was substantiated by a study for the Boulder city area. Police departments felt that SRAT would encourage crime especially if designated pick up and drop off

points were specified. However, a representative of the Boulder Sheriff's Department felt that since hitchhiking was already legal, SRAT might provide a mechanism for placing some restraints on hitchhiking and actually reduce crime.

All interviewees expressed the need and desirability for a registration scheme to try and screen out those persons who are the most obvious risks. However, the problem of obtaining criminal information records due to privacy acts was considered to be a drawback. No agency was prepared to render definitive character assurances on the basis of available information. Finally, there was a fear that if a public agency endorsed and promoted an SRAT system, the public expectations regarding security precautions would be increased.

2. Competition with Existing Carriers

One of the greatest potential barriers to SRAT implementation is competition with existing transit services. This concern was emphasized by the public transit operators and the taxi companies, as well as other agencies, in all the case study cities. The only exception was a taxi company representative in Portland who felt SRAT would be serving a different market than taxis (e.g., work trips).

Naturally, the competition problem is greatest in areas where existing services are most extensive. A Boulder transit official stated, even if SRAT did not operate along existing transit routes, if SRAT proved to be successful on other routes, it would simply indicate that a new transit route should be established. Even in the case of Tidewater, where the regional transit director is a strong advocate of paratransit services and might sup-

port SRAT, the transit union would very likely be opposed to the service.

While the potential for SRAT to reduce the peak period service requirements for existing transit operators was viewed favorably by transit management in Tidewater, in most cases, both transit management and labor were not receptive to this argument. In Boulder there was a concern that even if SRAT was tailored to serve peak period trips not currently using transit, some diversion from transit would occur. Similarly, in Boston any diversion from transit to SRAT was viewed unfavorably by both transit agency and city officials.

If UMTA funds are used for SRAT, then 13(c) negotiations can provide a focal point for opposition. In a number of case study sites, 13(c) agreements for other services either delayed or blocked implementation of a new service. If a 13(c) agreement is not required, opposition from existing operators would take other channels.

In a number of sites, taxi ridership has been declining and even though few work trips are served by cabs, taxi operators voiced opposition to SRAT. In some cases this opposition was more a result of a desire on the part of taxi operators to provide the SRAT service rather than a fear of competition with existing services. Taxi companies (and in some cases, police departments), felt SRAT should not be allowed if cabs are restricted from cruising or offering shared-ride service. Although in suburban areas transit operators may not oppose SRAT service, it is still conceivable that taxi companies would be in opposition. A possible method for alleviating some of the concerns of taxi operators which appeared to have some potential in Tidewater, is for the taxis to provide SRAT back up services.

3. Traffic Safety and Disruption

The potential for increasing traffic accidents and disruption was cited frequently although it was not perceived to be as difficult to overcome as the personal security issue. In some areas, existing traffic codes specify where stops can and cannot be made. For instance, in Boulder the regulations specify that special turn off lanes must be constructed for stops on major arterials. Since the local ordinances governing traffic operations often differ among communities (e.g. Tidewater), any multijurisdictional application of SRAT might require additional coordination or different operating rules in different communities. In some cases, hitchhikers and those who pick them up are notorious for ignoring traffic rules. Unless enforcement becomes tougher, a significantly enlarged body of hitchhikers might prove to be quite a visible hazard on the highways, in some cases.

4. Selection of a Management Agency

The identification of an appropriate public agency to organize and administer SRAT varied according to the specific characteristics of the study site. In both Tidewater and Portland regional agency management was considered to be most appropriate because travel patterns suggested the need for a multijurisdictional SRAT service. Within the Boulder area, however, it was felt that the cities or towns could implement their own SRAT system, though management by the regional transit district would also be acceptable. In both Boulder and Boston, the regional transit operators noted that any increased administrative burden due to SRAT would be a strong disincentive to their involvement as the management agency. In Boston, the State Department of Public Works was mentioned as a possible management agency because of their anticipated involvement in promoting carpooling.

Naturally it is also possible to develop an SRAT service based on a club concept or focusing on specific employers which would not require any public agency role in managing the system.

A private, probably non-profit corporation could also be established to administer SRAT in some areas. This is probably not an attractive option because the annual system membership costs of perhaps $30 and extra annual insurance costs of a similar or high amount (see section II.B.7) would discourage some participants. Potential SRAT riders, in particular, were identified as likely to be very fare-elastic. Since adequate SRAT service levels depend strongly on high participation rates, the reduction in participants due to a membership fee reduces system service levels, which in turn further reduces participation.

At least for early SRAT deployments, therefore, an arrangement through which some system costs could be subsidized appears beneficial.

Another drawback of a private SRAT management agency is that it may have more difficulty obtaining required certificates and permissions from regulatory agencies, traffic departments, police, etc., than a government agency.

On the positive side, however, SRAT may be more readily introduced in some areas if no subsidy is required. Also, an independent organization may be more active in promoting SRAT and more responsive in operating the system than a government agency.

VI. CONCLUSIONS

A. General Feasibility of SRAT Operation

The feasibility of SRAT depends on the answers to three critical questions:

- What travel patterns, demand densitites and operating rules are required to effect a level of service that will attract enough participants to sustain a SRAT system?
- If a SRAT system were available, would potential travelers (drivers or passengers) use it?
- What legal and institutional barriers must be overcome to permit a SRAT system to operate?

Travel patterns at a regional level were analyzed for eight sample U.S. cities to determine average driver flows in peak and off-peak periods. These average flows turned out to be quite low (often only one trip per hour between one square mile suburban areas). Thus SRAT service is unlikely to be ubiquitious*, in most applications, but must be concentrated in areas where the driver density is significantly greater than average. Intermediate origins and destinations must be served by driver trips (instead of only carrying passengers whose entire trip coincides with that of the driver) in many settings if an acceptable service level for riders is to be achieved. Unfortunately, the need to concentrate in higher density markets will bring SRAT into conflict with existing modes in some cases.

A more detailed analysis of four case study cities shows that it is possible to find some settings for SRAT in urban areas that do not directly compete with transit, and yet possess sufficient driver flows for the SRAT system.**

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*This claim has never been made for SRAT, but it was considered an open question by the study.

**However, in at least one city, this was taken to be evidence that transit could be supported in the setting.

The study determined that peaking of work trips is fairly sharp. Driver flows fall sharply at 9 a.m. and 6 p.m., creating a situation that may require provisions for back-up service. Finally, due to the high transit mode shares to the central business district (CBD) in most cities, the highest driver flows were actually observed to other parts of the central city than the CBD.

Turning to the second issue--potential system usage--several conclusions emerge. Urban SRAT systems carrying passengers from their origin to their destination appear to offer a moderate service level and may generate a moderate number of riders, based on extrapolation from observed carpool behavior.* SRAT typically attracted 10% mode shares of both drivers and passengers in the case studies examined, although these varied markedly by auto ownership level. In carless households, 30 or 40 percent of work trips would be made by SRAT in many cases, and of course no drivers are generated. One car-households generate perhaps 15% drivers and 5% riders, while two-car households generate very few riders or drivers. Thus, based strictly on measured service level attributes, there appears to be potential for attracting participants to SRAT in well-designed urban applications. Attitudinal concerns, especially those related to personal security and perhaps reliability, could change this conclusion, however.

Preliminary assessments of attitudes of the general public toward SRAT indicate that there is some concern over entering a car with strangers and some apprehension over the system neither having a fixed schedule like

*The models used in this study rely basically on measured variables such as time, cost and income; they assume that the non-measured attributes of SRAT like security, reliability, and flexibility are, taken together, equivalent to carpooling. This may or may not be a valid assumption, but without actual operational experience with SRAT, it is perhaps the best prediction that can be made.

transit nor a prior agreement like carpooling. These concerns would have to be addressed directly in setting up a SRAT system. There is also some consumer resistance to the idea of paying a fare for a ride; drivers may feel embarrassed about it. Drivers also expressed a fear of commitment to pick up individuals at SRAT stops on a daily basis, which was viewed as an infringement of their privacy.

Another area of concern in the model results in the high proportion of riders from carless households while drivers come from one- and two-car households. Previous carpooling surveys have shown the composition of most carpools to be very homogeneous; the effect of social differences is not included in model projections.

Low fare levels (25 or 50 cents) appear to produce the highest SRAT driver and rider participation. Riders appear to be quite elastic with respect to fare, and thus expected driver revenues rise as fare decreases. Relatively low occupancies result for SRAT with drivers picking up one or no passengers on a typical trip. Regional changes in vehicle miles travelled (VMT) and auto occupancy even with an extensive SRAT system were negligible because some SRAT drivers and riders were diverted from higher-occupancy carpool and transit modes; in fact, VMT actually increased slightly in a few cases.

Rural systems showed about the same performance as urban systems in terms of market shares, occupancy, and recommended fare. However, rural systems may have much greater impacts on trip frequency and mobility than mode choice. Due to the lack of transportation alternatives and the simpler institutional structure in these areas, SRAT may be even more attractive in rural than urban settings. Urban community systems serving shopping and other non-work trips and employer based systems restricted

to employees of a single company were analyzed only briefly: they appear to have some potential, but because of the restricted number of participants they appear to require some aids to matching riders and drivers (probably through the use of the telephone) to operate satisfactorily. Urban SRAT systems based on strong integration with transit (such as a feeder system) appeared to be the least feasible concept, due to difficulty in coordinating SRAT arrivals and departures with often long headway transit schedules, two fares being paid, and a transfer being required.

B. Feasibility of SRAT - Legal and Regulatory Issues

The next basic determinants of feasibility are the legal and institutional frameworks for SRAT. One of the findings of the legal research is that SRAT has three opportunities to escape regulatory problems in most areas: 1) agencies will lack jurisdiction to regulate SRAT (e.g. no fare systems), 2) SRAT may qualify for a statutory exemption from regulation (e.g. carpooling), and 3) regulation would be by a local agency favorable to SRAT (e.g. the implementing agency). To a large extent, whether and how SRAT is regulated, especially on the local level, will depend on how persuasive the SRAT advocates are, and how receptive the regulating agencies are. No firm guidance can be given, as each situation will have a unique set of characteristics. If SRAT must qualify as a certified common or contract carrier, the burden of compliance is likely to be so onerous that SRAT cannot be implemented.

If a SRAT agency uses any funds under the Urban Mass Transportation Act of 1964, it must agree under section 13(c) of the act to protect the interests of mass transit employees who will be affected by the assistance.

There are several strategies that can be used to minimize the impacts of this provision, including avoiding competition with existing transit routes, allowing existing unions some role in SRAT management or operations, and identifying factors in the service area other than SRAT that might contribute to a worsening of employment conditions for transit workers and including this in the 13(c) agreements. However, since section 13(c) is really one element of a larger, on-going bargaining relationship between transit management and labor, some concessions beyond the minimum required by a strict reading of section 13(c) may be necessary if SRAT is managed by a transit agency. The final measure, of course, for avoiding section 13(c) issues is to use funding from a source other than UMTA, such as the Federal Highway Administration Carpool Demonstration Project funding, state funds, private funds, or to make SRAT self-supporting. Even some of these sources may have associated labor issues.

A registration procedure for riders and drivers must balance the added personal security and confidence of strict requirements with the cost, possible exclusion of certain groups, and deterrence of potential users that these requirements might also imply. The limited data available concerning hitchhiking and taxi crime indicates that the problems faced by SRAT may not be as serious as first imagined. Nevertheless, a registration requirement may improve security significantly.

Applicants could be required to fill out an application form and present verification of valid driver's license, insurance, residence, vehicle inspection and age. Verification of driving record can generally be obtained from the state registry of motor vehicles; however, state and Federal records on past criminal convictions typically would not be avail-

able to a SRAT agency because of state and local privacy laws.

In incidents involving the SRAT system, it is possible that the SRAT agency would be one of the parties named in any lawsuit. Liability insurance may be appropriate; at this point its cost can be estimated only very generally, but it is not expected to be expensive.

It is assumed that SRAT activities will be covered by ordinary private passenger automobile insurance policies; insurance company and state insurance officials have informally agreed that SRAT would not fall within the clause in many policies that excludes coverage if the car is used as a "public conveyance". To offset the concentration of liability of SRAT drivers who at times may carry several passengers, higher-than-minimum bodily injury limits are suggested, with limits of $100,000 per person, $300,000 per accident being perhaps the most appropriate level. The cost of this additional insurance is expected to be relatively low for drivers with safe driving records; however, some high-risk drivers may have difficulty obtaining it, or may have to pay very high rates.

Federal income tax rulings indicate that SRAT would be treated as a shared-expense carpool arrangement and that fares collected by a driver would not be treated as income unless they exceed the vehicle operating expenses. Neither can drivers (or riders) deduct SRAT expenses from their taxable income. Generally, the income tax consequences at the state level will be the same, since most states rely upon the Federal income tax definitions for gross and taxable income. In some states, however, SRAT revenue would be treated as income and could create extra paperwork for drivers.

Traffic law considerations make it advisable in most areas to designate pick-up and drop-off points that are separate from the flow of traffic. This will add some expense for SRAT and may require riders to walk greater distances to stops.

C. Feasibility of SRAT - Institutional Issues

The factors that facilitate or impede SRAT implementation vary markedly from site to site. While a number of potentially serious barriers to SRAT exist, it appears that by designing the system to reflect a site's particular institutional setting, most of these barriers can be overcome.

There are, however, a number of concerns that will probably have to be addressed in any urban and some rural applications of SRAT: (1) Police agencies are likely to express a strong concern for personal security. (2) Government agencies were concerned over liability in the event of crime, especially in areas where insurance costs have increased greatly. (3) There was a fear that if a public agency promoted SRAT, public expectations regarding security precautions would be increased. (4) Concern over competition with existing transit services was emphasized by transit and taxi operators (with only one exception), as well as other agencies, in all case study cities. (5) The potential for increasing traffic accidents was cited frequently although it was not perceived to be as difficult to overcome as the personal security issue. In short, careful design and promotion of the system will be required to overcome these and other institutional barriers. Identification of a lead agency to implement SRAT must be very sensitive to local conditions, with local, regional and private agencies all being possible candidates in different localities.

D. Summary of Feasible SRAT Configurations

Several of the SRAT configurations considered in this study may warrant further study and demonstrations. The leading candidates include:

- rural/low density systems for the travel disadvantaged;
- club concepts that are more like carpools than SRAT, but which involve some flexibility in travel times; these are likely to be employer-based;
- community-based systems, based on telephone matching to serve the travel disadvantaged, but also to reduce energy use, provide social opportunities, etc.; these systems might be oriented toward nonwork trips.

The other SRAT concepts examined are often (though not always) infeasible or less appropriate than alternative systems for actual applications; these include:

- SRAT feeder to transit, which provides poor service levels due to difficulty in coordinating with transit schedules;
- SRAT bus replacement, due to 13(c) problems, likely decreased patronage, and possible problems in ensuring that service is made available to the transit-dependent and is accessible to the elderly and handicapped along the route;
- SRAT urban linehaul (possibly with SRAT feeder as well, as in the CARTS concept), due to likely diversion of patronage from transit, likely regulation as a common carrier which could block its introduction, and difficulties in assuring safety and security to potential riders and drivers when operating in a wide area; and

- activity center SRAT, for the same general reasons as urban linehaul, except in defined communities with little or no existing transit service.

Identification of potential demonstration sites could proceed as follows for the three types of system configuration that appear to have some possible further potential:

- U.S. Census data could be used to identify rural counties with a high proportion of the population being elderly; counties without specialized service already implemented but with an identifiable implementing agency could be potential sites;
- Club concepts would likely be based on either a single employer or a group of employers in the same activity center with a fairly large existing carpooling program; these could be identified and the club concept explored within the context of the present carpooling program.
- Community-based systems would be appropriate in towns with little or no taxi and transit service, yet of sufficient size to generate a moderate number of moderate length trips to form a base for the system; again, Census data could be used as a base, coupled with brief contacts to determine the state of the transit or taxi service.

All three concepts are likely to have a significant number of potential sites. A small number of demonstrations in promising sites may be warranted to further resolve many of the issues involved in the SRAT concept that require actual experience with the system.

REFERENCES

A. SRAT Systems

Clear Creek County, Colo. (1975), Ride-stop, An Application to the Rural Public Transportation Demonstration Program.

Mann, W. (1974), Auto Rapid Transit, Traffic Engineering, Vol. 44, No. 8, May, 1974.

Marin Jitney Corp. (no date), Marin Jitney, A Non-profit Corporation to Encourage Casual Carpooling.

Massport (Massachusetts Port Authority) (1977), Proposal for Share-A-Cab Service at Logan International Airport, February 8, 1977.

MITRE Corp. (1975), Automobiles Used as Minibuses?, Transporation Research News, Number 61, Winter, 1975.

Morse, J., (1977), "Riding the Togetherness Line", Newsday, Sunday, February 20, 1977, page 160.

Sargent, G. (1976), Shared Ride Auto Transit as a Tool to Improve Efficiency of Existing Transit System, Proceedings of Conference on Urban Transportation Efficiency, July, 1976, published by American Society of Civil Engineers.

Schmeir, K. (1974), The Neighborhood Transportation System, report to the Marin County Transit District, May 28, 1974.

Stetten, K. (1975), An Outline of a Proposal to Test Community Auto Rapid Transit Systems (CARTS), Report M75-28, Mitre Corp., April 7, 1975.

Social Autostop Committee of Poland (1976), "Autostop" (pamphlet).

Southeastern Virginia Planning District Commission (1975), Preliminary Staff Analysis of Paratransit Options.

State of Vermont, House of Representatives (1977), text of House bill 110.

University of Colorado (1975), Hitchhiking--A Viable Addition to a Multi-modal Transportation System?

University of Oregon, Center for Environmental Research (no date), Ridestop, A Supplementary Transportation System for the Eugene-Springfield Metropolitan Area.

Virginia Governor's Council on Transportation (1976), "Report of the Paratransit Subcommittee of the Northern Virginia Transportation Needs Task Force of the Governor's Council on Transportation", September 29, 1976.

Waldau, G. (1977), Commuter Automobile Ride Sharing: An Alternative to Car Pooling, Southern New England Telephone Company, New Haven, Conn.

Westport Transit District (1976), Summary of Plan for a Service and Methods Demonstration of Integrated Conventional Transit and Paratransit Services, September, 1976.

B. Other Reports

Cambridge Systematics, Inc. (1976), Carpool Incentives: Analysis of Transportation and Energy Impacts, prepared for Federal Energy Administration, June, 1976.

Peat, Marwick, Mitchell & Co. (1972). An Analysis of Urban Area Travel by Time of Day, Report No. FH-11-7519, January, 1972.

APPENDIX A

Existing and Proposed SRAT Systems

1. Marin County, California

- System Description: "Rides Program"

  This system, now in the planning stage, will serve the central freeway crossing the Golden Gate Bridge in San Francisco, focusing on commuter traffic during the rush hour periods.

  The current proposal is for a "casual carpool" system. Interest was generated by concern for energy and the environment. It is believed by the system advocates that the public attitude will be receptive even though it is highly urbanized. The proposed SRAT system has the support of local transportation officials. Police have not opposed the system, but they do not want to be involved in a criminal records check.

- Registration:

  Criteria (same for drivers and riders):

  (1) Must be a working member of community.
  (2) Age requirements have not yet been considered.
  (3) Criminal records checks have been rejected because of privacy laws. Considering verification of residence and employment for safeguard.
  (4) Seatbelts will be recommended but not required.
  (5) Auto insurance: considering 20/50 minimum.

  Procedure:

  (1) Application forms handed out with promotional fliers at bridge toll booths.
  (2) Application returned by mail.
  (3) Application form must list place of residence and place of employment.
  (4) Certificate of insurance submitted by driver.

  Fee:

  A fee will be charged to cover cost of application, boarding pass, and decal. $10 is being considered for drivers and riders.

- Hitchhiking Laws:

  It is lawful to hitchhike in an incorporated city as long as person is not standing in roadway. On unincorporated county roads, person may not stand in roadway and motorist cannot stop on roadway.

- Driver/Rider Matching:

  Having a carpool referral service under CalTrans' "Dial-a-Ride" is a consideration.

  "Boarding passes" will be used to identify rider as participant and will designate place of business. Decal will identify driver as participant and will designate place of business. Passes and decals will be color coded for route.

- Pick-up/Drop-off Procedure:

  No specific points for pickup and drop off are anticipated. Anticipate approval of Golden Gate Transit Authority to use islands on Highway 101. No specific hours of operation will be set. Pick-up/drop-off points within San Francisco not yet considered.

- Fare:

  Charge for ride to be half of bus fare charged for similar ride. Bus fares are approximately $1.00. Fare will be paid in cash.

- Liability:

  Management liability is eliminated because the Rides Program is a matching service. Driver's insurance coverage is in force when personal vehicle is used on a shared-expense basis. Participants are treated as any passenger would be. The California Guest Statute was repealed in 1975, making it possible to be sued by a passenger.

- Regulation:

  Carpools are exempt from PUC regulations.

- Labor Issues:

  Have not been considered.

- Promotion:

  CalTrans officials have agreed to pass out fliers with application forms attached at Golden Gate Bridge toll gates.

  Also plan to advertise with signs along roads in Almeda, Contra Costa, San Manteo, and Marin Counties.

  American Automobile Association supports this concept.

- Administration Costs:

  Estimated to be $30,000/year. Administered either by Marin Jitney Corp., a nonprofit corporation, or possibly by the Marin County Transit District.

2. Aspen, Colorado

- System Description:

Aspen is a rural community where hitchhiking and carpooling are very common and, in fact, encouraged. Hitchhiking is viewed as a way of helping out neighbors and carpooling has become an established way of life. It is the rule rather than the exception. People generally hitchhike or join carpools for two reasons: (1) economic, (2) climate. The cold winter temperatures make driving difficult, and many of the residents do not own cars, as they are only seasonally employed. Consequently, "sharing rides" is necessary, and although no SRAT system exists there, some organization has been done by the City.

Consequently, "sharing rides" is necessary, and although no SRAT system exists there, some organization has been done by the City.

The City of Aspen has designated specific pickup stations for hitchhikers in the City and throughout Pitkin County. These pick-up stations are indicated by signs with a thumb on them. Shelters are not provided.

In addition, several public transit services are available. (1) City Bus Service is free, subsidized by the sales tax. It operates from 6:30 a.m. to 1:00 a.m., only within the City of Aspen. (2) The County Bus System covers Pitkin, Garfield and Eagle Counties, Colorado. Finally, there are two ski resort bus services in Aspen, both without fare.

3. Clear Creek County, Colorado

- System Description: Ridestop

Ridestop is funded under a grant from the Federal Highway Administration, Rural Public Transportation Demonstration Program (section 147). This system, which is in the planning stage, will primarily serve those under 16 years old and the elderly. A general inadequacy of public transportation in Clear Creek County indicates a need for alternative transportation systems.

- Registration:

Rationale: Established in response to fear for personal safety expressed. Citizens are concerned that such a system will attract transients rather than members of the county's communities.

Criteria:
(1) Safe driving record
(2) Insurability
(3) Residency
(4) Criminal records check considered; dependent upon legal problems.
(5) Have not considered vehicle safety requirements.

Riders:
(1) Students: Comportment in school, to be decided by the Superintendent of Schools. An estimated 95% of students will be allowed to use system.
(2) Others: at the discretion of review committee. Consideration of criminal records check dependent upon legal problems.

Parental permission for those under 18 may be required; this age group will represent a large number of participants.

Procedure:
(1) Application made in person. Form includes place of residence/employment.
(2) License Review Committee, chaired by the school superintendent will review credentials presented at time of application.
(3) Members' names will be published in local newspapers.

Fee: None.

- Hitchhiking Laws

Hitchhiking is legal in the State of Colorado (effective July 1, 1975) and common in Clear Creek County.

- Driver/Rider Matching

Drivers will have bumper stickers, riders will have registration cards.

- Pickup/Dropoff Procedures:

  Stations will be marked by the Ridestop insignia and four permanently attached signs from which travellers would indicate to passing motorists their desired mode of transportation and destination or general direction of travel (i.e., "Georgetown," or "School Bus," or "West"). Ridestop is to be installed in five Clear Creek County locations, one in each of the incorporated cities and one in an unincorporated area.

- Fare: No fare.

- Liability:

  The Colorado State Insurance Commission has ruled that drivers need not carry extra liability insurance if no fares are paid. There has been no ruling for a fare system.

- Regulation:

  PUC regulations do not apply to a "no-fare" system.

- Labor Issues:

  There is no labor protection requirement with FHWA funding.

- Promotion:

  Publicity and recruiting prominent citizens into the system will be used to overcome fears associated with the hitchhiking concept. This will be done through the newspaper with particular emphasis on publishing names of citizen members.

- Administrative Costs:

  Project costs:

(1) Final architectural and engineering design, working drawings, and administration (estimated)	$ 3,500
(2) Construction (estimated @ $3,000/Ridestop)	$15,000
Total Funding Requested	$18,500

  Funding Sources:

(1) Development and construction source: FHWA	$18,500
(2) Maintenance, monitoring, and evaluation source: Clear Creek County (estimated value of first year services)	$ 2,500

4. Portland, Oregon

- System Description: People's Transhare

This system is a nationwide travel referral service using computer matching for automobile and air travel. It was established in 1972, although it did not become computerized until two years ago. The system is self-supporting, relying on membership fees to provide necessary funds. Transhare now has obtained permission to register members of the Armed Services through the Pentagon.

- Registration:

Criteria: (same for drivers and riders)

(1) Identification sufficient to cash a check or two major credit cards.
(2) Personal questionnaire including residence, age, sex, mother's maiden name.
(3) Parental consent for those under 17.
(4) No criminal records check because of privacy laws.

Procedure: (same for drivers and riders)

(1) in person or by mail.

Fee: (same for drivers and riders)

(1) $10 for automobiles
(2) $15 for airplanes

Although this licensing system is extremely lenient, no crimes have been reported.

- Hitchhiking Laws:

People's Transhare is not a "hitchhiking system." It is a pre-planned meeting between members, not a random ride from the side of the road.

- Driver/Rider Matching:

This is done by computer. Member calls the toll free number and tells where, when, and how he wants to go. Each traveller is given the first name and phone number of possible companions. It is then up to the individual to make the contact.

- Pickup/Dropoff Procedure:

These arrangements are decided upon by the travellers, independent of the organization.

- Fare:

  Fares are negotiated by the travellers, independent of the organization.

- Liability:

  People's Transhare is not concerned with liability since it provides a matching service only.

- Regulation:

  ICC Regulations - Because Transhare is a "club" that offers names of potential travelling companions and does not charge a percentage of fares negotiated among members, it is not affected by ICC regulations. Providing rides, unless licensed by the ICC, became illegal in 1939-40.

  Oregon PUC Regulations - Because Transhare is interstate, it is exempted from PUC regulations.

- Labor Issues:

  Transhare uses no outside funds. It is self-supporting through membership fees.

- Promotion:

  Advertising through brochures at various walk-in centers.

- Administrative Costs:

  Approximately $4,800/month, including $2,300 for telephone and $800 for advertising.

5. Montpelier, Vermont

- System Description: Car Hopper Program

  This proposed system was introduced in the Vermont House of Representatives during the 1977 legislative session, but was killed in committee.

  The proposed system was originally designed for commuters but not restricted to commuter use. It was first to have been tried in Washington County for two years and then expanded to other counties.

- Registration:

  Criteria:

  (1) Minimum insurance - $10,000/$100,000 if seating capacity is less than seven or comparable surety bond, and residency requirement.

  Procedure: (drivers only)

  (1) Application form including: name, address, social security number, type of vehicle, driver's license number, registration plate number, name of insurance company, policy number.
  (2) Proof of minimum liability.

  Fee: $5.00

- Hitchhiking Laws:

  Hitchhiking is legal in the State of Vermont. It is prohibited, by ordinance, in the City of Montpelier. However, it is not enforced and police departments are not concerned about it.

- Driver/Rider Matching:

  Drivers will be issued a "distinctive decal" to be placed on right bottom corner of windshield for easy identification.

- Pickup/Dropoff Procedure:

  Clearly marked "car hopper stop" shelters will be erected at designated spots. No specific times of day have been established.

- Fare: Fares shall be mutually negotiated.

- Liability:

  Lower premiums have been offered for carpool participants.

- Regulation:

  Assumption by sponsors is that if the system is restricted to routes not competing with certified carriers then there would be no state regulations. Vermont income tax regulations comply with IRS rulings. Therefore, fare income will not be taxable.

- Labor Issues:

  Planning to route system in non-competitive area.

- Promotion: No information available.

- Administrative Costs: No information available.

6. Ft. Collins, Colorado

- System Description: Fort Collins Community Carpool

  This system was organized to circumvent hitchhiking laws in Colorado and fell into disuse when hitchhiking was legalized July 1975. The system operated for 1-1½ years.

- Registration: (riders and drivers)

  Criteria: anyone

  Procedure:

  (1) Completion of file card including name, address, driver's license, or other ID number, and fingerprints. (While fingerprints were taken, no criminal records were checked.) These cards were filed alphabetically and by membership number.
  (2) Members signed agreement to:
      (a) pick up other members
      (b) abide by law
      (c) not to use membership in any malicious or illegal way
      (d) members were issued decals and membership cards.

  Fee: 25¢ - this paid for printing of cards, stickers, forms and information sheets.

- Hitchhiking Laws:

  Hitchhiking is now legal in the State of Colorado.

- Driver/Rider Matching:

  Drivers were issued a bright orange decal to be placed on right side of windshield.

  Riders were issued a bright orange card.

- Pickup/Dropoff Procedure:

  The city government provided signs for 40 stops around the city.

- Fare: Discount coupons for a food cooperative were given to drivers originally, but this incentive fell into disuse.

- Liability:

  The Colorado State Insurance Commission has ruled that drivers need not carry extra liability insurance if no fares are charged. There has been no ruling for a fare system.

- Regulation:

  PUC regulations do not apply to no-fare systems.

- Labor Issues: None.

- Promotion:

  Fact sheets were distributed to the public explaining that hitchhiking was illegal and how the Carpool worked.

- Administrative Costs:

  Approximately 25¢ per person.

7. Eugene/Springfield, Oregon

- System Description: RideStop

  This system was an interurban system developed by the Departments of Urban Planning and Architecture at the University of Oregon as a supplementary transportation system primarily for students attending the University of Oregon and Lane Community College. There were plans to expand the service to meet the needs of the general public but it fell into disuse before this was attempted. The system worked well until transit service was improved, which then proved more reliable than RideStop.

- Registration:

  RideStop was an informal system without licensing. Fear for personal safety, however, was a significant concern expressed by citizens.

- Hitchhiking Laws:

  Hitchhiking is legal in Oregon on all roads, including freeways. The only restriction is on obstruction of traffic.

- Driver/Rider Matching:

  At each school, there were two pickup stations, one with "Eugene" on it, the other with "Springfield." Ride Stop way stations (indicated by signs more often than shelters because of city objections to the shelters) were set up along heavily travelled routes convenient to student housing areas in the two cities.

- Pickup/Dropoff Procedure:

  At RideStop way stations indicated by signs and designed for safety.

- Fare: No fare.

- Liability:

  No fare riders were covered under driver's insurance policy the same as any other passenger.

- Regulation: PUC regulations do not apply to no-fare systems.

- Labor Issues: No UMTA funding.

- Promotion: Literature distributed on campuses.

- Administrative Costs: No information available.

8. Pittsburgh, Pennsylvania

- System Description: Courtesy Ride

  This was developed by Carnegie-Mellon University, Urban Systems Institute, to serve as an alternative transportation solution to transit strikes. It was used during a three-day strike in December 1976. The Golden Triangle Association (a trade association, primarily retailers in CBD) and the Pittsburgh Departments of City Planning and Public Works cooperated in establishing the system.

- Registration:

  There was no licensing and no identification.

- Hitchhiking Laws:

  Hitchhiking is legal in the Commonwealth of Pennsylvania and the City of Pittsburgh, as long as it is not on a roadway.

- Driver/Rider Matching:

  Riders hold up "C" sign with destination written on it. Drivers place "C" sign in their windows with destination written on it. CBD trips were the focus of the system.

- Pickup/Dropoff Procedure:

  Thirteen stations were designated at major CBD exits from the City. These were used for the evening rush hour. In the morning, riders were to stand at their usual bus stop with "C" sign. The 13 stations corresponded with the major routes feeding the CBD.
  The City Planning Department reviewed the sites and approved putting signs up to mark the stops.

- Fare: None.

- Liability:

  No insurance requirement. Pennsylvania's "no-fault" insurance legislation minimizes risk of ride-sharing.

- Regulation: PUC regulations do not apply to no-fare systems.

- Labor Issues: No UMTA funding.

- Promotion:

  A sheet with an explanation of how to use Courtesy Ride, a map showing designated pickup stations, and a "C" sign were widely distributed (200,000 copies) in the CBD area. These were also published in the two

major newspapers on the first day of the strike. Overhead signs marking the stations and the neighborhoods they served were hung by the City's Department of Public Works.

- Administrative Costs: No information.

9. Westport, Connecticut

- System Description:

  Three possible SRAT elements are being considered: use of SRAT to supplement fixed route services during the peak to alleviate overcrowding, use of SRAT service on new low-density routes in peak periods, and use of an SRAT system with drivers paid by the transit district to carry elderly or handicapped passengers. Final definition of SRAT alternatives will depend on a feasibility study currently being done; all information following is preliminary and tentative. The Westport Transit District would be the implementing agency. Implementation would not occur until mid-1978 at the earliest.

- Registration: Not defined.

- Hitchhiking Laws:

  Hitchhiking is legal if the person is standing off the roadway.

- Driver/Rider Matching:

  Riders stand at bus stops for fixed route services; all routes feed the commuter rail station and the town center. Elderly and handicapped service by telephone matching.

- Pickup/Dropoff Procedure:

  At bus stops for SRAT fixed routes; at-your-door for elderly and handicapped service.

- Fare:

  Same as transit system. Most riders ride on annual pass, so that the transit district would pay the SRAT drivers.

- Liability: Not yet investigated.

- Regulation:

  Transit district is local regulatory body in Connecticut.

- Labor Issues:

  All transit and taxi services are under management of transit district and employees will presumably be protected. SRAT will supplement existing services.

- Promotion: Not yet considered.

- Administration: Existing transit district management.

10. Northern Virginia

- System Description: CARTS

  This system is oriented toward long work trips from northern Virginia to the Washington, D.C., area. System is in planning stages.

- Registration:

  Required for both drivers and riders.

- Hitchhiking Laws:

  Vary by local jurisdiction; it is legal in Arlington and Alexandria, the two key areas.

- Driver/Rider Matching:

  Both parties have conspicuous color coded signs indicating general origin and destination.

- Pickup/Dropoff Procedure:

  On local streets at residential end of trip, and at employment center.

- Fare:

  Set by SRAT agency; $1 is the suggested level.

- Liability:

  Limited no-fault insurance exists in Virginia; SRAT system will recommend insurance limits.

- Regulation:

  SRAT qualifies for ride-sharing exemption from state regulation. Local regulation by transit district.

- Labor Issues: Not yet addressed.

- Promotion:

  System considered to be self-promoting.

- Administrative Costs:

  Estimated first year operating cost is $150,000, dropping to $50,000 annually thereafter. Administered by Northern Virginia Transportation Commission (NVTC), with review by the Governor's Council on Transportation.

APPENDIX B

Derivations of Equations Used in SRAT Route and Stop Analysis

1. SRAT Zone Size Analysis

This section discusses the tradeoffs between rider walk time, rider wait time, and driver time in determining a zone size for SRAT operations. It expands the summary discussion given in Section II.B.3. Several different operating policies are examined, through the use of simple analyses. Some component relationships required for the analysis are summarized below:

a. Average Rider Wait Time

Let W = average rider wait time (min.)

ρ = driver density (drivers/hour/(mi.^{2} at origin x mi.^{2} at destination))

A = zone area (mi.^{2})

$$W = 1/2 \cdot \frac{60}{\rho} \cdot \frac{1}{A^2}$$

$$= 30/\rho A^2$$

The "headway" of drivers between one square mile zones is $60/\rho$ minutes; this is multiplied by $1/A^2$ to find the "headway" of drivers between zones of area A; finally, the average wait time is assumed to be approximately half the headway.

b. Average Rider Walk Time

Let K = average rider walk time (min.).

For one stop per zone,

$$K \tilde{=} 1/2 \cdot 20 \cdot \sqrt{A} = 10\sqrt{A}$$

based on the theorem that the average distance from a random point in a rectangle to the center is half the average length of the sides. The average

Extra Driver Time Derivation

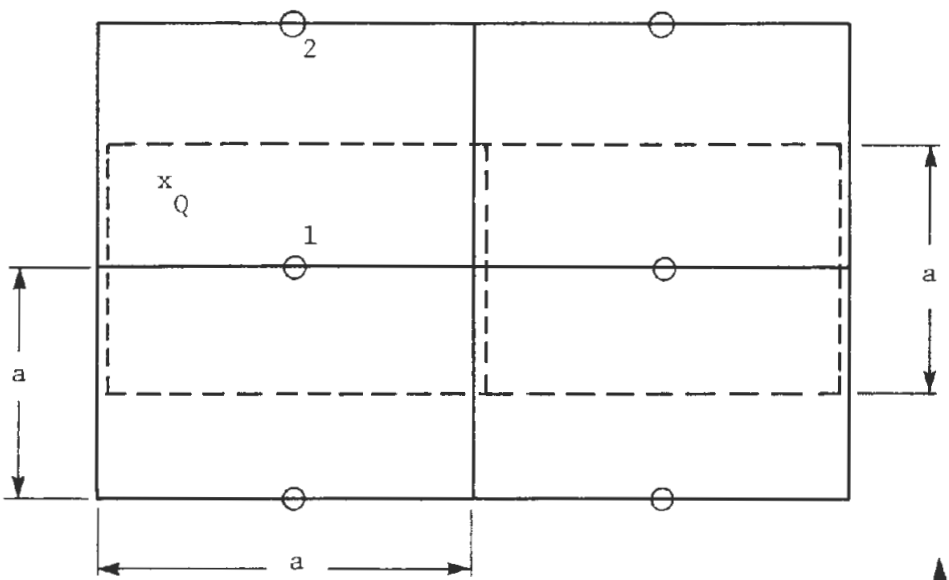


Figure B.1

driver zone boundaries

rider zone boundaries

Trips $_{A=a^2}$

length of a side is approximated by $\sqrt{A}$. Finally, to convert from distance to time, a factor of 20 minutes/mile (3 mph) is used.

For one route per zone,

$$K \tilde{=} 1/4 \cdot 20 \cdot \sqrt{A} = 5\sqrt{A},$$

based on the theorem that the average distance to one side of a rectangle is half the length of the other side. The length of the "other side" of the rectangle is $\frac{1}{2}\sqrt{A}$, approximately, since the route splits the zone into two such rectangles.

c. Driver Time Required for Pickup and Drop Off

Let T = extra driver time (min.)

For one stop per zone,

$$T \tilde{=} 0$$

Refer to Figure B.1

Assume that trips are being made in the direction shown by the arrow. Riders are assumed to walk to the nearest stop, regardless of the destination. Drivers go to the first stop in the direction of their destination, even if it is not the closest stop. Thus, a rider at point Q in the figure would walk to stop 1, while a driver from point Q heading north would go to stop 2.

For one route per zone, two alternative assumptions are possible. Figure B.2 shows a series of four SRAT zones. A driver going from Point A to point D could simply access the route at the closest points to A and D, and only serve trips between zones 2 and 3. In this case, T = 0. A second possibility is that the driver would backtrack to the south boundary of zone 1 and proceed all the way to the north boundary of zone 4 if he or she

had any passengers going that far. In this case the average extra distance is $\sqrt{A}$ both in the origin and destination zone, or $2\sqrt{A}$. At 20 mph, the extra time is $6\sqrt{A}$ minutes. Thus,

$$T \tilde{=} 6\sqrt{A}$$

in this second case.

For the multiple stops per zone, yet a third derivation of driver time is required. Figure B.3 represents this case for two sample zones.

Let N = number of stops in a zone

M = maximum walk distance for riders (mi.)

Then $N = (\frac{A}{2M})^2$

Figure B.3 shows the number of stops that result when M = 1/4 mile, the usual "walk refusal" distance for transit riders. Drivers originating or terminating in each zone are required to pass by each stop to look for or drop off riders if required.

$$T \tilde{=} 6A,$$

based on graphical analysis. (Rider wait times are based on the total zone size A, and average rider walk time is simply 0.5 · 20M, or 10 M minutes.)

d. Summary of Derivations

	(Walk) K	(Wait) W	(Driver) T
One Stop	$10\sqrt{A}$	$30/\rho A^2$	0
One Route	$5\sqrt{A}$	$30/\rho A^2$	0 or $6\sqrt{A}$
Multiple Stops	10M	$30/\rho A^2$	6A

All times are in minutes.

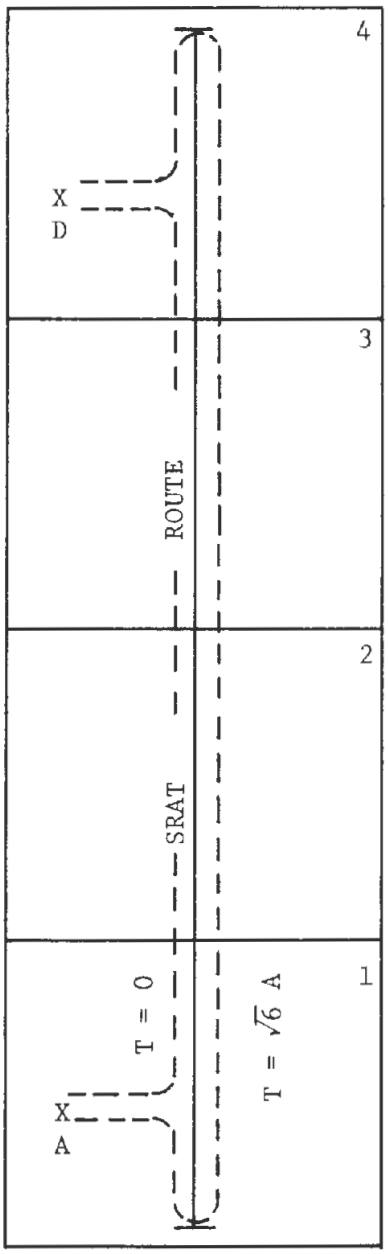
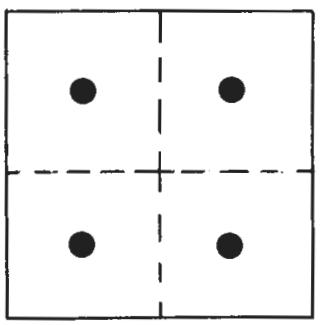


Figure B.2

Different SRAT Route Operating Rules and Their Effect On Drivers' Time

A = 1
N = 4



A = 4
N = 16

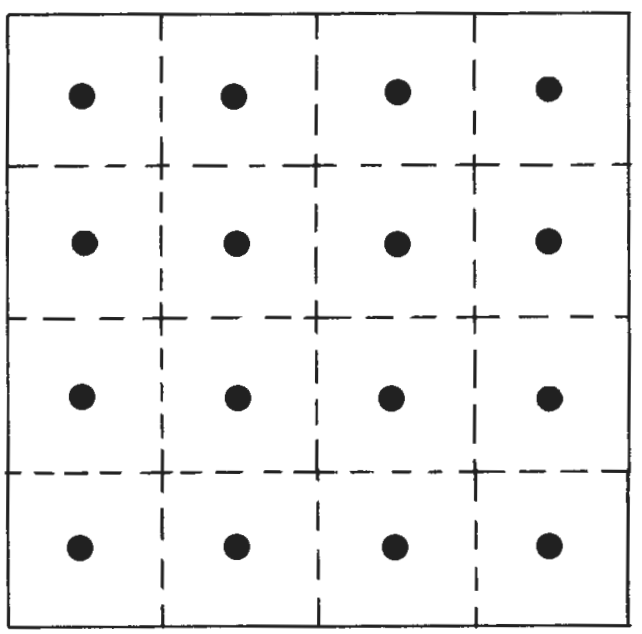


Figure B.3

Examples of SRAT Zones With Multiple SRAT Stops

An analysis of several SRAT matching options is presented next to find the optimum zone size for each, and the wait, walk, and extra driver times it produces.

Option 1 - One stop per zone, equal weighting of rider wait and walk time

We wish to choose the zone size that minimizes the sum of rider wait and walk times. (Driver time for one stop per zone systems is zero, so it need not be considered in general.*) Wait and walk times will be weighted equally; thus, c(K) = c(W) in the notation of Chapter 2. This equation is then written as:

$$\min Z = \frac{30}{\rho A^2} + 10\sqrt{A}$$

The minimum is achieved at $A^* = (\frac{12}{\rho})^{0.4}$, and Table B.1 shows the wait and walk times that result. Figure B.4 graphs these times. As can be seen, fairly long average walk times result from this option. The maximum walk time is twice the average walk time, both of which are probably unacceptable to most users.

Option 2 - One stop per zone, quadratic weighting on rider walk time

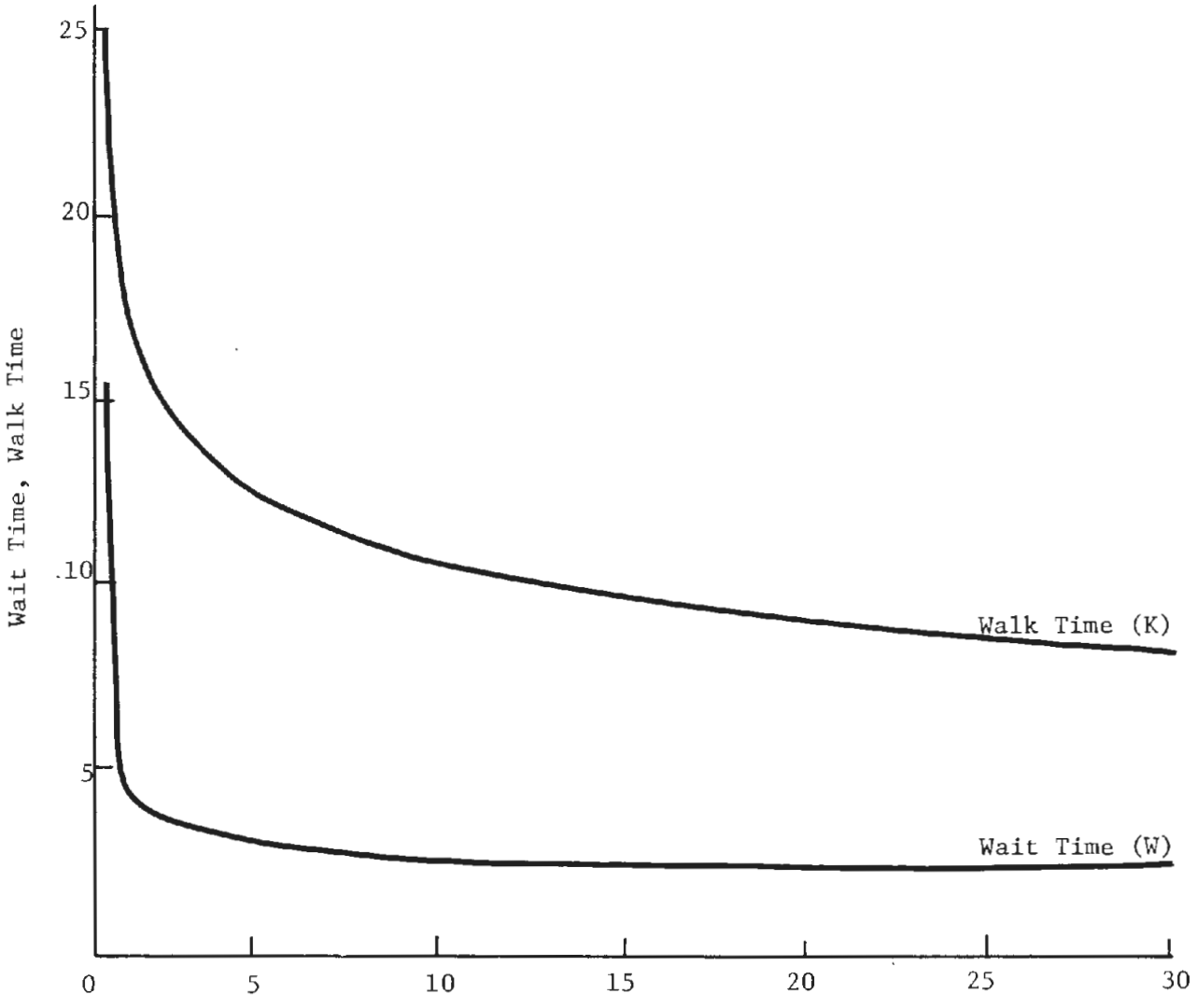
This option weights the walk time proportionally to itself - a ten minute walk is weighted twice as much as a five minute walk, or is four times as onerous in total, etc. A one minute walk is weighted the same as a one minute wait to establish the basis of the weighting scheme.

*Backtracking could be required, but is not analyzed in this case.

Table B.1

Supply Analysis - Option 1

ρ (drivers/hr/mi^4)	A* (mi^2)	W (min.)	K (min.)
0.1	6.8	6.5	26.1
0.5	3.6	4.6	19.0
1.0	2.7	4.1	16.4
5.0	1.4	3.1	11.8
10.0	1.1	2.5	10.5
20.0	0.8	2.3	8.9
50.0	0.6	1.7	7.7



Supply Option 1

Figure B.4

This option is formulated in response to the very high walk times that resulted in option 1. In this case, the equation is

$$\min Z = \frac{30}{\rho A^2} + (10\sqrt{A})^2$$

Z is minimized at $A^* = (\frac{3}{5\rho})^{1/3}$. The wait and walk times that emerge are shown in Table B.2 and Figure B.5. The areas are much smaller than those in option 1, and the walk times are much more acceptable; however the wait times are high.

Option 3 - One route per zone, quadratic weighting of rider walk time

In this alternative, riders can hail an SRAT vehicle along a single designated route through the zone, instead of having to walk to only a single stop. The extra driver time to cover the entire SRAT route in the origin and destination zones is included in this option, and is weighted half as heavily as rider wait time*, based on typical planning practice. Thus, the equation is

$$\min Z = \frac{30}{\rho A^2} + (5 \quad A \quad)^2 + 3 \quad A$$

A* is approximately given as $(\frac{12}{5\rho})^{1/3}$. Table B.3 shows the results. Walk times are acceptable at the higher driver densities, and wait times are reasonably short as well, though not instantaneous. This alternative may require some effort on the driver's part to follow the SRAT route and even possibly extend his or her trip at the origin or destination. Presumably, the driver can be compensated for this to gain his or her participation.

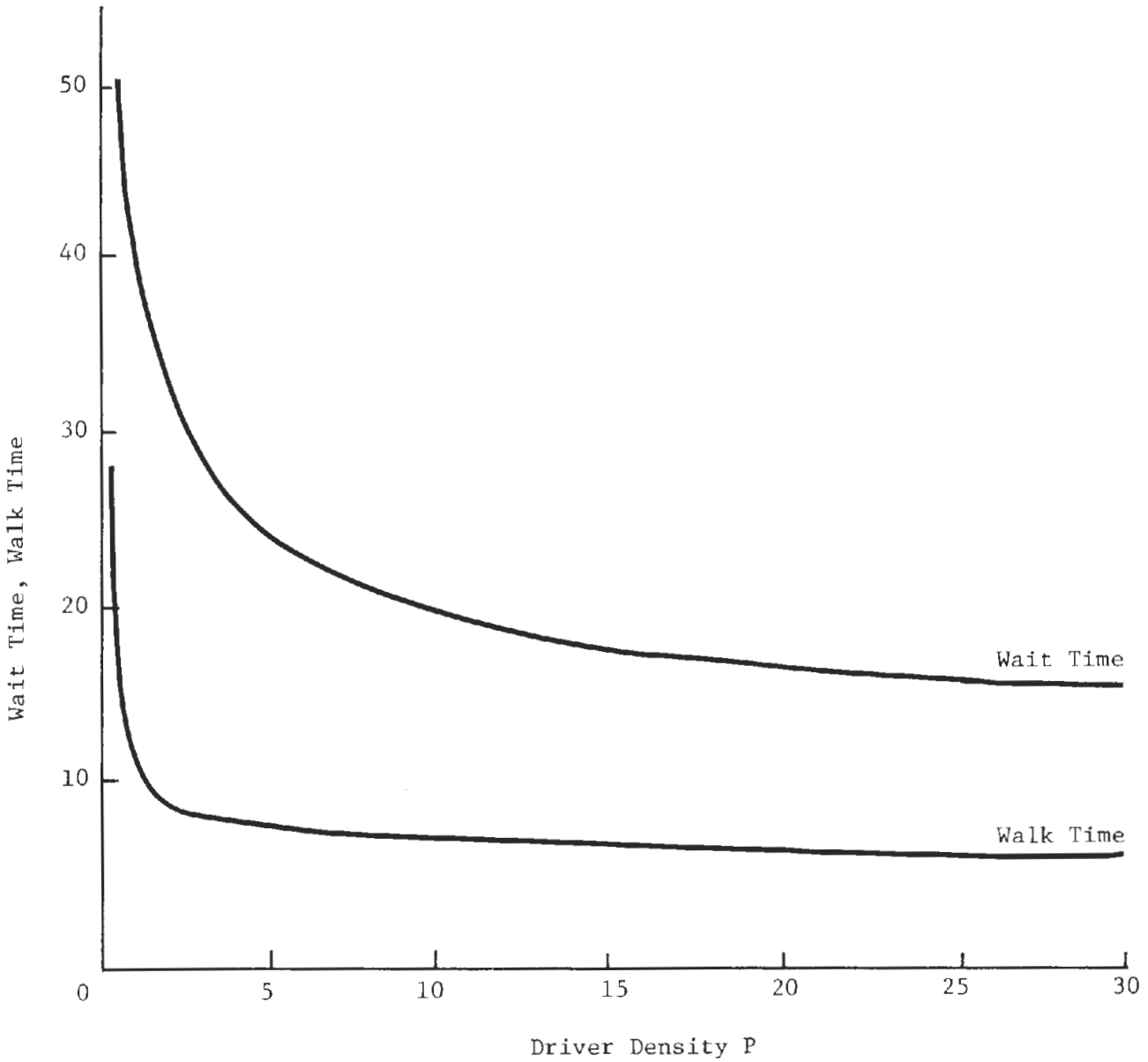
---

*This is an exception to the weighting used in Option 4 and reported in Chapter 2, for this case only. For case 3, then, c(T) = 0.5.

Table B.2

Supply Analysis - Option 2

ρ	A*	W	K
0.1	1.8	92.6	13.4
0.5	1.1	50.0	10.5
1.0	0.8	46.9	8.9
5.0	0.5	24.0	7.1
10.0	0.4	19.4	6.3
20.0	0.3	16.7	5.5
50.0	0.2	15.0	4.5



Supply Option 2

Figure B.5

Table B.3

Supply Analysis - Option 3

ρ	A*	W	K
0.1	2.9	35.7	8.5
0.5	1.7	20.8	6.5
1.0	1.3	17.8	5.7
5.0	0.8	9.4	4.5
10.0	0.6	8.3	3.9
20.0	0.5	6.0	3.6
50.0	0.4	3.8	3.2

A fare level of about 7¢/minute (for a $16,000 annual income) is required if value of time considerations are used. Since service level appears to be a more critical issue than cost in SRAT at this point in the analysis, we will assume that drivers do extend their trips as needed to the zone boundaries along the route.

Option 4 - Multiple stops per zone, equal weighting of extra driver time and rider wait time

The equation for Option 4 is:

$$\min Z = \frac{30}{\rho A^2} + 6A$$

The optimum area A* is given by $(\frac{10}{\rho})^{1/3}$. Table B.4 shows the wait, walk, and extra driver times. The fares required to compensate drivers for their time* at 7¢ per minute vary from $1.93 (27.6 minutes) to 25¢ (3.6 minutes); these can be split over the expected number of riders.

Option 4 provides the best service level of riders of any option examined, but at the expense of some extra driver time. As stated in Chapter 2, it cannot be used with intermediate stops.

2. Effect of Intermediate Stops on SRAT Service

Average driver density ρ is given in Table 5 in Chapter 2 for eight sample cities. It was computed assuming a completely uniform trip end density, which is, of course, not a totally realistic assumption. In this section, the effects of trip length distributions and intermediate drop-offs and pick-ups by drivers are estimated in approximate ways.

*In addition to sharing operating costs.

Table B.4

Supply Analysis - Option 4

ρ	A*	W	K	T
0.1	4.6	14.2	2.5	27.6
0.5	2.7	8.2	2.5	16.2
1.0	2.2	6.2	2.5	13.2
5.0	1.3	3.6	2.5	7.8
10.0	1.0	3.0	2.5	6.0
20.0	0.8	2.3	2.5	4.8
50.0	0.6	1.7	2.5	3.6

The driver densities ρ that emerge from Table 5 are unexpectedly low, and they indicate that ways of increasing the effective density of SRAT rides available to riders must be explored. Table B.5 summarizes the maximum ρ values in each sample city.

The first way to increase the ride density (denoted R) above the driver density ρ is to have drivers handle intermediate trips to their trip. A single driver trip can handle many rider O-D pairs, thus multiplying the effective amount of service. For an example, see Figure B.6. A driver trip from zone 1 to zone 4 serves the following O-D pairs:

Length of Trip	O-D Pairs Served
1	1-2, 2-3, 3-4
2	1-3, 2-4
3	1-4

In general, the number of O-D pairs B served by a trip traversing N zones is

$$B(N) = N(N-1)/2$$

The number of rides E of length C (number of zones traversed) offered by this single driver trip is:

$$E(C) = N-C$$

Thus, in the example, N = 4, and the number of rides offered that traverse one zone is (N-C), or 3, etc.

The second factor that affects ride density R is the trip length distribution of driver trips. We assume uniform participation (though not necessarily 100%) by drivers, regardless of trip length, for this analysis. The work trip length distribution is assumed to have a gamma distribution.

Table B.5

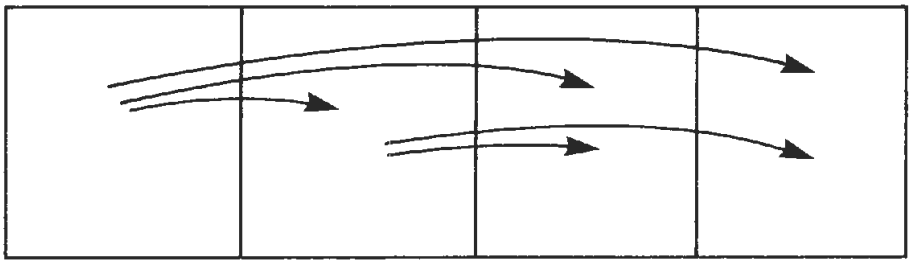
Maximum Driver Densities in Sample Cities

City	Maximum ρ Values to: CBD*	Central City	SMSA
Boston	28	3.8	0.15
St. Louis	32	8.7	0.7
Louisville	76	4.3	1.4
Seattle	54	7.5	0.5
Stockton	-	12.0	3.9
Fall River	17	3.5	0.7
Oklahoma City	15	0.5	0.4
Colorado Springs	-	5.7	0.9

*Assumes 1 mi.^{2} CBD for all cities.

Figure B.6

O-D Pairs Served By Single Driver Trip



The cumulative distribution function is given by:

$$F(L) = 1 - (1 + 2L/\bar{L})e^{-2L/\bar{L}}$$

where $F(L)$ = proportion of trips whose length is less than or equal to L

$\bar{L}$ = average trip length (miles)

Table B.6 shows the proportion of work trips in each distance category.

The column labelled "popularity" gives the ratio of the density of driver trips of length L to the area-wide driver trip density ρ. It is derived by comparing the proportion of trips in a category to the proportion of land area in a category:

$$P = \frac{f(L_1, L_2)}{\frac{\pi(L_2^2 - L_1^2)}{\pi L_{max}^2}}$$

where P = "popularity"

$f(L_1, L_2)$ = proportion of trips of length between L_1 and L_2

L_{max} = maximum trip length in region (assumed to be $3.0\bar{L}$)

The column labelled ride density factor (RF) is the ratio of rides supplied at this trip length to driver ride density ρ. Thus, if ρ = 5 and RF(L) = 50, there are 250 rides/hr./mi.^{4} offered at trip length L.

Table B.6 is worked out for zones of dimension $(0.1\bar{L})^2$. If $\bar{L}$ = 5, zone size is about 0.25 mi.^{2}. Table 8 in Chapter 2 shows the same computation for zones of size $(0.2\bar{L})^2$. If $\bar{L}$ = 5, zone size is about one square mile. In both tables, the zone-to-zone ride density is about the same.

Table B.6
Effect of Intermediate Stops on SRAT Service

Trip Length	Proportion of Total Trips	Cumulative Prop. of Trips	Popularity	Ride Density
0-0.1$\bar{L}$	.017	.017	15.3	452.
0.1-0.2$\bar{L}$	.045	.062	13.5	365.
0.2-0.3$\bar{L}$	.060	.122	10.8	293.
0.3-0.4$\bar{L}$	.069	.191	8.9	235.
0.4-0.5$\bar{L}$	.073	.264	7.3	187.
0.5-0.6$\bar{L}$	.073	.337	6.0	148.
0.6-0.7$\bar{L}$	.071	.408	4.9	117.
0.7-0.8$\bar{L}$	.067	.475	4.0	92.
0.8-0.9$\bar{L}$	.062	.537	3.3	71.
0.9-1.0$\bar{L}$	.057	.594	2.7	55.
1.0-1.1$\bar{L}$	.051	.645	2.2	41.
1.1-1.2$\bar{L}$	.047	.692	1.8	31.
1.2-1.3$\bar{L}$	.041	.733	1.5	23.
1.3-1.4$\bar{L}$	.036	.769	1.2	16.
1.4-1.5$\bar{L}$	.032	.801	1.0	11.
1.5-1.6$\bar{L}$	.028	.829	0.8	7.
1.6-1.7$\bar{L}$	.024	.853	0.65	4.5
1.7-1.8$\bar{L}$	.021	.874	0.54	2.5
1.8-1.9$\bar{L}$	.019	.893	0.46	1.2
1.9-2.0$\bar{L}$	.015	.908	0.35	0.4
2.0-2.5$\bar{L}$	.052	.960	0.21	-
2.5-3.0$\bar{L}$	.023	.983	0.08	-
> 3.0$\bar{L}$	.017	1.000	-	-

*Assumes all trips use arterials only; no expressways considered.

A third factor affecting ride density is the use of expressways. The portion of a driver trip that is on an expressway cannot generally be used for rider pickup or dropoff, and thus, driver trips cannot serve intermediate stops while on the expressway. This reduces the number of O-D pairs served on a trip, which in turn reduces the ride density R. Data from five of the sample cities indicates that 23% of all VMT is on expressways. Another 10% of all VMT occurs on collector streets, many of which will not be used for SRAT pickup or dropoff regularly. Thus, about 30% of the average trip may not be available for SRAT pickup or dropoff. Without knowing the expressway use as a function of trip length (which does not appear to be available), it is not possible to quantify this effect accurately. If we assume all trips use an expressway for 30% of their length, the number of O-D pairs served as a ratio of the number served if all intermediate O-D's were served is:

$$C = \frac{0.7N(0.7N-1)/2}{N(N-1)/2}$$

$$= \frac{0.49N-0.7}{N-1}$$

$$\approx 0.5$$

Thus, the ride densities shown in Tables B.6 and 8 must be cut in half to account for expressway usage.

A final factor affecting ride density R is the area served by SRAT. There are possible economies of scale in SRAT operations if a region-wide system could be set up. Restriction of SRAT to only subareas can substantially reduce the ride density R even in the areas designated for SRAT operation. Certain trips within any subarea may have been served as inter-

mediate points on longer trips only passing through the subarea. If these drivers would continue to participate in SRAT only in the area in which it is set up, ride density would not be affected. However, if these drivers choose not to participate (as is likely), ride density can decrease dramatically.

The ride density can vary between the following limits in any subarea:

$$R_{min} = P \cdot \rho \cdot DP$$

$$R_{max} = R \cdot \rho \cdot DP$$

where R_{min}, R_{max} = minimum and maximum ride densities

P = "popularity" (Tables B.6 and 8)

R = ride density factor (Tables B.6 and 8)

ρ = driver density

DP = driver participation rate in SRAT ($0 \leq DP \leq 1.0$).

To maximize the ride density in any subarea, the following should hold:

- the area should be as self-contained as possible (lowest percentage of external trips)
- arterials rather than expressways should be primary highway facilities in the area
- few internal rider trips should be very long in proportion to the area, as their expected service level is quite poor

It is likely to be quite difficult to find self-contained areas; an approximate guess as to the reduction in ride density for large subareas (i.e., 10% of the region) is 50% of R_{max}. This reduction in ride density from the level R_{max} in smaller areas may well be proportionally greater.